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Horizontal Loss Rate Patterns of Cu Content in Marine Bay

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Abstract: Many marine bays have been polluted along with the rapid of industry and population. This paper analyzed the horizontal loss rate patterns of Cu content in Jiaozhou Bay. Results showed that there were two different horizontal loss rate patterns for Cu content. Both absolute horizontal loss rate and relative horizontal loss rate of Cu were calculated by horizontal loss rate model. In case of the source strength was relative high, the absolute horizontal loss rate of Cu content was relative high, yet the relative horizontal loss rate was relative low. In case of the source strength was relative low, the absolute horizontal loss rate of Cu content was relative low, yet the relative horizontal loss rate was relative high.
Keywords: Cu content, Horizontal loss rate, Pattern, Jiaozhou Bay

1. INTRODUCTION

Many marine bays have been polluted by Cu along with the rapid of industry and population. Understanding the transferring process of pollutants is meaningful to pollution control. By means of gravity and marine current, a lot of Cu was transported to bottom waters along with the horizontal process in waters [1-4]. Hence, it's necessary to reveal the horizontal loss of Cu in waters. This paper used the horizontal loss rate model to reveal the unit-distance loss rate of Cu in Jiazhou Bay during the transferring process based on investigation data on Cu in June and July 1982. It was found that that marine current was the unique Cu source in sampling time, and there were two different horizontal loss rate patterns for Cu content.

2. STUDY AREA AND DATA COLLECTION

Jiaozhou Bay (35°55′-36°18′ N, 120°04′-120°23′ E) is located in the south of Shandong, China. The area, bay mouth width and average water depth and average water depth are 390 km^2, 2.5 km and 7.0 m, respectively (Fig. 1). There are more than ten inflow rivers such as Licun River and Haibo River, all of which are seasonal rivers [5-6].

The investigation on Cu in surface waters in Jiaozhou Bay was conducted by North China Sea Environmental Monitoring Center in June (Site H37 and H39) and July (Site H83 and H121) 1982 (Fig. 1). The investigation and measurement of Cr were following by National Specification for Marine Monitoring [7].

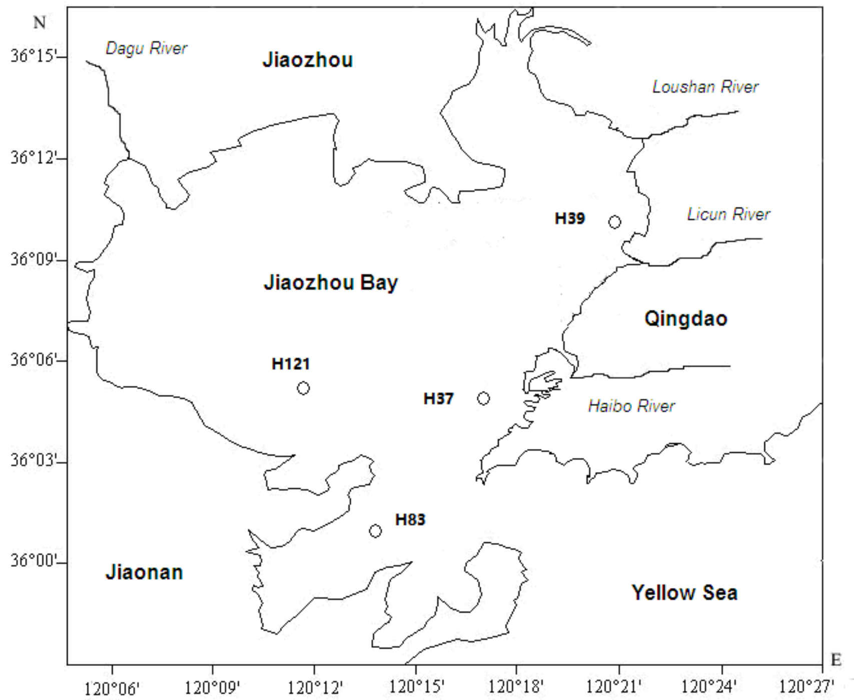

Fig.1 Geographic location and sampling sites of Jiaozhou Bay

3. RESULTS

3.1 Horizontal distances of the sampling sites

Cu contents in two sampling sites (H37, H39, H83 and H121) were monitored. The positions and Cu contents of the sampling sites were listed in Table 1. The distance between H39 and H38 and the distance between H83 and H121 were named as L_1 and L_2, respectively. In according to the longitude and latitude, $L_1 = 13396.18$ m, $L_2 = 13138.04$ m.

