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GRAIN SIZE CHARACTERISTICS OF THE COLEROON ESTUARY SEDIMENTS, TAMILNADU, EAST COAST OF INDIA

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Abstract: The present study was carried out in order to study the textural characteristics of sediments, and their seasonal changes along with the Coleroon estuary. Samplings were done at different stations during two seasons from monsoon of 2009 to postmonsoon of 2010. Granulometric studies reveals that the grain size parameters at different Coleroon estuary locations. The differences between the seasons were larger than those between the geomorphological units. During the monsoon the mean size was medium to fine, sorting was moderately sorted to moderately well sorted in nature, and the distribution was more positively skewed. The major part of the sediment fall in a medium to fine grained category. with respect to spatial distribution sand is dominating in the upper estuarine region i.e. up to the station 7 silt, clay are mostly enriched in lower part of the estuary. Based on the CM pattern the sediment fall in rolling and suspension field.

Keyword; Coleroon estuary, Granulometric, spatial, fluvial environment, Tamilnadu, east coast.

1. INTRODUCTION

Estuaries are in a state of constant flux and their dynamic nature provides many ecological niches for diverse biota. The health status and biological diversity of Indian estuarine ecosystems are deteriorating day by day through multifarious man-made activities. The dumping of enormous quantities of sewage and industrial effluents into estuaries has resulted in a drastic reduction of shallow water fish populations, increased pollution and ecological imbalance resulting in the large-scale disappearance of numerous flora and fauna (Rajendran et al. 2004).

The sediment infilling in many estuaries is ascribed to the gravitational circulation that carries sediments landward close to the sea bottom and seaward nearer to the surface (Wolanski et al., 1996; Uncles & Stephens, 1997). However, the residual sediment transport can be controlled by the asymmetry between flood and ebb tide in tide-dominated regions (Postma, 1961; Dronkers, 1986; Aldridge, 1997). The tidal pumping induces the deposition of sediments in a number of macro-tidal estuaries (Guan et al., 1998; Mitchell et al., 1998, 2003). In the present investigation the grain size parameters are used to interpret sediment movement in Coleroon estuary.

2. STUDY AREA

The study area is drained by Coleroon river and its distributaries. All these river are ephemeral and carry floods during monsoon. They generally flow from west towards east and the pattern is mainly sub parallel. The eastern coastal part near Pazhayar is characterized by back water. Coleroon river, a major waterway of the Tiruchirapallia and district Thanjavur district, is formed by the bifurcation of the Cauvery flows through the Chidambaram taluk for 36 miles and finally joins the Bengal 6 miles south of Portonova (Parangipettai).Since the district is underlined by sedimentary formation ,the major land forms that occur are natural levees near Maliaduthurai coastal plain covering almost the entire district with beaches beach ridges, mudflats swamps, and backwater along the coastal stretch. The deltaic plains are found near the confluence of river Coleroon with sea in the east and also in the south. Flood plain deposits are observed along the river course (Fig. 1).

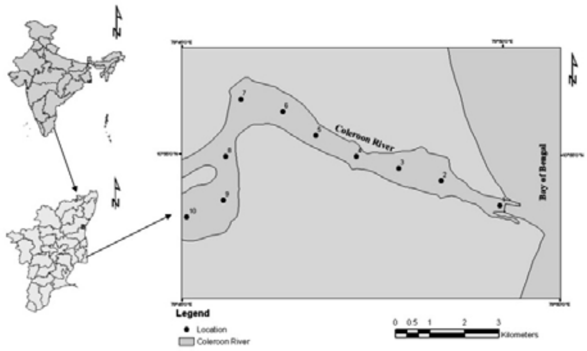

Figure 1. Location map of the area of study

3. MATERIAL AND METHODS

Twenty sediment samples were collected representing monsoon 2009 and postmonsoon of 2010 covering the estuarine limits of Coleroon river. The sediment samples were collected by using a Van Veen grab sampler on board hired fishing trawler. Sub-sampling of the sediments was done by taking from the upper portion 5cm of the sample from the grab with the help of plastic spatula. Sediment samples were then frozen to 4^{o}C prior to analysis. Station locations were obtained by the Global positioning system (GPS). Sediment samples were then kept in a oven and dried at 60^{o}C for further analysis. Sieving technique is applied to separate the grains of various size classes (Ingram, 1970). Initially 100 gm of sample is prepared by removing carbonate and organic matters by treating with 10% dilute hydrochloric acid and 6% hydrogen peroxide respectively.

