Oriental Journal of Chemistry Vol. **26**(4), 1309-1313 (2010)

The temporal variation of organic carbon during the pre-monsoon and post-monsoon seasons in Pahang River-estuary, Pahang, Malaysia

B.Y. KAMARUZZAMAN[1]*, A. SITI WAZNAH[1], S. SHAHBUDIN[1], K.C.A. JALAL[1] and M.C. ONG[2]

[1]Institute of Oceanography and Maritime Studies,
International Islamic University Malaysia, 25200 Kuantan, Pahang, (Malaysia).
[2]Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu,
21030 Kuala Terengganu, Terengganu (Malaysia).

(Received: September 03, 2010; Accepted: October 14, 2010)

ABSTRACT

The percentage of organic carbon contents of 62 bottom sediments in Pahang river- estuary were analyzed using the wet dichromate oxidation method. The sediments particle sizes at the same stations were also measured using the dry sieving and laser diffraction methods. In this study, the concentrations of organic carbon are relatively higher during pre-monsoon season and become much lower during the post-monsoon season. The average concentrations of organic carbon for both pre-monsoon and post-monsoon seasons are 1.61% and 0.88% respectively. This finding indicates that the annual seasonal changes that occur in Pahang river- estuary might probably have the important role in regulating the concentrations of organic carbon.

Key words: Pahang river-estuary, organic carbon, pre-monsoon, post-monsoon.

INTRODUCTION

In marine sediment, organic carbon usually originates in the atmosphere and via the riverine introduction of pollutants, including industrial and domestic waste, agricultural and mining runoff, accidental spillages and decomposition debris from marine organisms. Organic carbon in marine environment can be described as dissolved organic carbon, suspended organic carbon and particulate organic carbon. These equal the total amount of organic carbon in water column. However, different factors may control the partitioning and also the bioavailability of the hydrophobic organic compound within the benthic ecosystem. These factors include various sediment characteristics, such as grain size distribution, mineral composition and organic content (Lambert, 1967; Forstner, 1977; Khalaf *et al.,* 1981). Surface sediments may be resuspended and redistributed by the action of waves and currents Cahoon and Reed (1995). As these phenomena erode the top most layers of the sediment column, resuspended sediments contain recently deposited organic matter. Total organic carbon has a major influence on both chemical and biological processes that are take place in sediments. The amount of organic carbon has a direct role in determining the redox potential in sediment, thus regulating the behavior of other chemical species such as metals (Eshleman and Hemond, 1985; Kerekes *et al.,* 1986). Natural processes and human activities have resulted in elevated content of total organic carbon in soils, sediments and streams. These include diverse input from throughfall, stemflow, inappropriate animal waste applications and disposals, forest clear cuttings, agricultural practices, and changes in land-uses (Moore and Jackson, 1989).

Only limited work has been done on the organic matter, both in the sediment and in the suspended sediment in Malaysian coastal areas. Although there have been many studies of the distribution of particulate organic carbon in suspended matter in sea water and in the bottom sediments in South China Sea and adjacent seas (Ichikawa *et al.,* 1987; Muller, 1977), data on the coastal water and rivers of Malaysia are still limited. In view of the importance of the organic carbon content to various aspects of the environment, research on the distribution of organic carbon in sediment was carried out.

MATERIAL AND METHODS

Sampling sites and Samples collection

The study was carried out at Pahang River estuary which located at Pekan and situated 50 km south of Kuantan (Fig. 1). This area has a humid tropical climate with two monsoon periods, characterized by bimodal pattern: southwest and northeast monsoons bringing an annual rainfall which varies between 1488 to 3071mm. The Pekan area is mostly influenced by the semidiurnal tides with two high tides and two low tides, within a lunar day. A total of 62 bottom sediments which lies between longitude 103°25'56.48" E to 103°29'10.55" E and latitude 03°33'01.78" N to 03°30'50.38" N, were collected using a Smith McIntyre at Pahang river- estuary in April 2008, using the RV Unipertama III

Analytical Methods

Total Organic carbon (TOC) Analysis

The organic carbon was determined using the wet dichromate oxidation technique of Holme and McIntyre (1984). The samples were dried in oven and grounded in an agate mortar. Then the samples were sieved through a 63µm, without dispersion agent, to avoid contamination to the samples. Briefly, about 0.5g sample weighed. The non-carbonic and carbonate contents in the samples were destroyed using sulfuric and phosphoric acids.

The samples were then titrated using iron (II) sulfate. Finally, the percentage of organic carbon that presents in the samples was calculated using a formula as shown below:

$$\% \text{ of Organic Carbon} = \frac{(V_1 - V_2) \times 0.003 \times 100}{\text{Weight of sample (g)}}$$

where, V1 is the volume of dichromate and V2 is the volume of iron (II) sulfate that has been used for titration (mL). The precision assessed by replicate analyses was within 3%. The accuracy was also examined by analyzing, in duplicate a reference material of Glucose, and the results coincided with the certified values within a difference of ± 3%.

