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Nutrient Distribution of Core Sediments in the mangroves of Manakudy estuary, Southwest coast of India

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Abstract

Mangrove sediments play a pivotal role in the nutrient biogeochemical processes by behaving as both source and sink for nutrients and other materials. Core sediments were collected from various location of the Manakudy mangrove and analyzed for nutrients organic carbon and calcium carbonate. Spatial distribution of nutrients is controlled by the external and internal loadings.

Keywords: Estuary, mangrove, nutrients, $CaCO_3$ and sulphur.

Introduction

The mangrove ecosystems are highly productive intertidal forests distributed along the tropical coast and they stabilize the coastal zone from erosion and act as a buffer zone between land and sea. The mangrove environment offers an ideal experimental site to study a number of biogeochemical, hydrogeochemical and hydrological processes. Generally, the mangrove sediments are reducing in nature[1,2] and contain high amounts of organic matter and ammonia[3]. The mangrove ecosystems, therefore, supply a substantially larger amount of carbon to the coastal waters than the rivers and influence the global biogeochemical cycling of nutrients. Recent estimates show that as much as 11% of the total organic carbon across the land-ocean interface in the tropics is of mangrove origin which explains that the carbon fixed by mangrove is potentially significant in the carbon biogeochemistry of the coastal zone[4]. Thus the mangrove ecosystem is generally regarded as both a sink for nutrients and dissolved minerals and source of organic matter[5]. Core sediments provide useful information on the changes in the quality of the estuary from a past period. Sediment core contain information about the events that occurred in precultural time in the estuary and its catchment area.

Description of study area: Manakudy estuary which has an area of about 150 ha is situated about 8 kilometers northwest of cape comorin in Kanyakumari District. It is the confluence of river pazhayar, which has its origin from the western ghats. The Manakudy estuary is abound with varied habitats that include shallow open waters, sandy beaches, muddy flats, mangrove forest, river delta and sea grass. Mangroves are a significant ecosystem in the estuary with a luxuriant growth on the mud flats. The litter on the mangrove floor undergo humification and mineralisation and the nutrients are leached into the estuarine water due to surface run-off adding to the productivity of the estuary. To study the flux of nutrients seven stations were selected around the mangrove forest.

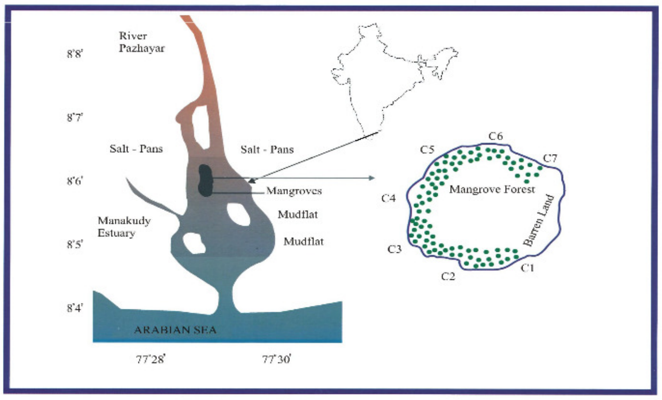


Figure-1
Location of the study area

Material and Methods

Core collection: Sediment core samples were collected at seven stations (C1,C2,C3,C4,C5,C6,C7) along the course of the estuary around the mangroves. A PVC coring tube (7.5 cm diameter and 1 m length), precleaned with water was used for the collection of core samples. The PVC tube was driven into the sediment until about 80 cm of the pipe, and the remainder remained above the ground and the rest was filled with ambient water on the top. The PVC tube was closed using a plumber`s dummy and it was sealed and pulled out from the sediment. The water on the top was then decanted and the pipe was just cut off above the top of the cored sediment and subsamples were obtained at definite intervals by cutting the core samples. Organic carbon (OC) was determined by exothermic heating and oxidation with potassium chromate and concentrated sulphuric acid followed by titration of excess dichromate with 0.5N ferrous ammonium sulphate solution[6]. Calcium carbonate was determined followed the procedure of Loring and Rantala[7]. Sulphur was estimated gravimetrically. Nitrogen was determined by Kjeldahl's method.Phosphorous was determined by Olsen's method.

Results and Discussion

Nutrients, Organic carbon and $CaCO_3$: In all the core samples, Nitrogen was maximum at the depth of 2.5 cm and progressively decreases in relation to increasing depth. Phosphorous was maximum in higher depth and lower at the depth of 2.5 cm. OC was relatively higher at a depth of 2.5cm and $CaCO_3$ was maximum at the depth of 2.5 cm and lower in higher depth (table-1-7).

