



Status of Pollution Level in Dal Lake of Jammu and Kashmir - A Review

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Abstract:

The present review paper deals with the assessment of water quality and source of pollution in world's famous Dal Lake in Jammu and Kashmir (India). Dal lake receives water from four famous basins namely Hazratbal, Bod dal, Gagribal and Nageen. Literature published on Dal lake indicates that water quality parameters like BOD, electrical conductivity, nitrate, dissolved oxygen etc show spatial and monthly variations due to increase in the urbanization, unreasonable activity, lack of knowledge of local residents, inflow coming from 15 major drains of Srinagar city, plastic debris, stagnation of lake water, and other various factors. The water sample shows poor quality of water near the house boats and banks of lake as compared to open area of water body. There is a drastic change in the quality of water from the area of contamination, around house boats and open area of water body indicating heavy organic pollution to the water body from the contamination areas and habitation. Further, sudden and unexpected rise in the temperature in valley restricts the growth of various aquatic species present in the dal lake, rise in temperature may become fatal to fish growth, phytoplanktons, zooplankton etc.

Keywords: Dal Lake, Urbanization, sewage, plastic debris, algal blooms, weeds, pollution

1. Introduction:

Dal Lake, an urban lake, is situated towards northeast of Srinagar at an altitude of about 1586 m above sea level between the geographical coordinates of 34° 5' - 34° 6' N latitude and 74° 8' - 74° 9' E longitude. The lake is shallow with saucer shaped basin and has an open drainage (Zutshi & Khan, 1978(1) i.e. regular inflow and outflow of water takes place. The main source of water is Dachigham Telbal nallah (a perennial stream) which supplies about 80% of water (Qadri & Yusuf, 1980(2)) and a large number of springs arising from the lake bed (Kundangar, 1995(3)). The water flows out of the lake through a weir and lock system at Dalgate. Dal Lake comprises of four basins viz Hazratbal, Bod dal, Gagribal and Nageen. The lake which

has been 7.44 km long, 6m depth and about 3.5 km broad and covering an area of about 22 sq.km. at the beginning of this century has shrunk little over half of the area to about 11.45 sq.km. Jammu and Kashmir is one of the beautiful parts of this planet with rich water resources. There are many water bodies in the state and Dal Lake is a largest water body after Wular Lake. The average annual flow, according to discharge measurements, has been estimated as 291.9 million cubic meters, with Telbal Nalah accounting for 80% of the total and 20% contributed by other sources like 15 major open drains coming from Srinagar city. The silt load has been estimated at 80,000 tonnes per year with 70% contribution from the Telabal nallah, with 36,000 tonnes recorded as settling in the lake.



Figure-1 shows the Dal lake and its Basins (DAS 1972)

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Pollution is turning the famous mountain-ringed Dal Lake in Kashmir into a weed-clogged swamp, hampering the recovery of tourism in the region, environmentalists say. And cleaning up the lake is vital to tourism as visitors begin to return to the terrorism-hit state amid moves by India and Pakistan to end their dispute over the territory. Dal Lake, famed for its ornately-carved cedar houseboats, is the centre piece of Srinagar’s tourist trade. But in the past two decades it has shrunk by more than half to 11 square kilometers and lost 12 meters in depth. “This lake is dying fast. It’s turning into a swamp,” says Manzoor Ahmed, a leading businessman who is spearheading a campaign to rescue the lake.

2. Ecosystem of Dal Lake:

Ecosystem of Dal lake is ecologically rich in macrophytes (aquatic plant), submerged macrophytes (lily pads, fig 1), 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 *Nelumbo nucifera* (lotus flowers, fig2) which bloom in July and August every year. The lake is popular as a visitor attraction and a summer resort (source Wikipedia(4).)

The major activities in Dal lakes are fisheries, harvesting of food and fodder plants are also important on Dal. The weeds from the lake are extracted and converted into compost for the gardens. It also serves as a flood lung of the Jhelum River. Swimming, boating, snow skiing (particularly when the lake is frozen during the severe winter), and canoeing are amongst some of the water sports activities practiced on the lake. Visitors and native alike also enjoy relaxing on the water in a houseboat or a shikara boat, often called "the Gondola of Kashmir" but when we look today at this beautiful and worlds famous lake its polluted everywhere and we people are responsible for it.



