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# Fluctuations in the values of Nitrogen in Dal Lake of Kashmir

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***Abstract :*** *Nitrogen in any form is in fact a depiction of the productive status of the natural ecological systems provided its concentration is within the prescribed limit. But unregulated anthropogenic intervention in the aquatic ecosystems enhances the nitrogen content and accelerates its senescence. Dal Lake in the present area of study is under incessant human interference which has in fact reduced it to a mere sink of the refuse generated by the stakeholders living around. As a consequence of the present investigation, nitrate, nitrite and ammonia values were found to record an increase.*

**Keywords:** Nitrate, Nitrite, Ammonia, Dal Lake

## Introduction

Nitrogen is generally considered as the primary limiting factor influencing biomass accumulation in phytoplanktons (Rabalais, 2002) but Elser *et al*. (1990); James *et al*. (2003) opined that nitrogen limit lake production either as a primary limiting factor or as colimiting factor with phosphorus. The accumulation of nitrogen in lakes and other natural water bodies due to intense human intervention alters the basic ecological processes. Increased nutrient content cause multiple and complex changes in aquatic ecosystems which in turn cast their influence on the indwelling biota. Although N and P fluxes from point sources often covary and because soil surpluses of N have increased as much or more than those of P (Isermann, 1991), there is little consensus on whether excess N inputs can causes eutrophication of lakes, even though environmental degradation of estuaries by N is well established (Smith, 2003, 2006).

Water quality degradation can arise from diffuse nutrient sources for several reasons. First, inputs of phosphorus (P) and nitrogen (N) to agriculture in the form of chemical fertilizer and animal feed supplements often exceed outputs in agricultural product (Foy *et al*., 2002). Second, excessive densities of livestock can lead to manure production and application that exceeds the regional requirements of crops. Third, excess application of N in the form of chemical fertilizer or manure can lead to ammonia ($NH_3$) volatilization and N deposition at remote locations (Schlesinger and Hartley, 1992). In all cases, excess nutrient application can lead to soil surpluses of both N and P that are mobile and can leach into downstream aquatic ecosystems (Smith *et al*., 1995; Bennett *et al*., 1999). Globally, this process is particularly pronounced for P (Bennett *et al*., 2001) and in principle, can lead to situations in which excess P runoff leads to N limitation of algal production in receiving water bodies (Schindler, 1977).

The forms of nitrogen that affect aquatic ecosystems include inorganic dissolved forms; Nitrite ($NO_2$), Ammonium ($NH_4$), Nitrate ($NO_3$) and a variety of dissolved organic compounds such as amino acids, urea and composite dissolved organic nitrogen, and particulate nitrogen. Ammonia in water is produced by microbiological degradation of organic

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nitrogenous matter. Free $NH_4$ is an important parameter indicating pollution. Surface waters generally have lesser Ammonium form than bottom waters because it is liberated often from the decomposing organic matter of the lakes and its release in the deep layers is governed by anoxic conditions (Kaul and Handoo, 1980). In surface layers the low $NH_4$ concentrations result through its utilization by plankton and other plants (Prochazkova *et al.,* 1970). In general, $NO_2$ and $NH_4$ forms are present in natural waters in smaller quantities when compared to the $NO_3$ form. Nitrite is the product of intermediate oxidation state of N produced both in the oxidation of $NH_4$ to $NO_3$ and in the reduction of $NO_3$. It is an intermediate compound in N cycle and is unstable. The low concentration of $NO_2$ is in consonance with its insignificant role in the environment and also with its short residence time in water (Malhotra and Zanoni, 1970). Presence of $NO_2$ in water depends on oxygen content of water. $NO_3$ is the most highly oxidized form of N, which is the product of aerobic decomposition of organic nitrogenous matter. $NO_3$ is a plant nutrient and inorganic fertilizer that enters water supply sources from septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills and garbage dumps. The most important source of $NO_3$ in waters is biological oxidation of nitrogenous organic matter of both autochthonous and allochthonous origin, which include domestic sewage, agricultural run-off and effluents from industries (Saxena, 1998). Maximum permitted limit of drinking water level of $NO_3$ N is 20 $mgL^{-1}$ according to ICMR (1975) and 45 $mgL^{-1}$ according to ISI (1991). $NO_2$ form of N is formed by incomplete bacterial oxidation of organic nitrogen while $NO_3$ concentration depends on geochemical conditions such as degree of use of agricultural fertilizers and industrial discharges of nitrogenous compounds (Kataria *et al.,* 1995).

