Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
JPP 2019; 8(1): 1748-1755
Received: 19-11-2018
Accepted: 21-12-2018

# Trophic assessment of a semi-drainage Himalayan lake

**Hafsa Javeed, Adnan Abubakr, Masood-ul-Hassan Balkhi, Farooz Ahmad Bhat, Ashwani Kumar, Bilal Ahmad Bhat, Rizwana Malik and Sobiya Gul**

**Hafsa Javeed**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Adnan Abubakr**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Masood-ul-Hassan Balkhi**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Farooz Ahmad Bhat**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Ashwani Kumar**
Faculty of Fisheries, Rangil Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Bilal Ahmad Bhat**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Rizwana Malik**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Sobiya Gul**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Correspondence**
**Hafsa Javeed**
Faculty of Fisheries, Rangil, Ganderbal Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Kashmir, India

**Abstract**
The present study was carried to assess the water chemistry of Lake Ahansar, a semi-drainage lake situated in the district Ganderbal of Kashmir valley. Water samples from five different locations viz., inlet, outlet, littoral zones and centre were collected for a period of 9 months covering three different seasons viz., winter, spring and summer. The season wise mean values recorded for various physico-chemical parameters were: air temperature (17.4±3.46 ºC), water temperature (17.42±0.19 ºC), depth (2.37±0.49m), transparency (1.5±0.1m), dissolved oxygen (9.38±0.32mg/l), pH (8.0±0.08), free carbon dioxide (9.9±0.6mg/l), chloride (13.0±0.32mg/l), total alkalinity (231.1±2.1mg/l), total hardness (317.0±1.9mg/l), calcium hardness (71.6±1.7mg/l), magnesium hardness (57.9±0.8mg/l), ammonical nitrogen (96.8±1.2µg/l), nitrate nitrogen (485.5±2.6µg/l), total phosphorous (231.0±1.1µg/l) and orthophosphate (29.8±0.6µg/l).Overall, it was established that water quality of the lake has deteriorated, when compared with earlier records.

**Keywords:** Ahansar Lake, water chemistry, fresh water, trophic status, physic-chemical parameters, Kashmir

## 1. Introduction
The fresh water lakes of Kashmir Himalayas have been playing a great role in the socio-cultural and economic status of the valley since ancient times. These lakes have been categorized into glacial, alpine and valley lakes based on their origin, altitudinal location and nature of biota and provide an excellent opportunity for studying the structural and functional processes of an aquatic ecosystem system (Zutshi *et al.* 1972; Kaul, 1977; Trisal, 1985) [55, 16, 44]. The nutrient level of many lakes and rivers has increased dramatically over the past 50 years in response to increased discharge of domestic wastes and non-point pollution from agricultural practices and urban development (Mainstone and Parr, 2002) [25]. For more than 30 years, nutrient enrichment, especially phosphorus (P) and nitrogen (N), has been considered as a major threat to the health of aquatic systems (Andersen *et al.* 2004) [3]. The physico-chemical properties of water quality assessment give a proper indication of the status, productivity and sustainability of a water body (Djukie *et al.* 1994) [10]. The changes in the physic-chemical characteristics like temperature, transparency and chemical elements of water such as dissolved oxygen, nitrate and phosphate provide valuable information on the quality of the water, the source (s) of the variations and their impacts on the functions and biodiversity. Hence, the consideration of the physico-chemical factors in the study of limnology is basis for the understanding of trophic dynamics of a water body. Moreover, the physical and chemical properties of water immensely influence uses of a water body for the distribution and richness of biota (Unanam and Akpan, 2006) [45].

## 2. Materials and Methods
This study was conducted for assessing the water quality status of lake Ahansar, a small fresh water, rural lake which is situated at Sumbal, Sonawari (District, Ganderbal) in the floodplains of River Jhelum about 26 km north-west of Srinagar lying within the geographical coordinates of 34° 18´ N latitude and 74° 39´ E longitude. The lake is semi-drainage type (Zutshi and Khan, 1978) [54] with a maximum depth of 4.80 m and is spread over an area of 0.80 km² located at an altitude of 1584 M.A.S.L. The lake is shallow with an extended zone of emergent vegetation all along its periphery. The water supply of the lake is maintained by underground springs spread over its basin. Besides an ephemeral irrigation channel also supplements the water mass during paddy cultivation period. The lake has a permanent outflow channel on western side which drains excessive water into River Jhelum. The shores of the lake are elevated forming a long stretch of 'Karewas' which are mostly horizontally stratified deposits

of fine grained sand. The lake is essentially ox-bow type and has probably originated by meandering of alluvial deposits.

Surface water samples were collected by hand from the sampling sites in one litre polyethylene bottles marked distinctly. For dissolved oxygen, water samples were collected in separate glass stoppered bottles of 125ml capacity and the fixation of samples was done at the site. Parameters like air temperature, water temperature, depth, secchi disc transparency were determined at the respective sampling sites and the detailed analysis for parameters like dissolved oxygen, pH, total phosphorous, total hardness, Calcium hardness, total alkalinity, Ortho-phosphate, Magnesium hardness, chloride, nitrate nitrogen ($NO_3$-N), Ammonical nitrogen ($NH_4$-N) was carried out in the laboratory by using the methods outlined in APHA (2012) [2].

**Five sites were selected for the whole lake**

**Site 1:** This site is located near the inlet of lake which is shallow and is covered with dense growth of aquatic vegetation

**Site 2:** This sampling site is located near the outlet of lake where water is drained out of the lake towards river Jhelum.

**Site 3:** This is a littoral sampling sites with apple orchards in its immediate catchment.

**Site 4:** This site is located towards the north of lake.It is a pelagic site and is characterized by the absence of macrophytes.