Figure 2: Left: Dal Lake lily pads. Right: *Nelumbo nucifera* widely grown in the floating gardens of Dal Lake

3. Literature on Dal Lake

(i) 2014-2015:

In the first study, The Srinagar's directorate of environment, ecology and remote sensing studies indicates that more than 50% of water bodies in and around Srinagar have disappeared during the past century. Estimation has also shown that Dal Lake, a major tourist attraction in Srinagar, has shrunk from 2,547 hectares in 1971 to 1,620 hectares in 2008 (swati bansal (6))

(ii) 2010-2016:

The physico-chemical properties of lake water are checked by various scholars in different years:

Table-1 physico-chemical characteristics of Dal Lake in various years:

Basin	year	Air temp(°C)	Water Temp(°C)	pH	Specific Conductivity (µ at 25 °C)	Dis. Oxygen (mg/ltr)	Silicate (mg/ltr)	Alkalinity (mg/ltr)	Nitrate Nitrogen (mg/ltr)	Phosphorous (mg/ltr)	Ammonical Nitrogen (mg/ltr)	Reference
Hazratbal	2011,2012	18.2,18.8	16.4,15.4	7.8,7.5	394,422	7,6.5	4,3.6	102,105.2	507,665	504,583	366,345	Bhat Tanveer H(7)
Nishtar	2011,2012	18.5,23.8	16.6,16.1	8.1,7.8	277.296	7.3,7.8	3.1,3.5	56,45	456.493	507.608	263.223	Bhat Tanveer H(7)
Nigeen	2011,2012	17.2,16.8	15.3,15.7	8,7.8	486.537	6.5,6.2	4.2,4.5	125,126.5	442,582	570.532	461,348	Bhat Tanveer H
Nehru park	2011,2012	19.4,22.8	17.4,18.1	7.9,7.2	333,386	6.4,6.1	3.8,4	87.84.8	752,535	535,521	662,698	Bhat Tanveer H(7)
Dal lake	2010	16.75	13.50	7.60	223	4.94	5.70	156.36	406	145	125	Basharat mushtaq ,rajni raina (8)
Telbal	2014	-	-	6.4	527	6.6	-	170	18	-	-	Javaid Fayaz Lone ¹ , Akhtar Rasool (9)
Nishtar	2014	-	-	4.5	289	5.8	-	170	16	-	-	Javaid Fayaz Lone ¹ , Akhtar Rasool (9)
Nigeen	2014	-	-	6.9	471	6.6	-	180	20	-	-	Javaid Fayaz Lone ¹ , Akhtar Rasool (9)
Nehru	2014	-	-	7.1	252	7.5	-	110	21.33	-	-	Javaid Fayaz Lone ¹ , Akhtar Rasool (9)
Dal lake	2014 to 2015	19.85	15.6	8.45	295	6.3	-	324	39	-	316	Sajad Hussain Dar Asrar Amin Khan (10)

i) 2009-2010:

In the third study, The conclusion given by shafiq- ur- rehman (sher-e-kashmir-university of agricultural science and technology of Kashmir in 2009 (11)) on his study” POLLUTION IN THE RED-BLOOMED

HIMALAYAN DAL LAKE OF KASHMIR” is “The evidences show that the lake water is basic in characteristic which bears decreased dissolved oxygen and raise alkalinity. The chemical nutrients, that contribute eutrofication of water bodies such as phosphorous, nitrate, ammonium and potassium, were high in contents. Since the Kashmir geology impresses its water with high iron levels, the similar expression of iron was also apparent in the lake waters. The heavy metals, CD, Cr, Cu, Mn, Ni, and Zn were accumulated in abundance in the stagnant water areas”.

