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Research

SEASONAL VARIABILITY OF DISSOLVED NUTRIENTS IN MANGROVE ECOSYSTEMS ALONG SOUTH WEST COAST OF KERALA, INDIA

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ABSTRACT

The mangroves of Kerala are fast disappearing due to developmental activities.There are very few studies conducted in the chemical aspects of these ecosystems.The main objective of this study is to assess the spatial and seasonal variation of hydrographical as well as nutrients in mangrove ecosystems along Kerala coast. Five sampling sites least intervened by industries were selected for the study. Sampling was done for a period of six months in monthly intervals. A monsoonal hike of dissolved nutrients was observed in all ecosystems except in the constructed mangrove wetland. The constructed wetland exhibited a different hydrography and nutrient level in all seasons. The mangrove forest in this area consists of the species *Bruguiera gymnorrhiza* which has been planted since forty years.

Key words: wetlands, mangroves, nutrients, season, constructed wetland

INTRODUCTION

Mangroves are unique wetlands along the coastline of tropical and subtropical regions. They have special adaptations to stressful environments and a huge demand for nutrients because of rapid growth, and high primary productivity, metabolism and turnover (Yang et al., 2 008). They can be considered as open ecosystems which are important in providing energy and matter to estuarine and coastal systems (Lugo & Snedaker, 1975) via litter fall and decomposition. Through out welling of leaf litter and dissolved organic matter, mangroves can act as detritus sources to the adjacent oligotrophic marine food webs, supporting valuable estuarine and coastal fisheries (Singh et al., 2005). Mangroves are thought to be important in the nutrient budgets of many tropical coastal areas (Boto & Bunt, 1981). Boto et al (1984) and Ridd et al (1988) have shown that large quantities of organic and inorganic nutrients are exported from mangrove swamps to coastal waters. Such nutrient out welling may affect the productivity of coastal fisheries. The export of plant litter or macro-particulate matter from mangrove creeks is beyond doubt, but no general consensus has been reached for other materials, such as nutrients and dissolved and particulate organic matter (Simpson et al., 1997).Naturally mangrove plays an important role in the regulation of the nutrient balance in the coastal environment. It can absorb excess nutrients and sequester other pollutants from entering water while enabling the export of large amounts of organic matter in the form of detritus by tidal currents to support the productivity of the adjacent coastal ecosystem. Concurrently, mangrove can reduce the concentration of waterborne suspended solids.

Understanding the hydrography and nutrient cycling in the mangrove water is complicated by the continual mixing of water masses with different physical-chemical properties (Odum et al., 1972). Saraya (1984) showed that the environmental conditions of mangrove waters are largely governed by two dominant factors, namely, short term changes resulting from tidal inundation and seasonal changes induced by the monsoonal cycles. Furthermore, virtually nothing is known on the nutrient dynamics of mangrove systems along the Kerala coast, whereas mangrove systems elsewhere have been very well researched in terms of nutrient fluxes and export to the near shore (Alongi 1990).The present study aims to document the seasonal variability of hydrographical parameters and nutrients in mangrove ecosystems along the west coast of Kerala. This is a preliminary study conducted for assessing the seasonal influence in the dynamics of nutrients in these ecosystems.

