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SEDIMENT CHARACTERISTICS OF THE THEKKUMBHAGOM KAYAL OF THE ASHTAMUDI ESTUARY, KERALA, INDIA

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Abstract: The Ashtamudi Estuary, one of the Ramsar sites, forms an important estuarine system of south Kerala. It is the second largest estuarine system in Kerala, covering an area of 32 km^2, branches off into 8 creeks known by different names and confluences with the sea through a permanent opening at Neendakara, one of the most important fishing harbors of India. Thekkumbhagom Kayal, one of the extensions of Ashtamudi Estuary was surveyed and sediment samples were collected from five different stations for a period of one year from February 2009 to January 2010. For all the five selected stations the sediment temperature ranged from 26^0C in June 2009 to 31^0C in April 2009. pH varied from 5.9 to 7.8. The maximum pH was recorded in the months of June, November and December 2009 and the minimum in July 2009. Organic carbon content varied from 0.21% in April 2009 to 3.2% in February 2009 at different stations. Textural analysis revealed that sand was a dominant component (75%) followed by silt (14.8%) and clay (10.6%). The sand content varied from 56% in April 2009 to 75% in January 2010, silt fraction showed a variation from 14.8% in January 2010 to 33.6% in April 2009, however, clay content differed from 10% in August 2009 to 10.6% in March 2009. Among the soil constituents sand was the dominant component and the deposition of sand in the study area can be attributed to the physical processes like tidal influx within the system and the human activities like dredging and sand mining.

Key words: Sediment, pH, Sediment texture, Temperature, Organic Carbon

INTRODUCTION

Sediments are defined as the organic and inorganic materials or solid fragments derived from the weathering process of sand, pebbles, silt, mud and fine-grained soil. Sediments can also be defined as the materials on bottom of aquatic systems originating from soil erosion and precipitation by chemical and biological process. Sediment materials carried into the estuary from the sea and rivers form the mud flats. The nature and rate of sedimentation in an estuary mainly depends on the nature, water transport and ecological stress (Postma, 1967). Tidal flats in marine or brackish parts of estuarine systems have been the focus of numerous morphosedimentary studies (Amos, 1995; Perillo, 1995; Black *et al*., 1998; Dyer, 1995; Dyer *et al*., 2000a,b). Estuarine sediments act as a storage house of nutrients in the aquatic environment. In the tropical estuarine system sediment concentration pose one of the worst environmental problems. Siltation is another common problem in the tropical estuaries; it is due to urbanization and anthropogenic activities. Sediments may not only act as sinks but also act as a source of contaminants in aquatic system (Adams *et al*., 1992; Burton and Scott, 1992). These are the indicators of quality of overlying water and its study is useful tool in the assessment of the status of environmental pollution. In the present study the sediment samples from five different stations of Thekkumbaghom Kayal were collected during the monsoon and non monsoon

season of the year, and were analyzed for the temperature, pH, organic carbon content and the textural features.

MATERIALS AND METHODS

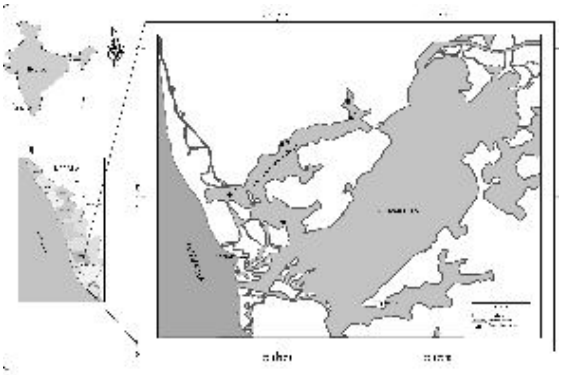

Fig. 1. Map of Thekkumbhagom Kayal, with study sites (Station.I- St. Joseph Church Kadavu, II-Kochuthuruth Kadavu, III-Vadakkumbhagom Kadavu, IV-Pavumpa Kadavu and V-Gopalakrishnan Kadavu

Monthly samples of sediments were collected from March 2009 to February 2010. Five representative stations were selected for the study. Samples were collected using a PVC corer of 15-cm length and diameter of 6 cm. The corer was pushed vertically into the bottom by a diver, taking care not to stir the sampling area. Such sediments samples collected were stored in clean polyethylene covers and brought to the laboratory for further analysis. The pH of the sediment samples was measured using a portable pH meter (Hanna Instruments, USA) having 0.1 accuracy. The organic carbon content was determined by the method given by Krumblein and Petti John (1938). The proportions of different textural components were expressed in percentage.

