Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 9 (24): 4253-4257, 2009
ISSN 1812-5654

Variability of Organic Carbon Content in Bottom Sediment of Pahang River Estuary, Pahang, Malaysia

[1]B.Y. Kamaruzzaman, [1]A. Siti Waznah, [2]M.C. Ong, [1]S. Shahbudin and [1]K.C.A. Jalal
[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

Abstract: The percentage organic carbon content of 62 bottom estuarine sediment in Pahang river estuary were analyzed using the wet dichromate oxidation method. In this study, the organic carbon distribution ranged from 0.09 to 2.05%. The high concentration can be found near the Pahang river mouth while the low concentration occurred at upstream. The sediment particle size at the same transects were also measured with the dry sieving and laser diffraction method. The average concentration of organic carbon was 0.88% while the average grain size was 2.44 ϕ. In this study, the carbon organic showed a significant relationship with the mean size ($p<0.05$) with the organic carbon content increase with the increase of mean size values.

Key words: Estuarine sediment, Pahang river estuary, organic carbon, particle size

INTRODUCTION

Naturally occurring Total Organic Carbon (TOC) in river sediments is a key component in a number of chemical, physical and biological processes. It contributes significantly to acidity of natural waters through organic acids (Goni and Hedges, 1995; Hernes and Benner, 2002), biological activity through light absorption and carbon metabolism and water chemistry through the complexation and mobilization of metals and organic pollutants. By forming organic complexes, TOC can influence nutrient availability and control the solubility and toxicity of contaminants (Cho *et al*., 1998). In general, TOC consists of Dissolved Organic Carbon (DOC) and Particulate Organic Carbon (POC). Dissolved organic carbon is known to be a strong complexing agent for many toxic metals such as iron, copper, aluminum, zinc and mercury. Dissolved organic carbon can also increase the weathering rate of minerals and increase the solubility and thus the mobility and transport of many metals and organic contaminants (Min and Warner, 2003; Kim and Ahn, 2005).

Natural processes and human activities have resulted in elevated content of TOC in soils, sediments and streams. These include diverse inputs from throughfall, stemflow, inappropriate animal waste applications and disposals, forest clear cuttings, agricultural practices and changes in land uses (Como *et al*., 2007). Only limited work has been done on the organic matter, both in the sediment and in the suspended sediment in Malaysian rivers (Alongi *et al*., 2002, 2004). 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 (Tesi *et al*., 2007a; Bird *et al*., 2008; Kulinski and Pempkowiak, 2008), data on the coastal water and rivers of Malaysia are still limited. In recent years, the study area especially for the first km along the Kuala Pahang estuary has been heavily impacted by discharges from municipal and industrial outflows. This was due to the rapid development of the area via expansion of the industrialization area as well as the increase in population. The aim of this work was to determine the total organic carbon distribution in the area, their source and mode of incorporation in their sediments with regards to the sedimentological conditions of the area.

MATERIALS AND METHODS

Sampling sites and sample collection: The study was carried out at Pahang river estuary. Pahang river estuary located at Pekan which is situated 50 km South of Kuantan. The samples were collected from 62 stations (Fig. 1) during post-monsoon season in April 2008 using the ponar grab (Bianchi *et al*., 2007). This area has a humid tropical climate with two monsoon periods,

Corresponding Author: B.Y. Kamaruzzaman, Institute of Oceanography and Maritime Studies, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia

