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Baseline

Baseline survey of sediments and marine organisms in Liaohe Estuary: Heavy metals, polychlorinated biphenyls and organochlorine pesticides

Hongjun Li [a], Sheng Ye [b], Jinqing Ye [a], Jingfeng Fan [a,*], Meiling Gao [c], Hao Guo [a]

[a] Marine Ecology Department, National Marine Environmental Monitoring Center, Dalian 116023, China
[b] College of Fisheries and Life Science, Dalian Ocean University, Dalian 116023, China
[c] School of Life Science and Biotechnology, Dalian University of Technology, Dalian 116024, China

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ABSTRACT

A geographically extensive investigation was carried out to analyze the concentrations of heavy metals, PCBs and OCPs in the sediments and marine organisms collected from the Liaohe Estuary. In order to determine the spatial distribution and potential ecological risk of heavy metals, the surface sediments were collected from 44 sites in the Liaohe Estuary. The results showed that the heavy metal contents in the sediments were observed in the following order: Cr (11.2–84.8 mg/kg) > Cu (1.7–47.9 mg/kg) > Pb (4.3–28.3 mg/kg) > As (1.61–12.77 mg/kg) > Cd (0.06–0.47 mg/kg) > Hg (0.005–0.113 mg/kg). In comparison with the concentrations of heavy metals and POPs in other regions, the concentrations of As, Pb and DDTs in the Liaohe Estuary were generally low, and other pollutant concentrations were inconsistent with those reported in other regions. The contamination factor (CF), the pollution load index (PLI), the geoaccumulation index and the potential ecological risk index were used to analyze the pollution situation, which showed that the heavy metal pollution in Liaohe Estuary is mainly dominated by Cd and Hg. The concentrations of the four heavy metals varied significantly in the three kinds of tested organisms (fish, mollusk and crustacean), indicating the different accumulative abilities of the species. The results obtained in this study provide useful information background information for further ecology investigation and management in this region.

With the rapid population growth in coastal regions, anthropogenic contaminations have resulted in the current worldwide deterioration of aquatic environment, and attracted global attention in recent years (Fu and Wang, 2011). The coastal and estuarine ecosystems are facing increasing metal pollution pressures in China. Heavy metals are being introduced to aquatic environment through a variety of natural and anthropogenic sources, including industrial and domestic discharges, mining, smelting, and e-wastes recycling (Pan and Wang, 2012). Terrestrial runoff is one of the most common way for metals entering into coastal environment. Coastal sediments always act as the final repository of various contaminants, and important sinks for metals through sedimentation (Chapman et al., 1998). Toxic metals have the tendency to accumulate by marine organisms and transfer to human via food chain, which pose a serious threat to public health. Thus, it is important to monitor their concentrations in the multiphase media for seafood safety and consumer health.

Persistent organic pollutants are subject to long-range transport, and regarded as ubiquitous contaminants in the marine environment, even present in remote and pristine areas (Klánová et al., 2008). They are of great concern for their persistent, highly accumulative nature as well as toxic biological effects. Polychlorinated biphenyls (PCBs) are introduced in the 1930s and have been used in a variety of applications as dielectric and hydraulic fluids. PCBs were banned at the end of 1970s and included in the first list of the 12 initial POPs (Xing et al., 2005). Dichlorodiphenyltrichloroethanes (DDTs) hexachlorocyclohexanes (HCHs) and are two types of popular organochlorine pesticides (OCPs). DDTs were extensively used worldwide in the 1940s and 1950s as an insecticide. It was prohibited in the 1970s and 1980s due to its negative effects on animal and human health (Turusov et al., 2002). DDTs and HCHs are still being produced and used in some developing countries because of their broad-spectrum killing characteristics. China is a large producer and user of DDTs and HCHs in the world. Technical DDTs and HCHs were widely used between 1950s and 1980s, until the production of DDTs and HCHs was officially prohibited in 1983 (Gong et al., 2007). However, measurable concentrations of DDTs and HCHs still exist in marine environment and organisms in China (Xu et al., 2013; Wang et al., 2014).

Liaohe Estuary is an important ecological and economical region in the northeast of the Bohai Sea. The Liao River watershed includes Daliao watersystem (Hun River, Taizi River, and Daliao River) and Liao River watersystem (Liao River). The Liahe River Delta Wetland has been ranked as the largest bulrush wetland and the second largest swamp in the world. It provides important habitat for various marine wildlife,

* Corresponding author.
E-mail address: jffan@nmemc.org.cn (J. Fan).

