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PHYSICO-CHEMICAL CHARACTERISTICS OF BOD DAL BASIN OF DAL LAKE, KASHMIR, INDIA

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ABSTRACT

The present paper deals with the physico-chemical characteristics of the Bod Dal basin of Dal lake as observed from January to September 2004. Most of the parameters showed both spatial as well as monthly variations. The water samples showed higher values near house boat area with luxuriant macrophytic growth as compared to open waters indicating heavy organic pollution to the water body from the catchment as well as from the habitations.

INTRODUCTION

Dal Lake, an urban lake, is situated towards north-east of Srinagar at an altitude of about 1586m above sea level between the geographical coordinates of 34^0 5′-34^0 6′N latitude and 74^0 8′- 74^0 9′E longitude. The lake is shallow with saucer shaped basin and has an open drainage (Zutshi & Khan, 1978) i.e. regular inflow and outflow of water takes place. The main source of water is Telbal nallah (a perrenial stream) which supplies about 80% of water (Qadri & Yousuf, 1980) and a large number of springs arising from the lake bed (Kundangar *et al.*, 1995). The water flows out of the lake through a weir and lock system at Dalgate. Dal Lake comprises of four basins viz Hazratbal, Bod dal, Gagribal and Nigeen. The lake which has been 7.44 km long and about 3.5 km broad and covering an area of about 22 sq.km. at the beginning of this century has shrunk little over half of the area. At present the lake area is about 11.45 sq.km. During the past few years grave concern is being voiced by people from different walks of life over the deteriorating conditions of Dal Lake. The water quality has deteriorated considerably in the past few years due to organic matter dumping, sewage and other pollutants. Thus the present study was undertaken to observe the physicochemical characteristics of lake water.

MATERIALS AND METHODS

Study Area

Four sampling sites from the Bod-Dal basin of Dal Lake (Srinagar, Kashmir) were selected for the study (Fig. 1). Site I was located about 20 meters away from the SKICC with a mean depth 2.5 m. It was found to be

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mainly dominated by floating hydrophytes. Site II, an open water site with a mean depth of 2.63m, was located in between SKICC and Rupa Lank (an islet within the lake) predominantly covered by submerged macrophytes like *ceratophyllum Sp., Hydrilla sp., Myriophyllum* sp. etc. Site III was situated near the northern side of the Rupa Lank with an average depth of 2.48 meters. Site IV, with mean depth of 2.57m and a dense growth of rooted floating hydrophytes like *nelumbo sp., Nymphea sp.* etc., was located near the inhabitations having high human interference, and the presence of the floating gardens was peculiar feature at this site.

Methods

Surface waters were collected monthly from the four sites for a period of nine months from January to September 2004. The samples for the analysis of physicochemical parameters like pH, alkalinity, calcium, magnesium, iron, phosphate and nitrates were collected in polyethylene bottles of two litre capacity by dipping the bottles 30cm below the water surface, while that for dissolved oxygen water was taken in separate 8oz. glass bottles and fixed on the spot in accordance with the Winkler's method. The other parameters were analyzed within 24hours of sampling in accordance with APHA (1998), Trivedi *et al.* (1987) and Golterman & Clymo (1969).

RESULTS

The data on various physicochemical parameters of the lake basin is presented in Table 1. The transparency of the water varied from a lower value of 1.1m at Site III in the month of May and a higher value of 1.6m at Site I in the month of January. The pH of the waters was observed to be on the alkaline side throughout the study period and varied from 7.23 at Site II to a higher value of 9.23 at Site III in the month of July. Dissolved oxygen concentration throughout ranged from a lower value of 4.6mg/L in the month of May at Site III and the highest value of 8.8mg/L at Site II in the month of February. Total alkalinity as contributed by both carbonates and bicarbonates varied from 90mg/L at Site III in the month of July and a higher value of 128mg/L at Site II in the month of September. The calcium content ranged between 14.65mg/L at Site I in the month of July and a highest concentration of 22 mg/L at Site IV in the month of April. Similarly the concentration of magnesium varied from 1.89mg/L at Site II in the month of July

