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Study of Sediment for Nutrient Enrichment of Gundolav Lake, Kishangarh (Ajmer), Rajasthan

Dr. Anita Sharma

Associate Professor, Samrat Prithviraj Chauhan Government College, Ajmer

Abstract: ***Sediment plays an important role in influencing water quality, biota, and organic productivity. In an aquatic ecosystem, the analysis of sediment for physico-chemical characteristics is necessary for judging the relationship between water and sediment with respect to various properties. Gundolav is an important fresh-water lake of Kishangarh city because of its location in the heart of the city and its multifold pressure. Sediment act as "store-house of nutrients" for the overlying water and help in mineralization of organic matter, absorption, and release of nutrient into the water. The pH ranged from 7.66 to 9.13 units, specific conductivity (ranging 187.84 - 2536.26 µmho/cm), and total alkalinity (ranging 135.77 - 286.32 mg/l). The nitrate value fluctuated between 3.94-7.34 mg/l. The nature of the catchment area and the influence of human activities at station IV marks the high values of various physico-chemical parameters of sediments at this station. The data indicate that sediments at all stations have almost the same trend in the concentration of various elements.***

Keywords: Ecosystem, Sediment, Physico-chemical characteristics

1. Introduction

Most of our fresh-water bodies as ponds, lakes, streams, and rivers become polluted due to industrial growth, urbanization, and other man-made problems. This is a worldwide problem both for industrialized and developing as well as the under-developed countries. Inadequate management of water resources has directly or indirectly resulted in the degradation of the hydrological environment (Karanth, 1989). A small concentration of nutrients is essential to aquatic ecosystems but a large concentration of the same will act as pollutants, leading to eutrophication, which becomes almost irreversible. If the nutrient supply becomes sufficiently lavish, algae grows rapidly and can cover the surface as thick, slimy mats (Palmer, 1980).

The increase in productivity due to extra PO_4-P and NO_3-N is called eutrophication. Phosphate comes mainly from detergents while nitrogen is highly soluble and fertilizers form the major source of this element. Microorganisms (algae, fungi, protozoa, and bacteria) are particularly sensitive to changes in the level of temperature, pH, carbon dioxide, dissolved oxygen, etc. Changes in environmental conditions cause seasonal and periodic variations in the quality and quantity of different microorganisms. Microbial organisms (especially protozoan) play an important role in aquatic ecosystems by fixing energy in photosynthesis and processing dead organic material (Sherr and Sherr, 1984). In the association of bacterial flora, they are an active component of the micro food loop (Azam *et al.* 1983) and the main-grazers of them. Among the major group of aquatic organisms, protozoa are unicellular and their reproductive rate is very fast, therefore they are considered the most sensitive indicators of organic pollution (Antipa, 1977, Henebry and Cairns, 1980).

2. Study Area

Kishangarh is one of the important industrial cities of Ajmer district, located on NH-8 between Ajmer and Jaipur. The area in and around the city is characterized by many shallow perennial fresh-water bodies; Hammir pond, Ransamand pond, Gundolav lake, Santolav lake, etc.

Gundolav is an important fresh-water lake of Kishangarh city because of its location in the heart of the city and its multifold pressure. This lake is of great attraction and has occupied an important place in the historical, cultural, economic, and recreational life of the people. Due to the multifold pressure of urbanization, urban sewage waste discharge, cloth washing activities, agricultural practices, construction of housing colonies on a major part of lake margins, the water of Gundolav lake is greatly affected. A few sites of the lake are also surrounded by Aravalli Hillocks. The surface-flow adds water, which also contains urban wastes and fertilizers from agricultural fields to the lake during the rainy season. Hence, the study of this lake is important from an ecological and scientific point of view.

Topographically, this region is an ecotone region characterized by more or less a plain surface interrupted by low hills. Kishangarh has large stretches of sandy areas. The agro-climatic zone under which Kishangarh Tehsil falls is the semiarid eastern area. The basin of the Gundolav Lake has agricultural land which has been allotted to the farmers. The land is used by farmers when the lake dries up. There is about 1,002 bigha land used for farming. Around 252 bigha land is encroached by different people. Thus, the total agricultural land near the lake is about 1,254 bigha. Local people cultivate Singhara (*Trapabispinosa*), which is an aquatic emergent plant, grown for its fruit, the water chestnut.