Table. 1A. Graphic measure from the grain-size analysis of the samples (monsoon)

Station	Median Phi	Mean Phi	Standard deviation Phi	Skewness Phi	Kurtosis Phi	Sand %	Silt %	Clay %
S1	1.56	1.6	0.56	0.27	1.75	96.63	0.12	3.25
S2	1.37	1.31	0.69	-0.03	1.33	96.62	0.13	3.25
S3	1.61	2.02	0.92	0.6	1.43	96.61	0.13	3.26
S4	1.7	2.03	0.96	0.43	1.02	96.62	0.13	3.25
S5	1.86	2.12	0.93	0.37	0.87	96.62	0.13	3.25
S6	2.3	2.29	0.88	0	1.04	96.62	0.13	3.25
S7	2.42	2.4	0.9	-0.03	0.98	96.62	0.13	3.25
S8	2.46	2.43	0.9	-0.06	1.01	96.61	0.12	3.27
S9	1.88	2.13	0.93	0.36	0.88	96.62	0.12	3.26
S10	1.36	1.3	0.7	-0.03	1.31	96.62	0.13	3.25
Mini.	2.46	2.43	0.96	0.6	1.75	96.63	0.13	3.27
Max.	1.36	1.3	0.56	-0.06	0.87	96.61	0.12	3.25
Avg.	1.861	1.946	0.824	0.201	1.186	96.61	0.126	3.25

Sieving was carried out in ASTM sieve at ½ φ intervals for about 20 minute in Digital sieve shaker (Retsch AS 200). Pipette analysis was carried out to compute sand, silt and clay fractions. This basic data i.e. weight percentage frequency data is converted into cumulative weight percentage data, served as basic tool for the generation of other statistical parameters (Table. 1A and B) using USGS GSSTAT program (Poppe et al., 2004) described herein generates statistics to characterize sediment grain-size distributions and can extrapolate the fine-grained end of the particle distribution. It is written in Microsoft Visual Basic 6.0 and provides a window to facilitate program execution. The input for the sediment fractions is weight percentages in whole-phi notation (Krumbein, 1934; Inman, 1952).

Table. 1B. Graphic measure from the grain-size analysis of the samples (postmonsoon)

Station	Median Phi	Mean Phi	Standard deviation Phi	Skewness Phi	Kurtosis Phi	Sand %	Silt %	Clay %
S1	2.45	2.41	0.84	-0.05	1.14	96.62	0.12	3.25
S2	2.56	2.58	0.74	0.02	1.24	96.62	0.12	3.25
S3	2.56	2.57	0.76	0	1.25	96.62	0.12	3.26
S4	2.5	2.49	0.7	0.01	1.41	96.62	0.12	3.25
S5	2.54	2.54	0.78	-0.02	1.22	96.62	0.12	3.25
S6	2.47	2.46	0.81	-0.01	1.1	96.62	0.12	3.25
S7	1.65	1.79	0.64	0.46	1.64	96.61	0.11	3.25
S8	2.42	2.37	0.85	-0.07	1.21	96.62	0.12	3.27
S9	2.41	2.36	0.82	-0.06	1.21	96.62	0.13	3.26
S10	1.8	2.06	0.96	0.34	0.98	96.61	0.13	3.25
Mini.	2.56	2.58	0.96	0.46	1.64	96.62	0.13	3.27
Max.	1.65	1.79	0.64	-0.07	0.98	96.61	0.11	3.25
Avg.	2.297	2.333	0.791	0.084	1.251	96.61	0.120	3.255

