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Tendency and Causes Analysis of Marine Water Quality of Jinzhou Bay

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Abstract. Based on the three monitoring data of Jinzhou Bay in July 2008, September 2013 and September 2016, this article analysed the temporal trends of marine water quality of Jinzhou Bay. Results showed that Eutrophication parameters（E）is showing a clear upward trend. The emission of active phosphates from land-based pollutants is the main cause of this phenomenon. Large-scale dredging and land reclamation of Jinzhou Bay in recent years resulted in effective removal of contaminated sediment. Heavy metal pollution has been effectively controlled and improved of Jinzhou Bay. For non-persistent pollutant oils from ships must be strictly control to discharge into the sea.

1.Introduction

In recent years, with the exploit of China's coastal zones and the development of the main marine economy， increased emissions of pollutants into the sea which resulted in the environmental pressures increased in coastal waters[1-3]. The Jinzhou Bay is the western half of Liaodong Bay which has 105.2 kilometres coastline located at the bottom of the nearly closed Bohai Sea. It has small tidal range and weak seawater exchange capacity [4]. Red tide, eutrophication, heavy metals and oil pollution frequent occurred in Jinzhou Bay [5]. The problem of coastal waters pollution has become a bottleneck for sustainable development [6]. Therefore, the study of the tendency and causes analysis of water quality in Jinzhou Bay is very important in controlling coastal pollution and improving environmental quality [7].

2.Data and Method

2.1 Monitoring Data

This paper collected three monitoring data of Jinzhou Bay in July 2008, September 2013 and September 2016, which were monitored by Jinzhou Environmental Monitoring Center Station, State Oceanic Administration Dalian Marine Environmental Monitoring Center Station and Fujian Zhonghai Testing Technology Co., Ltd., separately. These three data represent the background value, the environmental status and current status of Marine Water Quality of Jinzhou Bay, separately. This paper by comparison of Marine Water Quality of Jinzhou Bay to analysis the trends and causes of marine water quality.

2.2 Research Methods

《Technical Regulations for Assessment of Seawater Quality Status (Trial)》（2015.10）introduced the method for calculation of eutrophication index (E). The specific calculation formula is as follows:

E=(CCOD×CDIN×CDIP×106)/4500

In the formula：

E—Eutrophication index;

CCOD—the concentration of Chemical oxygen demand, mg/L;

CDIN—the concentration of Inorganic nitrogen(IN-N), which is the sum of nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N) and ammonia-nitrogen (NH_4-N), mg/L;

CDIP—the concentration of Active phosphate, mg/L.

3. Research Result

This monitoring monitored temperature(T), pH, Salinity, Dissolved oxygen(DO), Chemical oxygen demand(COD), suspended matter(ss), Inorganic nitrogen(IN-N), Phosphate(PO43-), Petroleum, Copper(Cu), lead (Pb), Zinc (Zn) and Cadmium (Cd)in marine water. The average concentrations of these factors are listed in table 1.

Table.1 Partition table of Eutrophication index (E)

Eutrophication level	Eutrophication index(*E*)
Light eutrophication	$1 \leq E \leq 3$
Moderate eutrophication	$3 < E \leq 9$
Severe eutrophication	$1E > 3$

3.1 Physical Indicator

The physical indicator of marine water contain T, pH, Salinity and DO. The average DO concentration is between 6.06mg/L and 7.18 mg/L. The type I criteria of DO in the "Sea Water Quality Standard" is 6 mg/L. The concentration of DO in Jinzhou Bay can meet type I criteria of DO. Other physical indicator such as T, pH and Salinity has no significant changes. The physical indicators of marine water quality in Jinzhou Bay are relatively stable.

3.2 Eutrophication Index

Eutrophication index (E) is listed in Table 2 which increased in these years. The Eutrophication index (E) is 1.63 and 1.74 in July 2008 and September 2013, respectively, which indicates the marine water quality of Jinzhou Bay is light eutrophication. However, the eutrophication index (E) increased to 3.15 in September 2016 which bigger than 3 indicates the marine water quality of Jinzhou Bay is moderate eutrophication.

In order to better analyse the causes of eutrophication of marine water, the specific indicators of eutrophication including COD, inorganic nitrogen and active phosphate were exhaustive analysed. The trend of the eutrophication index (E) and its impact factors are shown in Figure 1. Figure 1 show that the concentration of COD lowers than 2 mg/L. It tells us that COD can meet the type I criteria of COD in the "Sea Water Quality Standard".

The concentration of inorganic nitrogen is 682.5μg/L in July 2008 which can't meet the type IV criteria of inorganic nitrogen in the "sea water quality standard". While the concentration of inorganic nitrogen is 458.71μg/L and 443.50μg/L in September 2013 and September 2016, respectively, which indicates the marine water quality of Jinzhou Bay can meet the type IV criteria of inorganic nitrogen in the "sea water quality standard".

The concentration of phosphate is 8.5μg/L in July 2008 which can meet the type I criteria of phosphate in the "Sea Water Quality Standard". While the concentration of phosphate is 17.04μg/L and 25.21μg/L in September 2013 and September 2016, respectively, this only can meet the type II criteria of inorganic phosphate in the “sea water quality standard”.

