CHARACTERISTICS OF SEDIMENTS OF BATTICALOA LAGOON OF SRI LANKA DURING RAINY SEASON WITH SPECIAL REFERENCE TO TEXTURE AND ORGANIC MATTER

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Abstract: *This paper presents the results of a study on spatial variation of texture and organic matter content in bottom sediments of the Batticaloa Lagoon, Sri Lanka. Sediment samples from the Batticaloa Lagoon were collected at 25 different locations during the latter part of rainy season (January 2015 to February 2015) to assess the characteristics of texture and organic matter content in the lagoon bottom sediments. The texture analysis of sediments shows that sand was found to be the major contributor to the sediment texture of the lagoon bed. The average percentage of sand, silt and clay in the Batticaloa Lagoon sediment was 87%, 6% and 7% respectively. Average amount of organic matter in the sediment was found as 2.62%. Total organic matter showed significant positive correlation with silt (r=0.758) and clay (r = 0.775) but significant negative correlation with sand (r = -0.925). The values of organic matter content do not exceed the acceptable limits (2.56 – 3g per 100g). The present study results of sediments will be a baseline information and useful tool for future researchers for actual assessment of environmental pollution of this lagoon in terms of organic matter content and particle size.*

Keywords: *Batticaloa Lagoon, texture, sediment, total organic matter.*

1. INTRODUCTION

Sediment has an important role in the nutrient cycle of aquatic environments. In some cases, sediment is responsible for the transport of essential nutrients as well as pollutants. Most surficial sediments in water originate from surface erosion and contain mineral, bedrock erosion and organic components during the process of soil formation (Toriman, 2005). The organic compounds, which may originate naturally from vegetative decay or organic discharge from municipal and industrial sources, have a remarkable affinity and capacity to bind minerals. The decomposition of those organic matter releases total organic carbon into the water which finally accumulates in the sediments (Dejoux *et al*., 1981). High percentage of organic matter and/or small grains in sediments are generally associated with reduced heavy metal bioavailability and toxicity (Ankley *et al*., 1996). Texture also an important character that determines the presence of ion concentrations in the sediment. Sediment texture refers to the proportions of sand, silt and clay below 2000 micro meters (2mm) in diameter in a mass of sediment (Ivara *et al*., 1999). USEPA (2001) also defined that the sediment is the loose sand, silt and other soil particles that settle at the bottom of a body of water. Sediments with a high percentage of small grains, such as silt and clay, have high surface-to-volume ratios and can adsorb more heavy metals than sediments composed of large grains, such as sand (Bentivegna, 2004).

Lagoons are coastal brackish water bodies and are in connection with the sea permanently or seasonally (Smakhtin and Piyankarage, 2003). Coastal lagoons tend to accumulate sediments from inflowing rivers, runoff from the shores of the lagoon and from sediment carried into the lagoon through inlets by the tide. Large quantities of sediment may be occasionally being deposited in a lagoon when storm waves over wash barrier islands. Mangroves and marsh plants can facilitate the accumulation of sediment in a lagoon. Benthic organisms may stabilize or destabilize sediments (Silva *et al*., 2013). The Batticaloa Lagoon of Sri Lanka is a chocked lagoon of primary concern for its biodiversity, its habitats and its resource supply, which have been severely impacted by human activities. There are several factors affecting the sediment quality of the lagoon. Therefore, to develop an efficient management plan of the lagoon, it is very important to analyze the quality of the bottom sediment as an initial step. As there is no any information on the sediment quality of Batticaloa Lagoon the present study was conducted to assess the sediment texture and organic matter content as an initial step to make a comprehensive study about the bottom sediment of the Batticaloa Lagoon.

2. METHODOLOGY

2.1 Study Area

This study was conducted in Batticaloa Lagoon, that comprises Batticaloa and Ampara district belongs to Eastern province of Sri Lanka. The geographical coordinates of the Batticaloa Lagoon is 7°34′ N, 81°41′ E and surface area is 41.18 square kilometres and is 56 km long.

2.2 Sampling station

A total of twenty-five (25) different sampling points (Figure 1) were selected along the lagoon distance where runoff water accumulates in to the lagoon. This study was conducted during the latter part of the rainfall season (January 2015 to February 2015).