4. RESULTS AND DISCUSSION

4.1. Statistical analysis

4.1.1. Graphic mean

The mean is calculated using the method of moments where the midpoint of each grade is the arithmetic grade size limits in millimeter e.g geometric mean (Krumbein, 1936 Pettijohn, 1984). It is average size of the sediments and is influenced by the source of supply, transporting medium and the energy condition of the depositing environment. Mean size indicates the central tendency or the average size of the sediment and in terms of energy. it indicates the average kinetic energy velocity of depositing agent (Sahu 1964).

Mean size of Coleroon estuary during monsoon season the maximum value 1.3 to 2.43 and minimum 1.3. During postmonsoon season it ranged from 1.79 to 2.58 indicating that they are of medium to fine sand. Gradual decrease in grain size from coarse to medium sand to fine sand is noticed towards coast. The gradual decrease in mean size clearly exhibits that the gradual increase in energetic condition of fluvial regime towards coast. (Fig. 2A and 2B).

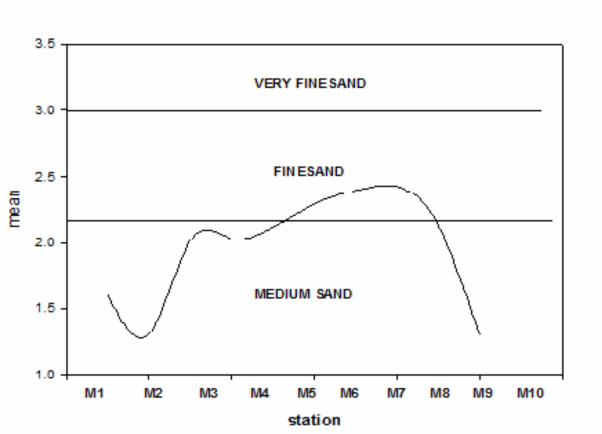

Figure 2A. Mean showing the trends of all the samples (monsoon)

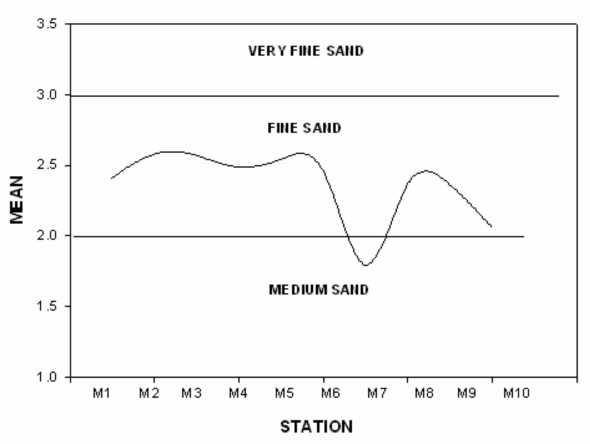

Figure 2B. Comparative histograms of all samples showing mean during postmonsoon)

4.1.2. Standard deviation

It is expressed by inclusive graphic standard deviation of Folk & Ward (1957) as it covers both the tails of the distribution. Standard deviation is a poorly understood measure that depends on the size range of the available sediments, rate of depositing agent and the time available for sorting. The sorting variation observed attributes to the difference in water turbulence and variability in the velocity of depositing current.

The standard deviation value for Coleroon estuary sands ranges from, during monsoon season it ranged from 0.56 to 0.96 its clearly indicates moderately sorted to moderately well sorted in nature. During postmonsoon season it ranged from 0.64 to 0.96 its indicates moderately sorted to moderately well sorted in nature, during monsoon season some changes was occurred downstream side fine size grain concentration more this phenomenon also noted by Inman (1952), Friedman (1967) and Pettijohn (1984) (Fig. 3A and 3B).

