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RESEARCH ARTICLE

Limnological Assessment of Keetham Lake at Soor-Sarovar Bird Sanctuary in Agra

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ABSTRACT

To investigate the limnology of fresh water Keetham Lake in Taj city of Agra (U.P.), samples of water collected from 3 different stations at each month from March 2013 to February 2014, the eleven physical and chemical factors taken for the study of Keetham lake. These limnological parameters were estimated and analyzed systematically. Water temperature, Turbidity, Light penetration, Depth, pH values varied from 16 to 35° C, 72 to 142 cm,20 to 28.8 cm., 12 to 22.5 ft, 6.8 to 8.5 respectively. A value of D.O. was 5.5 to 8.4 mg/l, B.O.D. was 63-139.3 mg/l and 85-220 mg/l, C.O.D. was recorded. CO_2 and alkalinity were limited from 27.0 to 39.5 mg/l and 185.87to 315.0 mg/l respectively. T.D.S. was recorded in bearable concentrations in such lake. Lake never revealed any significant pollution at hypothetical Stations as well as no significant variations were observed among various parameters under study. Correlation coefficients were found out to make correlation analysis among parameters. At a glance present Research work showed that all stations of lake had excellent level of D.O., alkaline pH, moderate alkalinity, enriched nutrients, better transparency which supported abundance of biotic flora and fauna. The lake was also found to have excellent place for migratory birds.

Key words: *limnology, Pollutometric, Keetham, Correlation Analysis*

INTRODUCTION

In India greater regional differences are found in the topography, ecology, climate etc. As a result of these differences the limnological resources (lake, pond & reservoirs) and their morphometries are very unevenly distributed. Nevertheless India is blessed with vast water recourses in the form of rivers, estuaries, lakes, natural and artificial ponds and mangrove wetlands, which are ideal natural habitat for biotic placements and sites for fishery and its development.

Physico- chemical state of any water body depends on natural contents of physical factors & nutrients. Physico- chemical equilibrium is must between components of water body dissolved in it for fishery development and conservation of biodiversity. Therefore any seasonal, periodic (natural) and anthropogenic, environmental (artificial) alteration in water characteristics like temperature, light, wind current, turbidity, D.O., pH, alkalinity, total hardness, other chemicals nutrients and soil texture & composition, diversity and food chain of aquatic ecosystems and even deterioration of water recourses if physico-chemical features get distributed more. This is an exercise in identifying limnological conditions of Keetham lake, although lake is considered a best asylum for birds from abroad . They come to keetham lake from a long distance during their longer travel as migration. However author not taken this account for his research in present research piece of work. The proposed work has, therefore, been undertaken, keeping in view the complete survey with the aim of knowing abiotic parameters of such lake.

Present limnological investigations of Keetham lake are undertaken to record monthly fluctuations in abiotic parameters (temperature, light penetration, depth, turbidity, hydrogen ion concentration, dissolved oxygen, free carbon dioxide, alkalinity, BOD, COD etc), for a period of one year only. However the vital processes are at the optimum when the physical and chemical conditions are normal. The eleven (11) physical and chemical factors taken for the study of Keetham lake. The important physical and chemical factors taken for the study of

Keetham lake water play a significant role in controlling the distribution and growth of biotic flora and fauna, suitability for migratory birds, use the water for other purposes including recreational activities.

MATERIAL AND METHODS

Water samples were collected help of labor in the second week of each month from March 2013 to February 2014. Three replicates each of 2 lit. Samples were collected in sampling bottles in the morning hours from three 'I', 'II' & 'III' sampling stations and brought to the laboratory for analysis. Standard methods for the examination of water and waste water (APHA 1996) were used for the analysis.

