



Baseline

Elemental concentration based potential ecological risk (PER) status of the surface sediments, Pulicat lagoon, Southeast coast of India

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ABSTRACT

Eighty-three surface sediments were collected to investigate the element concentration based sediment pollution and potential ecological risk status of the Pulicat lagoon, southeast coast of India. The textural characteristics, Fe and Mn concentration in the surface sediments are chiefly controlled by the confluence of riverine inputs and vicinity of the marine environment. The varied distribution of CaCO₃ concentration is due to the depth of the lagoon followed by the sand and silty sand characteristics of the substratum. The surface sediments are derived from riverine sources. Sediment Pollution Index (SPI), Potential Ecological Risk Index of the sediments suggests that they are falling under less polluted and low potential ecological risk category.

The coastal lagoonal environment and estuarine systems are probably considered as a most important ecosystem due to commercial, recreational and ecological values. The increasing coastal population and urban development have led to the degradation of the lagoonal ecological status. The spatial and temporal variation of the element in the marine sediment is due to sediment load delivered by the river tributaries from the urban environment and its exchanges with the sea (Panda et al., 2013). The sediment transport from the lagoon to the open sea depends on various parameters including number of water inlets (Aubrey et al., 1993), size and shape of the lagoon system (Chandramohan and Nayak, 1994), inlet cross sectional area (Vincent and Corson, 1980) and circulation pattern (waves, tides and currents). In addition, the maximum amount of sediment associated contaminants from estuarine/lagoons begins to flocculate and settle in the bottom of the lagoon surface due to their hydrodynamic settings, varied salinity, water temperature and redox effects (Gijs et al., 2002; Jayaprakash et al., 2008). The sediment accumulated toxic elements are indicating the Sediment Pollution Index level (SPI) and Potential Ecological Risk Index (PERI) status of the lagoon/marine sediments. The various studies on PERI have been carried out in marine and reef sediments all

over the world (Singh et al., 2002; Hakanson, 1980; Saravanan et al., 2018).

Pulicat lagoon is a largest shallow brackish water lagoon in India with an average depth of about 1.5 m and the depth of the lagoon is gradually reduced due to over siltation. The lagoon is extended towards Tiruvallur District in Tamil Nadu and Nellore District in Andhra Pradesh states, with an average area of about 460 km² parallel to the Bay of Bengal, Southeast coast of India (Fig. 1). Pulicat lagoon covers an average length of about 59 km from north to south direction and has a maximum width of about 19 km along the east to west direction at the northern side of the lagoon. The fresh water is contributed into the lagoon through three major rivers viz. Arani river from the southern side, Kalangi river from the midwestern side and Swarnamukhi river from the northern end of the lagoonal system. The southern tip of the lagoon confluence into the Bay of Bengal near Pazhaverkadu through a narrow inlet of 200 m width and the average depth of this place is about 1 m (the depth of this channel varied from 0.5 m to 6 m). The Pulicat lagoon experiences limited tidal fluctuations and the average height of the low to high tide is approximately 30 cm (Chacko et al., 1952). The calm environmental conditions of the lagoon are probably due to the occurrence of long barrier spit along the lagoonal

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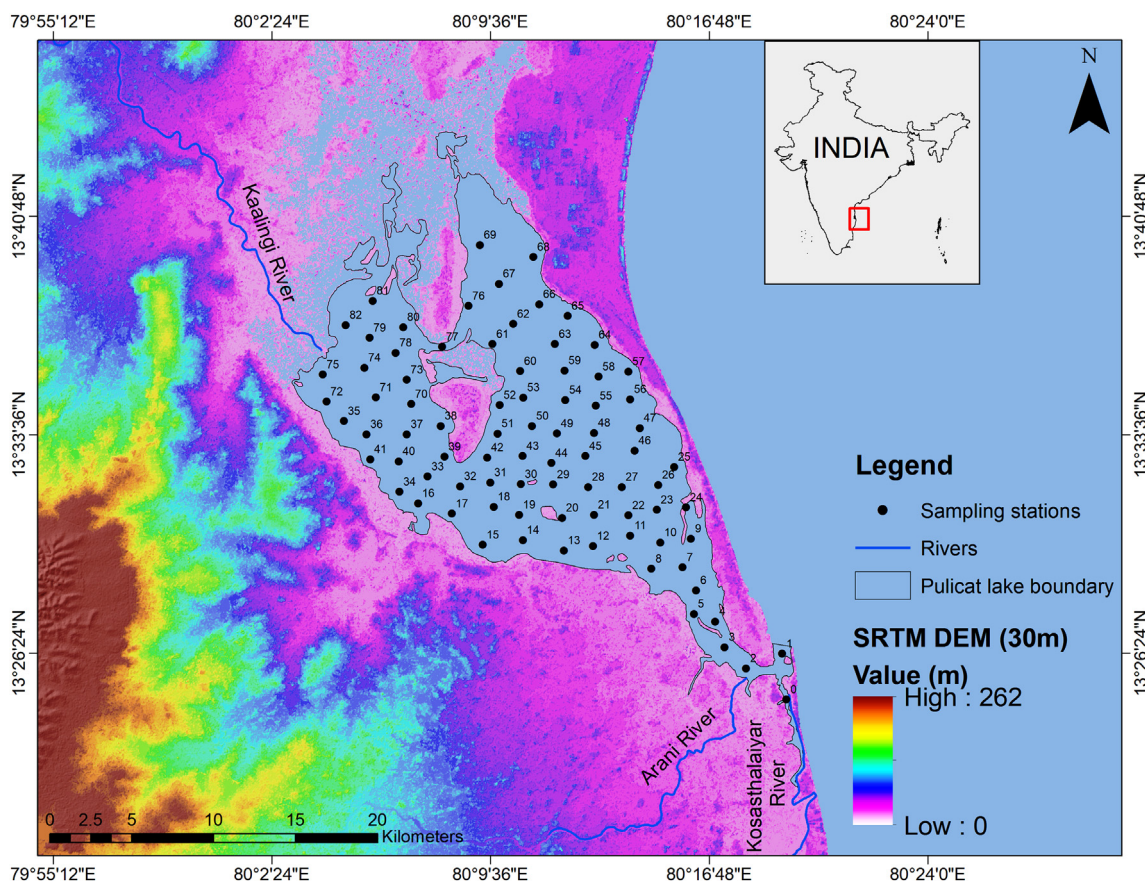


