



Baseline

Assessment of heavy metal pollution in surficial sediments from a tropical river-estuary-shelf system: A case study of Kelantan River, Malaysia



Ai-jun Wang^{a,*}, Chui Wei Bong^{b,c}, Yong-hang Xu^a, Meor Hakif Amir Hassan^b, Xiang Ye^a, Ahmad Farid Abu Bakar^b, Yun-hai Li^a, Zhi-kun Lai^a, Jiang Xu^a, Kar Hoe Loh^b

^a Laboratory for Coast and Ocean Geology, Third Institute of Oceanography (TIO), State Oceanic Administration of China, Xiamen 361005, China

^b Institute of Oceanography and Earth Science (IOES), University of Malaya, Kuala Lumpur 50603, Malaysia

^c Institute of Biological Sciences, University of Malaya, Kuala Lumpur 50603, Malaysia

ARTICLE INFO

Keywords:

Heavy metal pollution
Grain size
Total organic carbon
Source-to-sink
Kelantan river-estuary-shelf system

ABSTRACT

To understand the source-to-sink of pollutants in the Kelantan River estuary and the adjacent shelf area in Malaysia, a total of 42 surface sediment samples were collected in the Kelantan River-estuary-shelf system to analyze for grain size, total organic carbon (TOC) content, Al and heavy metals (Cr, Ni, Cu, Zn, Cd and Pb). The surficial sediments were mainly composed of clayey silt and the TOC content in sediments decreased from the river to the shelf. The surficial sediments experienced Pb pollution; Cr only showed a certain level of pollution in the coastal area of the estuary but not in other areas, and Ni, Cu, Zn, and Cd showed no pollution. The heavy metals mainly originated from natural weathering and erosion of rocks and soils in the catchment and enriched near the river mouth. Total organic carbon can promote the enrichment of heavy metals in sediments.

A critical issue of current global concern is environmental pollution resulting from increasing human activities, particularly in areas such as rivers, estuaries, and coastal waters that are closely linked to human survival. As the intensity of human activities continues to increase, the global sediment flux from rivers into the sea has decreased significantly worldwide, leading to changes in the material transport pattern of estuaries and adjacent sea areas (Syvitski et al., 2005). However, in the tropics, increasing human activities in river basins have aggravated the destruction of tropical rainforests in recent years. In the background of heavy rainfall, the sediment flux from rivers into the sea has increased, making the biogeochemical cycling processes more complex in tropical estuaries and adjacent shelf areas (Syvitski et al., 2005).

Malaysia is a country in Southeast Asia with relatively high socio-economic development. Since the 1980s, the water environment in most areas of Malaysia has suffered a certain level of pollution (Abdullah, 1995; Muyibi et al., 2008; Yap et al., 2011; Looi et al., 2013), seriously affecting local socio-economic development and the safety of people's lives and property. In recent years, there has been gradually increasing investigation and research into marine heavy metal pollution in Malaysian coastal area, especially estuaries and seaport areas closely related to human activities (Din, 1995; Yap et al., 2002; Sany et al., 2013; Yusoff et al., 2015; Shaari et al., 2015).

The Kelantan River basin is located in the northwestern part of Malaysia. The range of this river basin covers the entire Kelantan state,

and it flows into the South China Sea through the vicinity of Kota Bharu, the state capital of Kelantan. The entire river basin covers an area of 13,100 km², and its highest altitude is 2135 m; approximately 95% of the river basin area is steep mountains, and only 5% of the basin area is lowland plains (Koopmans, 1972; Ayane, 1998; Milliman and Farnsworth, 2011). The upstream mountains are mainly covered by primary tropical rainforests, while paddy, rubber and oil palm are planted midstream and downstream. Along with the consistent local socio-economic development, the water environment of the Kelantan River basin has shown a certain level of heavy metal pollution in recent years (Ahmad et al., 2009; Yen and Rohasliney, 2013; Ab Razak et al., 2016); and, heavy metals are enriched in vegetables and fish (Aweng et al., 2011; Hashim et al., 2014; Khairiah et al., 2014), affecting the livelihood and production activities of local residents. There has been little research on heavy metal contamination in sediments from estuarine wetlands and adjacent shelf areas (Abdulla et al., 2012). Additionally, previous studies have not investigated the river, the estuary, and the adjacent shelf area as an integrated system. Various materials in the river basin are discharged through the river into the estuary and then into coastal waters. Various processes of materials in this system contribute to system behaviors, and a change in each link will alter the system behavior. Moreover, the main human activities are dominated by agricultural development in the range of the Kelantan River basin. However, with continuous socio-economic development, a certain level

* Corresponding author.

E-mail address: wangaijun@tio.org.cn (A.-j. Wang).