International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Studies on Conservation Efforts of Dal Lake, Kashmir, and Management of Its Aquatic Macrophytic Species

Umar Mushtaq Sofi

Ph. D Research Scholar (Environmental Science), SunRise University Alwar, (Rajasthan)-301026, India
Email: *sofiomar291[at]gmail.com*

Abstract: ***The present studies was carried out regarding the efficiency of fluidized aerated bed (FAB) based sewage treatment plants to determine the water chemistry of Dal Lake in Kashmir, as well as the fluctuations in the physico-chemical parameters of the lake's water. The lake's water chemistry varied to a lesser extent from one basin to the next. Water samples have been collected almost every fortnightly from all the three sewage treatment plants (Stp's.) of Habbak, Laam and Hazratbal and were carried to Lakes and Waterways Development Authority (LAWDA) laboratory for detailed analysis. While there has been some improvement in water quality due to the development of sewage treatment facilities, the quality of water at some sites continues to deteriorate. According to the current study, increased phosphorus concentrations and the appropriate P/N ratio will have a significant impact on the primary production and structure of plankton communities and aquatic macrophytes in various regions of the lake, resulting in a deterioration of water quality. A general survey was carried out randomly on all the four sites of Dal and Nigeen lakes (Hazratbal, Nigeen basin, Nehru Park and Nishat basin). During survey different weeds were collected and photograph of each weed was taken out separately along with the growing habitat. Macrophytes, submerged macrophytes, floating macrophytes, and phytoplankton abound in Dal Lake's environment. The lake is known for its lotus blooms (Nelumbonucifera), which bloom in July and August. Ceratophyllumdemersum (which grows all year), Typhaangustata, Potamegtoncrispus, and Nymphae sp. have all been documented to grow prolifically in eutrophic zones. The knowledge about the current and the potential uses of these weedy species was gained from the local Hanji's and farmers inhabiting in and around the banks of Dal Lake. The frequency distribution of these weeds was observed on monthly basis. A general survey was carried out on the restoration and conservation processes and photographs of different works like manual de-weeding, harvester de-weeding encroachment, rehabilitation and resettlement, anthropogenic activities, spring restoration and bunding of Dal catchment to stop soil erosion and increase water infiltration was taken. Pictures of rehabilated colony of Dal dwellers' were also taken at Rakh-i-ArthBemina.***

Keywords: conservation, Dal Lake, macrophytes, management, water

1. Introduction

A lake is a closed body of water that is completely surrounded by land and has no direct connection to the ocean. Increased anthropogenic activity on lake water systems results in significant pollutant loads, such as phosphorus and nitrates, causing a rapid deterioration in water quality. Lakes are easily contaminated by distant inputs, are less dynamic, and accumulate toxins over time. According to data and case studies collected around the world, lake water quality has been quickly deteriorating, particularly in developing nations, due to natural and anthropogenic processes. The lake is located within a catchment area covering 316 square kilometers (122 sq. mi) in the Zabarwan mountain valley, in the foothills of the Himalayan range, which surrounds it on three sides. The lake, which lies to the east and north of Srinagar city covers an area of 18 square kilometers (6.9 sq. mi), although including the floating gardens of lotus blooms, it is 21.2 square kilometers (8.2 sq. mi) (an estimated figure of 22–24 square kilometers (8.5–9.3 sq. mi) is also mentioned). The main basin draining the lake is a complex of five interconnected basins with causeways; the Nehru Park basin, the Nishat basin, the Hazratbal basin, the Nigeen basin and the Barari Nambal basin. Navigational channels provide the transportation links to all the five basins.

The average elevation of the lake is 1, 583 meters (5, 194 ft.). The depth of water varies from 6 meters (20 ft.) at its deepest in Nigeen Lake to 2.5 meters (8.2 ft.), the shallowest at Gagribal. The depth ratio between the maximum and minimum depths varies with the season between 0.29 and 0.25, which is interpreted as flatbed slope. The length of the lake is 7.44 kilometers (4.62 mi) with a width of 3.5 kilometers (2.2 mi). The lake has a shore length of 15.5 kilometers (9.6 mi) and roads run all along the periphery. Irreversible changes through urban expansion and road building have been made along the shore line to accommodate for dramatic tourist growth. Two islands built in the basin have placed further restrictions on the flow of the lake and as a result, marshy lands have emerged on the peripheral zones, notably in the foothill areas of the Shankaracharya and Zaharbwan hills. These marshy lands have since been reclaimed and converted into large residential complexes.