STUDY AREA

The location of the study area is given in the Fig 1. Five mangrove ecosystems along Kerala coast were selected for study. Station 1(Chetwa) is an uninhabited island situated in Chetwa estuary. The Chetwa estuary is the main location in Thrissur district having mangroves. The mangrove stand was dominated by Rhizophora with scattered Avicennia Officianalis. It is a unique mangrove ecosystem with least antropogenic disturbance. Station 2 (Kumbalangi) is an impressive fishing village that is located near Palluruthy in the vicinity of Ernakulam. An array of mangroves, separate land from water providing a breeding ground for prawns, crabs, oysters and small fishes.The village is 16 Sq.Km in area and is a hamlet inhabited by coir spinners, toddy tappers, farmers, fishermen and labourers.This island is ornamented with rich diversity of mangroves and mangrove associates. Station 3 (Sathar island) is a small island in the confluence of Periyar River with the Arabian Sea.this island is affected by Tsunami waves. Station 4 (Vypin) is an island which is about 27 km along Ernakulam district of Kerala. About 70% of the vegetation comprise mangroves and its associates. Station 5, Kumarakom, an island 8 km from Kottayam on the Vembanad Lake, which is a famous tourist spot. A constructed wetland for forty years is selected for study. Bruguiera gymnorrhiza was found to be abundant in low saline areas like Kumarakom. Monsoon hit all these islands during June- September. A dry pre monsoon was affecting all these areas during Feb- May. The same climate is prevailing in all these islands.

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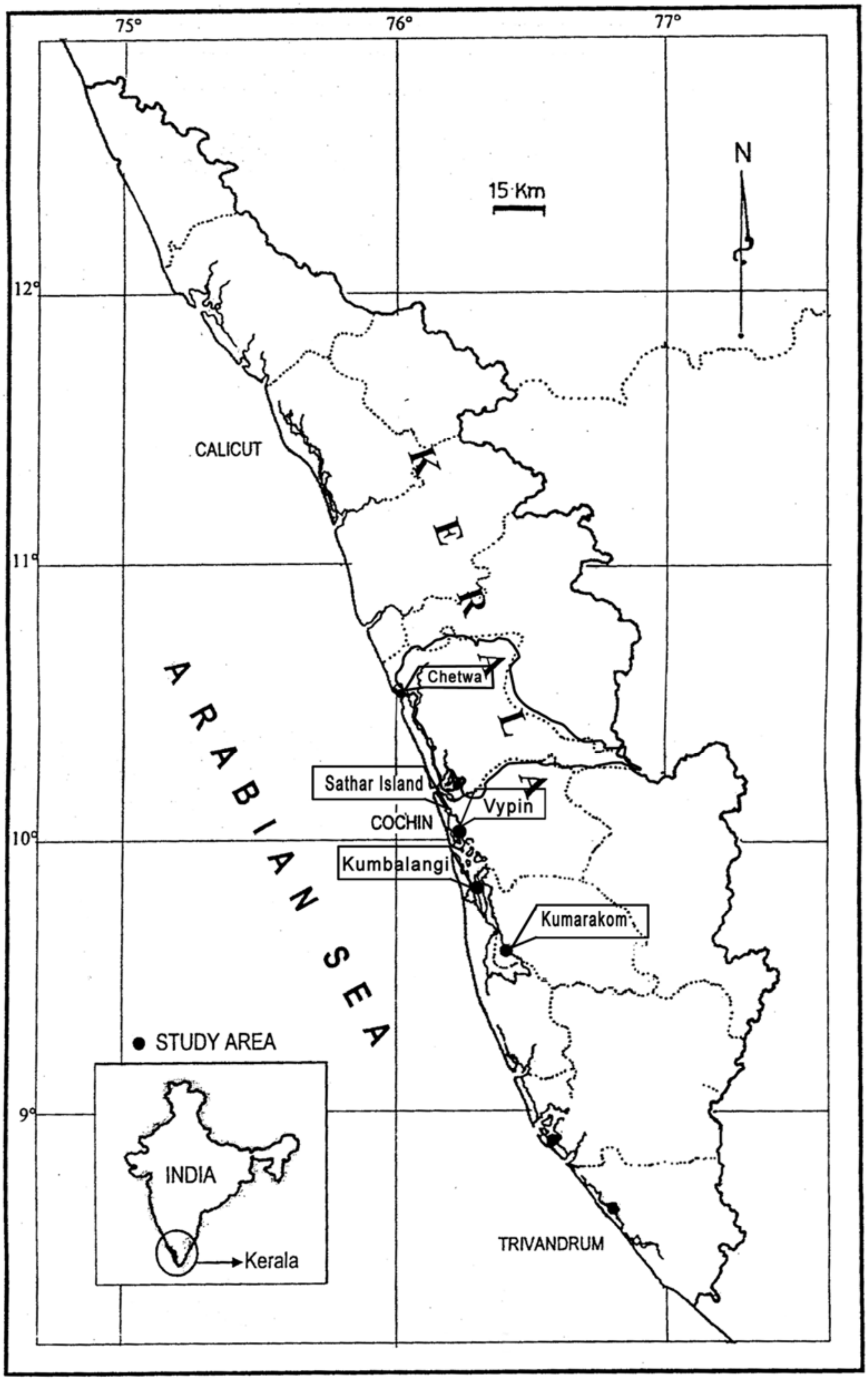

