Yang’s Clearing-up Feature in Marine Bay

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Abstract. Using investigation on Cadmium (Cd) in surface and bottom waters in this bay during 1984-1988 (in absence of 1987), this paper analyzed the horizontal distributions of Cd, calculated the absolute and relative settlement and accumulation of Cd. Results showed that the settlement of Cd was rapid, resulting in the consistency of Cd contents in surface and bottom waters. In case of little source input, Cd contents in waters were very homogeneous with a small different of 0.01 μg L⁻¹. The absolute and relative settlement amounts of Cd were 0.14-6.47 μg L⁻¹ and 70.0-99.8%, respectively. The absolute and relative accumulation amounts of Cd were 0.10-1.29 μg L⁻¹ and 55.5-100.0%, respectively. The settlement/accumulation of Cd in bottom waters were high/low in case of Cd contents in surface waters were high/low. Furthermore, in order to demonstrate the migration processes of substances in marine bay, we provided Yang’s Clearing-up Feature, as well as the mathematical expression.

1.Introduction
Cd has been widely used in industry and agriculture [1-5]. A large amount of Cd-containing wastes have been discharging to the environmental along with the rapid development of economic in the past several decades [6-10]. Many marine bays have been polluted by Cd since ocean is the sink of pollutants [11-15]. Understanding the migration processes of Cd in marine bay is essential to environmental protection and remediation[16-20].

Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. By using investigation on Cd in surfac and bottom waters in this bay during 1984-1988, this paper analyzed the horizontal distributions of Cd, calculated the absolute and relative settlement and accumulation of Cd. Furthermore, in order to demonstrate the migration processes of substances in marine bay, we provided Yang’s Clearing-up Feature, as well as the mathematical expression. The aim of this paper is to provide basis for research on the migration of Cd in marine bay.

2.Materials and dataset
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 km² and 7 m, respectively (Fig. 1). The bay mouth is very narrow (3 km), and is connected to the Yellow Sea in the south. There are a dozen
of rivers including Dagou River, Haibo River, Licun River, and Loushan River etc., all of which are seasonal rivers [21-22].

Dataset on Cd in Jiaozhou Bay was provided by North China Sea Environmental Monitoring Center [3-20]. The investigations were carried on in July and October 1984, April, July and October 1985, April and July 1986, and April and July 1988, respectively. Cd in waters was monitored follow by National Specification for Marine Monitoring [23].

3. Results and discussion

3.1 Vertical distribution of Cd.

In July and October 1984, Cd contents in surface waters were 0.06-0.17 μg L⁻¹ and 0.08-0.20 μg L⁻¹, while in bottom waters were 0.05-0.06 μg L⁻¹ and 0.08-0.18 μg L⁻¹, respectively. In April, July and October 1985, Cd contents in surface waters were 0.19-0.44 μg L⁻¹, 0.16-0.21 μg L⁻¹ and 0.03-0.39 μg L⁻¹, while in bottom waters were 0.19-0.32 μg L⁻¹, 0.11-0.17 μg L⁻¹ and 0.04-0.17 μg L⁻¹, respectively. In April and July 1986, Cd contents in surface waters were 0.01-0.38 μg L⁻¹ and 0.13-6.48 μg L⁻¹, while in bottom waters were 0.00-0.22 μg L⁻¹ and 0.17-1.29 μg L⁻¹, respectively. In April and July 1988, Cd contents in surface waters were 0.09-0.12 μg L⁻¹ and 0.10-0.45 μg L⁻¹, while in bottom waters were 0.08-0.10 μg L⁻¹ and 0.09-0.18 μg L⁻¹, respectively. The horizontal distributions of Cd in bay waters were determined by the source inputs and the horizontal and vertical water's effects [24-26].

3.2 Vertical settlement and accumulation of Cd.

In according to the distributions of Cd contents in surface and bottom waters, the vertical absolute and relative settlement amounts were calculated and listed in Table 1. In 1984, 1985, 1986 and 1988, the vertical absolute settlement amounts were 0.14 μg L⁻¹, 0.41 μg L⁻¹, 6.47 μg L⁻¹ and 0.36 μg L⁻¹, respectively, while the vertical absolute settlement amounts were 70.0%, 93.1%, 99.8% and 80.0%, respectively.
respectively. The settlement of Cd in bottom waters were high/low in case of Cd contents in surface waters were high/low. In according to the distributions of Cd contents in surface and bottom waters, the vertical absolute and relative accumulation amounts were calculated and listed in Table 1. In 1984, 1985, 1986 and 1988, the vertical absolute accumulation amounts were 0.13 μg L⁻¹, 0.28 μg L⁻¹, 1.29 μg L⁻¹ and 0.10 μg L⁻¹, respectively, while the vertical absolute settlement amounts were 72.2%, 87.5%, 100.0% and 55.5%, respectively. The accumulation of Cd in bottom waters were high/low in case of Cd contents in surface waters were high/low. In general, by means of the source inputs and the horizontal and vertical water’s effects [24-26], the settlement/accumulation of Cd in bottom waters were high/low in case of Cd contents in surface waters were high/low.

| Table 1 Absolute and relative settlement amount of Cd in Jiaozhou Bay |
|---------------------------------------------------------------|
|                  | 1984   | 1985   | 1986   | 1988   |
| Absolute settlement amount/μg L⁻¹ | 0.14  | 0.41  | 6.47  | 0.36  |
| Relative settlement amount/%     | 70.0% | 93.1% | 99.8% | 80.0% |
| Absolute accumulation amount/μg L⁻¹ | 0.13  | 0.28  | 1.29  | 0.10  |
| Relative accumulation amount/%   | 72.2% | 87.5% | 100.0% | 55.5% |

3.3 Yang’s Clearing-up Feature.
The vertical distributions and the vertical settlement processes of Cd during 1984-1988 indicated the differences of Cd contents between surface and bottom waters. Meanwhile, during 1984-1988, the major Cd sources in Jiaozhou Bay were marine current and river discharge, whose source strengths were 0.12-6.18 μg L⁻¹ and 0.21-1.07 μg L⁻¹, respectively. Here, we provided the definition of “Yang’s Clearing-up Feature” for substances in marine bay waters. In a certain waters, the dynamic substance’s intrinsical contents are stable if there is little source input. Once the source input is beginning, the dynamic substance’s contents will be exceeding the substance’s intrinsical contents. Once the source input is stopping, the substance’s dynamic contents will be returning to the substance’s intrinsical contents.

