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Evaluation of Pollution Source of the Bays in Fujian Province

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Abstract

Based on investigation data of pollution sources of seven bays in Fujian province(Luoyuan Bay, Quanzhou Bay, Xiamen Bay, Sansha Bay, Xinghua Bay, Meizhou Bay and Dongshan Bay), the pollutant source composition, total amount and distribution character of pollution sources are evaluated in this article. The result shows that: Pollution Sources of the Bays in Fujian province are mainly land-based pollution. Agricultural pollution source makes up the largest percentage of the land-based pollution sources, followed by domestic pollution source and soil erosion while industrial pollution source makes up the smallest percentage. Sea-based pollution sources come mainly from aquaculture pollution while vessel-source makes up only a very small percentage. Among the seven bays, Meizhou Bay has the largest amount of COD discharged into sea and Dongshan Bay the smallest; Xinghua Bay has the largest amount of TN,TP and Luoyuan Bay the smallest. The concept of pollutant load per unit tidal prism is introduced to evaluate the pollution pressure of each bay. The research can be a scientific support of the total amount control of pollution discharged into bay and promote the socioeconomic sustainable development in Fujian coastal area.

Keywords: pollution source; pollution character; bay; Fujian province

Since 1970s, with china's rapid economic growth in coastal area, the total amount of pollutant discharged into sea has increased continuously which led to severe marine environmental issues such as the degradation of the sea water quality [1], frequent occurrence of red tide, broken balance of marine ecosystem and declination of the fishery resources [2, 3]. In order to improve marine environment and control the downward trend of sea water pollution [4], research on bay pollution character is greatly needed to learn the ways that pollution gets into bays and its distribution character. In this paper, based on investigation data of pollution sources of seven bays in Fujian province(Luoyuan Bay, Quanzhou Bay, Xiamen Bay, Sansha Bay, Xinghua Bay, Meizhou Bay and Dongshan Bay), the pollutant source compositon, total amount and distribution character of pollution sources are evaluated in this article. The

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research can be a scientific support of the total amount control of pollution discharged into bay and promote the socioeconomic sustainable development in Fujian coastal area.

1. Introduction

1.1 Geographical Location

Coastal area of Fujian Province lies in the southeast margin of the Eurasian plate and the edge of the western Pacific plate. The distance from north to south is 380km with a longitude long and narrow shape. Fujian coastal area lies between 23°27′～27°10′N which borders Zhejiang to the north, Guangdong to the south, West Coast Economic Zone to the west and Taiwan Strait to the east. With Taiwan lying to the east, just across the straight, this area has geographical advantages and strategic importance. The regional advantage of Fujian coastal area plays an important role in the current construction of the West Coast Economic Zone, the reunification of China and promotion of cooperation between Fujian and Taiwan.

1.2 Research area

The research areas include Luoyuan Bay, Quanzhou Bay, Xiamen Bay, Sansha Bay, Xinghua Bay, Meizhou Bay and Dongshan Bay (Figure 1). The reasons for selecting these bays are: (1) from the point of view of the bays' physical characteristic, some of the bays are relatively open-type and some are bays with narrow mouths and large shallow water areas. Some have rivers flowing into them while others have not. These bays are all typical bays in Fujian Province that can represent different hydrodynamic conditions and different ways that pollution gets into bays; (2) from the point of view of social-economic conditions, some of the areas around the bays are developed area and some are relatively backward areas. These bays can represent different social-economic conditions.

Fig.1. Distribution of Main Bays in Fujian Province

2. Data Resources And Methods

2.1 Data Resources

The data of Luoyuan Bay, Quanzhou Bay and Xiamen Bay used in this paper are mainly from the related research result of total amount control of pollutant discharged into sea. The data of Sansha Bay, Xinghua Bay, Meizhou Bay and Dongshan Bay are mainly from the numerical simulation and environmental research of main bays in Fujian Province.

2.2 Investigation Methods for Pollution Sources

The amount of industrial pollutant discharge is estimated by collecting and sorting out of industrial pollution data. The pollutant amount from domestic discharge [5] and breeding of livestock and poultry [6] are both estimated using discharge coefficient method. The pollutant load caused by chemical fertilizer loss is estimated by using the data of nitrogen and phosphorus fertilizer input in each subwatershed. Pollutant flux from river is calculated according to the pollutant concentration and runoff amount.

