Quantification of sedimentation and accumulation of Cd in Jiaozhou Bay

Dongfang Yang[1, 2, a], Zhenqing Miao[3, b,c], Haixia Li [1], Hang Zeng[1], Xiaolong Zhang[1]

[1]Accountancy Shool, Xijing University, Xian 710123, China;

[2]North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China;

[3]College of Fisheries, Zhejiang Ocean University, Zhoushan, 316022, China.

[a]dfyang_dfyang@126.com, [b] corresponding author, [c]mzq@zjou.edu.cn.

Keywords: Cd; Sedimentation; Accumulation; Quantification; Jiaozhou Bay.

Abstract: Sedimentation and accumulation are important transporting processes of pollutants in marine bay, and the quantification of these processes are essential to pollution control. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. Based on investigation data on Cd during 1979—1983, this paper analyzed the vertical variations of Cd, and quantified the sedimentation and accumulation of Cd. Results showed that the absolute sedimentation amount and relative sedimentation amount of Cd were 0.23—3.23 μg L^{-1} and 79.2%—100.0%, respectively, while for absolute accumulation amount and relative accumulation amount were 0.08—1.97 μg L^{-1} and 75.4%—100.0%, respectively.

1. Introduction

A large amount of Cd-containing wastes were discharged to marine bays Along with the rapid development of industry, and Cd pollution is one of the critical environmental issues in many marine bays [1-6]. Sedimentation and accumulation are important transporting processes of pollutants in marine bay, and the quantification of these processes are essential to pollution control [7-12], and quantifying the sedimentation and accumulation of Cd in marine is essential to pollution control.

Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China, and had been polluted by various pollutants including Cd [7-12]. This paper analyzed the vertical variations of Cr, and quantified the sedimentation and accumulation of Cd in Jiaozhou Bay during 1979-1983. The absolute and relative sedimentation amounts, as well as absolute and relative accumulation amounts were quantified. These finding were were providing important 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 km^2, 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 Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [13-14].

The investigation on Cd content in surface and bottom 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 surface waters was sampled and monitored follow by National Specification for Marine Monitoring (Fig. 1)[15].

  DOI: 10.25236/icceme.2019.028

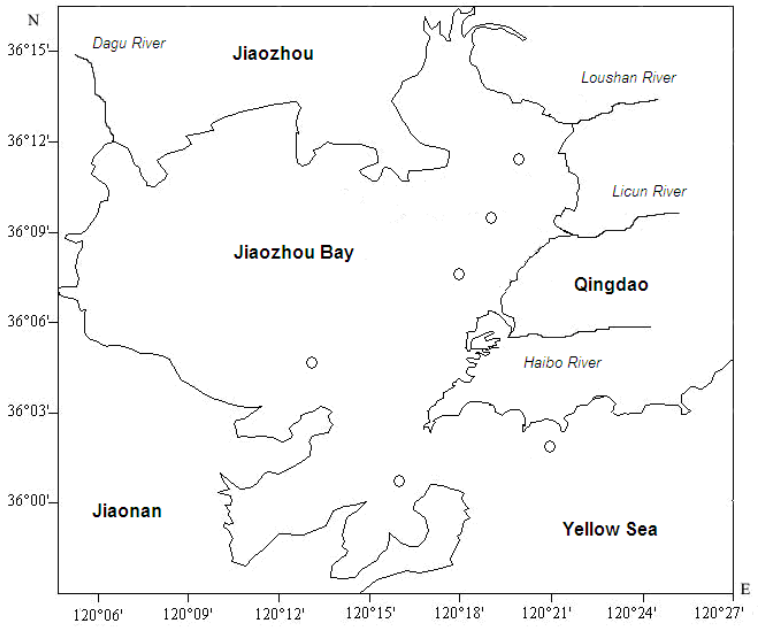

Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

3. Results and discussion

3.1 Vertical variations of Cd contents in surface and bottom waters.

The vertical variation of Cd contents between surface and bottom waters were results of sedimentation and accumulation, which were determined by water's effect [16-20]. In order to defined the vertical variations, Cd contents in surface waters in each sampling sites in each month were subtracted by which in bottom waters, which were indicating that weather Cd in surface waters were higher or lower than in bottom waters. The results were listed in listed in Table 1 to Table 5, respectively.