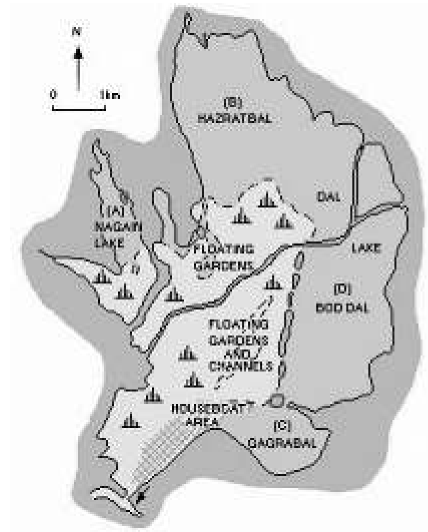

Fig. 1 Location of the Bod Dal basin within Dal Lake, Srinagar, Kashmir.

and 4.59 mg/L in the month of April. Chlorides in the water are believed to be due to the salts of sodium, potassium, and calcium, the chloride content ranged between 10.45mg/L to 41.5 mg/L, being lowest at Site III in July and highest at Site I in August. The concentration of iron ranged from 215 μg/L at Site III in February to 415 μg/L at Site IV in July. The concentration of orthophosphate varied from 175 μg/L at Site I in February to 510 μg/L at Site III in July. Ammonical nitrogen concentration was found to be 195 μg/L at Site I in march to a high value of 525 μg/L at Site IV in June. Nitrate nitrogen concentration varied from a lower value of 190 μg/L Site II in March and the highest value of 510 μg/L at Site I in July.

DISCUSSION

Dal Lake with an average depth of 2.5m at Bod dal basin is getting heavily polluted because of the inflow of sewage from the nearby areas and from the house boats within the lake. Agricultural runoff from the catchment areas and from the floating gardens within the lake is also deteriorating the water quality of the lake.

The higher sechi transparency values in March (1.6m at Site I) appears to be agreeable as Cooke and Kennedy (1970) found that the transparency was higher in springs in European lakes. The lower value of 1.1m at Site III in May might be due to luxuriant growth of macrophytes at this site. The comparatively higher pH at Site III may be due to the presence of

Table 1. Physico-chemical characteristics of Bod Dal Basin of Dal Lake, January – September, 2004

Parameter/Site	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Mean	± SD	Range
Transparency, *m*												
Site I	1.6	1.1	1.2	1.5	1.3	1.2	1.3	1.2	1.5	1.33	0.17	1.1-1.6
Site II	1.3	1.5	1.3	1.1	1.4	1.2	1.6	1.4	1.5	1.35	0.15	1.1-1.6
Site III	1.2	1.3	1.2	1.3	1.1	1.2	1.5	1.2	1.3	1.25	0.10	1.1-1.5