Fig 1. Location of study area showing the sampling sites

METHODOLOGY

Samplings were made in 2008 in three seasons: Monsoon, post monsoon and the pre monsoon season to understand the importance of season in driving nutrient dynamics. Ninety water samples were collected from these stations. pH was measured in situ using a portable pH meter. Samples of 25 ml were transferred to gas tight Winkler bottles for O_2 analysis within 24 h by the standard Winkler technique (Parsons et al., 1984). Triplicate water samples were taken back to the laboratory on ice where they were analysed for salinity,chlorophyll, dissolved nitrite, nitrate and soluble reactive phosphate (Grasshoff, 1999). Water samples of 100–200 ml were passed through GF/F filters.and extracted for 24 h at 5°C for spectrophotometric analysis of chlorophyll a according to the method of (Parsons et al 1984). Salinity of water samples was estimated by Mohr-knudsen method (Strickland and Parson,1972). All nutrients were estimated spectrophotometrically (using UV- VIS Hitachi 150-20) after converting each of the species to a required coloured substance. Nitrite was converted to N-(1-naphthyl) ethylene diamine dihydrochloride (Grasshoff,1983).Nitrate was reduced to nitrite and estimated as nitrite. Formation of phosphor-molybdate complex using ascorbic acid as reductant was used for phosphate (Koreleff,1983).

The data generated were analysed using statistical tools. One-way analysis of variance of the means and correlation were employed to test for seasonal differences in dissolved nutrients and correlation between various parameters.

RESULTS AND DISCUSSION

Results

Variation of p^H during the three seasons is given in the Fig 2. Water present in all the systems is alkaline in all the three seasons. But the alkailne nature gradually decreases from premonsoon to postmonsoon in all stations except 2. The value of pH varied from 7.3 in station 3 to 8.9 in station 1. In the station 2 , highest value was observed in the pre monsoon and least in the monsoon. Among all other stations,the lowest value was observed during post monsoon. The high value of pH during pre monsooon may be due to high photosynthetic activity which will lead to undersaturation with respect to carbon dioxide. The high photosynthetic activity during pre monsoon was reported earlier (Silas and Pillai, 1975).

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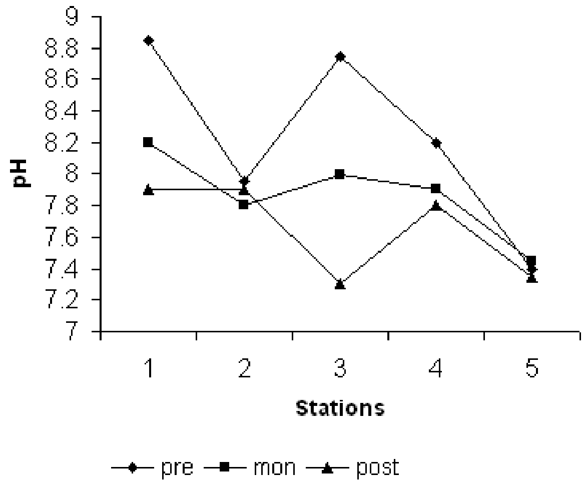

