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Physico-chemical analysis of upper lake water in Bhopal region of Madhya Pradesh, India

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ABSTRACT

Lake water samples were collected from thirteen (15) locations during pre and post monsoon season. The physico-chemical parameters such as pH, Total hardness, Ca hardness, Mg hardness, Ca content, Mg content, Chloride, BOD and COD were analyzed to know the present status of the lakewater quality. Lake water quality of pre-monsoon season was better than post monsoon season. The upper lake water requires appropriate water treatment measures prior to be used for drinking purpose.

Key words: Lake water, physico-chemical parameters, Bhojtal, drinking water.

INTRODUCTION

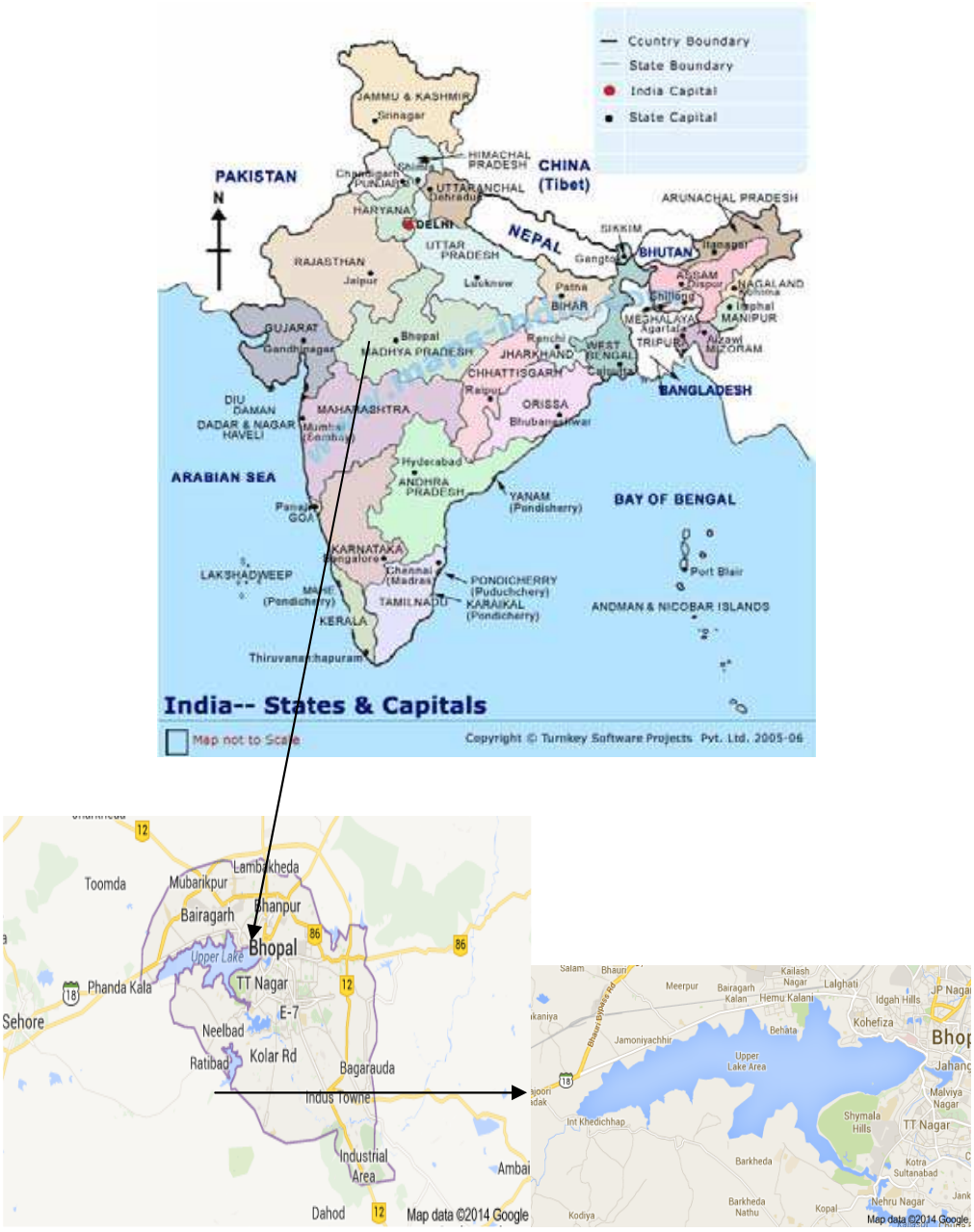
Bhojtal, formerly known as Upper Lake is a large lake which lies on the Western side of the capital city of Madhya Pradesh, Bhopal. It is a major source of drinking water for the residents of the city, serving around 40% of the residents with nearly 30 million imperial gallons (140,000 m^3) of water per day.

