

Spatial Distribution Characteristics Of Total Nitrogen, Total Phosphorus And Organic Matter In Surface Sediments Of Duliujianhe River

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Abstract. Sediment is the sink and source of nutrients in overlying water. The study of the total nitrogen(TN), total phosphorus(TP) and organic matter(OM) in surface sediments is significant to understand their circulation in water-sediment interface. In this study, the distribution characteristics of the TN, TP and OM contents in the surface sediments of Duliujianhe River were investigated. The experimental results showed that the contents of TN, TP and OM of the entire Duliujianhe River were 124.00-1948.44 mg/kg, 481.67-1635.33 mg/kg and 24397.28-91400.00 mg/kg. TN, TP and OM had the same distribution trend along Duliujianhe River, which increased firstly and then decreased then increased. According to the results of correlation analysis, TN, TP and OM had a certain degree of connection with each other: TN and OM might be derived from the same pollution sources, and there was an obvious interaction between TN and TP. Duliujian River was polluted by organic materials and organic nitrogen, and the pollution of upper and middle reaches was more serious than the downstream.

1. Introduction

Phosphorus and nitrogen are the primary limiting factors for biological growth and important ecological processes, their migration and circulation in the land-river-sea ecosystem will directly affect the primary productivity of the water, thus affecting the global carbon cycle[1].The nitrogen, phosphorus and organic matter in the water are deposited in the sediment under the physical, chemical and biological effects. At the same time, these substances in the sediments are returned to the overlying water by these effects, so the sediment is an important place for "sink" and "source" of the process of the entire water ecosystem material circulation[2].

At present, the studies on TN, TP and OM in sediments are mainly concentrated in wetlands, lakes, inland rivers and coastal areas[3-5], but the studies on the river into the sea are less. This paper reviews the distribution of TN, TP and OM in the surface sediments of Duliujianhe River, which provides an important basis for the investigation of the source of nutrient and eutrophication in the coastal areas.

2. Material and methods

2.1. Study area



The Duliujianhe River is located in the Daqing River system of Tianjin, which is 67km. It is an artificial river that leads the flood of the Daqinghe River and the Ziya River directly flowing into the sea. The Duliujianhe River area is in the temperate semi humid continental monsoon climate zone in the northern hemisphere. It is located near the Bohai Bay and is affected by the monsoon circulation. The daily average temperature is 12.8 °C, the average daily water vapor pressure is 1180 Pa, daily average rainfall is 1.4 mm, and daily average wind speed is 4.1 m/s. The soil of river is characterized by salinity and high salinity, poor soil fertility and poor soil conservation, which are not conducive to the development of planting industry so it mainly develops fishery and industry along the river.

2.2 Sampling strategy

Depending on the characteristics of the river, a sampling point was set for each 5km, there were 15 sampling points along the river, and 3 samples were collected at each sampling point. Using gravity sampler, samples were collected of 1-10 cm thick on the surface of the sediment in December 2016 and taken in the sealed plastic bags and brought back to the laboratory for natural air drying.

2.3 Experimental and analytical methods

The samples were dried at room temperature and grinded into powder and screened through a 100 mesh sieve. TN was measured by alkaline potassium persulfate UV spectrophotometric, and TP was measured by SMT[6]. The dry sediments were burned at 550 °C for 5 h to determine the OM[7].

Organic index and organic nitrogen index are the indicators to classify the sediment contamination and the nitrogen pollution of surface sediment[8]:

$$\text{Org-Index} = \text{Org-C}(\%) \times \text{Org-N}(\%) \quad (1)$$

$$\text{Org-C}(\%) = \text{OM}(\%) \times 1.724^{-1} \quad (2)$$

$$\text{Org-N}(\%) = \text{TN}(\%) \times 0.95 \quad (3)$$

where Org-C(organic carbon, %) is the weight percentage of organic carbon, which is equal to the percentage of OM divided by 1.724, Org-N(%) is the weight percentage of organic nitrogen, which is equal to the weight percentage of TN times 0.95.

Table 1 shows the classification of sediment contamination levels based on the values of organic index and organic nitrogen index.

Table 1. Evaluation standards of organic index in sediments

Org-Index	<0.05	0.05-0.20	0.20-0.50	» 0.50
Org-N	<0.033%	0.033%-0.066%	0.066%-0.133%	» 0.133%
Types	Practically uncontaminated	Uncontaminated to moderately contaminated	Moderately contaminated	Heavily contaminated
Grades	I	II	III	IV

All data analysis and processing were performed by Excel 2010 and Origin 9.1. Each sample is represented by mathematical mean values, and each sampling point is the mathematical average of three samples.

