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The Influences of Spatial-temporal Changes of Source Input on the Changes of Cd in Marine Bay

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Abstract. Using investigation on Cd in May and August,1990, this paper analyzed the spatial-temporal changes of Cd sources and the influences on spatial-temporal changes of Cd in Jiaozhou Bay. The horizontal distributions in May and August were different, and the vertical variations in different sampling sites were also different. The major Cd sources were the wharf and atmosphere deposition, whose source strengths were 1.02 μg L^{-1} and 1.26 μg L^{-1}, respectively. From May to August, the major Cd source was changing from the wharf to atmosphere deposition, resulting in the changes of the source strengths and the source input locations, and therefore the spatial-temporal changes of Cd contents in the bay.

1. Introduction

Along with the rapid increasing of economic and developing of industry, a large amount of wastes are generated, yet the waste treatment in many countries and regions is always lagging [1−6]. Therefore, a lot of wastes are discharged to the soil, water, air, and to the ocean since ocean is the sink of various pollutants [7−18]. Understanding the migration process of the substance in marine bay is essential to environmental protection and remediation [19−21]. Jiaozhou Bay is a semi−closed bay located in Shandong Province, China. This bay is surrounded by cities of Qingdao, Jiaozhou and Jiaonan. This bay has been polluted since 1980s due to the rapid increase of industry and economic [22−32]. Using investigation on Cd in May and August, 1990, this paper analyzed the spatial-temporal changes of Cd sources and the influences on spatial-temporal changes of Cd in Jiaozhou Bay. The aim of this paper is to provide scientific basis for research on the migration process of pollutants in marine bay.

2. Materials and method

2.1 Study area. Jiaozhou Bay (120°04′-120°23′ E, 35°55′-36°18′ N) is located in the south of Shandong Province, eastern China (Fig. 1). It is a semi-closed bay with the total area, average water depth and bay mouth width of 446 km^2, 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo Rriver, Licun Rriver, and Loushan Rriver [33−34].

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2.2 Data source. The data was provided by North China Sea Environmental Monitoring Center. The investigations were conducted in May and August, 1990, respectively. Surface and bottom water samples in 2 sampling sites (i.e., 55 and 60) were collected and measured followed by National Specification for Marine Monitoring (Fig. 1) [35].

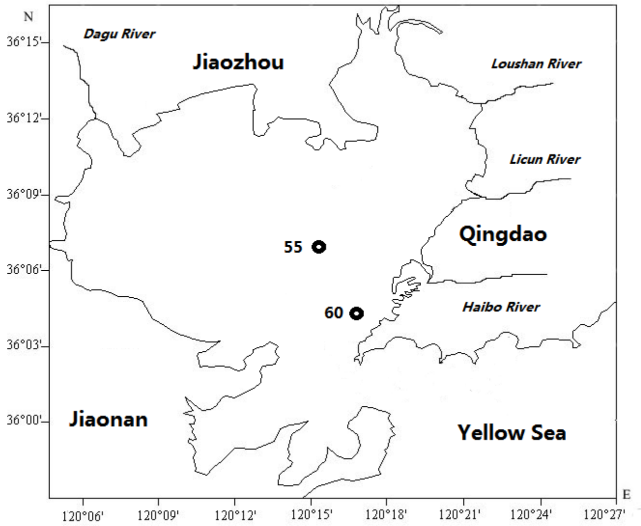

Fig. 1 Geographic location and monitoring sites in Jiaozhou Bay

3. Results and discussion

3.1 Spatial variation of Cd. In May, 1990, Cd contents in surface waters were relatively high in the wharf in the east of the bay (1.02 μg L^{-1}). There was a high value region in the east of the bay, and the contour lines of Cd contents were forming a series semi-circles that decreasing from the east of the bay to the bay center (0.35 μg L^{-1}). In August 1990, Cd contents in surface waters were relatively high in the bay center (1.26 μg L^{-1}). There was a high value region in the bay center, and the contour lines of Cd contents were forming a series circles that decreasing from the bay center to the bay mouth(0.22 μg L^{-1}) (Fig. 2). It could be found that the horizontal distributions in May and August were different. In order to assess the vertical variation, Cd contents in surface waters in each sampling sites were subtracted by what is in bottom waters. In May 1990, the differences were 0.00 to 0.91 μg L^{-1}, while in August 1990 were 0.04 to 0.78 μg L^{-1}. It could be found that the vertical variations in different sampling sites were also different.