**Site 5:** This is the central sampling site which is the deepest part of the lake (4.8m). This site has no apparent macrophytic growth (Fig. 1)

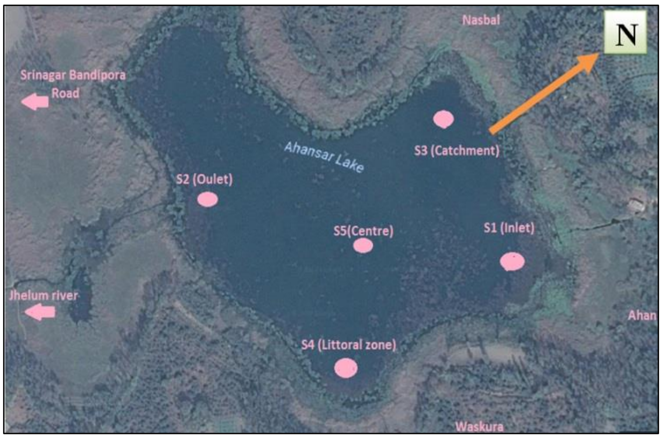


**Fig 1:** Map representing overall view of sites within Ahansar Lake

## 3. Results and Discussion

### Air temperature

Temperature is an important parameter which controls the behaviour, physiology and distribution of organism (Srivastav *et al.* 2009) [40]. Air temperature is determined by the air masses over the particular land mass, climatic condition (Hutchinson, 1967) [14], time of sample collection, climate, solar radiation and topography (Kant and Raina, 1990) [15].

The air temperature varied from a minimum of 2.8 ºC at site 1 varied in the month of January to a maximum of 33º at site 3 in the month of August (Fig 2). The observed low value of air temperature in winter is related to lower solar radiation and cold breeze, while higher values during summer could be attributed to high solar radiation. Similar results were obtained in Amghass lake, Morocco (Mustapha *et al.* 2013) [30], Manasbal lake (Dar *et al.* 2013) [7], Dal lake (Lori *et al.* 2014; Malik, 2015) [23, 26], Anchar lake (Bashir *et al.* 2017) [4]. Smaller the body of water, more quickly it reacts to changes in the atmospheric temperature and thus the water body operates as the cooling source on the microclimate of the surrounding area (Welsch, 1952) [49]. Air temperature near or over bodies of water is much different from that over land due to differences in the way water heat and cool (Wong *et al.* 2012) [52].

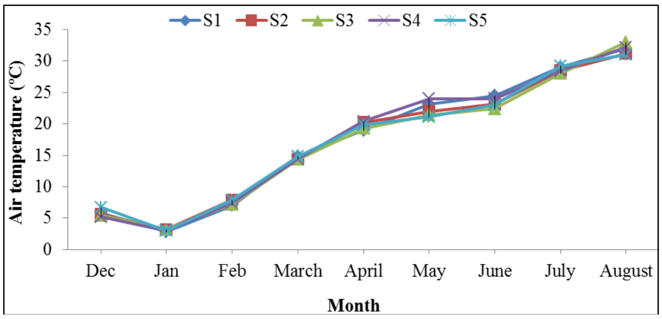


**Fig 2:** Monthly variation in air temperature (ºC) at different sites of Ahansar Lake

### Water temperature

Water temperature is of enormous significance as it regulates various abiotic characteristics and biotic activities of an aquatic ecosystem (Hutchinson, 1957) [13].

The minimum water temperature of 3.6 ºC was recorded at site 1 in the month of February and a maximum water temperature of 33.1 ºC was recorded in the month of August at site 3 (Fig 3). These fluctuations in water temperature could be due to the seasonal effect of winter and summer (Mustapha *et al.* 2013) [30]. Decrease or increase in water temperature mainly depends on the climatic conditions, sampling times, sunshine hours and is also affected by specific characteristics of water environment such as turbidity, wind force, plant cover and humidity (Mahmoud, 2002) [24]. As described by Ganai and Parveen (2014) [11] in their study on effect of physico-chemical conditions on the structure and composition of the phytoplankton community in Wular Lake, lower water temperature was due to cold, low ambient temperature and shorter photoperiods.

Dar *et al.* (2016) [8] recorded lower values for water temperature during winter and higher during summer in Dal Lake and attributed this to low water level, clear atmosphere and greater solar radiation. Bashir *et al.* 2017 [4] obtained similar results for water temperature in Anchar Lake.

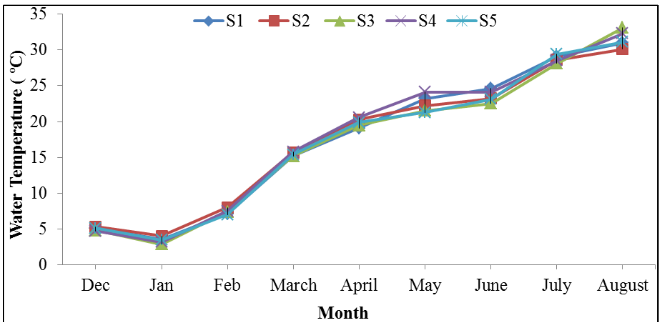


**Fig 3:** Monthly variation in water temperature (ºC) at different sites of Ahansar Lake

### Depth

The depth at site 1 varied from a minimum of 1.3 m in the month of March to a maximum depth of 4.8 (m) in the month of August at site 5 (Fig 4).

The variation in the water level fluctuations during the course of study period depended on the amount of precipitation received in the form of rain and snow and also due to changes in the amount of water brought in by an ephemeral feeding channel. The most obvious factor that affects the productivity of a lake is its depth (Scheffer and Van Nes, 2007) [37]. Kundangar and Abubakr while studying the comparative limnology of Dal Lake observed fluctuation in water depth of Nigeen Lake and related this to the opening and closing of exit gate of Nigeen Lake, as the water level of entire gate is being regulated by the lock gate.

