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REVIEW ARTICLE

TROPHIC STATUS OF DAL LAKE, KASHMIR, INDIA

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ABSTRACT

The study was conducted in the Dal lake, which is situated on the northeast of Srinagar at latitude 34^0,07/ N and longitude 74^0, 52/ E on the right bank of river Jhelum. Four water- sampling sites (Viz: Hazratbal, Nishat, Nehru park and Nigeen) were selected for study. The water samples were analyzed for pH, conductivity, turbidity, dissolved oxygen, chemical oxygen demand, chlorine, hardness, total alkalinity, ammonium nitrogen, sulphate and phosphorus on fortnightly basis for six months. The results showed that the maximum value of pH was observed at Nehru Park (DD3) 10.66±0.21 mg/1 and the minimum 8.14±0.01 mg/1 at Telbal Nallah (DH4) respectively. The conductivity value, an indication of total nutrient concentration, was notably higher at various sites of Dal Lake. The maximum value of conductivity is 426.3±10.12µs/cm and the minimum 186.3±7.11µS/cm at Telbal Nalah (DH4) and near Heemal Hotel (DD2) respectively. The D.O. ranged between 10.31±0.01 mg/l at Centaur hotel (DD4) to 5.0±0.01 mg/1at Telbal nallah (DH4).The turbidity value was recorded to be maximum of 45.02±0.01 at Dhobighat (DH1) and minimum of 1.90±0.00 mg/1 at Central site (DH2). The higher values of C.O.D prevail over the entire lake water, particularly at DH4 of Telbal Nalah 84.33±1.9 mg/1 and the lowest value at DD3 of Nehru park (42.40±6.1 mg/1) respectively. The maximum value of chloride, hardness, total alkalinity, ammonium, nitrogen sulphate and phosphorus was observed at Hazratbal basin. This study has clearly demonstrated that the Hazratbal basin of Dal Lake is highly polluted in comparison to other sites owing to regular addition of urine and human waste dumped into the lake along with run off of chemical fertilizers from the waste drainage basin around it.

INTRODUCTION

Water pollution is the specific impairment of water quality by agricultural, domestic or industrial wastes (including thermal and atomic wastes) to a degree that has an adverse impact upon any beneficial use of water. Man has polluted water to such a degree that it loses any of its value as natural resource (Beck, 1954). The physico-chemical and biological characteristics of water depend upon several factors including the location of water body, type of sewage, waste disposal, localized human population in catchment area and their activities. As a result, large quantities of organic and inorganic nutrients are added. The enrichment of nutrient also occurs due to disposal of domestic and sewage from surrounding areas which support the growth of a variety of macrophytes and microbes in aquatic system. Some of these organisms in aquatic system have paramount significance either as biological indicator or as an agent in self-cleaning process (Park, 1972). Dal lake is situated on the north east of Srinagar at latitude 34^0,07/ N and longitude 74^0, 52/ E on the right bank of river Jhelum. Dal Lake is already being prepared for its funeral. Death of Dal means a life sentence for more or less 50,000 people who reside in the lake and eke out their livelihood from it. According to London based Kashmir Environment Watch Association; the Dal has shrunk in size; compared to 1907 records, Dal lake has decreased by fifty percent in volume from 22 sq.km. The lake is also getting polluted with an estimated 30,000 to 45,000 liters of urine and 30 tones of human waste dumped into it every month. And add to it, run-off of chemical fertilizers from the vast drainage basin around it, and you have a lake whose internal life processes are under severe stress. During the past few years, grave concern is being voiced by people from different walks of life over the deteriorating condition of Dal lake. There is no denying that the lake has fallen victim to human greed, as a result of which entire ecosystem is rapidly changing. The water quality has deteriorated considerably during last few decades. Large numbers of residential buildings, restaurants and hotels have come up along the lakefront. Over the years, the lake became shallow due to siltation and accumulation of the plant debris, shrunk in size and pollution of this world famous water body has taken place. The Dal Lake, known for its enchanting beauty, pristine glory, embodiment of cultural ethos and a pride of national heritage is fast loosing its charm due to pollution of sorts that is being caused to it. The present study deals with water quality of the Dal Lake, causes of deterioration and suggestions for improvement.