Sediment Characteristics Analysis

Samples which consist of more than 90% sand were analyzed using dry sieving and wet sieving methods. Meanwhile, samples having more than 90% fine sediments were analyzed using the laser diffraction method. For the laser diffraction technique, the organic components were firstly removed by adding 20% hydrogen peroxide (H_2O_2). The flocs of finer particles were destroyed by adding a dispersing agent (5% calgon solution). Then, the samples were analyzed using Particle Size Analyzer (PSA) system. The mean, standard deviation and skewness of each sample were calculated by the moment's method using equations defined by McBride (1971).

RESULTS AND DISCUSSION

The distributions of organic carbon contents at Pahang river- estuary for both pre-monsoon and post-monsoon seasons were shown in Figure 2. In this study, the average value of organic carbon contents are relatively higher during pre-monsoon season (1.61 ± 0.55%) compared to post-monsoon season (0.88 ± 0.63%). During the pre-monsoon, the organic carbon may have been derived from the activity of aquatic organisms, especially the benthic organisms, which are reported to contribute organic carbon to the estuary and the near shore areas (Wang *et al.,* 2000). Meanwhile, during the post-monsoon season which is associated with heavy rain and high water current, organic carbon was washed away to the open ocean and apparently reduced their concentrations in estuarine environments.

Overall, the organic carbon content is relatively higher compared to Terengganu coastal water and Pahang coastal water (Ichikawa *et al.,* 1987). These results are probably due to the relatively low primary productivity and rapid decomposition in the open ocean compared to the nearshore environment. Furthermore, the inputs from terrestrial organic matter, and grazing by benthic organisms were dominantly found in Pahang river- estuary. Additionally, high organic carbon concentrations could be primarily caused by the river run-off, which seem to have been the main supply of organic matter into the aquatic system.

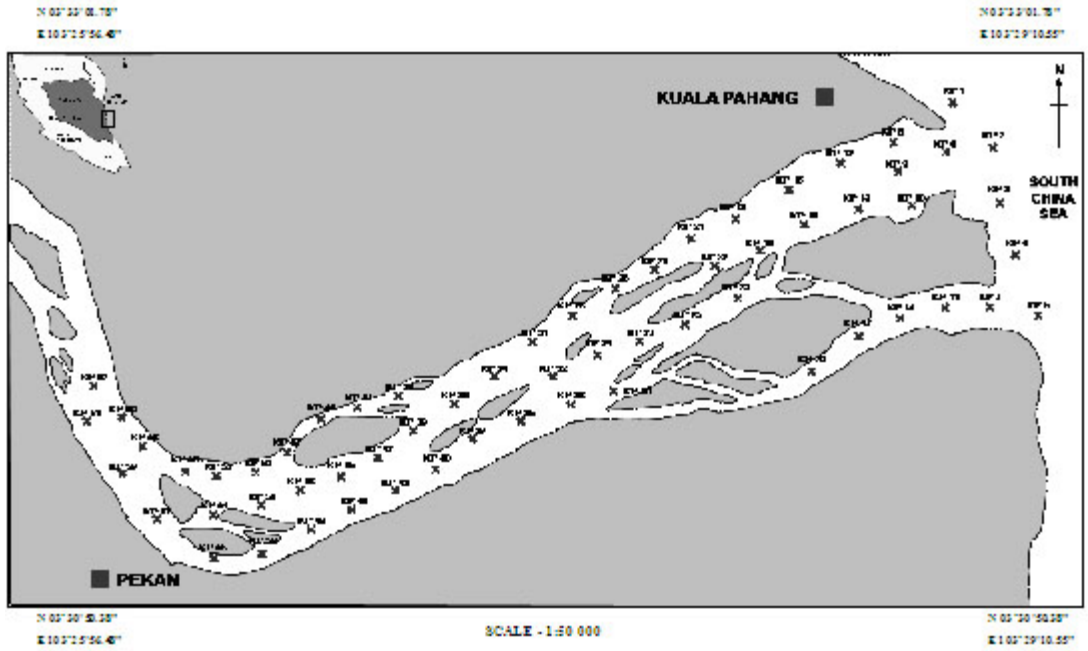

Fig. 1: Location of the study area showing sampling site along Pahang River- Estuary, Pahang