Figure 1: Showing sewage treatment Fig.2. Location of Dal Lake in Srinagarplants (STPs)) in Dal lake

Study area 1

The Dal Lake environment (Lat.340 – 6′ N, 740 – 45′ E, alt.1583m) in the heart of Srinagar, the summer capital of Jammu & Kashmir State, has been under immense anthropogenic strain from more than three decades The second-largest urban lake in the state is important for tourism and pleasure in Kashmir and is known as the "Jewel in the Crown of Kashmir" or "Srinagar's Jewel. " Commercial fishing and water plant harvesting are also key activities on the lake.

The lake's 15.5-kilometer (9.6-mile) shoreline is surrounded by a boulevard lined with Mughal-era gardens, parks, houseboats, and hotels. Mughal gardens along the lake's shore, such as Shalimar Bagh and NishatBagh (constructed during the time of Mughal Emperor Jahangir), and houseboats sailing along the lake in colorful shikaras, provide scenic views of the lake. During the winter, the temperature can reach 11 degrees Celsius (12 degrees Fahrenheit). The lake is 18 square kilometers (6.9 square miles) in size and is part of a natural wetland that is 21.1 square kilometers (8.1 square miles) in size, including its floating gardens. During the months of July and August, the floating gardens, known in Kashmiri as "rad, " bloom with lotus blossoms. Causeways separate the marsh into four basins: Gagribal, Lokut Dal, Bod Dal, and Nagin (although Nagin is also considered an independent lake). Rup Lank (or Char Chinar) and Sona Lank are the islands in the middle of Lokut-dal and Bod-dal, respectively.

Study area-2

The ecosystem of Dal Lake is ecologically rich in macrophytes, submerged macrophytes, floating macrophytes and phytoplankton. Macrophyte flora recorded in the lake's aquatic and marshland environment consists of 117 species, belonging to 69 genera and 42 families. The lake is noted in particular for its *Nelumbonucifera* (lotus flowers) which bloom in July and August. The prolific growth of *Ceratophyllumdemersum* in the eutrophic zones has been reported, with *Myriophyllumspicatum* and *Potemogettonlucens* cited as dominant species. Other macrophytes discerned in different zones of the lake include *Typhoangustata*, *Phragmitesaustralis*, *Myriophyllum*, *Sparganiumevectum* and *Myriophyllumverticillatum*, which contribute to the production of macrophites. The rooted variety of the floating leaf type consists of *Neelambiumnucifera*, *Nymphaea alba*, *N. tertagonia*, *N. candida*, *Nymphoidespeltatum*, *Salvinianatans*, *Hydrocharisdubia*, *Nymphaea sp.* and *Potamogetonnatans*, all of which occupy 29.2% of the lake. Phytoplanktons include *Navicularadiosa*, *Nitzschiaaccicularis*, *Fragilariacrotonensis*, *Diatomaelongatum*, *Scenedesmusbijuga*, *Pediastrum duplex*, *Tetraedron minimum*, *Microcystisaeruginosa* and *Merismopediaelegans.*

2. Methodology

(A) Water sampling: Water samples have been collected almost every fortnightly from all the three sewage treatment plants (stp.) of Habbak, Laam and Hazratbal. Water samples have been collected from both inlet and outlet chambers of treatment plantsto determine the efficiency of treatment plants. water samples have been collected in plastic bottles of 1 litre capacity and were carried to LAWDA laboratory for detailed analysis.

(B) Survey on weedy species:

A general survey was carried out randomly on all the four sites of Dal and Nigeen lakes (Hazratbal, Nigeen basin, Nehru Park and Nishat basin). During survey different weeds were collected and photograph of each weed was taken out separately along with the growing habitat. The knowledge about the current and the potential uses of these weedy species was gained from the local Hanji's and farmers inhabitating in and around the banks of Dal Lake. The frequency distribution of these weeds was observed on monthly basis.