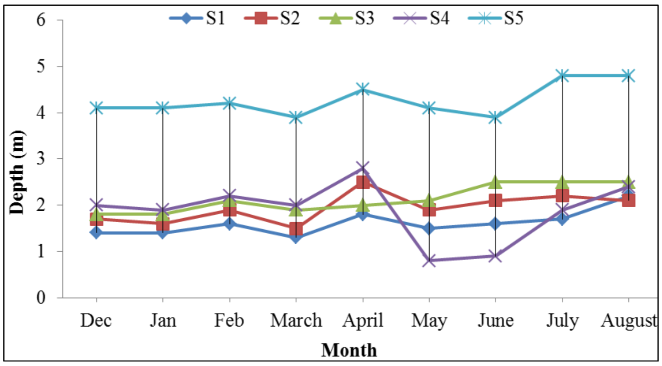


**Fig 4:** Monthly variation in Depth (m) at different sites of Ahansar Lake

### Transparency

The transparency varied from a minimum of 0.3 (m) in the month of July at site 1 to a maximum of 2.5 (m) in the month of January at site 5 (Fig 5). Lower values of transparency during summer could be attributed to increased planktonic growth and also due to increased silt load bought in by glacial activity through an ephemeral feeding channel present in the lake during summer. Higher values during winter could be due to sedimentation of suspended soil particles and low suspended organic matter. Zutshi and Vass, 1970 [53] in their study on high altitude lakes of Kashmir are of the opinion that lower transparency values could be attributed to higher planktonic population.

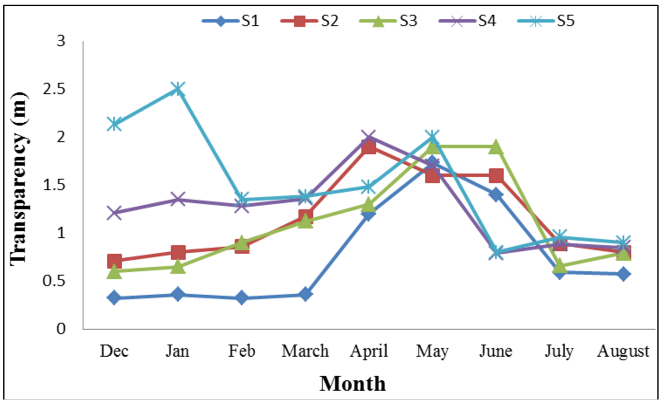


**Fig 5:** Monthly variation in transparency (m) at different sites of Ahansar Lake

### Dissolved oxygen

Dissolved oxygen varied from a minimum of 7 mg/l in the month of August at site 1 to a maximum of 12.5 mg/l in the month of May at site 4 (Fig 6) depicting an inverse relation between dissolved oxygen and temperature. Lower dissolved oxygen in summer recorded could be due to the presence of wastes of animal origin, getting decomposed at a faster rate at higher ambient temperature there by reducing the oxygen levels of water. On the other hand, the higher dissolved oxygen in spring may be as a result of increased solubility of oxygen at lower ambient temperature. Besides a marked variation in Dissolved oxygen content among different sites of the lake was seen. The extent of variability in dissolved oxygen concentration between the offshore and inshore areas may be dependent upon a number of factors such as temperature, decompositional activities, photosynthesis and the load of aeration (Kundangar and Abubakr, 2006) [20]. Wanganeo and Wanganeo (1991) [47] is also of the opinion that the oxygen concentration in water depends upon temperature, plankton population and the degree of sewage pollution.

As per the reports of (Vass *et al.* 1977) [46], high dissolved oxygen during spring could be attributed to low biological activity. Similar findings were reported in Almatti Reservoir, Karnataka (Hulyal and Kaliwal, 2011) [12], Nalanda lake, Srilanka (Nawarathana and Makehelwala, 2016) [31].

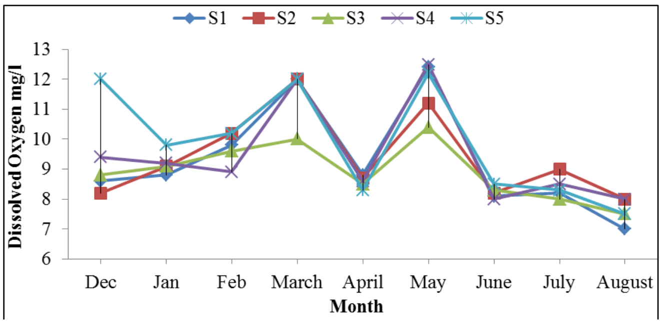


**Fig 6:** Monthly variation in the dissolved oxygen (mg/l) at different sites of Ahansar Lake

### pH

The minimum pH was recorded to be 7.4 in the month of December with a maximum pH of 8.8 in the month of May at site 1 (Fig 7). pH is one of the important chemical characters of water explaining certain significant biotic and abiotic ecological characteristic of an ecosystem in general (Chandrasekhar *et al.* 2003) [6]. Overall alkaline pH was recorded in the lake water during all seasons of the year, a finding that has been linked to the state of eutrophication by various workers (Njenga, 2005; Mathur *et al.* 2008) [32, 28]. According to White more (1984) [51], the acidic pH (<6.5) is usually a feature of oligotrophic lakes, while the circum-neutral (6.5-7.5) and alkaline pH (>7.5) is mainly exhibited by eutrophic lakes. As per these ranges, the present lake clearly falls into eutrophic category.