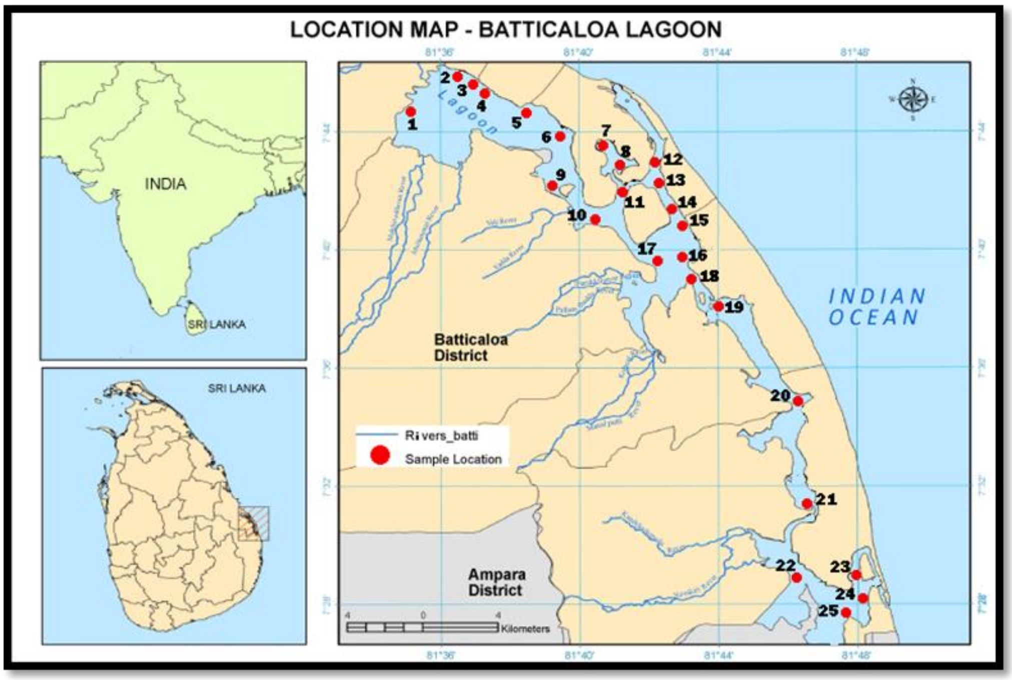

Figure 1: Sampling points at Batticaloa Lagoon

2.3 Sediment sample collection and laboratory analysis

Three replicate samples from the lagoon bed at the depth of 25 cm and volume of 125cm^3 sediments were randomly collected from each station using a core sampler, then the samples were placed into polyethylene bags to transfer the sample to the laboratory. At the laboratory, the sediment samples were air dried at room temperature in an open dust free environment. Organic debris and other unwanted materials which were floating on the lagoon water removed from the samples. The dried sediment samples were ground and sieved using 2mm sieve. Samples were then transferred into air tight polyethylene bags and stored for the purpose of further analysis. Walkley and Black Method was used to determine the total organic carbon content in sediment samples (Walkley and Black 1934) and sediment texture was analyzed by Mechanical analysis by pipette method that consisted of five major sub procedures.

2.4 Data analysis

The data and results of the laboratory test were further analyzed for descriptive statistics and correlation using Minitab 15 and Microsoft excel.

3. RESULTS AND DISCUSSION

Table 1 shows the sampling Locations with their sediment characteristics in terms of total organic matter and texture measurement.

Table 1: Texture and organic matter content of the lagoon bottom sediments collected at different locations

