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The Variation of Loss Amount Decided by Time and Space

Dongfang Yang[1,2,4,a], Danfeng Yang[3], Fengyou Wang[1,2], Sixi Zhu[1,2], and Xiuqin Yang[1,2]

[1]Research Center for Karst Wetland Ecology, Guizhou Minzu University, Guizhou Guiyang, Guizhou Guiyang, China
[2]College of Chemistry and Environmental Science, Guizhou Minzu University, Shanghai, 550025, China
[3]College of Information Science and Engineering, Fudan University, Shanghai, 200433, China
[4]North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China
[a]dfyang_dfyang@126.com

ABSTRACT. *Based on the investigation data of Hg in Jiaozhou Bay in May and August of 1991, according to the horizontal and vertical matter content variation model proposed by the author, the horizontal loss amount, vertical disputed amount and vertical sediment amount of Hg at surface and bottom were determined, and the modelling diagram of horizontal and vertical variation of Hg content were established. In May and August, the variation of absolutely and relatively horizontal loss amount of Hg at surface and bottom was 0.021-0.060μg/L and 40.74-74.07%, the variation of absolutely and relatively vertical disputed amount was 0.004-0.049μg/L and 20.00-60.49%, and the absolutely and relatively vertical sediment amount was 0.010-0.033μg/L and 19.60-61.11%. The variation of horizontal loss amount showed that, Hg content in bay, whether transported in eastern nearshore waters or bay center in May and August, caused the high horizontal loss at surface and bottom. The variation of vertical loss amount disclosed that Hg content at surface and bottom were vertical sediment amount in eastern nearshore waters, but vertical disputed amount in bay center. Hence, it was believed that space, not time, decided that Hg content at surface and bottom was vertical sediment amount or vertical disputed amount. The variation of vertical loss amount further disclosed that in May or August, these two waters were far from each other, however, the relatively vertical variation amount of Hg content at surface and bottom was consistent, changing from 19.60-20.00% to 60.49-61.11%. Therefore, it was believed that space, not time, decided the relatively vertical variation amount.*

KEYWORDS: *Hg content; variation model; horizontal and vertical loss amount; space and time; Jiaozhou Bay*

A large number of ships are used for marine transport, causing Hg content in sea

water. In this way, marine environment was polluted by Hg content. Hg content reached surface layer of sea water, and sedimented to sea floor through waters in vertical transport [1-11]. In this paper, based on the horizontal and vertical variation mode of matter content proposed by the author, according to the investigation data of Hg content in Jiazhou Bay in May and August of 1991, the horizontal transport and vertical sediment of Hg content was displayed, and the pollution of Hg transported by ships and wharfs was studied, to provide scientific reference for the study on the vertical sediment and horizontal transport of Hg content at surface and bottom.

1. Investigation Waters, Materials and Methods

1.1 Natural environment of Jiaozhou Bay

Jiaozhou Bay, located in southern Shandong Peninsula, is a typical semi-closed bay. The geographical location is 120°04′-120°23′E, 35°58′-36°18′N. Bounded by the line connecting Tuandao Cape and Xuejiadao Island, it connects with Yellow Sea, covering an area of about 446km^2, with the average depth of about 7m. There are dozens of rivers reaching the ocean in Jiaozhou Bay, among of which, the rivers with a larger volume of runoff and sand content include Dagu River, Yang River, Haibo River in Qingdao, Licun River, Loushan River and so on. These rivers are seasonal streams, and hydrological characteristics vary seasonally [12, 13].