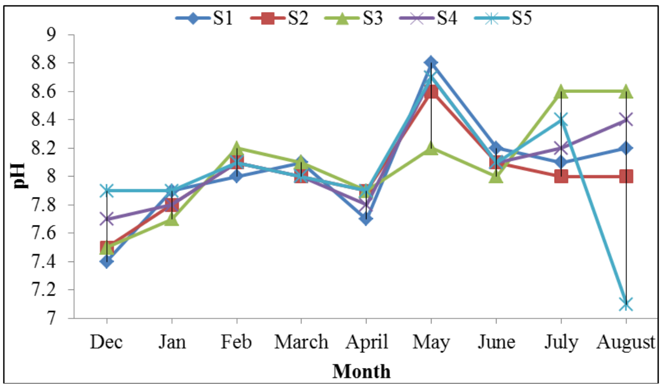


**Fig 7:** Monthly variation in pH at different sites of Ahansar Lake

### Free $CO_2$

The minimum Free $CO_2$ was reported to be 5.5 in the month of March at site 1 and maximum of 20 mg/l in the month of April at site 4 and 5 (Fig 8). The presence or absence of the free carbon dioxide in water is mostly governed by its utilization by algae during photosynthesis and also through its diffusion from air (Lianthuamluaia *et al.* 2013) [22]. Higher values of free carbon dioxide in the month of April could be attributed to lower utilization of carbon dioxide by green plants on account of low temperature.

Free $CO_2$ was reported to be absent during summer season (July) The complete absence of free carbon dioxide during summer season could be due to its complete utilization in photosynthetic activity or as a result of its inhibition by the presence of appreciable amount of calcium carbonate in water. Higher values of free carbon dioxide during spring could be attributed to lower utilization of carbon dioxide by green plants on account of low temperature.

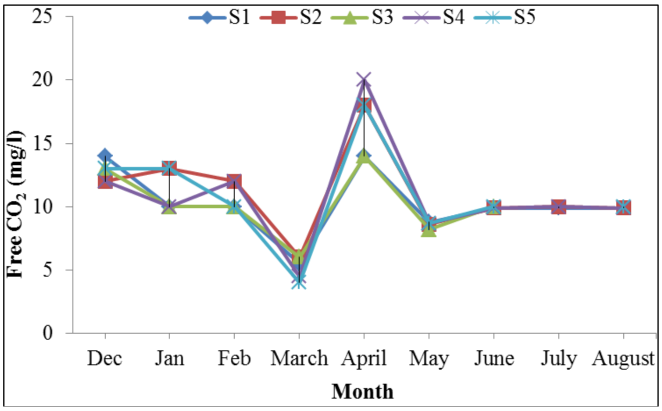


**Fig 8:** Monthly variation in Free $CO_2$ (mg/l) at different sites of Ahansar Lake

### Chloride

The minimum chloride content of 7.6 mg/l was recorded in the month of January at site 2 to a maximum chloride content of 22 mg/l in the month of May at site 1 (Fig 9). Chloride content in water is regarded as an indication of organic load of animal origin from the catchment area (Kumar *et al.* 2004) [19]. Concentration of chloride in an aquatic system is an index, not only of eutrophication, but also of pollution caused by sewage and other wastewaters (Munawar, 1970) [29]. The relative increase in the chloride concentrations during hot period may be due to increase in air and water temperatures. In general, concentration of chlorides is affected by several factors, such as increased human and cattle activities. According to Sreenivasan (1964) [39], low chlorides 4-10 ppm indicate the purity of water and freedom from pollution, whereas high value of chloride is denoted as pollution of organic matter.

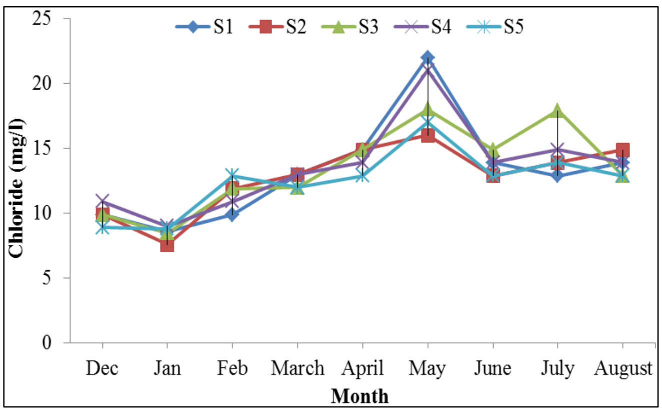


**Fig 9:** Monthly variation in chloride (mg/l) at different sites of Ahansar Lake

### Total alkalinity

The minimum total alkalinity of site 1 was reported to be 120 mg/l in the month of May to a maximum of 385 mg/l in the month of January at site 3 (Fig 10) which could be because of increase in atmospheric temperature and the consequent increase in the photosynthetic processes in summer, alkalinity values depict a significant fall from the spring. Total alkalinity in the lake followed a decreasing trend from winter to spring months which is in line with the findings of Agarwal and Thapliyal (2005) [1] who also obtained maximum alkalinity during winter months in Bhilangana.

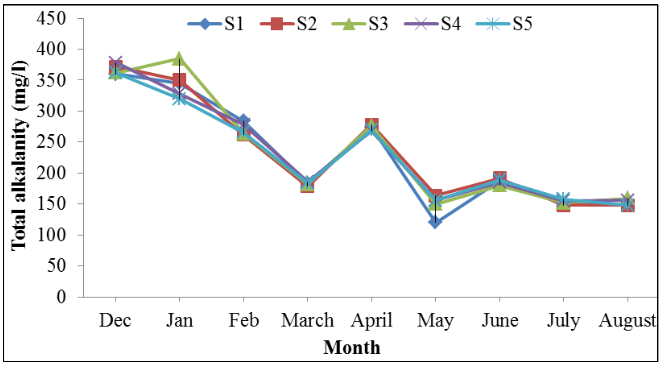


**Fig 10:** Monthly variation in total alkalinity (mg/l) at different sites of Ahansar Lake

### Total hardness

The minimum and maximum total hardness content was reported to be 250 mg/l and 395.5 mg/l in month of June and January at sites $S_3$ and $S_1$ respectively (Fig 11). Similar results were reported by Bhat *et al.* (2013) [5] in Anchar Lake. According to hardness scale of water quality association (Lehr *et al.* 1980) [21], hardness values ranging from 0-17 mg/l is soft water, 17 to 60 mg/l is slightly hard, 60 to 120 mg/l is moderately hard, 120-180 mg/l is hard and more than 180mg/l is very hard. The present study thus clearly indicates that the water of ahansar Lake are hard.