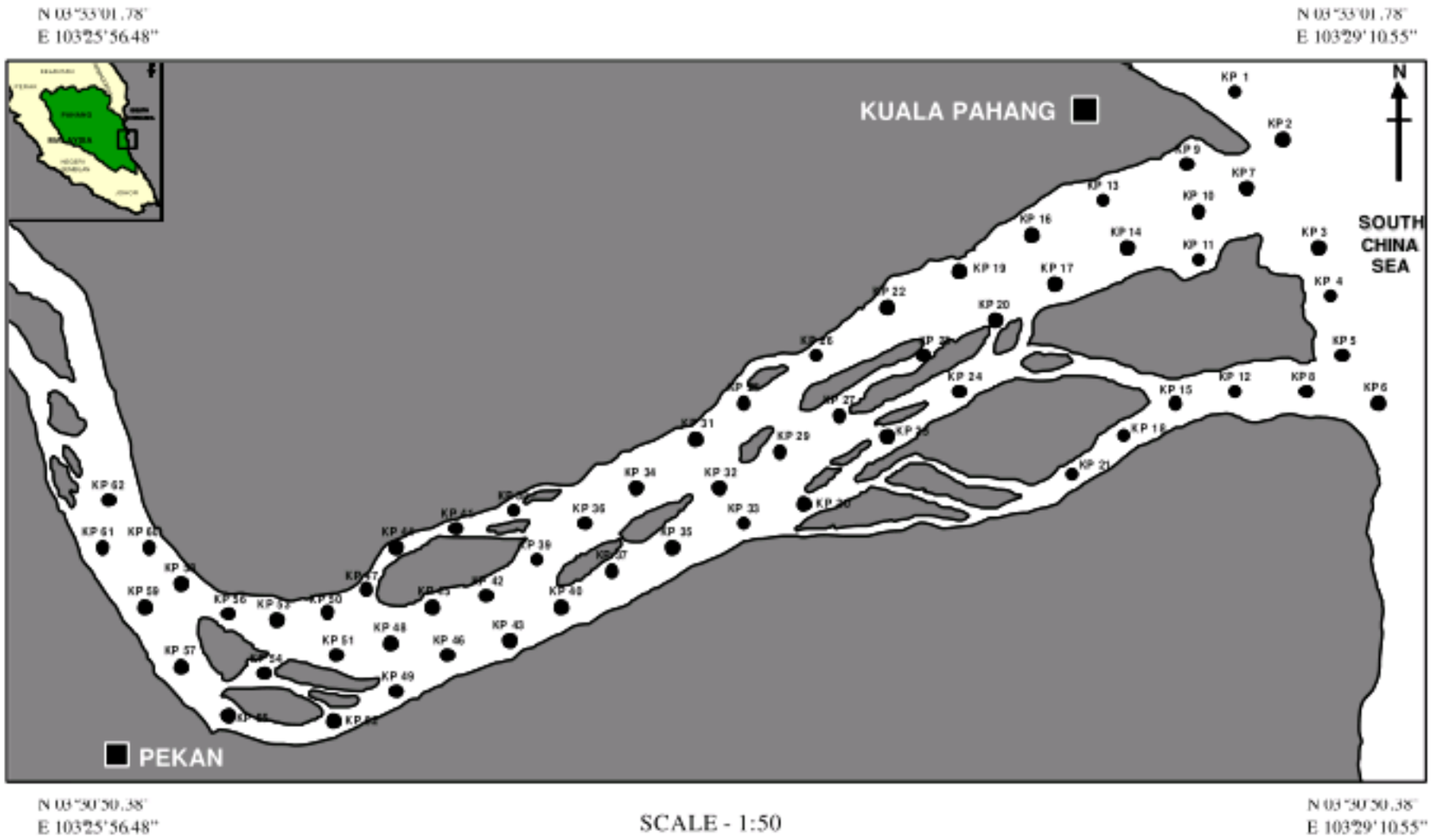

Fig. 1: Location of the study area showing sampling site along Pahang River- Estuary, Pahang

characterized by bimodal pattern: southwest and northeast monsoons bringing an annual rainfall which varies between 1488 to 3071 mm. Pahang is mostly influenced by the semidiurnal tides with two high tides and two low tides, within a lunar day.

Analytical method

Total Organic Carbon (TOC) analysis: The organic carbon in this study were determined using the total organic carbon analyzer, model TOC-V 5000/5050, Shimadzu, Japan (Temnerud *et al*., 2007; De-Vittor *et al*., 2008). Briefly, about 20 mg sediment samples were weighted in the tin crucible sample boats and were burnt in the furnace for 30 min at temperature 900°C. The total organic carbon was then calculated by subtracting the Inorganic Carbon (IC) from the Total Carbon (TC) that was obtained from the total organic carbon analyzer. The precision assessed by replicate analyses was within 3%. The accuracy was also examined by analyzing, in duplicate a reference materials of glucose and the results coincided with the certified values within a difference of ±3%.