Fig 2 Seasonal variation of p^H

The distribution of oxygen during different seasons is exihibited in the Fig .3. The waters in the station 5 was extremely rich in oxygen during three seasons and did nnot show much variation during different seasons. The values varied between 13.15 mgl^{-1}- 13.60 mgl^{-1}. The highest value was oserved in the monsoon and the lowest in the premonsoon in all stations. The value ranged between 1.75 mgl^{-1}- 4.76 mgl^{-1} in the stations 1-4. Lowest value noted in the station 4 during pre monsoon and the highest in the station 1 during monsoon season in the station 5 was extremely rich in oxygen during three seasons and did not show much variation during different seasons. The values varied between 13.15 mgl^{-1}- 13.60 mgl^{-1}. The highest value was oserved in the monsoon and the lowest in the premonsoon in all stations. The value ranged between 1.75 mgl^{-1}- 4.76 mgl^{-1} in the stations 1-4. Lowest value noted in the station 4 during pre monsoon and the highest in the station 1 during monsoon season.

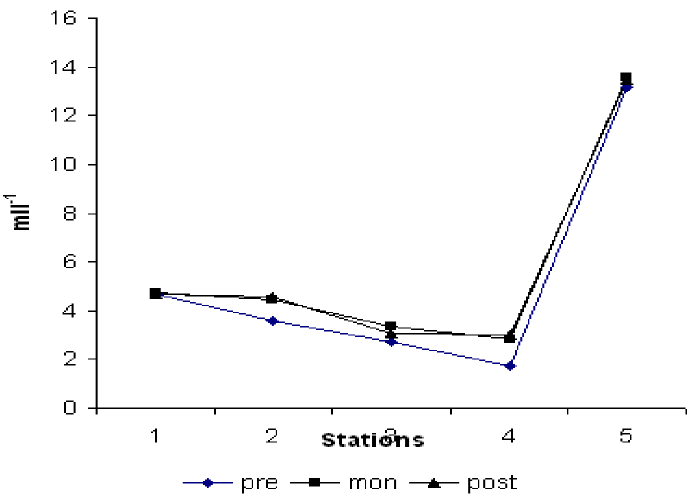

Fig 3 Seasonal variation of Dissolved Oxygen

Salinity distribution during three different seasons were depicited in Fig 4. The highly saline water was observed in staion 1& 2 during pre monsoon. The value noted were 32 ppt and 49.74 ppt respectively. This is because of their close pxomity to the sea waters. Least seasonal influence was obseved in station 5, where the water was least saline in all seasons. Among the staions 3 and 4 an increase in salinity during pre monsoon and a decrease in monsoon was observed. The amount ranged between 9.676ppt and 38ppt.The average salinity of estuarine waters is 226ppt while that of mangroves, creek waters and

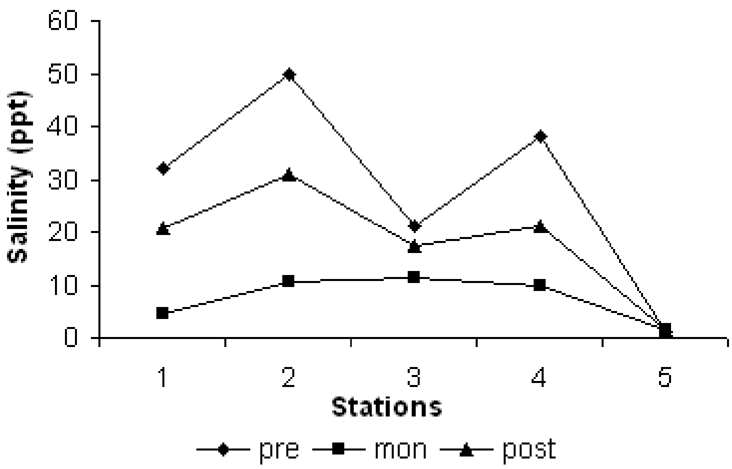

Fig 4 Seasonal variation of Salinity

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The average salinity of estuarine waters is 226ppt while that of mangroves, creek waters and interstitial waters of surface sediments is much less (Bava & Seralathan,1999.). The ultimate source of salinity in the mangrove habitat is the neritic water, ingression of which is higher during summer than during monsoon. During monsoon, flood water dominates limiting the influence of seawater. The high temperature of summer increases evaporation, resulting in high salinity (Kathiresan, 2000).