1.2 Materials and methods

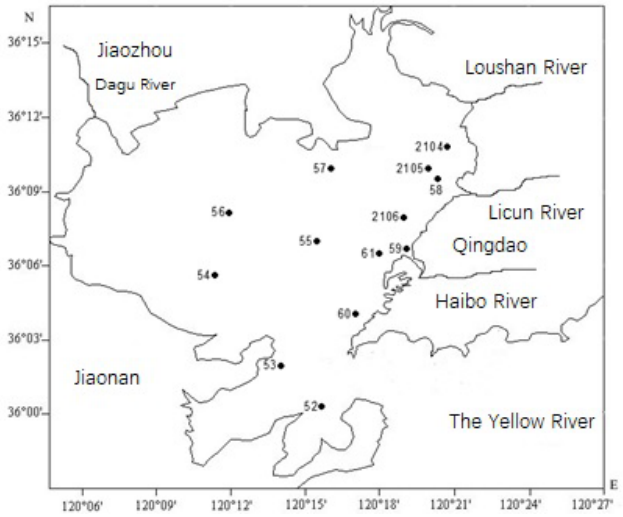

Fig.1 Investigation sites in Jiaozhou Bay

The materials about Cu in Jiaozhou Bay waters in May and August of 1991 was provided by North China Sea Environment Monitoring Center, State Oceanic Administration. In May and August, site 55 and 61 were established, which are shown in Figure 1. Samplings were performed for three times in May and August in 1991, respectively. According to the depth of water, sampling and survey were conducted (surface and bottom layers were sampled when the depth of water is more than 10m, but just surface layer when less than 10m). The survey on Cu of Jiaozhou Bay waters was in accordance with national standard method, which was included in The Specification for Marine Monitoring (1991) [14].

2. Results

After the exchange of waters inside bay and open sea water, the concentration of matter inside bay decreased. According to the definitions and equations of horizontal loss amount, vertical disputed amount and vertical sediment amount of matter content proposed by the author, the corresponding absolutely and relatively ones were calculated.

2.1 The definition and equation of horizontal matter content

At surface waters of eastern nearshore to bay center, suppose matter content was A in eastern nearshore waters, and B in bay center.

The absolutely horizontal loss amount was D>0 and relatively horizontal loss amount was E. When D<0, the absolutely horizontal loss amount was -D>0. It was shown in Equation (1).

$$D=A-B, \qquad E=|A-B|/\max(A,B) \tag{1}$$

At bottom waters of eastern nearshore to bay center, suppose matter content was a in eastern nearshore waters, and b in bay center.

The absolutely horizontal loss amount was d>0 and relatively horizontal loss amount was e. When d<0, the absolutely horizontal loss amount was -d>0. It was shown in Equation (2).

$$d=a-b, \qquad e=|a-b|/\max(a,b) \tag{2}$$

2.2 The definition and equation of vertical matter content

From eastern nearshore waters to bay center, suppose matter content was A at surface and a at bottom. Suppose the site was n, from surface to bottom, the absolutely vertical disputed amount was Vna>0, and relatively one was Vnr. When Vna<0, the absolutely vertical sediment amount was-Vna>0, and when Vna<0, the relatively one was -Vnr. It was indicated in Equation (3).

$$Vna=A-a, \qquad Vnr=|A-a|/\max(A,a) \tag{3}$$

2.3 The horizontal loss amount at surface and bottom

Suppose the waters from eastern nearshore waters to bay center was from A to B. The matter content was mainly Hg content. The horizontal variation of Hg content disclosed its variation at surface and bottom.

In May and August, at surface, the Hg content greatly varied [15], which could be calculated and shown in Table 1 by Equation (1).

Table 1 The horizontal variation of Hg content at surface

From A to B	D	E	E
May	0.021	0.5121	51.21%
August	-0.060	0.7407	74.07%

In May and August, at bottom, the Hg content greatly varied [15], which could be calculated and shown in Table 2 by Equation (2).

Table 2 The horizontal variation of Hg content at bottom

From A to B	d	e	e
May	0.035	0.6862	68.62%
August	0.022	0.4074	40.74%

2.4 The vertical disputed amount and vertical sediment amount

The matter content was mainly Hg content. The vertical disputed amount and vertical sediment amount of Hg content were disclosed by the vertical variation of Hg content.

In May and August, at surface and bottom, the Hg content greatly varied [16-18]. The vertical disputed amount and vertical sediment amount of Hg content could be calculated and shown in Table 3 by Equation (3).

