ENVIRONMENTAL GEOCHEMISTRY OF THE PULICAT LAKE, SOUTH INDIA

PURANIK GAYATRI RANGANATH

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ABSTRACT

The Pulicat lake, adjoining the Bay of Bengal is a shallow water body, bordering the east coast of India and located 40 km north of Chennai. The lake is one of the largest salt-water lake in India that supports a wide range of socioeconomic and cultural activities. The primary aim of this study is to understand the biogeochemical processes of the Pulicat lake ecosystem in order to preserve the ecological and environmental characteristics of this fragile ecosystem. Seasonal samples of water, bed, suspended and core sediments were collected over a one-year period in three zones (southern-channel, central and northern regions) of the Pulicat lake. The lake receives fresh water discharge only during monsoon, from two seasonal rivers, the Arani discharging into the southern region of the lake (zone I) and the Kalangi discharging into the northwestern region of the lake (zone III). The Buckingham canal, running parallel to the coastline discharges sewage contaminated water and industrial effluents into the Pulicat lake. Due to the limited freshwater supply and tidal action, the mouth of the lake gets silted up and closed during the dry season.

Understanding the spatial and seasonal variations in the water chemistry was one of the primary aspects of this study. The chemical composition of the surface water indicates a strong influence by seawater during the summer and diluted by river water during the monsoon season. The results obtained indicate that the dominant cations and anions of the surface water are in the order of Cl>Na>$S0_4$>K>Mg>$HC0_3$>Ca. Nutrient distribution in the lake water showed ammonia nitrogen NH_3 -N (598 ug 1^{-1}) dominates nitrogeneous nutrients in the lake ecosystem, followed by $N0_3$ -N (27 (ug l^{-1}) and $N0_2$-N (24 ug1^{-1}') indicating that ammonification was a dominant process in the lake ecosystem. The average N:P ratio for

surface water is 9N:1P in comparison to the Redfield ratio of 16N:1P, suggesting higher utilization of N over P by the primary producers. This also indicates additional nutrient loading through agricultural river runoff and other industrial discharge through the Buckingham canal.

In the second part of this study, the grain size distribution was studied and indicates that the lake is a depositional environment, underlain by very fine sandy silt sediments. The statistical relationship of grain size and trace metal concentration of different elements discerned that finer particles contain high content of trace metals than their coarser counterparts. This shows that adsorption to the surface act as a key factor for elemental association in the surface sediments. The trace metal concentration was higher in suspended sediments due to its large surface area.

The third aspect of the study deals with the rate of sedimentation and elemental accumulation in the core sediments. Radiometric dating has been used to determine the modern rate of sedimentation in the Pulicat lake. The rate of sedimentation for eight cores was calculated using the ^{210}Pb methods. The best fit line through the data points yield accumulation rates in the range between 6.06 mm yr $^{-1}$and 15 mm yr^{-}1 with an average of 10.05 mm yr^{-1} (i.e. about 1 m per 100 years) indicating a serious problem of siltation resulting in the continuous filling up of the lake. The vertical distribution of major and trace metals (Fe, Mn, Zn, Cu, Cr, Ni) in the core sediments shows enrichment of metals at the surface when compared to depths indicating the recent increase in metal deposition into the lake environment due to the industrialization.

In summary, the biogeochemical nutrient budgeting for the Pulicat lake ecosystem was made to quantify the fluxes of nutrients from the rivers to the lake to the Bay of Bengal. The water and salt budgets for the lake ecosystem was computed and the average residence

time (water exchange time) was determined to be 36 days. These results highlight the fact that the lake is subjected to high rate of sedimentation and rapid siltation. The stoichimetric calculation of net ecosystem metabolism has been carried out and the results indicate that there is a net dinitrification process occurring in the system and the Pulicat lake ecosystem is strongly heterotrophic. The Pulicat lake demands greater attention in management strategies and programs to preserve the natural ecosystem.