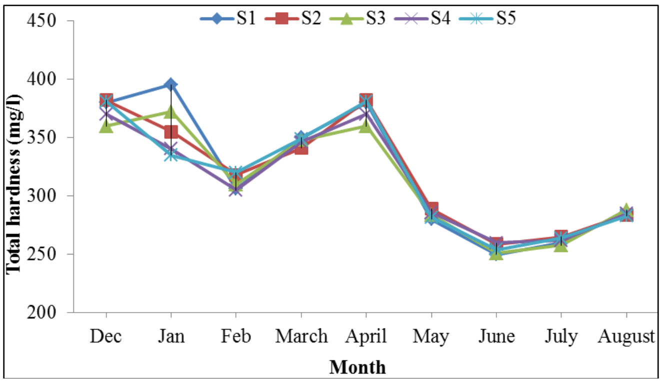


**Fig 11:** Monthly variation in total hardness content (mg/l) at different sites of Ahansar Lake

### Calcium hardness ($Ca^{2+}$)

Minimum Calcium hardness was reported to be 53.9 mg/l in the month of June at Site 2 and maximum value was reported 117 mg/l in the month of December from site 1 (Fig 12). Minimum values for calcium during summer could be attributed to photosynthetic activity of macrophytes attaining their peak growth during the season (Koul *et al.* 1978) [18] while as maximum values of calcium in the lake could be attributed to the lime rich catchment which brings a high calcium load along with storm waters. Similar findings were

reported in Anchar lake (Bhat *et al.* 2013) [5], reservoirs of Andhra Pradesh (Das, 2000) [9].
According to Rodhe (1949) [35], the freshwater lakes maintain a constant ionic composition i.e., Ca>Mg>Na>K and $HCO_3$>$SO_4$>Cl. Applying the Rodhe's ionic composition to Ahansar lake, it is evident that the lake shows uniform ionic composition i.e., Ca (85.8 mg/l) > Mg (62.5 mg/l) > Cl (14.8 mg/l).Such a progression according to Rodhe (1949) [35], is characteristic for fresh waters; the dominance of Ca over other cations being probably related to its leaching from the surrounding areas.

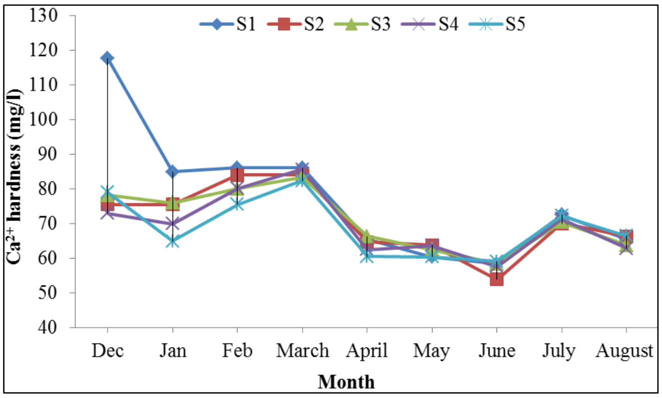


**Fig 12:** Monthly variation in calcium hardness (mg/l) content at different sites of Ahansar Lake

## Magnesium hardness
The minimum magnesium hardness content reported to be 46 mg/l from site 1,3 and 4 in the month of July to maximum of 79 mg/l in the month of April from site 5 (Fig 13). The low concentration may be due to uptake of $Mg^{2+}$ by plants in the formation of Chlorophyll, magnesium poryphyrin metal complex and in enzymatic transformation (Wetzel, 1975). Similar results were reported by Bhat *et al.* (2013) [5] in Anchar Lake and recorded minimum value for magnesium in the month of July and maximum in the month of February.

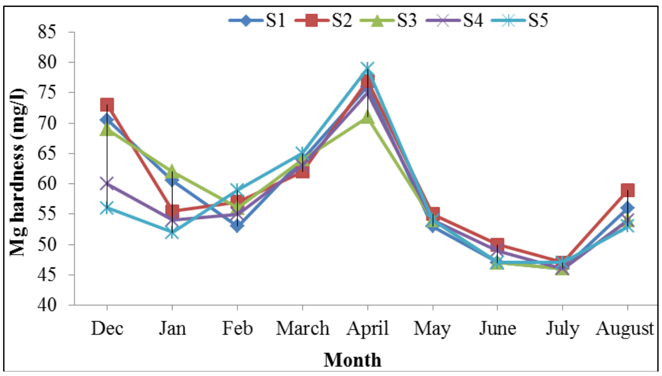


**Fig 13:** Monthly variation in magnesium hardness content (mg/l) at different sites of Ahansar Lake

## Ammonical nitrogen ($NH_4$-N)
The minimum ammonia content of 76.2 µg/l was reported from site 5 to a maximum ammonia content of 140 µg/l in the month of December at site2 (Fig 14). Higher values of ammonia during winter could be due to lower metabolic processes as development of plant life is very low and also due leaching from the surrounding terrestrial vegetation due to rains. Lower values of ammonia during summer could be due to the photosynthetic assimilation by autotrophs (Pandit, 1999) [33]. As has been reported by Dar *et al.* 2013 [7] in Manasbal Lake, lower values of ammonical nitrogen in winter season were due to nitrification or direct absorption by many phytoplanktons.