Abbasi (1997) did not detect any $NO_3$ in *Punnur puzha* while they reported lower values of the same in *Kuttiadi* dam. Osborne *et al.* (1987) observed that concentration of P and N increased during higher water levels. Closer coupling between benthic and pelagic process occur in deep lakes (Bengtsson, 1975). Nutrients are stored in sediments (Threkeld, 1994; Jeppensen *et al*., 1997). In deep lakes settling of suspended matter can lead to low nutrients in the epilimnion during summer. Hence internal loading depends upon the intensity of turbulence across seasonal pycnocline that transports nutrient rich hypolimnetic water to the photic zone in summer (Jellison *et al*., 1993 and Romero *et a*l.,1998). Blum (1956) reported that highest values of $NO_3$ in rainy season may be due to the addition of N in the form of runoff water and organic pollution due to sewage entry whereas $NO_3$ depletion in winter and summer may be due to the photosynthetic activity of the alga or due to the oxidation of organic compounds.

Realising the importance of nitrate, nitrite and ammonia in ecological systems especially lakes, present investigation was carried out.

## Materials and Methods

Dal Lake is characterized by an open water area, marshy land and floating gardens. The open water area is comprised of three sub-basins - the northern Hazratbal Basin, the central Bodal Basin and the southern Gagribal Basin. Besides these basins, the Nagin Basin appears as a detached arm of Dal Lake on its west. The lake catchment, with an area of 33717 ha (337.17 sq. km), consists of mountain ranges on the North and Northeast side and on the other side is enclosed by flat arable land. The catchment is characterized by a rugged terrain with high relief. The highest part in the North is at an elevation of about 5107m above the mean sea level.

Dal lake is a postglacial shallow lake bounded on the south west by the state capital-Srinagar and encompassed on the other sides by terraced gentle slopes at the base of precipitous mountain which rise up to 1000 m above lake level. This lake has historically been the centre of Kashmiri civilization and has played a major role in the economy of the state through its attraction of tourists as well as its utilization as a source of food and water.

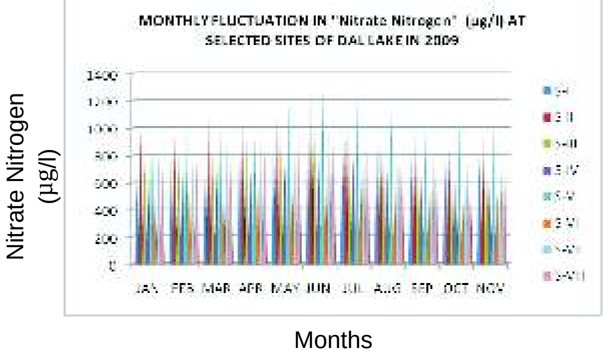
Eight sites were demarcated in the lakes Dal and Nagin with respect to the degree of biotic disturbance caused in the lakes. These sites are subjected variously to degrees of the disturbances and a few are rather visually undisturbed being away from the source of pollution.

The different forms of nitrogen were determined by using standard methods viz, nitrate nitrogen was determined by phenol disulphonic acid method, nitrite by diazotization method and ammonia by Phenate Method (APHA *et al*., 1985).

## Results and Discussion

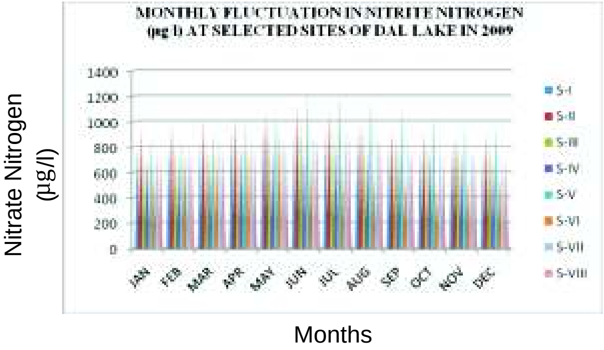
The observations on nitrate, nitrite and ammonia are described below separately for different stations.