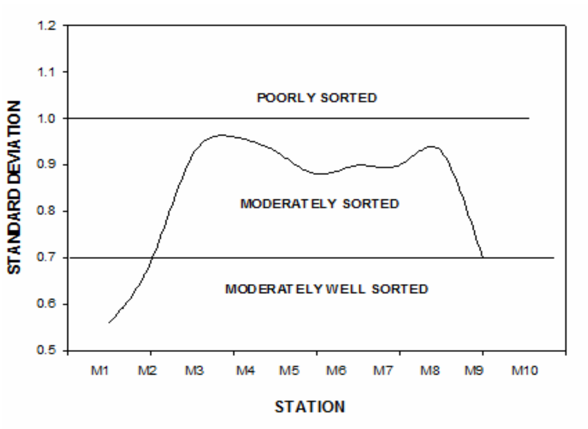

Figure 3A. Standard deviation showing the trends of all the samples (monsoon)

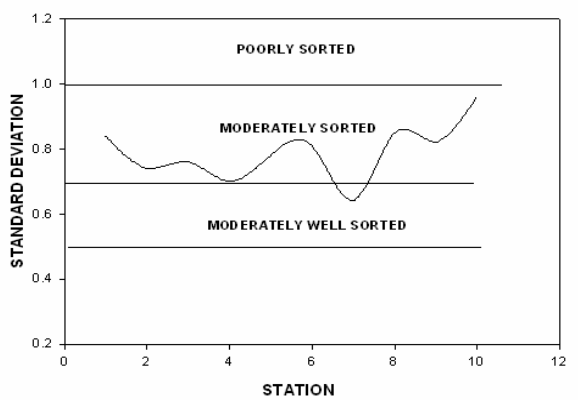

Figure 3B. Standard deviation showing the trends of all the samples (postmonsoon)

4.1.3. Skewness

It is used to determine the symmetry of the central part of the distribution. It reflects the symmetry or asymmetry of the frequency distribution of the sediments. The skewness value for Coleroon estuary it ranged from during monsoon season -0.06 to 0.6, this season river mouth samples shows fine skewed to near symmetrical skewness upstream side shows near symmetrical skewness its indicates substantiates the winnowing action over these area, towards the coastal region of the study area beaches predominance of fine skewed near symmetrical, during postmonsoon season skeweness value ranged from -0.07 to 0.46 its indicates near symmetrical to strongly skewed (Fig. 4A and 4B).

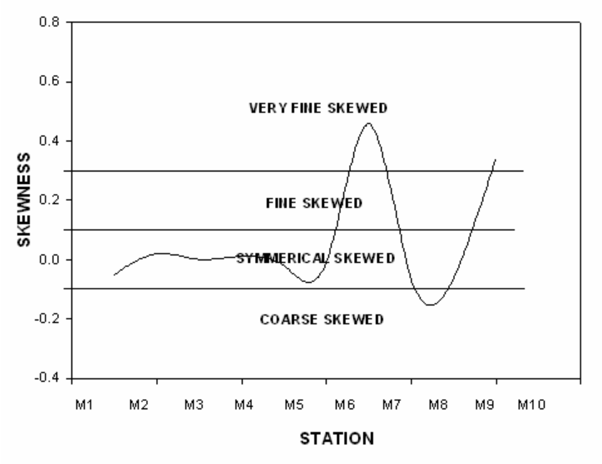

Figure 4A. Skewness showing the trends of all the samples (monsoon)

