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Sedimentological characters of the mangrove ecosystem of Kali estuary, Karwar, west coast of India

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Abstract

Estuarine mangroves give natural support to the protection of the riverbanks, due to their accumulative nature. To study this effect, it is necessary to measure sedimentation rates under estuarine mangroves. Sediment plays an important role in the storage and release of nutrient into the water column, the mineralization of organic carbon deposits by various kinds of microbes. In association with other parameters, the sediment is responsible for the variations in densities of majority of benthic organisms. Regular monthly collections of bottom water and sediment were made for a period thirteen months from January 2008 and January 2009 at five different study sites using the motorized outrigger canoe. The present investigation encompassed collection of data pertaining to various aspects of sedimentology. Sediment temperature varied from 25.10^{0}c to 30.45^{0}c. The pH ranged between 6.18 to 8.30. Organic carbon Varied between 2.06 to 29.45%, moisture content varied from 20.10% to 41.88. Values of interstitial water content is varied between 1.60% to 30.95%. Wide variation in the percentage composition of sand (28.45% to 80.10%), silt (12.78% to 54.28%), and clay (3.66% to 33.63%) was observed.

Keywords: Sedimetology , Ecosystem, Mangrove, Kali river, Karwar.

Introduction

Mangroves, a group of salt-tolerant shrubs and trees, constitute a valuable coastal resource for many tropical and subtropical countries. Their strategic locations at the land-sea interface as well as inherent productivities are highly interactive with the surrounding environments. The mangrove ecosystem not only holds and stabilizes sedimentary deposits from erosion, but acts as a buffer between transitional, near shore, and lagoon or estuarine environments with respect to their influence on freshwater discharge, salinity regime, and the adjacent aquatic system. However, mangroves

themselves influence the hydrodynamic regime through their physical configuration and thus exert direct effects on the sediment flux. Hence, an attempt has been made in this investigation to understand the textural characteristics of the sediments of Kali estuary and creek to have proper insight into the particle size distribution. Energy conditions and transportational pattern of this sediment has been studied as a starting point to elucidate the environmental quality of the basin, since there is no systematic and detailed textural studies available in this region. Estuaries form a transition zone between river environments and ocean environments and are subject to both marine influences, such as tides, waves, and the influx of saline water; and riverine influences, such as flows of fresh water and sediment. The inflow of both seawater and freshwater provide high levels of nutrients in both the water column and sediment, making estuaries among the most productive natural habitats in the world.

Materials & Methods

Mavinahole creek which is situated at northern part of the Kali estuary, where the hydrographical parameters are highly influenced by the influx of river water and inshore waters (Figure 1). Station 2 is fixed in the backwaters of Kanasgeri, which is about 3.25 km away from the estuary point located on the northern bank of River Kali and has a vast and luxuriant growth of mangrove floral stretch. Third study station is also located in the mangrove habitat Sunkeri which is about 5.75 km from the estuary point and located at the southern bank of the river is covered with rich mangrove floral stretch with maximum mangrove species. Station 4 is situated around 9 km from the Kali estuary and is located in the Kadwad area. This study point located in the mangrove habitat of the river and this area is also known for good fishery throughout the year. Station 5 is located in the Kinnar which is around 12.5 km from the estuarine point and is mostly fresh water biotope with more number of freshwater fin fish species.

Regular monthly collections of bottom water, sediment and benthos were made for a period thirteen months from January 2008 and January 2009 at five different study sites using the motorized outrigger canoe. The sediment samples were collected with the help of a Petersen grab having mouth biting an area of 2651.7cm^2 and depth of 15cm. A plastic core or quadrate was used to take sample from the central part of the grab sample. After collection of the sediment samples, immediately sediment temperature, pH, moisture content, Interstitial water & organic carbon were observed. And was immediately brought to the laboratory for further analyses like sediment texture.