No	Location	GPS point		Total organic matter (%)				Particle size (%)		
		Latitude	longitude	R_1	R_2	R_3	Mean	Sand	Silt	Clay
1	Pankudahweli	N 07º44'12.7"	E 081º34'46.5"	2.27	2.52	2.81	2.53	91%	3%	6%
2	Eravur	N 07º46'16.1"	E 081º36'12.2"	2.57	2.59	2.61	2.59	86%	8%	6%
3	Mylampaweli	N 07º45'27.3"	E 081º37'29.2"	2.54	2.59	2.63	2.59	86%	8%	6%
4	Thannamunai	N 07º44'58.2"	E 081º38'36.8"	2.59	2.58	2.59	2.59	88%	4%	8%
5	Sathurukondan	N 07º44'19.4"	E 081º40'49.7"	2.52	2.66	2.69	2.62	85%	7%	8%
6	Pillayarady	N 07º43'57.3"	E 081º39'59.8"	2.60	2.63	2.65	2.63	85%	7%	8%
7	Urani	N 07º43'43.3"	E 081º40'49.7"	2.70	2.70	2.75	2.72	82%	10%	8%
8	Puliyanthivu	N 07º43'02.4"	E 081º41'39.3"	2.57	2.69	2.74	2.67	84%	12%	4%
9	Eachanthivu	N 07º42'06.5"	E 081º39'20.6"	2.63	2.47	2.36	2.49	95%	2%	3%
10	Kannankudah	N 07º40'51.8"	E 081º40'23.6"	2.47	2.60	2.80	2.62	85%	11%	4%
11	Thimilatheevu	N 07º41'26.2"	E 081º40'47.9"	2.51	2.57	2.61	2.56	89%	3%	8%
12	Navalady	N 07º45'19.5"	E 081º41'07.1"	2.59	2.55	2.54	2.56	90%	8%	2%
13	Kallady	N 07º43'15.7"	E 081º42'20.0"	2.66	2.90	3.12	2.89	77%	11%	12%
14	Nochimunai	N 07º42'06.5"	E 081º42'38.8"	2.51	2.54	2.56	2.54	90%	6%	4%
15	Kattankudy	N 07º40'34.7"	E 081º43'23.7"	2.52	2.52	2.53	2.52	91%	3%	6%
16	Arayampathy	N 07º39'47.6"	E 081º43'34.6"	2.58	2.59	2.60	2.59	87%	5%	8%
17	Mahiladithivu	N 07º39'26.1"	E 081º41'58.1"	2.58	2.57	2.57	2.57	89%	5%	6%
18	Manmunai	N 07º38'17.3"	E 081º43'53.6"	2.55	2.51	2.50	2.52	92%	2%	6%
19	Puthukudiyruppu	N 07º37'34.8"	E 081º45'08.1"	2.69	2.59	2.54	2.61	87%	7%	6%
20	Chettipalayam	N 07º34'37.9"	E 081º46'29.7"	2.94	2.82	2.80	2.85	81%	10%	9%
21	Paddiruppu	N 07º30'56.3"	E 081º46'51.9"	2.60	2.27	2.21	2.36	96%	2%	2%
22	Mandur	N 07º25'46.3"	E 081º47'30.6"	2.69	2.66	2.64	2.66	85%	7%	8%
23	Koddaikallar	N 07º29'03.1"	E 081º48'00.9"	2.90	2.69	2.52	2.70	84%	8%	8%
24	Periyakallar	N 07º28'27.8"	E 081º48'27.7"	2.60	2.94	2.96	2.83	76%	10%	14%
25	Thuraineelawanai	N 07º27'32.3"	E 081º47'59.1"	2.82	2.51	2.48	2.60	93%	3%	4%

(R_1, R_2, R_3: Replications)

3.1 Total Organic matter content in sediment sample

Table 2: Range and average of total organic matter in the sediment samples of the Batticaloa Lagoon

Parameter	Mean Range	Average
Organic matter (%)	2.36 – 2.89	2.62

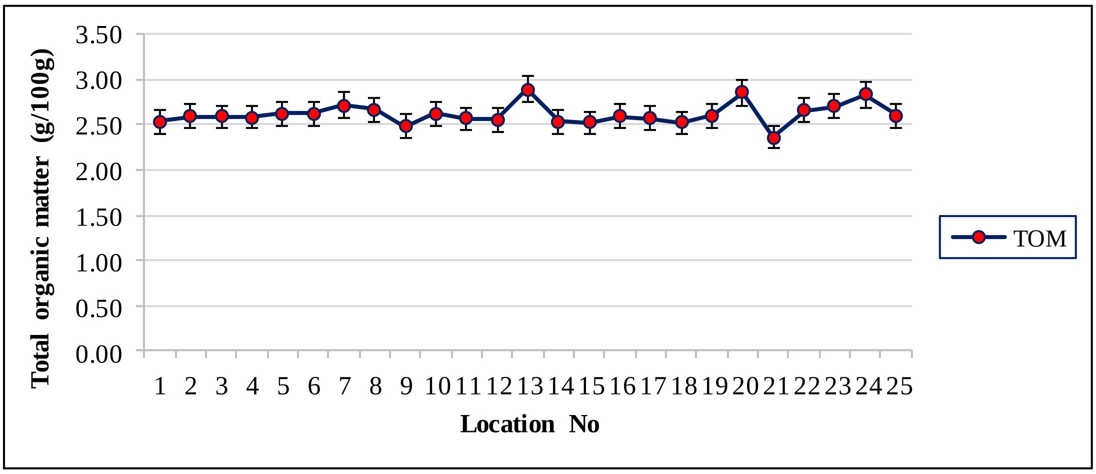

Figure 2: Spatial distribution of Mean Total organic matter + SE (5%) in the sediment samples of the Batticaloa Lagoon

