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Physico-Chemical Dynamics in Littoral Zone of Nageen Basin of Dal Lake, Kashmir, India

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Abstract

The present study has been under taken to evaluate physico-chemical parameters and their dynamics in the littoral zone of Nageen basin of the world famous Dal Lake. The investigated parameters included Air temperature, water temperature, pH, specific conductivity, Total dissolved solids, oxygen saturation, dissolved oxygen, total hardness, calcium, magnesium, total alkalinity, chlorides, orthophosphates, nitrates, and total iron. The investigation revealed that the dynamics of physico-chemical parameters depends on both autochthonous and allochthonous inputs and interactions taking place in the Lake Littorals.

Keywords: Littorals, nageen basin, physico-chemical dynamics.

Introduction

Nageen is one of the five basins of the world famous Dal Lake. It is situated at the distance of about six kilometres to the north of Srinagar city (Jammu and Kashmir) India, at an elevation of 1584 m.a.s.l, covering an area of 4.5 Sq Km.

The water supply of the basin is maintained by Dal Lake in addition to springs within the basin, and atmospheric precipitation. The agricultural runoff and domestic effluents being other sources of water supply.

Nageen basin is the narrow stretch of water making it ideal place for stationing house boats and conducting aquatic sports as a result the basin has been tremendously stressed.

The autochthonous and allochthonous inputs to the basin and interactions taking place within the basin are first manifested in the littorals. Littorals are less understood and studied, therefore present investigation was undertaken to investigate dynamics of physicochemical parameters in the littoral zone of Nageen basin. For the sake of study four sites were selected (figure-1) and investigation was carried for six months.

Material and Methods

Monthly water samples were collected from the four sampling sites viz. site I, site II, site III, and site IV, (figure-1) for six months. The sampling was carried out during last week end of the month.

The water samples were collected in plastic bottles of size one litre. Separate water samples were collected for determination of dissolved oxygen in corning glass bottles of 125ml capacity.

The water samples were analyzed after the methods of Mackereth[1], Golterman[2], and APHA[3].

Results and Discussion

The ecological condition of lentic waters are greatly influenced by the autochthonous and allochthonous inputs. The interaction of these inputs are manifested first in littoral zone of the ecosystem, which makes it more productive and in extreme cases worst polluted.

The results of physicochemical analysis of the investigated lake littorals are revealed in table -1.

Variation in the Air temperature is due to climate of the valley and also diurnal variation due to inclination of Sun rays[4].

Water Temperature is an important Limnological parameter that plays a prominent role in regulating nearly all other physical and chemical characteristics of the water as well as the biological productivity[5]. Surface water being directly in contact with the atmosphere is straight away influenced by the air temperature. The variation in air and water temperatures was irregular, most of the time the water temperature was greater than the air temperature, and at times air temperature greater than the water temperature. This phenomenon is due to variation in the sampling time, and has been referred as Thermal inertia[6].

The pH was generally alkaline which is attributed to the calcium bicarbonate system[7]. The minor fluctuation in the pH is because of divergence from the equilibrium due to photosynthetic activity and ionic composition[6].

Specific conductivity was in the medium range. According to the Juday and Birge[8], richness of water body is related to the increase in the electric conductance. The observed conductance reveals the average trophic level of the investigated sites.

Hardness of investigated basin is mainly contributed by calcium and magnesium. The source of calcium and magnesium is attributed to the presence of lime stones and dolomites in the catchments[9]. But the fluctuation in the concentration can be attributed to the formation of marl by aquatic plants[10]. Calcium was found dominant contributor of hardness than magnesium, the dominance of the Ca^{2+} is attributed to the more catchments input and high pH of lake water, which cause precipitation of Mg^{2+}.Wetzel[5] also reasoned low Mg^{2+} content to the utilization by plants for chlorophyll formation. As per Ohle[11], the investigated area is calcium rich and as per Clarke[12] the lake belongs to average hard type.

The source of chloride in the place of investigation is Sewage[13] and human population in the lake (Lake Dwellers). This is further testified by present revelations as Site I, Site II and Site IV, which is highly interfered by floating house boats, and has high chloride concentration.

Alkalinity in most fresh waters is imported by the presence of bicarbonates and carbonates[5]. For the reason of involvement of carbon dioxide in buffering system, total alkalinity has been used as a rough index of lake productivity. In maintenance of pH values 7 to 9, bi- carbonates are of great significance. Same observation was made in the present investigation as phenolphthalein alkalinity (OH^- and CO_3^{2-}) was zero in all months except May, where phenolphthalein alkalinity was encountered, at all sites, which is attributed to high pH (8.7 – 9.6), caused by (OH^-) ions released due to intense photosynthesis[5], leaving exception of May, the study area is bi - carbonate alkalinity type water body[14]. Hence fluctuation of alkalinity is attributed to the diurnal change in photosynthesis and seasonal change in biomass.

