Case Study

Seasonal Variation in Physiochemical Parameters of Ahansar Lake

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Abstract:
The Ahansar Lake is a small water body (0.80km²) located at Sumbal, Sonawari. A limnological study of this water body was initiated in December, 2011 and data on different physiochemical and biological features are being regularly collected on monthly basis. The water body is facing multi fold pressure due to discharge of domestic sewage, agricultural runoff and solid wastes from the adjoining areas. The lake is highly alkaline with high conductivity. Unique feature of this lake is its high alkalinity and high calcium content which is due to its lime rich catchment which brings high calcium load along with storm waters. The nutrient concentration showed seasonal fluctuations in close association with the various activities going on in the catchment.

Key words: Ahansar Lake, Water chemistry, Nutrients, Seasonality

INTRODUCTION

Lakes are extremely variable in their physical, chemical and biological characteristics. Physically they vary in terms of the level of light, water current, and temperature. Chemically they vary in nutrients, major ions and contaminants, biologically in terms of biomass, population numbers and growth. Human intervention, different microbial abundance, water quality, nutrient supply, climatic variations are the main factors that determine the tropic status of the lake. Quality of water reflects the environmental conditions of any water body. The shallow lakes are much influenced by the intensive exchange of nutrients between their water column and the sediments (Vicente.et.al, 2006).
STUDY AREA

The lake Ahansar is small fresh water, rural lake. It is situated at Sumbal, Sonawari (District, Bandipora) 26 km north of Srinagar. The lake is located at an altitude of 1584 m (a.s.l). The lake is semi–drainage type (Zutshi and Khan; 1978) with a maximum depth of 5 m and is spread over an area of 0.80 km². 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 lake is under heavy ecological stress due to increasing land use encroachment. Agricultural activities are carried on the lake shore. The lake is highly productive and is at higher level of trophic evolution (Rather and Pandit; 200). Few studies have been under taken on Ahansar Lake. Zutshi and Khan (1978) reported on Lake Topology. Kundanger and Zutshi (1985) reported environmental features and plankton population. In (1987) same authors studied ecology of macrophytes. Kawoosa (1997) reported species composition and population dynamics of periphyton. Rather and Pandit (2002, 2005) studied diversity of emergent macrophytes. Till date no work has been done on this lake. Therefore a few references are available on flora and fauna and physio chemical fetures of this lake. Keeping the above views in mind, it was envisaged to carry out detailed study on lake Ahansar with respect to physio chemical parameters.

MATERIALS AND METHODS

Surface water samples are collected for physio chemical parameters every month from December 2011 to November at a depth of 0.2 m in 1 litre polyethylene containers. Water samples for dissolved oxygen are collected in air tight stoppered glass bottles of 250 ml capacity. Fixation of sample was done on spot following modified Winklers method (APHA, 2005). Both air and water temperature, pH, conductivity are recorded on spot using mercury thermometer, portable Ph meter and portable conductivity meter respectively. Water samples collected are brought to the laboratory and subjected to analysis immediately for carbon dioxide, alkalinity, hardness, following standard methods (APHA, 2005), (C.S. I.R, Pretoria, 1974).

STUDY SITES

As the lake is very small, only two study sites were selected which characterise the whole.

Site 1: - The site was located on the north side of the lake. It has a large shallow water area covered with dense growth of vegetation.

Site 2: - The site was located on eastern side of the lake near human habitation, where sewage and effluents find their way into the lake.
RESULTS AND DISCUSSIONS

HYDROGEN ION CONCENTRATION

PH is an important parameter that determines the suitability of water for various purposes. PH of water is important for the biotic communities because most of the plant and animal species can survive in a narrow range of pH from slightly acidic to slightly alkaline condition.

During the study period pH showed high positive relationship with water temperature. The maximum value 8.8 at site 1 was recorded during summer, minimum value 7.7 was recorded during winter at site 2. In the present investigation the pH range showed that water of the lake is alkaline in nature. High values of pH during summer may be low water level and high photosynthetic activity. Yousuf.et.al (1986) attributed that high rate of photosynthesis demands carbon dioxide which raises the pH. Low pH during other seasons could be attributed due to increased decomposition.(Graph 1)

FREE CARBON DIOXIDE

Carbon dioxide in an important parameter that is required for photosynthetic process in plants. Carbon dioxide reacts with water and forms carbonic acid which dissociates into soluble bicarbonates and insoluble carbonates that alters the pH of the water.

