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Baseline

Seasonal variations and environmental risk assessment of trace elements in the sediments of Uppanar River estuary, southern India

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ABSTRACT

Twenty four surface sediments were gathered from the Uppanar river estuary, southern India to evaluate the trace element contamination risk in the sediments. The circulation of organic matter and calcium carbonate were controlled by algal blooms and shell fragments. Moreover, the concentrations of iron and manganese in the estuarine sediments were possibly contributed by riverine sources and geogenic processes. The geoaccumulation index, enrichment factor and contamination factor reveals that the sediments were contaminated by copper and chromium. The pollution load index recommends that the estuarine sediments have the risk of pollution. The sediment pollution index highlights that the majority of the sediments are low polluted sediments. The potential ecological risk index discloses that the Uppanar river estuary is under moderate risk. The statistical analysis reveals that the organic matter content is managed by fine fractions and the majority of the trace elements are associated with each other having similar origin.

Pollution of the marine and estuarine ecosystem by trace elements is a global issue, and the risks associated with it are severe owing to the hasty progress of industrialization, vast improvement of economics, population growth, urbanization, and agricultural actions. Industrialization and urbanization have warped a robust hazard of trace element contamination in estuaries and other aquatic natural environments (Bryan et al., 1980; Langston, 1982). The trace elements move into the sediments, mainly through geogenic and anthropogenic processes. Both natural and human-induced actions release trace elements and influence the sedimentary environment (Lalah et al., 2008). Geogenic processes such as rock weathering and natural erosion and anthropogenic aspects such as solid waste disposal, sludge applications, vehicular exhaust, wastewater irrigation, industrial activities, sewage sludge, metal mining, landfill leachate, and boating activities are the key sources of sediment contamination with trace elements (Singh et al., 2005; Khan et al., 2008; Su et al., 2013; Hasrizal et al., 2015; Iqbal et al., 2016; Lin et al., 2017). Trace elements from geogenic and anthropogenic sources enter the aquatic environments and pose a severe threat owing to their toxicity, tenacity, and biogeochemical buildup into the aquatic environments (Armitage et al., 2007; Yuan et al., 2011; Cheng et al., 2015). Sediments generally provide helpful information on the significance of ecological and geochemical pollution, as well as metals released into the natural environment (Tam and Wong, 2000; Tamim et al., 2016). Accumulation of trace elements in the marine sediments often induces harmful effects on marine biota, when the concentration limit exceeds certain threshold values (Macfarlane and Burchett, 2000). Several complexation processes occur within the sediment–water interface, which acts as a binder with the fine fractions, thus accumulating more metals in the sediments and deteriorating the environmental quality (Lim et al., 2012a, 2012b). Estuaries act as a buffer zone that controls a wide range of organic substances, water, and sediments from terrestrial discharge with high efficiency (Oursel et al., 2013). They operate like a transitional zone from multiple inputs from sea, river, and land thus making it more vulnerable to pollution (Kharroubi et al., 2012; Dong et al., 2012; Hu et al., 2013). According to the United States Environmental Protection Agency (USEPA), 12 trace elements such as arsenic, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, titanium, and zinc have been recognized as the most toxic elements for the aquatic environments (Islam et al., 2015; Chen et al., 2017). Various contamination indices such as geoaccumulation index (Igeo), enrichment factor (EF), contamination factor (CF) followed by pollution load index (PLI), potential ecological risk index (PERI) assessment, and sediment pollution index (SPI) are frequently used to evaluate the overall risk of trace elements in the surface sediments. Estuaries in India are generally contaminated with trace elements, and the probable sources for these elements are from natural weathering and anthropogenic activities. The Uppanar River estuary, which is

