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Role of Physico-chemical Parameters in Determination of Trophic Status of an Urban Monomictic Lake in Kashmir, India

Aubid Bashir[1], Anuja Gupta[2], Mohammad Farooq Mir[3], Mohd Yaseen Gudoo[1], Sualiha Tabassum[1], Rifat Farooq[1] and Muzamil Bashir[1]

[1]Hydrobiology Research Laboratory, Govt. Sri Pratap College (The Constituent College, Cluster University Srinagar) Kashmir, India and Department of Zoology, Barkatullah University Bhopal (M.P.), India
[2]Department of Zoology, Govt. MVM Bhopal (M.P.), India
[3]Hydrobiology Research Laboratory, Govt. Sri Pratap College (The Constituent College, Cluster University Srinagar) Kashmir (J&K), India

(Corresponding author: Aubid Bashir)
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ABSTRACT: The present investigation encompasses the study of the physico-chemical parameters for determination of water quality and status of Dal Lake. During present work, the average water temperature recorded was 17.8°C, the depth was measured 3.3m indicating shallowness due to accumulation of humus and rich micro-vegetation at bottom. Secchi-Transparency was found in low range (1.2 m) due to turbid water which directly or indirectly affects the rate of photosynthesis. pH (7.8) values depict alkaline type of water due to increased organic compound degradation. Average dissolved oxygen values fluctuated between 5mg/l to 7mg/l, but at D5 (Nigeen basin) DO values were almost nil due to high organic matter content establishing anoxic conditions. Electrical conductivity and alkalinity were found considerably higher due to nutrients released during organic matter decomposition. Chloride and total Hardness values were found above the reference range due to the presence of large amounts of organic matter of both allochthonous and autochthonous origin. Iron (173.1µg/l), Ammonical nitrogen(169.9 µg/l) and total phosphorous(340µg/l) values on an average were found extremely high, but nitrates at D5 were found highest (558µg/l) among all the parameters with Orthophosphorous (464.5µg/l) and phosphorus (167µg/l) due to large inputs of phosphorous coming into lake from agricultural runoff and human settlements. Nearly, all the values of physico-chemical parameters depict heavy pollution load in lake especially in Nigeen basin which reveals that Dal Lake is facing tremendous eutrophication and timely rehabilitation of houseboats, Hanji population must be accomplished.

Keywords: Dal Lake, physico-chemical parameters, decomposition, eutrophication.

I. INTRODUCTION

Lakes constitute one of the most important natural resource on earth and contribute globally 0.088% to fresh water resource, which is generally available for drinking and domestic purposes. These productive ecosystems are immensely important for any geographical region as they play a significant role in its ecological sustainability [16]. The Jammu and Kashmir lies 33°01′ to 35° 00′ North latitude and 73° 48′ to 75°30′ East latitude and is surrounded by Himalayas. It is estimated that nearly 6% of the land area in Kashmir is under aquatic habitats [35]. The abundance of water is the main feature of earth which serves as a resource and a habitat for a number of organisms [26]. But with the increase in urbanization, deforestation etc. the water quality is deteriorating day by day, which has adversely affected the biotic components. The Mughal rulers of India designated Srinagar as their summer resort. They developed Dal in Srinagar with enchanting Mughal gardens and pavilions as enjoyable and pleasant resort. Dal Lake is a world famous water body and referred as lake par excellence by Sir Walter Lawrence. The Dal Lake receives a large amount of raw sewage from its densely populated habitation. The Pollution of Dal Lake is a matter of great concern, since it has reached an alarming level due to inflow of large volume sewage and solid wastes therefore it has become grave concern to monitor the water quality and trophic status of Dal Lake. The useful aspects of these water bodies and their vulnerability by man's activities have necessitated their study and the study of various Physico-chemical and biological aspects of these water bodies [12].

A. Study Area

Dal lake, an urban lake is fluviatile in origin which is situated towards northeast of Srinagar at an elevation of about 1580m above sea level between the geographical coordinates of 34°5′-34°6′N latitude and 74°8′-74° 9′E. the lake is shallow with saucer shaped basin and has an open drainage [34] *i.e*., regular inflow and outflow of water takes place. The main source of water is Telbal nallah (a perennial stream) which supplies about 80% of water [19] and a large number of springs arising from the lake bed [11]. The water flows out of the lake through a weir and lock system at Dal lock gate. Dal Lake comprises of four basins viz Hazratbal, Nishat, 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 beginning of this century has shrunk little over half of the area approx 11.7sq.km. Presently the lake is spread over 1620 hectares, consisting 1305 hectares of water body and 315 hectares of marshy area. Keeping in view, the ecological significance of water bodies in Kashmir like Dal Lake, the present investigation were undertaken to determine the physico-chemical characteristics of Dal Lake.

B. Lake Climate and Area

The climate of Dal Lake is humid and temperate type ranging its temperature from 33°C in summer to subfreezing temperatures in winter. The open water basin area of the different basins of Dal Lake (km^2) is shown in following Table 1.