During the present study the concentration of free carbon dioxide was maximum 31 mg /l at site 1 during winter, minimum 9 mg /l at site 1 during Summer. High concentration during winter may be related to decomposition of organic matter utilizing dissolved oxygen and liberating carbon dioxide and no or little photosynthesis occurs during winter. Yousuf.et.al (1986) attributed that the carbon dioxide liberated as a by product in the respiration of animals and plants gets accumulated in water in large quantities. This accumulated carbon dioxide
results in decrease in pH during this period. It was absent during the growing season (April/May) at site 1 when pH was 8.3 and 8.5 respectively. It may be attributed to the fact that rate of photosynthesis during growing season increases. Koul.et.al (1971) reported that macrophytes are the main contributors to photosynthetic activity in the lakes of Kashmir valley. It may therefore explain presence of carbonates and absence of carbon dioxide during these growing months as the lake harbours an abundant growth of macrophytes which use carbon dioxide for photosynthetic activity which naturally depletes carbon dioxide. (Graph 2)

![Graph 2: showing seasonal variation in free CO₂ at site 1 and site 2.](image)

ALKALINITY

Alkalinity of surface water is primarily a function of carbonates, bicarbonates, hydroxide content. It also includes contributions from borate, silicate, phosphate and other bases. Alkalinity is a measure amount of strong acid needed to lower the pH of a sample to 8.3 which gives free alkalinity (phenolphthalein alkalinity) and to a pH 4.5 which gives total alkalinity. Most of the alkalinity of water is to dissolution of carbonates.

During the study period alkalinity showed positive relationship with temperature and PH. Alkalinity values were maximum 292 mg /l at site 1 during summer and minimum 145 mg /l at site 2 during winter. It seems maximum value during summer may be due to increase in organic decomposition which liberates carbon dioxide which reacts with water to form bicarbonates, thereby increasing the total alkalinity in summer. Additionally increase in alkalinity during summer may be due to decrease in water level. Zutshi.et.al (1980) Yousuf and Qadri (1981) asserted that higher values of alkalinity during summer can be related to its non open type lake which over the geological period of time has concentrated mostly due to evaporation of water. Wetzel (1983) related decrease in alkalinity during winter and spring with dilution caused by rain water.
This is in line with the findings of present investigation that minimum value of alkalinity during winter may be due to dilution of nutrients with rain water. According to Ali kunhi (1957) water with alkalinity greater than 100 mg/l is productive. In the present lake alkalinity value comes in the range of 145 mg/l to 292 mg/l which indicates the lake is highly productive. (Graph 3)

Graph 3: showing seasonal variation in alkalinity at site1 and site2.

CHLORIDE

Chloride anion is generally present in natural waters. The chloride concentration is higher in organic wastes and its higher level in natural waters is definite indication of pollution from domestic sewage. The ecological significance of chloride lies in its potential to regulate salinity of water.

During the study period chloride showed increasing as well as decreasing trend. However it showed positive relationship with temperature PH and alkalinity. Maximum concentration 18 mg/l was recorded at site 2 during summer and minimum concentration 13 mg/l at site 1 was recorded during spring. Maximum value during summer may be due to higher concentration of chloride resulted from evaporation. Minimum value may be due to dilution with water. Yousuf, et.al 1986 related small quantities of chloride during summer in Nilnag Lake with the dilution of chloride content by the melt water. (Graph 4)
Dissolved oxygen

Dissolved oxygen is one of the most important parameter in assessing the water quality of water which is essential to maintain biotic forms. The oxygen supply in water mainly comes from two sources atmospheric diffusion and photosynthetic activity of plants. Dissolved oxygen in surface water is controlled by temperature and has both seasonal and a daily cycle. It is a measure of how much oxygen is dissolved in water. Dissolved oxygen can tell us a lot about water quality.

During the present study concentration of dissolved oxygen was maximum 9.9 mg / l during winter at site 1 and minimum 5.6 mg /l during summer at site 2. Solubility of oxygen increases with decrease in temperature. Maximum concentration during cold months is due to low temperature, as cold water has great capacity to hold oxygen than warm water. Vass.et al (1977) related high dissolved oxygen during winter or spring with low biological activity. Minimum concentration during summer is due to high temperature, because of its utilization in decomposition of organic matter. (Graph 5)
Total hardness

Water hardness reflects mainly the contents of ions calcium and magnesium ions, combined with carbonates and bicarbonates, but may also be combined with sulphides and chlorides.

