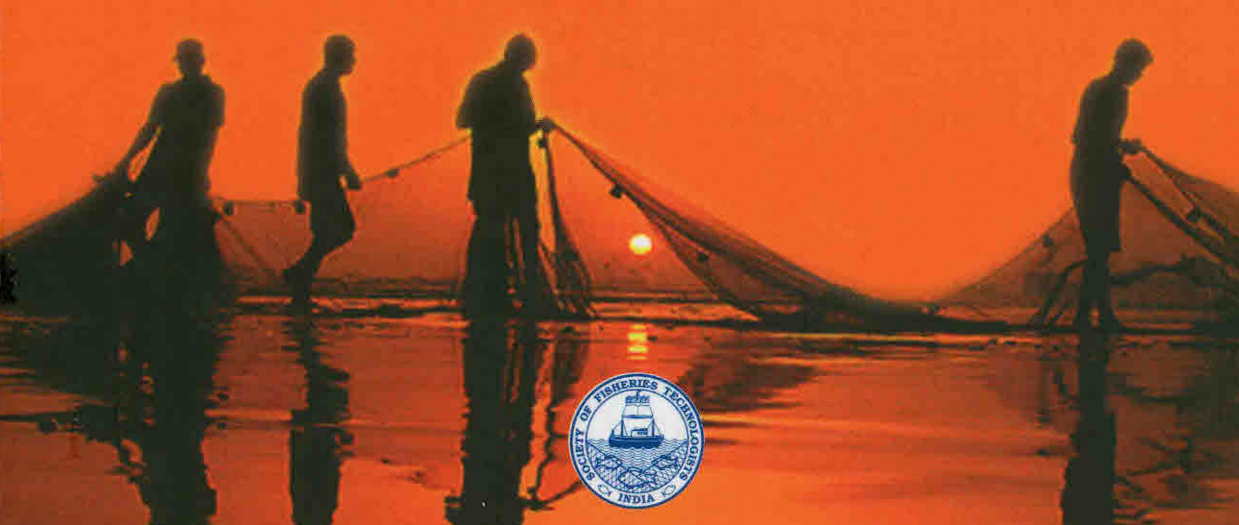
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ◆ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

Proceedings of the National Seminar on Conservation and Sustainability of Coastal Living Resources of India, 1-3 December 2009, Cochin

Organised by

Society of Fisheries Technologists (India), Cochin
and
Centre for Ocean and Environmental Studies, New Delhi

In association with

Ministry of Earth Sciences (New Delhi)
Central Marine Fisheries Research Institute (Cochin)
National Institute of Oceanography (Goa) and
Central Institute of Fisheries Technology (Cochin)

ISBN: 978-81-901038-7-9

Published by

Society of Fisheries Technologists (India)
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

URL : www.fishtech.org
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Citation:

Rao, G.S. (2010) Current status and prospects of fishery resources of the Indian continental shelf, In: Coastal Fishery Resources of India: Conservation and Sustainable Utilisation (Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., Eds.), p. 1-13, Society of Fisheries Technologists (India), Cochin

