Research on evaluation model of Baoding city river black-odor

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Abstract

As urbanization continues to develop, city river pollution is more and more serious, black-odor problem has become increasingly prominent. This study selected 15 sampling points in Baoding city river, monitored some water quality indicators such as T, pH, DO, COD, BOD5, NH3-N, TP, Fe and Mn, conducted correlation analysis screening between these water quality indicators and TO (olfactory threshold), CH (chroma）, established multiple linear regression evaluation model and combined the black-odor indexes with the actual water body senses that correspond to it. Baoding city river black-odor degree was divided into no-odor, micro-odor, and black-odor 3 levels.

Keywords

City river; black-odor; evaluation model.

1. Introduction

Black-odor state is an extreme state of water body; its own characteristics are very different from other states. Its physical and chemical environment is strong reducing properties that organic and inorganic pollution is extremely serious, water body has odor and it is not suitable for the survival of aquatic life. Aquatic vegetation has degenerated or even become extinct. Phytoplankton, zooplankton, benthic fauna species exist only a small stain [1, 2].

Baoding city river mainly has Qingshui river, Fu river, Hucheng river and so on, throughout the Baoding downtown area. As society continues to progress, urbanization continues to develop, the sewage that generated in the city is also increasing, making the city river are seriously polluted and the river black-odor problem is more and more serious. City river black-odor problem has a great impact on the city's appearance, development and residents' health and daily life [3, 4]. This paper conducted the sampling and analysis of Baoding city river and established multiple linear regression model that evaluated for the extent of black-odor.

2. Experimental method

2.1 Designing sampling points.

Sampling points selected 15 points within the Baoding river. The latitude and longitude location of 15 sampling points are shown in Table1.

2.2 Sample collection and pre-treatment

All samples (a total of 15) were collected on April 22, 2015 .The samples that were collected were divided into three for each sample and they were stored in plastic bottles, glass bottles and polyethylene bottles. Among them, the plastic bottle samples were used for the determination of COD, BOD_5, NH_3-N;the glass bottles samples were used for the determination of TP; the polyethylene bottles need to be soaked for 24 hours by HNO_3 in advance, their samples were used for the determination of Fe, Mn. All samples were measured in 48 hours.

2.3 Determination methods of water quality indicators

It detected T, pH, DO, COD, BOD_5, NH_3-N, TP, Fe, Mn, TO (olfactory threshold), CH (chroma) and other water quality indicators during the study. T, pH were measured by the portable pH meter on site, DO was measured by the portable dissolved oxygen meter on site, TO was measured by three points comparative flask method. Other indicators are measured by the appropriate standard methods in the 《Monitoring and analysis methods of water and wastewater(fourth edition)》.Detailed determination methods are shown in Table2.

Table1 Information of sampling points' coordinates

Sampling points	latitude	longitude
1#	38°52.104N	115°33.290E
2#	38°52.936N	115°31.937E
3#	38°54.504N	115°29.963E
4#	38°54.695N	115°28.193E
5#	38°54.273N	115°25.109E
6#	38°52.270N	115°24.768E
7#	38°51.708N	115°24.902E
8#	38°50.705N	115°25.660E
9#	38°49.482N	115°28.325E
10#	38°51.059N	115°29.303E
11#	38°50.965N	115°30.231E
12#	38°50.726N	115°30.874E
13#	38°51.079N	115°30.867E
14#	38°52.055N	115°30.179E
15#	38°51.920N	115°21.519E

Table2 Determination method

Indicators	Determination method
COD	Potassium dichromate method
BOD_5	Dilution inoculation method
NH3-N	Nessler reagent spectrophotometry
TP	Mo - Sb Anti-spectrophotometry
Fe	Flame atomic absorption spectrometry
Mn	Flame atomic absorption spectrometry
CH	Dilute multiples method

3. Results and discussion

3.1 Analysis of factors that affecting olfactory threshold

In order to ensure the comprehensiveness of selected evaluation indicators, this study used the measurement data of DO, COD, BOD_5, NH_3-N, TP and other water quality indicators of each sampling point and researched the correlation between these water quality indicators and olfactory threshold. If a water quality indicator and olfactory threshold have a good correlation, the indicator will be used as the modeling factor, otherwise excluded.