During the present study hardness was maximum 262 mg/l at site 1 during winter and minimum 145 mg/l at site 2 during summer. According to Wetzel (1975), it is also used as an indicator of water quality. According to Moyal (1949) a lake with an hardness value over 90 mg/l is hard. The present lake is hard as hardness comes in the range of 145 mg/l to 262 mg/l. Higher hardness of lake water is probably due to continuous addition of sewage, agricultural runoff from catchment areas. (Graph 6)

![Graph 6: showing seasonal variation in hardness at site 1 and site 2.](image)

Calcium and Magnesium

The predominant compound in many interior waters in the form of calcium carbonate is also one of the least soluble. Only a small amount can be dissolved in pure water, but in the presence of carbonic acid it is represented as the soluble calcium bicarbonate. The initial input of allochthonus calcium compounds to aquatic habitat comes from various erosional phenomena. During the present study calcium concentration was maximum 132 mg/l at site 2 during winter and minimum 76 mg/l at site 2 during summer. Summer decrease of calcium in waters is attributed in photosynthetic activity of macrophytes attaining their peak growth and production during the season (Koul. et.al 1978). The lake has high calcium content which is due to the lime rich catchment which brings a high calcium load along with storm waters. Magnesium concentration in the water always remains lower than calcium content. Variation in magnesium concentration has been attributed to different biogeochemical activities in the water ecosystem.
During the present investigation magnesium concentration was maximum 34 mg/l at site 1 during winter and minimum 13 mg/l at site 2 during summer. (Graph 7, 8)

Graph 7: showing seasonal variation in calcium hardness at site1 and site 2.

Graph 8: showing seasonal variation in magnesium hardness at site 1 and site 2.

**Nitrate - nitrogen**

Nitrate is the most oxidized form of nitrogen compounds commonly present in natural waters, because it is a product of aerobic decomposition of organic nitrogenous matter.

During present study concentration of nitrate nitrogen was maximum 389 microgram/l in winter at site 2 and minimum 281 microgram/l in summer at site 1. Maximum value of nitrate nitrogen during winter low metabolic activities occur due to low plant growth and minimum value during summer may be due assimilation of plant growth. Paulose and Maheshwari (2007) opined that high nitrate content can be correlated with high rate of organic decomposition. (Graph 9)
Ammonical – nitrogen

Ammonical nitrogen is a measure for the amount of ammonia, a toxic pollutant often found in land fill leachate and in waste products such as sewage, liquid manure and other liquid organic waste products.

During the present study concentration of ammonical nitrogen was maximum in winter 223 µg/l at site 1 and minimum 123 µg/l in summer at site 1. Higher rate of ammonical nitrogen during winter may be due to lower metabolic processes as development of plant life is very low and accumulation of degradation products. (Graph 10)
Total phosphorus

Phosphorus is a nutrient important for plant growth. In most lakes phosphorus is a limiting nutrient. Phosphorus has a direct affect on plant and algal growth in lakes. The more phosphorus is available the more plants there are in the lakes. Phosphorus is also present in animal fragments suspended in lake water. Phosphorus is usually measured in two ways total phosphorus and orthophosphate. In lakes there usually is not lot of orthophosphate because it is incorporated into plants quickly.

During the present study total phosphorus concentration was maximum 269 µg/l at site 1 during summer and minimum 161 µg/l during winter at site 1. Similarly concentration of orthophosphate was maximum 33 µg/l at site 2 in summer and minimum 19 µg/l at site 2 during winter. (Graph 11, 12)

Graph 11: showing seasonal variation in total phosphorus at site 1 and site 2.

Graph 12: showing seasonal variation in orthophosphorus at site 1 and site 2.
Conductivity

Conductivity is an index of the amount of minerals present and it varies with temperature. Natural water has low conductivity but contamination can increase the level. Most of the salts dissolved in water are in ionic form and thus water can conduct electricity. Thus electrical conductivity of water depends on the concentration of ions and its nutrient status. Increased availability of ions is due to decomposition processes as well sewage input.

During the present investigation maximum conductivity 422 µs/l was recorded at site 2 during winter and minimum value 309 µs/l at site 2 during summer. Maximum value during winter may be due to decomposition of organic matter which releases large amount of salts and also due to rainfall, melting of snow which brings large amount of nutrients from catchment areas. Minimum value of conductivity during summer may be due to uptake of ions by plants. This is in line with the findings of Pandit (1999) who related low values of conductivity in summer with uptake of ions by plants. (Graph 13)

Graph 13: showing seasonal variation in conductivity at site 1 and site 2.

Conclusion

In essence the physic chemical parameters of the lake reveal that it is tending fast towards eutrophication. PH was always towards alkaline side. Higher values of alkalinity and hardness shows the lake is typical hard water body. The quality of water is deteriorating day by day due to inflow of domestic sewage, agricultural runoff.

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Seasonal variation in hardness at site 1 and site 2

Seasonal variation in calcium hardness at site 1 and site 2

Seasonal variation in magnesium hardness at site 1 and site 2
Seasonal variation in chloride at site 1 and site 2

Seasonal variation in ammonical nitrogen at site 1 and site 2

Seasonal variation in nitrate nitrogen at site 1 and site 2
Seasonal variation in total phosphorus at site 1 and site 2

Seasonal variation in orthophosphate at site 1 and site 2

Seasonal variation in Conductivity at site 1 and site2