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Limnological studies of lower lake of Bhopal, India

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Abstract: **Limnological studies of lower lake include comparison of water quality parameters of two different sites of the lower lakes namely Kali Mandir and Neelam Park in every month at surface and bottom level of lower lake, Bhopal during 2012. Water sample collected were analyzed for their limnological characters viz. temperature, pH, conductivity, total hardness, TDS, DO, BOD, COD, total alkalinity, chloride, sulphate and nitrate. Data obtained from these analyses were analyzed and it reveals that quality of lower lake water changes and need proper monitoring.**

Keywords: **Limnological, lower lake, conductivity, total hardnesss, total alkalinity**

I. Introduction

Water is the most essential requirement of life. It is essential for our daily life, for growth and involved in a number of biological processes. Surface water is generally available in Rivers, lakes, ponds and dam is used for drinking, irrigation and power supply etc. Water is one of the abundantly available substances in nature, which man has exploited more than any other resources for the sustenance of life. Water resources in India have reached a point of crisis due to improper urbanization and industrialization [1],[2]. Water of good quality is required for living organisms. Now days fresh water has become a rare commodity due to over exploitation and pollution [3],[4].

Although water covers about 2/3rd of earth surface, however, only 1% of the water resource is available as fresh water. Most water bodies are contaminated due to incorporation of different pollutants [5]. Water quality parameter provides the basis for judging the suitability of water for its different uses [6]. Therefore, it has become obligatory to analyze the important water parameters of water bodies in regular interval of time. Keeping in view the above facts, an attempt has been made to examine the suitability of lower lake water for drinking and irrigation purposes.

Study Area

The Lower Lake or Chhota Talaab is a lake in Bhopal, the capital of Madhya Pradesh state of India. Along with the Upper Lake, it forms the Bhoj Wetland. The Lower Lake is located to the east of the Upper Lake. An earthen dam separates the two lakes. The two lakes are built in a terraced manner, the lowest level of the Upper Lake is just below the highest level of the Lower Lake.The Lower Lake has an area (water spread) of 1.29, and its catchment area is 9.6 km^2. The lake receives subsurface seepage from the upper lake. The lower lake is surrounded by human settlements from all sides. Pollution is one of the major problems of the lower lake. Day by day the quality of water is depleting in the lower lake. The water in lower lake is much more polluted than upper lake. It is an eutrophic lake where the amount of nutrient is very high and oxygen depletion is very prominent.

Fig. 1 Lower Lake Bhopal, Madhya Pradesh, India

II. Methods and Methodology

In the present communication water quality of lower lake was assessed to evaluate the degree of pollution caused due to input of toxic as well as domestic wastewater from its catchment. The physico-chemical study includes comparison of water quality parameter in two different sites of the lower lake namely Kali mandir as S1 and Neelam park as S2 during the year 2012. The water samples are collected in clean polythene containers in morning. The temperature and pH of water samples were recorded at the site itself. All other parameters such as electrical conductivity, TDS, BOD, and COD are analyzed by standard methods [7]. Alkalinity, total hardness, chloride, nitrate and sulphate are analyzes by Spectrophotometer method.

Water Temperature

The water temperature was measured by using a mercury thermometer graduated up to 100 ^{o}C with an accuracy of 0.1 – 0.2 ^{o}C.

Turbidity

The turbidity was determined by turbidity meter (Systronic, model no.135). Results were expressed as JacksonTurbidity Unit (JTU).

Conductivity

Conductivity of the samples was measured by using conductivity meter (Systronics, model no. 306) having a conductivity cell containing platinum electrode.

TDS

TDS was determined by TDS meter, which gives reading directly in mg/L

pH

pH was measured by water analysis kit by using hydrogen ion selective electrode.

Dissolved oxygen

It acts as an indicator of water quality, tropic status and magnitude of eutrophication. It is measured by Winkler's method with azide modification.

Total alkalinity

The total alkalinity was obtained by adding carbonate and bicarbonate alkalinity. The carbonate alkalinity was determined by titrimetric method using phenolphthalein as indicator. The bicarbonate alkalinity was determined by titrating sample with standard acid solution using
methyl orange indicator.

Total hardness

Total hardness (as CaCO3) was determined by EDTA titrimetric method using Erichrome Black-T indicator.

Chloride

Chloride ion is essential to the electrolytic balance of essential ions in our bodies. Chloride concentration was determined by argentometric titration method involving formation of reddish brown complex by adding potassium chromate which is titrated against $AgNO_3$ solution.

Biochemical oxygen demand (BOD)

Biochemical oxygen demand was determined by measuring the difference of the
Oxygen concentration (By modified Winkler's method) between the sample and after incubating
it for five days at 20 ^oC.

Chemical Oxygen Demand (COD)

The Chemical Oxygen Demand (COD) is the amount of the oxygen consumed by organic matter from boiling acid potassium dichromate solution. Reflux condensation method was used for the determination of Chemical Oxygen Demand.

