# Impact of Sewage Waste from Human Settlements on Physico-Chemical Characteristics of Dal Lake, Kashmir

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## ABSTRACT

The present study carried out for a period of one year from December 2001 to November 2002, deals with the general water quality of Dal lake with emphasis on the impact of sewage water from human settlements on the lake waters. The investigation revealed that much higher levels of nutrients were recorded near the regions receiving sewage outfalls as compared to open water areas.

*Keywords:* Sewage, human settlements, impact, Dal lake

## INTRODUCTION

The natural lakes of Kashmir Himalaya exhibit various degrees of trophic evolution ranging from oligotrophy through mesotrophy to eutrophy which is generally understood to be the result of anthropogenic pressures. Recently there has been a great concern about the fast deterioration of Dal lake. The lake system is not only shrinking in surface area but its water are also declining in quality posing great threat to many people. Due to ecological stress particularly from human activities, deterioration not only takes place in water quality but the aquatic life of the lake is also badly affected. Consequently, the aging process of this beautiful water body has been hastened. The lake is undergoing rapid trophic evolution as it is under great ecological stress due to fast urbanization in its surrounding areas. The lake receives huge quantities of untreated sewage and solid garbage from the dense population, which has deteriorated its water quality and is manifested in the form of weed infestation besides obnoxious algal blooms. A large number of drains open into lake in the littoral regions. Therefore, in order to assess the ecological status of lake it becomes imperative to

assess the impact of sewage on lake system. It is in this backdrop the present investigation was undertaken for assessing the impact of sewage wastes on physico-chemical characteristics of water in Dal lake.

## STUDY AREA

Dal lake is situated in the northeast of Srinagar City between 34° 5' N - 34° 6' N latitude and 74° 8' - 74° 12' E longitude at the altitude of 1584 m (a. s. l.) It is multibasined lake, with Nagin, Gagribal, Hazratbal and Boddal as its four basins. The four basins of Dal lake differ markedly in their area, depth, and other characteristics.

For the present study four sites were selected in from different basins of Dal lake near the entrance of drains near Nishat (Site I), Dalgate (Site II), Sadrabal (Site III) and Dhobigath (Site IV). Besides, four respective open water sites were selected for the comparison in Boddal, Gagribal, Nagin and Hazratbal basins respectively.

## MATERIAL AND METHODS

The surface water samples were collected in two litre polyethylene bottles. While temperature was recorded on spot, other parameters were analyzed, within 24 hours of sampling, following standard methods of Mackereth (1963), Golterman and Clymo (1969) and APHA (1998).

## RESULTS AND DISCUSSION

A comparison of physico-chemical parameters of Dal lake water receiving sewage outfalls in comparison with their respective open water sites is depicted in Table 1. There were marked differences in physico-chemical parameters of water near drains as compared to open water sites. The depth of Dal lake waters varies with time and space. At the site of drains the depth was not measured. Among the other sampling sites (i.e. open water sites) the depth showed a range of 120.831.44cm and 380 ± 17.32cm. While as the seasonal changes in the Sacchi transparency was not measured at the buffering zone near drains. The maximum transparency was noted during winter and autumn and minimum during summer. The mean value for transparency fluctuated from 110 ± 5.0cm during summer to 278.67 ± 22.03cm during autumn. The changes in the surface water temperature at the study sites showed a close relationship with atmospheric temperature. The regions receiving sewage outfalls showed slightly greater values of temperature (5.93 ± .095-28.23 ± 0.35 °C) as compared to open water sites (5.33 ± 1.15-27.8 ± 0.49°C). Very low values of dissolved oxygen (0.90 ± 0.10-2.93 ± 0.75 mg/l) were usually recorded near drains as compared to open water sites (4.70 ± 0.10-9.23 ± 1.63 mg/l). The pH was towards alkaline side and depicted almost an identical behaviour. Moreover, the pH at open water site was slightly more alkaline than near