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MATERIALS AND METHOD

Collection of sample

The lake water samples were collected in clean plastic container at fortnightly interval for six months from four study sites viz. site-1, Nehru park basin (divided into Dalgate channel-DD1, near Heemal hotel-DD2, Mir mohalla-DD3), Site-2, Nishat basin (divided into Centaur hotel-DD4, Char chinari-DD5, Near kabutar khana-DD6, in between Nishat and Camel bridge-DD7), site-3, Hazratbal basin (divided into Near dhobi ghat-DH1, Central site-DH2, Opposite National Institute of Technology-DH3, Telbal nallah-DH4, Metador stand-DH5), site-4, Nigeen basin (divided into Near Ashai bagh-DN1, Central site-DN2) from a depth of about 0.3m.

Sample Analysis

Turbidity, EC and pH were determined by turbidity, conductivity and pH meter. Dissolved oxygen, chloride, hardness, total alkalinity,

chemical oxygen demand, ammonium nitrogen, sulphate and phosphorus were determined by using methods as described in standard methods for the examination of water and waste water (APHA, 1998).

RESULTS AND DISCUSSION

Table 1-4 indicated the physico-chemical properties of the Dal lake water sampled at fortnightly intervals. The perusal of data of the tables indicated that most of the studied parameters namely, turbidity, EC, pH, dissolve oxygen, chloride, hardness, alkalinity, Chemical Oxygen Demand, Ammonium nitrogen, Sulphate and Phosphate were on higher side. The maximum value of pH has observed at Nehru park (DH3) 10.66±0.21 mg/1 and the minimum 8.14±0.01 mg/1 at Telbal nallaha (DH4) respectively.

The conductivity value, an indication of total nutrient concentration, was notably higher at various sites of Dal lake. The maximum value of conductivity recorded is 426.3±10.12µs/cm and the minimum 186.3±7.11 µs/cm at Telbal nallah (DH4) and near Heemal hotel (DD2) respectively. The amount of dissolved oxygen drops in various sites of the lake due to addition of the large amount of the waste water entering to Dal lake through number of drains, houseboats, hotels, floating gardens and waste water from the whole Srinagar city. However, the D.O. ranged between 9.7±0.01 to 4.3±0.0 mg/1 and 10.02±0.01 to 2.45±0.01 mg/1 at Dhobighat (DH1) and Nehru park (DD3) respectively. The higher values of C.O.D. prevail over the entire lake water, particularly at Telbal nallah, DH4 (84.33 mg/1) and the lowest value at Nehru park, DD3 (42.40±6.1 mg/1) respectively. The dissolved oxygen is found declining in various sites of the lake (DH4, Hazratbal basin, DN1 Nigeen basin and DH3 Hazratbal basin)

Table 1. Physico-Chemical Characteristics (mean value= SE) of Nehru Park Basin

Sites	PH	Conductivity µs/cm	Turbidity mg/1	D.O. mg/1	Chloride mg/1	Hardness mg/1	Total Alkalinity mg/1	COD mg/1	Ammonium Nitrogen mg/1	Sulphate mg/1	Phosphorus mg/1
Dalgate (DD1)	9.84 ±0.01	228.4 ±9.02	6.35 ±0.01	6.8 ±0.01	19.4± 0.03	116 ±0.02	105± 1.03	54.0 ±1.8	1.33 ±0.0	25.50 ±1.43	0.80± 0.00
Near Heemal hotel (DD2)	9.84 ±0.01	186.3 ±7.11	5.0 ±0.01	9.4 ±0.02	17.7± 0.11	97 ±1.1	231± 15.7	65.05 ±3.2	1.10 ±0.0	20.50 ±0.1	0.41 ±0.00
Nehru Park (DD3)	10.66 ±0.21	310.2 ±10.11	5.45 ±0.01	8.3 ±0.01	15.3± 0.09	106 ±1.0	218± 13.1	42.40 ±6.1	1.3 ±0.0	27.14 ±0.23	0.35 ±0.00