(C) Survey on restoration and conservation works:

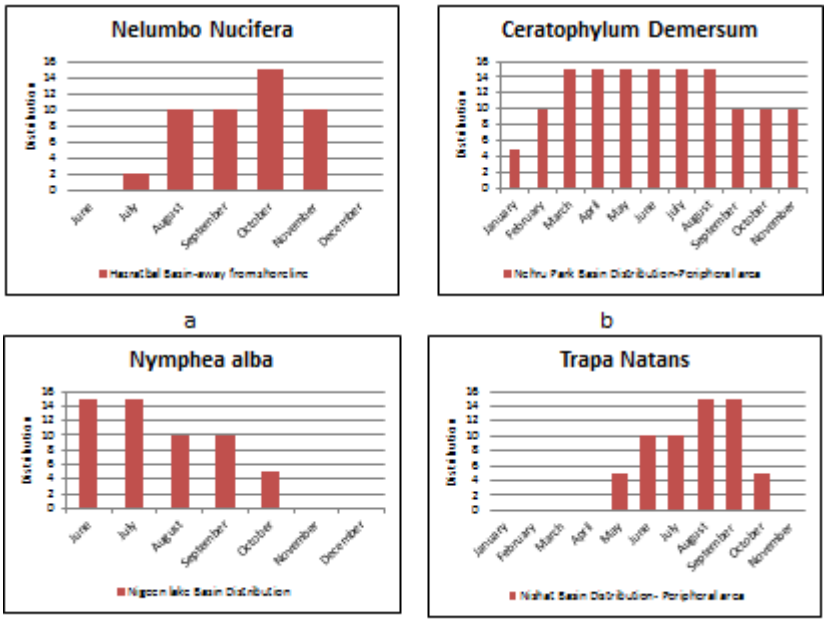
A general survey was carried out on the restoration and conservation processes and photographs of different works like manual deweeding, harvester deweeding encroachment, rehabilitation and resettlement, anthropogenic activities, spring restoration and bunding of dal catchment to stop soil erosion and increase water infiltration was taken. pictures of rehabilated colony of Dal dewellers was also taken at Rakh-i-ArthBemina.

(D) Chemical analysis:

Chemical analysis of water samples collected from both inlet and outlet chambers of STP'S were carried out at LAWDA laboratory at Nishat basin. pH of water was determined by electrometric method using a laboratory pH meter. Nitrate Nitrogen ($No3^{-N}$) µg/l, Ammonical nitrogen ($NH4^{-N}$) (µg/l)

and Ortho-phosphate (µg/l) were determined separately on spectrophotometric device employing methods given in (APHA) 1998.

Fig'a-d graphically showing monthly growth of different weeds in Dal Lake for the months of year 2021 (Away from shoreline)



a b c d

Fig'a-b stacked line graph with markers showing monthly growth of different weeds in Dal Lake /NigeenLake for the months of year 2021 (Near shoreline)