**Table 1. Physico-chemical features of water of Dal lake at different selected sites**

| S. No. | Parameters | Drains (Range) Mean / SD | Open water sites (Range) Mean / SD |
|---|---|---|---|
| 1 | Water Temperature (°C) | 5.93 ± 0.95 - 28.23 ± 0.35 (at site I) | 5.33 ± 1.15 - 27.83 ± 0.49 (at site II & IV resp.) |
| 2 | Depth (cm) | ---- | 120.83 ± 1.44 - 380 ± 17.32 (at site II & III resp.) |
| 3 | Transparency (cm) | ---- | 110.0 ± 5.00 - 278.67 ± 22.03 (at site II & III resp.) |
| 4 | Dissolved oxygen (mg/l) | 0.90 ± 0.10 - 2.93 ± 0.75 (at site II & III resp.) | 4.70 ± 0.10 - 9.23 ± 1.63 (at site III & I resp.) |
| 5 | pH | 7.17 ± 0.12 - 8.18 ± 0.33 (at site II & II resp.) | 7.67 ± 0.25 - 8.97 ± 0.05 (at site II & III resp.) |
| 6 | Conductivity (µS/cm) | 276.67 ± 18.90 - 492 ± 63.17 (at site IV & I resp.) | 212.67 ± 3.06 - 336.3 ± 61.65 (at site IV & I resp.) |
| 7 | Bicarbonates (mg/l) | 70.70 ± 0.6 - 206.7 ± 22.5 (at site IV & IV resp.) | 61.70 ± 0.6 - 156.7 ± 11.5 (at site IV & IV resp.) |
| 8 | Carbonates (mg/l) | 1.0 ± 1.7 - 23.30 ± 20.8 (at site I & III resp.) | 0.70 ± 1.20 - 17.30 ± 16.20 (at site I & III resp.) |
| 9 | Alkalinity (mg/l) | 72.03 ± 1.79 - 211 ± 29.46 (at site IV & IV resp.) | 61.67 ± 0.58 - 167.3 ± 21.9 (at site IV & IV resp.) |
| 10 | Chloride (mg/l) | 29.0 ± 2.6 - 49.30 ± 20.3 (at site III & II resp.) | 20.0 ± 3.0 - 33.70 ± 1.50 (at site IV & III resp.) |
| 11 | Calcium (mg/l) | 16.87 ± 2.83 - 29.87 ± 2.58 (at site III & IV resp.) | 17.13 ± 1.63 - 29.47 ± 2.84 (at site II & III resp.) |
| 12 | Magnesium (mg/l) | 2.43 ± 0.06 - 7.02 ± 2.37 (at site I & III resp.) | 1.90 ± 0.62 - 6.47 ± 3.21 (at site I & IV resp.) |
| 13 | Orthophosphate (µg/l) | 100.3 ± 8.7 - 171.20 ± 9.0 (at site IV & II resp.) | 63.07 ± 10.79 - 98.60 ± 5.90 (at site I & IV resp.) |
| 14 | Total phosphate phosphorus (µg/l) | 609 ± 53.73 - 677.67 ± 54.12 (at site II & IV resp.) | 335.67 ± 42.74 - 433.00 ± 8.00 (at site I & IV resp.) |
| 15 | Nitrate nitrogen (µg/l) | 523.3 ± 65.68 - 697.3 ± 144.9 (at site III & I resp.) | 328.6 ± 6.66 - 462.6 ± 12.01 (at site IV & I resp.) |
| 16 | Ammonical nitrogen (µg/l) | 591.3 ± 3.21 - 648 ± 1.73 (at site III & I resp.) | 353 ± 21.07 - 431.33 ± 11.9 (at site IV & I resp.) |
| 17 | Silicates (mg/l) | 2.80 ± 0.56 - 5.97 ± 0.25 (at site III & I resp.) | 2.17 ± 0.31 - 5.10 ± 1.36 (at site IV & I resp.) |

drains. The mean value of pH fluctuated from (7.17 ± 0.12 - 8.18 ± 0.33) near drains to (7.67 ± 0.25 - 8.97 ± 0.05) at open water sites. The mean conductivity values were, in general, comparatively higher near drains (276.67 ± 18.90 - 492.00 ± 63.17 µS/cm) than at open waters (212. 67 ± 3.06 - 336.33 ± 61.65 µS/cm). The total alkalinity showed a mean variation from 61.67 ± 0.58 - 167.33 ± 21.94 mg/l near open waters and (72.03 ± 1.79 - 211.00 ± 29.46 mg/l) near drains. Though the chloride content did not show any definite seasonal trend yet it exhibited almost identical behaviour with respect to sites, and the values obtained at drains (29.00 ± 2.6 - 49.30 ± 20.30 mg/l) were comparatively higher than those of recorded at the

open water sites (20.0 ± 3.0-33.70 ± 1.57 mg/l).