Impact of season on the distribution of chlorophyll was given in Fig 5. Waters in the stations 1, 2, 3 & 4 were extremely rich in chlorophyll during monsoon. In station 5 monsoonal hike was observed , but the amount was comparatively low. The value ranged between $3\mu gl^{-1}$- $82.2\mu gl^{-1}$. The lowest value was observed in station 5 during post monsoon and the highest in the monsoon in station 1.The high concentration of chlorophyll observed in all the stations may be due to the monsoonal runoff wherein high concentrations of nutrients are brought into these environments stimulating a rich phytoplankton growth. (Subramanyan, 1959).

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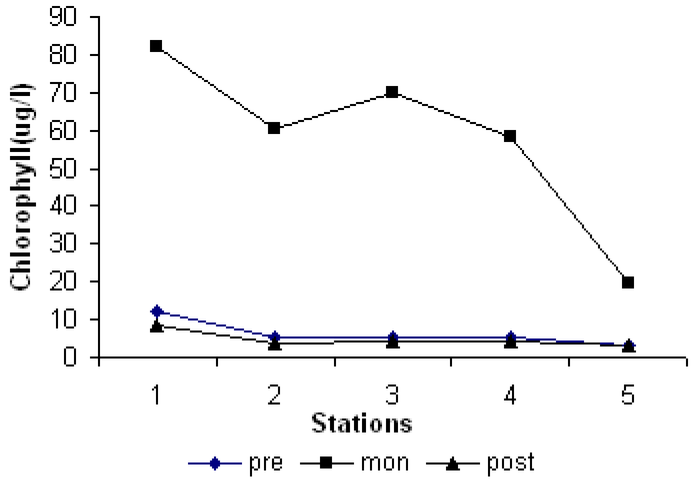

Fig 5 Seasonal variation of Chlorophyll

Significant seasonal variation of nutrients was observed during the study.The distribution of Nitrite during different seasons is given in the Fig 6. The concentration of nitrite was comparatively low. Nitrite was not detected in station 5 in all the three seasons. The value varied between 0.97 µgatoml^{-1}- 2.82 µgatoml^{-1} .The highest value was observed in station 2 during monsoon and the lowest value in station 1 during premonsoon.

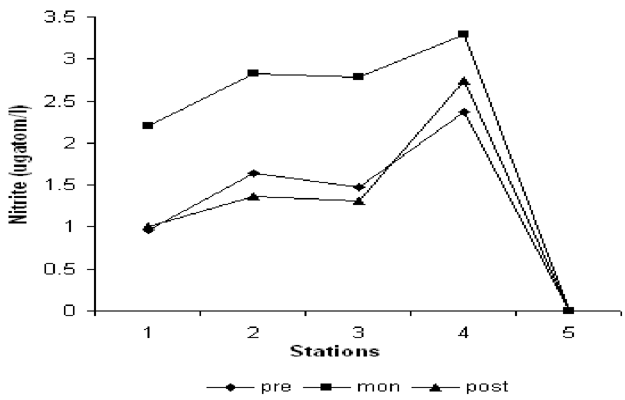

Fig 6 Seasonal variation of Nitrite

Seasonal influence on the nitrate and phosphate content were given in Fig 7 & 8 respectively.