The source of phosphate to the lake is sewage runoff, house boats, and macrophyte decomposition. However the sink of the same is co precipitation with marl[5]. Diatoms are also capable of adsorbing phosphate in large quantities. The overall average of phosphate phosphorous was 65.75µg/l. The high concentration at the site IV throughout the investigation reveals constant source of pollution .This observation was confirmed by the presence of drain, emptying into lake at the site. Increase in the concentration of PO_4-P at Site I during May and June was due to increase in number of tourists living in the houseboats during these months. The release of phosphate in the littorals is also attributed to Bioturbation[15].

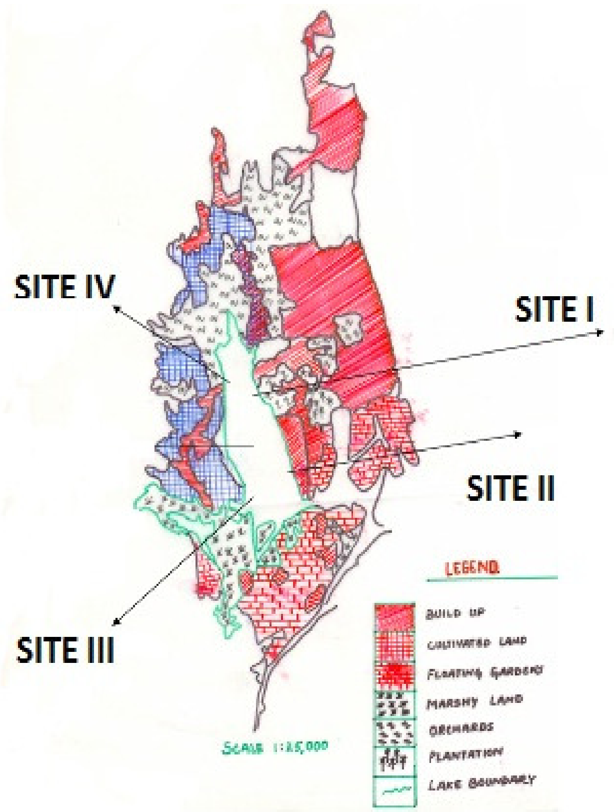

Figure-1
Map of Nageen Basin along with Land use pattern in the surroundings

Table-1

Physico-Chemical Characteristics of Littoral Zone of Nageen Basin

S No.	PARAMETER	MARCH				APRIL				MAY			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
1	AIR TEMPERATURE (^{0}C)	15	16	14	18	22	24	21	20	24	25	23	27
2	WATER TEMPERATURE (^{0}C)	18	17	16	17	24	25	24	24	27	26	26	27
3	CONDUCTIVITY µs/cm at 25^{0}C	307	284	286	320	202	199	193	247	193	137	143	222
4	T.D.S (mg/L)	224	207	208	233	147	146	141	180	140	100	104	162
5	pH	8.2	8	8.2	8.3	9.5	7.4	7.4	7.5	8.7	9.4	9.3	9.6
6	SATURATION (%)	92	71	60	55	90	95	65	60	115	115	90	110
7	DO (mg/L)	9	6.9	5.6	5	8	6.8	5.2	4.8	8.9	9.6	7.2	8.4
8	TOTAL HARDNESS (mg/L $CaCO_3$)	108	104	92	106	56	82	72	62	52	40	38	56
9	CALCIUM (mg/L)	48	51.2	44.8	54.4	28.8	64	36.8	28.8	33.6	22.4	20.8	22.4
10	MAGNESIUM (mg/L)	23.04	19.2	17.28	18.24	9.6	1.6	12.48	12.48	4.8	5.76	5.76	13.44
11	Total Alkalinity (mg/L $CaCO_3$)	132	128	132	136	100	112	100	116	60	64	60	76
12	CHLORIDES (mg/L)	56.8	14.2	14.2	28.4	14.18	11.34	14.18	17.01	14.18	14.18	42.5	56.7
13	NO_3 –N (µg/l)	150	950	40	130	155	480	160	210	240	120	100	95
14	PO_4-P (µg/l)	10	16	20	40	50	50	25	76	110	170	85	115
15	IRON (µg/l)	170	220	220	240	130	225	235	560	100	230	55	165
S. No.	PARAMETER	JUNE				JULY				AUGUST			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
1	AIR TEMPERATURE (^{0}C)	25	30	25	24	27	25	27	30	33	29	33	30
2	WATER TEMPERATURE (^{0}C)	26	26	26	27	27	26	28	29	28	26	26	27
3	CONDUCTIVITY µs/cm at 25^{0}C	236	166	171	294	186	194	205	239	235	210	206	250
4	T.D.S (mg/L)	172	121	123	215	135	141	149	174	171	153	150	182
5	pH	7	7.2	7	7.4	8.4	8.3	8.2	8	8.6	7.8	8	7.5
6	SATURATION (%)	145	102	80	90	103	50	41	48	55	125	70	60
7	D.O (mg/L)	12.8	8.2	6.4	7.2	8.8	4.8	3.2	5.6	4.4	8.8	5.6	4.8
8	TOTAL HARDNESS (mg/L $CaCO_3$)	52	34	40	64	46	52	56	52	64	58	70	66
9	CALCIUM (mg/L)	36.8	25.6	25.6	30.4	24	27.2	33.6	27.2	35.2	28.8	40	27.2
10	MAGNESIUM (mg/L)	2.88	0.96	3.84	12.48	7.68	8.64	6.72	8.64	9.6	10.56	9.6	15.36
11	Total Alkalinity (mg/L $CaCO_3$)	120	100	110	145	100	105	125	120	145	140	160	160
12	CHLORIDES (mg/L)	28.3	28.3	14.2	28.4	14.18	14.18	14	14.18	42.5	42.5	28.4	56.7
13	NO_3 -N (µg/l)	280	145	60	200	170	150	70	80	150	90	91	180
14	PO_4-P (µg/l)	220	23	35	70	25	27	45	90	70	80	35	82
15	IRON (µg/l)	53	45	80	50	45	12	40	50	150	105	125	103