Sediment characteristic analysis: For the sediment characteristics analysis, surface sediment at all sampling points along each transects were collected during low tides. The grain size is expressed in phi (ϕ) units defined by $\phi = - \log_2 d$ where d is a diameter of grain in mm (Ergin *et al*., 2007). By using the negative value, coarse grain size will have a lower phi (ϕ) value which tend to increase when the particles size become finer. A sample which consists of more than 90% sand were analyzed using the dry sieving and wet sieving techniques. Meanwhile samples having more than 90% fine sediments were analyzed using the laser diffraction method (PSA). For the PSA method, the organic components were first removed by adding 20% hydrogen peroxide (H_2O_2) solution to the samples. The floc of finer particles was destroyed by adding a dispersing agent (5% calgon solution). Sediments collected composed of mostly (80% by weight) fine sediments, while is still within the detection limit of the laser diffraction machine. Thus, sediment grain size was analyzed using the laser diffraction method only. The mean, standard deviation and skewness of each sample were calculated by the moment's method using equations defined by Saye and Pye (2005).

RESULTS AND DISCUSSION

The organic carbon distributions in this study were presented in Fig. 2. In this study, the organic carbon content averaging 0.88% and varied from 0.09 to 2.05%. The highest concentration was found at St. 49, while the lowest concentration was found at St. 39. Burns *et al*. (2008) reported that the organic carbon was highest in