Table 1: **Dal Lake Area.**

S. No.	Basin	Open water basin	Marshy Land	Total Area
1.	Hazratbal	5.6	3.2	8.8
2.	Bod Dal Basin	4.2	-	4.2
3.	Gagribal Basin	1.3	-	1.3
4.	Boulevard Basin	0.3	0.2	0.5
5.	Floating gardens	0.3	4.5	4.8
	Total	11.7	7.9	19.6

II. MATERIAL AND METHODS

A. Site Selection

To investigate and to monitor the water condition in Dal Lake, a total of five sites were selected based on difference in their geographical profile from five basins viz., Telbal inlet of Hazratbal basin (D1), 50 m towards NW Nishatgarden of Nishatbasin (D2), Rup lank (Chaar-chinari) in Bod Dal Basin (D3), Central site of Gagribal basin (D4) and Central site of Nigeen basin (D5). Water enters in Dal Lake at site (D1) where telibal nallah drains in Dal Lake along with silt and sediment. Among these five sites site second (D2) is constantly disturbed during summer by manual deweeding process by local Hanjies. Average depth of this site is 2.3 meters. Gagribal basin (D4) is characterized by dense growth of macrophytes. One sampling station was also selected from Nigeen basin designated as (D5) Nigeen central site deepest site were average depth varies from 5.5-6 meters with open water area.

B. Methodology

For studying water quality of Dal Lake, Water samples were collected between 9am to 4pm with the help of Ruttner type of water sampler having 2.5L capacity in 2L polyethylene plastic bottles on monthly basis. Separate water samples were collected for determination of dissolved oxygen in corning glass bottles of 125ml capacity. During sampling the analysis of some physical-chemical parameters was carried out at sampling sites immediately, those parameters include Air and water temperature, transparency, for dissolved oxygen sample fixation, pH and conductivity. The samples were taken to laboratory for further analysis. The water samples were analyzed within 24 hours by adopting standard methods [1,13].

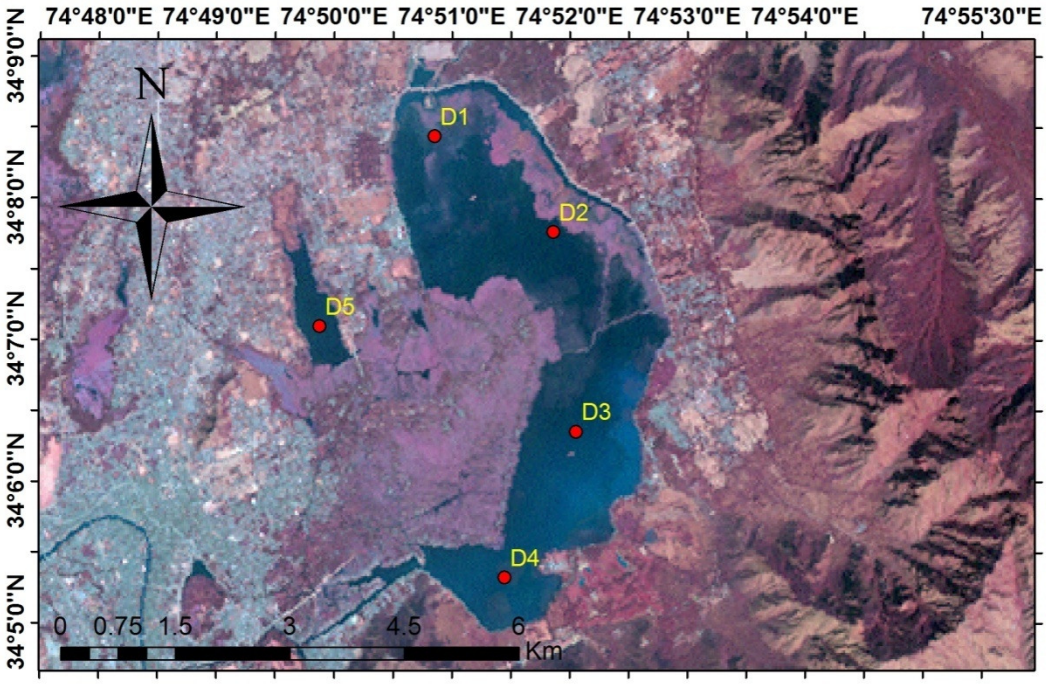


Fig. 1. Satellite map showing location of study sites in Dal Lake.

III. RESULTS AND DISCUSSION

A. Results

A detailed investigation of different parameters of water samples were carried out in Dal lake from February to December 2016. The average results of the physico-chemical parameters of water samples are presented in table 2.

Table 2: Mean values of physico-chemical parameters of D1, D2, D3, D4 and D5 in Dal Lake.