3. Results and discussion

3.1. Spatial distribution characteristic

The distribution range and average value in the 45 sediment samples and the coefficient of variation of 15 points of TN are 124.00-1948.44 mg/kg, 824.748 mg/kg and 30.33%. TP and OM are 481.67-1635.33mg/kg, 774.98 mg/kg and 19.95% and 24397.28-91400.00 mg/kg, 52325.97 mg/kg and 21.40%. The spatial difference of TN is the largest along the river.

The distribution trends of TN, TP and OM are the same. They all increase from upstream to downstream firstly, then decrease and then increase. TN and OM have the largest content at point 2, and the smallest at the 5 point, TP has the largest content at point 4 and the smallest at point 7 (figure 1).

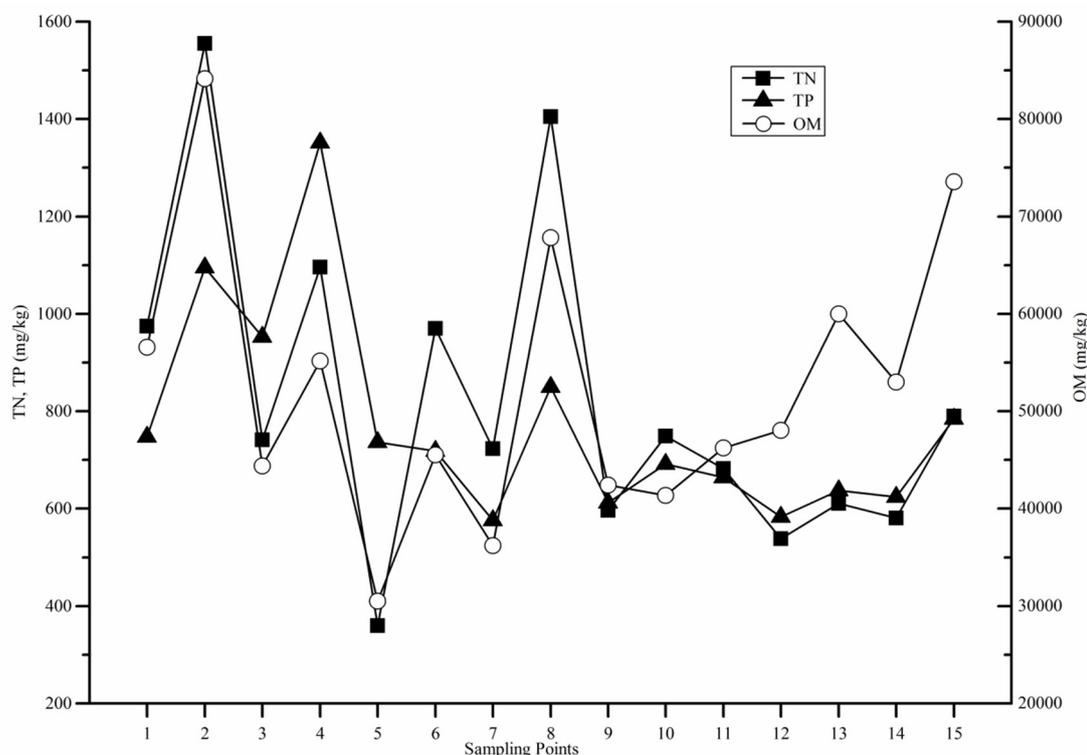


Figure 1. Concentrations of TP, TN and OM at different sampling pints in Duliujianhe River(mg/kg)

3.2. Correlation analysis

If there is a strong correlation between phosphorus and nitrogen in sediment, it is indicated that phosphorus, nitrogen and carbon in sediments arise out of the same origin[3]. The results of correlation analysis of TP, TN and OM in the study area are given in Table 2.

Table 2. Liner relationship among OM, TN and TP in surface sediments of Duiliujianhe River

	Regression equation	R ²	Pearson's r
OM/TN	$P_{TP}=0.01781P_{OM}-107.108$	0.617	0.791**
OM/TP	$P_{TN}=0.00596P_{OM}+463.141$	0.228	0.494**
TN/TP	$P_{TN}=1.25892P_{TP}-150.895$	0.442	0.674**

* Significant($P<0.01$, $n=45$)

The datas of Table 2 show that the significance of OM and TN, OM and TP and TN and TP(bilateral) are less than 0.01, indicating OM and TN, TN and TP and OM and TP are significant respectively. Therefore, the correlation between the three groups is statistically significant. When $r>0.8$ it is strong correlation, $0.5<r<0.8$ is medium correlation, $0.3<r<0.5$ is weak correlation. The correlation of OM and TN and of TN and TP are medium, indicating that OM and TN has similar sources, and the interaction between TN and TP is more obvious. OM and TP are weak correlation depending on their weak effecting.