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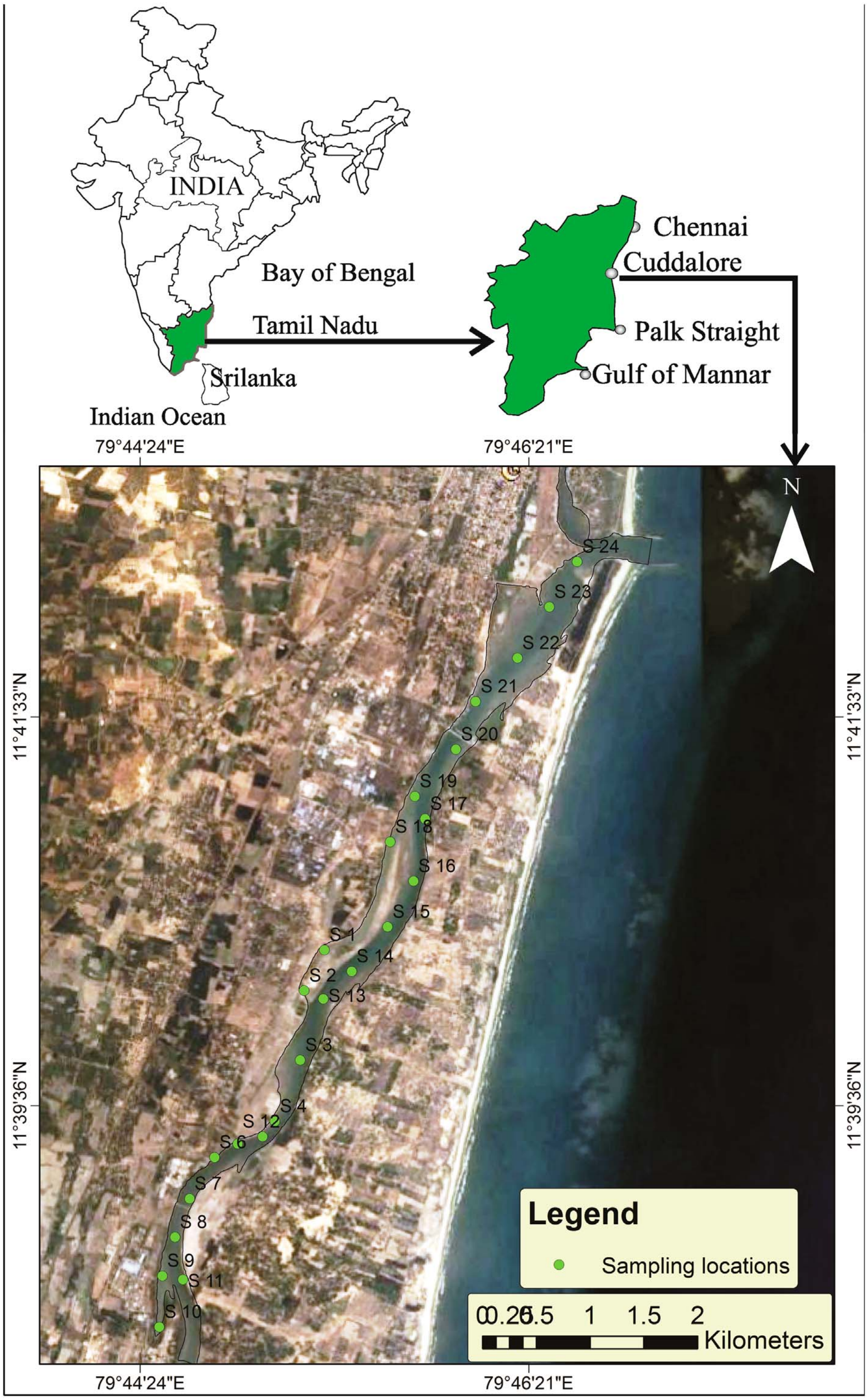

Fig. 1. Location map of the study area.

situated in southern India, has a similar kind of contamination source, and it varies seasonally owing to inputs from river discharge and sea water. The aim of the present study is to understand the seasonal variation of metal accumulation in the Uppanar estuarine sediments, its source, and pathways. Metals such as Cr, Cu, Pb, Co, Ni, Zn, Fe, and Mn followed by sediment texture (sand, silt, and clay), calcium carbonate, and organic matter (OM) of sediments were considered. Various indices such as Igeo, EF, CF, PLI, PERI, and SPI were applied to assess the overall risk of trace element contamination in the estuarine sediments and the current status of metal pollution in the Uppanar estuary.

The Uppanar River estuary is located near the Parangipettai coast, southern India, with coordinates between 11° 41′ 0″ and 11° 43′ 0″ N Latitude and 79° 44′ 01″ and 79° 49′ 01″ E Longitude (Fig. 1). The length of the estuary is approximately 5 km, with a width of 30 m and an average depth of 2.5 m. The mean elevation of the estuary is 1 m above mean sea level, and the tidal fluctuations interfere with the estuarine water column; it extends up to 6 km upstream (Rajaram et al., 2005). The major industrial hub (SIPCOT - State Industries Promotion Corporation of Tamil Nadu) is situated on the western part of the study area, and it is flourished to about 520 acres comprising 44 major