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Baseline

Trace element concentration in surface sediments of Palk Strait, southeast coast of Tamil Nadu, India

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ABSTRACT

The present work was carried to decipher the trace element accumulation in surface sediments of Palk Strait, southeast coast of Tamil Nadu, India. The elemental concentration and correlation results suggest that fine fractions with $CaCO_3$ content followed by organic matter (OM) of the surface sediments control the trace element accumulation in the study area. In addition, Fe and Mn concentration is chiefly contributed from riverine process and controlled by the mangrove ecosystem. The other elements are derived into marine environment through confluence of untreated industrial pollutants into the river system. The EF result shows that the studied marine sediments are enriched by Ni, Mn, Cu, Pb, Cd, Cr, followed by Zn. The order of the pollution intensity with respect to geo-accumulation index suggests the following ascending order: Ni > Mn > Fe > Cu > Pb > Cd > Cr > Zn. Pollution Load Index (PLI) values reveal that all the samples are falling under moderately to unpolluted category.

The economic developments and rapid industrialization along the coastal regions have undoubtedly introduced heavy metals into marine sediments. Numerous potentially hazardous trace elements are brought to the marine environment by the direct discharge of urban waste and industrial waste waters. In particular, the elements can also be transported through the atmosphere from point source to coastal locations. The collection of geochemical informations from sediments especially marine sediments not only provides a close sight on the present environmental quality of the ecosystem but also serves as a baseline for future investigations. In addition, geochemical characteristics of the sediments can be used to infer the weathering trends and the source of pollution. The metal pollutant distribution trend in the sediments depends on the redox potential, pH, salinity, dissolved metal species, and its composition (Bryan and Langston, 1992). The concentration pattern of trace metals in sediments plays an important role in environmental monitoring, evaluation, and its subsequent remedial measures, because they can introduce into biological cycle as potentially toxic substances. Similar environmental disturbances were suspected in the Palk Strait, which is a narrow channel connecting the Gulf of Mannar and Bay of Bengal and is expanded about 75 km wide between Sri Lanka and India (Fig. 1). The coastal area is extended from Rameswaram in the south-west to Point Calimere in the northeast (Long. 78° 50′–79° 55′ Lat. 9° 15′–10° 20′). This area is bounded by Sri Lanka on the east, by Mannar Island on the south, and the coastal districts of Tamil Nadu on the west. Moreover, the present study area is composed of two diverse ecosystems such as mangrove ecosystem in the north and coral reef ecosystem in the south. The study area is decorated by various geomorphological units including coastal sand dunes, sandy ridges and mud flats, shoals and sand spits, etc. The average speed of the longshore currents vary from 0.1 to 0.3 m/s. The drainage system consists of ephemeral streams like Pamaniar, Agniar, Ambuliar, Vellar, Kottakkarai, Uppar, and Vaigai and their tributaries. The study area received maximum rainfall during northeast period of October to November with an average of 79 cm/year (Kasilingam, 2014). The soil variety of the adjacent hinterland is denoted as black, red ferruginous, and arenaceous type. The major part of the study area is chiefly covered by recent alluvial sediments with patches of granitic gneisses and Laterite caps. In the past three decades, a number of metal pollution studies have been carried out along the southeast coast of India (Jonathan et al., 2004, Stephen Pitchaimani et al., 2008; Magesh et al., 2013). Similarly, considerable biologically related studies on seaweeds, marine organisms, and coral reef have been assessed along the southeast coast especially all along Palk Stait region (Suriyanarayanan et al., 2010, Madhu et al., 2014). However, a systematic approach and a baseline record of metal distribution in the Palk Strait comprising the mangrove and coral ecosystem has not been reported so far. So, the aim of the present study is to create a baseline data of metal distribution for such a complicated ecosystem which can assist future workers and policy makers.