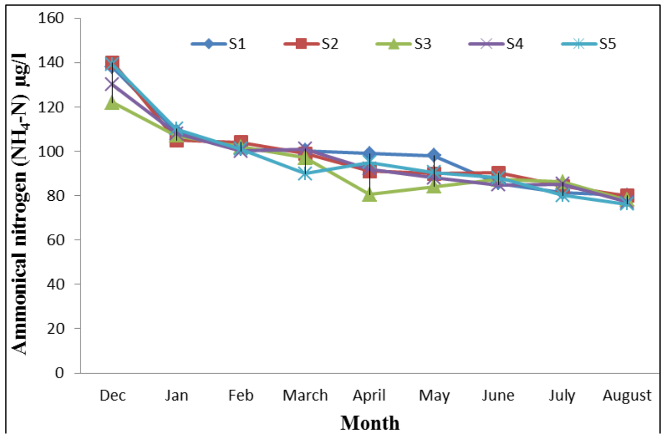


**Fig 14:** Monthly variation in ammonia (µg/l) at different sites of Ahansar Lake

## Nitrate nitrogen ($NO_3$-N)
The minimum nitrate content was recorded to be 249 µg/l in the month of August at site 4 to a maximum of 683 µg/l in the month of December at site 3 (Fig 15). Higher values of nitrate during winter could be due to reduced metabolic activities because of less plant cover while as minimum values of nitrate during summer could be due to its assimilation by plant growth. A higher concentration of nitrate was reported in Dal waters (Kundangar and Abubakr, 2006) [20] and (Maryam, 2017) [27].

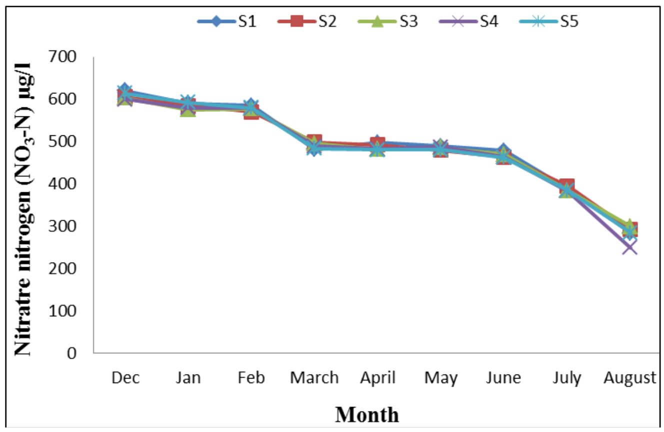


**Fig 15:** Monthly variation in nitrate content (µg/l) different sites of Ahansar Lake

## Total phosphorous
The minimum total phosphorous content was reported to be 183µg/l in month of August at S1 to a maximum concentration of 288 µg/l in the month of December at site 4 (Fig 16). Minimum values of total phosphorous during winter season could be attributed to reduced fertilizer use in the agricultural fields surrounding its catchment while as maximum values of total phosphorous during summer season could be attributed to anthropogenic inputs of fertilizers rich in phosphate applied to the agriculture fields in lake catchment, rapid evaporation and mineralization of decomposed materials.
Similar results were reported by Khan *et al.* (2014) [17] related high phosphate concentration of Dal water to sewage contamination and perturbations caused by human inference in the catchment areas and also to the heavy infiltration by

migratory birds found in abundance in the lake during warmer months.

Generally the total phosphorous content of water bodies has been used for categorization of aquatic habitats. Toerien and Walmsley (1979) [43] suggested that 25-30 mg/l total phosphorous be regarded as the border line for eutrophy. Thornton and Nduku (1982) [42] proposed two sets of the values for delimiting the lower boundary of eutrophy, 30 µg/l for temperate and 50-6-µg/l for tropical lakes. Welch, 1980 [48] is also of the opinion that the presence of phosphorous in excess of 30 µg/l in water bodies is regarded as a major nutrient triggering eutrophication.

As per the above limits, the present lake has higher values of Total phosphorous and thus falls under eutrophic category. Higher total phosphorous levels in water have been taken as indicative of pollution (Pathak and Mankodi, 2013) [34].

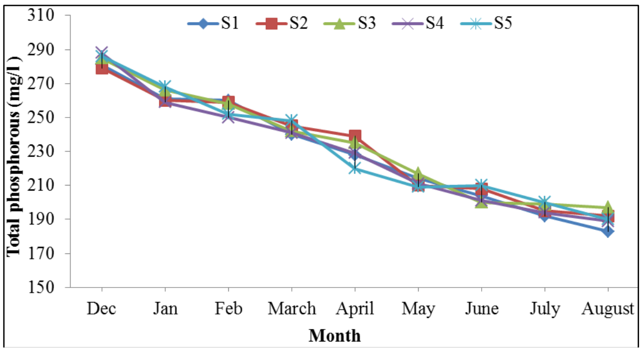


**Fig 16:** Monthly variation in total phosphorous content (µg/l) at different sites of Ahansar Lake

### Ortho-phosphate

The minimum Orthophosphate content was reported to be 19 µg/l in month of August at site1 to a maximum concentration of 42.1 µg/l in the month of December at site5 (Fig 17). Higher values of orthophosphate during summer could be attributed to increased agricultural activities in the lake catchment during the season while as lower values of orthophosphate during winter season could be attributed to reduced agricultural activities in winter. Shrishail and Mathad (2008) [38] and Sunder and Khatri (2015) [41] also registered higher values during summer and lower during winter months in Khaji Kotnoor reservoir of Gulbarga region. Sawyer *et al.* (1945) [36] suggested 30 µg/l of orthophosphate as critical level, beyond which blooms indicative of enhanced trophic status can normally be expected. In the lake basin under investigation, orthophosphate has crossed the critical level and that may be the reason for the occurrence of algal blooms seen during warmer months throughout the boundaries of the lake.