S. NO.	Name of the Parameter	UNITS	D1	D2	D3	D4	D5	MEAN	STD. DEV ±
1	Air Temperature	**°C**	19.9	20.5	20.5	20.6	20.6	20.4	0.29
2	Water Temperature	**°C**	17.5	17.8	17.5	17.7	18.3	17.8	0.33
3	Depth	**M**	3.2	2.3	3	2.2	6	3.3	1.55
4	Transparency	**M**	1	1.2	1.5	1	1.4	1.2	0.23
5	pH	**-**	8.1	7.8	7.3	7.9	7.8	7.8	0.29
6	Electrical conductivity	**µs/cm**	215.4	199.3	203.6	239.1	260.2	223.5	25.68
7	Dissolved Oxygen	**mg/l**	7.4	6.5	6.6	5.8	5.5	6.4	0.74
8	Alkalinity	**mg/l**	157.3	132.9	132	150.2	180.2	150.5	19.88
9	Calcium Hardness	**mg/l**	38.1	35.1	33.7	35.9	37.2	36.0	1.73
10	Magnesium Hardness	**mg/l**	4.1	3.4	3.4	3.9	4.3	3.8	0.41
11	Total hardness	**mg/l**	157.3	132.9	132	150.2	180.2	150.5	19.88
12	chloride	**mg/l**	11.6	13.7	10.4	15.2	18.5	13.9	3.18
13	Ammonia-nitrogen	**µg/l**	148.4	145.7	146.9	193.5	215	169.9	32.28
14	Nitrate-nitrogen	**µg/l**	530.9	469.4	461.2	504.9	558.6	505.0	41.02
15	Iron	**µg/l**	193.1	156.4	140.7	181.6	193.9	173.1	23.63
16	Orthophosphorous	**µg/l**	141.6	108.2	82.3	136.9	167	127.2	32.64
17	Total phosphorous	**µg/l**	380.7	263	228.4	363.2	464.5	340.0	94.97

B. Discussion

Physico-chemical characteristics of an aquatic ecosystem reflect not only the quality of the system but also the type and density of its biota, analysis of such characters generates information regarding pollution pattern and magnitude of pollution loading of an aquatic ecosystem [11]. Due to discharge of large quantities of wastes from human settlements, agricultural runoff and house boats remarkable changes have occurred in water chemistry of Dal Lake.

The average air temperature ranged from minimum 19.9°C to maximum 20.6°C. The highest air temperature was recorded at site D5. Water temperature is an important factor that controls the energy relationship at different trophic levels. During the study period, the average water temperature varied from max. 18.3°C at D5 to min.17.5°C at D3 and D1. The surface water temperature of all sites follows closely to that of the air temperature. Similar observation has also been made by [32]. The temperature variation recorded during the study period was optimal for normal growth and survival of aquatic organisms [6].

Water depth showed gradual saptio-temporal variation. The Depth increased gradually from spring to summer and showed gradual decrease towards winter. The site D4 showed minimum average depth of 2.2m to maximum 6m depth at D5. The minimum depth at D4 reflects the shallowness of area due to accumulation of sediment, wastes humus and rich macro vegetation at bottom.

Transparency (using secchi disk values) of water is an important factor in determining the penetration of sunlight through water affecting process of photosynthesis. Most workers have found transparency to be higher in winter and lower in summer. At site D1 and D4 transparency showed minimum average value of 1.0m while as maximum transparency was seen at D3 with 1.5m value. The value when compared with the [17] falls within the category of Eutrophic lakes. This condition has been attributed to different factors by different limnologists like setting of materials in calm weather suspension of phytoplankton in water and glacial silt [34]. The transparency was low almost at all sites of Dal Lake, which may be due to increased suspended matter, silt load and humus.

pH of a water body indicates whether water is acidic or alkaline. The pH of water fluctuated on an average minimum from 7.3 at D3 to maximum of 8.1 at D1.The values of pH depict water of Dal Lake as alkaline in nature. The higher values of pH are due to addition of hydroxyl, bicarbonate and carbonate anions, production of salicylic acid by hydrolysis of silicates in the rock beds of the catchment areas [34]. It may also be attributed due to increased organic compound degradation which is high in the lake. High range of pH at site D1 (Telibal inlet) may be due to continuous dilution of the lake water with the Telibal stream and indicates higher productivity of the water body. This is in conformity with the conclusions drawn by Harrel [10].