Site IV	1.1	1.3	1.4	1.2	1.4	1.3	1.3	1.2	1.4	1.28	0.10	1.1-1.4
Mean	1.3	1.3	1.27	1.27	1.3	1.22	1.42	1.25	1.45	1.31	0.07	1.22-1.45
±SD	0.19	0.14	0.08	0.15	0.12	0.04	0.13	0.08	0.11	0.11	0.04	0.11-0.18
Range	1.1-1.5	1.1-1.3	1.2-1.4	1.1-1.5	1.1-1.4	1.2-1.3	1.3-1.6	1.2-1.4	1.3-1.6	1.25-1.35	0.07-0.17	
Depth, *m*												
Site I	2.4	2.5	2.4	2.5	2.6	2.6	2.5	2.5	2.6	2.51	0.07	2.4-2.6
Site II	2.7	2.8	2.6	2.7	2.5	2.4	2.6	2.7	2.7	2.63	0.11	2.4-2.8
Site III	2.5	2.3	2.3	2.6	2.4	2.5	2.7	2.6	2.5	2.48	0.13	2.3-2.7
Site IV	2.6	2.5	2.7	2.4	2.6	2.5	2.6	2.5	2.8	2.57	0.11	2.4-2.8
Mean	2.55	2.525	2.5	2.55	2.52	2.5	2.6	2.57	2.65	2.54	0.10	0.1-2.65
± SD	0.11	0.18	0.16	0.11	0.08	0.07	0.07	0.08	0.11	0.08	0.03	0.07-0.17
Range	2.4-2.6	2.3-2.8	2.3-2.7	2.4-2.7	2.4-2.6	2.4-2.6	2.5-2.7	2.5-2.7	2.5-2.8	2.48-2.63	0.07-0.13	
pH												
Site I	8.46	8.82	8.42	8.51	9.03	9.07	8.71	8.89	8.56	8.75	0.27	8.42-9.03
Site II	8.69	8.83	7.74	7.51	9.13	9.01	8.73	7.23	8.63	8.52	0.66	7.23-9.01
Site III	8.63	8.43	7.80	7.62	9.15	8.79	9.23	8.57	7.69	8.43	0.54	7.62-9.23
Site IV	8.20	8.09	7.41	7.91	9.03	8.83	8.79	8.31	8.64	8.35	0.46	7.41-9.03
Mean	8.49	8.54	7.84	7.88	9.22	8.92	8.86	8.25	8.38	8.51	0.48	7.84-9.22
± SD	0.19	0.30	0.36	0.39	0.14	0.12	0.21	0.62	0.4	0.15	0.16	0.14-0.62
Range	8.20-8.7	8.09-8.83	7.41-7.84	7.51-8.51	9.03-9.22	8.79-9.07	8.71-9.23	7.23-8.89	7.69-8.64	8.35-8.75	0.27-0.66	
Dissolved oxygen, mg/L												
Site I	7.8	8.4	7.2	6.0	5.6	6.4	7.6	7.2	8.8	7.26	1.02	5.6-8.8
Site II	6.04	9.2	6.4	8.4	6.0	6.8	7.6	6.4	8.2	7.22	1.16	6.0-9.2
Site III	8.0	6.4	7.2	6.4	4.6	7.2	8.4	6.8	8.8	7.08	1.26	4.6-8.8
Site IV	8.8	6.0	6.8	7.6	6.4	5.2	7.2	6.8	8.4	7.02	1.13	5.2- 8.8
Mean	7.66	7.50	6.9	7.10	5.65	6.40	7.70	6.8	8.55	7.14	1.16	6.40-8.55
± SD	1.16	1.54	0.38	1.10	0.77	0.86	0.50	0.32	0.3	0.11	0.06	0.32-1.16
Range	6.04-8.8	6.0-9.2	6.4-7.2	6.0-8.4	4.6-6.4	5.2-7.2	7.2-8.4	6.4-7.2	8.2-8.8	7.02-7.26	1.02-1.26	