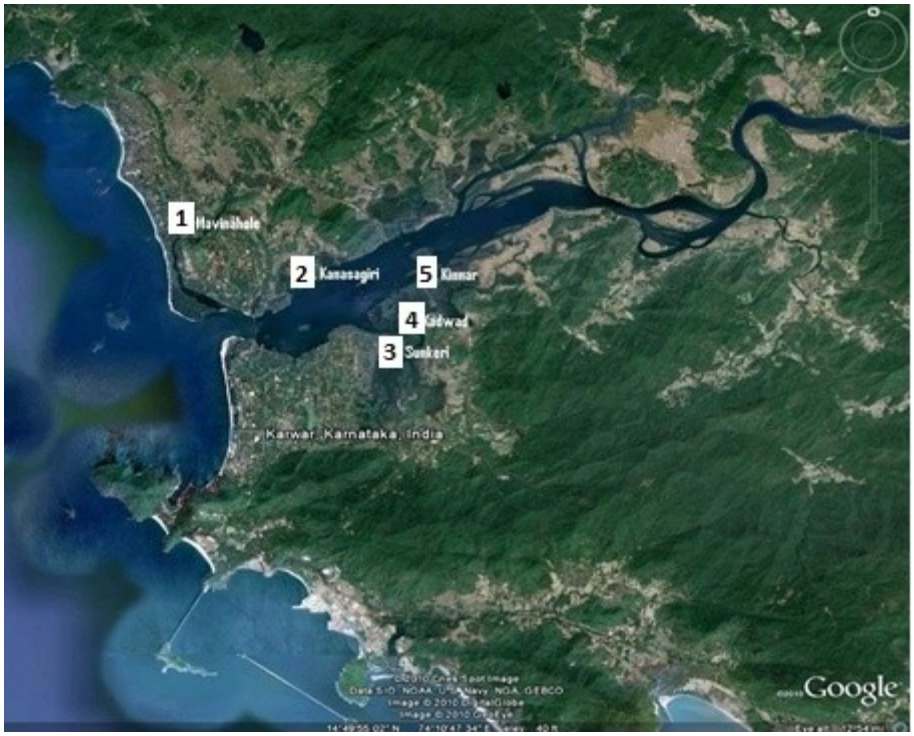

Figure 1: Map showing the location of the study stations in the mangrove: 1: Mavinahole; 2: Kanasageri; 3: Sunkeri; 4: Kadwad; 5:Kinnar

Sediment texture: sediment grain size analysis was carried out with the help of sieves. Silt and clay fractions were determined by pipette analysis as described by Holme & McIntyre (1971). Later, the results were plotted on triangular diagrams (Eltringham, 1971; Holme & McIntyre 1971; Parsons *et al*., 1977) and the sediment texture was determined.

The depth could not be considered as an additional bearing during the relocation of the stations as it varied around the year owing to land run off and other natural processes. Hence, the standard deviation of depth is calculated the values are given in Table 1. The standard deviation is determined as follows,

$$\text{Standard deviation} = \sqrt{\frac{\Sigma (m - M)^2}{n}}$$

Where, m = depth in different months

M = mean depth

n = number of sampling

Results and Discussion

Sediment temperature did not vary much among the five study stations and all stations showed more or less similar pattern of distribution during the study period (Fig. 2). The yearly mean varied between 27.70 (Stn. 4) and 28.69 (station 1) (tab 1). In all study stations, maximum temperature recorded during pre monsoon and minimum during southwest monsoon season. Variation in values at study sites could be due to recording at different timings.

Fig. 3 explains the variation and trend in the hydrogen ion concentration (pH) parameter at all five-study stations during the present study period. Maximum values were recorded at station 2 during April to July whereas other stations showed more or less similar trend and minimum values were noticed at station 3. Yearly mean values with SD in parenthesis, at study station 1-5 are of 7.69 (± 0.31), 7.75 (± 0.29), 6.67 (± 0.39), 6.78 (± 0.30) and 6.76 (± 0.26) respectively (Table 1).