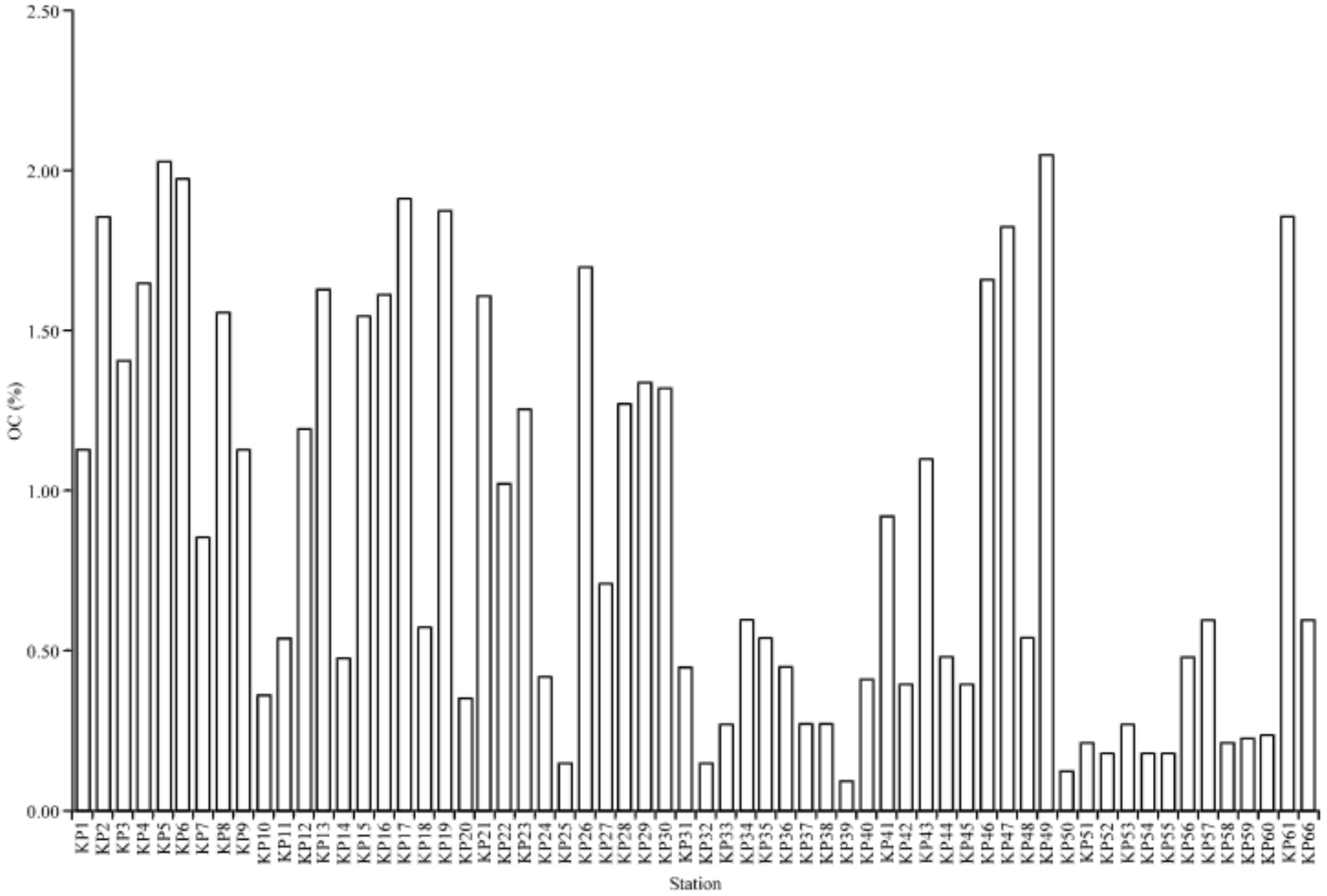

Fig. 2: Distribution of organic carbon content in Kuala Pahang River

mixing zone where the processes of flocculation were maximums. Overall, the average value was higher than the sediment from the open ocean (Tesi *et al*., 2007b; Cha *et al*., 2007; De-Vittor *et al*., 2008). The actual reason for the higher percentage of organic carbon in would be probably that primary productivity input terrestrial organic matter, preferential decomposition and grazing by benthic organisms are dominantly found in Kuala Pahang River. Meanwhile, the high concentration of organic carbon observed near the estuary could be attributed to organic matter from the industrial and municipal wastewater. When compared with other studies, the organic carbon content in the study areas were relatively higher than the coastal water of Terengganu (Chandru *et al*., 2008) and are generally lower than those reported by Al-Ghadban (1990) in the Arabian Gulf. The sedimentological characteristics of Kuala Pahang estuary, like most other coastal environments, are much dependent upon the combination of physical forces such as freshwater runoff, tidal currents and waves (Van-Santeen *et al*., 2006; Xu, 1999). In this study area, particle mean size ranged from -0.770 to 7.227ϕ with the average of 2.44±3.21ϕ. Figure 3 shows the relationship between organic carbon and particle mean size. The

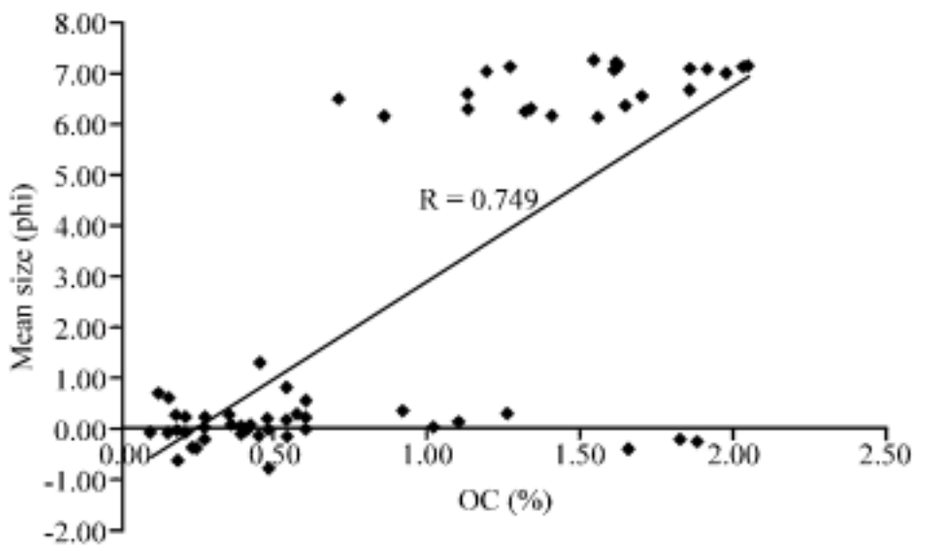

Fig. 3: Correlation of organic carbon concentration (%) and mean size (Φ) in Pahang River- Estuary