The mean values of calcium varied from 16.87 ± 2.83 to 29.87 ± 2.58 mg/l and from 17.13 ± 1.63 to 29.47 ± 2.84 mg/l near drains and open waters respectively. $Mg^{++}$ did not exhibit a uniform behaviour at all the study sites and the mean values of magnesium varied from a minimum of 1.90 ± 0.62-6.47 ± 3.21 mg/l near open waters to a maximum of 2.43 ± 0.06-7.02 ± 2.37 mg/l near drains. Like other parameters the orthophosphate phosphorus is recorded higher values near drains (100.38 ± 8.7 -171.20 ± 9.0 µg/l) than at the open waters (63.07 ± 10.79 - 98.60 ± 5.9 µg/l) throughout the year. The TPP fluctuated from a low of 335.67 ± 6.66 to 462.67 ±12.0 µg/l) to a high of 609 ± 53.73 to 877.67 ± 54.12 µg/l being registered near drains. Like most of the nutrients nitrogen was obtained in higher amounts near drains than open water areas and as such concentration near open waters fluctuated from 328.67 ± 6.66 to 462.67 ± 12.01 µg/l and near drains showed variation from 523.33 ± 65.68 697.33 ± 144.92 µg/l. Ammonical nitrogen of Dal lake did not depict any seasonal periodicity. However, the higher values of $NH_4$-N were recorded near the drains of all the study sites. Silicates during the period of investigation did not show marked variation between two types of waters and fluctuated from 2.17 ± 0.31 to 5.10 ± 1.01 mg/l and 2.80 ± 0.56 to 5. 97 ± 0.25 mg/l respectively near open water and near drains. It also followed a trend very similar to other ions at the two types of sites.

Over all drains exhibited higher values of all the major ions as compared to their corresponding open water sites. However, dissolved oxygen was the only parameter, which was found in lesser amounts at the former as compared to the later.

The low values of transparency are attributed to silt impregnated water from the catchment besides the development of plankton blooms. Low values of dissolved oxygen in the buffering zone near drains are an indication of anoxic condition, which restricts the development of plant and animal life except some hardy species which thrive well under such conditions. The present results in general, depicted much higher values of conductivity at the sites of drains as compared to open water sites. Juday and Bridge (1933) related an increase in electric conductivity to the state of nutrient enrichment. As per this criterion the lake can be regarded to be at higher levels of enrichment. Near the sites of drains the high chloride content owes its origin to sewage waters carrying detergents and sewage from human settlements into the lake. The total alkalinity of lake water is due to mainly bicarbonates, although very small quantities of carbonates were recorded at different sites during some months. These observations are in agreement with those of Zutshi *et al.* (1980). Higher values of $Ca^{++}$ and $Mg^{++}$ were recorded near drains as compared to open water sites. According to Zutshi *et al.* (1980) calcium is generally the dominant cation in Kashmir lakes because of the predominance of lime rich rocks in the catchment area. Higher levels of orthophosphate and total phosphate are attributed to the addition of faecal matter and use of phosphate fertilizers in floating gardens.

Though $NH_4$-N was reported to be in low quantities as compared to $No_3$-N, yet appreciable quantities of $NH_3$-N were reported to be found in lake water that indicated the higher pollution status of the lake in terms of $NH_3$ concentration, being the end product of ammonification.

In conclusion, it was noted that the sewage waters contained higher doses of minerals and low oxygen levels as compared to their corresponding open water sites indicating that the input of heavy doses of sewage leads to the nutrient enrichment of lake waters thus deteriorating water quality which has serious implication on the overall functioning of the ecosystem.

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