Cover design: Vineethkumar, P., CIFT, Cochin

Printed at PAICO, Cochin - 682 035, India

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2010

Pollution in the Estuaries of North Kerala

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Introduction

Deterioration of the perennial rivers and estuarine areas due to human interventions, over exploitation and increased pollution is a major concern among the policy makers, planners and researchers. Estuaries are heterotrophic ecosystems and act as source of carbon dioxide due to the increased anthropogenic disturbances (Mukhopadhyay *et al.*, 2002; Biswas *et al.*, 2004). Freshwater runoff, sediment transport, fluxes of carbon and nutrients in coastal ecosystems are affected by changes in land use pattern and reduced coverage of vegetation (Walsh, 1991). The key link of global carbon cycle is the transfer of organic matter from the land to ocean through the rivers (Richey *et al.*, 1990). Every year, large volumes of sediment were transported through the estuaries to the oceans out of which 85% are minerals and the rest is mainly organic matter. Annual load of sediments from the estuary to the northeast coast of Bay of Bengal was estimated to be 65.19×10^{6} t (Mukhopadhyay *et al.*, 2006). This has resulted in large quantities of nutrient release which temporarily rests on the banks, flood plains and river beds. These nutrients were again released during turbulent conditions in the estuarine areas, resulting in variations in the nutrient levels. Suspended sediments play an important role in transporting nutrients and it was reported by several authors that the turbidity is related to increased nutrient levels (Caitcheon *et al.*, 1995; NLWRA, 2002). In a mangrove dominated estuarine system, inorganic nitrogen and phosphorus are regenerated from the external organic matter in the water column during their transport along the estuary to the coastal waters (Mukhopadhyay *et al.*, 2006). The estuarine areas of tropical rivers were not only an important source of nutrients to the coastal waters but also a sedimentary sink for nutrients (Gonneea *et al.*, 2004). More than 50% of the world's population are located along coastal watersheds and large lakes leading to competing water uses, including potable water requirements, irrigation needs for agriculture and attempts to minimize estuarine water flow reductions (Vitousek *et al.*, 1997). Most of the estuaries located in urban areas results in discharge of larger volumes of pollutants through drainages and industrial wastes. In the present study, the spatiotemporal distribution of dissolved nutrients and trace metals along with other hydrographic parameters of the estuarine areas in north Kerala, has been examined.

Materials and Methods

Kerala is a tropical region which experiences annual rainfall of 3000-4000 mm and has three seasons *viz.* monsoon (June to September), post monsoon (October to January) and pre monsoon (February to May). Thirteen stations *viz.*, Chandragiri (1), Padanna (2), Pazhayangadi (3), Baliyapatnam (4), Dharmadom (5), Mahe (6), Iringol (7), Korapuzha (8), Chaliyar (9), Kadalundi (10), Ponnani (11), Chettuva (12) and Kodungallore (13) in north Kerala were selected for the study (Fig. 1). The surface water samples were collected from the thirteen stations during June 2008 to June 2009. Samples from the upstream and down stream of the estuaries were collected from each station and analysed separately. Water samples were collected in thoroughly cleaned polythene bottles and kept in cold storage till the time of analysis. The water samples were filtered through Whatman No. 40 filter paper and analysed voltammetrically for zinc, cadmium, lead and copper using Autolab 797 VA Computrace with HMDE, Pt and Ag/AgCl reference system as per DIN 38406 Part 16. Due to significant variation of salinity between the seasons, the metal analysis was carried out by standard addition method as described in AOAC (2003). The hydrographical parameters like pH, salinity, turbidity, nitrite-N and phosphorus were measured as per Strickland and Parsons (1972). Two way ANOVA and correlation analysis were applied using MS Excel. Statistical significance stated in the ensuing discussion is at Pd"0.05 unless otherwise stated.

Results and discussion

Hydrographic parameters

The pH of the water varied from 7.22 to 7.81, 8.01 to 8.28 and 7.85 to 8.17 during monsoon, post monsoon and pre monsoon, respectively (Fig 2a). pH was significantly lower during monsoon in all the stations. During post monsoon all the stations recorded pH higher than 8, whereas during pre monsoon it was between 7.85 and 8.17. The pH variation during monsoon and post monsoon were significantly higher in station 1 and from