organic carbon concentration shows a strong correlation (r = 0.749) with mean size (Fig. 3). According to Soto-Jimenez *et al*. (2003), size particle plays a role in bonding organic carbon where 10 to 20% of organic carbon matter is believed to bond to fine particle (<4 μm). A study by Jia *et al*. (2002) also explained that the organic matter is mainly attached to the fine grained fraction. Harlin *et al*. (1982) and Kennedy *et al*. (2004) stated that beside the grain size, the sorption of organic matter to the surface of

the individual grains and the possible sheltering of organic matter in small pores in the sediment particles could be the main controlling factor of organic matter content in the sediment.

CONCLUSION

In conclusion, present results indicate that the content of organic carbon in sediment is much influenced by many factors including the physical, biological and chemical processes. The organic content decreases with depth in the sediment, due to decay processes thought to be suboxic and induced by biological processes, sediment oxygenation rather than physical processes. Meanwhile the relative higher organic matter content in estuary areas appears to be derived from allochthonous source from the river and autochthonous reactive part from the algal mats and mangrove trees. However, more details study are suggested such as the combined study of the optical and geochemical approaches in order to have a better understanding of the sedimentary process of the organic matter in the sediment.

ACKNOWLEDGMENTS

This research was conducted with joint funding from the Malaysian Ministry of Science, Technology and Innovations, under the e-Science fund. The authors wish to express their gratitude to the lab assistant of the Oceanography laboratory teams of IIUM for their invaluable assistance and hospitality throughout the sampling period.

REFERENCES

Al-Ghadban, A.N., 1990. Holocene sediments in a shallow bay, southern coast of Kuwait, Arabian Gulf. Mar. Geol., 92: 237-254.

Alongi, D.M., V.C. Chong, P. Dixon, A. Sasekumar and F. Tirendi, 2002. The influence of fish cage aquaculture on pelagic carbon flow and water chemistry in tidally dominated mangrove estuaries of peninsular Malaysia. Mar. Environ. Res., 55: 313-333.

Alongi, D.M., A. Sasekumar, V.C. Chong, J. Pfitzner and L.A. Trott *et al*., 2004. Sediment accumulation and organic material flux in a managed mangrove ecosystem: estimates of land-ocean-atmosphere exchange in peninsular Malaysia. Mar. Geol., 208: 383-402.

Bianchi, T.S., J.J. Galler and M.A. Allison, 2007. Hydrodynamic sorting and transport of terrestrially derived organic carbon in sediments of the Mississippi and Atchafalaya Rivers. Estuarine Coastal Shelf Sci., 73: 211-222.

Bird, M.I., R.A.J. Robinson, N. Win-Oo, M. Maung Aye and X.X. Lu *et al*., 2008. A preliminary estimate of organic carbon transport by the Ayeyarwady (Irrawaddy) and Thanlwin (Salween) Rivers of Myanmar. Q. Intl., 186: 113-122.

Burns, K.A., G. Brunskill, D. Brinkman and I. Zagorskis, 2008. Organic carbon and nutrient fluxes to the coastal zone from the sepik river outflow. Continental Shelf Res., 28: 283-301.

Cha, H.J., M.S. Choi, C.B. Lee and D.H. Shin, 2007. Geochemistry of surface sediments in the Southwestern East/Japan Sea. J. Asian Earth Sci., 29: 685-697.

Chandru, K., M.P. Zakaria, S. Anita, A. Shahbazi, M. Sakari, P.S. Bahry and C.A.R. Mohamed, 2008. Characterization of alkanes, hopanes and polycyclic aromatic hydrocarbons (PAHs) in tar-balls collected from the East Coast of Peninsular Malaysia. Mar. Pollut. Bull., 56: 950-962.

Cho, Y.G., C.B. Lee and M.S. Choi, 1998. Geochemistry of surface sediments off the Southern and Western Coasts of Korea. Mar. Geol., 159: 111-129.

