Review

Heavy metal pollution in coastal areas of South China: A review

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ABSTRACT

Coastal areas of South China face great challenges due to heavy metal contamination caused by rapid urbanization and industrialization. In this paper, more than 90 articles on levels, distributions, and sources of heavy metals in sediments and organisms were collected to review the status of heavy metal pollution along coastal regions of South China. The results show that heavy metal levels were closely associated with local economic development. Hong Kong and the Pearl River Estuary were severely contaminated by heavy metals. However, concentrations of heavy metals in sediments from Hong Kong have continually decreased since the early 1990s. High levels of heavy metals were found in biota from Lingdingyang in Guangdong province. Mollusks had higher concentrations of heavy metals than other species. Human health risk assessments suggested that levels of heavy metals in some seafood from coastal areas of South China exceeded the safety limit.

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1. Introduction

Since the 1950s and the occurrence of the cadmium-caused Itai–itai disease and the mercury-caused Minamata disease in Japan, heavy metals contamination, especially in marine environments, has been of great concern because of their inherent toxicity, vast sources, persistence, and non-degradability. Anthropogenic sources of heavy metals derived from mining, smelting, agriculture, the petrochemical industry, printing, aquaculture, the electronic industry and municipal waste are ultimately discharged into the marine environment where they can be bioaccumulated by marine organisms and even biomagnified through the food chain, resulting in elevated levels in predatory organisms (Rainbow and Luoma, 2011). The

levels of heavy metals in marine ecosystems deserve much attention because of their potential ecological effects and public concern for seafood safety (Wang et al., 2005). Therefore, better understanding the current pollution status of heavy metals in coastal ecosystems is significant for the seafood industry, public health concerns, and the sustainable development of marine ecosystems.

With rapid urbanization and industrialization, coastal areas of China are now facing great challenges in regard to heavy metal contamination. A large number of studies reported that many coastal regions of China have been seriously polluted by heavy metals (Wan et al., 2008; Ding et al., 2009; Fang et al., 2009; Deng et al., 2010). Heavy metal contamination along coastlines varies with the local economic development, pollution sources and geographical conditions (Pan and Wang, 2012b).

South China covers Guangdong and Hainan provinces, Guangxi Zhuang Autonomous Region, Hong Kong and Macao Special Administrative Regions (the administrative levels of autonomous regions, special administrative regions and provinces are equivalent) (Fig. 1). Hong Kong, Macao, and Guangdong provinces are traditional industrial areas, while Guangxi and Hainan provinces are traditional agricultural regions. Additionally, Guangxi and Hainan are well-known tourist destinations. Although heavy metal pollution in coastal areas of southern China was considered to be better than in the northern part, some regions, e.g., Hong Kong and the Pearl River Estuary (PRE), have been listed as "hot spots" for being severely polluted by heavy metals (Pan and Wang, 2012b). More importantly, heavy metal contamination in coastal areas of South China has some special features because of the types of industry present, the time of onset of industrialization and characteristics of geography: (1) The rapid growth of the economy in South China since the reform and opening-up policy in 1978 has been accompanied by considerable environmental side effects, especially in the local elec-

tronics industry which has produced remarkable heavy metal pollution (Wong et al., 2007); (2) South China is located in the tropical and subtropical regions where the coastal areas support distinctive marine ecosystems, namely, coral reefs, sea grass and mangroves (Vane et al., 2009); and (3) The fishing industry and aquaculture have been rapidly booming in South China for decades. In 2010, Guangdong, Guangxi, and Hainan provinces produced 4.02×10^6, 1.54×10^6, 1.18×10^6 tons of seafood products, respectively (MA, 2011). In addition to domestic consumption, a considerable fraction of aquatic products have also been exported to other countries. Therefore, it is essential to understand heavy metal levels and their potential hazardous risk to marine ecosystems and humans.

Heavy metal pollution along the coastlines of China in the past 10 years was reviewed by Pan and Wang (2012b), which only covered parts of organisms and several representative coastal regions in South China. However, the Pearl River Delta has become one of the most rapidly developed regions in China over the past decades, and the rapid growth of industrial and agricultural activities, municipal development and the large use of chemicals have caused serious pollution problems in this region. PRE has been a main source of persistent organic pollutants released into the adjacent South China Sea (Fu et al., 2003), which is the largest open sea in China with military, political and scientific significances. In this review, papers published in both international and Chinese journals from past decades on heavy metal pollution in sediments and organisms from coastal areas of South China have been collected. The aim of this review is to present a comprehensive understanding of heavy metal concentrations, distributions, and sources in sediments and marine organisms from this region. Heavy metal pollution in seawater is not addressed because it is difficult to determine levels of heavy metals in seawater, as they can change
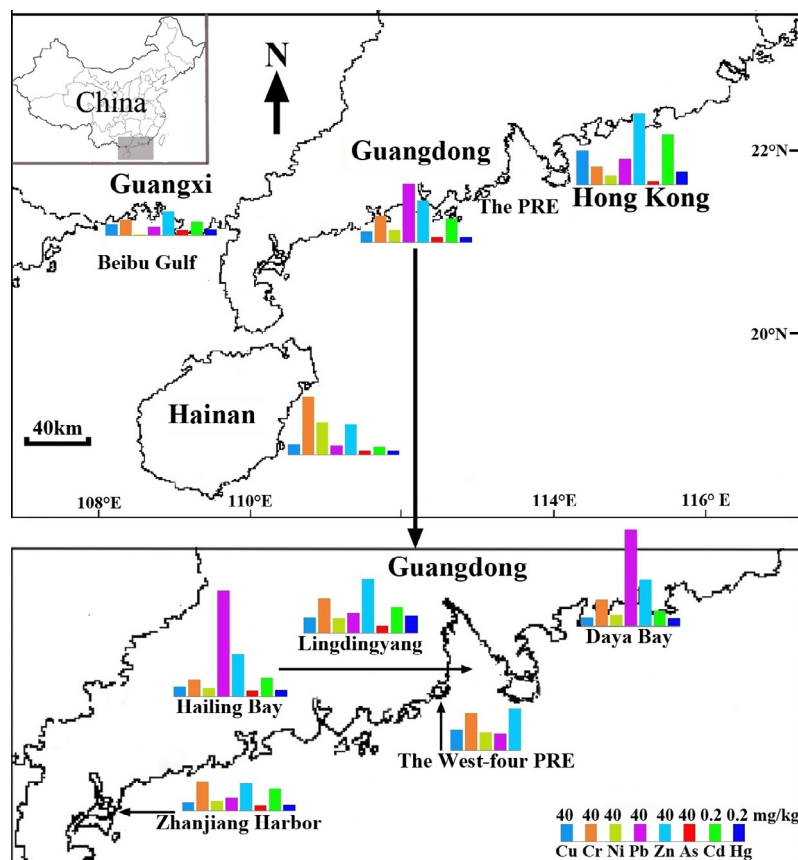

Fig. 1. Heavy metal concentrations in sediments from different regions of South China.