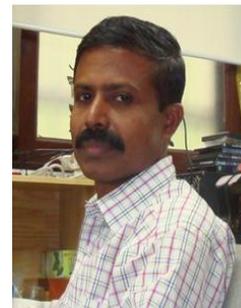


ENVIRONMENTAL BIOGEOCHEMISTRY OF TAMIRAPARANI RIVER BASIN,

SOUTH INDIA

Arthur James



ABSTRACT

Fresh water is a finite resource that without appropriate consideration given to its quantity and quality will not support development particularly in perennial river basin. Some major causes of water quality degradation in river basin include; discharge of toxic chemicals, long-range transport of atmospheric pollutants and contamination of river water in the substances such as excess nutrients (N and P) that promote algal growth. The Tamiraparani river basin is one of the most important perennial river basins in Tamil Nadu, located in the southern part of the state lying between the latitude $8^{\circ}10'N$ and $9^{\circ}13'N$ and longitude $77^{\circ}10'E$ and $78^{\circ}10'E$. The river originates in the eastern slope of the Western Ghats at an altitude of 2000 m above mean sea level (MSL). The river meanders through a distance of about 150 km, with a drainage area of 5869 km^2 and drains through three important geologic formations, i.e., Archean rocks, Tertiary and recent sediments. The seven important tributaries of the river are Servalar, Karaiyar, Chittar Manimuthar, Gadana, Pachaiyar and Ramanathi. The present study focuses in greater detail the biogeochemical factors that control the flow and the concentration of water and sediment constituents in the Tamiraparani river.

The first phase of the present work focuses on the spatial distribution and seasonal changes of major ions, trace metals in surface water and their dissolved fluxes. The river water is alkaline in nature. The total dissolved solid (TDS) show increasing trend towards downstream and is higher during summer (526 mg l^{-1}) and lower during monsoon (367 mg l^{-1}) due to dilution by the floodwaters. Among the major ions HCO_3 contributes 46% of the average chemical composition and is derived from both silicate (54%) and carbonate (44%) weathering. Chloride contributes about 26%, followed by Na (8%), SO_4 (7%), Ca (5%), Mg (4%) and H_4SiO_4 (4%) of

the total dissolved solids. The rock-water interaction was found to be the main factor controlling the river water chemistry. The monsoon season transports ($243 \times 10^3 \text{ t yr}^{-1}$) maximum amount of (78%) dissolved load from the river basin to Gulf of Mannar (Bay of Bengal). The tributaries Gadana (32%), Karaiyar (24%), Servalar (18%), Manimuthar (15%) and Ramanathi (11%) contributes considerable amount of chemical load to the Tamiraparani river. A five fold increase in the concentration of trace metals As, Cr, Cu, Ni, Se and Zn has been observed in the downstream region which is derived mainly from anthropogenic sources.

The second part of this study deals with the spatial variations of nutrients in both surface water and bed sediments. The major impacts of agricultural activities on water quality are the following: i) increasing water quality deterioration due to chemical fertilizers and pesticide application; ii) possible eutrophication due to fertilizers and pesticides leaching process. The influence of agricultural activities play a dominant role in causing a two-fold increase in nutrients level in the surface water during post-monsoon, in comparison to the pre-monsoon season. In the upstream region, the natural forest ecosystem enhances nitrification resulting in high 'N' levels in the catchments area. At the same time, the influence of reservoirs (anaicuts) and weirs reduces nutrient concentration in the midstream, significantly. The bed sediments have a high concentration of total carbon (2.2%), nitrogen (0.13%) and amino acid ($574 \mu\text{g g}^{-1}$) in the upstream region due to its source from the forest. Similarly a high concentration has been recorded in the estuarine region due to the accumulation of organic matter in the coastal zone. The estuarine systems thereby act as effective filters for sediments and pollutants in the coastal zone. The high C/N ratio (213) and biogeochemical indicators such as Gulam/Galam (1.33%), Asp/ β -ala (27.25%) further indicates that the estuarine region contains a significantly large amount of organic matter.

Elements analysed for Tamiraparani river were classified in to three types based on the nature of origin and its association with other elements as follows: i) Si, Al, Fe, Na, K, Ca, Mg and Sr indicates that these elements are derived through geochemical weathering process; ii) Mn, Ni, Cr, Zn, Co, Pb and As are in association with anthropogenic sources and iii) Zr, Nb, Th, Rb, Y and U are grouped with placer deposits in the estuarine zone. All the trace metals are enriched in suspended sediments by 2 to 5 fold in comparison to bed sediments. This indicates that trace

metals tend to bind in fine size fractions of the sediments. The Tamiraparani river carries $48 \times 10^3 \text{ t yr}^{-1}$ of sediment load to the Bay of Bengal. Also it was found that the chemical erosion rate ($18.94 \text{ t km}^{-2} \text{ yr}^{-1}$) is higher than physical erosion rate ($7.9 \text{ t km}^{-2} \text{ yr}^{-1}$) mainly due to damming of the river.

The geochronology of the sediment core shows that the minimum deposition rate (5.2 mm yr^{-1}) with maximum erosion rate (0.018 mm yr^{-1}) was observed in the upstream region. Similarly in the downstream region, a higher sediment accumulation rate (12.2 mm yr^{-1}) corresponds to a lower erosion rate (0.006 mm yr^{-1}) in the river basin. The trace metal accumulation in the top 10 cm of the sediment core indicates that the industrialization commenced in the early 80s in the river basin.

The concentrations of HCH in surface water show a maximum near the non-point agricultural drainage canals ($313 \text{ to } 829 \text{ ng l}^{-1}$). The low DDT concentration in the river basin shows its restricted use for agricultural practices. The occurrence of DDT is attributable to its non-degradable nature of extensive usage in the past. New promising tools such as GIS, salt water and nutrient budgeting have been used in this study to map the most sensitive areas vulnerable to water quality and quantity changes in the Tamiraparani river basin.