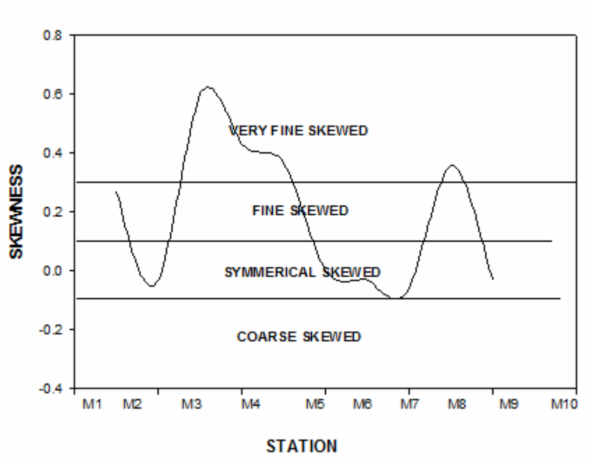

Figure 4B. Skewness showing the trends of all the samples (postmonsoon)

4.1.4. Kurtosis

It is measure of Peakness. Accordingly to Adigan (1961), it is also functional of internal sorting or distribution. During monsoon season kurtosis value ranged from 1.87 to 1.75 very leptokurtic to mesokurtic nature, down stream sediment samples shows mostly very leptokurtic to leptokutic nature it indicates due to the moderate sorting of medium to fine fraction. With respect to kurtosis value in Coleroon estuary down steam side indicates low energy level for finer fraction present, upstream side high energy level for medium to coarse sand present. During post monsoon season not observed more variation (Fig. 5A and 5B).

4.2. Spatial distribution

Sedimentological datasets are typically larger and compiled into tables or databases, but pure numerical information can be difficult to understand and interpret. Thus, scientists commonly use graphical representations to reduce complexities, recognize trends and patterns in the data, and develop hypotheses. Of the graphical techniques, one of the most common methods used by sedimentologists is to plot the basic gravel, sand, silt, and clay percentages on equilateral triangular diagrams. This means of presenting data is simple and facilitates rapid classification of sediments and comparison of samples (Poppe & Eliason, 2008).

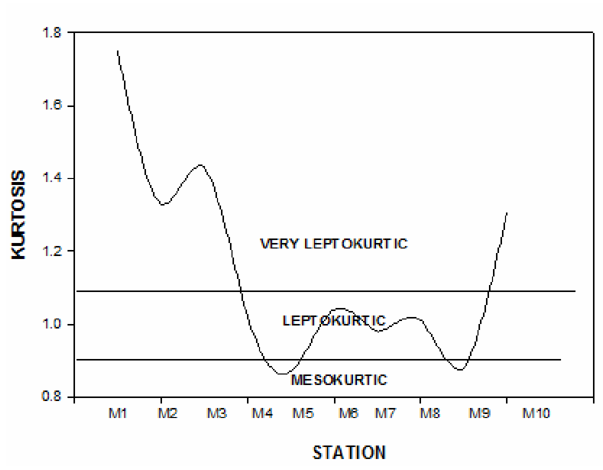

Figure 5A. Kurtosis showing the trends of all the samples (monsoon)

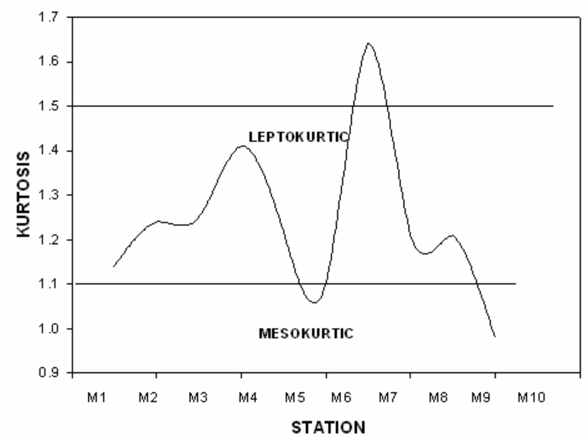

Figure 5B. Kurtosis showing the trends of all the samples (postmonsoon)

