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A Preliminary Limnological Investigation of Golden- Key Lake, Clemant Town, Uttranchal

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Abstract

The present study was undertaken to provide some baseline knowledge of the general limnology of Golden Key Lake, Clement town, which stands nearly unstudied artificial lake in Dehradun, India. The investigation was intended to get a coherent picture of the quantitative and qualitative aspects of the lake. This study was undertaken for a short period of time and therefore it should only constitute a starting point for studies imperative for management of these ecosystems of unique nature in the country. Four study sites were selected and analyzed for the main chemical variables and nutrients. An examination of the water chemistry data on comparative level revealed that both ions and nutrients were significantly higher at site I located at a point where sewage water without any treatment enters into the lake. Computed on an average basis the inorganic elements have been found to follow the sequence: Ca > Na> Mg > K for sites I and II, while for sites III and IV, the sequence was: Ca> Mg>Na>K.

Key Words: Golden-Key Lake, Clement Town, Sewage, Reservoir, Limnology

Introduction

The world's water resources are under pressure and must be managed for human survival. It is, therefore, necessary to have most relevant information for arriving at rational decisions that will result in the maximum benefit to most people. Accurate and reliable information on the water resource system can, therefore, be a vital aid to strategic management of the resources [1]. Artificial lakes in different parts of the word are made to support different aims on the way of runoff, rivers and groundwater [2, 3]. Some of these are just made for recreation and to attract tourists, others to control floods, economical benefits, to make the weather more fine and to help aquaculture trends [4, 5]. A comprehensive knowledge of the limnological features of a lake or any environment is imperative for assessing its productivity and suitability for providing a dwelling place for an ecosystem or any other creature. Water along with land is the most important natural resource gifted to man by nature. The proper combination of these two primary resources in space and time sets the upper limit of the population and carrying capacity of the area [6].

Reservoirs, man-made inland water bodies constructed for a variety of human benefits, have resulted in manifold environmental impacts changing the ecosystem continuum at different levels. Asian reservoirs are rarely, if ever, constructed for fisheries purposes alone, being usually designed as multifunctional structures for irrigation to enable a second annual rice crop, the generation of hydroelectric power and the provision of water for domestic and industrial use. Nevertheless, fisheries yields and the income generated from these contribute significantly to the total income arising from reservoirs [7,8] and particularly for rural communities where government investment is limited or is being reduced in terms of structural adjustment and related policies. Moreover, during the last 20 years, the use of reservoirs' for aquaculture has contributed increasingly to the enhancement of protein production as well as to increased incomes in rural areas where both are needed [9]. The level of limnological knowledge and understanding of manmade lakes and reservoirs belies both their dominance of the landscape [10], and their importance in exploiting agriculture potential [11]. The control and monitoring of the water quality in artificial lakes is crucial, since these constitute essential renewable water resources for domestic, agricultural, and industrial purposes, amongst many others.

Study Area

Dehradun is the capital of Uttarakhand State which is considered as important business, educational and cultural destination of North India. The term 'dun or doon' means the low lands at the foot of a mountain range and as the bulk of the district lies in such a terrain, it justify the dun part of the name. The Doon Valley is a unique micro geomorphic unit parallelogram shaped structure in Northwest – South East direction following the main Himalayan trend. It is bounded in the North by the younger Shivalik ranges, river Yamuna and Ganges from the Valleys Western and Eastern boundaries in the Northwest and South East direction. respectively Geographically the valley lies between latitude 29 ^{0} 55'N and 38 ^{0} – 30'N, longitude 77 ^{0} – 35 'E and 78 ^{0} – 20 ^{0} E, covering an area of about 2002 .9 square kilometer.

The study was carried out from Nov. 2008 – Feb. 2009 on an artificial lake named as 'Golden Key Lake' which is located in Clement Town. Clement Town is recognized by the presence of a large Buddhist Monarchy which is a about 1 km away from study area. It is about 5 km away from the ISBT

(Bus Terminal) Dehradun and is situated in the South direction of Dehradun city or Doon Valley. The lake is surrounded on North, West, South West and South East direction by a Town named as Behruwala, Gurdwala, Indian Air Force and Army respectively. The lake is divided into two compartments I and II, with I-compartment having an area of about 2000 m^2 while the II^{nd} compartment has an area of about 4500m^2. The lake is recharged by tube-well water.