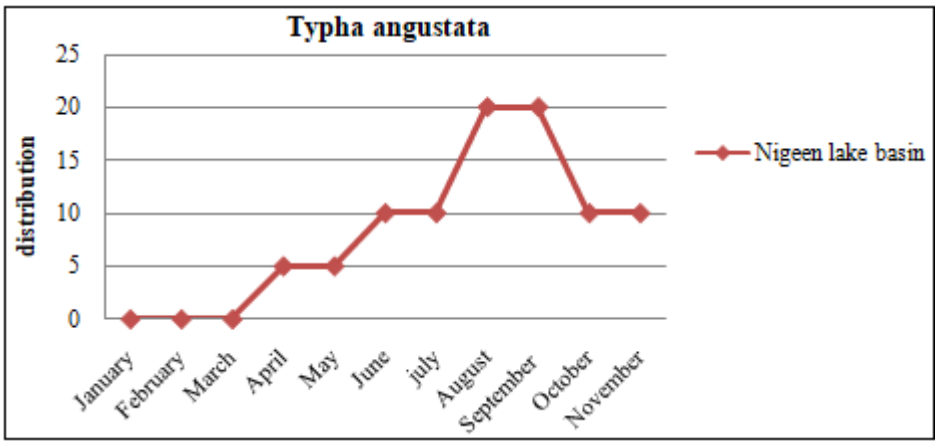


Figure a

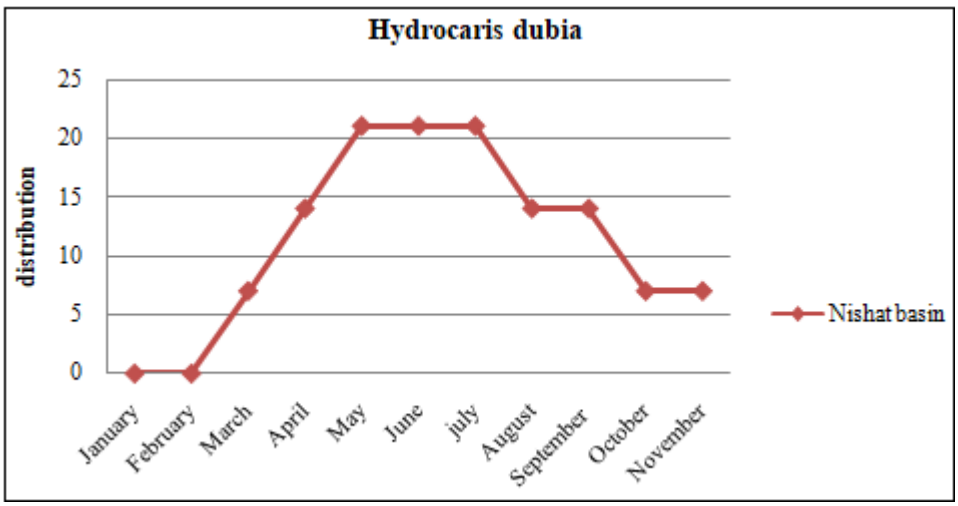


Figure b

Table 1: Measurement of Ammonical nitrogen ($NH4^{-N}$), Ortho-phosphate, Total phosphate of both inlet and outlet water samples at 4.5 Mld. sewage treatment plant (STP) Laam

STP. Laam	Ammonical nitrogen ($NH4^{-N}$) (µg/l)			Ortho-phosphate (µg/l)			Total phosphate (µg/l)		
Sampling Date	Raw	Final	Reduction %age	Raw	Final	Reduction %age	Raw	Final	Reduction %age
15th February, 2021	1602	90	31.96	876	322	63.24	1597	951	40.45
27th February, 2021	1450	698	51.86	678	336	50.44	1467	888	39.46
13th March, 2021	1877	1217	35.16	525	376	28.38	849	540	36.39
27th March, 2021	1842	1154	37.35	424	174	58.96	1544	719	53.43
15th April, 2021	2315	2150	7.12	333	201	39.6	555	75	50.45
27th April, 2021	1359	420	69.09	1359	420	69.09	1615	909	43.71

Table 2: Measurement of Conductivity, pH, Nitrate of both inlet and outlet water samples at 3.2 Mld. Sewage treatment plant (STP) Habbak

STP. Habbak	Conductivity (µs/cm)		PH		Nitrate Nitrogen ($No3^{-N}$) µg/l		
Sampling Date	Raw	Final	Raw	Final	Raw	Final	Reduction %age.
15th February, 2021	592	590	7.23	7.37	223	271	-21.52
27th February, 2021	668	611	7.34	7.52	168	196	-16.66
13th March, 2021	661	605	7.51	7.63	289	322	-11.41
27th March, 2021	650	590	7.54	7.72	170	195	-14.70
15th April, 2021	643	577	7.64	7.74	163	186	-14.11
27th April, 2021	660	639	7.47	7.74	263	297	-12.92

3. Review of Literature

Adnan (2010), when pushing for wetland treatment chambers for waste water entering Dal Lake, noted the senative role of Phragmitis Communis, Typhaaugustata, Ceratophyllumdemersum, and Lemnasp. After cultivating them in various fibre glass containers containing Dal lake sediment and water, they were given the names Salvinianatans and Salvinianatans. The author observed an increase in pH, which created conditions for NH4-N volatilization, Phosphorus and CaCO3 precipitation, as well as an increase in dissolved oxygen, and an update of Nitrogen and Phosphorus by aquatic plants, all of which improved water quality.

Adnan and Kundangar (2009) in a research paper titled three decades of Dal Lake pollution-restoration, documented changes in the hydrochemistry and biodiversity of Dal and Nigeen during the last three decades, as well as the current ecological state of Dal Lake. The authors' investigations have shown that FAB-based sewage treatment for effluent treatment at Hazratbal/Habak is a complete failure, especially during the winter months. The authors have also proposed restoration techniques for the eco system of Dal Lake.