Como, S., P. Magni, D. Casu, A. Floris and G. Giordani *et al*., 2007. Sediment characteristics and macrofauna distribution along a human-modified inlet in the Gulf of Oristano (Sardinia, Italy). Mar. Pollut. Bull., 54: 733-744.

De-Vittor, C., A. Paoli and S.F. Umani, 2008. Dissolved organic carbon variability in a shallow coastal marine system (Gulf of Trieste, Northern Adriatic Sea). Estuarine Coastal Shelf Sci., 78: 280-290.

Ergin, M., S. Keskin, A.U. Dogan, Y.K. Kadioglu and Z. Karakas, 2007. Grain size and heavy mineral distribution as related to hinterland and environmental conditions for modern beach sediments from the Gulfs of Antalya and Finike, Eastern Mediterranean. Mar. Geol., 240: 185-196.

Goni, M.A. and J.I. Hedges, 1995. Sources and reactivities of marine-derived organic matter in coastal sediments as determined by alkaline CuO oxidation. Geochimica Cosmochimica Acta, 59: 2965-2981.

Harlin, M.M., B. Thorne-Miller and J.C. Boothroyd, 1982. Seagrasse sediment dynamics of a flood-tidal delta in Rhode Island (USA). Aquat. Bot., 14: 127-138.

Hernes, P.J. and R. Benner, 2002. Transport and diagenesis of dissolved and particulate terrigenous organic matter in the North Pacific Ocean. Deep Sea Res. Part: 1 Oceanographic Res. Papers, 49: 2119-2132.

Jia, G., P. Peng and D. Fang, 2002. Burial of different types of organic carbon in core 17962 from South China Sea since last glacial period. Q. Res., 58: 93-100.

Kennedy, H., E. Gacia, D.P. Kennedy, S. Papadimitriou and C.M. Duarte, 2004. Organic carbon sources to SE Asian coastal sediments. Estuarine Coastal Shelf Sci., 60: 59-68.

Kim, H.S. and S.M. Ahn, 2005. Three dimensional hydrodynamic eutrophication model (HEM-3D): Application to Kwang-Yang Bay, Korea. Mar. Environ. Res., 60: 171-193.

Kulinski, K. and J. Pempkowiak, 2008. Dissolved organic carbon in the Southern Baltic Sea: Quantification of factors affecting its distribution. Estuarine Coastal Shelf Sci., 78: 38-44.

Min, D.H. and M.J. Warner, 2003. Basin-wide circulation and ventilation study in the East Sea (Sea of Japan) using chlorofluorocarbon tracers. Deep Sea Res. Part II: Top. Stud. Oceanography, 52: 1580-1616.

Saye, S.E. and K. Pye, 2005. Variations in chemical composition and particle size of dune sediments along the west coast of Jutland, Denmark. Sedimentary Geol., 183: 217-242.

Soto-Jimenez, M., F. Paez-Osuna and A.C. Ruiz-Fernandez, 2003. Geochemical evidences of the anthropogenic alteration of trace metal composition of the sediments of Chiricahueto marsh (SE Gulf of California). Environ. Pollut., 125: 423-432.

Temnerud, J., J. Seibert, M. Jansson and K. Bishop, 2007. Spatial variation in discharge and concentrations of organic carbon in a catchment network of boreal streams in Northern Sweden. J. Hydrol., 342: 72-87.

Tesi, T., S. Miserocchi, M.A. Goni and L. Langone, 2007a. Source, transport and fate of terrestrial organic carbon on the Western Mediterranean Sea, Gulf of Lions, France. Mar. Chem., 105: 101-117.

Tesi, T., S. Miserocchi, M.A. Goni, L. Langone, A. Bolfrin and M. Turchetto, 2007b. Organic matter origin and distribution in suspended particulate materials and surficial sediments from the Western Adriatic Sea (Italy). Estuarine Coastal Shelf Sci., 73: 431-446.

Van-Santen, P., P.G.E.F. Augustinus, B.M. Janssen-Stelder, S. Quartel and N.H. Tri, 2006. Sedimentation in an estuarine mangrove system. J. Asian Earth Sci., 29: 566-575.

Xu, J.X., 1999. Grain-size characteristics of suspended sediment in the Yellow River, China. Catena, 38: 243-263.