3.3. Assessment of pollution state

The assessment results of organic pollution index and organic nitrogen index are shown in figure 2. The result shows that the organic index is from 0.065 to 0.722. The organic nitrogen index is from 0.034% to 0.148%. The organic pollution index and organic nitrogen index at points 2 and 8 exceed the level IV and are serious pollution. The organic index of point 1, 3, 4, 6, 7, 10 and 15 and the organic index of point 1, 6, 13 and 15 are moderately polluted in the III level. Some parts of the river are polluted by organic materials, and some are serious. Meanwhile, the pollution of the upper and middle reaches is worse than downstream.

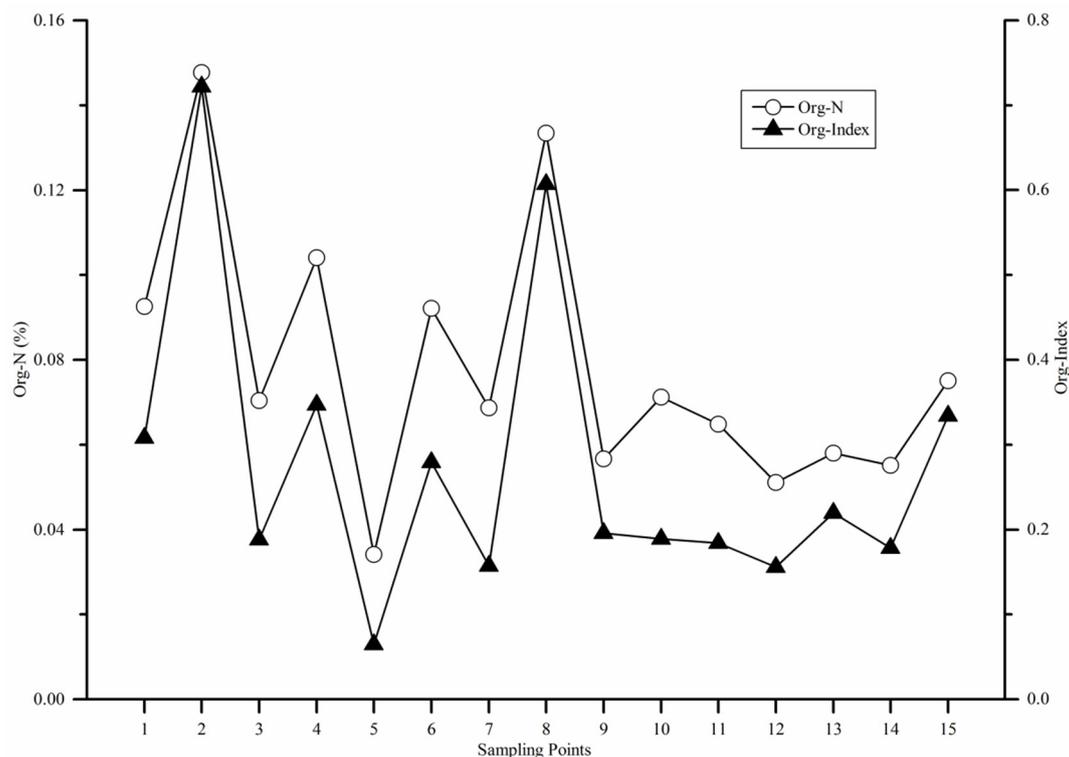


Figure 2. The assessment results of organic pollution index and organic nitrogen index

4. Conclusion

This paper studied the spatial distribution characteristics of TP, TN and OM in surface sediments of the Duliujianhe River. TN, TP and OM had a certain degree of association of each other. The correlation between TN and OM was high, indicating that they had the similar sources; and the high correlation between TN and TP showed that they influenced each other. There was a certain degree of organic pollution and organic nitrogen pollution along the river. The pollution in the upper and middle reaches was more serious than that in the downstream. Therefore, some measures need to be made to control the pollution of the river.

Acknowledgments

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