In Jiaozhou Bay, 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 μg L^{-1}, 0.07-0.85 μg L^{-1}, 0.48-3.33 μg L^{-1}, 0.14-0.55 μg L^{-1}, 0.38-0.53 μg L^{-1} and 0.16-1.50 μg L^{-1}, respectively. In could be seen from Table 1 to Table 5 that Cr contents in bottom waters were consist with which in surface waters, and the differences between surface and bottom waters were small, never no matter in different years or seasons. The variations the ranges of the subtractions of Cd contents between surface waters and bottom waters were determined by the variations of the input of the sources, as well as water's effect [16] that contained vertical water's effect [17] and vertical water's effect [18]. Furthermore, it could be found that the sedimentation of Cd and the accumulation of Cd in bottom waters were notable and the quantification of sedimentation and accumulation amount was necessary.

Table 1 The ranges of the subtractions of Cd contents between surface waters and bottom waters in Jiaozhou Bay 1979/μg L^{-1}

Month	May	August	November	Whole year
Range	0.05—0.06	-0.08—0.03	0.00—0.235	-0.08—0.23

Table 2 The ranges of the subtractions of Cd contents between surface waters and bottom waters in Jiaozhou Bay 1980/μg L^{-1}

Month	June	July	September	October	Whole year
Range	−0.22—0.03	−0.15—0.36	−0.16—0.11	−0.11—0.00	−0.22—0.36

Table 3 The ranges of the subtractions of Cd contents between surface waters and bottom waters in Jiaozhou Bay 1981μg L^{-1}

Month	April	August	November	Whole year
Range	−0.02—0.12	−0.08—0.27	0.00—0.00	−0.08—0.27

Table 4 The ranges of the subtractions of Cd contents between surface waters and bottom waters in Jiaozhou Bay 1982μg L^{-1}

Month	April	July	October	Whole year
Range	−0.19—0.07	−0.06—0.32	−0.11—0.11	−0.19—0.32

Table 5 The ranges of the subtractions of Cd contents between surface waters and bottom waters in Jiaozhou Bay 1983μg L^{-1}

Month	May	September	October	Whole year
Range	−0.01—0.30	−1.50—2.53	−1.50—0.07	−1.50—2.53

3.2 Sedimentation and accumulation amount of Cd.

In according to the Cd in surface and bottom waters and the differences between surface and bottom waters, it was found that contents in surface and bottom waters were tending to be consisting by means of sedimentation and accumulation. The sedimentation amount of Cd was big/small in case of Cd contents in surface waters were high/low, resulted in the consistency of Cd contents in surface and bottom waters.

During 1979—1983, the absolute sedimentation amount and relative sedimentation amount of Cd in Jiaozhou Bay were 0.23—3.23 μg L^{-1} and 79.2%—100.0%, respectively, while for absolute accumulation amount and relative accumulation amount were 0.08—1.97 μg L^{-1} and 75.4%—100.0%, respectively. Obviously, it could be found that never mind Cd contents in waters were high or low, the relative sedimentation and accumulation were always high (Table 6). At temporal scale, the relative sedimentation and accumulation were stable along with year, indicated both sedimentation and accumulation of Cd were important chains in vertical transporting process in marine bay.

Table 6 Cd in surface and bottom waters and the differences between surface and bottom waters/μg L^{-1}

Year	1979	1981	1982	1983	Average
Cd in surface waters/μg L^{-1}	0.02—0.25	0.00—0.48	0.00—0.40	0.11—0.53	0.10—3.33
Cd in surface waters/μg L^{-1}	0.01—0.09	0.00—0.35	0.00—0.13	0.13—0.53	0.03—2.00
Absolute sedimentation amount/μg L^{-1}	0.23	0.48	0.40	0.42	3.23
Relative sedimentation amount/%	92.0%	100.0%	100.0%	79.2%	96.9%
Absolute accumulation amount/μg L^{-1}	0.08	0.35	0.13	0.40	1.97
Relative accumulation amount/%	88.8%	100.0%	100.0%	75.4%	98.5%

These results indicated that Cd contents in surface and bottom waters were tending to be consistent and the sedimentation and accumulation of Cd was notable. The absolute sedimentation

and accumulation were strongly impacted by Cd contents in waters, while the relative sedimentation and accumulation were not impacted by Cd contents in waters but were notable and stable along with year. However, once there was little Cd in surface waters, the sedimentation and accumulation of Cd in bottom waters were stopping, and Cd contents were tending to be little since Cd could be transported to sediments in sea bottom. That was the transporting characteristic of the vertical transporting process of Cd in marine bay.