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more soluble calcium and magnesium carbonates as well as higher rate of photosynthesis while as the lower pH value of 7.23 at Site II may be due to decreased productivity and dilution of lake water (Ambhasht, 1988).

Dissolved oxygen gives a valuable information about the metabolic status of the lake. The higher values of 8.8mg/l at Site II may be due to the higher rates of photosyntesis and cooler waters. The lower values of D.O. 4.6mg/l at Site III may be due to higher water temperatures which causes higher microbial activity (Zutshi & Vaas, 1971).

The higher chloride concentration at Site I could be attributed to higher organic pollution (Thresh et al., 1944) and presence of higher levels of human and animal excreta (Cole, 1975), which finds their way into the lake from houseboats and other settlements within the lake. The lower level at Site III could be because of the lower levels of human excreta. The lower levels of calcium ions at Site I can be attributed to excessive precipitation of calcium ion in the form of calcium carbonate by the activity of producers (Rich

Total alkalinity, mg/L											
Site I	101	112	104	122	101	108	112	106	126	112	8.84	101-126
Site II	115	103	117	111	100	98	104	112	124	110	8.66	98-117
Site III	105	113	101	103	115	120	90	102	128	108	11.50	90-128
Site IV	103	109	114	124	108	102	104	94	118	108	9.11	94-124
Mean	106	109	109	115	106	107	103	104	124	109	9.52	102-124
± SD	6.22	4.50	7.7	9.83	6.97	9.6	9.14	7.55	4.32	1.56	1.32	4.32-9.83
Range	101-115	103-113	104-117	103-122	100-115	98-120	90-112	94-112	118-126	108-112	8.66-11.5	
Calcium (Ca^{2+}), mg/L											
Site I	17.41	19.23	18.12	20.15	19.23	18.32	14.65	19.23	20.15	18.49	1.70	14.65-21
Site II	18.32	15.57	19.23	21.1	18.32	16.48	17.40	15.57	17.80	17.75	1.77	15.57-21
Site III	15.57	19.43	18.32	19.23	17.40	17.40	16.5	18.32	16.5	18.70	1.30	15.6-19.4
Site IV	16.48	19.23	15.37	21.98	18.32	16.72	19.23	14.65	18.32	15.77	2.26	14.65-22
Mean	16.94	18.36	17.76	20.61	18.32	17.23	16.94	16.94	18.19	17.67	1.76	16.94-21
± SD	1.18	1.86	1.66	1.19	0.75	0.82	1.90	2.18	1.512	1.33	0.39	0.74-2.2
Range	15.57-18.32	15.57-19.43	15.37-19.23	19-22	17.40-19.23	16.48-18.32	14.65-19.23	14.65-19.23	16.5-20.15	15.77-18.70	1.30-2.26	
Magnesium,Mg^{2+}, mg/L											
Site I	2.94	3.35	2.91	4.59	3.59	3.25	2.79	2.89	2.65	3.21	0.59	2.79-4.6
Site II	2.91	3.08	3.40	3.32	2.86	1.89	3.20	3.47	2.86	2.95	0.60	1.89-3.47
Site III	2.50	3.81	3.50	2.96	2.52	2.35	2.01	3.81	3.35	2.97	0.68	2.01-381
Site IV	2.47	3.37	2.98	3.79	3.79	2.96	1.89	3.96	3.50	3.19	0.64	1.89-3.96
Mean	2.70	3.40	3.19	3.66	3.19	2.61	2.47	3.53	3.09	3.08	0.63	2.47-3.66
± SD	0.25	0.30	0.29	0.70	0.74	0.61	0.63	0.47	0.4	0.14	0.04	0.25-0.74
Range	2.47-2.94	3.08-3.81	2.91-3.5	2.96-4.6	2.52-3.8	1.89-3.52	1.89-3.20	2.89-3.96	2.65-3.5	2.95-3.21	0.59-0.68	
Chloride (Cl^{-}), mg/L											
Site I	21.30	14.45	21.30	28.40	24.85	23.30	28.40	32.35	24.85	24.35	5.63	14.45-33
Site II	17.75	28.40	24.85	21.30	24.85	17.45	21.30	26.50	21.30	22.63	3.77	17.45-29
Site III	24.85	21.30	17.75	17.75	14.20	19.30	10.65	28.40	21.80	19.55	5-02	10.65-29
Site IV	17.75	21.30	28.40	19.30	24.85	14.75	21.30	24.85	21.75	21.58	3.96	14.75-29
Mean	20.41	21.36	23.07	21.68	22.18	18.70	20.41	28.02	22.42	22.02	4.59	18.70-29
± SD	3.4	5.7	3.07	4.58	4.70	3.59	7.32	3.23	0.40	0.14	0.88	0.40-5.69
Range	17.75-24.85	14.45-21.36	17.75-28.45	17.75-28.40	14.20-24.85	17.45-23.30	10.65-28.40	24.85-32.35	21.30-24.85	19.55-24.35	3.77-5.63	
Iron (Feric), µg/L											
Site I	335	305	225	352	320	280	345	295	315	308	38.85	225-352
Site II	324	280	345	325	275	375	330	315	290	318	32.19	275-375
Site III	315	215	335	295	360	390	375	350	280	323	51.41	215-390
Site IV	305	340	265	380	335	275	415	325	295	320	48.52	265-415
Mean	320	285	292.5	338	322.5	330	366	321	295	317	42.75	285-366
± SD	13	53	57.37	36.41	35.70	60.96	37.50	22.86	14.71	6.50	8.85	12.78-61
Range	305-335	215-340	225-345	295-380	275-360	275-390	280-415	295-350	280-295	308-320	32.19-51.41	
Orthophosphate, µg/L											
Site I	221	235	235	280	205	240	175	285	225	229	32.81	175-285
Site II	227	250	205	260	180	210	190	235	229	220	26.63	180-260
Site III	510	480	450	500	480	460	510	450	410	472	33.08	410-510
Site IV	190	215	221	229	250	227	210	180	229	244	21.34	180-250
Mean	287	295	278	317	279	284	271	287.5	273	291	28.46	273-295
± SD	150	125	115	124	137	118	160	116.5	91.18	121	5.60	91-137
Range	190-510	215-480	205-450	229-500	180-480	210-460	175-510	180-450	225-410	220-472	21.34-33.08	

