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Sediment texture and nutrients of Arasalar estuary, Karaikkal, south-east coast of India

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Abstract: *Sediment samples were collected for texture, composition and nutrient such as organic carbon, total nitrogen and total phosphorus for a period of two years from three stations in Arasalar estuary. The sediment temperature, pH and nutrients were higher during summer season and lower during monsoon season. At station 1, sediment texture was loamy sand during summer and premonsoon season. At station 2, clay type soil was recorded. Whereas, at station 3, clay was observed in summer and premonsoon and then it shifted to sandy loam type soil during monsoon. Sediment nutrients were lower than that of values of various ecosystem of India.*

Key words: *Sediment texture, Temperature, pH, Nutrient, Estuary*

Introduction

Estuarine sediments and waters are characterized by specific and complex physical, chemical and microbiological properties. These properties depend and interact with each other and collectively constitute a unique environment to the organism. The study of sediments represents a useful tool for determining the actual state of environmental pollution of a water body.

It is well recognized that the primary productivity in shallow marine environment depends on nutrients economy which is known to be governed by the sediment nutrient level. Knowledge on the role of sediments in this is useful in determining the sediment water interactions which eventually affect the productivity of the overlying water body (Venkatasamy Reddy and Hariharan, 1986). The three important elements carbon, nitrogen and phosphorus are underlying various biogeochemical processes, which affect the productivity of the ecosystem (Ghosh and Choudhury, 1989). Nitrogen is probably the major regulatory nutritional factor in most detrital based system (Tennore, 1981). The physicochemical character of sediments regulates the type of food, feeding and other life activities of benthic forms to a great extent. (Ramachandra *et al.,* 1984). The variability of freshwater discharge at the upstream boundary is a major control on sediment concentration and transport (Schubel and Prichard, 1986; Sharp *et al.,* 1986; William, 1989; Rajasegar *et al*., 2002).

Many studies have been carried out so far on sediment nutrients from various estuaries of India (Remani *et al.,* 1980; Murthy and Veerayya, 1981; Sivakumar *et al.,* 1983; Sesamal *et al.,*1986; Nair *et al*., 1987; Satyanarayana *et al.,* 1993; Seralathan *et al.,* 1993 ; Rajasegar *et al.,* 2002). The present study is carried out on the seasonal composition, texture and distribution of organic carbon, nitrogen and phosphorus of sediments in the Arasalar estuary. Study will be a useful tool for future ecological assessment and monitoring of this estuary. Further, it is learnt that the Government of Pondicherry has proposed to construct a fishing harbour in the Arasalar estuary. Therefore, the observations will be more useful to monitor the possible ecobiological changes resulting during and after the construction of fishing harbour.

Materials and Methods

Monthyly sedement samples were collected from three stations (Fig. 1) in Arasalar estuary (10°55' N; 79°05') for a period of two years from June, 1999 to May, 2001 using a Peterson grab of size 0.08m^2. Station 1 is situated near the mouth of the estuary with average depth 3m and Station 2 is situated 1 km away from the station 1 with average depth 2.5m. Station 3 is situated 2 km away from the station 2 with average depth 4 m. Sample was taken to the laboratory in clean plastic bags. Soil pH was recoreded by pH meter (Hanna Instruments, Mauritius). The sediment temperature was recorded by inserting the thermometer just below the surface of the sediment. The percentage composition of sand, silt and clay were determined by combined sieving and pipette method as described by Krumbein and Pettijohn (1938). The sediment texture was analysed by Brady (1995) method. Total organic carbon content of sediment was detemined by the method of El-Wakeel and Riley (1956). Total nitrogen in the sediment was estimated by Kjeldahl method as out lined by Barnes (1959) and total phosphorus was determined by the method described by Rochford (1951). Correlation values were calculated and significance level was computed by the methods of Fisher and Yates (1963).

Results and Discussion

The range, mean and standard deviation with standard error values of temperature, pH, sediment composition, total organic carbon, total nitrogen and total phosphorus are given in Table 1.

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Table - 1: The range, mean, standard deviation with standard error values of sediment characters recorded from station 1, 2 and 3 of Vellar estuary during June, 1999 to May, 2001