Table 2. Physico-Chemical Characteristics (mean value= SE) of Nishat Basin

Sites	PH	Conductivity µs/cm	Turbidity mg/1	D.O mg/1	Chloride mg/1	Hardness mg/1	Total Alkalinity mg/1	COD mg/1	Ammonium Nitrogen mg/1	Sulphate mg/1	Phosphorus mg/1
Corner Site Centaur Hotel (DD4)	9.92 ±0.01	290.1 ±9.00	9.08 ±0.01	10.31 ±0.01	21.7 ±1.01	107.7 ±1.01	90 ±1.0	46.80 ±1.1	0.81 ±0.0	19.27 ±1.01	0.38 ±0.01
Charchinari (DD5)	9.03 ±0.01	420.2 ±11.12	6.91 ±0.01	6.9 ±0.0	15.5 ±0.09	87.7 ±1.0	93 ±1.01	42.70 ±1.0	1.07 ±0.0	20.86 ±0.9	0.39 ±0.01
Kabutar Khana (DD6)	9.52 ±0.01	410 ±10.11	5.64 ±0.0	6.5 ±0.0	17.9 ±0.10	110.2 ±1.2	221 ±9.21	64.19 ±1.01	1.31 ±0.0	19.27 ±1.01	0.38 ±0.01
In between Nishat & Camel Bridge (DD7)	8.19 ±0.01	383.3 ±9.23	9.06 ±0.01	6.3 ±0.0	27.4 ±0.23	191.3 ±1.31	186 ±7.7	52.97 ±0.01	0.53 ±0.0	45.07 ±0.9	0.52 ±0.02

Table 3. Physico-Chemical Characteristics (mean value= SE) of Hazratbal Basin

Sites	PH	Conductivity µs/cm	Turbidity mg/1	D.O. mg/1	Chloride mg/1	Hardness mg/1	Total Alkalinity mg/1	COD mg/1	Ammonium Nitrogen mg/1	Sulphate mg/1	Phosphorus mg/
Dhobighat (DH1)	9.9 ±0.01	401.4 ±9.21	45.02 ±0.01	9.7 ±0.0	17.7 0.11	149 ±1.01	196 ±1.23	58.52 ±0.8	0.57 ±0.0	95± 1.23	0.44 ±0.01
Central Site (DH2)	9.51 ±0.01	310.2 ±7.11	1.90 ±0.0	6.8 ±0.0	24.3 ±0.11	118± 1.0	231 ±1.33	40.40 ±1.2	1.31 ±0.0	55.15 ±1.01	0.48 ±0.00
Opp.Rec (DH3)	9.7 ±0.01	396.6 ±7.12	3.03 ±0.0	6.5 ±0.0	33.7 ±0.33	164± 1.11	30.3 ±13.7	54.20 ±1.7	1.04 ±0.0	81.80 ±2.4	0.85 ±0.00
Telbal Nallah (DH4)	8.14 ±0.01	426.3 ±10.12	16.33 ±0.12	5.0 ±0.01	21.7 ±0.11	24.4 ±1.23	25.5 ±1.31	84.33 ±1.9	0.88 ±0.0	95.83 ±2.3	0.72 ±0.00
Metador Stand (DH5)	9.93 ±0.01	364.3 ±7.01	2.20 ±0.2	9.7 ±0.0	17.7 ±0.01	9.50 ±6.13	150 ±1.01	58.54 ±1.8	1.40 ±0.0	89.90 ±2.1	0.97 ±0.02

Table 4. Physico-chemical characteristics (mean value= SE) of nigeen basin

Sites	PH	Conductivity µs/cm	Turbidity mg/1	D.O mg/1	Chloride mg/1	Hardness mg/1	Total Alkalinity mg/1	COD mg/1	Ammonium Nitrogen mg/1	Sulphate mg/1	Phosphorus mg/1
Ashaibagh Bridge (DN1)	9.71 ±0.01	268 ±7.11	1.99 ±0.01	6.5 ±0.0	26.9 ±0.11	126 ±1.00	209 ±7.11	64.9 ±1.08	1.2± 0.0	51.02 ±1.0	0.33 ±0.00
Nigeen Cent (DN2)	8.81 ±0.01	390 ±8.33	2.63 ±0.03	7.8 ±0.0	37.5 ±0.13	139 ±1.01	143 ±3.1	74.50 ±1.03	1.30 ±0.01	55.53 ±1.01	0.16 ±0.00

