

The changes of Cd sources in Jiaozhou Bay 1979—1983

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Abstract. Many marine bays have been polluted due to the rapid development of economic and population. Understanding the changes of pollution sources of pollutants in marine bays is essential to pollution control. This paper analyzed the changes of Cd in Jiaozhou Bay during 1979—1983. Results showed that there were six Cd sources including marine current, river flow, island top, atmosphere deposition, overland runoff and wharf, whose source strengths were 0.12-0.25 $\mu\text{g L}^{-1}$, 0.07-0.85 $\mu\text{g L}^{-1}$, 0.48-3.33 $\mu\text{g L}^{-1}$, 0.14-0.55 $\mu\text{g L}^{-1}$, 0.38-0.53 $\mu\text{g L}^{-1}$ and 0.16-1.50 $\mu\text{g L}^{-1}$, respectively. The changes of the sources were mainly determined by human activities, and the distributions of Cd in Jiaozhou Bay were influenced by the spatial-temporal variations of the sources. In general, source control would be necessary countermeasures of pollution control in marine bay.

1. Introduction

Both industry and agriculture in China have been rapidly increasing after reform and opening-up, and many marine bays have been polluted due to the time-lag of water treatment and pollution control. Understanding the changes of pollution sources of pollutants in marine bays is essential to pollution control. Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China. This bay had been polluted by various pollutants including Cd since marine is the sink of pollutants [1-10]. This paper analyzed the changes of Cd in Jiaozhou Bay during 1979—1983, and provided basis information to scientific research and pollution control practice.

2. 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, average water depth and bay mouth width are 446 km², 7 m and 3 km, respectively. This bay is connected to the Yellow Sea in the south. There are a dozen of rivers, and the majors are Dagou River, Haibo River, Licun River, and Loushan River etc., all of which are seasonal rivers [11-12].

The investigation on Cd content in surface waters in Jiaozhou Bay was conducted in May, August, and November 1979, June, July and September 1980, April, August and November 1981, April, June, July and October 1982, and, May, September and November 1983, respectively [1-10]. Cd in waters was sampled and monitored follow by National Specification for Marine Monitoring (Fig. 1)[13].