At the time of water sampling (at spots) temperature, depth and light penetration were recorded. Temperature was recorded with the help of mercury Thermometer. For the measurement of D.O., water samples were fixed with the help of a manganous sulphate and alkali iodide azide solution at the sites and analyzed in the laboratory using Winkler's iodo metric method. Turbidity was measured by digital nephelometer, B.O.D. and C.O.D. were analyzed by B.O.D. incubator and potassium- dichromate methods respectively. pH (using a pH meter), CO_2 (using Sodium carbonate titration), alkalinity (titration method by H_2SO_4 and NaOH using phenolphthalein and methyl orange indicator), chloride (by Mohr's argentometric method using potassium chromate as indicator), Ammonia (by simple nesslerisation method), phosphate (by Atkins modification, stannous chloride methods), Silicate (Ammonium molybdate method), T.D.S. (by evaporation method), and nitrate using phenol-disulphonic acid colorimetric test.

Table 1: Limnological parameters with their mean values and Standard Deviations of Keetham Lake (mean values shown in the table taken from 3 stations as I, II and III)
(March 2013 to Feb. 2014)

Parameter/ month	Water temp.	Turbidity	Light penetration	Depth (feet)	pH	D.O.
March	27.0 ±0.69	85 ±1.06	28.8±0.98	14 ±0.77	7.8 ± 0.33	7.7±0.78
April	30.4 ± 0.91	72 ±1.40	26.8±0.90	14.5±0.50	8.0 ± 0.16	6.2±0.88
May	34.6 ±0.66	74±1.70	24.0±0.95	12.0±0.28	8.4±0.48	5.5±0.26
June	32.8 ±0.57	85±1.0	24.1±1.39	13.5 ±0.40	8.5±0.32	6.2 ±0.18
July	33.0 ±1.21	118±0.81	21.5±0.84	19.0±0.47	6.8±0.28	6.2 ±0.34
Aug.	30.6 ±0.46	125±0.93	20.7±0.54	22.5±0.64	7.5 ± 0.38	6.8±0.18
Sep.	29.2 ±0.89	142±0.48	20.0±0.93	22.0±0.52	7.9± 0.87	7.3±0.86
Oct.	26.0 ±1.44	125±0.85	22.5±1.02	20.0±0.48	8.0±0.28	7.8±0.65
Nov.	23.4 ±0.86	98±1.04	25.0±1.00	20.2±0.35	8.1±0.76	7.1±0.34
Dec.	18.2 ±0.75	98±1.30	28.2±0.94	18.5±0.76	8.0±0.56	8.2±0.76
Jan.	16.7 ±0.88	88±0.82	26.0±0.90	19.2±0.52	7.9±0.45	8.1±0.64
Feb.	19.6 ±0.94	78±0.85	27.8±0.9	18.5 ± 0.88	7.7±0.58	8.4±0.36

All Mean values derived from three stations viz. I, II & III are expressed in mg/lit., except Temp. (^{0}C), pH, Turbidity and Light penetration (cm), Depth (feet). All values are given with their Standard Deviations (S.D.) respectively. Higher S.D. shows that values have more difference in three stations while Lower S.D. shows that values have less difference among three stations.

Table 2: Limnological parameters with their mean values and Standard Deviations of Keetham Lake (mean values shown in the table taken from 3 stations as I, II and III)
(March 2013 to Feb. 2014)

Parameter/ month	B.O.D.	C.O.D.	CO_2	Alkalinity	TDS
March	88 ±6.6	130±2.10	34.0 ±0.67	255.0 ± 4.3	575 ± 3.8
April	97.6 ± 6.12	145±3.87	30.0 ± 0.86	275.0 ± 3.6	854 ± 3.5
May	102.3± 7.13	170±2.1	27.0 ± 0.65	280.2 ± 3.2	1090 ± 2.7
June	116.5± 6.2	185±2.90	29.0 ± 0.34	315.0 ± 3.1	1640 ± 7.5
July	121.3 ± 4.7	192 ±5.35	39.5 ± 0.98	185.7 ± 5.3	1820 ± 7.7
Aug.	139.3± 5.7	220 ±4.67	36.5 ± 0.88	194.5 ± 2.8	1520 ± 4.5
Sep.	96.2 ± 4.9	210±3.98	30.8 ± 1.1	208.5 ± 3.6	1010 ± 4.8
Oct.	98± 8.1	188±4.55	28.5 ± 1.3	214 ± 3.7	1100 ± 7.2
Nov.	84 ± 4.8	152±5.6	29.8 ± 0.46	225.0 ± 4.8	1250 ± 6.8
Dec.	65.6 ± 4.9	85±5.80	31.6 ± 0.55	238.2 ± 2.8	1140 ± 6.3
Jan.	63.0 ± 5.09	94±3.88	28.0 ± 0.90	245.0 ± 2.6	1210 ± 5.6
Feb.	77.6 ± 4.4	89±4.1	30.0 ± 0.94	250.0 ± 3.1	900 ± 4.8