(iv) 2007-2008

According to an article published in greater Kashmir newspaper on 2008 by arif shafi wani (12) “Flow of raw sewage from these settlements and catchments areas account to 156 tons of phosphorous and 244 tons of Nitrogen annually into the lake, resulting in serious weed infestation and frequent algal blooms. Besides ingress of heavy siltation of about 80,000 tons annually is yet another problem faced by the lake”.

(v) 2012-2013

According to an article published in Greater Kashmir in 23 august 2013 by Arif Shafi Wani on Weeds, Azolla deface Dal Lake“ Azolla have proliferated and engulfed many pockets of the lake mainly along the SKICC, Nishat Pipeline Bund and Northern Foreshore Road”.

Dr Abdul Majeed Kak(13) said Azolla hampers water circulation in the lake which is mandatory as it carries away the lake’s nutrients and prevents growth of harmful water ferns. Thick mats of Azolla block sunlight to the lake’s flora and fauna and ultimately cause their decay. Frequent removal of Azolla manually will reduce chances of formation ofspores,”he suggested

Dr Kak said biological control is one of the most economical and effective method for eradication or controlling Azolla. Infestation of a tiny insect called Weevil scientifically known as Stenopelmus Rufinasus has proven successful in South Africa and North America to check Azolla, he informed.

“Weevil is easy biological agent to control Azolla. Being monophagous, it feeds, reproduces and completes its life cycle on a particular species. So when infested on Azolla en mass, weevils are highly devastating for Azolla,” he said.

5. Plant species:

As per previous data and present records around 31 species were recorded from Dal Lake. Among the rear and emergent ,Typha angustata and Phragmites australis covered vast expanses

Of the lake,while among the rooted floating leaf type,Nilembo nucifera,Nymphaea Mexicana,Nymphoides Pelatum and Trapa natans dominated the lake.The open water water zone of the dal lake was fully colonized by dominant submerged species,mainly Ceratophyllum demersum.As per my present study the most striking feature revealed was the absence of species like Euryale ferox and Chara sp earlier reported by Mukerjee(1921) in Dal lake.Instead some new species have found their way into the lake. Kundaghar et al (2003) reported Azolla Pinnata and Eichornia crassipes as new records to the dal lake.Azolla Pinnata,which was a rare species in the lake till recently,has become now serious threat to other aquatic species,especially the free floating plant species.(15)

Table 2.List of the Macrophytic species recorded from the Dal Lake during 2005-2007:

Sr No	species
1	Alisma Plantago-aquatica
2	Carex sp
3	Cyperus defformis
4	Lycopus europus
5	Nasturium verticillatum
6	Phragmites australis
7	Polygonum hydropiper
8	Sagittaria saggitifolia
9	Scirpus triqueter
10	Sium latijugum

Rooted Floating Leaf type

Sr No	Species
1	Hydrocharis dubia
2	Nelumbo nucifera
3	Nymphaea alba
4	Nymphaea Mexicana
5	Nymphoides peltatum
N	Trapa natans

Submerged:

Sr No	Species
1	Ceratophyllum demersum
2	Hydrilla verticillata
3	Potamogeton lucens
4	Potamogeton natans

Free floating

Sr No	Species
1	Azolla pinnata
2	Lemna spp
3	Salvinia natans

Ceratophyllum demersum, Myriophyllum spicatum, Hydrilla verticillata, salvinia natans and Azolla pinnata were found dominant in the lake, which has been attributed by Khundangar and Zutshi (1987) to anthropogenic pressure. This is substantiated by data on the plants' nutrients like N and P, which are contributed by the inflow channels and sewage drains.

6. Socio Economics status of Dal Lake:

The information given in the detailed project Report prepared by the Alternate Hydro Energy centre, University of Roorkee for J&K lakes and Water Ways Authority in Oct.2000, about 90 percent of the Dal dwellers have a poor socio-economic base and eke out their modest living from agricultural activities, mat weaving tourist related activities like paddling of shikaras and dewatering of weeds.