Table 1 positions and Cr contents of the sampling sites

Sampling site	Longitude	Latitude	Cu content/$\mu g\ L^{-1}$	Distance/m
H37	120°17′	35°05′	5.31	13396.18
H39	120°21′	35°11′	1.17	
H83	120°23′	36°02′	2.33	13138.04
H121	120°18′	36°07′	0.15	

3.2 The changes of Cu sources

In June 1982, Cu contents were decreasing from the bay mouth to the northeast of the bay along with the flow direction of marine current. This indicated that marine current was the major source of Cu in June 1982, and the source strength could be as high as 5.31 $\mu g\ L^{-1}$. In July 1982, Cu contents were also decreasing from the bay mouth to the northeast of the bay along with the flow direction of marine current, and were indicating that marine current was the major source of Cu in July 1982, yet the source strength was relative low as 2.33 $\mu g\ L^{-1}$.

3.3 Horizontal loss rate of Cu

Suppose that the horizontal distance between position A and B is *L*, and the Cu contents in A and B are a and b, respectively, the absolute horizontal loss rate (V_{asp}, 10^{-5} $\mu g\ L^{-1}\ m^{-1}$) is described as:

$$V_{asp} = (a - b)/L \tag{1}$$

Meanwhile, the relative horizontal loss rate (V_{rsp}, 10^{-5} % m^{-1}) is described as:

$$V_{rsp} = (a - b)/a\ L \tag{2}$$

These models reveal the unit-distance loss rate of Cu content in marine bay during the transferring process. V_{asp} represents the absolute unit-distance loss rate of Cu contents, while V_{rsp} represents the relative unit-distance loss rate of Cu content.

Both absolute horizontal loss rate and relative horizontal loss rate of Cu were calculated by horizontal loss rate models. Since the unit and numerical value of V_{asp} and V_{rsp} were too complex, a symbol namely *AYDF* was used to take the place of 10^{-5} m^{-1}, another symbol namely *RYDF* was used to take the place of % m^{-1}. The absolute and relative horizontal loss rate of Cu content in Jiaozhou Bay was calculated and listed in table 2.

Table 2 The absolute and relative horizontal loss rate of Cu content in Jiaozhou Bay

Temporal variation	June	July
Spatial variation	H37 to H39	H83 to H121
Cu source	Marine current	Marine current
Transport process	Coastal waters in the northeast	Coastal waters in the southwest
Transport distance	13396.18m	13138.04m
Input strength	5.31μg/L	2.33μg/L
V_{asp}	30.90 *AYDF*	16.59 *AYDF*
V_{rsp}	77.97 *RYDF*	93.56 *RYDF*

4. DISCUSSION

4.1 The implication of horizontal loss rate model

Once the absolute horizontal loss rate and relative horizontal loss rate of Cu were identified, Cu contents in different position (e.g., M) between two certain positions (e.g., A and B) could be estimated. Supposed that Cu contents in A (C_A, μg L^{-1}) is higher than in B (C_B, μg L^{-1}), and the distance between A and M was L_M (m), Cu content in position M (C_M, μg L^{-1}) could be calculated as:

$$C_M = C_A - V_{\mathrm{asp}} L_M \tag{3}$$

Where, V_{asp} was calculated by Eq. (1).

Obviously, these models were simple yet effective enough to better reveal the transferring process of pollutants in marine bay.

4.2 Different patterns of horizontal loss rate of Cu

Marine current was the unique Cu source in June and July 1982, yet the source strength was relative high in June 1982. Furthermore, the transport process in June 1982 was in coastal waters in the northeast of the bay, yet in June 1982 was in coastal waters in the southwest of the bay (Table 2). In June 1982, the source strength was as high as 5.31μg L^{-1}, and the V_{asp} and V_{rsp} were 30.90 *AYDF* and 77.97 *RYDF*, respectively. In July 1982, the source strength was relative low as 2.33 μg L^{-1}, and the V_{asp} and V_{rsp} were 16.59 *AYDF* and 93.56 *RYDF*, respectively. In case of the source strength was relative high, the absolute horizontal loss rate of Cu content was relative high, yet the relative horizontal loss rate was relative low. In case of the source strength was relative low, the absolute horizontal loss rate of Cu content was relative low, yet the relative horizontal loss rate was relative high. That were the different patterns of horizontal loss rate of Cu in marine bay. In general, the horizontal loss rates of Cu in June and July 1982 were different since their source strengths and transport process were different.

5. CONCLUSION

Both The horizontal loss rate model, and the horizontal loss rate patterns of Cu content in Jiaozhou Bay were revealed. In June 1982, the source strength was as high as 5.31μg L^{-1}, and the V_{asp} and V_{rsp} were 30.90 *AYDF* and 77.97 *RYDF*, respectively. In July 1982, the source strength was relative low as 2.33 μg L^{-1}, and the V_{asp} and V_{rsp} were 16.59 *AYDF* and 93.56 *RYDF*, respectively. There were two different horizontal loss rate patterns for Cu content. In case of the source strength was relative high, the absolute horizontal loss rate of Cu content was relative high, yet the relative horizontal loss rate was relative low. In case of the source strength was relative low, the absolute horizontal loss rate of Cu content was relative low, yet the relative horizontal loss rate was relative high.

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