Four sites were choosen from the lake for purpose of investigation. The sites are named as I, II, III & IV.

Site I lies in East direction of lake near exit point of the lake. The domestic waste water which comes through a drain meets with lake water in West. The surrounding area is swampy with dense vegetation.

Site II is located in the centre of the lake, on the left side of the landmass which divides the lake into two compartments.

Site III is located in the South-West direction of the lake. It lies about 15 feet away from the point, where water enters into the lake from a tube-well.

Site IV is located in North direction of lake and lies about 15 feet away from the landmark which divided the lake into two compartments.

Materials and Methods

Water samples were collected one metre inside from the lake in high density polyethylene bottles of one litre capacity. The parameters like pH, conductivity were measured with digital pH metre and conductivity metre respectively. Dissolved oxygen was estimated by Winkler's titration method and COD by Closed Reflex method. The parameters like chloride (Argentimeteric), alkalinity (Titrimetric) and hardness (EDTA titrimetrc method) were measured by tittrimetry methods while, nitrate (Sodium salicylate), phosphorus (Stannous Chloride), and sodium and potassium were analysed by spectrophotometric and flame photometric methods respectively [12-14].

Result and Discussion

Table 1. Physico-chemical attributes of Golden Key Lake at four different sites

S.No	Parameters/units	Site	Months				Mean	S.D
			Nov.	Dec	Jan	Feb		
1								
	Water Temperature (^{O}C)	I	14.2	16.3	17.2	20.1	16.95	2.45
		II	16	17	17.6	18.4	17.25	1.01
		III	15	17	18	18.7	17.175	1.61
		IV	16.8	18	19	19.2	18.25	1.10
2	Transparency (cm)	I	10	9.5	9	9	9.375	0.48
		II	65	61	58	58	60.5	3.32
		III	74	73	65	65	69.25	4.92
		IV	85	83	76	75	79.75	4.99
3								
	TSS(mg/L)	I	400	600	673	674	586.75	129.23
		II	300	342	300	310	313	19.90
		III	100	107	113	117	109.25	7.41
		IV	10	14	21	23	17	6.06
4								
	TDS(mg/L)	I	120	130	141	146	134.25	11.62
		II	400	390	309	308	351.75	50.11
		III	200	210	211	217	209.5	7.05
		IV	400	380	363	367	377.5	16.66
5								
	pH	I	6.4	6.1	6.5	6.7	6.4	1.8
		II	7.1	6.9	7	7	7	0.08
		III	7.4	7	7	7	7.1	0.20
		IV	7.54	8.0	7.9	7.6	7.76	0.22

6	Alkalinity (mg/L)	I	560	590	594	600	586	17.81
		II	260	281	287	293	280.25	14.36
		III	260	287	289	290	281.5	14.39
		IV	240	249	253	259	250.25	7.97
7	Hardness (mg/L)	I	280	300	331	341	313	28.08
		II	214	234	241	253	235.5	16.34
		III	216	222	231	233	225.5	7.94
		IV	216	240	215	219	222.5	11.79
8	Calcium (mg/L)	I	70	75	72	75	73	2.45
		II	60	62	62	66	62.5	2.52
		III	45	49	52	53	49.75	3.59
		IV	41	58	48	52	49.75	7.14
9	Magnesium (mg/L)	I	25	28	34	36	30.75	5.12
		II	17	19	20	22	19.5	2.08
		III	25	24	25	24	24.5	0.58
		IV	28	23	23	22	24	2.71
10	Sodium(mg/L)	I	37	40	43	47	41.75	4.27
		II	17	19	23	25	21	3.65
		III	17	17	18	20	18	1.41
		IV	15	16	16	20	16.75	2.22
11	Potassium (mg/L)	I	10	12	14	14	12.5	1.91
		II	1	5	5	5	4	2.00
		III	1	3	4	4	3	1.41
		IV	2	6	9	7	6	2.94
12	Chloride (mg/L)	I	55	60	63	65	60.75	4.35
		II	18	22	26	25	22.75	3.59
		III	10	14	17	19	15	3.92
		IV	6	12	12	13	10.75	3.20
13	DO (mg/L)	I	2.8	2.9	2	2.1	2.45	0.47
		II	6.7	6.1	5.8	5.9	6.125	0.40
		III	6.9	6.3	6.1	5.9	6.3	0.43
		IV	6.1	5.9	6	6	6	0.08
14	COD(mg /L)	I	200	250	263	290	250.75	37.71
		II	102	104	100	101	101.75	1.71
		III	115	114	112	112	113.25	1.50
		IV	109	109	109	111	109.5	1.00
15	Nitrate-N (µg/L)	I	1800	2000	2100	2700	2150	387.30
		II	600	700	900	800	750	129.10
		III	400	600	600	800	600	163.30
		IV	200	500	700	900	575	298.61
16	Orthophosphate(µg/L)	I	500	520	460	530	502.5	30.96
		II	60	70	75	60	66.25	7.50
		III	20	20	50	70	40	24.49
		IV	50	40	50	50	47.5	0