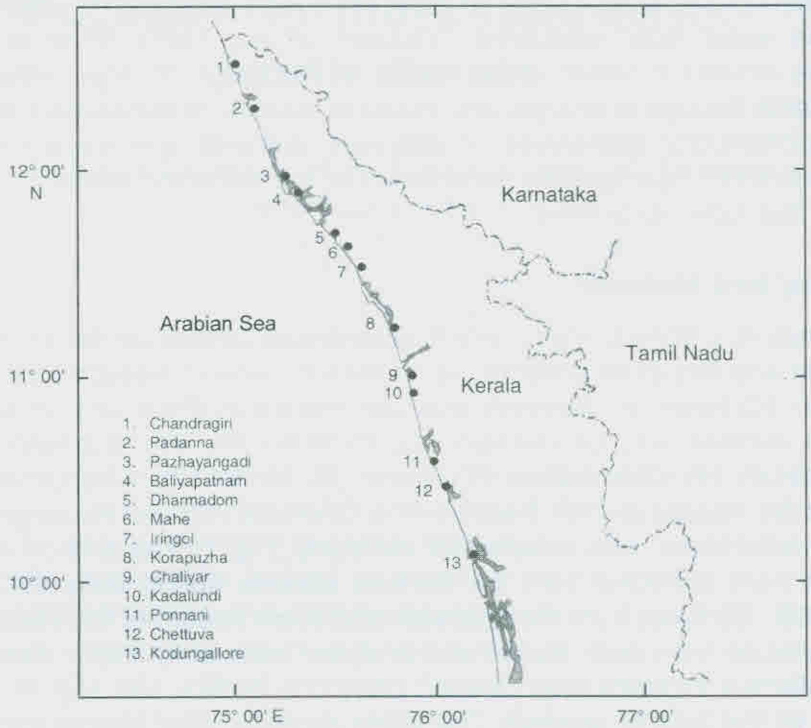

Fig 1. Sampling stations in north Kerala

stations 6 to 13. Freshwater inputs during monsoon period resulted in the lowering of pH. The fluctuation in pH values may be due to the changes in the sulphur oxidation state, resulting in strongly acidic conditions and high redox potentials (Benmoussa *et al.*, 1997).

Salinity in the estuarine areas during the study ranged from 2.06 to 28.79, 14.34 to 31.83 and 18.05 to 34.46 during monsoon, post monsoon and pre monsoon, respectively (Fig. 2a). Season-wise distribution of salinity was pre monsoon > post monsoon > monsoon. Station 13 (Kodungallore) exhibited comparatively lower salinities throughout the year. Turbidity levels exhibited during the study was monsoon > pre monsoon > post monsoon. The estuarine waters were more turbid during monsoon season and between stations their variation was irregular. The west coast of India experience heavy monsoon during June to September which results in heavy river water runoff with sediments and other organic constituents. Jagtap *et al.* (2006) has reported that in the Mandovi estuary, the salinity slowly increased from September and reach its highest value during May. Similar trend was observed in all the estuaries studied in north Kerala.

Nutrients

Nitrite nitrogen (NO_2–N) in the estuarine waters ranged from 0.010 to 0.255, 0.085 to 0.327 and 0.00 to 0.047 ppm during monsoon, post monsoon and pre monsoon, respectively (Fig. 2a). In the estuarine systems, oxidation of NH_4–N and reduction of NO_3–N are chief sources of NO_2–N. Jagtap *et al.* (2006) has reported 0.12 to 1.04 $\mu g.l^{-1}$ in the estuarine waters of Mandovi estuary with highest concentration during monsoon season. According to them, the highest concentration was due