Table 3 The vertical disputed amount and vertical sediment amount of Hg content at surface and bottom

Time	Waters	Vna	Vnr	Vnr
May	Eastern nearshore waters	-0.010	0.1960	19.60%
	Bay center	0.004	0.2000	20.00%
August	Eastern nearshore waters	-0.033	0.6111	61.11%
	Bay center	0.049	0.6049	60.49%

3. Discussion

3.1 The variation of matter content

Matter content varied when it was transported. Hg content in eastern nearshore waters was mainly transported by ships and wharfs. According to the vertical and horizontal waters effect and waters effect proposed by the author [16-18], its horizontal variation disclosed the loss effect of horizontal waters, and the variation at surface and bottom displayed the sediment effect and disputed effect of vertical waters. Thus, according to horizontal and vertical matter content variation model proposed by the author, the horizontal and vertical transport of Hg content from eastern nearshore waters to bay center could be analyzed quantitatively.

3.2 The horizontal and vertical variation of Hg content

In May and August, from eastern nearshore waters to bay center, the horizontal loss amount at surface could be calculated and shown in Table 1 by Equation (1), the variation at bottom also could be calculated and shown in Table 2 by Equation (2), and the vertical disputed amount and vertical sediment amount at surface and bottom were calculated and shown in Table 3 by Equation (3).

Spatially, at surface layer of eastern nearshore waters, the Hg content of 0. 061μg/L was transported by ships and wharfs in May and there was no transport in August. At surface layer of bay center, there was no transport in May and the Hg content of 0.081-0.086μg/L was from atmospheric sedimentation in August. At surface waters, under the tidal action and ocean current, Hg content decreased continuously from the center with high content to the periphery with low content.

In May, the horizontal loss amount at surface reached 51.21%, and the horizontal loss amount at bottom was 68.62%. In addition, vertical sediment amount at surface and bottom reached 19.60% in eastern nearshore waters and vertical disputed amount was 20.00% in bay center. It was shown in Figure 2.

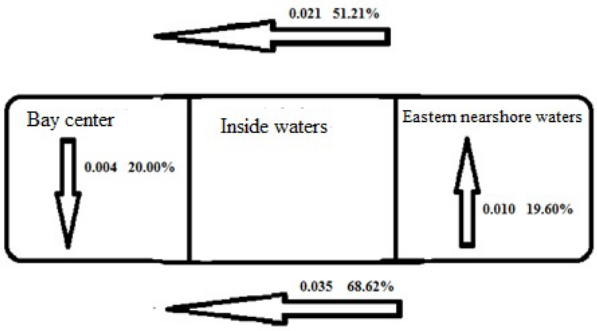

Figure 2 The modelling diagram of horizontal and vertical variation of Hg content in May

In August, the horizontal loss amount at surface reached 74.07%, and the horizontal loss amount at bottom was 40.74%. In addition, vertical sediment amount at surface and bottom reached 61.11% in eastern nearshore waters and vertical disputed amount was 60.49% in bay center. It was shown in Figure 3.

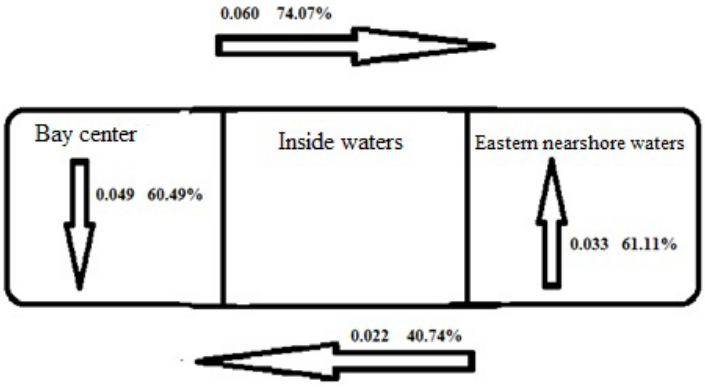

Figure 3 The modelling diagram of horizontal and vertical variation of Hg content in August

In short, in May and August, the absolutely horizontal loss amount at surface and bottom was 0.021-0.060μg/L, and the relatively one was .00-11.72%. The vertical decrease amount at surface and bottom was .00-3.70℃, and the relatively one was 40.74-74.07%. The absolutely and relatively vertical disputed amount at surface and bottom was 0.004-0.049μg/L and 20.00-60.49%. The absolutely and relatively vertical sediment amount was 0.010-0.033μg/L and 19.60-61.11%.