The main reason for smelly water is biochemical effects of organic pollutants, in each sampling point, COD and TO had a good linear correlation, the correlation coefficient $R^2 = 0.6182$.Therefore COD was chosen as the evaluation indicator of river black-odor.

NH_3-N is an important factor that caused river black-odor, organic nitrogen entering the river is converted into ammonia under the ammonification, simultaneously, consuming large amounts of oxygen in the water, causing water quality's deterioration, and it leads to black-odor if serious.

Within Baoding river, the correlation coefficient R^2 =0.6715 between NH_3-N and TO, they had a good correlation, so NH_3-N can be chosen as evaluation indicator of river black-odor.

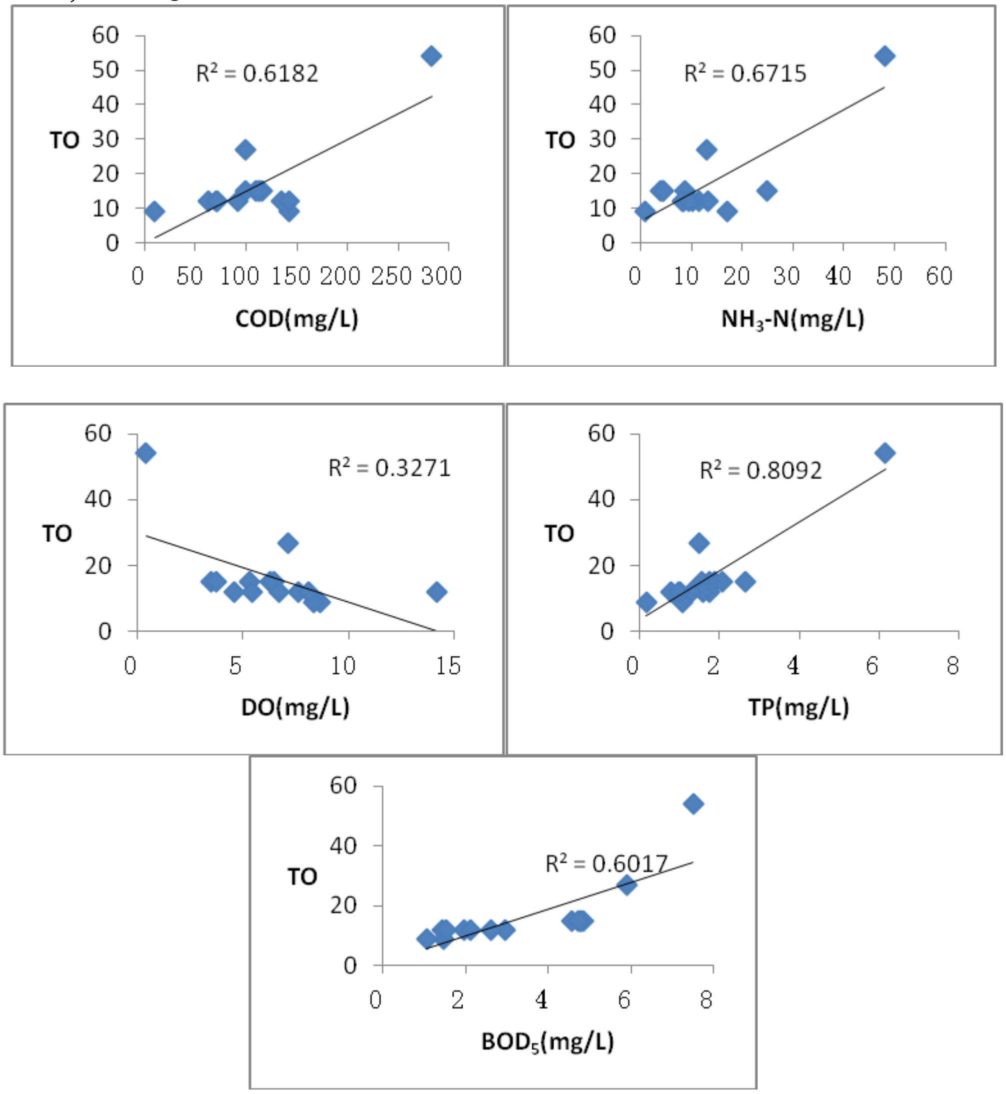

Fig.1 Correlation between various water quality indicators and olfactory thresholds

