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## Evaluating the Water Quality Pollution Potential of Hazratbal Basin of Dal Lake, Kashmir, India

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*Dal Lake, situated in the heart of Srinagar city in India is under tremendous anthropogenic pressure. This work evaluates the surface water quality in terms of physio-chemical parameters for the Hazratbal basin of the Dal lake. Water quality was surveyed at three different sites which were located on the Hazratbal basin. There were two types of data obtained from the lake water quality sampling exercise, i.e in-situ and laboratory analyses data. A total of seven water quality parameters namely pH, Electrical Conductivity (EC), Salinity, Dissolved Oxygen (DO), Turbidity, Air temperature and Water temperature were measured at the sampling sites. While for laboratory analysis, there were fourteen parameters namely Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Dissolved Salts (TDS), Free Carbon-dioxide, Acidity, Nitrite, Phosphate, Sulphate, Colour, Total Hardness, Alkalinity, Chloride, Calcium and Magnesium ion concentration. Monthly changes in various physical and chemical parameters were analyzed.*

### Introduction

Water is an elixir of life. It is an important component of human survival. The demand for clean and potable water has increased tremendously due to rapid development and growing population. The requirement of water in all lives, from micro-organisms to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization (Singh et al.,2002). The demand is not only for human beings but also for aquatic life that use water as their habitats and this aquatic life eventually become a source of protein for humans.

Thus, it is imperative that every effort should be made to protect and conserve existing water resources for present and future needs.

Lakes are subjected to various natural processes taking place in the environment, such as hydrological cycle. Storm water runoff and discharge of sewage into the lakes are two common ways that various nutrients enter the aquatic ecosystems resulting into the death of those systems. One of the most famous and beautiful lakes of world, Dal lake, is a Himalayan urban lake surrounded by mountains on its three sides. Dal lake is situated at an altitude of 1,886m above sea level between  $34^{\circ}6'$  -  $34^{\circ}10'$  N latitude and  $74^{\circ}8'$  -  $74^{\circ}9'$  E longitude, in the heart of the Kashmir valley on the north east of the state summer capital Srinagar at the foot of the Zabarwan mountains. The total water surface area of the lake is  $11.45 \text{ Km}^2$  of which  $4.1 \text{ Km}^2$  is floating under gardens.  $1.151 \text{ Km}^2$  and  $2.25 \text{ km}^2$  are land marsh respectively, where as total volume estimated is  $9.05 \times 10^3 \text{ m}^3$  and the ratio between mean and maximum depth (m) ranges between .20 and .25 indicating the gentle slope of the lake bed (Jeelani and Shah.,2006). It is believed that the Dal is fed up by a number of underground springs, but the main source is the Telbal Nallah that enters into the lake on the north side of it. The lake is multi-basined comprising of four basins viz., Hazratbal, Bod Dal, Gagribal and Nigeen. By area the Hazratbal basin is the largest, named after the world famous Hazratbal shrine that is located on its bank. A lot of research has been carried out on the limnology of Dal lake yet the biggest basin- Hazratbal basin has not so far been exclusively studied. Consequently, the present endeavour has

been made for which three sites of the Hazratbal basin have been selected which differ tremendously in nature and extent of pollution. Dal lake is undergoing fast eutrophication due to pollution caused by agricultural practices in the catchment area which has subsequently enriched the lake water with enormous inputs of fertilizers, nutrient content, organic matter from both autochthonous and allochthonous modes etc.

## Experimental

### Sampling site

Hazratbal basin is the largest basin of the world famous Dal Lake (Fig.1). This study was conducted on this basin by choosing three sites which differ on the extent of pollution. The three sites selected from the basin were- site 1 near Telbal Nallah, site 2 Dhobi Ghat area and site 3 near Sonilank.