RESULTS AND DISCUSSION

The observed temperature, pH, organic carbon and sediment textural composition (sand, silt and clay) of the sediment collected from 5 stations of Thekkumbhagom Kayal during 2009-10 are given in Table 1.

In the present study the sediment temperature was high during premonsoon season. Low temperature was recorded during monsoon season (Fig.2). This could be due to the absorption of appreciable amount of heat from the water to the sediments during warmer periods of the year and transmit heat to water during winter periods (Wetzel, 1975) and low temperature due to the fresh water in-flow during monsoon season. Similar trend was noted by Rajasegar *et al*. (2002) from Vellar estuary, Binushma *et al*. (2010) and Soumya *et al*. (2011) from Ashtamudi estuary. The sediment temperature of the study area ranged between 26°C and 31°C. The lowest temperature of 26°C was recorded at stations III, IV and V in June 2009 and the highest 31°C was observed at station II in April 2009. At station I the highest sediment temperature (30°C) was noticed in March 2009 and the lowest (27°C) in June, July, August, September, November and December 2009. At station II the maximum temperature of 31°C was observed in April 2009 and the minimum of 27°C was recorded in June, July, August, November, December 2009 and January 2010. At station III the temperature was high (29°C) during February and March 2009 and it was low (26°C) during June 2009. At station IV the temperature was high (29°C) during February and March 2009 and it was low (26°C) during June 2009. At station V the temperature was high (29°C) during February and March 2009 and it was low (26°C) during June. Similar observations were also recorded by Bhatt (1984) in Kali estuary, Rajasegar *et al*. (2002) from Vellar estuary, Bragadeeswaran *et al*. (2007) from Arasalar estuary Karaikkal, Vasantha, 2009 from Thengapatnam estuary and Binushma *et al*. (2010) in Ashtamudi estuary. Temperature between seasons were significant at 1% level (F=56.333).

The sediment pH of study area varied from 5.9 (July 2009) to 7.8 (June, November and December 2009) (Fig.3). Sediment pH at station I ranged from 7.3 (January 2010) to 7.8 (June, November and December 2009). The sediment pH at station II was high (7.4) during May and December 2009 and low (5.9) during July 2009. Maximum value of sediment pH recorded at station III was 7.5 in August and December 2009 and it was minimum

Table 1. Seasonal variation of sediment temperature (°C), pH, organic carbon (%) in the sediments of Thekkumbhagom kayal.

	Station 1			Station 2			Station 3			Station 4			Station 5		
Month	Temp	pH	oc	Temp	pH	oc	Temp	pH	oc	Temp	pH	oc	Temp	pH	oc
							Pre Monsoon								
Feb-09	29	7.4	0.43	29	7.2	1.66	29	6.4	1.58	29	6.6	3.2	29	7.4	0.8
March	30	7.5	0.42	29	6.7	0.36	29	6.8	1.65	29	7.5	0.76	29	6.8	0.56
April	29	7.7	0.47	31	6.8	0.68	28	7.1	0.8	28	7.7	0.86	28	7.1	0.21
May	29	7.7	0.43	29	7.4	0.29	28	6.9	2.33	28	6.6	1.8	28	6.4	0.38
Mean	29.25	7.575	0.4375	29.5	7.025	0.7475	28.5	6.8	1.59	28.5	7.1	1.655	28.5	6.925	0.4875
							Monsoon								
Jun	27	7.8	0.47	27	7.2	1.4	26	7.2	1.85	26	7.4	1.72	26	7.2	1.62
Jul	27	7.4	0.29	27	5.9	0.36	27	7.2	1.7	27	7.1	2.1	27	7.1	1.22
Aug	27	7.6	1.1	27	7.1	0.61	27	7.5	2.1	27	6.6	1.04	27	6.6	2.7
Sep	27	7.4	0.86	28	7.1	1.2	28	7.4	1.9	28	6.7	0.96	27	7.1	1.34
Mean	27	7.55	0.68	27.25	6.825	0.8925	27	7.325	1.8875	27	6.95	1.455	26.75	7	1.72
							Post Monsoon								
Oct	28	7.5	0.42	28	7.1	0.32	28	6.8	1.6	28	6.8	1.26	27	7.2	1.78
Nov	27	7.8	1.1	27	7.1	0.5	27	7.3	1.8	27	7.2	0.56	27	7.5	1.82
Dec	27	7.8	0.8	27	7.4	1.5	27	7.5	1.76	27	7.4	1.72	27	6.8	0.56
Jan-10	28	7.3	0.47	27	6.9	1.05	28	7.2	1.62	27	6.7	1.61	27	7.6	0.3
Mean	27.5	7.6	0.6975	27.25	7.125	0.8425	27.5	7.2	1.695	27.25	7.025	1.2875	27	7.275	1.115