HumairaQadri and Yousuf (2004) researched the macrozoobenthos ecology in Nigeen Lake and found that the macrozoobenthos community was influenced by the type of substarte, macrophyte abundance, and calcium concentration. The authors described the physico-chemical characteristics of Nigeen Lake in 2002 in order to document the eutrophic species.

Kaul et al., (1980) while researching the mineral removal potential of various macrophytes in two lakes of Kashmir reported that the macrophyte growing in eutrophic lakes are more efficient in removal of N, Ca and K compared with P and Na from the nutrient pool. While calculating the heat budgets in several basins of Dal Lake, Vass and Zutshi (1983) reported the maximum heat storage for all basins during July, as well as that of Nigeen 428 cal. The heat budget for the Nigeen basin stayed steady for the months of June, July, and August, according to the authors, after which the basin lost the heat it had conserved.

Kundangar and Adnan (2006) compared the morphometry, hydrochemistry, ionic balance, plankton flora, and macrophytic vegetation of various basins of Dal Lake, including Nigeen, in a research study titled "limnology of Himalayan Dal Lake Kashmir, " and the authors drew comparisons as well as evaluating the trophic status of each basin.

Kundangar et al., (1995), published the hydrobiological properties of Nigeen Lake during the years 1992-93 who observed that the lake basin was enriched to a great extent due to sewage and effluents from the immediate Catchment. Sarwar et al. (1996) found increased conductivity, chloride, calcium, sodium, potassium, nitrate, and total phosphorus near the floating gardens than in the open waters of the lake when researching the impact of floating gardens on the limnological features of Dal Lake.

Murtaza et al., (2010) reported an increase in sp. Conductivity, total-alkalinity, silicate, and nitrate-nitrogen and a decrease in dissolved oxygen content, silicate, and phosphorus while studying the impact of pollutants on physico-chemical characteristics of the Dal Lake under temperate conditions of Kashmir based on data on physico-chemical parameters during 2007-2008. The scientists linked the rise in chemical parameters to drought and eutrophication, while the declines were attributed to thermal stratification and macrophyte vegetation's efficient use of these elements.

Sameera et al., (2003). The impact of floating gardens on the water quality and cladocera population in Nigeen Lake was investigated by The scientists. it was found that waters near floating gardens were more enriched, as evidenced by high levels of chloride, phosphate, nitrogen, and electric conductivity.

Zutshi and Wanganeo (1988) attempted to analyze the trophic state of various Kashmir lakes using a fertilizer load model. According to the author, the annual export of phosphorus and nitrogen from the catchment region, human wastes, and other sources entering Dal waterways is predicted to be 49.17 tones and 636.67 tons, respectively. The authors calculated the degree of eutrophication using a load tolerance model that included the mean depth, flushing rate, and critical phosphorus level.

4. Conclusion

The current study on Dal Lake revealed thatfluidized aerated bed (FAB) based installed sewage treatment plants may enhance the chemical characteristics of incoming sewage to some extent, contrary to the claims made by the Dal Lake authorities in their health bulletin. In the situation where the stp's are malfunctioning, in my opinion, this will not only increase the problem of pollution in Dal Lake but will also have catastrophic consequences since non-point sources of pollution will be turned into point sources of pollution. Increased phosphorus concentrations and the appropriate P/N ratio will have a significant impact on the primary production and structure of plankton communities and aquatic macrophytes in various regions of the lake, resulting in a deterioration of water quality. The profound variation in the abundance and distribution of various macrophytes in the Dal Lake may attribute to its nutrient rich water, varied water depths and favorabletemperature. The explosive growth of *Ceratophylumdemersum* in some areas of Lake is clear indication of eutrophication. Moreover the high incidence of *Salvinianatans* has been attributed to increasing levels of pollution. The restoration and rehabilitation procedures envisioned under the "Conservation and Management of Dal Lake" are still not fully implemented. Mechanical and manual de-weeding, restoration of springs in and around the lake's banks by LAWDA authorities, dredging at various locations in the lake, and removal of illegal structures within the lake, including some floating gardens, were among the measures taken to rehabilitate the lake and return it to its original eutrophication-free status. A prohibition on new construction along the green belt area of lakeside, including the construction of new houseboats, has also been imposed. Despite aeration of the lake's water in certain locations and the installation of a few sewage treatment plants, the lake's water quality and overall ecology show little signs of improvement. As a result, regular lake basin monitoring and limnological data compilation are required in order to develop a repository mechanism for future conservation activities.