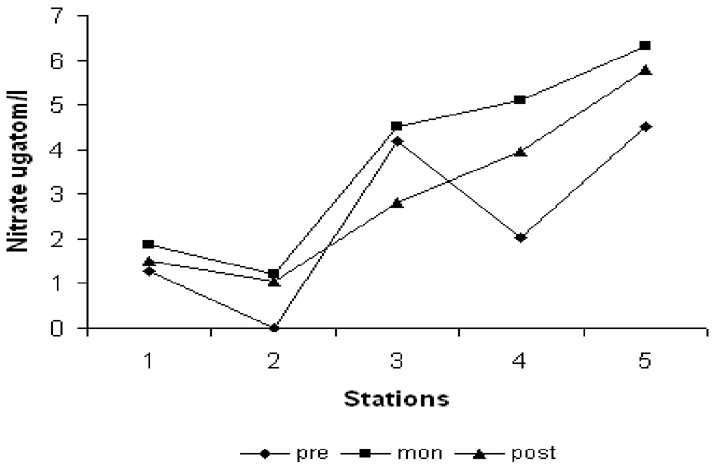

Fig 7 Seasonal variation of Nitrate

In Kenya, high dissolved inorganic nitrite, nitrate and phosphate levels have been found seasonally in mangrove systems following rain or groundwater runoff (Kazungu et al., 1989), Kitheka et al.,1999). Phosphate originates from rock and sediment breakdown in catchments in accordance with the phosphorus cycle, so it generally increases with river in-flow (Grobler & Silberbauer, 1985). Under low flow conditions, phosphate and sediments flocculate out, but at high flow levels, sediments are carried out to sea as a plume of brown water, a seasonal feature commonly seen with Southern African estuaries (Cooper et al.,1999 and Grobler & Silberbauer, 1985a) and have similarly shown positive correlations between phosphate export and runoff for seven South African catchment.

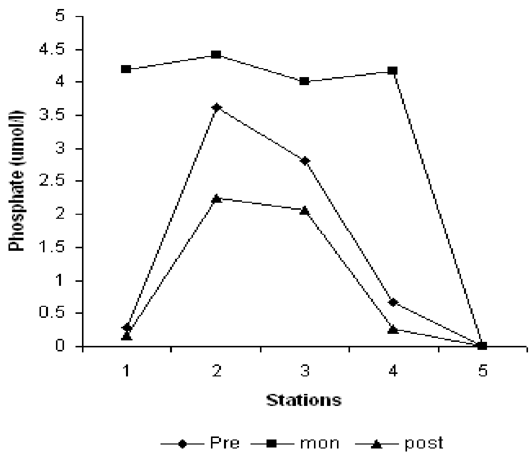

Fig 8 Seasonal variation of Phosphate

Discussion

Most mangrove ecosystems in the world are located in tropical areas with high rainfall and hence chemical and biological processes are strongly influenced by rainfall and runoff. Significant seasonal differences were found for salinity, dissolved oxygen, chlorophyll, nitrate and phosphate. Some seasonal patterns of nutrient concentrations may be related to litter fall and decomposition processes (Boto and Wellington, 1988). During monsoon, the ecosystems were rich in nutrients, oxygen and chlorophyll. This was due to rain water runoff and which further added the solute load by leaching from adjoining anthropogenic stress areas viz. agricultural land, human settlement as well as aqua culture pond, etc.

The one-way ANOVA showed that the observed F value was considerably higher than the calculated value from the table. This shows the seasonal impact on the hydrography and the nutrients in the mangrove ecosystems is highly significant. Relationships between parameters were assessed by Pearson product moment correlation coefficients. Significant effects were determined at $p<0.05$.Correlation analysis showed a significant negative correlation between nitrite and oxygen and a positive correlation between oxygen and other nutrients.

CONCLUSION

The present study revealed seasonal impact on the hydrography and the dissolved nutrients of mangroves. The hydrography and the nutrient content of the constructed wetland (station 5) were different from the natural mangrove ecosystems. The water in this ecosystem was oxygen rich and devoid of nitrite and phosphate. A monsoonal hike was noted for all the parameters in all stations. Leaching of plant parts along with the ground water runoff during monsoon contribute to this hike.

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