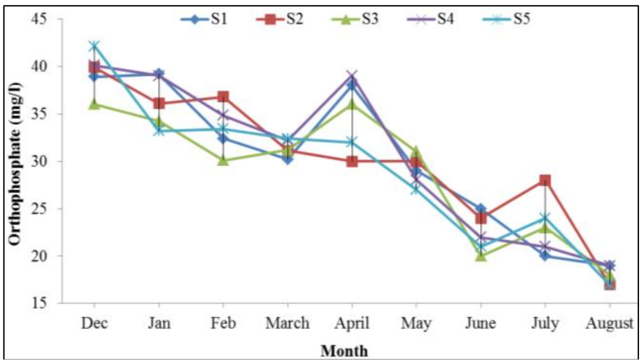


**Fig 17:** Monthly variation in orthophosphate content (µg/l) at different sites of Ahansar Lake

## 4. Conclusion

On comparing the present water quality with previous records, it was observed that the lake waters have been altered drastically in the last 30 years. Higher values of various parameters viz., ammonical nitrogen, nitrate nitrogen, total phosphorous, ortho phosphate indicate that the lake has become eutrophic. The possible reason for this is human intervention in the catchment. The uses of pesticides in the orchards around the lake directly pave way into the lake basin with run-off. Moreover, lake littorals are used for paddy cultivation which has lead to shrinking of its boundaries. Therefore, it becomes imperative for Government to develop policies to protect these aquatic ecosystems from further deterioration for human well-being.

## 5. References


1. Agarwal NK, Thapliyal BL. Preimpoundment hydrological study of Bhilangana River from Tehri Dam reservoir area in Uttaranchal. Environmental Geochemistry. 2005; 8:143-148.
2. American Public Health Association. Standard methods for examination of water and wastewater. 21st Edn. APHA, AWWA, WPCF, Washington DC, USA, 2012.
3. Andersen JH, Conley DJ, Hedal S. Palaeoecology, reference conditions and classification of ecological status: the EU Water Framework Directive in practice. Marine Pollution Bulletin. 2004; 49(4):283-290.
4. Bashir M, Chauhan R, Mir MF, Ashraf M, Amin N, Bashir SA, Tabasum S. Effect of pollution on the fish diversity in Anchar Lake, Kashmir, 2017.
5. Bhat SA, Meraj G, Yaseen S, Bhat AR, Pandit AK. Assessing the impact of anthropogenic activities on spatio-temporal variation of water quality in Anchar Lake, Kashmir Himalayas. International Journal of Environmental Sciences. 2013; 3(5):1625.
6. Chandrashekar JS, Babu L, Somashekar RK. Impact of urbanization on Bellandur Lake, Bangalore-a case study. Journal of Environmental Biology. 2003; 24(3):223-227.
7. Dar JA, Mir MF, Bhat NA, Bhat MA. Pollution Studies of a Monomictic Lake, Srinagar, Jammu and Kashmir. India. Forest Research. 2013; 2(110):2.
8. Dar SH, Khan AA, Shah TA, Shami QJ. Assessment of physico-chemical parameters of dal lake, Srinagar Kashmir. International Journal of Innovative Research and Advanced Studies. 2016; 3(11):272-279.
9. Das AK. Limno-chemistry of some Andhra Pradesh reservoirs. Journal of the Inland Fisheries Society of India, 2000.
10. Djukie N, Maletin S, Pujin V, Ivanc A, Milajonovic B. Ecological assessment of water quality of Tisze by physico-chemical and biological parameters. Tisca Szeged. 1994; 28(1):37-40.
11. Ganai AH, Parveen S. Effect of physico-chemical conditions on the structure and composition of the phytoplankton community in Wular Lake at Lankrishipora, Kashmir. International Journal of Biodiversity and Conservation. 2014; 6(1):71-84.
12. Hulyal SB, Kaliwal BB. Seasonal variations in physico-chemical characteristics of Almatti reservoir of Bijapur district, Karnataka State. International Journal of Environmental Protection, 2011.
13. Hutchinson GE. A Treatise on. Limnology 1, 1957.
14. Hutchinson GE. Introduction to lake biology and the limnoplankton. A treatise on Limnology, John Wiley and Sons. Inc. NY. 1967; 2:1115.