3. Evaluation And Analysis

3.1 Total Amount of Pollutant Discharged into the Main Bays in Fujian Province

Based upon the above methods, the total amount of pollutant discharged into the main bays in Fujian Province is estimated (Table 1). The total amount of COD discharged into the seven bays is 603693.54t/a; The total amount of TN is 136723.5t/a; The total amount of TP 15521.85t/a.

Table 1. Total Amount of Pollutant Discharged into the Main Bays in Fujian Province (t/a)

Bays	COD	TN	TP
Luoyuan Bay	31579.00	3096.00	622.00
Quanzhou Bay	40941.00	20103.00	1791.78
Xiamen Bay	58386.00	28922.00	3249.00
Sansha Bay	159064.70	12808.72	1228.54
Xinghua Bay	101880.63	40132.72	5762.80
Meizhou Bay	188314.21	19211.06	2867.73
Dongshan Bay	23528	12450	-
Total	603693.54	136723.50	15521.85

3.2 Distribution Character of Pollution Sources

Among the seven bays, Meizhou Bay（188314.2t/a） has the largest amount of COD discharged into sea and Dongshan Bay （23528t/a）the smallest; Xinghua Bay （40132.72t/a）has the largest amount of TN and Luoyuan Bay（3096t/a） the smallest; Xinghua Bay（188314.2t/a） has the largest amount of TP and Luoyuan Bay （23528t/a）the smallest.

The environmental effect caused by the pollutant discharged into the sea is not only determined by the absolute value of pollutant amount, but also physical characters of the bays receiving the pollutant such

as hydrodynamic conditions and diffusion ability of the bays. The concept of pollutant load per unit tidal prism is introduced here: divide the total amount of pollutant discharged into the bay by the tidal prism of the bay. The result is shown in Table 2. Quanzhou Bay has the largest number of pollutant load per unit tidal prism which means that its pollution pressure is the highest being in accord with the fact that the value of N, P in Quanzhou Bay is relatively high. Among the seven bays, the pollutant load per unit tidal prism of Luoyuan Bay and Sansha Bay is smaller than others which means that pollution pressure of the two bays is relatively low. However, both of the two bays have narrow mouths and large shallow water areas that is disadvantage to the diffusion of pollutant and thus the pollutant tend to stay inside the bays leading to the high value of N, P. Quanzhou Bay, Xinghua Bay and Meizhou Bay all have wide mouths, and the pollutant load per unit tidal prism from highest to lowest is Quanzhou Bay>Xinghua Bay>Meizhou Bay. This sequence is in accord with the value of N, P in the three bays which shows that to a certain degree, the concept of pollutant load per unit tidal prism is able to reflect the pollution pressure of the bays.

Table 2. Pollutant Load Per Unit Tidal Prism of the Main Bays in Fujian Province

Item		Luoyuan Bay	Quanzhou Bay	Xiamen Bay	Sansha Bay	Xinghua Bay	Meizhou Bay	Dongshan Bay
Bay Areas(km^2)		162.62	128.18	460	675.5	624.97	457.72	247.89
Tidal Flat Areas(km^2)		78.18	80.48	152	290.5	223.70	169.90	92.36
Average Tidal Range(m)		4.98	4.27	3.98	5.05	4.74	4.65	2.3
Tidal Prism($\times 10^4 m^3$)		61518	37550	152832	267776	243219	173338	46393
Amount of Pollutant Discharge (t/a)	COD	31579	40941	58386	159064.7	101880.6	188314.2	23528
	TN	3096	20103	28922	12808.72	40132.72	19211.06	12450
	TP	622	1791.778	3249	1228.54	5762.8	2867.73	-
Pollutant Load Per Unit Tidal Prism	COD	0.51	1.09	0.38	0.55	0.42	1.09	0.51
	TN	0.05	0.54	0.19	0.04	0.17	0.11	0.27
	TP	0.01	0.05	0.02	0.00	0.02	0.02	-
Investigation Year		2009	2008	2009	2004	2004	2004	2003

Note：pollutant load per unit tidal prism=total amount of pollutant discharged into the bay / tidal prism of the bay

3.3 Composition Character of Pollution Sources

Pollution sources of coastal area in Fujian province are categorized into two types: land-based pollution sources and sea-based pollution sources. Land-based pollution sources include industrial pollution source, agricultural pollution source, domestic pollution source and pollution source from soil erosion. Sea-based pollution sources include aquacultural pollution source and pollution source from vessel.