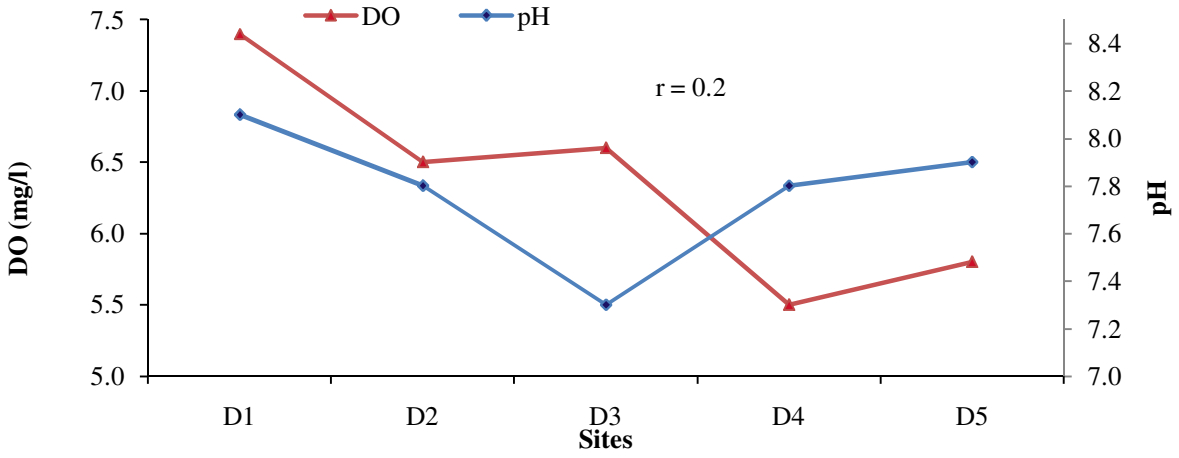
Electrical conductivity is a measure of ability of a solution to conduct electric current. The average value of conductivity ranged between 199µS/Cm to 260 µS/Cm. the maximum value was found at site D5 and minimum average value was found at D2. The higher values above 200 µS/Cm of conductivity at sites D1, D3, D4 and D5 were recorded which indicates Eutrophic nature of water but at site D2 the values of conductivity were 199 µS/Cm is an indicative that water is at its highest permissible limit and is shifting to Eutrophic nature. The higher values were related to the abundance of nutrients released during decomposition of organic matter (macrophytes and animals) at rising temperature. It reported that high levels of conductivity indicate pollution status and trophic levels of lakes and rivers [32].

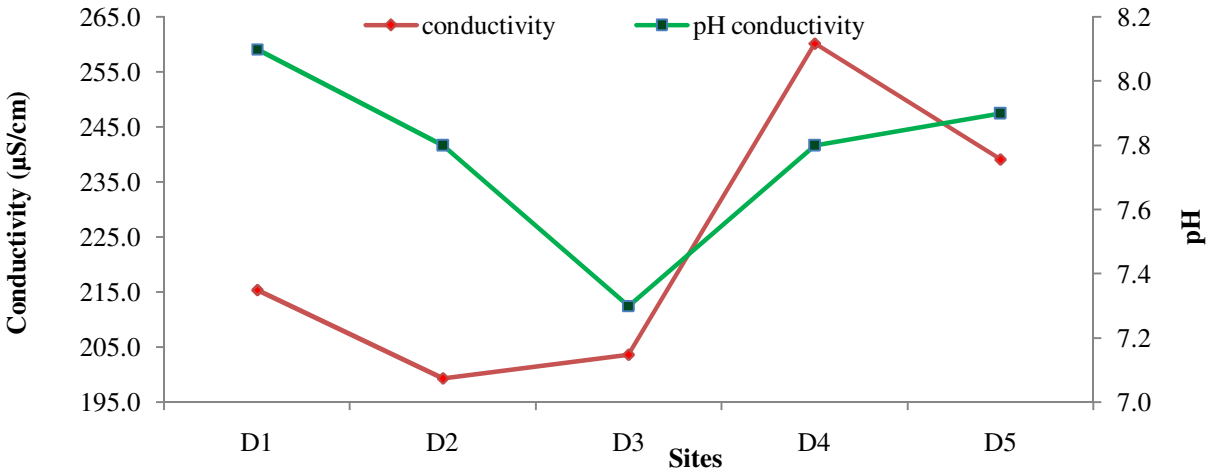
Dissolved oxygen (DO) content of a water body is inversely proportional to temperature and decomposition processes in lake on which survival of aquatic fauna is completely dependent. The average DO levels oscillated from 5.5mg/L to 7.4 mg/L. it was found maximum 7.4mg/L at D1 and minimum 5.5 mg/L at D5. The higher value of DO at site D1 may be due to low organic matter decomposition and continuous addition of water from telibal stream which has turbulent flow and its value were observed minimum at D5 can be due to high amount of nutrient which in turn causes prominent oxygen depletion, DO also show close relationship with temperature. During present study DO decreased in June and July as a result of increasing water temperature and consumption rate [30] and [11].