CORRELATION ANALYSIS

A positive and significant correlation was found out between water temperature, BOD, COD, CO_2, and Chloride. A negative and significant correlation has been recorded between temperature and D.O. Turbidity exhibited negative relation with light penetration, pH and D.O. while positive correlation with most of parameters. pH showed positive correlation with alkalinity, chloride and D.O. and negative correlation with rest of the parameters. D.O. positively correlated with light penetration and pH. BOD and COD had negative correlation with light penetration, D.O., and chloride while other parameter more or less positively correlated with both ones. CO_2 negatively significant correlated with D.O. and alkalinity in short strength, while positively correlated with most of the parameters.

RESULTS AND DISCUSSION

WATER TEMPERATURE:

The water temperature governs species richness and diversity (Thirumala *et al.,* 2006) distribution and their rates of activity besides water mixing, turbulence and production of currents (Ruttner, 1963; Cole, 1983). Maximum 34.6^{0}C recorded in May 2013, while minimum 16.7^{0}C in Jan. 2014. Variation in water temperature in present work as monthly changing was found due to heat gain from solar radiation from the air and transfer by conduction in water body. At different water level temperature was observed uniform, so no thermal stratification was noted, which made lake productive. A positive correlation between bright sunlight, its longevity and water temperature was observed by Ahmad & Singh, 1990; Vishwakant, 2007.

TURBIDITY:

Turbidity makes the water bodies unfit for direct or indirect consumption by human for various uses. Excess value of turbidity hinders the fish yield by reducing other factors like light penetration, pH, D.O., ammonia, chlorides etc. (Vishwakant, 2007). At station 'I' maximum 146 recorded in September 2013, while minimum 76 in April 2013 at station 'III'. However mean values ranged from 72 to 142 cm.

Turbidity is the Pollute metric factor. It was observed in high proportion at station 'I' (146 cm in Sept 2013) because Domestic discharge, dirt other impurities coming from nearby area also anthropogenic and zoogenic activities, inflow of silt, surface run off during raining season raised turbidity. In present work higher turbidity during monsoon due to suspended particles might

observe nutrient concentration (phosphate & nitrate) making them unavailable for plankton production. While minimum turbidity was noted in summer. Turbidity was found as inversely related with light penetration, pH, and D.O.

LIGHT PENETRATION (TRANSPARENCY):

Maximum average 28.8. Recorded in March 2013, while minimum 20.0 in Sept. 2013. Maximum transparency was recorded in spring season; moderate in winter as well. High transparency could be attributed to les decomposition of organic matter due to less temperature and less input of solids & wastes. Low transparency and high turbidity reduce photosynthesis of plankton & plants which in turn lessen the growth of biota& density of fish.

DEPTH:

At station 'II' maximum 24.5 ft recorded in Aug. 2013, while minimum 13.5 ft (station III) in May 2013. Average values were from 12 to 22.5 ft. Although depth was maximum observed in rainy season, but higher values of depth were also noted in winter & spring. An inverse relation was observed between Depth and light penetration; In present work all stations had saturated water level for suitability for lake to exist.

pH:

The pH an indicative of hydrogen ion concentration. The hydrogen ion concentration of natural waters is very essential environmental factor, the variations of which, among other causes are linked with species composition and life processes of animal and plants communities inhabitating them (jhingran, 1988). PH is often used as an index for water condition. Mean values from minimum 6.8 ± 0.28 to maximum 8.5 ± 0.32 recorded in July and June 2013 respectively. The lower values of pH during rainy season in present study got support by the works of Kaushik *et al*.,1991; Saxena 1994. Moderate value of pH in water spring and reached max. in summer might be due to higher photosynthesis, algal blooms, reach population of submerged macrophytes as reported by Saxena 1994.