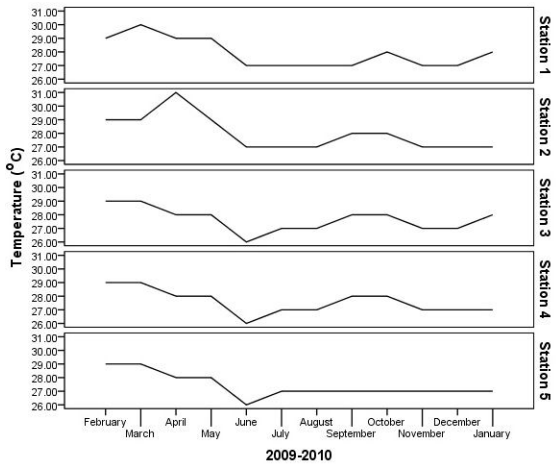

Fig. 2. Monthly variation in sediment temperature

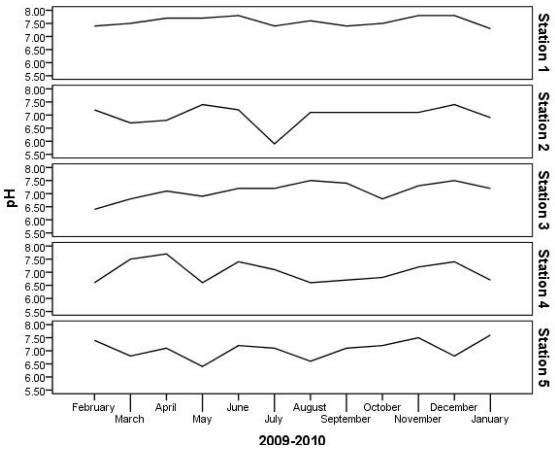

Fig. 3. Monthly variation in sediment pH

Table 2. Seasonal variation of sand (%), silt (%) and clay (%) in the sediments of Thekkumbhagom kayal.

	Station 1			Station 2			Station 3			Station 4			Station 5		
Month	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
Pre Monsoon															
Feb-09	58	31.8	10.2	61	28.7	10.3	69	20.6	10.4	63	26.9	10.1	65	24.8	10.2
March	61	28.7	10.3	66	23.9	10.1	65	24.8	10.2	68	21.6	10.4	65	24.4	10.6
April	63	26.7	10.3	65	24.9	10.1	64	25.5	10.5	68	21.7	10.3	56	33.6	10.4
May	63	26.8	10.2	64	25.8	10.2	63	26.7	10.3	65	24.9	10.1	64	25.6	10.4
Mean	61.25	28.5	10.25	64	25.825	10.175	65.25	24.4	10.35	66	23.775	10.225	62.5	27.1	10.4
Monsoon															
Jun	70	19.6	10.4	70	19.8	10.2	72	17.7	10.3	69	20.6	10.4	71	18.8	10.2
Jul	72	17.6	10.4	68	21.6	10.4	68	21.7	10.3	68	21.6	10.4	71	18.6	10.4
Aug	70	19.7	10.3	68	21.8	10.2	73	16.8	10.2	68	21.8	10.2	67	22.9	10
Sep	68	21.8	10.2	66	23.9	10.1	71	18.9	10.1	65	24.7	10.3	67	22.8	10.2
Mean	70	19.675	10.325	68	21.775	10.125	71	18.775	10.125	67.5	22.175	10.325	69	20.775	10.2
Post Monsoon															
Oct	65	24.7	10.3	63	26.7	10.3	70	19.8	10.2	71	18.9	10.1	66	23.8	10.2
Nov	71	18.8	10.2	62	27.9	10.1	65	24.9	10.1	70	19.7	10.3	64	25.7	10.3
Dec	71	18.6	10.4	72	17.8	10.2	65	24.7	10.3	63	26.9	10.1	70	19.9	10.1
Jan-10	64	25.7	10.3	65	24.9	10.1	75	14.8	10.2	68	21.9	10.1	62	27.8	10.2
Mean	67.75	21.95	10.3	65.5	24.325	10.175	68.75	21.05	10.2	68	21.85	10.15	65.5	24.3	10.2