Among five stations, maximum values of organic carbon were noticed at station 1 throughout the study period whereas minimum values noticed at station 4 whereas at stations 2nd and 5th comparatively higher organic carbon content was recorded in the sediment (Fig. 4). Yearly mean of all the stations recorded at study stations 1 to 5 are 2.82 (±0.57), 2.65 (±0.40), 2.46 (±0.18), 2.33 (±0.25) and 2.56 (±0.63) respectively (Table 1). The high percentages of organic carbon may be due to relatively denser benthic populations present in the saline waters. During the pre and post monsoon months the lower amounts of organic carbon present in the sediment may be due to the fresh water influx. Similar findings were recorded in other parts of west coast of India by several workers (Fernando, 1981; Kidwai *et al*., 1972., Paropakari, 1979)

Among the five study stations, the lowest values of moisture content were recorded at station 5 and highest at station 3 respectively (Fig. 4). In all these study stations, maximum moisture content values were recorded during southwest monsoon and post monsoon seasons respectively. Yearly mean

of station 1 to 5 are of 28.99 (±5.25), 30.23 (±4.28), 33.53 (±6.26), 31.18 (±4.99) and 27.78% (±5.69) (Table 1).

Among the five study stations, the lowest values of interstitial water content was recorded at station 3 and highest at station 1 respectively (Fig. 5). In all these study stations, maximum interstitial water content values were recorded during southwest monsoon and in post monsoon seasons respectively. Yearly mean of station 1 to 5 are of 28.20 (±1.12), 27.96 (±0.51), 27.03 (±0.99), 27.55 (±0.90) and 28.63% (±0.46) (Table 1).

Table 1: Monthly variations in different Sedimentological parameters at Station 1 – Mavinahole creek

Months	Sediment Temperature (^{0}C)	pH	Organic Carbon (%)	Moisture (%)	Int. water (%)	Sand (%)	Silt (%)	Clay (%)
Jan-08	28.80	7.43	3.51	24.38	29.12	65.10	18.18	16.15
Feb	28.10	7.21	3.06	25.95	29.62	66.28	18.32	14.38
Mar	29.20	7.50	2.26	26.13	28.34	71.18	15.40	14.28
Apr	29.30	7.62	3.40	24.10	30.26	64.20	20.18	16.10
May	29.75	7.92	3.38	24.20	28.45	59.48	23.48	18.72
Jun	28.56	8.30	2.30	37.06	30.12	68.14	16.10	15.38
Jul	27.40	8.10	2.27	36.80	30.63	73.10	14.18	14.13
Aug	28.00	7.90	2.06	37.10	30.95	74.82	13.60	11.32
Sept	28.10	7.80	2.19	34.22	28.85	77.32	12.78	10.16
Oct	29.30	7.72	2.68	28.48	28.13	69.10	14.18	15.18
Nov	29.40	7.68	2.63	27.10	26.90	68.10	16.20	16.42
Dec	28.00	7.52	3.52	26.12	29.12	62.40	19.80	17.68
Jan-09	29.10	7.30	3.41	25.24	29.15	64.82	17.64	17.10
Mean	28.69	7.69	2.82	28.99	29.20	68.00	16.93	15.15
SD(±)	0.72	0.31	0.57	5.25	1.12	5.09	3.06	2.39

Among five study stations, station 1 showed comparatively higher values of sand whereas at station 3 lower sand proportions were recorded during the study period (Fig. 6 and 7). Comparatively higher sand content was noticed at all study stations (50.61 - 65.0%) respectively. The yearly mean values of this parameter are of 68.00 (± 5.09), 66.63% (± 9.40), 51.40 (±13.85), 51.85 (± 8.02) and 53.12 (± 2.73) respectively (table 1).

Fig. 8., explains monthly variation in silt content in the sediment texture at study stations 1-5 during the present study period. Lowest proportion of silt was noticed at station 1 (16.93%) and highest in station 3 (33.45%). The yearly mean values of this parameter are of 16.93 (± 3.06), 25.67% (± 5.32), 33.45 (±10.36), 27.10 (± 5.35) and 32.94 (± 7.58) respectively (table 1).