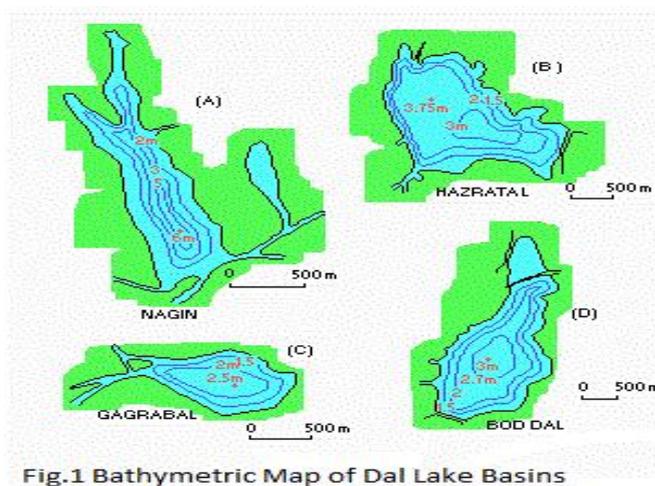


Fig.1 Bathymetric Map of Dal Lake Basins

### Sample collection and pre-treatment

The sampling network was designed to cover a wide range of determinates of key sites, which reasonably represent the water quality of the lake system. Sampling for water quality parameters were carried out at the three sites on monthly basis. The samples were collected from 8:00 A.M to 10:30 A.M. Water samples were collected using open water grab sampler (1.5 L capacity) equipped with a simple pull-ring that allowed for sampling at various depths. In order to determine the water quality, water samples were kept in 5 L polythene cans wrapped with carbon. All water samples were stored in insulated cooler containing ice and delivered on the same day to laboratory and all the samples were kept at 4°C until processing and analysis (clesceri et al., 1998).

### Chemicals and reagents

Double distilled water was used throughout the work. All chemicals and reagents were analytical grade, Merck (Darmstadt, Germany). Standard solutions of two elements (i.e Ca and Mg) were prepared by dilution of 1000 ppm certified standard solutions.

### Analytical procedure

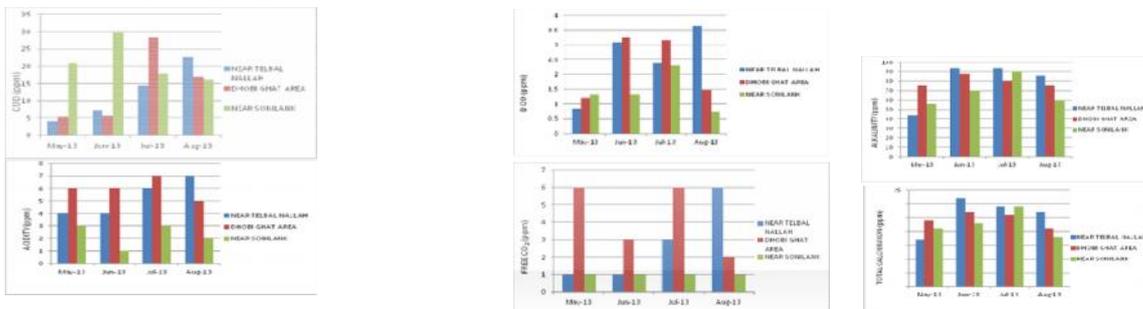
Physico-chemical parameters of water, their units and method of analysis were analysed. The air temperature, water temperature, pH, EC, salinity, DO, turbidity of each sample were measured at the sampling points following the standard procedures of U.S Environmental Protection Agency (2007),

by using mercury thermometer, digital pH, EC, DO, turbidity meter respectively. In laboratory the water samples were analyzed for other physico-chemical parameters and detection of metal ions (i.e Ca and Mg). These parameters were analysed within 48 h, COD determined on the same day of the sampling by utilizing spectroquant photometer of Merck. While as for evaluating BOD, five day incubation time at 20<sup>o</sup>C is a must and is measured by subtracting DO on fifth day from DO on first day multiplied by appropriate dilution factor. Colour was analysed visually by comparing the water samples with colour standards made of potassiumchloroplatinate (K<sub>2</sub>PtCl<sub>6</sub>) and cobaltous chloride (CoCl<sub>2</sub>.6H<sub>2</sub>O) in double distilled water.