The spatial distribution of Coleroon river estuary sediment samples collected ten places. The sediment samples collected upstream to downstream. Coleroon estuary sediment samples mostly medium to fine sand type present. With respect to spatial distribution clearly indicates, during monsoon season sand silt clay varies from sand 96.61 to 96.63, silt 0.12to 0.13, clay 3.25 to 3.27. Sand cont shows decreasing trend from station 7 up to 10 and further increase trend up to the station 1 to 8 and increase towards the mouth region. Silt shows increasing trend up to the station 7 to 10 with lower value at station 6 to 1 further downstream it showing decreasing trend. In general clay decreasing trend from station 4 to 9 and further downstream they show increasing trend till the station 9 and then show decreasing trend towards the mouth. During postmonsoon sand content varies from 96.61 to 96.62, silt from0.12 to 0.13, clay from 3.25 to 3.27. Sand showing increasing trend from station 1 to 4 then 5 to 6 further upstream shows degreasing trend up to station 10, and again it increase towards mouth. Silt content decrease from 3 to 7 and further shows increasing trend up to 10 clay shows decreasing trend up to 5 to 7 then 9 to 10, further it showed increasing trend up to station 3 to 5 then station 7 to 8 and then decrease towards the mouth region. (Fig. 6A to 6F).

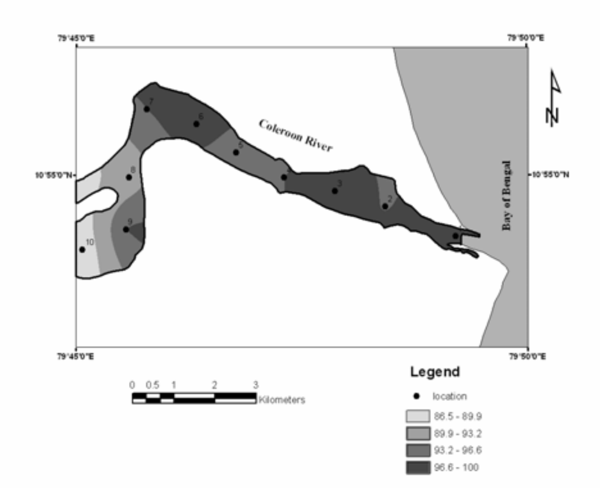

Figure 6A. Spatial distribution of sand percentage in estuary sediment (monsoon)

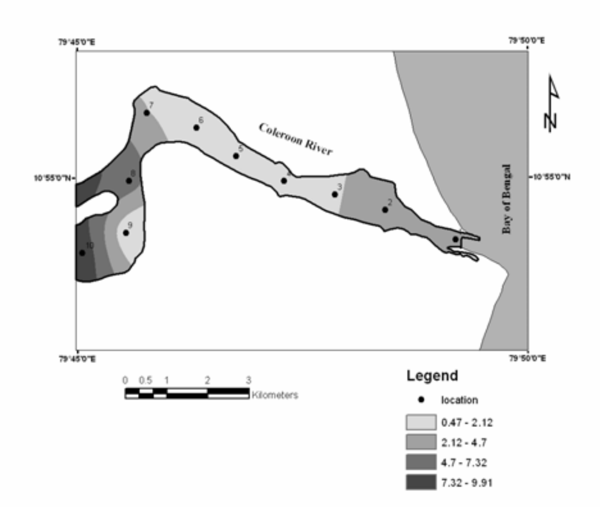

Fig.6B. Spatial distribution of sand percentage in estuary sediment (postmonsoon)

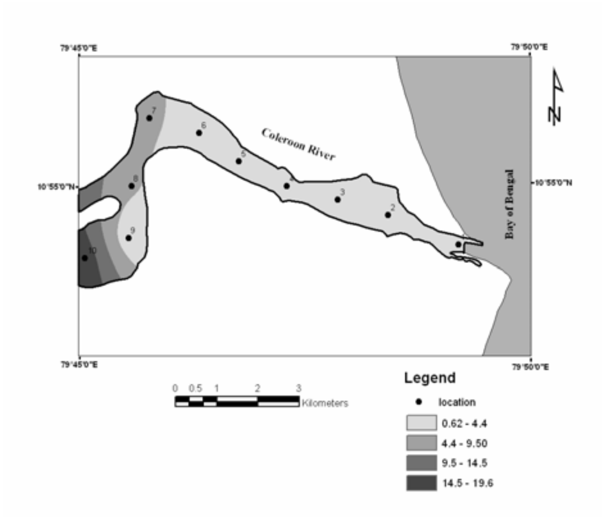

Figure 6C. Spatial distribution of silt percentage in estuary sediment (monsoon)