**Nitrate:** During the course of present study, nitrate recorded an increasing trend from January to June when it reached a maxima and then a decreasing trend upto December (Table 1, Fig. 1). So nitrate values recorded a unimodal peak during the peak summer season (June) at all the stations. Higher values of $NO_3$-N during summer may be due to rapid decomposition of organic matter and influx of municipal and domestic sewage (Saxena, 1998; Sunderay *et al.*, 2006; Prasanna and Ranjan, 2010). Contrary to the present finding Blum (1956) recorded an increase in nitrate concentration in monsoon. Zafar (1956) also emphasized that when the dead organic matter decomposes in water, it forms complex proteins which get converted into nitrogenous organic matter and finally to nitrate by bacterial activity. The increased concentration of $NO_3$-N during spring was due to entry of large volumes of snow melt and rain water which brought in appreciable quantities of nutrients from the catchment (Parray *et al*., 2009).



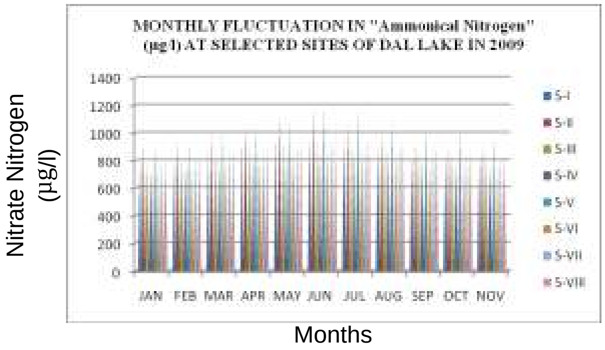
Of all the stations, station S-VI recorded lowest values of 475 µg/l and S-II and S-V recorded higher values of 1292 µg/l and 1310 µg/l. The presence of nitrate in higher concentration at stations II and V depict the polluted status of these stations.

**Nitrite:** Perusal of the Table 2 and Fig. 2 reveals that nitrites also recorded an increasing trend from January to June when it recorded a maxima followed by a decline uptil December. The nitrite concentration thus recorded a unimodal peak in June and minimum concentration was recorded in December. This increase in nitrite concentration from January onwards may be due to an increase in the use of chemical fertilizers for agricultural practices in spring season upto the summer season where after the application of fertilizers in agricultural fields decline and hence the decrease in nitrite concentration after July upto December. Similar profile of nitrite values were recorded by Zuber (2007) in Lake Mansar.



Of all the sites, stations VI recorded minimum values (530 µg/l) while stations V and II recorded maximum values of 1240 µg/l and 1130 µg/l. The low amounts of nitrite nitrogen detected are in conformity with the tendency for rapid transition between nitrate ammonia and molecular nitrogen.

**Ammonia:** Perusal of Table 3, Fig. 3 reveals that ammonia recorded an increase in concentration from January onwards till it reaches its maxima in June where after it recorded a decrease in its concentration upto December. The nitrates were thus observed to record unimodal maxima. Prasanna and Ranjan (2010) also recorded an increase in ammonia values in pre monsoon season and a decline in post monsoon season. Of all the stations SII (1185 µg/l) and SV (1211 µg/l) recorded higher values in comparison to other stations while minimum values were recorded for SIV (744 µg/l) and SVI (741 µg/l) stations. At all the sites, the highest concentration of ammonia was recorded in June and July and the lowest in December and January.



Nitrates showed maximum value of 640 mg/1 from bottom waters in June 2009 and the minimum of 49.0 mg/1 from surface waters in March, 2009. The highest values were recorded in summer and the lowest in autumn. The highest nitrite value of 84.0 mg/1was recorded from bottom waters in June, 2009 and the lowest of 2.0 mg/1 from surface waters in October, 2008. In general the highest concentrations were recorded in May and June and the lowest in February and October. For ammonia, the maximum value of 161.7 mg/1 has been recorded from bottom waters in January, 2009 and the minimum of 11.0 mg/1 from surface waters in September, 2008. On seasonal basis, generally the highest concentrations were recorded in winter and the lowest in autumn.

In fact nitrite and ammonia recorded lower values than nitrate. Prasanna and Ranjan (2010) also reported that observed concentration of ammonia was less than that of nitrate

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