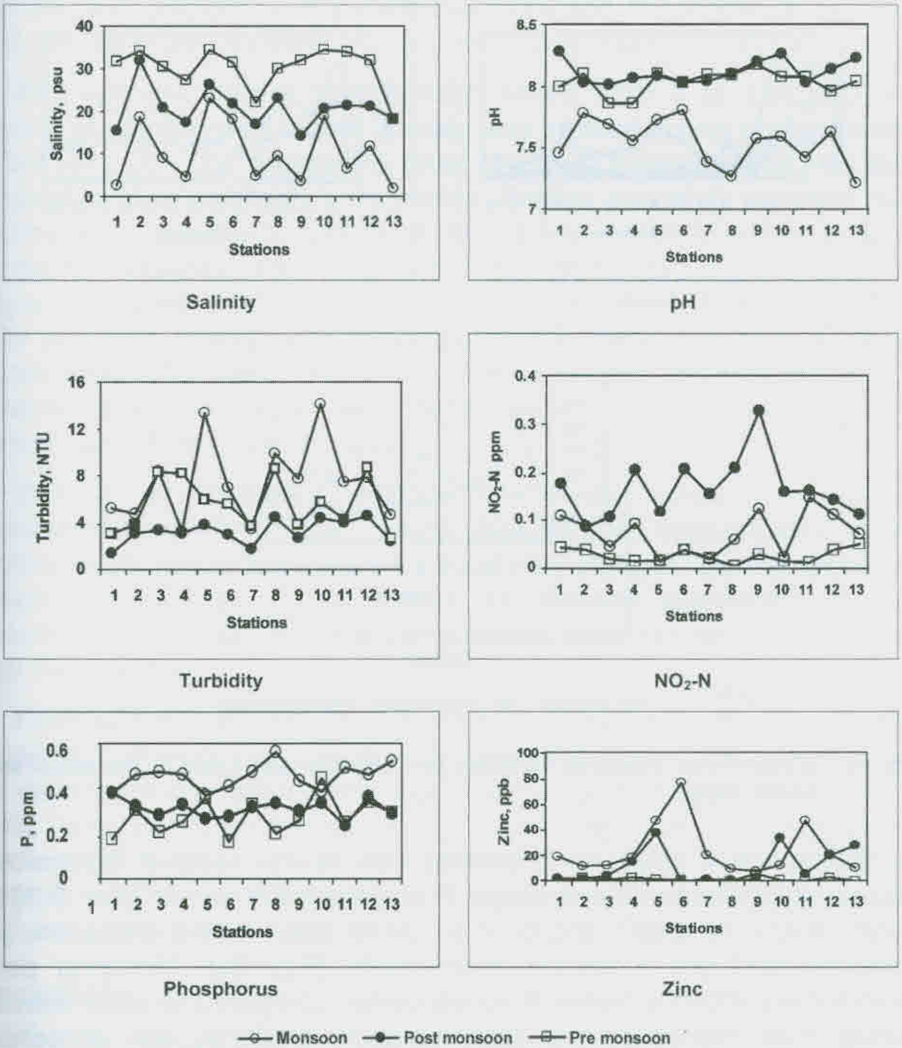

Fig. 2a. Station-wise seasonal variation in salinity, pH, turbidity, NO_2-N, Phosphorus, and Zinc in the estuaries of north Kerala

to the increased freshwater inflow bringing heavy nutrient load from terrestrial and mangrove habitats. Most of the estuarine rivers studied were having increased flow of water and narrow bar mouth. The NO_2–N was significantly higher during post monsoon. The post monsoon season is considered to be the most productive season in the region. The NO_2–N NO_2–N concentration varied distinctly between the stations, in different seasons. Higher levels of NO_2–N during post monsoon may be due to increased biological activities in all the stations.