References

[1] Adnan Abubakar and M. R. D. Kundangar.2009. Three decades of Dal Lake pollution-Restoration. *Eco. Env. and Cons.*, 15 (4): PP 825-833.
[2] Adnan Abubakar and M. R. D. Kundangar.2009. Three decades of Dal Lake pollution-Restoration. *Eco. Env. and Cons.*, 15 (4): PP 825-833.
[3] Adnan Abubakar.2010. Sanative role of Macrophytes in Aquatic Ecosystems. Nat. *Env. Poll. Tech.*, Vol 9 (4): PP 654-662.
[4] Ashok, K., Pandit, J. A. Javeed and AnjumBanday.2006. Current limnology of Dal Lake in Trends In Bio-diversity & Aqua culture. edit. A. Wanganeo. Langer.
[5] HumariaQadri and A. R. Yousf.2004. Macro zoo-benthos in Nigeen Lake. *Jr. Res & Dev.*, Vol 4. CORD, Univ. of Kashmir.
[6] Kanakiya, R. S., Singh S. K., Sharma J. N., (2014), "Determining the Water Quality Index of an Urban Water Body Dal Lake Kashmir, India" *IOSR Journal of Environmental Science, Toxicology and Food Technology* Volume 8 (12), pp 64-71.
[7] Kaul, V., Trisal, C. L. and Kaul, S.1980. Mineral removal potential of some macrophytes in two lakes of Kashmir. *J. Ind. Bot. Soc.*, 59: 108-118
[8] Kaul, V., Trisal, C. L and Kaul, S.1980a. Mineral removal potential of some macrophytes ion two lakes of Kashmir. *Journal of Indian Botanical Society*, Vol.55, pp.113-123.
[9] Kundangar, M. R. D. and Adnan Abubakar.2006. Comprative limnology of Himalayan Dal Lake Kashmir in Wanganeo and R. K. Langer Ed. *Trends of biodiversity and aqua culture*. Daya publishing House, Delhi
[10] Lone, S. A., Lori, S. M., Awasthi A. K., (2014), "Limnological studies of a famous Himalayan lake: the Dal lake (Srinagar, India) " *International Journal of Current Research* ISSN: 0975-833X, Volume 6 (1), pp.4357-4361
[11] Murtaza, S., M. A. Aziz, S. M. Fazshi Ah. and S. A. Hassan.2010. Physico-chemical characteristics of Dal Lake water, temperate Conditions of Kashmir.
[12] Ravinder, K. and A. K. Pandit (2005). Community architecture of macrophytes in Hokersar Wetland, Kashmir. *Indian J. Environ. andEcoplan*., 10 (3): 565-573.
[13] SameeraSiraj, A. R. Yousuf and Muni Parveen.2003. Impact of floating gardens on the water quality and Cladocera population. *Jr. Res and Dev.* Vol 4 Univ. of Kashmir.
[14] Sarwar, S. G. A. R. Naqashi and G. R. Mir.1996. Impact of floating gardens on the limnological features of Dal Lake poll. *Res*., 15 (3): 217-221.
[15] Trisal, C. L.1987. Ecology and Conservation of Dal Lake Kashmir. Butterworth and Co. Pub. co.
[16] Zutshi, D. P. and A. Wanganeo.1988. Nutrient dynamics and trophic statues of Kashmir lakes, Ind. SciCongr. Jubilee Session Pune.
[17] Zutshi, D. P. and A. Wanganeo.1988. Nutrient dynamics and trophic statues of Kashmir lakes, *Ind. SciCongr. Jubilee Session Pune.*

Author Profile

The author namely **Umar Mushtaq Sofi** is a Research scholar currently perusing Doctors in Environmental science from SunRise University, Alwar Rajasthan (India). (301026). myresearch work isbased onmacrophytic species and waste treatmentProcesses of Kashmir Lake ecosystems. The author is an editor and member of "Global Environment and ClimateChange" (NGO) based FB page.