In case of NO_3-N, no seasonal pattern could be established. Out of four sites, I and II was under influence of houseboats which are unpredictable source of inputs to the basin, which is in conformity to the results of Sarwar and Wazir[16]. At the Site III, NO_3 –N concentration decreased generally from March to August which is attributed to the luxuriant growth of macrophytes and attainment of stable temperature for de-nitrification. The high concentration of NO_3-N at the site IV, compared to other sites, was due to perennial source of Nitrates from the urbanized pocket of the catchment.

Iron concentration in the lake littorals was fairly good with an average concentration of 142µg/l throughout investigation. The good concentration of iron in the basin further strengthens the argument that springs beneath the basin also contributes to the basin's water source. Moreover, the dissolved oxygen concentration also remains fairly good throughout the year except at few polluted sites, which made the Ferric (Fe^{3+}) ions available at the water sediment interface[11]. Use of iron nails and iron cords in the construction and fastening of house boats to the shore is also additional source of iron to investigated lake littorals.

While underground water from springs and high D.O. content makes iron available in littorals, the phosphates on other hand cause iron precipitation. The natural interaction between iron and phosphate was depicted at less polluted Site III, i.e. in March Iron concentration was 240µg/l and Phosphate was 40µg/l, In April Iron concentration was 235µg/l while phosphate was 25µg/l. This all is attributed to the co-precipitation of phosphate by Ferric ions near the surface[17].

Dissolved oxygen is an important parameter vis-à-vis the life present in the water body. Dissolved oxygen has been referred to as most fundamental parameter[5]. The solubility of oxygen and particularly the dynamics of oxygen distribution in inland waters are basic to the understanding of the distribution, behavior, and growth of aquatic organisms. In the present investigated case dissolved oxygen at Site I, ranged between 8 – 12.8 mg/L during March to July, which is attributed to the presence of submerged vegetation and thereof the intense photosynthesis[16]. However, in August saturation decreased to 55% resulting D.O to decline to 4.4 mg/l because of high water temperature (28^0C). Same was true for site II and III. At site IV Dissolved Oxygen was less in March and April, increased in May and June and again decreased Sharply in July and August, this behavior is due to pollution at the site, dissolved Oxygen decreased in March and April, however increase in temperature increased rate of photosynthesis, and enhanced Dissolved Oxygen concentration[16], but even more increase in temperature plus pollutant load again decreased the dissolved oxygen concentration sharply.

The Conductivity, T.D.S, Hardness, Alkalinity, and the concentration of Chlorides, Nitrates, and Iron was highest during early spring month (March) which is due to the ending winter overturn of water, thereby enriching surface waters, However at the same time ortho-phosphate concentration was very low which is attributed to its co precipitation in presence of calcium and iron.

Conclusion

The present investigation revealed that physicochemical parameters does not only depend on allochthonous and autochthonous inputs but also on various biological, physical and chemical interactions taking place in the lake littorals either naturally or initiated in response to the pollution. Present findings also indicated that lake dwellers and sewage run-off are considerable source of ionic inputs to the lake littorals. Based on the study it was also concluded that site-IV is more polluted.

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