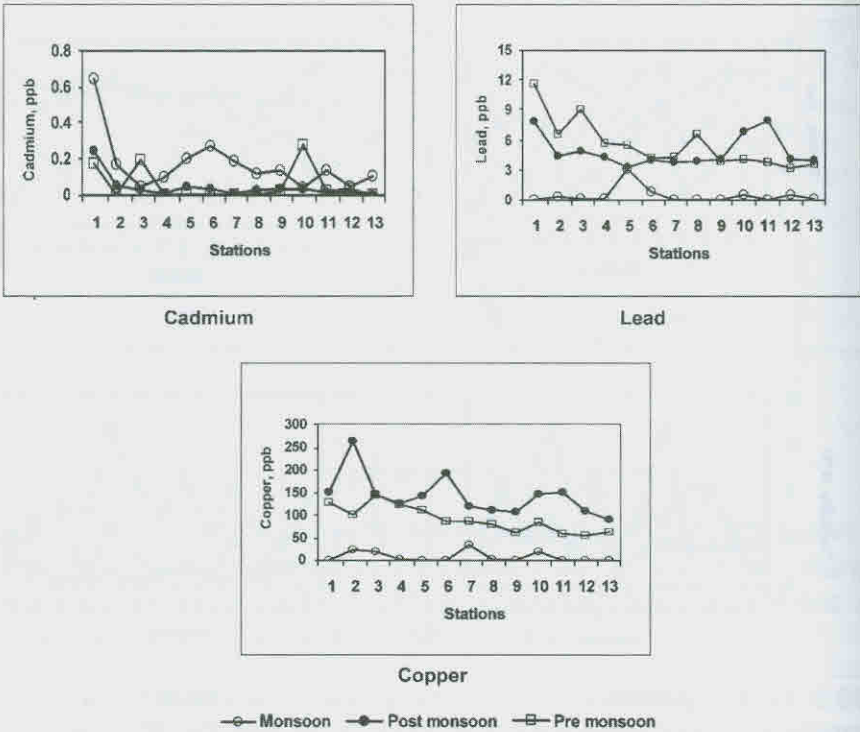

Fig. 2b. Station-wise seasonal variation in Cadmium and Lead in the estuaries of north Kerala

Phosphorus plays an important role in the nutrient dynamics of aquatic ecosystems. The average P concentration varied from 0.366 to 0.556, 0.227 to 0.337 and 0.17 to 0.440 ppm during monsoon, post monsoon and pre monsoon, respectively (Fig. 2a). Monsoon period recorded significantly higher P concentration compared to other seasons. During post monsoon and pre monsoon seasons, the phosphorus concentration varied irregularly. Phosphorus from agricultural fields was carried to the rivers and estuaries by rainwater run-off. Estuarine waters in the urban areas, *viz.*, Chaliar, Baliapatnam, Padanna and Pazhayangadi recorded comparatively higher concentrations of phosphorus.

Trace metals

Lead concentration in the estuaries ranged from 0 to 11.64 ppb (Fig. 2b). Chandragiri (Station 1) estuary recorded significantly higher levels of lead. Lead concentrations varied significantly between seasons and stations, especially in stations 1 to 9. Order of increase was pre monsoon > post monsoon > monsoon. During pre monsoon, lead varied from 3.19 to 11.64 ppb. Stations 1 to 3 exhibited increased concentrations of lead in all the seasons; however, its present levels were not alarming.

The average copper concentration varied from 0 to 262 ppb and higher concentrations of copper in water was present during post monsoon season (Fig. 2b). The decreasing order of copper concentration was post monsoon > pre monsoon > monsoon. Similar seasonal variation was reported by Alagarsamy (2006) in the sediments of Mandovi estuary. Among the stations, Padanna recorded considerably higher levels of copper. The concentration of copper during monsoon ranged from 0 to 18.59 ppb and during post monsoon, all the stations recorded values greater than 100 ppb. Stations 1 to 6 recorded significantly higher concentrations of copper and there was a decreasing trend in concentration from north to south.

Zinc is an important micronutrient in the ecosystem and its concentration varied from 0 to 76 ppb (Fig. 2a). Zinc concentration varied significantly between the seasons, in all the stations. During monsoon season, the stations 5 to 7 and 11 showed significantly higher concentrations of zinc. Pre monsoon seasons showed lower levels of zinc in all the stations.

Cadmium is known to be a toxic trace metal and its concentration ranged from 0 - 0.65 ppb, during the year (Fig. 2b). Cadmium variation was dependant on seasons and significantly higher levels were recorded during monsoon in all the stations. Station 1 showed highest levels of cadmium and, in general, stations 1 to 9 exhibited higher levels throughout the year. All the samples collected during pre monsoon showed low cadmium concentrations except in station 1, 3, and 10.

Conclusion

The hydrographic and chemical characteristics of all the estuarine areas showed seasonal variations. The trace metals and nutrient concentrations were not above the permissible limit, during the period of observations. Further studies and continuous monitoring are required to ascertain the long term changes in the estuarine environment and to take timely mitigative measures where needed.

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