Input pathways of cadmium in Jiaozhou Bay 1989

To cite this article: Dongfang Yang et al 2018 IOP Conf. Ser.: Mater. Sci. Eng. 382 052042

View the article online for updates and enhancements.
Input pathways of cadmium in Jiaozhou Bay 1989

Dongfang Yang1,2,*, Xiaolong Zhang1, Yuan Zhang1, Qi Wang1, Haixia Li1
1Accountancy Shool, Xijing University, Xian 710123, China;
2North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China;
*dfyang_dfyang@126.com

Abstract. Many marine bays have been polluted by Cadmium (Cd) due to the rapid development of industry, and identifying the sources and understanding the input pathways are essential to environmental remediation. This paper analyzed the contents, pollution levels, sources and input pathways in Jiaozhou Bay, Shandong Province, eastern China in 1989. Results showed that Cd contents in surface waters in April, July and October 1989 were 0.04-0.13 μg L⁻¹, 0.07-0.40 μg L⁻¹ and 0.09-7.31μg L⁻¹, respectively. In accord to Chinese Sea Water Quality Standard (GB 3097-1997), the water quality for Cd in April and July 1989 was Class I, while the high value in October was Class III. In general, the pollution levels of Cd in this bay in 1989 were slight and moderate. The major input pathways of Cd in this bay were river discharge and overland runoff, whose source strengths were 0.13-0.40 μg L⁻¹ and 7.31 μg L⁻¹, respectively. These indicated that Cd pollution in river discharge was still very slight, yet in overland runoff was moderate. Targeted countermeasures should be putted into effect in accord to the input pathways.

1. Introduction
Cd is one of the heavy metal elements that widely used in electroplating industry, chemical industry, electronics industry, nuclear industry and so on. The usage amount of Cd is increasing rapidly along with the rapid development of industries, resulting in Cd pollution in many counties and regions due to the lag of waste treatment and clean production [1-2]. Nowadays, Cd pollution in marine bays has been one of the critical environmental issues [3-4], and therefore identifying the sources and understanding the input pathways are essential to environmental remediation.

Jiaozhou Bay is a semi-closed bay located in south of Shandong Peninsula, eastern China. This bay is embracing by cities of Qingdao, Jiaozhou and Jiaonan in the eastern, northern and southern, respectively, and has been polluted by various pollutants including Cd due to the rapid development of industry in since China’s Reform and Opening-up [4-7]. This paper analyzed the contents, pollution levels, sources and input pathways in Jiaozhou Bay, Shandong Province, eastern China in 1989. The analysis revealed that the major input pathways of Cd in this bay were river discharge and overland runoff. Cd pollution in river discharge was still very slight, yet in overland runoff was moderate. These findings provided basic information for environmental decision-making in marine bay.

2. Study area and data collection
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 km², 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo...
River, Licun River, Dagu River, and Loushan River etc., most of which have seasonal features [8-9].

Data on Pb contents in surface waters in Jiaozhou Bay was provided by North China Sea Environmental Monitoring Center. The survey was conducted in April, July and October 1989. There were 10 sampling sites (04, 05, 06, 84, 85, 86, 87, 88, 89 and 90) in April and July compared to 7 sampling sites (84, 85, 86, 87, 88, 89 and 90) in October (Fig. 1). Surface water samples were collected and measured followed by National Specification for Marine Monitoring [10].

![Fig.1 Geographic location and monitoring sites in Jiaozhou Bay](image)

3. Results

3.1 Contents and sources of Cd. Cd contents in surface waters in April, July and October 1989 were 0.04-0.13 μg L⁻¹, 0.07-0.40 μg L⁻¹ and 0.09-7.31 μg L⁻¹, respectively. In April 1989, high value of Cd contents was in Site 89 in the estuary of Haibo River (0.13 μg L⁻¹), and the contour lines were forming a series of semi-circles that decreasing from the northeast of the bay to the bay center (0.05 μg L⁻¹) and the north coast (0.04 μg L⁻¹), respectively (Fig. 2). In July 1989, high value of Cd contents was in Site 86 in the estuary of Dagu River (0.40 μg L⁻¹), and the contour lines were forming a series of parallel lines that decreasing from northwest of the bay to southeast of the bay (0.12 μg L⁻¹) (Fig. 3). In November 1989, high value of Cd contents was in Site 87 in the north of the bay (7.31 μg L⁻¹), and the contour lines were forming a series of parallel lines that decreasing from the north of the bay to the bay mouth (0.19 μg L⁻¹) (Fig. 4).
Fig. 2 Horizontal distribution of Cd in surface waters in Jiaozhou Bay in April 1989/μg L⁻¹