due to the addition of large amount of waste water. The maximum value of chloride 33.7±0.13 mg/1 (DH3), hardness 950±6.13 mg/1 (DH5), total alkalinity 303±1.37 mg/1 (DH3), ammonium nitrogen 1.31±0.01 mg/1 (DH2), sulphate 95.83±2.3 mg/1 (DH4), and phosphate 0.97±0.0 mg/1 (DH5) at Hazratbal basin and the minimum values of 15.3±0.09 mg/1 (DD3), 87.7±1.0 mg/1 (DD5), total alkalinity 90±1.0 mg/1 (DD4), ammonium nitrogen 0.53±0.0 mg/1 (DD7), sulphate 0.53±0.01 mg/1 (DD4), and phosphate 0.16±0.0 mg/1 at Nehru park basin, Nishat basin and Nigeen basin respectively.

Pollution at various sites of Dal lake is attributed to the discharge of large quantities of wastewater from human settlement, agricultural lands and houseboats. The ecological stresses of the system is refluxed by excessive growth of waterweeds, deterioration of water quality, high incidence of faecal coliforms and increased levels of biological productivity (Kundangar and Sarwar (2001), Zutshi (1997), Trisal (1997), Kundangar (2005) provided extensive data of different aspects of Dal lake ecology. This is conformity with results obtained by Rao *et al.* (1982) for high altitude lakes. Further the predominance of bicarbonates for alkalinity of water seen in the present study confirms the study of Kumar and Rai (2000). Variation in the pH and alkalinity with time is perhaps tied with biological activity. On the basis of alkalinity, the lake water can be categorized as hard water type (Moyle 1946). Addition of huge amount of untreated domestic sewage through a number of sources/agricultural return water results in significant degradation of water quality of Dal lake. The various basins viz. Nehru park, Nishat, Hazratbal and Nigeen basin are witnessing significant deterioration and do not meet the criteria of its designated best use. The contamination in the whole lake is predominantly organic in nature resulting in rapid depletion of D.O. affecting the Dal lake ecosystem. The bio degradation of organic waste leads to release of nutrients, which in turn promotes the growth of algae and other aquatic plants in the lake leading to eutrophication. Pant *et al.* (1998) have also reported production of certain toxic substances like H_2S from this lake during the different period of the year, which has been reported at as typical feature of eutrophic water body (Mc Coll, 1972). The floating gardens are also contributing fertilizers into the lake water, which are highly responsible for increasing the nutrient levels of the lake system and can promote the growth of algae and other aquatic plants. Besides, the agricultural return water also enriches the ecosystem. The enrichment of ecosystem is termed as eutrophication. Dal Lake is also witnessing eutophication at number of sites. In addition to that number of Dhobi ghats in the periphery of Dal lake are contributing the detergents in the lake directly which can be detrimental to the growth and occurrence of some useful plants and animal like fish. Fish mortally has also raised in Dal lake. Besides, some important species have either declined or completely disappeared. (Singh *et al.,* 1982 and Pandey *et al.,* 1993).

At present Dal lake is being polluted, catchments being denuded, fisheries are being destroyed; drainage channels are being obstructed and subject to encroachments. Present area of Dal lake is about 11.56 sq.km only. Indiscriminate dumping of garbage, municipal waste and effluent from the carpet and other industries are polluting the lake. In recent years increased incidence of water borne human diseases is another consequence of lake pollution.

As a result, Srinagar city gradually losing its recreational value, which in turn has lead to several socio-economic problems in the region. On the basis of experimental results it may be concluded that Dal Lake water is highly polluted by (a) tourism leading to boating, rowing and other recreational activities and (b) Removal of natural vegetation from shore line area which facilitates addition of eroded materials. In order to manage the water quality of this lake some efforts have now been made, but an efficient management is required with due emphasis on; (a)proportionate inhabitation and tourism (b) erecting barriers to check debris and sediment flow and its safe disposal (c) modification of houseboats and collection of wastage generated by them with the help of floating garbage collector or by modification of sewerage system (d) recycling of wastes to produce manure, electricity and gas for cooking purposes, (e) eradication of weeds and its conversion into compost (f) cleaning of lake water through chemical and biological means and (g) eco-tourism.

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