In order to demonstrate the migration processes of substances in marine bay, we provided Yang’s Clearing-up Feature, as well as the mathematical expression.

\[
\begin{align*}
T &= A, B = 0 \\
T &= A + B, B > 0 \\
T &= A, B = 0
\end{align*}
\]

(1)

where, \( T \) refers to the dynamic substance’s content, \( A \) refers to the the substance’s intrinsical content, \( B \) refers to the substance’s content provided from the source input.

During 1984-1988, the settlement of Cd in Jiaozhou Bay was rapid, resulting in the consistency of Cd contents in surface and bottom waters. For instance, in case of little source input, Cd contents in waters were very homogeneous with a small difference of 0.01 μg L⁻¹. Yang’s Clearing-up Feature reveals the migration processes of substances in marine bay waters.

4.Conclusions
The horizontal distributions of Cd in bay waters were determined by the source inputs and the horizontal and vertical water’s effects. The absolute and relative settlement amounts of Cd were 0.14-6.47 μg L⁻¹ and
70.0-99.8%, respectively. The absolute and relative accumulation amounts of Cd were 0.10-1.29 μg L\(^{-1}\) and 55.5-100.0%, respectively.

Yang’s Clearing-up Feature reveals the migration processes of substances in marine bay waters. In a certain waters, the dynamic substance’s intrinsical contents are stable if there is little source input. Once the source input is beginning, the dynamic substance’s contents will be exceeding the substance’s intrinsical contents. Once the source input is stopping, the substance’s dynamic contents will be returning to the substance’s intrinsical contents.

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References
[1] Yang DF and Miao ZQ: Marine Bay Ecology (I): Beijing, Ocean Precess, (2010), p. 1-320.
[2] Yang DF and Gao ZH: Marine Bay Ecology (II): Beijing, Ocean Precess, (2010), p. 1-330.
[3] Yang DF, Wang FY, Zhu SX, et al.: Advances in Engineering Research, Vol. 65(2016), p. 298-302.
[4] Yang DF, Qu XC, Chen Y, et al.: Advances in Engineering Research, 2016, Vol. 80(2016), p. 993-997.
[5] Yang DF, Yang DF, Zhu SX, et al.: Advances in Engineering Research, Vol. 80(2016), p. 998-1002.
[6] Yang DF, Zhu SX, Wang ZK, et al.: Computer Life, Vol. 4(2016), p. 446-450.
[7] Yang DF, Wang FY, Zhu SX, et al.: World Scientific Research Journal, Vol. 2(2016), p. 38-42.
[8] Yang DF, Zhu SX, Wang M, et al.: International Core Journal of Engineering, Vol. 2(2016), p. 1-4.
[9] Yang DF, Yang DF, Zhu SX, et al.: Journal of Computing and Electronic Information Management, Vol. 3(2016), p. 467-474.
[10] Yang DF, Zhu SX, Wang ZK, et al.: Journal of Computing and Electronic Information Management, Vol. 4(2017), p. 1-9.
[11] Yang DF, Wang FY, Zhu SX, et al.: Computer Life, Vol. 5(2017), p. 1-7.
[12] Yang DF, Wang ZK, Su CH, et al.: Advances in Engineering Research, Vol. 123(2017), p. 1477-1480.
[13] Yang DF, Wang FY, Zhu SX, et al.: Computer Life, Vol. 5(2017), p. 91-95.
[14] Yang DF, Wang FY, Zhu SX, et al.: World Scientific Research Journal, Vol. 3(2017), p. 1-5.
[15] Yang DF, Li HX, Zhao XL, et al.: Advances in Engineering Research, Vol. 138(2017), p. 847-850.
[16] Yang DF, Chai JX, Wang ZK, et al.: International Conference on Sensing, Diagnostics, Prognostics and Control, 2017, p. 792-795.
[17] Yang DF, Miao ZQ, Li HX, et al.: Earth and Environment Science, Vol. 81(2017), p.1-6.
[18] Yang DF, Wang Q, Wang ZK, et al.: Earth and Environment Science, Vol. 81(2017), p. 1-4.
[19] Yang DF, Wei LZ, Feng M, et al.: Earth and Environment Science, Vol.81(2017), p. 1-5.
[20] Yang DF, Wang Q, Wang M, et al.: Advances in Engineering Research,Vol. 141(2017), p. 1587-1590.
[21] Yang DF, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23(2005), p. 72-90.
[22] Yang DF, Wang FY, Gao ZH, et al.: Marine Science, Vol. 28 (2004), p. 71-74.
[23] China's State Oceanic Administration: The specification for marine monitoring (Ocean Press, Beijing 1991), p.1-300.
[24] Yang DF, Wang FY, He HZ, et al.: Proceedings of the 2015 international symposium on computers and informatics, 2015, p. 2655-2660.
[25] Yang DF, Wang FY, Zhao XL, et al.: Sustainable Energy and Environment Protection, 2015, p.
191-195.

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