3. Observation and Results

The chemical analysis of sediment is an important aspect of aquatic biological investigations. It is quite well known that the sediment influences nutrients greatly in a pond ecosystem. The biogeochemical cycling in the system helps replenishment and consequent removal of nutrients from the system. Such an exchange of nutrients depends upon the characteristics of the sediments and the hydrographic

features of the lake. The potential energy and aquatic organic matter are stored inside the bottom soil of a lake in the form of humus and organic residue, which maintains the biota in the aquatic ecosystem. The biotic component of a lake is not only based on the nutrient status of the water itself but is also influenced by the sediments in water, added sources of nutrient supplies, and the role of roots. The rooted emergent plants absorb nutrients wholly from the sediments whereas the submerged and free-floating macrophytes take up nutrients entirely from water. In addition to this, the chemical characterization of the sediments in lentic and lotic systems help in measuring the anthropogenic contamination and assess the probable impact on the environment (Das and Borah, 2003). Since the availability of nutrients and other elements in both sediments and the water column is an important determinant of nutrient uptake level, sediment analysis was undertaken in the study.

A perusal of the data on sediment analysis indicates variations in different parameters. The important observations are as follows:

The pH of sediment was alkaline ranging from 7.66 - 9.13. pH decreases during the rainy season and it is towards the more alkaline side throughout the study period. Srivastava and Saxena (2007) recorded the pH of sediments of some desert ponds near Bikaner in the range of 8.1 to 11.7, while Mehrotra (1988), in Lalsagar Reservoir, Jodhpur recorded acidic pH (6.0 to 6.5) of the sediment during monsoon and alkaline during summers.

High pH in summer maybe because of the decomposition process going on in the bottom mud making it more alkaline. Low pH values in monsoon can be due to the accumulation of more sand and silt brought about by runoff, which settles to the bottom, thereby decreasing the pH values. These results are in harmony with Gaidhane and Saksena (2007), but it is contrary to the observation of Ahmad *et al.* (1996) observed low average values of pH in summers, than monsoon and winters. Here the study station IV having an ample amount of organic matter always exhibited high pH values. Ramasubramanian*et al.* (2004) have documented that temporary change in pH is due to change in primary production, respiration, and decomposition of the organic matter in the sediments.

The conductivity of sediment influences the ionic concentration of water in the pond. The values of conductivity fluctuated between 187.84 - 2536.26 µmho/cm. The minimum value was recorded in winters (November) and maximum in summers (June). The conductivity of soil is affected by temperature. High values in summer because of the high rate of evaporation of water, thus decreasing water level and making the electrolyte more concentrated. A decrease in conductivity values in the monsoon may be attributed to dilution by rain-water. Low values were observed during winter because of the assimilation process by phytoplankton (Welch, 1952).

Gaidhane and Saksena (2007) reported very high specific conductivity values in Kharland Pond suggesting the presence of a large number of water-soluble cations and anions in saline soils.

Total alkalinity, as $CaCO_3$ in sediment, ranges from 135.77 - 286.32 mg/l during November (early winter) and March (early summer) respectively. Comparatively lower values were observed in monsoon because of dilution of runoff.

Total hardness as $CaCO_3$ showed peak value in the month of June (890.70 mg/l) and a minimum of 192.36 mg/l in March. Calcium hardness values were observed to be maximum during June and minimum in April (89.30 – 486.94 mg/l). Maximum values of magnesium hardness were recorded during the summer and winter months and the monsoon season showed comparatively lower values. Similarly, high values of calcium and magnesium were noted in the summer months. The discharge of sewage is an important source of calcium, hence high calcium values were observed at station IV.

The chloride and sulfate were found to be high in summer and decreases in the winter season. The higher values of chloride and sulfate, which were found to be higher at the station I and II, can be attributed to the comparative deepness of these stations having an accumulation of dissolved salts coming with running water. Another possible reason was washing and bathing activities by local residents.