In general, the concentration of inorganic nitrogen showed a downward trend, the concentration of COD had no significant changes, while the concentration of phosphate showed an increased trend. Due to the increasing of phosphate resulted the Eutrophication parameters（E）which is showing a clear upward trend. The emission of active phosphates from land-based pollutants is the main cause of this phenomenon.

3.3 Heavy Metal

The trend of the heavy metal and petroleum is shown in Figure 2. Figure 2 shows that the heavy metal including Copper (Cu), lead (Pb), Zinc (Zn) and Cadmium (Cd) in marine water is showing a clear downward trend. The concentration of Cadmium (Cd) is 3.5μg/L in July 2008 which can meet the type II criteria of Cadmium (Cd) in the "Sea Water Quality Standard". While the concentration of Cadmium (Cd) is 0.16μg/L and 0.14μg/L in September 2013 and September 2016, respectively, this can meet the type I criteria of Cadmium (Cd) in the “sea water quality standard”.

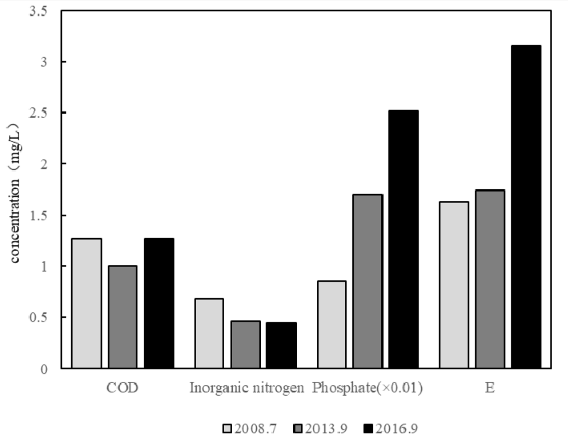

Figure 1. The trend of the eutrophication index (E) and its impact factors

The concentration of Zinc (Zn) is 70μg/L in July 2008 which can meet the type III criteria of Zinc (Zn) in the "Sea Water Quality Standard". While the concentration of Zinc (Zn) is 6.54μg/L and 6.01μg/L in September 2013 and September 2016, respectively, this can meet the type I criteria of Zinc (Zn) in the “sea water quality standard”.

The concentration of Copper (Cu) is 13μg/L in July 2008 which can meet the type III criteria of Copper (Cu) in the "Sea Water Quality Standard". While the concentration of Copper (Cu) is 1.19μg/L and 1.62μg/L in September 2013 and September 2016, respectively, which can meet the type I criteria of Copper (Cu) in the "sea water quality standard".

The concentration of lead (Pb) is 4.5μg/L, 2.26μg/L and 1.18μg/L in July 2008, September 2013 and September 2016, respectively, which between 1μg/L to 5μg/L, tell us the concentration of Copper(Cu) only can meet the type I criteria of Copper(Cu) in the "sea water quality standard".

Large-scale dredging and land reclamation of Jinzhou Bay in recent years resulted in effective removal of contaminated sediment. Heavy metals in marine water quality of Jinzhou Bay are significantly reduced.

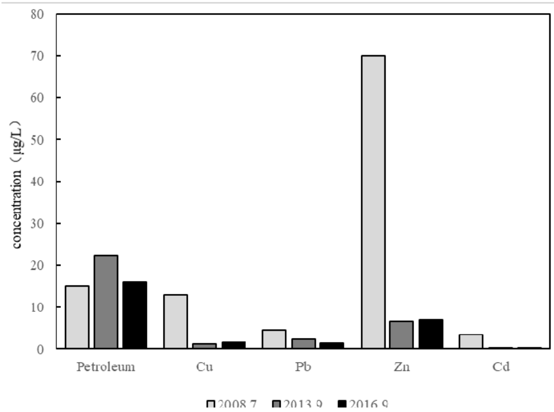

Figure 2. The trend of the heavy metal and petroleum

3.4 Petroleum

The trend of the petroleum is shown in Figure 2. Table 2 and Figure 2 showed that the petroleum has small change in July 2008 and September 2016, with average concentration of 15μg/L and 15.95μg/L, respectively. The concentration of petroleum was 22.34μg/L in September 2013 which increased significantly. It was due to the large-scale construction work in Jinzhou Sea area, the oily pollutants from the construction machinery in the construction process caused the rise of oil in the sea area. Since petroleum is a non-persistent pollutant, in the past two years, there have been very few construction operations in Jinzhou Bay caused oil has returned to its original state.

4. Conclusions

The physical indicator such as T, pH, DO and Salinity have no significant changes. The physical indicators of marine water quality in Jinzhou Bay are relatively stable.

The concentration of inorganic nitrogen showed a downward trend, the concentration of COD had no significant changes, while the concentration of phosphate showed an increased trend. Due to the increasing of phosphate results the Eutrophication parameters（E）showing a clear upward trend. The emission of active phosphates from land-based pollutants is the main cause of this phenomenon.

Heavy metal including Copper (Cu), lead (Pb), Zinc (Zn) and Cadmium (Cd) in marine water showing a clear downward trend. Large-scale dredging and land reclamation of Jinzhou Bay in recent years resulted in effective removal of contaminated sediment. Heavy metals in marine water quality of Jinzhou Bay are significantly reduced.

Petroleum is a non-persistent pollutant, mainly from the construction machinery in the construction process, will return to the original state when the construction is stopped.

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