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Baseline

# Depositional environment and geochemical response of mangrove sediments from creeks of northern Maharashtra coast, India

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ABSTRACT

Present study provides results of trace metal distribution in mangrove sediment cores collected from macro-tidal Khonda and Dudh creeks of Northern Maharashtra coast, India. Most of the metals showed significant higher addition in Dudh creek (core DC) as compared to Khonda creek (core KC). However, Khonda creek sediments did show anthropogenic enrichment of Mn, Zn and Ni, while Dudh creek sediments showed anthropogenic enrichment of almost all the studied metals. Large difference in metal concentration between the two creeks was attributed to their proximity to industries. The higher Mn, Zn and Ni content in Khonda creek was mainly attributed to addition from domestic and agricultural wastes. While high deterioration of Dudh creek sediments was the outcome of addition from industrial effluents.


Intertidal mangrove sediments act as traps and play an important role as sinks for heavy metals received from wide range of sources. Worldwide studies on metals have mainly focused on relatively larger estuaries and less attention has been paid on smaller creeks. Small sedimentary catchments respond quickly to external drivers making them highly sensitive to natural and anthropogenic processes (Gao and Jia, 2004). North Maharashtra along the west coast of India is one of the rapidly industrializing and urbanizing regions. Areas around Mumbai are well studied by various researchers, which focused on the level of pollution (Sahu and Bhosale, 1991; Jha et al., 2002; Ram et al., 2003; Fernandes et al., 2011). However, information on other important anthropogenically impacted inter-tidal areas in this part of the coast is scarce.

In this study, Khonda creek, present in ecologically sensitive area and Dudh (Kharekuran-Murbe) creek in close proximity of Tarapur industrial estate (MPCB, 2005) of Thane district were studied. Climate of Thane district is humid tropical with an average rainfall of about 2293.4 mm. Mangrove species reported from this region are *Avicennia alba*, *Avicennia marina*, *S. apetala*, *A. officinalis*, *Rhizophora mucronata* and *R. apiculata* (Naskar and Mandal, 1999). The Dudh creek is approximately 23 km long and freshwater to this creek is supplied by Dudh River. Mahim rainfall measurement station is in close proximity to this river. Hundred meter wide Savta creek and 400 m wide Khonda creek join together to form 500 m wide Dahanu creek. Freshwater to this creek is received from rivers Pankhadi, Kankradi, Gonda, Gorduna, etc. Nearly 1435 ha of wetlands locally known as Khajan lands surrounds this creek. The two creeks represent macro-tidal environment with maximum tidal range of 5.65 m at Khonda (Dahanu) creek and 5.03 m at Dudh creek (Chauhan et al., 2004). Both the creeks ultimately drain into the Arabian Sea. The two creeks are different from each other in terms of catchment area, freshwater input as well as addition of industrial and domestic wastes. Therefore the objectives of the present study are (i) to provide baseline metal concentrations in creeks along northern coast of Maharashtra and (ii) to understand factors controlling metal distribution in sediments of creeks facing dissimilar anthropogenic pressures.

Two intertidal-mangrove sediment cores, namely core KC and core DC, were collected towards the mouth of Khonda (19°58′01.5″N; 72°43′16.2″E) and Dudh (19°44′43.9″N; 72°42′39.6″E) creek respectively (Fig. 1). The two cores were collected during the field survey conducted from 20th to 29th of May 2009. The length of core KC was 72 cm while that of core DC was 56 cm. Sampling stations were located using hand held Global Positioning System (GPS). Sediment cores were collected using hand operated PVC corer. Sub sampling was done at 2 cm interval with the help of a plastic knife. The sub-samples were sealed in clean plastic bags, labeled and stored in ice box until laboratory analyses. Sediments were oven dried at 60 °C in the laboratory. Sediment components (sand: silt: clay) were analyzed following Pipette method (Folk, 1968). Portion of the dried samples was powdered and homogenized using an agate mortar and pestle. Part of powdered and homogenized samples was used for the estimation of Organic carbon following Walkey-Black method (Gaudette et al., 1974). Other part was used for metal analysis, in which after complete digestion of known weight of sediment sub-samples with 7:3:1 $HF:HNO_3:HClO_4$ acid mixture, sample

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**Fig. 1.** Location of core samples collected from Khonda and Dudh creeks, Maharashtra.