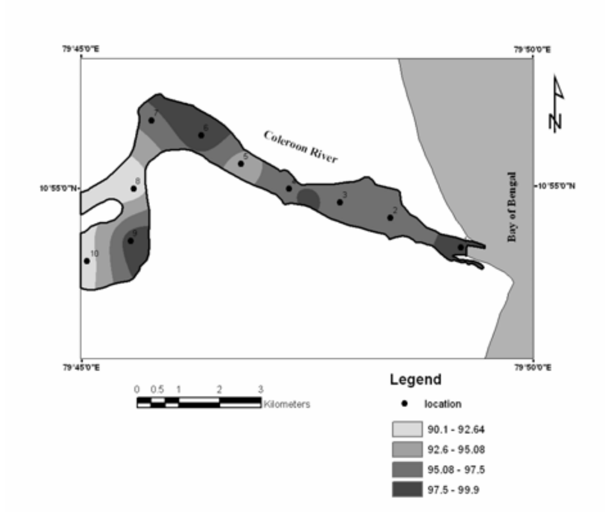

Figure 6D. Spatial distribution of silt percentage in estuary sediment (postmonsoon)

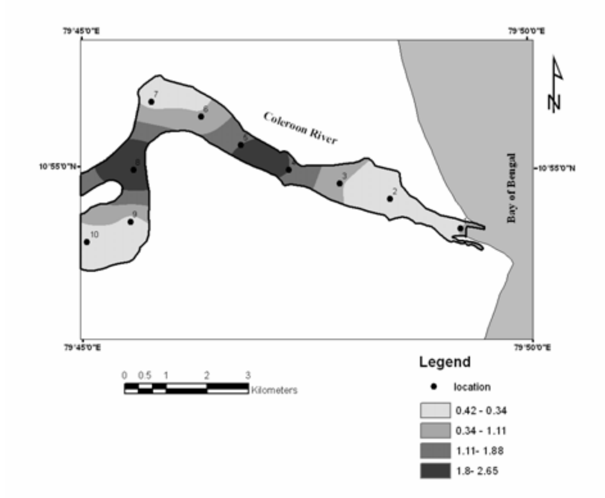

Figure 6E. Spatial distribution of clay percentage in estuary sediment (monsoon)

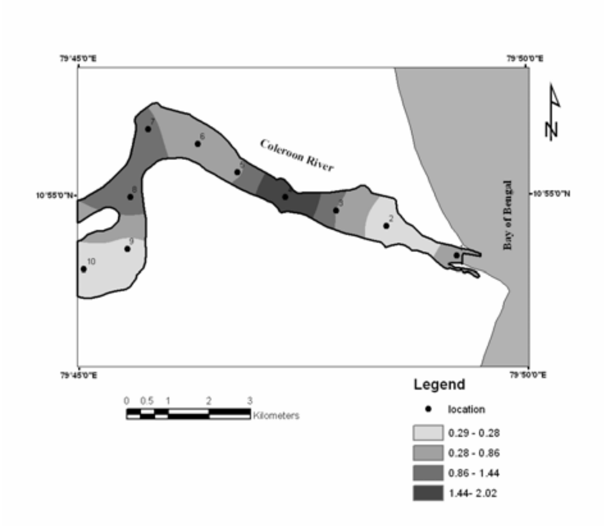

Figure 6F. Spatial distribution of clay percentage in estuary sediment (postmonsoon)