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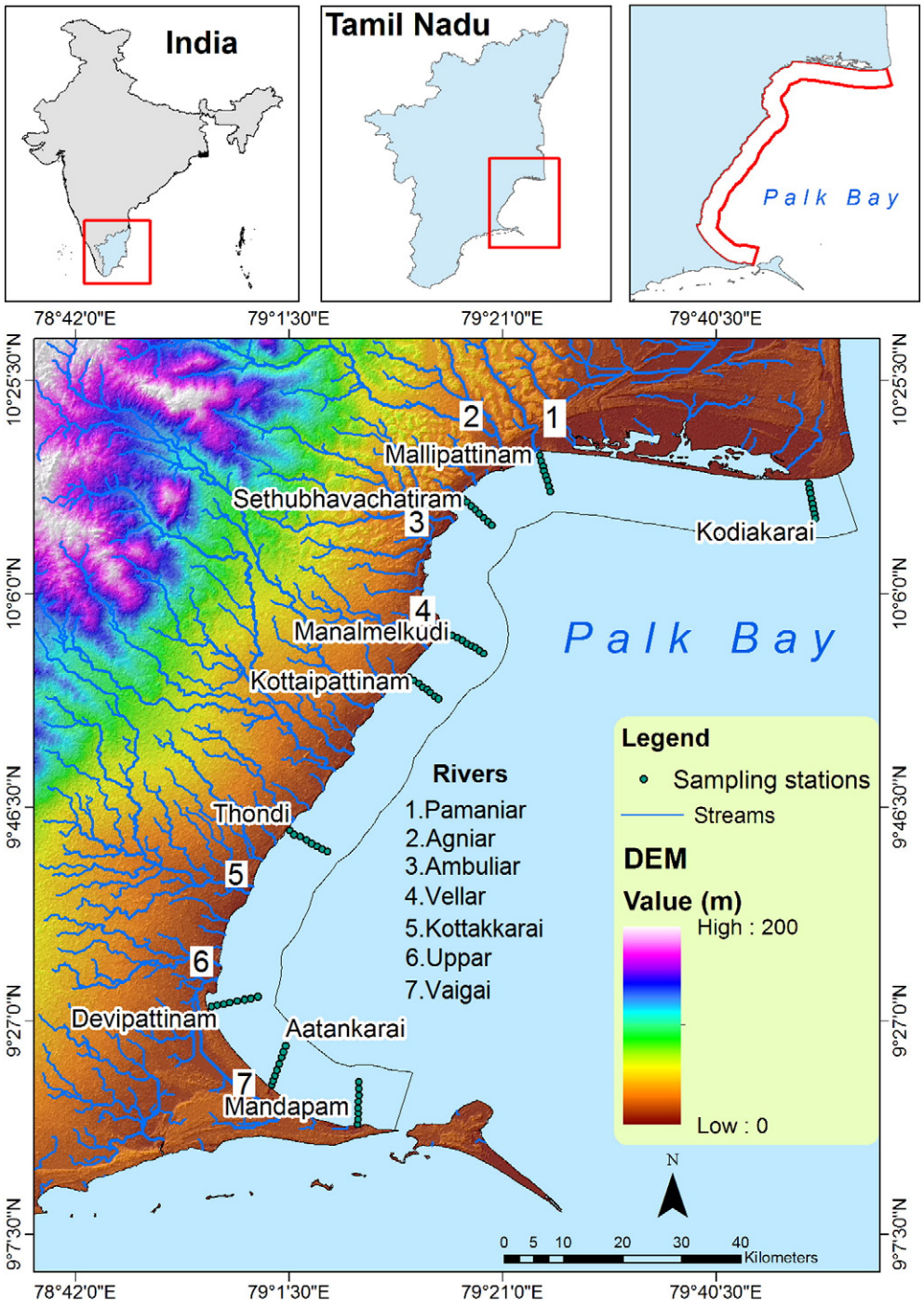

Fig. 1. Study area map.

Seventy-two surface sediment samples were collected using Van Veen grab sampler at a water depth of 20–25 m from two diverse ecosystems (mangrove and coral reef ecosystem) of the study area. The sampling stations are mentioned hereafter in the article using sampling IDs such as Mandapam (MP), Akkaraipettai (AK), Devipattinam (DP), Thondi (TH), Kottaipattinam (KP), Manalmelkudi (MK), Sethubavasathram (SB), Muthupet (MT), and Kodiyakkarai (KK). The sampling stations were fixed using a handheld global positioning system (Garmin eTrex GPS). The collected samples were packed in a thick polyethylene bag and properly labeled before adopting further laboratory geochemical analysis. The textural parameters such as sand, silt, and clay fractions were done based on the procedure by Ingram (1970). Determination of the calcium carbonate ($CaCO_3$) was done based on the methodology of Loring and Rantala (1992). Organic carbon content in the core sample was analyzed by exothermic heating and oxidation with potassium dichromate, with 0.5 N ferrous ammonium sulphate solutions (Gaudette et al., 1974). The samples were dried in hot air oven at 70 °C and were pulverized using an agate mortar. 0.15 g of the powdered sediment sample was treated with 4 mL of concentrated HNO_3 and 1 mL concentrated $HClO_4$ in a Teflon bomb and heated at 160 °C for 1 h. Further, 1 mL of concentrated HF was added to digest the insoluble resistant particles and heated to 10 h at the same temperature. Boric acid crystals were added to permit the complexation of excess fluoride. The final obtained solution was centrifuged at 200 RPM and diluted to 30 mL (Yang et al., 2012). The trace element analysis was carried out using atomic absorption spectrophotometer (Perkin