Bhojtal is situated on the west central part of Bhopal city and is surrounded by Van Vihar National Park on the south, human settlements on the east and north, and agriculture fields on the west. It has an area of 31 km^2, and drains a catchment or watershed of 361 km^2. The watershed of the Upper Lake is mostly rural, with some urbanized areas around its eastern end. The Kolans was formerly a tributary of the Halali River, but with the creation of the lake using an earthen dam and a diversion channel, the upper reach of the Kolans River and Bada Talaab now drain into the Kaliasote River. It is the largest artificial lake in Asia.

Correlation Matrix:

The correlation matrix of n random variables X_1, ..., X_n is the n . n matrix whose i,j entry is corr(X_i, X_j). If the measures of correlation used are product-moment coefficients, the correlation matrix is the same as the covariance matrix of the standardized random variables X_i / σ (X_i) for i = 1, ..., n. This applies to both the matrix of population correlations (in which case "σ" is the population standard deviation), and to the matrix of sample correlations (in which case "σ" denotes the sample standard deviation). Consequently, each is necessarily a positive-semidefinite matrix.

The correlation matrix is symmetric because the correlation between X_i and X_j is the same as the correlation between X_j and X_i.



SAMPLE COLLECTION:

The sampling locations consist of upper lake area. Lake water samples were collected from thirteen (15) locations during pre and post monsoon season. Samples were collected in plastic container to avoid unpredictable changes in characteristic as per standard procedure (APHA, 1998).

PHYSICO-CHEMICAL ANALYSIS OF UPPER LAKE WATER:

The collected samples were analyzed for different physico-chemical parameters such as Total alkalinity, Carbonet alkalinity, Bi-Carbonet alkalinity, Total hardness, Ca hardness, Mg hardness, Ca content, Mg content, Chloride,Phosphate,Total Phosphorus, Org. Phosphorus, Nitrate, BOD and COD as per the standard methods (APHA, 1998).

RESULTS AND DISCUSSION

The water quality analysis of different locations of Lake water samples have been carried out for Total alkalinity, Carbonet alkalinity, Bi-Carbonet alkalinity, Total hardness, Ca hardness, Mg hardness, Ca content, Mg content, Chloride, Phosphate,Total Phosphorus, Org. Phosphorus, Nitrate, BOD and COD. The status of water quality of these lake water sources are presented in table 1 and 2.

The mean COD to BOD ratio (36.0/4.75 = 7.58) of the lake water was found below 10.0, which indicates the abundance of biodegradable substances in the water.

Total alkalinity value of lake water samples varied between 42 to 114 and 46 to 90 during pre and post monsoon season respectively. The Total alkalinity value of Bhadbhada area lake water was found to be 114. Chloride in all samples are below the standard desirable limit. Total hardness in all the samples were found to be within the limit except some areas such as Bhadbhada in which the quality of water is hard and in Spill chanel water quality is moderately hard . Values are slightly higher in post monsoon than pre monsoon season. In few samples the magnesium contents have crossed the standard limit (IS: 10500) during post monsoon season. Nitrate concentrate has crossed the stanadrad limit at Betha and Spil Chanel in both pre and post moonsoon. Dissolved Phosphates are under the desirable limits.Therefore, the upper lake water requires appropriate water treatment measures prior to be used for drinking purpose.

Table 1. Water Quality at different locations of Upper Lake in pre-moonsoon seasons (Laboratory Analysis) Units mg/l

St.Name & No.	Layer	Total Alkalinity	Carbonate alkalinity	Bi-Carbonatealkalinity	Total Hardness	Ca hardness
KOLANS	Surface	52	8.0	44.0	76.0	50.4
BHORI	Surface	48	10	38.0	82.0	52.5
BETHA.	Surface	46	16	30.0	84.0	46.2
BAIRAGARH	Surface	42	20	22.0	80.0	48.3
BAIRAGARH EAST	Surface	52	24	28.0	78.0	50.4
KHANUGAU	Surface	56	18	38.0	72.0	52.5
KARBALA (U/7)	Surface	82	22	60.0	80.0	63.0
MEDICAL COLLEGE	Surface	72	24	48.0	82.0	67.2
KAMLA PARK	Surface	70	12.0	58.0	86.0	69.3
YATCH CLUB	Surface	46	12.0	34.0	76.0	54.6
BAN VIHAR	Surface	64	16.0	48.0	78.0	60.9
SPILL CHANEL	Surface	92	14.0	78.0	108.0	75.6
BHADBHADA	Surface	114	10.0	104.0	152.0	109.2
STUD FARM	Surface	56	20.0	36.0	78.0	58.8
BISENKHEDI	Surface	60	24.0	36.0	80.0	54.6