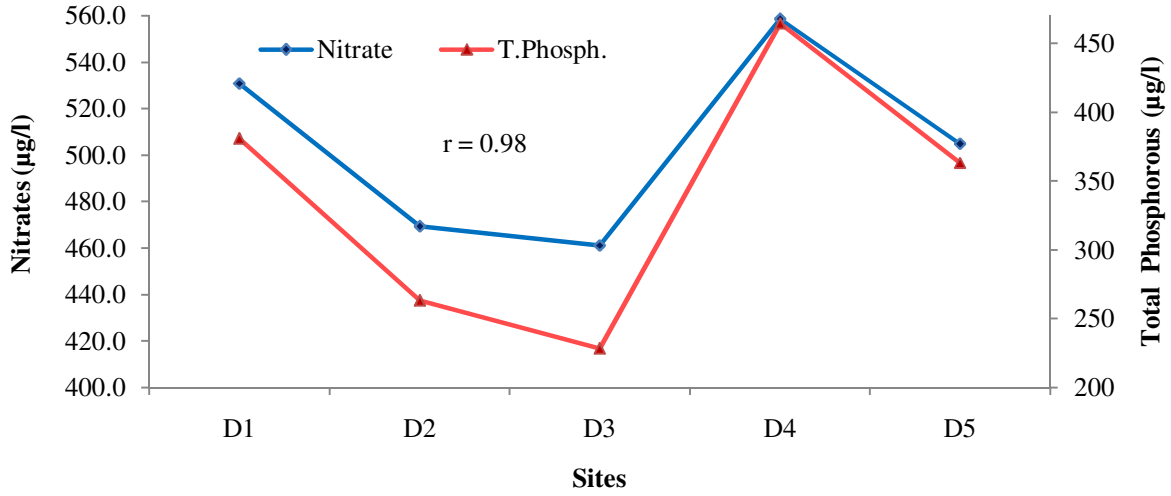
Alkalinity is generally associated with the presence of carbonates and bicarbonates in natural waters. The mean alkalinity of all sites varied between 132mg/L to 180.2mg/L. the values of alkalinity at site D2 and D3 depict intense photosynthetic activity continuously removing bicarbonates from CO_2 as a result calcium carbonate got precipitated and pH value increased. During present study the values of total alkalinity was found to be above hundred which indicate nutrient enrichment which is due to effluents and sewage coming from house boats and drainage from settlements. The alkalinity of the lake has been found higher which is due to nutrient enrichment [31].

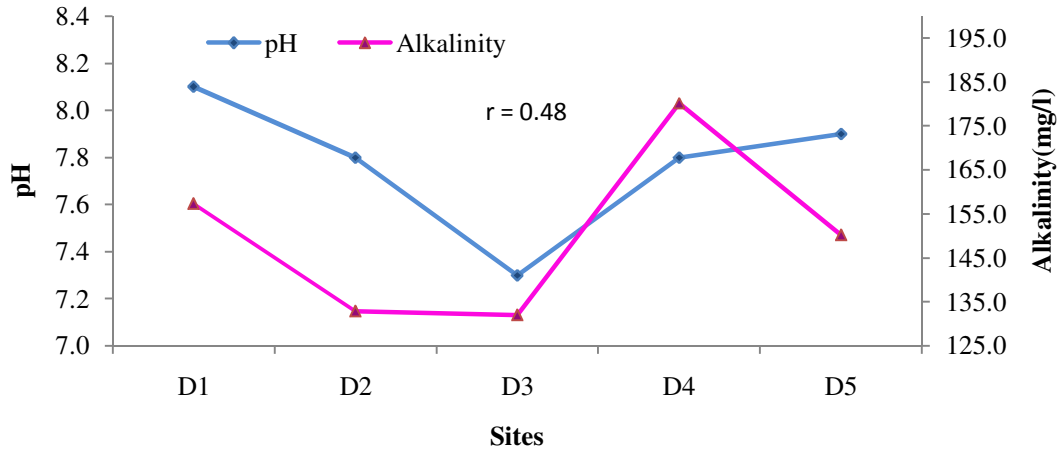
IV. CORRELATION

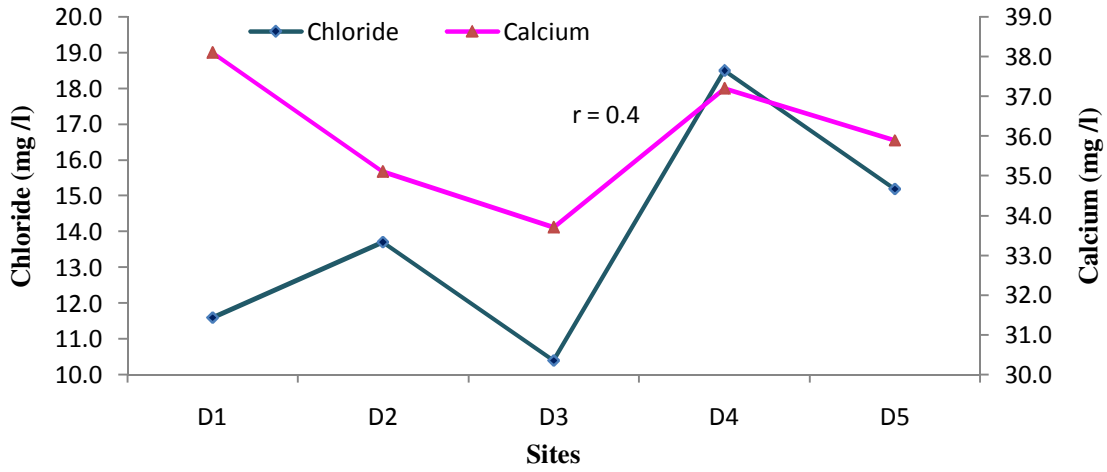
Graphs showing values of Coefficient of correlation (ʎ) between different physico-chemical parameters as follows:

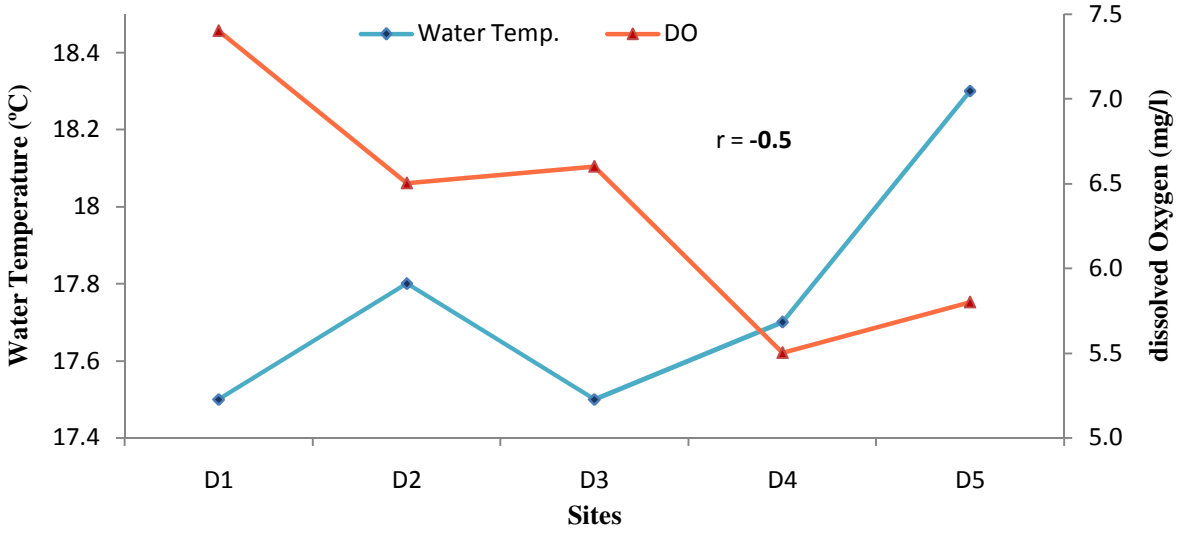







pH
Alkalinity
r = 0.48
pH
Alkalinity(mg/l)
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
195.0
185.0
175.0
165.0
155.0
145.0
135.0
125.0
D1
D2
D3
D4
D5
Sites


Chloride
Calcium
r = 0.4
Chloride (mg /l)
Calcium (mg /l)
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
39.0
38.0
37.0
36.0
35.0
34.0
33.0
32.0
31.0
30.0
D1
D2
D3
D4
D5
Sites


Water Temp.
DO
r = -0.5
Water Temperature (°C)
dissolved Oxygen (mg/l)
18.4
18.2
18
17.8
17.6
17.4
7.5
7.0
6.5
6.0
5.5
5.0
D1
D2
D3
D4
D5
Sites

The total hardness of water indicates whether water is soft or hard in nature and hardness of water is due to presence of carbonates and bicarbonates of calcium and magnesium from detergents and soap. During the present study the average value of total hardness of Dal lake ranged from 132.0mg/L at D2 and D3 to maximum of 180.2mg/L at D5. Present study revealed the Ca^{2+} and Mg^{2+} were found to be higher almost at all sites and it has been associated with thick population of plankton. The water of Dal Lake was found to be hard water type with highest hardness limit in Nigeen basin. Similar observations were made by [19, 29,15].

Magnesium content varied from minimum 3.4 mg/L at D2 and D3 to maximum of 4.3 mg/L. the source of magnesium and calcium can be attributed to presence of limestone in the catchment areas [14]. Low content of magnesium is possibly due to its uptake by plants in the formation of chlorophyll-porphyrin metal complexes and in enzymatic transformation [25].

Calcium is usually associated with hardness of water in combination with Magnesium. Calcium on an average varied from minimum average value of 33.7 mg/L at D3 to maximum average value of 38mg/L at D1. The higher value of calcium is associated with presence of lime stone in catchment area. The concentration of calcium remained high almost at all sites during study period placing wetland in Ca^{++} rich type [5].

The chloride contents of water samples at all sites varied on an average from 10.4mg/L at D3 to 18.5mg/L at D5. The present investigation found dynamic fluctuation in chloride content this may be due to rain water coming from catchments areas, sewage coming from house boats, settlements and due to organic runoff from floating gardens in Dal lake [2]. Higher chloride concentration of lake may be related to the presence of large amounts of organic matter of both allochthonous and autochthonous origin [18]. The highest concentration of chloride was observed at D5 (Nigeen central) is an indicator of inorganic pollution, again owes its origin to the sewage wastes from human settlements and chemical wastes from floating gardens draining into lake [5].

Ammonical Nitrogen (NH_3-N) showed fluctuating trend during the study period. It ranged from average minimum value of 145mg/L at site D2 to maximum value of 215mg/L at site D5. The high value of Ammonical nitrogen at some sites in a lake is due to wastes coming from human settlements, due to large number of house boats draining their sewage into lake and use of fertilizers in nearby floating /vegetable gardens [11] and their run-off finds direct way into the lake, but at some sites its value showed decreasing trend and may be due to nitrification or by direct absorption by phytoplankton [24,28].