Table-1
Nutrients, Organic carbon and Calcium carbonate of Station 1 (C1)

Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	220.5	58.92	1.123	1.13	17.5
7.5	219.25	59.92	0.272	1.15	12.3
12.5	217.5	60.71	0.173	1.01	11.5
17.5	217.25	61.16	0.272	1.24	11.4
22.5	211.75	65.62	0.272	1.17	11.5
27.5	210.25	64.73	0.272	1.35	12.5
32.5	209.5	60.71	0.297	1.63	10.5
37.5	209.5	63.39	0.347	1.22	12.5
Average	214.44	61.77	0.379	1.24	12.5
Min	209.5	61.9	0.123	1.01	10.5
Max	220.5	65.62	1.123	1.63	17.5

Table-2
Nutrients, Organic carbon and Calcium carbonate of Station 2 (C2)

Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	216.3	53.82	0.956	1.26	16
7.5	215.5	58.57	0.281	1.94	15
12.5	214.5	58.48	0.718	1.68	14
17.5	213.3	66.07	0.531	1.48	14
22.5	211.8	66.51	0.625	1.85	13.5
27.5	208.5	66.51	0.406	1.35	13.5
32.5	202.8	67.41	0.781	1.6	13.5
37.5	201.3	67.85	0.439	1.74	14
Average	210.5	63.15	0.59	1.61	14.2
Min	201.3	53.82	0.281	1.26	13.5
Max	216.3	67.85	0.956	1.94	16

Pearson Correlation: From the correlation table-8, in all the core sediments organic carbon was positively correlated with organic matter at 0.01 level. In C1 Calcium carbonate was positively correlated with OC, OM and Sulphur at 0.05 level. In C2 Calcium carbonate was negatively correlated with OC and OM but OM was positively correlated with Sulphur. In C3 Calcium carbonate was positively correlated with OC and OM at 0.01 level. In C5 Calcium carbonate was positively correlated with sulphur at 0.05 level. In C6 Calcium carbonate was negatively correlated with OC and OM at 0.05 level. In C7 Calcium carbonate was negatively correlated with OC and OM at 0.01 level and Sulphur at 0.05 level.

Table-3
Nutrients, Organic carbon and Calcium carbonate of Station 3 (C3)

Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	221.3	68.5	1.847	1.24	9.5
7.5	211.3	70.53	0.694	1.19	6
12.5	209.1	77.23	0.669	0.35	5
17.5	220	74.55	0.719	0.74	6
22.5	198.8	73.21	0.842	1.22	7.5
27.5	203.8	76.78	1.438	0.89	7.5
32.5	202.5	76.23	1.324	1.07	7.7
37.5	203.1	76.5	1.056	1.12	7.3
Average	208.7	74.19	1.074	0.98	7.1
Min	198.8	68.5	0.669	0.35	5
Max	221.3	77.23	1.847	1.24	9.5

Table-4
Nutrients, Organic carbon and Calcium carbonate of Station 4 (C4)

Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	213.8	63.39	1.53	1.61	12.5
7.5	211.3	66.07	0.71	1.79	10.5
12.5	197.5	67.85	0.78	1.01	10.5
17.5	183.8	65.62	0.893	1.57	10.5
22.5	161.3	65.17	0.687	1.7	8.5
27.5	163.8	66.51	1.031	1.85	5.5
32.5	163.1	66.43	1.213	1.56	4.7
37.5	162.6	67.32	1.086	1.64	5.1
Average	182.1	66.05	0.991	1.59	8.5
Min	161.3	63.39	0.687	1.01	4.7
Max	213.8	67.85	1.53	1.85	12.5

Table-5
Nutrients, Organic carbon and Calcium carbonate of Station 5 (C5)

Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	193.8	53.12	1.197	1.7	7.5
7.5	185	54.46	0.872	1.31	2
12.5	191.3	59.82	0.245	0.67	2
17.5	190	63.39	0.773	0.91	3
22.5	191.3	65.62	0.917	1.74	3.5
27.5	188.2	65.8	0.986	1.82	3.2
32.5	191.4	60.5	0.856	1.67	2.9
37.5	190.5	64.6	0.846	1.76	3.1
Average	190.2	60.91	0.837	1.45	3.4
Min	185	53.12	0.245	0.67	2
Max	193.8	65.8	1.197	1.82	7.5

Table-6
Nutrients, Organic carbon and Calcium carbonate of Station 6 (C6)

Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	198.8	55.91	1.533	1.69	4
7.5	186.3	57.91	0.397	1.94	3
12.5	190	58.48	0.581	2.15	3
17.5	191.3	56.69	0.765	1.93	3
22.5	192.5	57.14	1.408	1.76	2
27.5	188.8	58.23	1.345	1.82	2.5
32.5	190.6	57.84	1.248	1.78	2.2
37.5	191.4	59.52	1.396	2.01	2.9
Average	191.2	57.72	1.084	1.89	2.8
Min	186.3	55.91	0.397	1.69	2
Max	198.8	59.52	1.533	2.15	4