Mg hardness	Calcium content	Magnesium content	Chloride	Phosphate	Total Phosphorus	Org.Phosphorus	Nitrate	BOD	COD
25.6	21.2	6.2	16.98	0.838	1.360	0.522	0.590	6.4	40.0
29.5	22.1	7.2	14.99	0.710	1.472	0.762	0.810	5.2	36.0
37.8	19.4	9.2	13.99	0.270	1.890	1.620	1.859	6.4	44.0
31.7	20.3	7.7	14.99	0.587	1.648	1.061	0.641	6.8	32.0
27.6	21.2	6.7	14.99	0.493	1.648	1.155	0.670	4.8	28.0
19.5	22.1	4.7	12.99	0.236	1.657	1.421	0.467	4.8	36.0
17.0	26.5	4.1	14.99	0.460	1.888	1.428	0.476	4.8	24.0
14.8	28.2	3.6	15.98	1.217	1.657	0.440	0.520	4.4	28.0
16.7	29.1	4.1	17.98	0.249	1.146	0.897	0.572	4.0	44.0
21.4	22.9	5.2	14.99	0.739	1.648	0.909	0.089	3.6	32.0
17.1	25.6	4.2	12.99	0.710	1.888	1.178	0.840	3.6	28.0
32.4	31.8	7.9	14.99	1.272	3.594	2.322	1.643	4.0	32.0
42.8	45.9	10.4	34.97	3.148	4.046	0.898	0.310	4.4	72.0
19.2	24.7	4.7	13.99	0.310	1.557	1.247	0.470	4.0	36.0
25.4	22.9	6.2	14.99	0.180	1.561	1.381	0.771	4.0	28.0

Table 2. Water Quality at different locations of Upper Lake in post-moonsoon seasons (Laboratory Analysis) Units mg/l

St.Name & No.	Layer	Total Alkalinity	Carbonate alkalinity	Bi-Carbonatealkalinity	Total Hardness	Ca hardness	Calcium content
KOLANS	Surface	54	20	34	100	73.5	30.9
BHORI	Surface	52	16	36	90	63.0	26.5
BETHA.	Surface	50	24	26	92	60.9	25.6
BAIRAGARH	Surface	46	20	26	100	60.9	25.6
BAIRAGARH EAST	Surface	56	26	30	96	58.8	24.7
KHANUGAU	Surface	50	22	28	100	63.0	26.5
KARBALA	Surface	60	24	36	94	52.5	22.1
MEDICAL COLLEGE	Surface	62	24	38	96	65.1	27.3
KAMLA PARK	Surface	64	28	36	88	54.6	22.9
YATCH CLUB)	Surface	66	10	56	70	48.3	20.3
BAN VIHAR	Surface	64	12	52	80	60.9	25.6
SPILL CHANEL	Surface	68	4	64	118	73.5	30.9
BHADBHADA	Surface	90	abs	90	180	126.0	52.9
STUD FARM	Surface	54	24	30	90	63.0	26.5
BISENKHEDI	Surface	58	18	40	84	65.1	27.3

Mg hardness	Calcium content	Magnesium content	Chloride	Phosphate	Total Phosphorus	Org. Phosphorus	Nitrate	BOD	COD
26.5	30.9	6.4	23.98	0.837	1.356	0.519	0.580	3.2	14.0
27.0	26.5	6.6	19.98	0.709	1.468	0.759	0.800	4.8	10.0
31.1	25.6	7.6	21.98	0.269	1.886	1.617	1.849	5.0	20.0
39.1	25.6	9.5	25.97	0.586	1.644	1.058	0.631	3.6	12.0
37.2	24.7	9.0	20.98	0.492	1.644	1.152	0.660	3.6	18.0
37.0	26.5	9.0	19.98	0.235	1.653	1.418	0.457	3.4	14.0
41.5	22.1	10.1	18.98	0.459	1.884	1.425	0.466	3.2	10.0
30.9	27.3	7.5	17.98	1.216	1.653	0.437	0.510	4.0	10.0
33.4	22.9	8.1	18.98	0.248	1.142	0.894	0.562	3.6	10.0
21.7	20.3	5.3	19.98	0.738	1.644	0.906	0.079	4.0	22.0
19.1	25.6	4.6	15.98	0.709	1.884	1.175	0.830	4.0	14.0
44.5	30.9	10.8	20.98	1.271	3.590	2.319	1.633	5.0	20.0
54.0	52.9	13.1	38.96	3.147	4.042	0.895	0.300	18.0	28.0
27.0	26.5	6.6	19.98	0.309	1.553	1.244	0.460	4.4	10.0
18.9	27.3	4.6	21.98	0.179	1.557	1.378	0.761	4.0	8.0