4. Conclusion

During 1979—1983, the absolute sedimentation amount and relative sedimentation amount of Cd in Jiaozhou Bay were 0.23—3.23 μg L^{-1} and 79.2%—100.0%, respectively, while for absolute accumulation amount and relative accumulation amount were 0.08—1.97 μg L^{-1} and 75.4%—100.0%, respectively. The absolute sedimentation and accumulation were strongly impacted by Cd contents in waters, while the relative sedimentation and accumulation were not impacted by Cd contents in waters but were notable and stable along with year. Once there was little Cd in surface waters, the sedimentation and accumulation of Cd in bottom waters were stopping, and Cd contents were tending to be little.

Acknowledgment

This research was sponsored by the China National Natural Science Foundation (31560107), Doctoral Degree Construction Library of Guizhou Nationalities University and Research Projects of Guizhou Nationalities University ([2014]02), Research Projects of Guizhou Province Ministry of Education (KY [2014] 266), Research Projects of Guizhou Province Ministry of Science and Technology (LH [2014] 7376).

References

[1] Yang DF and Miao ZQ: Marine Bay Ecology (I): Beijing, Ocean Precess, (2010), p. 1-320. (in Chinese)

[2] Yang DF and Gao ZH: Marine Bay Ecology (II): Beijing, Ocean Precess, (2010), p. 1-330. (in Chinese)

[3] Yang DF, Chen Y, Wang H, et al.: Coastal Engineering, Vol. 29 (2010), p. 73-82.

[4] Yang DF, Chen Y, Liu CX, et al.: Coastal Engineering, Vol. 32(2013), p. 68-78.

[5] Yang DF, Zhu SX, Wu YF, et al.: Applied Mechanics and Materials, Vol.644-650 (2014), p. 5325-5328.

[6] Yang DF, Wang FY, Wu YF, et al.: Applied Mechanics and Materials, Vol.644-650 (2014), p. 5329-5312.

[7] Yang DF. Chen Y, Gao ZH, et al.: Proceedings of the 2015 international symposium on computers and informatics. Vol.(2015), p. 2667-2674.

[8] Yang DF, Zhu SX, Yang XQ, et al.: Materials Engineering and Information Technology Apllication, Vol. (2015), p.558-561.

[9] Yang DF, Zhu SX, Wang FY, et al.: Advances in Computer Science Research, Vol. 2352(2015), p.194-197.

[10] Yang DF, Wang FY, Sun ZH, et al.:Advances in Engineering Research, Vol. 40(2015), p.776-781.

[11] Yang DF, Yang DF, Zhu SX, et al.:Advances in Engineering Research, Vol. Part B (2016), p. 403-407.

[12] Yang DF, Yang XQ, Wang M, et al.:Advances in Engineering Research. Vol. Part B(2016), p. 412-415.

[13] Yang DF, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23(2005), p. 72-90. (in Chinese)

[14] Yang DF, Wang FY, Gao ZH, et al. Marine Science, Vol. 28 (2004), p. 71-74. (in Chinese)

[15] China's State Oceanic Administration: The specification for marine monitoring (Ocean Press, Beijiang 1991), p.1-300. (in Chinese)

[16] Yang DF, Wang FY, Zhao XL, et al.: Sustainable Energy and Enviroment Protection, 2015, p.191-195.

[17] Yang DF, Wang FY, He HZ, et al.: Proceedings of the 2015 international symposium on computers and informatics, 2015, p. 2655-2660.

[18] Yang DF, Wang FY, Yang XQ, et al.: Advances in Computer Science Research, Vol. 2352 (2015), p. 198-204.

[19] Yang DF, Miao ZQ, Xu HZ, et al.: Ocean Development and Management, Vol. 30(2013), p. 46-50 (in Chinese).

[20] Yang DF, Wang FY, Zhu SX, et al.: Applied Mechanics and Materials, Vol. 651-653 (2014), p. 1415-1418.