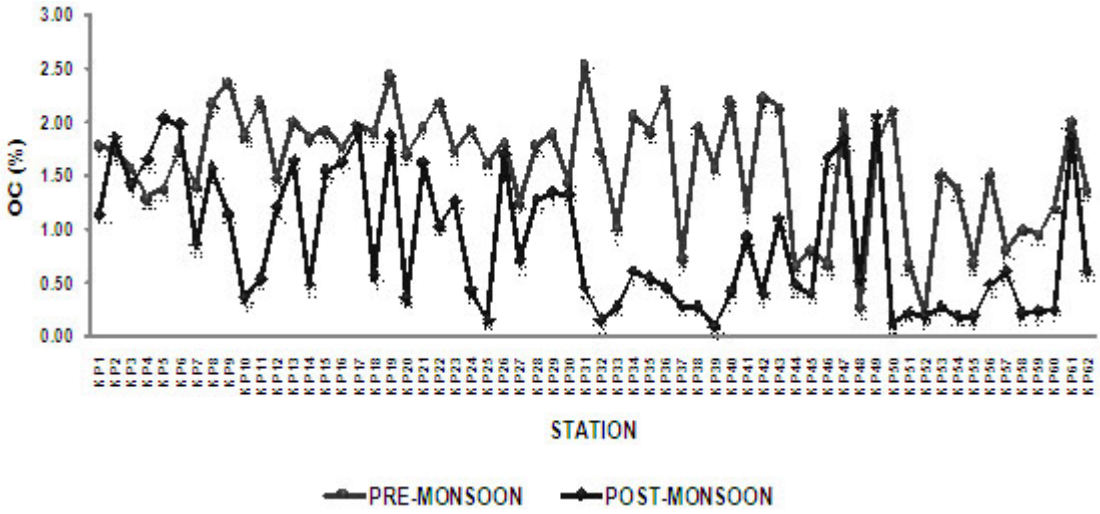

Fig. 2: Variation of organic carbon (%) during pre-monsoon and post-monsoon seasons according to stations

Figure 3 shows the distribution of sediments mean size for both pre-monsoon and post-monsoon seasons. The average value of sediment mean size during pre-monsoon season was 2.20 ± 2.90Ø, whilst slightly higher value was obtained during post-monsoon season (2.34 ± 3.17Ø). This phenomenon was also reported by Antonina (2001), who concluded that the mean sediment size of Peninsular Malaysia's east coast including the Pahang coastal water was significantly affected by the Northeast and Southwest monsoons. During the post-monsoon season which is associated with heavy rain and high water current, the water from river will transport high concentration of suspended and fine sediments to the coastal areas. Therefore, areas which have strong current (Kamaruzzaman, (1994), near the mouth estuary comprise mainly of coarser sediments compared to the areas further out to the open ocean which dominantly comprising of a fine sands.

The organic carbon was positively correlated with sediments mean size for both pre-monsoon and post-monsoon seasons. As reported by Rashid (1973), the particles mean size plays a role in bonding organic carbon where 10 to 20% of organic matter is believed to bond with fine particles. As reported by Jamil (2006), there is a positive correlation between grain size and the organic carbon concentrations suggesting the influence of the fine fraction in their incorporation into the sediments. However, in this study, a weak positive correlation was observed between organic carbon and silt and clay percent. In an ideal situation, higher organic carbon content values are associated with lower sediment particle size (El-Wakeel and Riley, 1957).

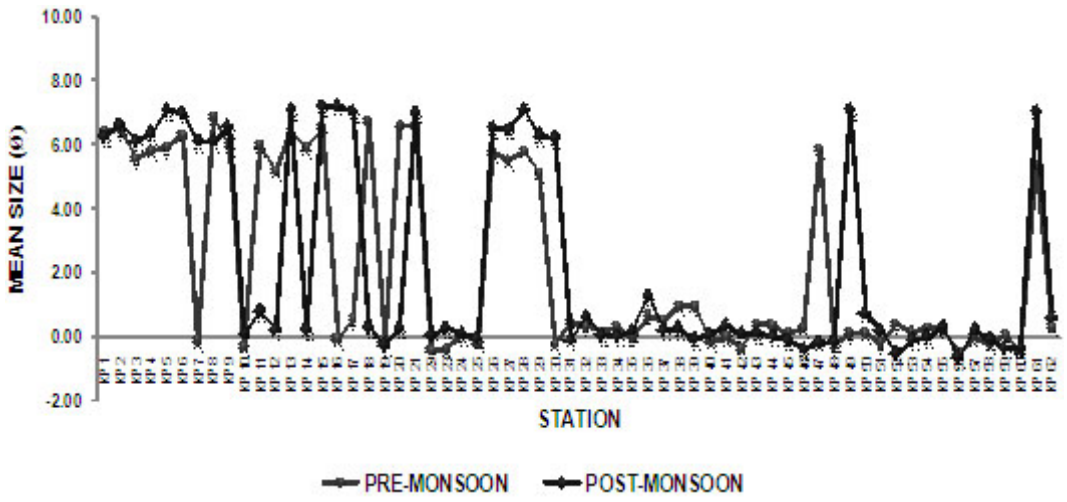

Fig. 3: The distribution of mean size during pre-monsoon and post-monsoon seasons according to stations

CONCLUSION

It can be concluded that the contents of organic carbon in sediment is much influenced by many factors such as physical, biological and chemical processes. Besides, seasonal changes also affect the distribution of organic carbon in the study area. Meanwhile, the relatively higher organic matter contents observed, appears to be derived from allochthonous sources from the rivers and autochthonous reactive part from the algal mats and mangrove trees. However, more detail studies are suggested in order to have a better understanding of the sedimentary process of the organic matter in the sediment.