4.3. C-M plot

Passega (1957) introduced C-M plot to evaluate the hydrodynamic forces working during the deposition of the sediments. It is a relationship of ‘C’ i.e. coarser one percentile value in micron and ‘M’ i.e. median value in micron on log-probability scale. The present plot is made and interpreted following Passega (1957, 1964) and Passega and Byramjee (1969). Accordingly, monsoon season most of the samples fall in N-O region of sector I, which denotes rolled sediments with little or no suspension (Fig. 7A). Postmonsoon season most of the samples fall in P-O region of sector I, which indicate rolling and suspension field (Fig. 7B).

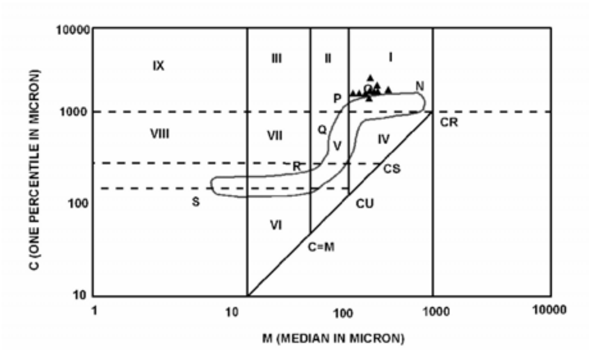

Figure 7A. C-M plot showing distribution of sediment samples during monsoon

5. CONCLUSIONS

Grain size analysis was carried out Coleroon estuary sediment samples mostly medium to fine-grained of Coleroon estuary area has been carried out. The important conclusion drawn is as follow, the frequency curves are dominantly indicative of two season, monsoon, and post monsoon, medium to fine-grained nature of the sediments. The graphic mean value in two season monsoon season majority of the sample fine sand particles, during postmonsoon season medium sand size to fine sand size. The gradual decrease in energetic condition of fluvial regime towards coast.

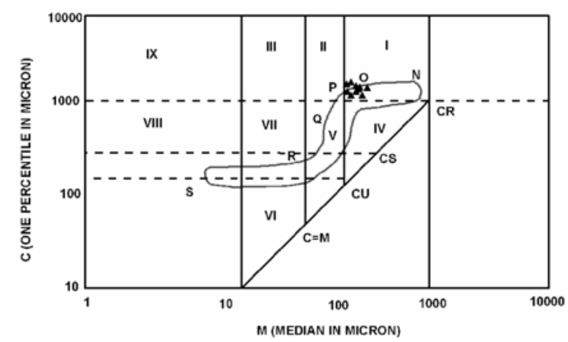

Figure 7B. C-M plot showing distribution of sediment samples during postmonsoon

The sediment, in general, show during monsoon season moderately sorted to moderately well sorted nature, during postmonsoon season same kind of result was observed, it is noted that the sorting with the lowering of mean size. The graphic skewness, shows during monsoon season near symmetrical to fine skewed category. Same kind of result was observed during postmonsoon season. Towards the mouth region of the study area estuary predominance of fine skewed to very fine skewed nature in noticed, which exhibit the removal of fine population. The graphic kurtosis it shows during monsoon season most of the samples fall in leptokurtic to very leptokurtic nature, during postmonsoon season meusokurtic to very leptokurtic in nature. The frequency curves of downstream sand are polymodal with moderate to high peak, because the total sediment is made up to concentration of multi dominant population resulting leptokurtic to mesokurtic. The kurtosis natures of the sediment in the Coleroon downstream suggest that the sediment achieved very poor sorting in the low energy environment. Spatial distribution sand is dominating in the upper estuarine region i.e. up to the station 7 silt, clay are mostly enriched in lower part of the estuary. The sediments are mostly rolled and deposited by traction currents, however, a few samples showing suspension mode is because of more quantity of fine grained material during monsoon and postmonsoon seasons.

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