The data obtained for different hydro chemical parameters are presented in Table 1.The water temperature, in general, varied from a minimum of 14.2 ^{0}C at site I in November to a maximum of 20.1^{0}C at same site in February. However, the highest (18.25±1.10^{0}C) and lowest (16.95±2.45^{0}C) mean values were recorded for site IV and I. The variation in annual air temperatures seems behind the sinusoidal pattern in lake water temperatures with maxima in spring and minima in winters [15].

The transparency was found to be greatly related with total suspended solids with highest at site IV and the lowest at site I. Similarly TDS was found highest at site IV and lowest at site I. This spatial trend was found to be related with sewage entering into the lake at site I. High values of water transparency coincided with low precipitation whereas low

values were recorded during rainy months. The entry of sewage into lake causes resuspension of particles and therefore contributing to significant difference in water clarity between site I and rest of the sites which on other hand also depicts coincidal pattern with TSS values. The increase in water transparency can also be related with copepod zooplankton grazer which presumably removed the phytoplankton biomass during warm months. On the other hand low transparency is likely due to large nonbiological turbidity and low biological turbidity.

The pH of the investigated lake at different sampling sites revealed alkaline pH except slightly acidic character at site I. The slightly acidic character as is revealed from the mean value at site I is attributed to continuous increase of carbonates from the domestic sewage and other pollutants from the nearest households and due to decomposition of organic matter releasing organic acids thereby lowering the pH [16].

Being a typical artificial lake alkalinity was chiefly due to Bicarbonate ion. The total alkalinity at different selected sites varied from 240 mg/L for site IV in November to 600 mg/L for site I in February while as maximum(586.0 ±17.81) mean value of alkalinity was recorded for site I against the minimum (250.3 ±7.97) being recorded for site IV. The significantly highest alkalinity was probably related to bicarbonate ion generation due to decomposition of organic matter by sulphate reduction [18]. Furthermore, the high alkalinity may be due to dissolution of $CaCO_3$ in bottom layer of lake [17].

The hardness of water is governed by the carbonates and bicarbonates of calcium and magnesium and other ions like Cl, SO_4^{2-} [19]. Calcium and magnesium accounted for most of the hardness in the lake. Moderate spatial and temporal variations in total hardness were noted among study sites. A perusal of the data during the study period revealed a minimum value of 214 mg/L at site II in November and a maximum of 341 mg/L at site I in February. Among the sites studied, the highest mean value for total hardness was recorded at site I (313±28.08 mg/L), followed by site II (235.5±16.34mg/L), site III (225.5±7.94 mg/L) and declining to the lowest at site IV (222.5±11.79 mg/L) during the period of investigation. The higher values are likely to be related to higher concentration of calcium, magnesium, sulphate and chlorides in the water that is being supplied to lake.