Total organic matter content of the sediment samples of the Batticaloa Lagoon during rainy season is represented in table 2. The table 2 shows, the average total organic matter content in the sediment samples of the Batticaloa Lagoon was 2.62 g per 100g during rainy season. The highest and mean total organic matter in the sediment sample were found as 2.89g per 100g at location 13 (Kallady) whereas, the lowest mean (2.36g per 100g) was recorded at location 21. In some locations at the Batticaloa Lagoon has more than 2.56g per 100g of organic matter due to the presence of decayed plant especially *Eichornia* sp., and animal detritus, bacteria or plankton formed or derived from natural and anthropogenic sources in the surroundings. Eutrophication, sewage and runoff water further increase the total organic carbon in the Batticaloa Lagoon. Hyland *et al.,* (2000) found that the extreme concentrations of total organic carbon can have adverse effects on benthic communities. Total organic carbon concentration less than 0.05 g per 100g and above 3 g per 100g were related to decrease in benthic abundance and biomass. Below 0.05 g per 100g or above 3 g per 100g may be indicative of a stressful environment.

However, most of the locations in Batticaloa Lagoon has low amount of organic matter which might be due to the enhanced sediment transport caused by erosion which can lower sediment TOC concentrations because inorganic constituents (minerals and clays) can dilute organic matter concentrations. Organic matter may mobilize or immobilize metal in the soil. The solubility of metals which are structural component of organic matter or which form complexes with it, can be determined by the solubility of the associated organic matter, thus metal complexed with the humic material are themselves soluble in high pH condition (Murice *et al*., 2014).

3.2 Texture analysis of sediment sample

Table 3: Texture of the sediments in the Batticaloa Lagoon

Parameter	Range	Average
Sand	76%-96%	87%
Silt	2%-12%	6%
Clay	2%-14%	7%

The percentage fractions of the textural components of the sediments from the Batticaloa Lagoon are represented in Table 3. The sediments of the Batticaloa Lagoon composed of 87% sand, 6% silt and 7% clay. The soil textural triangle was used to interpretative the results of the sediment composition.

The texture profile performed on the Batticaloa Lagoon sediment revealed that the texture of the lagoon sediment is sandy. About 87% of this is made up of sand and this is probably because of the closeness of the lagoon to the sea shore. Sandy soil does not aid in transport of pollutants due to it rough and large particle size which reduces it surface area. The silt and clay fraction are the primary carrier of adsorbed chemicals, especially phosphorous, chlorinated chemicals and most metals which are transported into aquatic systems. Silt and clay particles offer larger surface area for the adsorption of organic matter. River bottom characteristics might also have influenced on the variation of texture and organic matter content of the sediment samples. According to Foerstner (2004), Size of the particles is one of the important factors determining suspended and bottom-sediment capacity for concentrating and retaining organic and inorganic contaminants. Further he pointed that pollutants have been found to be present mainly on clay/silt particles; therefore, the presence of higher clay particles in the sediment samples collected in the present study is the indirect measure of the polluting status of the Batticaloa Lagoon as this lagoon is considered as chocked lagoon.