Table 3. Pearson Correlation Matrix for pre- moonsoon

	TA	CA	BI	THA	CAH	MGH	CAC	MGC	CHL	PH	TPH	ORG	NITR	BOD	COD
TA	1.000														
CA	-0.132	1.000													
BI	0.966	-0.383	1.000												
THA	0.830	-0.36	0.868	1.000											
CAH	0.938	-0.278	0.947	0.916	1.000										
MGH	0.210	-0.340	0.284	0.656	0.298	1.000									
CAC	0.939	-0.279	0.948	0.916	1.000	0.299	1.000								
MGC	0.210	-0.342	0.285	0.657	0.300	1.000	0.301	1.000							
CHL	0.712	-0.391	0.765	0.906	0.859	0.540	0.858	0.539	1.000						
PH	0.753	-0.38	0.801	0.905	0.866	0.526	0.866	0.525	0.885	1.000					
TPH	0.808	-0.242	0.816	0.896	0.802	0.625	0.803	0.625	0.667	0.821	1.000				
ORG	0.198	0.192	0.134	0.107	0.006	0.243	0.007	0.244	-0.256	-0.174	0.420	1.000			
NITR	-0.034	-0.017	-0.028	0.044	-0.171	0.426	-0.171	0.431	-0.278	-0.160	0.227	0.646	1.000		
BOD	-0.410	-0.093	-0.358	-0.146	-0.415	0.433	-0.414	0.428	-0.064	-0.117	-0.189	-0.139	0.280	1.000	
COD	0.481	-0.595	0.603	0.794	0.671	0.627	0.672	0.627	0.868	0.698	0.544	-0.171	-0.062	0.105	1.000

Table 4. Pearson Correlation Matrix for post-moonsoon

	TA	CA	BI	THA	CAH	MGH	CAC	MGC	CHL	PH	TPH	ORG	NITR	BOD	COD
TA	1.000														
CA	-0.455	1.000													
BI	0.852	-0.854	1.000												
THA	-0.170	-0.047	-0.072	1.000											
CAH	-0.148	-0.249	0.060	0.683	1.000										
MGH	-0.105	0.149	-0.149	0.782	0.079	1.000									
CAC	-0.151	-0.251	0.059	0.686	1.000	0.082	1.000								
MGC	-0.110	0.149	-0.152	0.779	0.074	1.000	0.077	1.000							
CHL	-0.604	0.048	-0.381	0.364	0.311	0.231	0.312	0.232	1.000						
PH	0.454	-0.564	0.597	0.375	0.414	0.158	0.414	0.153	-0.104	1.000					
TPH	0.398	-0.671	0.628	0.587	0.390	0.468	0.392	0.468	-0.027	0.539	1.000				
ORG	0.139	-0.383	0.307	0.421	0.159	0.438	0.162	0.441	0.044	-0.092	0.789	1.000			
NITR	-0.052	-0.239	0.110	0.466	0.455	0.247	0.456	0.248	0.159	0.124	0.615	0.636	1.000		
BOD	0.094	-0.435	0.311	0.087	0.251	-0.096	0.252	-0.089	-0.085	0.229	0.500	0.425	0.696	1.000	
COD	0.203	-0.451	0.384	0.059	-0.074	0.143	-0.071	0.143	0.111	0.263	0.481	0.377	0.364	0.305	1.000

TA: Total Alkalinity, CA: Carbonate Alkalinity, BI: Bi-Carbonate Alkalinity, THA: Total Hardness, CAH: Ca Hardness, MGH: Mg Hardness, CAC: Ca Content, MGC: Mg Content, CHL: Chloride, PH: Phosphate, TPH: Total Phosphoras, ORG: Organic Phosphoras, NITR: Nitrate, BOD : Biological Oxigen Demand, COD: Chemical Oxigen Demand.

Correlation matrix was prepared within the studied parameters in pre and post monsoon season and tabulated in Table 3 and 4 respectively. It shows very week positive co- relationship between COD and BOD. There are no co-relationship between Ca hardness and Organic Phosphoras and also between Ca contents and Organic Phosphoras. There are highly positive co-relationship between Total alkalinity and Bi-Carbonate alkalinity.

CONCLUSION

In general ground water quality of upper lake region is not harmful to human beings. Except for some parameters which were crossed prescribed limits of drinking water (IS: 10500). The reason behind this may be due to industrial and mining activities, weathering and erosion of bed rocks. Most of parameters showed analogous trend in seasonal variation. The values are comparatively high in post monsoon. It indicates that the extent of pollution occurred due to mining, industrial discharge, domestic discharge and other anthropogenic.

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