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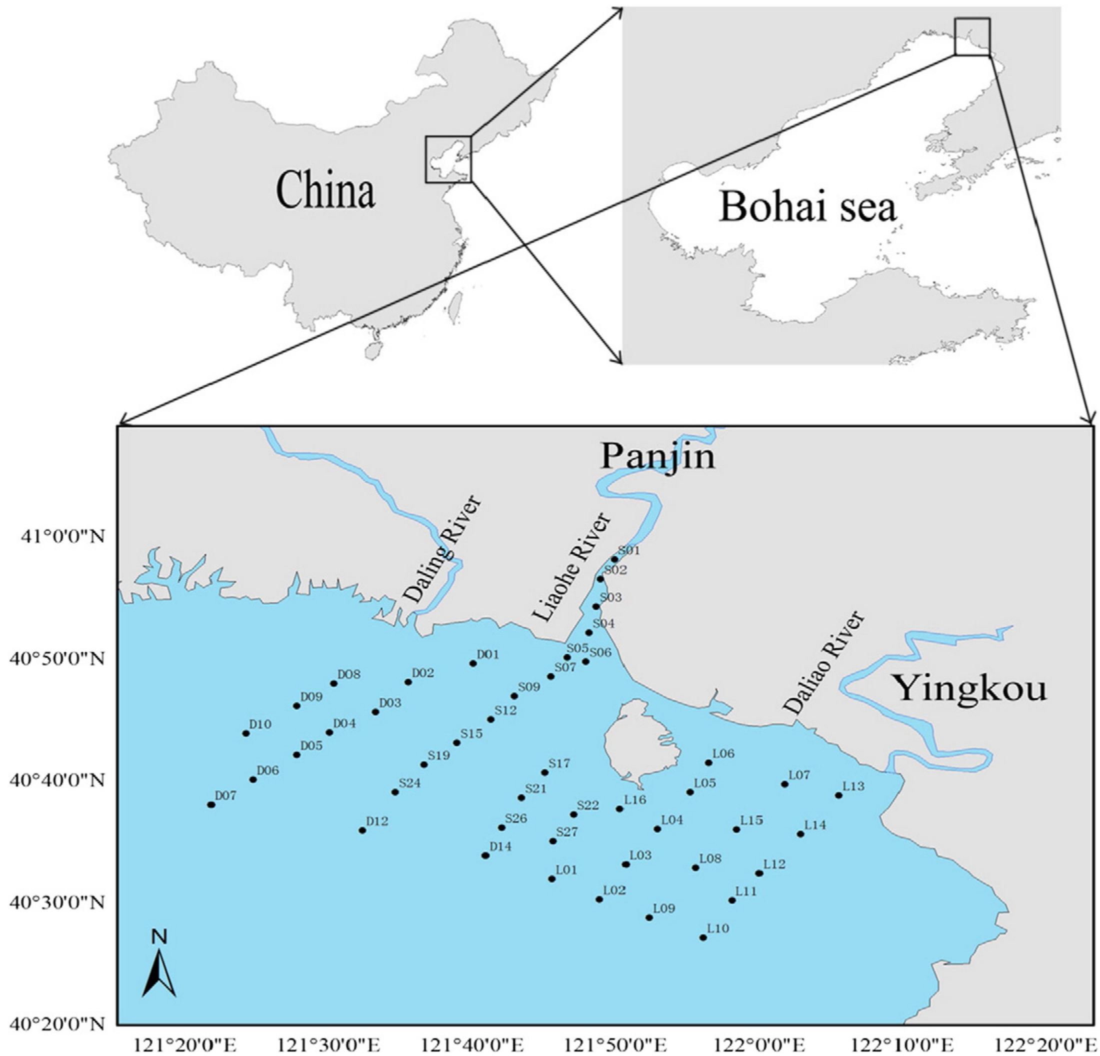

Fig. 1. Study area showing the location of sampling sites in sediment of Liaohe Estuary.

especially for some endangered species, such as spotted seal (*Phoca largha*), Saunders' Gull (*Larus saundersi*) and red-crowned cranes (*Grus japonensis*). The Liaohe River locates in the northeast of the Bohai Sea, discharges into the Liaodong Bay in Panjin City, one of the most polluted coastal areas in China. Therefore, this study aimed to discuss the following issues to benefit the sustainable development of marine ecosystem in this region: (1) to quantify and investigate the spatial distribution of heavy metals, PCBs and OCPs in surface sediments and marine organisms in the Liaohe Estuary; (2) to evaluate their potential ecological risks with ecological risk indices and sediment quality guidelines; (3) to assess their bioaccumulation differences in three kinds of marine organisms (fish, mollusk and crustacean).

Table 1
Comparison of the heavy metals concentrations (mg/kg) in the sediments from the Liaohe Estuary and other coastal areas. Abundance and guideline values of the National Standard of China (NSC, GB18668-2002) were also listed.

	Hg	As	Pb	Cu	Cd	Cr	References
Mean	0.039	6.54	12.86	14.94	0.175	49.04	This study
Range ($n = 44$)	0.005–0.113	1.61–12.77	4.3–28.3	1.7–47.9	0.06–0.47	11.2–84.8	This study
Guadiana Estuary, Spain	0.34	25.5	32.9	50.0	0.20	19.2	Delgado et al. (2010)
Gironde Estuary, France	0.16	18.7	46.8	24.5	0.48	78.4	Larrose et al. (2010)
Liaodong Bay, China	0.04	8.30	31.8	19.4	na	46.4	Hu et al. (2012)
Jiaozhou Bay, China	0.08	8.44	30.87	27.25	0.15	65.47	Wang et al. (2007)
Luoyuan Bay, China	0.06	11.6	30.1	22.9	0.16	35.2	Lin (2008)
Dingzi Bay, China	0.035	7.32	12.67	5.16	0.14	4.06	Pan et al. (2014)
Sanya Bay, China	0.06	7.10	17.5	9.5	0.13	12.4	Qiu and Yu (2011)
Masan Bay, Korea	na	na	44.0	43.4	1.24	67.1	Hyun et al. (2007)
Abundance[a]	0.025	7.7	20	15	0.06	60	Zhao and Yan (1994)
NSC Class I[b]	0.20	20.0	60	35.0	0.50	80.0	SEPA (2002)
NSC Class II[b]	0.50	65.0	130.0	100.0	1.50	150.0	SEPA (2002)

na: not available.
[a] Natural abundance of the elements.
[b] Values are the upper limit for the grades.