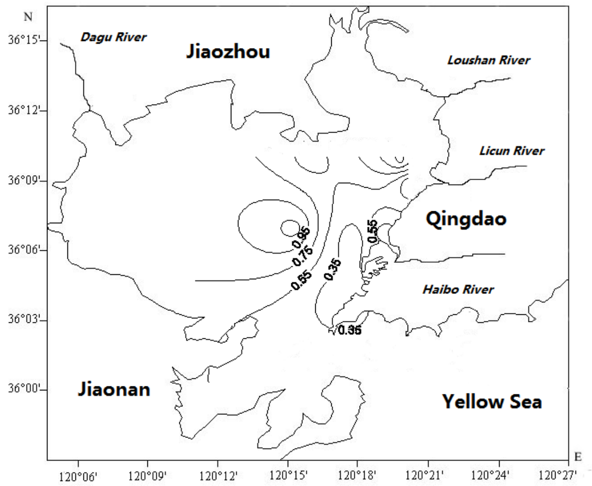

Fig. 2 Horizontal distribution in of Cd contents in surface waters in August 1990 in Jiaozhou Bay

3.2 Spatial-temporal changes of Cd sources. Cd contents in surface waters could be impacted by source input directly, and therefore the major source could be defined according to the horizontal distribution of Cd in surface waters. In May, 1990, Cd contents in surface waters were relative high in the wharf in the east of the bay. This indicated the wharf was the major Cd source in May, 1990. In August, 1990, Cd contents in surface waters were relative high in the bay center. This indicated atmosphere deposition was the major Cd source in August, 1990. From May to August, the major Cd source was changing from the wharf to atmosphere deposition, whose input location were in the east of the bay and the bay center, and whose source strengths were 1.02 μg L^{-1} and 1.26 μg L^{-1}, respectively. In general, the Cd sources were showing spatial-temporal difference.

Table 1 Sources of Cd in May and August 1990

Month	Source	Location	Source strength/μg L^{-1}
May	Wharf	East of the bay	1.02
August	Atmosphere deposition	Bay center	1.26

3.3 Spatial-temporal changes of Cd contents. In May 1990, the Cd source input was in the east of the bay, and Cd content in surface waters in the east of the bay was higher than what in bottom waters. Meanwhile, Cd contents were decreasing from the east of the bay to the bay center, and becoming homogeneous in the bay center. This indicated that the influence of the source input from the wharf in the east of the bay had not impacted Cd contents in the bay center yet, resulted in the homogeneous of Cd contents in the bay center. In August 1990, the Cd source input was in bay center, and Cd contents in surface waters in the bay center and the bay mouth were higher than what in bottom waters. Meanwhile, Cd contents were decreasing from the bay center to the bay mouth. This indicated that the influence of the source input from atmosphere deposition in the bay center had impacted Cd contents in the bay, resulted in the fact that Cd contents in surface waters were higher than what in bottom waters. From May to August, the major Cd source was changing from the wharf to atmosphere deposition, leading to the changes of the source strengths and the source input locations, and therefore the spatial-temporal changes of Cd contents in the bay.

4. Conclusion

The horizontal distributions in May and August were different, and the vertical variations in different sampling sites were also different. The major Cd sources were the wharf and atmosphere deposition, whose source strengths and input locations were different. The Cd sources were showing spatial-temporal difference. From May to August, the major Cd source was changing from the wharf to atmosphere deposition, resulting the changes of the source strengths and the source input locations, and therefore the spatial-temporal changes of Cd contents in the bay.

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