Sediment characters		Station 1			Station 2			Station 3		
		Range	Mean	Standard deviation	Range	Mean	Standard deviation	Range	Mean	Standard deviation
Temperature										
(°C)	1st Year	26.5-31.2	28.35	1.42 ±0.41	24.4-31.2	27.62	2.56 ±0.73	24.0-31.0	27.85	2.30 ±0.66
	2nd Year	27.0-30.7	28.5	1.32 ±0.38	26.5-31.0	28.7	1.63 ±0.47	23.0-30.8	27.72	2.94 ±0.84
pH	1st Year	7.5-8.3	7.70	0.25 ±0.07	7.1-8.1	7.6	0.32 ±0.09	7.2-8.1	7.63	0.31 ± 0.09
	2nd Year	7.2-8.2	7.75	0.36 ±0.10	7.2-8.3	7.7	0.35 ±0.10	7.3-8.2	7.70	0.26 ± 0.07
Sand	1st Year	70.2-90.3	80.38	5.82 ±1.68	30.9-85.1	53.83	18.7 ±5.39	21.3-70.6	39.60	17.41±5.02
(%)	2nd Year	73.2-89.98	80.5	5.06 ±1.46	32.5-80.7	51.21	18.8 ±5.27	23.4-70.3	43.31	20.47±5.91
Silt	1st Year	7.2-15.5	10.57	2.73 ±0.78	4.5-18.9	12.42	4.24 ±1.22	15.3-31.8	20.78	5.10 ±1.47
(%)	2nd Year	5.8-16.2	10.4	3.05 ±0.88	7.9-22.6	13.95	4.47 ±1.29	13.7-32.9	22.73	5.98 ±1.72
Clay	1st Year	2.1-14.3	9.04	3.74 ±1.07	9.1-50.2	33.73	14.8 ±4.25	7.6-58.3	40.28	18.64±5.38
(%)	2nd Year	3.3-12.4	9.10	2.50 ±0.72	8.5-49.5	4.85	16.7 ±4.72	6.6-57.1	34.1	18.92±5.46
Carbon	1st Year	1.21-9.5	5.34	3.27 ±0.94	1.45-16.62	7.57	5.96 ±1.72	1.83-17.32	8.51	6.20±1.79
(mg/g)	2nd Year	11.72-8.5	5.26	2.37 ±0.68	1.57-13.8	7.48	4.18 ±1.20	1.4-16.38	11.02	3.93±1.13
Nitrogen	1st Year	0.95-7.45	3.37	2.07±0.59	0.18-4.85	2.96	1.35 ±0.39	0.35-4.9	2.41	1.42 ±0.41
(mg/g)	2nd Year	0.90-6.33	2.83	1.44 ±0.41	0.19-4.72	2.95	1.62 ±0.46	50.35-4.85	2.75	1.35 ±0.39
Phosphorus	1st Year	0.02-0.19	0.08	0.06±0.01	0.04-0.30	0.17	0.08 ±0.02	0.34-0.42	0.18	0.10 ±0.03
(mg/g)	2nd Year	0.03-0.25	0.07	0.07±0.02	0.04-0.42	0.17	0.10 ±0.03	0.04-0.25	0.13	0.07 ±0.02

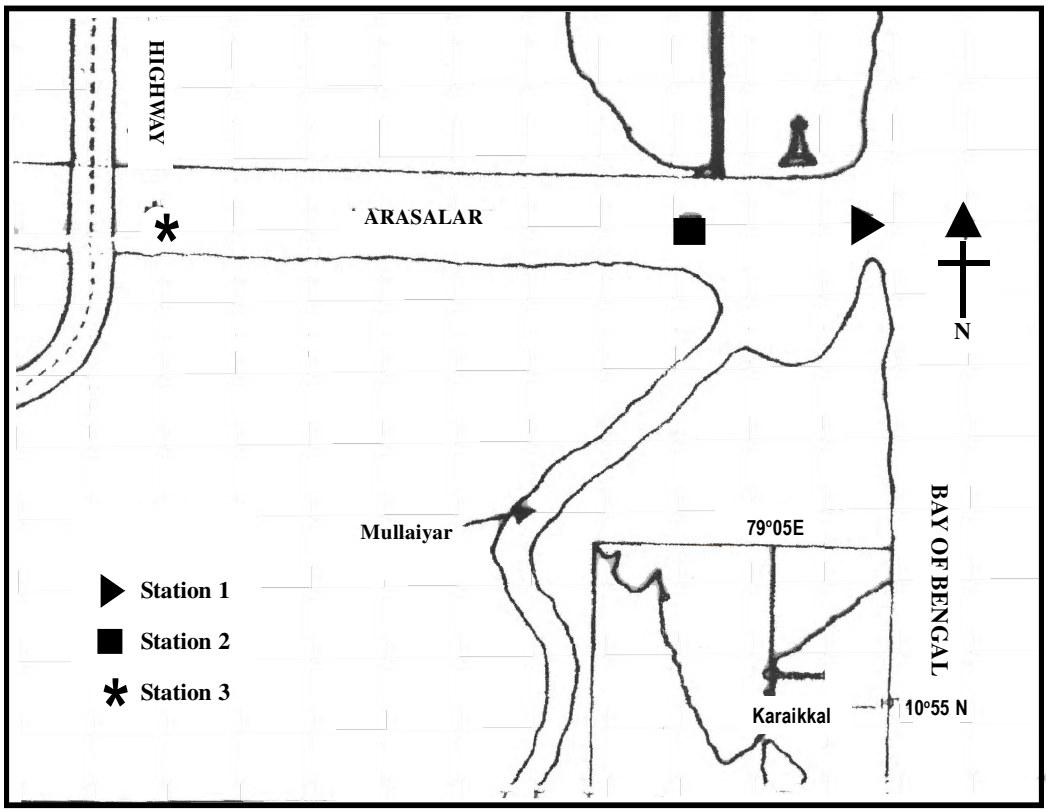

Fig. 1: Map showing the study area

In the present study sediment temperature was high during summer. Low temperature was recorded during monsoon season This could be due to ocean's large thermal inertia, which causes a lag between absorption and subsequent release of solar energy to the atmosphere (Varadhachari *et al*., 1987) during summer season 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.