**Table 1**
Average ± standard deviation values of the studied parameters in the three sections.

| Core KC | Sand (%) | Silt (%) | Clay (%) | OC (%) | Fe (%) | Mn (ppm) | Cu (ppm) | Zn (ppm) | Co (ppm) | Ni (ppm) | Pb (ppm) | Al (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *(a)* | | | | | | | | | | | | |
| Section I | 42.6 ± 7.1 | **27.6** ± 10.0 | **29.8** ± 15.2 | **0.36** ± 0.16 | 5.85 ± 0.61 | 1257 ± 81.7 | **96.6** ± 4.1 | 96.3 ± 3.48 | **58.6** ± 1.37 | 104 ± 7.67 | 52.6 ± 8.62 | 6.18 ± 0.26 |
| Section II | 45.4 ± 9.9 | 26.1 ± 6.6 | 28.5 ± 14.6 | 0.25 ± 0.11 | **5.99** ± 0.63 | **1440** ± 132 | 93.3 ± 4.0 | 97.6 ± 6.44 | 57 ± 3.48 | 112 ± 6.32 | **75.9** ± 21.2 | **6.49** ± 0.27 |
| Section III | **49.5** ± 13.1 | 23.4 ± 7.7 | 27.0 ± 16.0 | 0.28 ± 0.12 | 5.54 ± 0.87 | 1420 ± 74.2 | 91.9 ± 4.0 | **98** ± 6.52 | 54.9 ± 4.91 | **121** ± 8.76 | 55.8 ± 9.28 | 6.38 ± 0.32 |
| Core DC | Sand (%) | Silt (%) | Clay (%) | OC (%) | Fe (ppm) | Mn (ppm) | Cu (ppm) | Zn (ppm) | Co (ppm) | Ni (ppm) | Pb (ppm) | Al (ppm) |
| *(b)* | | | | | | | | | | | | |
| Section I | 26.9 ± 4.6 | 35.0 ± 2.1 | 38.0 ± 3.28 | **1.35** ± 0.33 | 7.99 ± 0.32 | 1337 ± 185.3 | 115 ± 8.6 | 184 ± 11 | 49.2 ± 7.06 | 115 ± 4.6 | 42.8 ± 29.5 | 8.56 ± 1.17 |
| Section II | **53.0** ± 24.4 | 21.6 ± 11.0 | 25.4 ± 13.5 | 0.64 ± 0.42 | 9.62 ± 1.04 | 1719 ± 348.8 | 138 ± 13.3 | **211** ± 21.7 | **54.7** ± 15.7 | 127 ± 4.94 | 36.7 ± 21.8 | 8.24 ± 0.93 |
| Section III | 13.8 ± 1.9 | **35.5** ± 2.99 | **50.7** ± 3.64 | 0.73 ± 0.06 | **9.99** ± 0.33 | **1721** ± 228.3 | **148** ± 6.18 | **211** ± 32.7 | 51.5 ± 9.43 | **156** ± 15 | **62.7** ± 30.9 | **9.08** ± 0.74 |

solutions were analyzed for bulk metal chemistry (Fe, Mn, Al, Cu, Zn, Co, Ni and Pb) using Atomic absorption spectrophotometer (AAS) (Varian AA240FS). Accuracy and Precision of method was checked with sediment reference standard from the Canadian National Bureau of Standards (BCSS-1). Accuracy was ±95% for Mn and Co, ±94% for Fe, Cu, Ni and Al, ±97% for Zn and Pb. Instrument was checked for its reproducibility by carrying out repeat analyses after every ten samples. The precision obtained for the metals is as follows: Fe 2.19%, Mn 3.04%, Al 3.24%, Co 2.16%, Cu 2.75%, Ni 2.89%, Pb 2.26% and Zn 3.67% of the standard deviation (%SD). Analytical grade reagents have been used throughout the study. Contamination during sampling, storage and analyses of the samples is avoided by taking due care. Ternary diagram was used to understand and compare the hydrodynamic conditions of the two creeks (Pejrup, 1988). To identify metal enrichment due to anthropogenic influence and diagenetic reactions, metal/Al ratios were plotted against depth. Al is used as a normalizer since it is a conservative detrital element (Skowronek et al., 1994; Balls et al., 1997). Anthropogenic factor (AF) was calculated for both the cores following Szefer et al. (1998). Statistical analysis was performed using SPSS ver. 16 for windows.

Based on the variation of sediment components cores are divided into three sections. In core KC, section I extends from 72 to 50 cm depth, section II from 50 to 26 cm and section III from 26 cm to surface of the core and in core DC, section I extends from 56 to 30 cm, section II from 30 to 14 cm and section III from 14 cm to surface of the core (Table 1a and b).

Increase in average sand percentage and decrease in average clay percentage is noted from section I to section III of core KC (Table 1a). Higher SD% values are noted in section III for sand

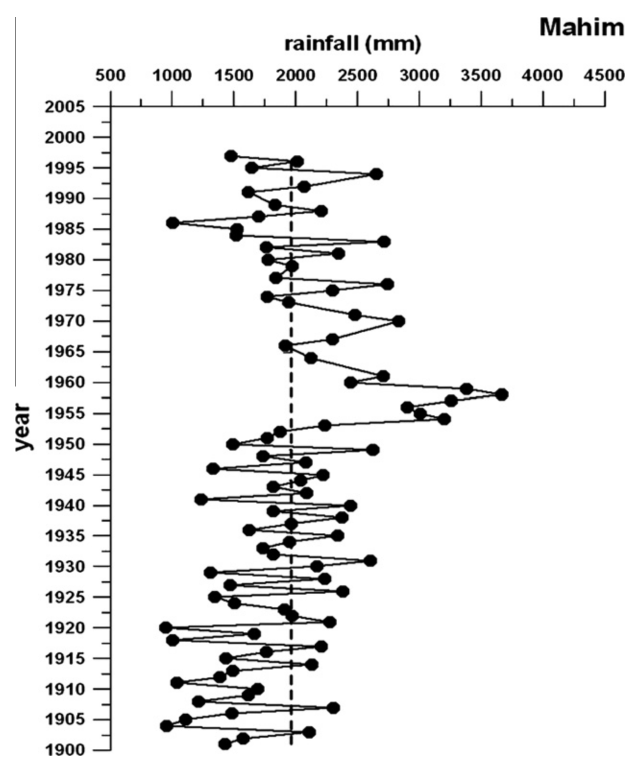


**Fig. 2.** Rainfall data of last 100 years for a station in Thane district.