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Seasonal-temporal variations of Cd contents on in Jiaozhou Bay 1984-1988

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Abstract. This paper analyzed the seasonal and spatial variations of Cadmium (Cd) in Jiaozhou Bay during 1984-1988. Results showed that Cd contents in Jiaozhou Bay in 1984, 1985, 1986, 1987 and 1988 were 0.06-0.20 μg L^{-1}, 0.03-0.44 μg L^{-1}, 0.01-6.48 μg L^{-1}, 0.07-0.12 μg L^{-1}, and 0.03-1.07 μg L^{-1}, respectively. The pollution levels of Cd in Jiaozhou Bay in 1984, 1985, 1986, 1987 and 1988 were Grade I, I, I-III and V, I, and I-II, respectively. The seasonal variation of Cd contents was summer > spring > autumn. The pollution level of Cd during 1984-1985 was still slight, while the pullution level during 1986-1988 was tending to be aggravating to be slight/moderate. In general, the source input of Cd to this bay was increasing during the five-year period, and the pollution level of Cd would be aggravating since the water environmental capacity was not infinite. As a whole, source control was one of the basic contourmeasures for pollution control and environmental remediation in this bay.

1 Introduction

Since 1980s, both industry and agricutre in China are developing rapidly [1-2]. Cd is one of the widely used heavy metal elements in industry and agricutre, and a large amount of Cd-containing wastes are generating and discharging to the environmental since the waste treatment was always lagging [3-4]. Many marine bays have been polluted by Cd since ocean is the sink of pollutants [5-6]. Hence, understanding the seasonal and temporal variations of Cd in marine bay is essential to environmental protection and remediation [7-8]. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China, and had been polluted by various pollutants including Cd since 1980s [9-10]. Using investigation on Cd in in Jiaozhou Bay during 1984[7-8]1988, this paper researched the seasonal and temporal variations, and provided basis for research on the vertical migration of Cd in marine bay.

2 Materials and method

Study area and data collection. Jiaozhou Bay is located in the south of Shandong Province, eastern China (35°55′-36°18′ N, 120°04′-120°23′ E). The total area and average water depth are 446 km^2 and 7 m, respectively. The bay mouth is very narrow (3 km), and is connected to the Yellow Sea in the south (Figure 1). There are a dozen of rivers including Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [11-12]. The investigation on Cd in Jiaozhou Bay was carried on by North China Sea Environmental Monitoring Center (Table 1). Cd in waters was sampled and monitored following by National Specification for Marine Monitoring [13].

Table 1 Sampling time of the investigation on Cd in Jiaozhou Bay

Year	April	May	June	July	August	October	November
1984				√	√	√	
1985	√			√		√	
1986	√			√		√	
1987		√		√			√
1988	√			√		√	

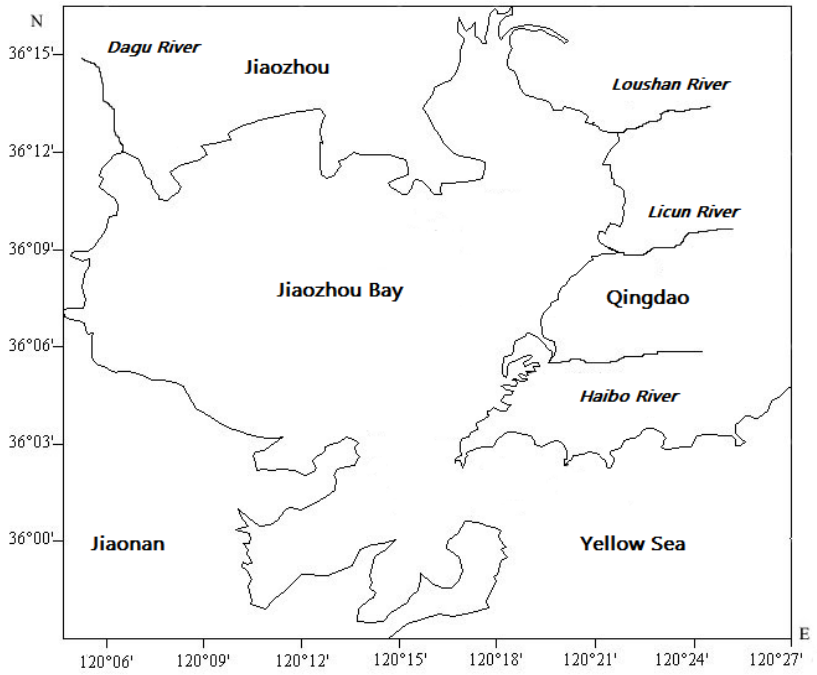

Figure 1 Geographic location of Jiaozhou Bay

3. Results and discussion

Basic status of Cd. Cd contents in Jiaozhou Bay in 1984, 1985, 1986, 1987 and 1988 were 0.06-0.20 μg L^{-1}, 0.03-0.44 μg L^{-1}, 0.01-6.48 μg L^{-1}, 0.07-0.12 μg L^{-1}, and 0.03-1.07 μg L^{-1}, respectively (Table 2). The China Sea Water Quality Standard (GB 3097-1997) establishes guide lines for Cd (Table 3). The pollution levels of Cd in Jiaozhou Bay in 1984, 1985, 1986, 1987 and 1988 were Grade I, I, I-III and V, I, and I-II, respectively (Table 4). In general, the pollution level of Cd during 1984-1985 was still slight, while the pullution level during 1986-1988 was tending to be aggravating to be slight/moderate.