3.3 The horizontal loss amount

In May, the horizontal loss amount at surface reached 51.21% from eastern nearshore waters to bay center, and in August, it was 74.07% from bay center to eastern nearshore waters, shown in Table 5. Hence, in May and August, it reached 51.21-74.07% at surface in either way, showing that no matter Hg content was transported in eastern nearshore waters or bay center, the horizontal loss amount were high.

In May, the horizontal loss amount at bottom reached 68.62% from eastern nearshore waters to bay center, and in August, it was 40.74%, shown in Table 5. Hence, in May and August, it reached 40.74-68.62% at surface in either way, showing that no matter Hg content was transported in eastern nearshore waters or bay center, the horizontal loss amount were high.

In short, no matter Hg content was transported in eastern nearshore waters or bay center, the horizontal loss amount were high.

3.4 The vertical loss amount

In eastern nearshore waters, vertical sediment amount at surface and bottom was 19.60% in May and 61.11% in August, showing that in this area, from May to August, Hg content at surface and bottom were vertical sediment amount, from 19.60% to 61.11%.

In bay center, vertical disputed amount at surface and bottom was 20.00% in May and 60.49% in August, showing that in this area, from May to August, Hg content at surface and bottom were vertical disputed amount, from 20.00% to 60.49%.

In May, vertical sediment amount at surface and bottom was 19.60% in eastern nearshore waters and vertical disputed amount at surface and bottom was 20.00% in bay center. So, the two areas were far from each other, the vertical variation was consistent, less than 1.00%, reaching 0.40%.

In August, vertical sediment amount at surface and bottom was 61.11% in eastern nearshore waters and vertical disputed amount at surface and bottom was 60.49% in bay center. So, the two areas were far from each other, the vertical variation was consistent, less than 1.00%, reaching 0.62%.

From May to August, Hg content at surface and bottom was vertical sediment amount in eastern nearshore waters but vertical disputed amount in bay center. Hence, it is believed that it is space, not time, that decided that it was vertical sediment or disputed amount.

In May or August, these two waters were far from each other, however, the relatively vertical variation amount of Hg content at surface and bottom was consistent, changing from 19.60-20.00% to 60.49-61.11%. Therefore, it was believed that space, not time, decided the relatively vertical variation amount.

4. Conclusion

According to horizontal and vertical matter content variation model proposed by the author, the horizontal loss amount, vertical disputed amount and vertical sediment amount of Hg content at surface and bottom were calculated, and the modelling diagram of horizontal and vertical variation of Hg content were determined. In May and August, the variation of absolutely and relatively horizontal loss amount of Hg at surface and bottom was 0.021-0.060μg/L and 40.74-74.07%, the variation of absolutely and relatively vertical disputed amount was 0.004-0.049μg/L and 20.00-60.49%, and the absolutely and relatively vertical sediment amount was 0.010-0.033μg/L and 19.60-61.11%.

In May and August, the horizontal loss amount at surface reached 51.21-74.07% from eastern nearshore waters to bay center or from bay center to eastern nearshore waters, showing that no matter Hg content was transported in eastern nearshore waters or bay center, the horizontal loss amount were high.

In May and August, the horizontal loss amount at bottom reached 40.74-68.62% from eastern nearshore waters to bay center, showing that no matter Hg content was transported in eastern nearshore waters or bay center, the horizontal loss amount were high.

In eastern nearshore waters, vertical sediment amount at surface and bottom was 19.60% in May and 61.11% in August, showing that in this area, from May to August, Hg content at surface and bottom were vertical sediment amount, from 19.60% to 61.11%. In bay center, vertical disputed amount at surface and bottom was 20.00% in May and 60.49% in August, showing that in this area, from May to August, Hg content at surface and bottom were vertical disputed amount, from 20.00% to 60.49%.

In May, eastern nearshre waters and bay center were far from each other, the vertical variation was consistent, less than 1.00%, reaching 0.40%. In August, the vertical variation was consistent, less than 1.00%, reaching 0.62%.

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