During the investigation period the values of nitrate nitrogen (NO_3-N) recorded were in the range from average minimum value of 461.2mg/L at D3 to average maximum value of 558.6mg/L at D5. The increased concentration of nitrates resulted in enhanced productivity of lakes [20,14] which is due to nitrification *i.e,* oxidation reactions of the Ammonical nitrogen taking place and converting it into nitrate [4].

Iron in surface water is generally present in the form of ferric state. The Iron content varied from the minimum average value of 140.7mg/L at D3 to Maximum average value of 193.9mg/L at D5. Surface waters in a normal pH range of 6 to 9 rarely carry more than 1 mg of dissolved iron per liter [31].

Phosphorous is considered as one of the important nutrients having role in the productivity of freshwaters as it is essential in determining the fertility of lakes. The orthophosphate phosphorous ranged from average minimum value of 82.3mg/L at D3 to average maximum of 167mg/L at D5.the lowered concentration of Orthophosphorous content in lakes is due to the formation of an insoluble calcium-phosphate complex [16].

On the other hand, average concentrations of phosphorous varied from average minimum of 228.4mg/L at D3 to average maximum of 464.5 at D5. The higher values recorded for phosphorous during study period can be related to agricultural practices. The present study is in complete agreement with the findings of [33] who attributed phosphate levels increasing up in Mansar Lake due to inflow of fertilizers from agricultural fields in the catchment area of the lake.

IV. CONCLUSION AND SUGESSTIONS

It may be concluded from the present investigation that Dal Lake is suffering from the tremendous anthropogenic pressure. The sewage from the house boats and other human settlements, silt and sediment from drains opening in lake and agricultural runoff from nearby floating gardens have caused nutrient enrichment in the lake which are responsible for eutrophication of Dal lake. It is therefore suggested that house boats and nearby human settlements (Hanjies, Donga-Walas) should be rehabilitated to the proper place which is need of an hour. The seasonal dredging and deweeding process should be employed and awareness programmes should be organized wherein people should be made aware about importance of Dal Lake and other ecosystems.

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REFERENCES

[1]. APHA (1998). *Standard Methods for the Examination of water and wastewater*. 20th edition American Public Health Association, Washington, D.C.

[2]. IA Ahangar., DN Saksena., MF Mir and MA Ahangar (2012). Seasonal variation in physico-chemical characteristics of Anchar Lake, Kashmir. *International journal of advanced biological research,* **3**(2), 352-357.

[3]. IA Ahangar, MF Mir., DN Saksena, and MA Ahangar (2012). Zooplankton Diversity of Anchar Lake with relation to trophic status, Srinagar, Kashmir. *Global journal of Environmental Research,* **6**, 17-21.

[4]. M Bashir., R Chouhan., MF Mir., M Ashraf., N Amin., SA Bashir and MY Gudoo (2017). To evaluate pollution studies in relation to the water quality status of Anchar Lake Srinagar Kashmir. *Journal of environmental science, computer science and engineering and technology,* **6**(1),17-23.

[5]. M Bashir., R Chouhan., MF Mir., M Ashraf., N Amin., SA Bashir and Tabasum S. (2017). Effect of pollution on Fish Diversity in Anchar Lake, Kashmir. *International journal of fisheries and Aquatic Studies,* **5**(1), xx-xx.

[6]. CE Boyd (1979). Water quality in warm water fish ponds. Craft Master Printers, INC Opelika Alabama.

[7]. JA Dar., MF Mir., NA Bhat and MA Bhat (2013). Pollution Studies of a Monomictic Lake, Srinagar Jammu and Kashmir India. *Forest research*, **2**(1).

[8]. SH Dar, AA Khan, TA Shah and, QJ Shami (2016). Assessment of Physico-chemical Parameters of Dal Lake, Srinagar Kashmir. *International journal of Innovative Research and Advanced Studies,* **3**(11).

[9]. S Fazal and A Amin, (2013). Boatmen and Status of Dal Lake and Its Environs: A Tale of Srinagar. *Environment and Urbanization Asia*, **4**(1) 73–92.

[10]. RC Harrel (1973). Limnological studies on a south east Texas Meander-Scar Lake. *The Texas journal of Science,* **24**(4), 517-533.

[11]. PSA Kanue., S Munshi., SM Zubair and HC Dutt (2013). Water chemistry of Hazratbal Basin of Dal Lake in Kashmir. *Life Sciences Leaflets,* **3**, 89-95.

[12]. MUZ Khan., I Majeed., IM Ganaie., K Hussain and, KH Bhat (2014). Limnological Study of Dal Lake Srinagar J and K. *International Journal of Engineering Research and General Science,* **2**(6).

[13]. FJH Mackereth (1963). Some Methods of Water analysis for Limnologists. *Fresh water Biology Association*, **21**, 1-70.

[14]. MF Mir, N Amin, A Farooq, AH Shah., M Bashir and A Bashir (2017). Vertebrate fauna of Hokarsar Wetland, Kashmir. *International Journal of Fauna and Biological Studies,* **4**(4), 109-111.