REFERENCES

1. Antonina, N. A., Sedimentology and Heavy Metal Studies of the Gulf of Thailand, East Coast of Peninsular Malaysia, Sabah and Sarawak Continental Shelf Sediments. Thesis, PhD. Faculty of Science and Technology, University Putra Malaysia Terengganu, Terengganu. 2-80 (2001).
2. Cahoon, D. R. and Reed, D. J., Relationship among marsh surface topography, hydroperiod and soil accretion in a deteriorating Louisiana Salt marsh. *Journal of Coastal Research* **11**(2): 357-369 (1995).
3. El-Wakeel S K and Riley J P., The determionation of organic carbon in marine muds. *Journal du Conseil International Pour* **12**: 10-183 (1957).
4. Eshleman, K. N., and H. F. Hemond., The role of soluble organics in acid-base status of waters at Bickford Watershed, Massachussetts. *Water Resource. Res*. **21**: 1503-1510 (1985).
5. Forstner U., Metal concentrations in fresh water sediments, naturak background and cultural effects. In Interactions Between Sediments and Freshwater (H. L. Golterman, ed.), Junk, *The Hague*, Wageningen, 94-103 (1977).
6. Holme, N. A., and McIntyre, A. D., *Methods for the study of Marine Benthos.* IBP handbook 16. Oxford: Blackwell Scientific Publications, 387 (1984).
7. Ichikawa, T, Law, T. A, and Kartini, M., Particulate organic carbon in the Malaysian coastal waters of the South China Sea. *Kagoshima University Research Center South Pacific* **8**: 79-86 (1987).
8. Jamil, Geochemistry and Sediment Characteristics of The Riverbed Sediment of Terengganu River,Terengganu, Malaysia. Thesis, Msc, Faculty of Science and Technology, Kolej Universiti Sains dan Teknologi Malaysia, Terengganu 4-90 (2006).
9. Kamaruzzaman, B. Y., A study of some physico-chemical parameters in the estuarine system of Chukai-Kemaman river, Terengganu, Malaysia, *Master thesis*, University Pertanian Malaysia (1994).
10. Kerekes, J. S., Beauchamp, R., Tordon, C., Trembley, and T. Pollock., Organic versus anthropogenic acidity in tributaries of the Kejimkujik Watershed in Western Nova Scotia. *Water Air Soil Pollut*. **31**: 165-173 (1986).
11. Khalaf, F., Literathy, P. and Anderlini, V., Vanadium as a tracer of chronic oil pollution in the sediments of Kuwait. Proceedings of the 2nd. *International Symposium on Interaction Between Sediment and Freshwater* Ontario, Canada., 14-18 (1981).
12. Lambert, S. M., Functional relationship between sorption in soil and chemical structure. *Jounal of Agriculture Food Chemistry* **16**(2): 340-343 (1967).
13. McBride, E. F., Mathematical treatment of grain size distribution data. In R. A. Davies Jr (ed.). *Procedure in sedimentary petrology.* New York: Wiley Interscience (1971).
14. Moore, T. R., and R. J. Jackson., Dynamics of dissolved organic carbon in forested and catchments, wetland. New Zealand. Larry River. *Water Resour. Res*. **5**: 1331-1339 (1989).
15. Muller P J., C/N ratios in Pacific deep-sea sediments: Effect of inorganic ammoniu and organic nitrogen compounds sorbed clays. *Geochimica et Cosmochimica Acta* **41**: 756-776 (1977).
16. Rashid, M. A., Role of humid acids of marine origin and their different molecular weight fraction in complexing di- and tri- valents metals. *Soil Sci.* **5**: 298 (1973).
17. Schnitzer, M., Humic substances: Chemistry and reactions. In: Soil Organic matter, M. Schnitzer and S. U. Khan, Ed. Elsevier Scientific Publishing Co., New York. 1-64 (1978).
18. Wang, Y. Amundson, R., and Niu, X., Seasonal and altitudinal variation in decomposition of soil organic matter from radiocarbon measurements of soil CO_2 flux. Global Biogeochemical Cycles, 14: 199-211 (2000).