A major portion of the population was found to be engaged in vegetable and Nadru (Nelumbo nucifera) cultivation. As per the information furnished by the Dal Dwellers' Zamindar Union, vegetables worth 35 crores are cultivated and supplied from the lake every year. The area of the land available for the vegetable cultivation is 450 ha. A small proportion of population is involved in weaving of Typha mats and also carpet weaving. As per the survey conducted by Ruhee (1985), 28 percent of the population possessed domestic animals including poultry, ducks and geese, while the present study revealed that only 5-6 percent of the population possessed domestic animals due to a shift in the occupation and the standard of living.

7. Land use category of Dal Lake

Table shows the land use category of Dal lake

LAND USE CATEGORY OF DAL LAKE	Area in km square
Administrative	0
Car parking/Transportation	0
Cultivated	2.29
Educational	0
Graveyard	0
Park/lawn	.03
Religious	0
Residential	.66

Roads/paths	.07
Shikara Stands	0
Tourist infrastructure	.01
Vacant land with or without vegetation	.37
Waterbody with Houseboats	.15
Waterbody with floating gardens	.35
Waterbody with submerged vegetation	15.41
Water body with floating vegetation	.25
Water body with floating emergent vegetation	5.01
Total	24.60

Source: LAWDA

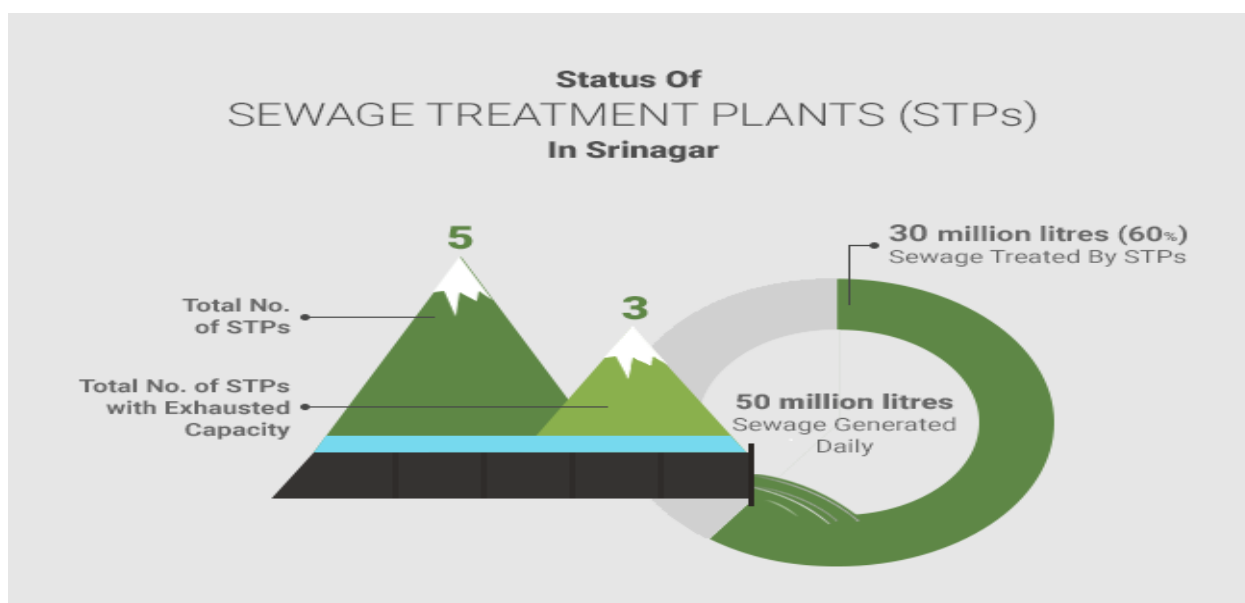
8. Depleting water quality and inefficient STP's

The lake, which once covered an area of 75 square kilometers, has shrunk to 12 square kilometers in the last two decades. The lake's depth has also come down by nearly 12 meters and is a grave sign of the dangers the lake faces. Numbers from the Dal Lake's pollution statistics look ominous as the Lakes and Waterways Development Authority (LWDA) estimates that nearly 80,000 tonnes of silt, 31,000 kg of nitrates and 4,000 kg of phosphates are added annually to the lake. In the past three decades, the nitrate and phosphate rich water has been responsible for gastrointestinal diseases for people living around the lake.