Table-7
Nutrients, Organic carbon and Calcium carbonate of Station 7 (C7)

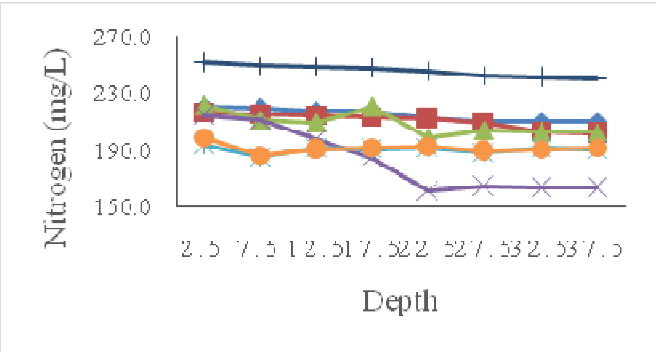
Depth (cm)	N (mg/L)	P (mg/L)	OC (%)	S (%)	$CaCO_3$ (%)
2.5	251.5	43.3	0.945	1.8	13
7.5	249.8	43.75	0.489	1.68	11.5
12.5	248.5	50.89	0.765	1.96	11.5
17.5	247.3	48.66	0.734	1.71	11
22.5	245.5	50.89	0.489	1.87	11
27.5	242.8	51.78	0.612	2.13	11
32.5	241.3	54.46	0.642	1.76	5.5
37.5	240.5	53.57	0.765	2.11	5
Average	245.9	49.66	0.680	1.88	9.9
Min	240.5	43.3	0.489	1.68	5
Max	251.5	54.46	0.945	2.13	13

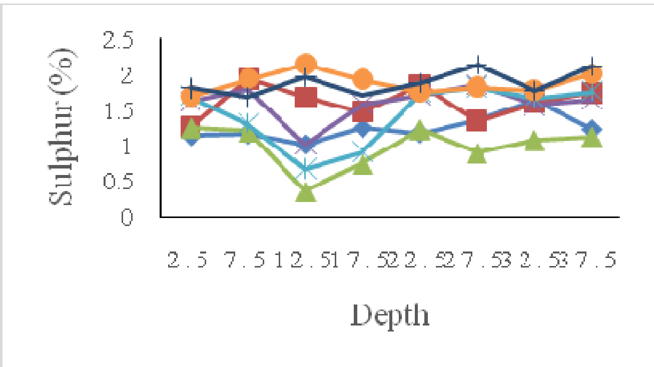
Table-8
Correlation between calcium carbonate, organic carbon, organic matter, and sulphur in C1, C2, C3, C4, C5, C6 and C7 core sample

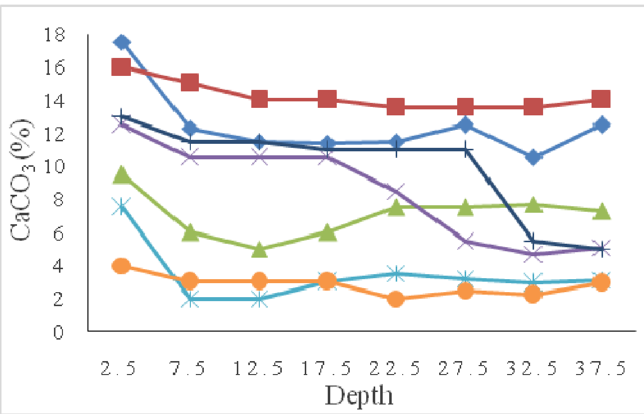
C1	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	0.573*	1		
Organic matter	0.571*	1.000**	1	
Sulphur	0.510*	0.264	0.262	1
C2	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	-0.487*	1		
Organic matter	-0.487*	1.000**	1	
Sulphur	-0.389	0.515*	0.515*	1
C3	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	0.791**	1		
Organic matter	0.791**	1.000**	1	
Sulphur	-0.312	-0.275	-0.274	1
C4	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	-0.317	1		
Organic matter	-0.324	0.998**	1	
Sulphur	-0.191	-0.387	-0.384	1
C5	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	0.057	1		
Organic matter	0.054	1.000**	1	
Sulphur	0.694*	0.277	0.273	1
C6	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	-0.745*	1		
Organic matter	-0.745*	1.000**	1	
Sulphur	0.448	-0.382	-0.382	1
C7	**Calcium carbonate**	**Organic carbon**	**Organic matter**	**Sulphur**
Calcium carbonate	1			
Organic carbon	-0.792**	1		
Organic matter	-0.792**	1.000**	1	
Sulphur	-0.525*	0.615**	0.614**	1