[15]. MF Mir, A Bashir., MY Gudoo., S. Tabassum., M Bashir., R Farooq and S Bundh (2017). Sediment Chemistry of Gagribal Basin of Dal lake. *International Journal of Fauna and Biological Studies,* **4**(4), 126-130.

[16]. B Mushtaq, R Raina, T Yaseen, A Wanganeo and AR Yousuf (2013). Variations in the physico-chemical properties of Dal Lake, Srinagar, Kashmir. *African Journal of Environmental Science and Technology*, **7**(7), 624-633.

[17]. OECD (Organization of Economic Cooperation and Development 1982). Scientific fundamentals of the eutrophication of lakes and flowing water with particular reference to nitrogen and phosphorous as factor in eutrophication (R.A. Vollenweider ed.), organization of Economic Cooperation and development Paris, 159.

[18]. AK Pandit (1993). Dal lake ecosystem in Kashmir Himalaya: Ecology and Management in ecology and pollution of Indian Lakes and reservoirs. (PC Mishra and RK Trivedy editions), *Ashish publication House,* New Delhi, India.

[19]. MY Qadri and AR Yousuf (1980). Influence of physico-chemical factors on the seasonality of cladocera in lake Mansbal. *Geobiosciences,* **7**, 273-176.

[20]. JB Rasmussen (1988). Littoral Zoobenthic Biomass in Lakes, and its Relationship to Physical, chemical and trophic factors. *Can. J. Fish. Sci.,* **45**, 1436-1447.

[21]. SA Shah and YA Shah. (2013). Physico-Chemical Dynamics in Littoral Zone of Nageen Basin of Dal Lake Kashmir, India. *International Research Journal of Environmental Science,* **2**(3), 11-14.

[22]. NJ Shaikh., A.A. Sayed and M.K.E. (2013). Study of Physicochemical of water quality in Katraj Lake, Pune. *International journal of Environmental sciences,* **4**(1).

[23]. M Sushil., JM Reshi and M Krishna (2014). To evaluate the water quality status and responsible factors for variation in Anchar Lake, Kashmir. *Journal of Environmental Science, Toxicology and Food technology,* **8**(2), 55-62.

[24]. M Takahashi and Y Saijo (1981). Nitrogen metabolism in lake Kizaki, Japan. Ammonium and Nitrate uptake by phytoplankton. *Arch Hydrobiologia*, **91**, 393-407.

[25]. RG Wetzel (2001). Limnology; lake and river ecocsystem. 3rd edition academic press.

[26]. RG Wetzel (2003). Limnology 2nd edition Saunders college publications New York.

[27]. RP Tokinova., AA Ratushnyak and OY Tarasov (2012). Influence of Nitrate-Phosphate overload on Macrozoobenthos communities in thickets of aquatic Macrophytes. *World applied Sciences Journal,* **20**(4), 615-619.

[28]. DQ Toetz (1981). Effects of pH, phosphate and ammonia on the rate of uptake of nitrate and ammonia by freshwater phytoplankton. *Hydrobiologia,***76**, 23-26.

[29]. CL Trisal (1977). Studies on primary production in regulated water bodies in Egypt Arch. *Hydrobiologia,* **133**, 107-128.

[30]. A Wanganeo and R Wanganeo (1994). Hydraulic detention period carrying capacity of a system. *Hydrobiologia*, **1**, 1-6.

[31]. MA Wani., A Dutta., MA Wani and UJ Wani (2015). Analyzing Physico-chemical Characteristics of Dal Lake Waters of Kashmir. *Global Journal of Engineering Science and Researchers*, **2**(3), 67-84.

[32]. SM Zuber., A Devi., SA Beigh., SY Parray., G Haroon., SA Ahmad and Winkle. (2010). Assessment of the biotic status of the Neeru Nallah Doda, J&K. *Intl. J. Comp. Imtel. Res.,* **6**(2), 299-304.

[33]. SM Zuber (2007). Ecology and economic valuation of Lake Mansar Jammu Ph.D. thesis University of Jammu, Jammu.

[34]. DP Zutshi., BA Subla., MA Khan and A Wanganeo (1980). Comparative limnology of nine lakes of Jammu and Kashmir Himalayas. *Hydrobiologia,* **72**(1-2), 101-112.

[35]. DP Zutshiand B Gopal (2000). State of biodiversity in lakes & wetlands of Kashmir valley. *International journal Environmental Biodiversity & Conservation* (M.A. Khan, ed.). A.P.H New Delhi. 51-67.

[36]. DP Zutshi., BA Subla., MA Khanand A Wanganeo (1980). Comparative limnology of nine lakes of Jammu and Kashmir Himalayas. *Hydrobiologia,* **72**(1-2), 101-112.

[37]. DP Zutshi and B Gopal (2000). State of biodiversity in lakes & wetlands of Kashmir valley. *International journal Environmental Biodiversity & Conservation* (M.A. Khan, ed.). A.P.H New Delhi. 51-67.