Fig. 3 Horizontal distribution of Cd in surface waters in Jiaozhou Bay in July 1989/μg L⁻¹
Fig. 4 Horizontal distribution of Cd in surface waters in Jiaozhou Bay in October 1989/μg L⁻¹

4. Discussion

4.1 Pollution level of Pb. In Chinese Sea Water Quality Standard (GB 3097-1997), there are 3 classes of water quality, and for Cd the guide lines for Class I, II and III (include IV) (Table 1). In April and July 1989, Cd contents were 0.04-0.13 μg L⁻¹ and 0.07-0.40 μg L⁻¹, and both lower than 1.00 μg L⁻¹ that meeting Class I. In October 1989, Cd contents were 0.09-7.31 μg L⁻¹, and high value region was in the northeast of the bay (>5.00 μg L⁻¹) that belong to Class III (include IV), while in other regions were Class I (<1.00 μg L⁻¹). In general, The pollution levels of Cd in this bay in 1989 were slight in April and July comparing to moderate in October (Table 2), and the seasonal variation is significant.

Table 1 Guide lines for Cd in Chinese Sea Water Quality Standard (GB 3097-1997)

| Class | I   | II  | III (include IV) |
|-------|-----|-----|------------------|
| Guide line/μg L⁻¹ | 1.00 | 5.00 | 10.00 |

Table 2 Pollution levels of Cd in Chinese Sea Water Quality Standard (GB 3097-1997)

| Month | April | July | October |
|-------|-------|------|---------|
| Guide line/μg L⁻¹ | 0.04-0.13 | 0.07-0.40 | 0.09-7.31 |
| Class | I   | I   | III (include IV) |

4.2 Sources of Cd. Cd contents in surface waters in marine bay were impacted by source input directly, and the major sources could be defined in according to the spatial distributions. In April 1989, high value of Cd contents was in Site 89 in the estuary of Haibo River, and Cd contents were decreasing from the northeast of the bay to the bay center and the north coast (Fig. 2). This indicated river discharge was the major Cd source in April. In July 1989, high value of Cd contents was in the estuary of Dagu River, and Cd contents were decreasing from northwest of the bay to southeast of the bay (Fig. 3). This indicated river discharge was the major Cd source in July. In November 1989, high value of Cd contents was in the north of the bay, and the contour lines were decreasing from the north of the bay to the bay mouth (Fig. 4). This indicated that overland runoff was the major Cd source in October. In comparison, Cd pollution in river discharge was still very slight in 1989, yet in overland runoff was moderate (Table 3).
### Table 3 Pollution levels of Cd in different sources

| Month  | River discharge | Overland runoff |
|--------|-----------------|-----------------|
| Class | 0.13-0.40 μg L⁻¹ | 7.31 μg L⁻¹ |
| I     |                 | III (include IV) |

### 4.3 Input pathways of Cd

The major input pathways of Cd in this bay were river discharge and overland runoff, whose source strengths were 0.13-0.40 μg L⁻¹ and 7.31 μg L⁻¹, respectively. The input strength of Cd from overland was much higher than in river discharge. This indicated that substantial anthropogenic Cd was generated and discharged land surface, and a large amount of Cd was washed from the land surface by means of rainfall-runoff. However, the input strength of Cd from river discharge were still low in 1989. The reason was that a big part of Cd was losing along with the transporting pathway via river runoff. In general, by means of rapid sedimentation process, the riverine retention of Cd is considerable. Hence, the loss of Cd during pathway of river discharge is larger than in overland runoff (Fig. 5).

**Fig. 5** The major input pathways of Cd in Jiaozhou Bay

### 5. Conclusion

Cd contents in surface waters in April, July and October 1989 were 0.04-0.13 μg L⁻¹, 0.07-0.40 μg L⁻¹ and 0.09-7.31 μg L⁻¹, respectively. The pollution levels of Cd in this bay in 1989 were slight in April and July comparing to moderate in October, and the seasonal variation is significant. The major input pathways of Cd in this bay were river discharge and overland runoff, whose source strengths were 0.13-0.40 μg L⁻¹ and 7.31 μg L⁻¹, respectively. By means of rapid sedimentation process, the riverine retention of Cd is considerable. The loss of Cd during pathway of river discharge is larger than in overland runoff.

### Acknowledgment

This research was sponsored by 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, Gao ZH. Marine Ecology I (Ocean Press, Beijing 2010), p. 1:320.
[2] Yang DF, Miao ZQ. Marine Ecology II (Ocean Press, Beijing 2010), p. 1:350.
[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, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23(2005), p. 72-90. (in Chinese)

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

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