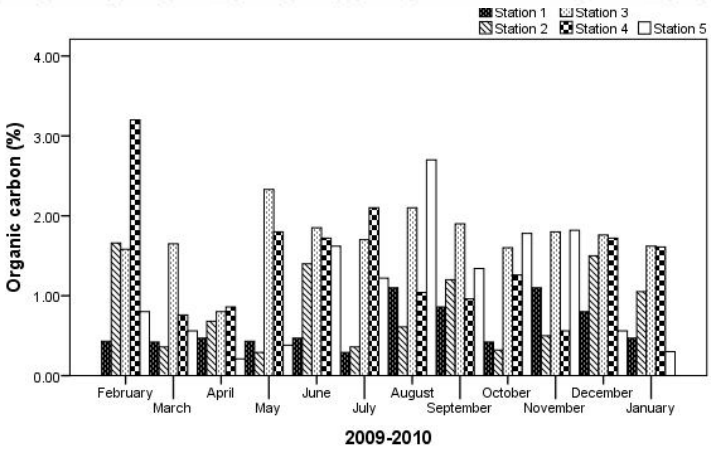

Fig. 4. Monthly variation in sediment Organic carbon

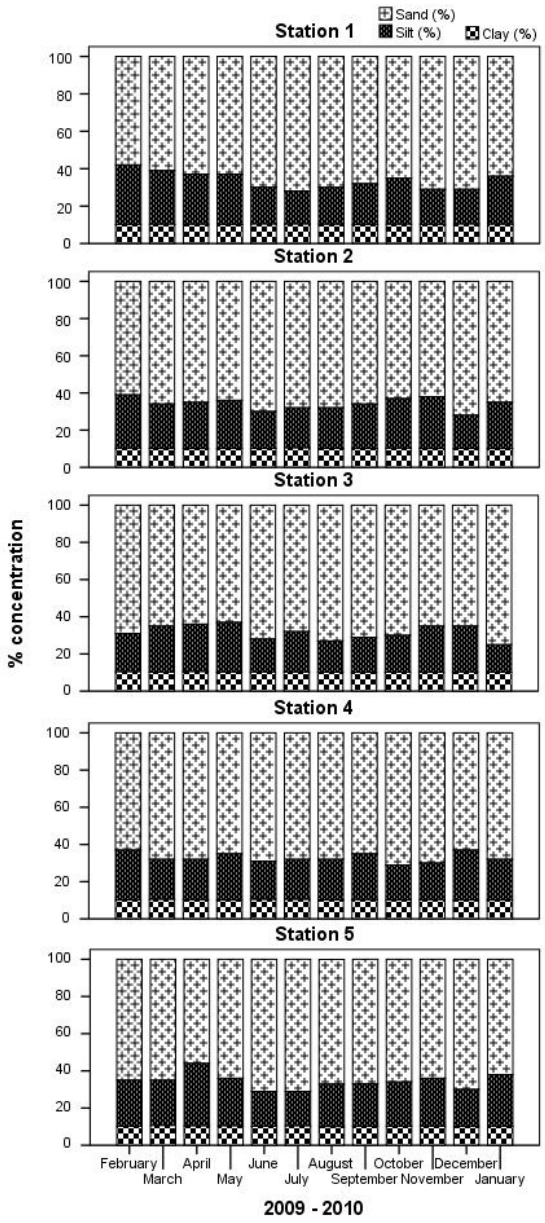

Fig. 5. Monthly variation in sand, silt and clay

(6.4) in February 2009. Highest sediment pH value registered at station IV was 7.7 (April 2009) and the lowest (6.6) in February, May and August 2009. At station V the sediment pH was high (7.6) during January 2010 and low (6.4) during May 2009. The major factors governing the pH of soil include the concentration of reduced metals like iron, manganese as well as carbonates, carbonic acid and humic acid (Patrick and Mikkelsen, 1974). Soil pH showed higher and lower values during the monsoon season. Nasnolkar *et al*. (1996) opined the utilization and release of dissolved oxygen by photosynthesis and respiration respectively affects the pH of estuarine water indirectly and play an important role in the recycling of nutrients between water and sediment in brackishwater ponds. Similar observations were reported by Binushma *et al*. (2010). pH between stations were significant at 1% level (ANOVA: DF=4, F=5.685).