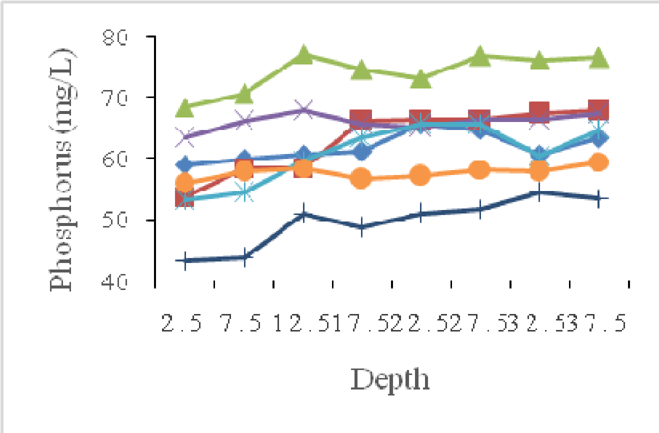
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

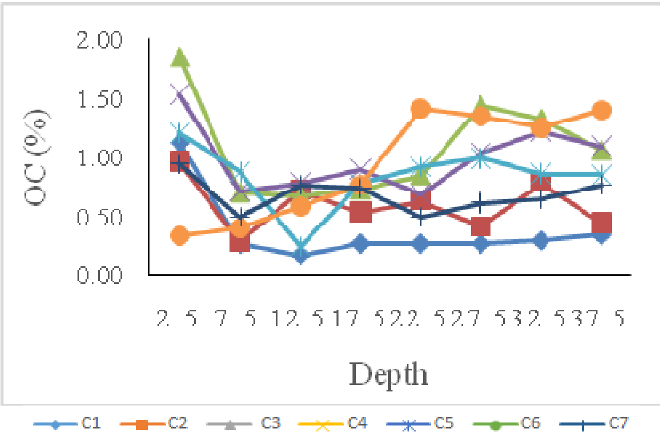
Nutrients in core sediments: The vertical distribution of nutrients in the mangrove core sediment is shown in figure 1. In all the core sediments C1, C2, C3, C4, C5, C6, and C7, the high levels of nitrogen at the surface are due to the direct input of nitrate compounds from external sources mainly from the aquaculture effluents, agricultural runoff and domestic sewage[8,9,10]. The low level of nitrogen with depth may be because of less nitrification and degradation of organic nitrogen compounds into inorganic form[3]. Mangrove soils are expected to contain high amount of phosphorous at the surface because of high amounts of organic matter[11,12]. But most of the available phosphorous is quenched by Ca, Fe, and Al and forms phosphates thus making it unavailable for biological systems. Increasing phosphorous with depth may be because of anoxia and sequestration of P, this is again redox sensitive[13]. In all the core sediments phosphorous was increasing with depth. High level of organic carbon at the surface was because of recent accumulation from the adjacent non-point sources like agricultural fields and mangrove litter[14]. High level of sulphur was observed in the deeper sections of the core. Sulphur dynamics in the anoxic mangrove sediments was largely driven by the sulphate reducers. In this mangrove, the activity of sulphate reducers was highbelow 17.5cm from the surface.

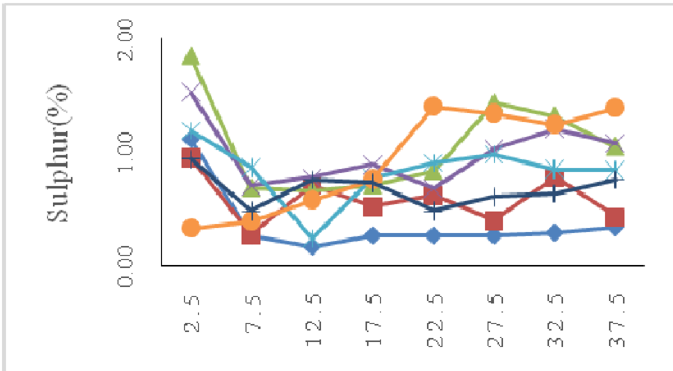












Figure–2
Vertical distribution of Nitrogen, Phosphorous, Organic carbon and Sulphur in core sediments.

Conclusion

The results of the sedimentological study indicate that in the Manakudy mangrove core sediments sand is the major fraction. Vertical variability of nutrients in the core sediments largely depends upon the microbial activities in sediments. Nitrogen was high in surface due to the direct input of nitrate compounds. OC was high in surface because of the recent accumulation from the non-point sources. P was increasing with depth. And sulphur concentration in the deep core sediments are high compared to the surface and are largely controlled by the sulphate reducers.

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