TDS and sulphate (SO<sub>4</sub><sup>2-</sup>) were determined gravimetrically. Total hardness was measured by EDTA complexometry titration and the indicator was Erichrome Black T (EBT) at pH 10 (Eatan et al., 1995). Total alkalinity determined by acid titration using methyl-orange as end point indicator and chloride content was estimated by silver nitrate (AgNO<sub>3</sub>) titration using Potassium Chromate (K<sub>2</sub>CrO<sub>4</sub>) solution as an indicator. Free carbon dioxide and total acidity were measured volumetrically by making use of N/44 sodium hydroxide and N/50 sodium hydroxide as standard titrant respectively and phenolphthalein as an indicator in both the cases. Phosphate (PO<sub>4</sub><sup>3-</sup>) and nitrite (NO<sub>2</sub><sup>-</sup>) were measured spectrophotometrically. Calcium and magnesium were determined by Atomic Absorption Spectrometer (AAS) of Perkin Elmer Precisely, AAnalyst 800 at USIC, Kashmir University.

### Graphical treatment

All the graphical depictions were made using Excel 2007 (Microsoft Office).



Graphic depictions for some water quality parameters of the three sites of Hazratbal Bain of Dal lake

Considerable fluctuations in pH were observed across the three sites. The pH range falls well within WHO limits. The average range of TDS and EC in the lake water was found 113-147.5 ppm and 171.75-210.75  $\mu\text{Scm}^{-1}$  respectively. The salinity average range was 103.75-135 ppm. DO average range was 3.99-4.69 ppm across the three sites of the Hazratbal basin of Dal lake. COD and BOD were having an average range of 12.02-21.2 ppm and 1.42-2.48 ppm respectively. Free carbon dioxide and acidity average range was 1-4.25 ppm and 2.25-6 ppm respectively. Turbidity and colour has an average range of 0.01-9.3 and 12.5-20 hazen respectively. Air temperature and water temperature were having an average range of 20.5-20.75<sup>o</sup>C and 22.75-24.25<sup>o</sup>C respectively. Alkalinity average range was 69-80 ppm. Chloride concentration was found in the average range of 8.5-12.25 ppm. The phosphate and nitrite values were found in the average range of 0.72-7.27 ppm and 0.034-0.75 ppm respectively. Sulphate was in the average range of 1.92-40.32. The average concentration range of calcium and magnesium ions was 22.75-26.25 ppm and 7-8.75 ppm respectively and was well within WHO limits.

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### Water quality parameters

Air and water temperature showed a very characteristic cycle, with higher values during July and August. The pH values of collected water samples were within those defined by WHO guidelines of 6.5-8.5 (WHO, 2004). The EC was appreciable due to significant amount of dissolved salts. The annual rainfall in the basin is little so a little variation was observed during the interval. EC increases with temperature at a rate of 1.9 per cent per °C (Bartram and Balance, 1996). The EC is attributed to high salinity and high mineral content in all sampling sites. It also corresponds to the highest concentration of dominant ions, which are the result of ion exchange and solubilization in the aquifer (Sachez-Perez and Tremolieres, 2003). The major cations (Ca and Mg) and major anions (Cl and SO<sub>4</sub>) in the lake water increase EC, is consistent with other study (Zacheus and Martikainen, 1997). Alkalinity values fluctuated among all sampling sites. In the month of August all the sites showed a dip in the values of alkalinity.

The oxygen in surface water comes from air or is produced by photosynthetic organisms like algae and plants in a water body. The oxygen content is decreased with increase in water temperature. It has negative impact on organic waste processing by the aerobic micro-organisms. The monitoring of oxygen concentration in aquatic system is an important subject (Galal- Gorchev et al., 1993), as the physical, chemical and biological processes involved in oxygen fluctuation in lake are numerous. The highest value of COD was recorded at the Sonilank site and lowest at the Telbal Nallah site. COD is widely used for determining waste concentration and is applied primarily to pollutant mixtures such as domestic sewage, agricultural and industrial waste. In case of BOD the higher values were observed at Telbal Nallah area, due to local anthropogenic pollution. The phosphate concentration also varied across the three sites.

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