The Dal Lake has been damaged extensively due to the part played by the local population. Nearly 7,500 people live in the houseboats that populate the Dal's surface. More than 50,000 people populate the small islands nearby and household waste from them is inevitably dumped into the Dal. Continuous disposal of waste has severely depleted the lake's water quality. Oxygen density in the water has come down from 10.2 mg/litre to 6.8 mg/litre. Dissolved solids such as phosphorus and nitrogen have increased, taking their levels from 30.2 mg/litre to 200 mg/litre. In certain parts of the lake, algae growth has made the water green.

Sewage Treatment Plants (STPs), necessary to treat sewage have sadly not been of much help in treating the Dal Lake's pollution problem. A July 2017 estimation by Srinagar's Lakes and Waterways Development Authorities (LWDA) said that nearly 50 million litres of sewage flows into the Dal Lake daily, of which 20 million litres is untreated. There are a total of five STPs in Srinagar of which three have become exhausted.

The STPs' inability to to treat more than 30 million litres daily (MLD) of sewage is hampering the lake largely. The near the lake STP was built in 2006 but in 11 years, has nearly exhausted its capacity. A High Court order in July 2017 directed the state government to install an additional STP to treat the inflow of sewage into the lake.(15)



The state of sewage treatment plants in Srinagar inefficient for sewage treatment

8. Conclusion:

Present report reveals that due to presence of impurities in the lake, there are many different parameters found to be increased during summer season and have got diluted during rainy season. So, this kind of changes would affect the aquatic environment as increase in nitrogen content would result in eutrophication naturally which leads to decrease in the oxygen content level. Lack of oxygen can cause fish kills and lack of fish enables malaria-hosting mosquitoes as mosquitoes are natural food for fish. Without oxygen at the bottom at all times, beneficial bacteria and insects cannot biodegrade the organic sediment at bed level of the lake. Purification methods should exist from filtration processes that should be carried out before introducing any foreign material into the water body. Some pollutants are released into the lake. Proper bioremediation techniques should also be used to improve that water quality. The seasonal values of WQI (water quality index) indicate that during summer season, lake water is more affected than during winter. This could be due to the fact that the microbial activity get reduced due to low temperature, thereby keeping DO level at a very satisfactory range during entire winter season. The suggested measures to improve the lake water quality include total ban on the activities that cause pollution. The effects of climate change need to be considered in tandem with atmospheric pollution policies. Carbon removal technologies at power stations utilize amines, which could increase ammonia releases, thereby enhancing deposition and, hence, both eutrophication and acidification. Idol immersion has major impact on water quality and fishes in lakes particularly concerning heavy metals. Many fishes increased after immersion of idols compared with the maximum permissible concentrations for human intake. Humans are exposed to these accumulated metals in fish by ingestion and can impose higher risks of human health because fishes are found virtually everywhere in the aquatic environment and they play a major ecological role in the aquatic food webs because of their function as carrier of energy from lower to higher tropic levels. It is further recommended that a real assessment of the water Demand for human consumption and the minimum water based on the ecological requirements of floodplains should be undertaken at regular intervals to harness the benefits accrued through their natural function. Discharge of untreated domestic sewage and industrial effluents, washing clothes, vehicles, animals and immersion of idols at the time of festivals contributing to the pollution of lake. The present review reveals that nutrient loading has exceeded the eutrophic condition leading to a hyper eutrophic status. Also it has been seen from last few years the tourism of Kashmir is declined due to the pollution famous lakes of Kashmir. Tourists accept Dal Lake as the beauty and heart of Kashmir tourism. Due to the pollution the water surface is completely covered by many free floating species, as it has been found *Azolla pinnata* has been seen predominantly over the entire surface of lake which decreases its aesthetic beauty. The lake water is unfit for the purpose of drinking and the general water quality is not even "GOOD". So all in all the conclusion is quite straightforward that the lake is about to see its near death unless and until government, local bodies and most importantly the people who live in and around the lake do something for its savior.

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