Fig. 9 explains the clay content in the sediment samples ranging from 9.58% (#2) to 20.14% (#4) during south west and post monsoon seasons (Table 1). During the present study period, yearly mean values of silt content in the sediment at different study stations were of 15.15% (±2.39), 9.58% (±3.60), 17.65% (±7.07), 20.14% (±8.06) and 14.15% (±5.99) respectively.

The high percentages of organic carbon may be due to relatively denser benthic populations present in the saline waters. During the pre and post monsoon months the lower amounts of organic carbon present in the sediment may be due to the fresh water influx. Similar findings were recorded in other parts of west coast of India by several workers (Fernando, 1981; Kidwai *et al*., 1972, Murthy *et al*., 1969;. The sediment texture also plays a very important role in contributing the organic carbon to the benthic realm. The finer grain sizes are believed to hold good amount of these materials within it. In general, according to Sanders (1956), all the clay mineral except Kaolin bind the organic carbon and the area with the high percentage of clay is capable of having high proportion of organic carbon during the different seasons. Similar findings were also noticed in the present investigation especially in the lower reaches (mangrove area) of the river Kali.

It is a known factor that a whole set of benthic organisms depend directly or indirectly on the nature and texture of bottom sediment in which they live. The organisms, which live wholly within the sediment, belong to the former category and those organisms, which depend on the sediment only for the purpose of support to the latter. The factors like organic carbon, sediment texture etc are the determinant factors for the survival, growth and propagation of the benthic organisms, especially of in-fauna in an aquatic environment.

Wide variation in the percentage composition of sand, silt and clay was observed over the seasons and stations. Sediment texture being predominantly sandy in nature, the average percentage composition was observed to be about 70% (post monsoon), 60% (pre monsoon) and 69% (southwest

monsoon). However, few of stations showed less than 45% in each of the seasons. Silt and clay percentage range from 10-30 percent and 5-40 percent is depending on the season and location of the sites.

Figure 2: Monthly variation in the sediment temperature at study stations 1-5

Figure 3: Monthly variation in the pH at study stations 1-5

Figure 4. Monthly variation in the moisture at study stations 1-5

Figure 5. Monthly variation in the interstitial water at study stations 1-5

Figure 6. Monthly variation in the sediment organic carbon at study stations 1-5

Figure 7. Monthly variation in the sand content at study stations 1-5

Figure 8. Monthly variation in the sediment temperature at study stations 1-5

Figure 9. Monthly variation in the sediment temperature at study stations 1-5

The study of sediment along with the hydrological conditions is equally important and also essential in understanding the principles operative in an ecosystem. Sediment plays an important role in the

storage and release of nutrients into water column, the mineralization organic bottom deposits by various kinds of microbes also provides a two dimensional substrate to sustain benthic life and not to mention of its importance as bed for the growth of algal pasture in shallow area (Naik *et al*., 2005). In all soil characters either directly or indirectly reflects the productivity of the system as a whole through parameters such as texture, composition, pH, interstitial water and organic matter. During the monsoon season, the mixing of water in the estuaries leads to flocculation resulting in the deposition of fine grained sediments. This type of deposition takes place within the 15 to 50m water depths corresponding to the distance of about 40 km from the coast (Bhat, 1984). This type of near shore deposition of river discharged sediments is common on shelves also. Other processes that may be operating in the deposition in environment and brings about are distribution of bottom sediments by bottom currents. These currents can be a combination of the tide and or wave generated. It is due to these currents play an important role in the sediment are process in the estuaries and neighbouring water spread area. This finding holds well in the present study areas also. On the shelf of Karnataka three most abundant sediment types are found namely clayey silt, silty-sand and sand. The clayey silt forms a relatively narrow band confined to less that 50 m water depth and within a distance of 25 to 40km from the coast.

Thus it is observed from the various sets of data on sedimentological factors studied during the present investigation that there has been no significant variation between the study stations but seasonally it varies considerably this could be probably due to the impact of southwest monsoon season which is sever on the bottom substratum of the mangrove ecosystems.

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