The mean nitrate values in sediment ranged from 3.94 - 7.34 mg/l during the month of March and October respectively. In general, high values were observed during monsoon and summer and low during winter. High values in summer were due to evaporation of water along with an increase in the organic matter concentration which in turn decomposes to liberate nitrogen. In the present investigation, the maximum value in October (late monsoon) may be on account of an increase in deposited organic matter content due to runoff from the catchment area.

Agricultural practices inside the lake margins might be responsible for increased nitrate contents in the sediments of Gundolav Lake. Low nitrogen content during March (early summer) and winter can be attributed to the exponential growth of both micro and macrophytes, which consume the nitrogen. A similar trend was also observed by Vyas et al. (1987) and Mathur (1992). In contrast, Lendhe and Yeragi (2004) reported a higher level during winter and minimum during monsoon.

Sodium and potassium were noted to be high in summers. The values of both parameters were also high in July. The mean sodium values in sediment ranged from 5.40 - 87.00 mg/l with an average value of 35.27 mg/l.

The productivity of any aquatic ecosystem is known to be influenced by the potassium content of bottom sediment in addition to nitrogen. The values of potassium varied between 4.40 - 32.40 mg/l. The values of potassium were also high in winters because the input in potassium in the form of fertilizers is more in this season particularly at station IV. Such nutrients are low during the rainy season as they flush away along with the surface flow. Station IV showed comparatively high values of potassium because an increase in the concentration of sewage generally increases the potassium content. The present observation is in accordance with the findings of Sivakumar *et al.* (2001) who

suggest that the concentration of sewage increases the potassium content.

The total organic carbon is an index of total biomass available in sediment. The recorded values for organic carbon were 0.40 - 6.34 ppm with an average value of 2.63 ppm for Gundolav sediment. Organic carbon was found to be significantly high in the summer season as compared to the winter and rainy season. High values during summer may be due to a decrease in water level and more accumulation of organic matter in the sediments. This is not in conformity to the findings of Lendhe and Yeragi (2004) who detected maximum organic carbon content during monsoon and minimum during winter.

Slightly higher values of organic carbon were always observed at station IV because this station harbors a large amount of organic matter coming in domestic effluents from the city. The sharp rise of organic carbon however is not a manifestation of high productivity but an accumulation of land runoff material following sewage discharge.

The moisture content was observed maximum during winter followed in decreasing order by monsoon and summer season. During the major part of the study period, the lake soil was of sandy loam type. Seasonal differences in chemical characteristics of sediment are due to several natural as well as anthropogenic factors. Similar observations were also made by Salodia (1995). According to Salodia (1995), the decomposition rate of various macrophytes in the sediment is another factor for differential chemical characteristics for different reasons.

Pollution alters the physico-chemical and biological properties of water (Ramasubramanian*et al.*, 2004), which later appears in bottom sediments (Di Pinto and Coull, 1997). Agarwal *et al.* (2000) reported that pH, temperature, electrical conductance, organic carbon, nutrient content (N, P, K, Ca, and Na) all show higher values at all the points of mixing of domestic wastes. From the above results, it is apparent that sediments at station IV, exposed to sewage discharges, were affected adversely and had higher values of different physico-chemical parameters of ecological importance in the biogeochemical process of sediments.

High values of pH, alkalinity, hardness, organic carbon, and other nutrients at station IV may be attributed to the nature of its catchment area and the influence of human activity which is much pronounced at this station. In addition, the station I and II which are the deeper sites of the lake, have accumulated region (station IV), which also have higher values of various ingredients.

The physico-chemical conditions present in various combinations and intensities, create the fundamental environment and structure upon which the occurrence, distribution, and success of aquatic organisms depend. Aquatic ecosystems are the most delicate ecosystem and are easily disrupted by various human activities. Zooplanktons are highly sensitive to environmental variations and as a result, change in their abundance, species diversity, or community composition can provide an important indication of environmental change or disturbance.

Conditions within an environment are mutually dependent to a great extent and the growth and distribution of the plankton population are not determined by a single factor but by the combined effects of many physico-chemical factors as has been pointed out by Reid, 1961 and Saha, 1985.

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