Nitrate

Nitrate was determined spectrophometrically using the phenol disulphonic acid method on HACH DR 4000 UV-Vis spectrophotometer.

III. Result and Discussion

The present study is based on the comparison of certain important physico-chemical parameters to assess the water quality of lower lake, Bhopal. An attempt was made in the study to assess the water quality changes at every month in the year 2012. The results obtained are shown in Table1 and Table 2.

TABLE I Water quality parameters of Lower lake during the year 2012 (Kali Mandir sampling station S1) S- Surface, B- Bottom

Month	Depth	Temp ^oC	pH	Conductance mS/cm	TDS mg/l	Turbidity JTU	Total alkalinity mg/l	CO_3^{-2} alkalinity mg/l
Jan	S	20.2	8	0.45	435	42	152	54
	B	19.1	7.6	0.46	435	48	148	53
Feb	S	20.7	8.1	0.45	450	74	165	33
	B	20.2	7.6	0.42	444	79	172	40
Mar	S	29.1	8.4	0.42	428	75	168	28

	B	25.5	7.2	0.43	432	87	174	22
Apr	S	32.8	8	0.52	578	81	158	29
	B	26.7	7.6	0.53	577	84	162	19
May	S	34.2	8.4	0.53	320	85	150	52
	B	31.3	7.6	0.53	350	88	158	68
Jun	S	20.3	8.3	o.55	342	83	178	42
	B	29.8	7.3	0.58	360	88	192	47
Jul	S	30.2	7.8	0.37	386	92	162	28
	B	29.4	7.6	0.35	388	98	170	22
Aug	S	29.8	8.2	0.4	477	88	160	32
	B	28.2	7.5	0.44	480	92	166	38
Sep	S	29.7	7.8	0.47	468	67	152	26
	B	28.3	7.7	0.48	472	71	158	27
Oct	S	27.7	8.2	0.44	442	64	144	48
	B	26.2	7.6	0.44	448	68	150	62
Nov	S	24.7	8	0.47	462	62	178	38
	B	22.3	7.4	0.46	460	65	192	54
Dec	S	20.4	8.1	0.44	438	58	152	78
	B	18.7	7.3	0.43	429	54	165	62

Month	Depth	HCO_3^{-2} alkalinity mg/l	Total hardness mg/l	Chloride mg/l	Nitrate mg/l	Sulphate mg/l	DO mg/l	BOD mg/l	COD mg/l
Jan	S	88	140	38	2.46	14	7.4	4.5	152
	B	92	143	40	2.82	18	4.3	11.48	148
Feb	S	86	148	42	2.61	12	7.6	6.1	165
	B	84	154	45	2.97	24	3.8	12.38	172
Mar	S	102	103	48	2.82	20	8.4	4.8	168
	B	110	110	47	2.98	28	2.9	11.42	174
Apr	S	94	128	50	2.82	16	9.8	5.3	158
	B	82	137	51	3.24	20	2.2	17.4	162
May	S	62	136	47	2.86	22	8.4	5.94	150
	B	52	148	49	3.32	33	1.8	11.8	158
Jun	S	68	160	48	1.89	12	7.6	15.8	178
	B	73	168	51	2.2	20	1.4	22.32	192

Jul	S	102	142	48	1.1	18	6.8	14.48	162
	B	92	154	52	1.8	12	0.8	24.92	170
Aug	S	82	134	44	1.58	30	7.1	6.38	160
	B	60	150	42	1.72	18	0.8	18.22	166
Sep	S	115	140	43	1.52	24	7.8	6.32	152
	B	104	148	44	1.64	29	1.2	12.28	158
Oct	S	92	142	40	1.48	28	7.4	5.82	144
	B	66	162	41	1.71	20	4	11.8	150
Nov	S	110	148	42	1.28	22	6.3	5.2	178
	B	82	156	40	1.64	18	0.6	11.8	192
Dec	S	54	144	41	1.14	32	7.4	4.2	152
	B	87	156	42	1.62	20	0.8	12.6	165

TABLE II Water quality parameters of Lower lake during the year 2012 (Neelam park sampling station S2) S- Surface, B- Bottom

Month	Depth	Temp ^{o}C	pH	Conductance mS/cm	TDS mg/l	Turbidity JTU	Total alkalinity mg/l	CO_3^{-2} alkalinity mg/l
Jan								
	S	20.4	8	0.43	423	40	142	40
	B	19.3	7.3	0.46	428	46	148	26
Feb	S	22.4	8.1	0.43	438	38	151	30
	B	19.2	7.5	0.44	444	43	156	36
Mar	S	29.8	8.6	0.41	433	38	158	26
	B	28.7	7.8	0.45	435	44	156	20
Apr	S	31	8.1	0.48	410	43	160	20
	B	29.8	7.4	0.49	400	47	166	16
May	S	33.4	8.4	0.53	318	50	151	24
	B	31.6	7.3	0.49	300	70	155	18
Jun	S	30.4	8.5	0.53	320	56	162	30
	B	29.8	7.5	0.54	328	64	166	22
Jul	S	29.6	7.8	0.48	300	54	152	26
	B	28.8	7.5	0.49	310	63	155	12
Aug	S	29.1	8.6	0.5	300	72	162	28
	B	28.21	7.4	0.48	290	60	168	24
Sep	S	31.8	8.1	0.46	450	62	148	38
	B	28.2	7.8	0.49	470	54	150	42