The calcium content of different sites was generally low and fluctuated from a minimum of 41 mg/L at site IV in November to a maximum of 75 mg/L at site I in December and February. The ion showed its lowest mean concentration (49.75±7.14 mg/L) each at site III and IV and highest (73±2.45 mg/L) at site I.Magnesium content depicted clear slight spatial and temporal variations during the whole study period. Data on monthly basis revealed that the magnesium concentration ranged from a low of 17 mg/L for site II in November to a high of 36 mg/L for site I in February. Among the sites studied the highest mean value for magnesium content was recorded at site I (30.7±5.12 mg/L), and lowest at site II (19.5±2.08 mg/L).

The monthly fluctuations for the concentration of sodium in spring waters depicted a minimum of 15mg/L for site IV in November and a maximum of 47 mg/L for site I in February whilst highest mean value was obtained for site I(41.75±4.27) against the lowest recorded for site IV (16.75±2.22). Potassium in the lake waters showed very little fluctuations during the entire period of study and it ranged from 1 mg/L each at site II and III in November to a maximum of 14mg/L at site I in January and February. Further, the maximum mean value was recorded at site I (12.5±1.91 mg/L) and minimum at site IV (6.0±2.94 mg/L). All the ions and nutrients depicted the highly increasing trend at site I due to increase in its pollution. Calcium and magnesium accounted for most of the hardness of water. The values of calcium and magnesium were higher during Jan and Feb months and could be attributed to its greater solubility at low water temperature. Concentration of sodium is slightly higher than that of potassium, as potassium being most likely absorbed by soil colloids. Computed on an average basis the inorganic elements have been found to follow the sequence: Ca > Na> Mg > K for sites I & II, while for sites III & IV, the sequence was: Ca> Mg>Na>K.

The chloride content of lake waters displayed wider spatial fluctuations ranging from a minimum of 6 mg/L at site IV in November to a maximum of 65mg/L at site I in February. A comparison of sites, on the basis of mean values, revealed site I(60.8±4.35 mg/L) ranking first, followed by site II(22.75±3.59 mg/L), site III((15.0±3.92 mg/L), and site IV (10.75±3.20 mg/L) in the descending order. The hardness of the lake waters indicated their hard water nature [20] with total hardness >200 mg/L $CaCO_3$ equivalent [21] except at site I. The high chloride concentration of the lake may be related to the presence of large amounts of organic matter of both allochthonous and autochthonous origin.

The monthly variations in dissolved oxygen concentrations at different sites revealed variations from a minimum of 2 mg/L for site I in January to a maximum of 6.9 mg/L for site III in November. Further, on the basis of mean values DO levels ranged from a minimum of 2.45±0.47 mg/L at site I to a maximum of 6.3±0.43 mg/L at site III during the four month study period.

The value of Chemical oxygen Demand (COD) ranged from 100mg/l for site 1 in January to a maximum of 290mg/l for site1 in February. On the basis of mean value Chemical oxygen Demand levels ranged from a minimum of 101.75 ±1.71 mg/l at site II to a maximum of 250.75 ±37.71 mg/l at site I. Both dissolved oxygen and COD values indicate the contribution of inorganics as well as organics into the lake from untreated sewage.

Nitrate nitrogen content of lake water depicted wide and irregular fluctuations both on spatial and temporal scale. During the study period, the value for nitrate nitrogen fluctuated between 200µg/L at site IV in November and 2700 µg/L at site I in February. A comparison of sites on the basis of mean values revealed the highest concentration of 2150±387.30 µg/L for site I and lowest of 575±298.61 µg/L at site IV.The ortho-phosphate phosphorus recorded the lowest value of 20 µg/L at site III during November and December to a high of 530 µg/L at site I in February. The studied sites also depicted appreciable variations in terms of mean values which fluctuated from a minimum of 40 ±24.49 µg/L at site III to a maximum of 502.5 ±30.96 µg/L at site I. The concentration of nitrate and phosphates was higher at site I, while the values of nitrate and phosphate concentration at rest of the sites showed a narrow variations. Domestic wastes both solid and liquid

which eventually reach the lake water through run off thereby increasing the level of nitrogen compounds in lake [22-24].

Conclusion

The study revealed that the sewage water entering into the lake water without any treatment is likely to diminish the value of lake in terms of tourism, ecology aesthetics and resource utilization.

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