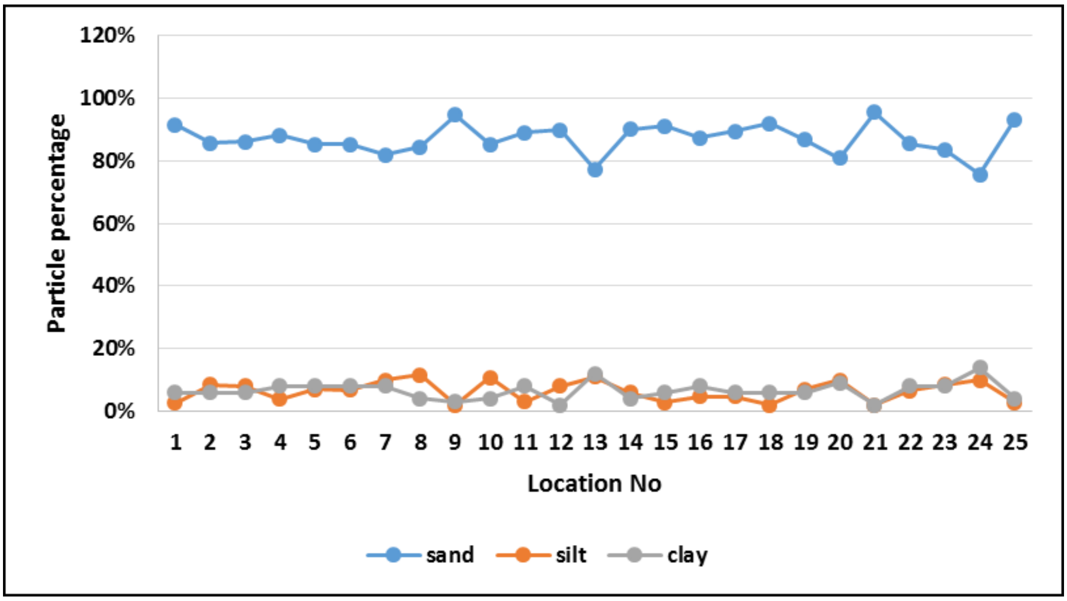

Figure 3: Spatial variation of the sediment texture in the Batticaloa Lagoon

3.3 Correlation between Texture and Organic matter content

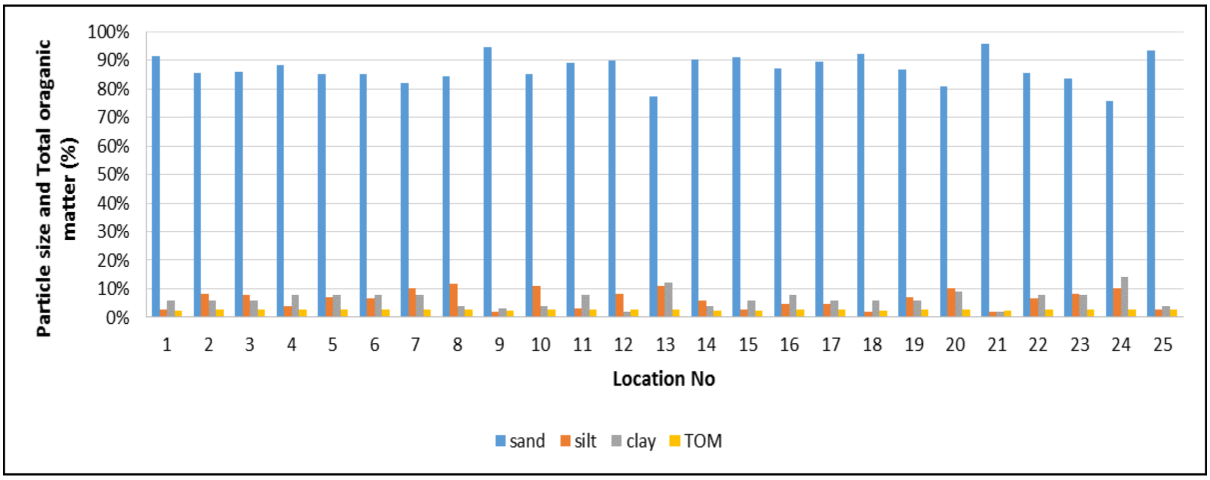

Figure 4: Particle size distributions and TOM percentage of all the location in the Batticaloa Lagoon

Table 4: Pearson's correlation coefficient of Sediment Texture and Total organic matter

Parameters	Sand	silt	Clay	Total organic matter
Sand	-	-0.848	-0.801*	-0.925*
silt	-0.848*	-	0.363*	0.758*
Clay	-0.801*	0.363*	-	0.775*
Total organic matter	-0.925*	0.758*	0.775*	-

*Values are significant at 5%

Sand exhibited significant negative correlation with clay (r= -0.925) and silt (r= -0.999). But silt and clay shared significant positive correlation with each other (r= 0.994). Total organic carbon showed significant positive correlation with silt (r=0.758) and clay (r = 0.775) but significant negative correlation with sand (r = -0.925). Lipsius (2002) and Kumar *et al*., (2012) also found similar results and revealed that the clayey soils have more organic matter and thus retain more water than sandy soils. Raghunath and Murthy (1996) also found that organic matter increases with silt percentage and mean grain size and decreases with increase in depth and sand percentage.

4. CONCLUSION

The results of the study indicated that the sediments of the Batticaloa Lagoon were having sand as the major contributor followed by silt and clay. Variation in sediment fraction mainly due to the topographical features of the particular area concerned. Total organic carbon showed significant positive correlation with silt and clay but significant negative correlation with sand. Percentages of TOM indicated the effect of decayed plant debris and incorporation of the runoff water with suspended particles on the natural sediments of the Batticaloa Lagoon. However, the concentration and dispersal pattern of these parameters were moderate and comparatively lower than the average value. It is therefore strongly recommended that strict measures should be taken against the disposal of wastes on the lagoon and maintain the natural nature of the lagoon environment. Further this study will be a useful tool for future researchers for the development of the Batticaloa Lagoon.

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