Table 2 Cd contents in Jiaozhou Bay 1984-1988

Content	April	May	July	August	October	November
1984			0.06−0.17	0.10−0.11	0.08−0.20	
1985	0.19−0.44		0.16−0.21		0.03−0.39	
1986	0.01−0.94		0.10−6.48		0.19−0.75	
1987		0.09−0.68	0.08			0.07−0.12
1988	0.09−0.12		0.10−1.07		0.03−0.04	

Table 3 China Sea Water Quality Standard (GB 3097-1997) guide lines for Cd

Grade	I	II	III and V[b]
Content/μg L^{-1}	1.00	5.00	10.00

[b]Guide lines for Cd of Grade III and V are same.

Table 4 Pollution levels of Cd in Jiaozhou Bay 1984-1988

Content	April	May	July	August	October	November
1984			I	I	I	
1985	I		I		I	
1986	I		III and V		I	
1987		I	I			I
1988	I		II		I	

Seasonal variation of Cd. In study area, April and May belong to spring, July, August and September belong to summer, and October and November belong to autumn, respectively. During 1984-1988, the pollution levels of Cd in spring and summer were all meet the Grade I in accoring to the China Sea Water Quality Standard (GB 3097-1997) (Table 5, Table 2). This indicated that the pollution levels of Cd in spring and autumn were very slight during the 5-year time period. However, the pollution levels of Cd in summer could be as serious as Grade III and V in 1986, and could be relative serious as Grade II in 1988 (Table 5). This indicated that pollution levels of Cd in summer could be slight/moderate. In general, the seasonal variation of Cd contents was summer > spring > autumn, so was the seasonal variation of the pollution levels of Cd.

Table 5 Pollution levels of Cd in different seasons in Jiaozhou Bay 1984-1988

Content	Spring	Summer	Autumn
1984	I	I	I
1985	I	I	I
1986	I	I, III and V	I
1987	I	I	I
1988	I	I−II	I

Temporal variation of Cd. The temporal change of Cd were mainly determined bay the variation of the source input of Cd, as well as the variation of water environmental capacity in this bay. The temporal changes of the maximum values of Cd contents during 1984-1988 tended to be increasing, particularly the maximum value of Cd contents in 1986 could be as high as 6.48 μg L^{-1} (Figure 2). However, temporal changes of the minimum values of Cd contents during 1984-1988 were very disorder and showing no trend (Figure 2). The reason was that the source input of Cd to this bay was increasing during the five-year period, and the pollution level of Cd would be aggravating since the water environmental capacity was not infinite. As a whole, source control was one of the basic contourmeasures for pollution control and environmental remediation in this bay.

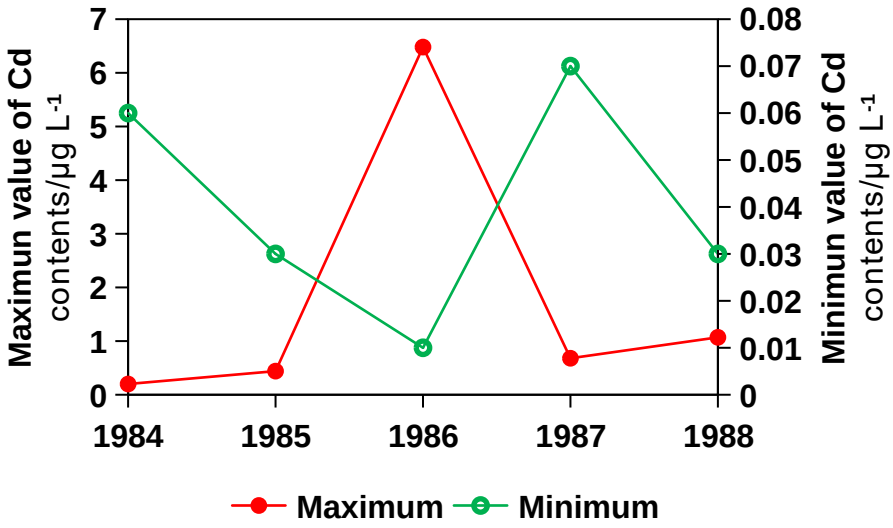

Figure 2 Maximun and minimum values of Cd contents in Jiaozhou Bay 1984-1988

4. Conclusions

The pollution level of Cd during 1984-1985 was still slight, while the pullution level during 1986-1988 was tending to be aggravating to be slight/moderate. The seasonal variation of Cd contents was summer > spring > autumn, as well as the seasonal variation of the pollution levels of Cd. The source input of Cd to this bay was increasing during the five-year period, and the pollution level of Cd would be aggravating since the water environmental capacity was not infinite. Source control was one of the basic contourmeasures for pollution control and environmental remediation in this bay.

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