15. Kant S, Raina AK. Limnological studies of 2 ponds in Jammu. 2. Physicochemical parameters. Journal of Environmental Biology. 1990; 11(2):137-144.
16. Kaul V. Limnological survey of Kashmir lakes with reference to trophic status and conservation. International Journal of Ecology and Environmental Sciences. 1977; 3:29-44.
17. Khan MUZ, Ganaie IM, Bhat KH. Limnological study of Dal lake Srinagar, J&K. International Journal of Engineering Research and General Science. 2014; 2(6):558-573.
18. Koul V, Trissal CL, Handoo JK. Distribution and production of macrophytes in some aquatic bodies of Kashmir. In: Concept of ecology (Eds. Singh JS, Gopal B), 1978, 313-334.
19. Kumar A, Mandal KK, Kumar A. Aspects of water pollution scenario in lentic and lotic freshwater ecosystem namely pond 7 river in Jharkhand India. Water Pollution (Ed. Kumar A), APH. Publishing Corp. 5-Daryaganj, New Delhi, 2004, 1-9.
20. Kundangar MRD, Abubakr A. Comparative Limnology of Himalayan Dal Lake, Kashmir. Trends in Biodiversity and Aquaculture, 2006, 174.
21. Lehr JH, Wayne EG, Jack D. Toxic inorganics and other constituents. In: Water Pollution-Causes effects and control, New Age International (*P*) Limited, New Delhi, 1980, 192-194.
22. Lianthuamluaia Asha T, Landge CS, Purushothaman Geetanjali D, Karankumar KR. Assessment of seasonal variations of water quality parameters of Savitri reservoir, Poladpur, Raigad district, Maharashtra. The Bioscan. 2013; 8(4):1337-1342.
23. Lori SM, Lone SA, Awasthi AH. Limnological studies of a famous Himalayan lake: The Dal Lake. International Journal of Current Research. 2014; 6(1):4357-4361.
24. Mahmoud SA. Evaluation of toxicity effect of some pollutants on histological feature and biochemical composition of *Oreochromis niloticus* L. living in River Nile (Damietta branch). Doctoral dissertation, Thesis Fac. Sci. Zagazig Univ. Egypt, 2002.
25. Mainstone CP, Parr W. Phosphorus in rivers-ecology and management. Science of the Total Environment. 2002; 282:25-47.
26. Malik MM. Rotifera (an important fish food) population in relation to trophic status of different basins of Dal Lake, Kashmir (Doctoral dissertation), 2015.
27. Maryam S. Assessment of physic-chemical changes in Nigeen Lake. International Journal of Advances Research. 2017; 5(3):225-236.
28. Mathur P, Agarwal S, Nag M. Assessment of physico-chemical characteristics and suggested remedial measures for Pushkar lake, Ajmer, Rajasthan (India). In: 12th World Lake Conference (Eds. Sengupta M, Dalwani R), 2008, 1518-1529.
29. Munawar M. Limnological studies on freshwater ponds of Hyderabad-India I. The Biotope. Hydrobiologia. 1970; 35(1):127-127.
30. Mustapha A, Driss B, Mohamed B. Seasonal variations in physico-chemical parameters of water body Amghass II Province Ifrane Morocco. Universal Journal of Environmental Research and Technology. 2013; 3:6.
31. Nawarathana TNTK, Makehelwala M. Study of Dissolved Oxygen (DO) Profile in Nalanda Lake, Sri Lanka. International Journal of Scientific and Research Publications. 2016; 6:4.
32. Njenga JW. Comparative Studies of Water Chemistry of Four Tropical Lakes in Kenya and India. Asian Journal of Water, Environment and Pollution. 2005; 1(1):87-97.
33. Pandit AK. Freshwater Ecosystems of the Himalaya. Parthenon Publishing, New York, London, 1999.
34. Pathak NB, Mankodi PC. Hydrological status of Danteshwar pond, Vadodara, Gujarat, India. International Research Journal of Environment Science. 2013; 2(1):43-38.
35. Rodhe W. The ionic composition of lake waters. Proceeding of International Ass. Limnology. 1949; 10:377-3s86.
36. Sawyer CN, Lacken JB, Lens AT. Investigations of the water order nuisance in the Madison lakes, particularly lakes Manoua, Wanbasa and Kegonsa from July 1943 to Kuly 1944, Madison Univ. Press, 1945.
37. Scheffer M, Van Nes EH. Shallow lakes theory revisited: various alternative regimes driven by climate, nutrients, depth and lake size. Hydrobiologia. 2007; 584(1):455-466.
38. Shrishail VG, Mathad P. Distribution and periodicity of phytoplankton in Khaji Kotnoor reservoir of Gulbarga region. Indian Ecology Environment and Constructions. 2008; 14(2-3):429-433.
39. Srinivasan A. Hydrological study of a tropical impoundment Bhavanisagar reservoir, Madras state, India, for the year 1950-61. Hydrobiologia. 1964; 54:514-539.
40. Srivastava N, Harit G, Srivastava R. A study of physico-chemical characteristics of lakes around Jaipur, India, 2009.
41. Sunder S, Khatri AK. Physico-chemical Properties of Water of Ottu Reservoir in District Sirsa, Haryana, India. Research Journal of Recent Sciences. 2015; 4:190-196.
42. Thornton JA, Nduku WK. Water chemistry and nutrient budgets. In Lake McIlwaine Springer, Dordrecht, 1982, 43-59.
43. Toerien DF, Walmsley RD. The chemical composition of the upper Hennops River and its implications on the water quality of Rietvlei Dam. Water South Africa. 1979; 5(2):77-89.
44. Trisal CL. Trophic status of Kashmir lakes. *Proceeding of National Sympos.* Evaluation Environment, 1985, 171-179.
45. Unanam AE, Akpan AW. November. Analysis of physicochemical characteristics of some freshwater bodies in Essien Udim Local Government area of Akwa Ibom State, Nigeria. In: Proceeding of the 21st Annual Conference of the Fisheries Society of Nigeria (FIS0N) Calabar 13-17 November, 2006.
46. Vass KK, Raina HS, Zutshi DP, Khan MA. Hydrobiolgical studies on River Jhelum. Geobios. 1977; 4:238-242.
47. Wanganeo A, Wanganeo R. Algal population in valley lakes of Kashmir Himalaya. Archiv for Hydrobiologia. 1991; 121:219-133.
48. Welch EB, Lindell T. Ecological effects of waste water Cambridge University Press. Cambridge, UK, 1980.
49. Welsch PS. Limnology. McGraw-Hill Book Company, Inc. New York, 1952.
50. Wetzel RG. Limnology: Philadelphia. WB Saunders Company, 1975, 3.
51. Whitemore TC. Tropical rain forest dynamics and its implications for management. Rain forest regeneration and management, 1984.

52. Wong NH, Tan CL, Nindyani ADS, Jusuf SK, Tan E. Influence of water bodies on outdoor air temperature in hot and humid climate. In ICSDC 2011: Integrating Sustainability Practices in the Construction Industry, 2012, 81-89.
53. Zutshi DP, Vass KK. High altitude lakes of Kashmir. Ichthiologica. 1970; 10:12-15.
54. Zutshi DP, Vass KK. Limnological studies on Dal lake-chemical features [India]. Indian Journal of Ecology (India), 1978.
55. Zutshi DP, Kaul V, Vass KK. Limnology of high altitude Kashmir lakes. Verhandlungen des Internationalen Verein Limnologie. 1972; 18:599-604.