In all stations in present work pH values did not undergo any sharp variation during whole of the year. Low records of pH during raining season was observed due to lower transparency, higher turbidity, and more depth, higher CO_2 lower D.O., reduced photosynthesis, which ultimately reduced fish production in such season. Moderate value of pH was observed in winter- spring seasons which led to flourishment of bio diversity and fruitful settlements of migratory birds.

DISSOLVED OXYGEN (D.O.):

Mean values from minimum 5.5 ± 0.26 to maximum 8.4 ± 0.36 recorded in May 2013 and Feb. 2014 respectively. D.O. directly affects survival, development, density and distribution of biota in an ecosystem. (Vijaya kumar *et al.,* 1999). In fact, at any time the concentration of D.O. is the balance between oxygen produced by photosynthesis during day and oxygen lost to respiring flora and fauna day and night. Higher values were recorded in winter and spring seasons due to less microbial decomposition of dead organic matter, its high solubility at low temperature (Kant and Raina, 1990; Sulthara, 2005), holding capacity of water, moderate photosynthesis and raised growth of submerged macrophytes, (Vishwakant *et al*., 2007) which led to good fish yield. While lower values of D.O. were observed in summer & rainy season due to higher free CO_2, lower photosynthesis, high Turbidity, higher respiration of biota, higher microbial activity, organic pollutants. All the time D.O. was observesd in significant concentrations which always helped the lake to keep promoting life conditions for existing biological organisms and visitor migratory birds.

B.O.D.:

Mean values from minimum 63.0 ± 5.09 to maximum 139.3 ± 5.7 recorded in Jan. 2014 and Aug. 2013 respectively.

C.O.D.:

Mean values from minimum 85.0 ± 5.8 to maximum 220 ± 4.6 recorded in Dec. And Aug. 2013 respectively.

CO_2:

The presence and absence of CO_2 is determined by its consumption by algae and plants during photosynthesis and also through its diffusion from air. Mean values from minimum 27.0 ± 0.65 to maximum 39.5 ± 0.98 recorded in May and July 2013 respectively. It was found that CO_2 inversely correlated with D.O. in different seasons. Higher values in summer rainy season were observed due to higher decomposition of dead organic matter & submerged macrophytes, lower photosynthesis, cloudy weather and increased suspended matter etc. led to lower biological activities, while in winter spring season lower CO_2 were observed in all stations, which led to higher growth of biotic communities and excellent water quality.

ALKALINITY:

The label of alkalinity is a measure of productivity of water. (Ghoshand George, 1989; Sharma and Kaushal, 2004.) Mean values from minimum 185.7 ± 5.3 to maximum 315 ± 3.1 recorded in July and June 2013 respectively.

Alkalinity in natural water is caused by salts of carbonates, bicarbonate, hydroxide etc. of course carbonate and bi carbonate forms and index of total alkalinity have a direct wearing and liner relationship with pH (Vishwakant 2010). An incensed pH in Keetham lake due to carbonates corroborates with the work of (Hutchinson 1957;Jhingran 1988; Goldman and Horne 1983). In all stations alkalinity had excellent values resulting their productive nature especially coupled with high production of phytoplankton (although known plankton analysis involved in given parameters). This is important factor to promote life conditions for existing biological organisms and visitor migratory birds.

CONCLUSION

In the present paper all stations of lake Keetham limnological parameters have been found to have changed during study. Present work emphasized over changed values of parameters during different months of investigated period, due to sewage, organic, agriculture, sedimental, siltation pollutants which ultimately changed the biotic profile of communities. All the parameters studied were found in the optimum range to sustainable development of this lake. All the parameters from water temperature to TDS under investigation were in significant concentrations giving excellent water quality to the lake which finally promoted various feasible life conditions for existing biological organisms and visitor migratory birds. A proper & systematic development of lake could lead to fisheries and allied sectors. The water of lake can be used for domestic (washing), agriculture, aquaculture and recreational purposes. So author selected such larger lake for assessment of its hydro biological characteristics.

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