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Ammonical nitrogen, µg/L												
Site I	319	325	195	335	600	290	380	350	375	380	108	195-600
Site II	355	410	355	395	510	305	480	225	285	368	91.40	225-510
Site III	343	375	210	470	430	350	325	380	460	371	79.56	210-470
Site IV	450	370	205	440	360	525	475	340	375	398	93.34	205-525
Mean	367	370	241	410	475	367	415	324	374	379	93.09	241-475
± SD	57.48	35	77	59	103	108	76	68	71.65	13.43	11.69	34.88-108
Range	319-405	325-410	195-355	335-470	360-600	290-525	325-480	225-380	285-461	368-398	79-108	
Nitrate nitrogen, µg/L												
Site I	250	320	450	440	350	280	510	193.5	230	301	110	193-510
Site II	236	285	190	311.5	380	415	480	250	330	319	92.57	190-480
Site III	280	350	255.5	295.5	410	185	395	320	280	304	66.24	185-410
Site IV	215	315	235.5	350	320	265	360	280	435	308	68.30	215-435
Mean	245	317.5	282.7	349	365	286	436	261	319	308	84.27	245-349
± SD	28	26.61	115	65	38.72	95	70.57	53.28	87.59	7.90	20.89	26.61-115
Range	215-280	285-350	190-450	295-440	320-410	265-415	360-510	193-320	230-435	301-319	66.24-110	

et al., 1971). The higher levels of iron at Site IV may be associated with increase in turbidity and suspended matter (Kothandaraman and Evans, 1978a;b).

REFERENCES

Ambhasht, R.S. 1988. *A Text Book of Plant Ecology* (9th ed.), Students, Friends and Co., Varanasi, p. 351.

APHA. 1998. *Standard Methods for the Examination of Water and Waste Water* . 20th edition. American Public Health Assoc. Washington D.C.

Ara, S., Khan, M.A. and Zargar, M. Y. 2003. Physico-chemical characterisics of Dal lake water of Kashmir valley, India. India *J. Environ and Ecoplan.* 7 (1) : 47-50

Cole, G.A. 1975. *Textbook of Limnology*. The C.V. Mosby Company, St. Louis, Missouri.

Cooper, L.H.N., 1958. Consumption of nutrient salts in the English Channel as a means of measuring production. *Rapp. Cons. Explor. Mer.* 144 : 35-37.

Golterman , H. I. and Clymo, R.S. 1969. *Methods for Physical and Chemical Analysis of Freshwaters. IBP Handbook* No.8. Blackwell Scientific Publication, Oxford, Edinburgh

Kothandaraman, V. and Evans, R.L. 1978a. Physical and chemical water quality characteristics of the Fox Chain of Lakes. *Transactions of the Illinois Academy of Science.* 71 (3) : 239–259.

Kothandaraman, V. and Evans, R.L. 1978b. Nutrient budget and its critical evaluation for the Fox Chain of Lakes. *Transactions of the Illinois Academy of Science*. 71 (3) : 273–285.

Kundangar, M.R.D., Sarwar, S.G. and Shah, M.A. 1995. Hydrobiological features of Hzratbal basin of Dal lake. Tech Report No. 3 (A), submitted to Govt of J and K.

Pandit, A.K.., Rather, S.A. and Bhat, S.A. 2001. Limnological features of fresh waters of Uri, Kashmir. *J. Res. and Dev.* pp 22-29.

Qadri, M.Y. and Yousuf, A.R. 1980. Limnological studies of lake Malpur Sar 1. *The Biotope geobiosis,* pp117-119.

Rich, P.H., Wetzal, R.G. and Thuy, N.V. 1971. Distribution, production and role of aquatic macrophytes in a southern Michigan marl lake. *Freshwater Biology.* 1 : 3-21.

Trivedy, R.K., Goel, P.K. and Trisal, C.L. 1987. *Practical Methods in Ecology and Environmental Science*. Environmental Publications, Krard. India.

Thresh, J.C., Suckling, E.V. and Baele, J.F. 1994. *The Examination of Water Supplies.* 6th edition (E.W. Taylor, ed.).

Zutshi, D.P. and Khan, M.A. 1978. On the Lake topology of Kashmir. Environmental physiology and ecology of plants. In: Singh, T. V. and Kaur, J., eds., Studies in the Eco-development of the Himalayas Mountain and Men. Lucknow, India, Print House. pp. 465-472.

Zutshi, D.P. and Vaas, K.K. 1971. Ecology and production of *Salvinia natans* Hoffin in Kashmir. *Hydrobiologia.* 38 (2) : 303-320.