DO is one of the main control indicators of water black-odor [5]. When the water is polluted, DO begins to reduce, but when pollution levels become serious, the rate of water absorb oxygen from air is less than the rate of oxygen consumption. It makes DO continue to reduce in the water, even near zero, making anaerobic bacteria multiply and organic corruption, so black-odor water body occurs. While the change of DO in the water is the result of biochemical reactions, not the root cause of black-odor, and the correlation coefficient R^2 =0.3271 between DO and TO, their correlation is poor, therefore it can't become the evaluation indicator of river black-odor.

TP (total phosphorus) is one of the essential elements of biochemical reactions, the correlation coefficient R^2 =0.8092 between TO and TP, their Correlation is good, that indicates TP influences Baoding river black-odor greatly, therefore it can be chosen as evaluation indicator of river black-odor.

BOD_5 reflects how much biodegradable organic matters, the correlation coefficient between TO and BOD_5 is 0.6017, their correlation is good, indicates BOD_5 influences Baoding river black-odor greatly, therefore it can be chosen as evaluation indicator of river black-odor .Based on the above analysis, this study selected some evaluation indicators such as COD, NH_3-N, TP and BOD_5 that had a good correlation with TO.

3.2 Analysis of factors that influence chroma

Fe and Mn are the main reason for the black water, however, due to sampling river is not black, and the measured content of Fe and Mn has a not good correlation with chroma, the correlation coefficient between the concentration of Fe , Mn and chroma were only 0.0322 and 0.0847,and correlation is poor, therefore they mainly evaluated the odor of Baoding river.

3.3 Establishing the black-odor evaluation model

By using Origin software, we can perform Multiple linear regression fitting between some organic pollution indicators such as COD, NH_3-N, TP and BOD_5 with TO, calculation results and black-odor index equation are as follows:

Table 3 Multiple fitting results

	intercept		TP		COD	
	value	error	value	error	value	error
TO	4.24995	3.53639	5.74994	2.68577	-0.07833	0.05583
	NH_3-N		BOD_5		statistics	
	value	error	value	error	Correction coefficient of determination	
TO	0.48264	0.20322	1.34801	1.03162	0.84203	

$$I = 5.74994[TP] - 0.07833[COD] + 0.48264[NH_3\text{-}N] + 1.34801[BOD_5] + 4.24995$$

By combining the resulting black-odor index with that corresponds actual water body senses, Baoding river black-odor grading results can be obtained as shown in Table 4:when I<13,water body smells no odor basically, it is no-odor state; when 13 ≤I≤30,water body smells a slight odor, it is light black-odor state; when I>30,water body smells the pungent odor, it is the stench state.

Table4 Baoding river black-odor grading table

Index(I)	Water Quality's performance	Black-odor degree	The extent of black-odor
I < 13	Odorless basically	No black-odor	I
13 ≤I ≤30	Slight odor	Mild black-odor	II
I >30	pungent odor	Severe black-odor	III

4. Conclusion

This study chose Baoding river as object, by the determination of water quality and apparent analysis, the results indicated that COD, NH_3-N, TP, BOD_5 and TO had good correlation, COD, NH_3-N, TP, BOD_5 can be chosen as impact factors of Baoding river black-odor. This study set up black-odor index multiple linear regression evaluation model that fitting Baoding river, combined the black-odor Index with that corresponds to the actual water body senses, Baoding river black-odor degree can be divided into no-odor, micro-odor, black-odor three levels. The model provided theoretical basis for establishing Baoding river black-odor warning system.

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