Pollution Sources of the Bays in Fujian province are mainly land-based pollution: the percentages of COD、N、P are respectively 61%、88%、84%. Agricultural pollution source makes up the largest percentage of the land-based pollution sources: the percentages of COD、N、P are respectively 28%、57%、48%.; The second comes from domestic pollution source: the percentages of COD、N、P are respectively 27%、56%、33%; The third comes from Soil erosion while industrial pollution source makes up the smallest percentage: the percentages of COD、N、P are averagely only 1%-3%. Sea-based

pollution sources come mainly from aquaculture pollution: the percentages of COD、N、P are respectively 39%、12%、16%. Vessel-source makes up only a very small percentage.

Table 3. Composition Character of the Pollution Sources

Item			Luoyuan Bay	Quanzhou Bay	Xiamen Bay	Sansha Bay	Xinghua Bay	Meizhou Bay	Average
COD	land-based pollution	Industrial Pollution	1%	-	12%	0%	6%	2%	3%
		Domestic Pollution	4%	-	55%	1%	40%	37%	27%
		Agricultural Pollution	2%	-	33%	0%	54%	39%	28%
		Soil Erosion	10%	-	-	1%	0%	4%	2%
		Total(Land-based)	17%	-	100%	2%	100%	82%	61%
	Sea-based pollution	Vessel-Source	0%	-	-	0.03%	0.01%	0.06%	0.03%
		Aquacultural Pollution	83%	-	-	98%	-	18%	39%
		Total(Sea-based)	83%	-	-	98%	-	18%	39%
TN	land-based pollution	Industrial Pollution	4%	4%	2%	0%	0%	1%	1%
		Domestic Pollution	5%	86%	40%	3%	11%	36%	26%
		Agricultural Pollution	29%	10%	58%	24%	86%	39%	57%
		Soil Erosion	16%	0%	-	2%	0%	13%	3%
		Total(Land-based)	54%	100%	100%	28%	97%	88%	88%
	Sea-based pollution	Vessel-Source	0%	-	-	0.1%	0%	0.1%	0.03%
		Aquacultural Pollution	46%	-	-	72%	3%	12%	12%
		Total(Sea-based)	46%	-	-	72%	3%	12%	12%
TP	land-based pollution	Industrial Pollution	0%	0%	5%	0%	0%	0%	1%
		Domestic Pollution	6%	83%	32%	7%	28%	48%	33%
		Agricultural Pollution	16%	17%	63%	12%	64%	27%	48%
		Soil Erosion	5%	0%	-	2%	0%	4%	1%
		Total(Land-based)	27%	100%	100%	21%	92%	80%	84%
	Sea-based pollution	Vessel-Source	0%	-	-	0.04%	0%	0.3%	0.01%
		Aquacultural Pollution	73%	-	-	79%	8%	20%	16%
		Total(Sea-based)	73%	-	-	79%	8%	20%	16%

Note：1. For the convenience of data statistic, the following relation is applied: COD_{Cr}＝2.5COD_{Mn}，NH_3-N/TN=30%，TIP/TP=45%

2. Dongshan Bay is not included in this analysis due to insufficient data。

4. Conclusion

(1) Among the seven bays, Meizhou Bay（188314.2t/a） has the largest amount of COD discharged into sea and Dongshan Bay （23528t/a）the smallest; Xinghua Bay （40132.72t/a）has the largest amount of TN and Luoyuan Bay（3096t/a） the smallest; Xinghua Bay（188314.2t/a） has the largest amount of TP and Luoyuan Bay （23528t/a）the smallest. Quanzhou Bay has the largest number of

pollutant load per unit tidal prism which shows that to a certain degree, the concept of pollutant load per unit tidal prism is able to reflect the pollution pressure of the bays.

(2) Pollution sources of coastal area in Fujian province are categorized into two types: land-based pollution sources and sea-based pollution sources. Land-based pollution sources include industrial pollution source, agricultural pollution source, domestic pollution source and pollution source from soil erosion. Sea-based pollution sources include aquacultural pollution source and pollution source from vessel.

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(3) Based on investigation data of pollution sources of seven bays in Fujian province(Luoyuan Bay, Quanzhou Bay, Xiamen Bay, Sansha Bay, Xinghua Bay, Meizhou Bay and Dongshan Bay), the pollutant source composition, total amount and distribution character of pollution sources are evaluated in this article. The research can be a scientific support of the total amount control of pollution discharged into bay and promote the socioeconomic sustainable development in Fujian coastal area.

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