The pH of the sediment was high during monsoon season. Low pH was recorded during premonsoon and monsoon respectively. Higher value during summer was due to a course of the redox changes in the sediment and water column apart from the influence of fresh water (Rajasegar *et al.,* 2002). The lower values of pH recorded during monsoon was due to inflow of fresh water. The pH of all the stations indicated the alkaline nature of the stations, which lie adjacent to the sea and influenced by influx of neritic waters during tidal cycle.

The sediment distribution in estuaries and near shore region to a large extent depends on the source and texture of sediments supplied and topographic features of the concerned area. (Sesamal *et al.,* 1986). In the present study, the percentage composition of sand in sediment was higher during monsoon season. This higher value may be attributed to the winnow activity of the monsoonal flood, which is affinity with the reports of Sesamal *et al.* (1986) from Diamond harbour and Sagar island and Rajasegar *et al*. (2002) from Vellar estuary.

Higher clay content was recorded during the post monsoon and summer and lower level recorded during monsoon. The higher value during summer 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).

The sediment texture showed variation due to the winnow activity of monsoonal floods and the sedimentation process occurring in higher saline conditions by flocculation. Sediment texture noticed at station 1 was loamy sand and at station 2 and 3 was clay in nature.

Total organic carbon in the sediment was high during summer season due to settling of decayed plant and animal wastes brought through municipal waste and adjacent agricultural field. The lower value recorded during monsoon might be due to incessant stirring up of the sediments releasing the organic carbon from the sediment to the water column. Further, the sediment was mainly composed of sand brought out by incessant flow of waters during monsoon season. Statistical analysis of the organic carbon showed negative correlation with sand ($r = (-) 0.62$; $p < 0.01$ at station 1; $r = (-) 0.61$; $p<0.01$ at station 2; $r = (-) 0.62$; $p<0.01$ at station 3; $n = 24$).

Higher organic carbon was recorded by number of workers from various environments. The higher value of carbon 24 mg/g was recorded by Sivakumar *et al.* (1983) from Vellar estuary, 33.77 mg/g of carbon was recorded by Nasnolkar *et al.* (1996) from Mandovi estuary, 74 mg/g of carbon recorded by Bijoy Nandan and Abdul Azis (1994) from Kadinamkulam estuary and lower total organic carbon (1.02 mg/g) was recorded by Sesamal *et al.* (1986) from Hooghly estuary than the present study.

The total nitrogen of sediments was higher during summer season due to the oxidation of dead plant organic matter, which has settled on the top layer. The lower value of total nitrogen during monsoon season may be accounted for the lower level of organic matter. Similar to that of total organic carbon, total nitrogen values were higher during summer and lower during monsoon. However it is evidenced by obtaining positive correlation between organic carbon and total nitrogen ($r=0.55$; $p<0.01$ at station 1; $r=0.72$; $p<0.01$ at station 2; $r=0.80$; $p<0.001$ at station 3; $n = 24$).

Total phosphorus in the sediment was high during summer season and low during monsoon season. The higher values were due to the dead organic matter settling from top and are related to the permeability of the sediments and the lower values may be due to the removal of top layer of sediments by heavy flood and deposition of sand. Further, it is evidenced by obtaining positive correlation between organic carbon and total phosphorus ($r=0.55$; $p<0.01$ at station 1; $r=0.84$; $p<0.001$ at station 2; $r=0.85$; $p<0.001$ at station 3; $n = 24$) .

The total phosphorus concentration was recorded from different region by many workers. 0.036 mg/g was recorded by Balasubrahmaniam (1961), 0.454 mg/g was recorded by Rajendran and Venugopalan (1973), 0.288 mg/g value was recorded by Sivakumar *et al.* (1983) and 0.264 mg/g was recorded by Rajasegar *et al. (*2002) from Vellar estuary.

Similarly total organic carbon, total nitrogen and the phosphorus values were also higher during summer and lower during monsoon. The total organic carbon, total nitrogen and total phosphorus values were lower than that of values of many workers recorded from various environments and this base line investigations of Arasalar estuary will be very useful for future studies pertaining to the assessment and monitoring of this estuary. Further it is learnt, that the Government of Pondicherry has a plan to construct a fishing harbor in this estuary. Therefore, the observation made and the results obtained in the present study will be very useful to predict the possible ecological changes in the estuary during and after the construction of the fishing harbor.

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