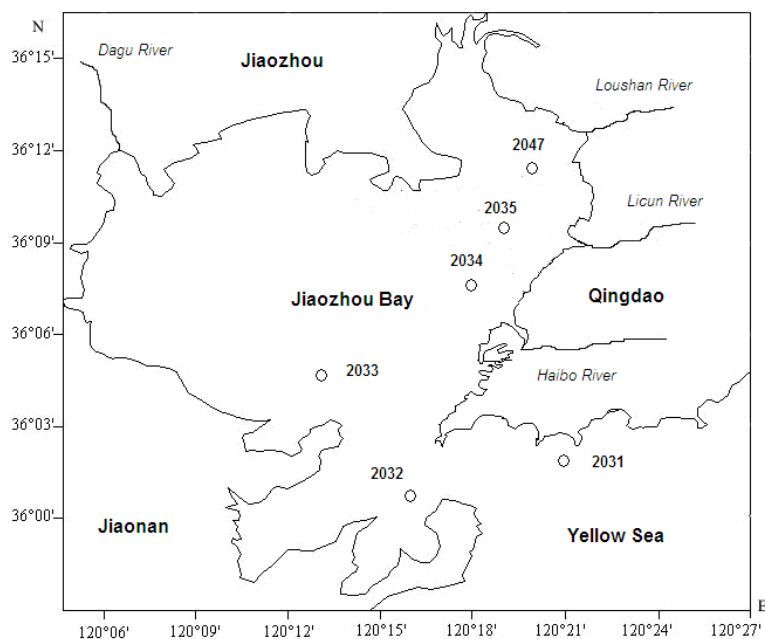


Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

3. Results and discussion

3.1 High value region and pollution source of Cd

The horizontal distributions particularly the high value regions of Cd contents were important evidences for identification of pollution sources. In according to the investigation data on Cd contents, we found the high value regions in different months during 1979–1983 (Table 1). In May, August, and November 1979, high value regions were in estuary of Licun River, estuary of Licun River and Haibo River, and open water, indicated that the major sources were river flow and marine current. In June, July, and September 1980, high value regions were in estuary of Licun River and bay mouth, bay mouth, and open water, indicated that the major sources were river flow, the top of island and marine. In April, August, and November 1981, high value regions were in center of the bay, northeast of the bay, and southwest of the bay, indicated that the major sources were atmosphere deposition and overland runoff. In April, June, July and October 1982, high value regions were in southwest of the bay, estuary of Licun River, southwest of the bay, and southwest of the bay, indicated that major sources were river flow and overland runoff. In May, September and November 1983, high value regions were in east of the bay and the open water, bay mouth, and estuary of Licun River and Haibo River, indicated that the major sources were wharf, river flow, marine current and island top. In general, Cd contents were decreasing from the high value region to waters far away, and the high value regions indicated there were six Cd sources including marine current, river flow, island top, atmosphere deposition, overland runoff and wharf, respectively.

Table 1 High value region of Cd content in different months in Jiaozhou Bay

Month	1979	1980	1981	1982	1983
April			Center of the bay	Southwest of the bay	
May	Estuary of Licun River				East of the bay and the open water
June		Estuary of Licun River and bay mouth		Estuary of Licun River	
July		Bay mouth		Southwest of the bay	
August	Estuary of Licun River and Haibo River		Northeast of the bay		
September		Open water			Bay mouth
October				Southwest of the bay	Estuary of Licun River and Haibo River
November	Open water		Southwest of the bay		

3.2 Changes of pollution source of Cd

In according to the high values, it could be found that the source strengths of the six Cd sources of marine current, river flow, island top, atmosphere deposition, overland runoff and wharf, whose source strengths were $0.12\text{--}0.25\ \mu\text{g L}^{-1}$, $0.07\text{--}0.85\ \mu\text{g L}^{-1}$, $0.48\text{--}3.33\ \mu\text{g L}^{-1}$, $0.14\text{--}0.55\ \mu\text{g L}^{-1}$, $0.38\text{--}0.53\ \mu\text{g L}^{-1}$ and $0.16\text{--}1.50\ \mu\text{g L}^{-1}$, respectively (Table 2). As a whole, the source strengths were ranging from $0.07\text{--}3.33\ \mu\text{g L}^{-1}$, and were showing significant spatial-temporal variations. In comparison, the source strength of island top was highest, and the source strength of wharf was second highest. In according to the guide line of Cd in Grade I ($1.00\ \mu\text{g L}^{-1}$) of National Sea Water Quality Standard (GB 3097-1997), the source strengths of island top and wharf were Grade II, while for the other sources were still confirmed to Grade I. Hence, the pollution level of Cd in Jiaozhou Bay in the early stage of reform and opening-up were still slight. However, it should be noticed that, the source strengths were showing increasing trends during 1979—1983 (Table 2). The changes of the sources were strongly impacted by human activities, and the distributions of Cd in Jiaozhou Bay were influenced by the spatial-temporal variations of the source strengths. For scientific research, the source strength of Cd in the early stage of reform and opening-up could be considered as background level of Cd. For pollution control practice, source control would be necessary countermeasures of pollution control in marine bay.

Table 2 The source strengths of Cd in Jiaozhou bay during 1979—1983/ $\mu\text{g L}^{-1}$

Source	1979	1980	1981	1982	1983
Marine current	0.25	0.12-0.24			
Overland runoff				0.38-0.53	0.41
River flow	0.07-0.85			0.21	0.8
wharf		0.16			0.20-1.50
Island top		0.48			3.33
Atmosphere deposition			0.14-0.55		

4. Conclusion

There were six Cd sources including marine current, river flow, island top, atmosphere deposition, overland runoff and wharf, whose source strengths were $0.12\text{--}0.25\ \mu\text{g L}^{-1}$, $0.07\text{--}0.85\ \mu\text{g L}^{-1}$, $0.48\text{--}3.33\ \mu\text{g L}^{-1}$, $0.14\text{--}0.55\ \mu\text{g L}^{-1}$, $0.38\text{--}0.53\ \mu\text{g L}^{-1}$ and $0.16\text{--}1.50\ \mu\text{g L}^{-1}$, respectively. The pollution level of Cd in Jiaozhou Bay in the early stage of reform and opening-up were still slight, while the source strengths were showing increasing trends. For scientific research, the source strength of Cd in the early stage of reform and opening-up could be considered as background level of Cd. For pollution control practice, source control would be necessary countermeasures of pollution control in marine bay.

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