The organic carbon content within the Kayal varied from 3.2% (February 2009) at station IV to 0.21% (April 2009) at station V (Fig.4). The maximum concentration of organic carbon (1.1%) was recorded in August and November 2009 at station I where as the minimum of 0.29% was found in July 2009. At station II the highest organic carbon content (1.66%) was observed in February 2009 and the lowest (0.29%) in May 2009. At station III high value of organic carbon content (2.33%) was registered in May 2009 and low value (0.8%) during April 2009. At station IV organic carbon ranged between 0.56% in November 2009 and 3.2% in February 2009. At station V high organic carbon content (2.7%) in August 2009 and low (0.21%) in April 2009. The high organic carbon noticed during premonsoon may be the result of dredging activities. High oxygen content, high temperature and shallowness of the system seems to favour the oxidation of organic matter in sediments (Murthy and Veerayya, 1972) which agrees the present result. The organic carbon between stations were significant at 1% level. (ANOVA: DF=4, F= 8.128).

The sand content in the study area varied from 56% (April 2009) to 75% (January 2010) (Fig.5). The sand content at station I ranged from 58% (February 2009) to 72% (July 2009). The sand content at station II was high (72%) during December 2009 and low (61%) during February 2009. Maximum value of sand recorded at station III was (75%) in January 2010 and it was minimum (63%) in February 2009 and December 2009. The highest sand content registered at station IV was

71% (October 2009) and lowest 63% (February and December 2009). At station V the sand was high (71%) during June and July 2009 and low (56%) during April 2009. In the present study the percentage composition of sand in sediment was higher during monsoon and postmonsoon season and lower during premonsoon. This higher value may be due to the activity of the monsoonal flood, which is in agreement with the reports of Sesamal *et al*. (1986) from Diamond harbour and Sagar Island, Bragadeeswaran *et al*. (2007) from Arasalar estuary and Rajasegar *et al*. (2002) from Vellar estuary. Sand between seasons were significant at 1% level (F=15.098).

The silt content within the Thekkumbhagom Kayal varied from 33.6% (April 2009) at station IV to 14.8% (January 2010) at station III (Fig.5). The maximum silt content recorded at station I was 31.8% (February 2009) to 17.6% (July 2009). At station II the highest silt content (28.7%) was observed in February 2009 and lowest (17.8%) was observed in December 2009. At station III the highest silt content (26.7%) was observed in May 2009 and lowest (14.8%) was observed in January 2010. At station IV high silt content was (26.9%) recorded from (February and December 2009) and low (18.9%) from October 2009. At station V high silt content (33.6%) was observed during April 2009 and low (18.6%) during July 2009. Silt between seasons were significant at 1% level (F=14.813).

The clay content in the study area varied from 10 (August 2009) to 10.6 (March 2009) (Fig.5). The clay content at station I ranged from 10.2 (February, May, September and November 2009) to 10.4 (June, July and December 2009). The clay content at station II was high (10.4) during July 2009 and low (10.1) during March, April, September, November 2009 and January 2010). Maximum value of clay recorded at station III was (10.5) in April 2009 and it was minimum (10.1) in September and November 2009. The highest clay content registered at station IV was 10.4 (March, June and July 2009) and lowest 10.1 (February, May, October, December 2009 and January 2010). At station V the sand was high (10.6) during March 2009 and low (10) during August 2009. Higher clay was recorded during premonsoon season and lower during monsoon and postmonsoon season. The higher value during premonsoon season may be due to the fluctuations and settling of finer fractions and at higher saline conditions the clay and colloidal particles are neutralized and are drawn together into larger particles, which could settle faster than individual charged particle (Rajasegar *et al*., 2002).

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