Oct	S	29.8	7.9	0.46	446	35	146	30
	B	29.2	7.2	0.46	442	39	150	44
Nov	S	29	8	0.47	290	34	144	28
	B	28	7.6	0.46	280	38	148	20
Dec	S	20.1	7.8	0.44	328	26	132	26
	B	19.2	7.5	0.44	330	34	136	18

Month	Depth	HCO_3^{-2} alkalinity mg/l	Total Hardness mg/l	Chloride mg/l	Nitrate mg/l	Sulphate mg/l	DO mg/l	BOD mg/l	COD mg/l
Jan	S	148	134	30	2.46	2.36	6.4	5.4	44
	B	158	137	32	2.72	2.44	0.7	12.1	62
Feb	S	144	130	38	2.58	2.14	7.2	6.3	609
	B	154	126	42	2.87	2.38	0.8	18.1	66
Mar	S	152	128	49	2.18	2.16	8.1	4.81	68
	B	168	130	44	2.38	2.32	1.3	16.35	80
Apr	S	158	132	41	2.66	2.52	7.9	4.48	82
	B	170	135	45	2.92	3.1	1.1	13.86	94
May	S	144	128	47	2.81	3.17	8.2	6.28	38
	B	154	132	50	2.91	3.4	0.7	24.18	54
Jun	S	166	130	41	2.34	2.14	8.4	18.26	40
	B	182	134	44	2.84	2.4	0.6	32.12	54
Jul	S	164	122	40	1.28	2.26	5.6	14	74
	B	170	126	46	1.72	2.14	0.3	30.26	80
Aug	S	150	122	46	1.56	2.08	6.7	12.34	72
	B	160	128	47	2.23	2.12	1.8	17.18	78
Sep	S	152	125	34	1.85	2.05	8	6.3	42
	B	156	128	36	2.61	2.3	0.8	14.38	52
Oct	S	140	122	31	1.23	2.12	7.4	6.78	72
	B	148	120	34	1.67	2.38	3.2	18.1	80
Nov	S	152	124	40	1.42	2.42	7.6	5.5	40
	B	158	129	44	1.72	2.48	0.8	16.1	52
Dec	S	128	120	34	1.34	2.81	7.8	3.8	42
	B	132	128	36	1.56	3.1	0.7	18.1	60

Station – 1 (Kali Mandir)

This sampling station is situated near the Kali mandir. At this station lake has maximum depth of near about 10-11 meter. The main sources of pollution for this station are sewage and solid waste from surrounding area.

Physicochemical characteristics

During the observation most of the parameters shows disturbance and values are high beyond the standardized value. In summer season, hypolimnetic water at the sampling point indicates the higher value of Biological Oxygen Demand [8]. This may be due to higher decomposition rate.During the monsoon season external loading of suspended and dissolved solids increases the turbidity. Concentration of chloride and nitrate are also found to be higher which causes the growth of algal population [9]. DO has a great importance in an aquatic eco-system. It was considered as pollution indicator parameter. A common observation was that the bottom O_2 demand is low as compare to surface water, because of high microbial activity [10]. The upper permissible limit of hardness in drinking water is about 75 mg/Lit. All the values are above this value and came under the category of hard water. The continuous flow of domestic sewage from the surrounding residential area has resulted in increase in COD, chloride, sulphate, nitrate, turbidity and total alkalinity [11]. Results show hyper eutrophic condition in this sampling station of lower lake.

Station – 2 (Neelam Park)

This is one of the most important sampling stations of lower lake. This station is situated near the densely populated Jahangirabad area and two major sewage inlets join the lower lake at this station.

Physicochemical characteristics

The water quality of this station is comparatively better. Although, this area is also affected by various pollution causing activities like disposal of sewage, domestic and industrial wastes, bathing etc. But these activities do not have much significant effect in water quality of this sampling station of lower lake. This is due to the conservation and management activities in this sampling station like catchment area treatment, solid waste management and removal of weeds, installation of floating fountain cum ozoniser [12].

Conclusion

The current study was conducted for the period of twelve months from January to December 2012 to investigate the physicochemical parameters of lower lake of Bhopal.The present study clearly reveals that water quality of lower lake varies from one sampling station to other sampling station. Water quality comparison of these two sampling stations of lower lake reveals that the situation is not too worst but it is alarming. It needs proper conservation and management plans, strategies for the restoration etc.

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