Fig. 1. Sampling locations and study area map, Pulicat Lagoon.

Table 1
Comparison of MESS 2 certified values for studied elements.

Elements	MESS 2		
	Obtained value	Certified value	% recovered
Fe	4.25	4.34	97.93
Cr	104.1	105	99.14
Mn	322.6	324	99.57
Ni	45.3	46.9	96.59
Cu	33.2	33.9	97.94
Zn	153	159	96.23
Pb	21.9	22.3	98.21

phase. The average wave height is about 0.57 to 1.0 m. The lagoon experiencing current direction towards the north from March to October month and towards south direction during November to February. The periodic shifting of the lagoonal inlet is probably controlled by the northern littoral drift currents and northeastern monsoon rainfalls (Chandramohan et al., 1990). Various studies on the elemental accumulation in estuarine sediments and the bioavailable toxic element were carried out by various workers (Reddy et al. 2016; Tholkappian et al., 2018; Vasanthi et al., 2014). The sediment transport and shoreline dynamic studies are also done by earlier researchers (Natesan et al., 2014; Nagalaksmi et al., 2017). The aim of this work is to document the trace element accumulation level, Sediment Pollution Index (SPI) and Potential Ecological Risk Index in the lagoon sediments, Pulicat lagoon, Southeast coast of India.

Eighty three surface sediments were collected using a Van Veen grab sampler from the Pulicat lagoon. A gridded sampling technique was adopted to retrieve the sediment samples. The sampling locations were fixed using a handheld Trimble Juno SB outdoor GPS. The collected samples were air dried at room temperature. The dried samples were homogenized and pulverized, using an agate pestle and mortar and passed through a 230 ASTM sieve set. The powdered samples settled in the bottom pan were kept in a zip lock polyethylene bag for elemental analysis. Calcium carbonate and trace element analysis were executed based on the procedure formulated by Loring and Rantala (1992). Organic carbon was determined by the exothermic heating method followed by oxidation with the $K_2Cr_2O_7$ solution and concentrated H_2SO_4 . 0.5 N ferrous ammonium sulphate solution was used to titrate the excess of dichromate salts (Gaudette et al., 1974).

The powdered sample was placed in a Teflon beaker and started the digestion procedures using aqua regia solution (2 h at 120 °C; HNO_3 : $HClO_4$: HF - 3:2:1 ratio). The digested solution was finally centrifuged at 1500 RPM and made up to 50 ml with double distilled water. The elemental analysis was carried out (Fe, Mn, Pb, Zn, Cu, Cr and Ni) using Graphite Furnace Atomic Absorption Spectrophotometer (Graphite AAS - PerkinElmer Analyst™ 800) at Institute for Ocean Management, Anna University, Chennai – 600 025. The Quality Assurance/Quality Check of the instrument was cross-checked with a standard reference material MESS-2 and the recoveries of the studied elements were within the acceptable limit of the certified values (Table 1). The analytical results reveal that the recovery values of the elements range between 92 and 97.5%. The detection limit of the elements such as Fe, Zn, Cr, Cu and Ni are $0.01 \mu g g^{-1}$, $0.02 \mu g g^{-1}$ for Mn and $0.05 \mu g g^{-1}$ for Pb. The

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