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The NH_4^+-N Pollution in the Liuxi River and the Correlations Analysis of NH_4^+-N and TN, COD, DO

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Abstract

To take in the pollution situation of the most important standby drinking water source of Guangzhou, a comprehensive investigation was conducted on the NH+ 4-N concentration, TN concentration, COD, DO and chlorophyll-a concentrations of the Liuxi River. Moreover, the correlations analysis of NH+ 4-N and TN, COD, DO, as well as chlorophyll-a was carried out. The study indicated that the middle and lower reaches of the Liuxi River have been seriously polluted by the NH+ 4-N, and resulting in the over state standard problems of TN, COD, DO and chlorophyll-a. Meanwhile, the NH+ 4-N in the Liuxi River had a remarkable correlation to TN, COD, DO and chlorophyll-a, which would be conducive to the contamination tracing and pollution treatment.

Keywords

Surface water; Ammonia nitrogen; Correlation analysis; Total nitrogen.

1. Introduction

As one of the most prevalent pollutants in the surface water, ammonia (NH_4^+) mainly originated from industrial wastes, agricultural surface source pollution, domestic sewage and soil erosion [1-4].

High concentration of ammonia nitrogen (NH_4^+-N) in surface water can cause the foul swell of the water [5]. In addition, excessive intake of the NH_4^+-N can potentially have toxic effect on fish and harm to human body. The intermediate product of NH_4^+-N oxidation in organisms is nitrite, which would cause the symptoms of lip purple, whole body blue and purple, blood pressure drop and so on [2]. Moreover, fishes are more sensitive to NH_4^+-N in water, the high concentration of ammonia nitrogen in water will directly lead to fish death. Also, the eutrophication of water caused by the NH_4^+-N does great damage harmful to the water ecosystem and function, NH_4^+N would cause algae and other aquatic plants to multiply in large quantities, causing the adverse decline of water transparency and dissolved oxygen, and the deteriorate of water quality would further result in the mass mortality of other aquatic organisms. Therefore, the NH_4^+-N pollution in the surface water can block and damage the water ecosystem and function, and finally lead to water body aging and death.

The high concentration of ammonia nitrogen not only damages the health of human and aquatic organisms, but also damages the water ecosystem and function. Therefore, NH_4^+-N is an important monitoring indicator of surface water quality, and would influence the other indicators of surface water quality, such as total nitrogen (TN), dissolved oxygen (DO) et al. Hence, the correlations study of NH_4^+-N and other indicators in surface water contribute to the contamination tracing and pollution treatment [6,7].

The Liuxi River is the most important standby drinking water source of Guangzhou, but the water quality of the Liuxi River is deteriorating. Hence, conducting the correlations study of NH_4^+-N and

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other indicators (such as DO, TN et al.) in the Liuxi River will be conducive to locating the essential cause of the pollution and the improvement on the water quality

2. Material and Method

Field surveys were conducted in November and December 2019, and 52 water samples were collected from 26 sampling sites in the Liuxi River to estimate NH_4^+-N, TN, DO, COD and chlorophyll-a concentrations, and the detailed information about the sampling sites are showed in Table 1. The locations of the sampling sites were plotted using a geographical information system (GIS, Mobile Mapper 100).

Water samples were analyzed for NH_4^+-N, TN and chlorophyll using an ultraviolet spectrophotometry (Purkinje TU-19, China). DO of the samples was measured in situ by hand-held dissolved oxygen meter (JPBJ-611Y, China), and COD of the samples was estimated using burettes with the permanganate index method.

Table 2 the detailed information about the sampling sites of the Liuxi River

NO.	Sampling sites	The reach of river	Latitude and longitude coordinates	Altitude/m
1	LT-1	The upper reaches	23°46'32N,113°58'24E	296
2	LT-2		23°48'57N,113°56'47E	206
3	DM-1		23°50'13N,113°50'28E	192
4	DM-2		23°49'53N,113°50'18E	213
5	HSK		23°46'07N,113°44'06E	192
6	LSK		23°46'18N,113°48'20E	188
7	LK-1	The middle reaches	23°42'13N,113°42'44E	58
8	LK-2		23°40'54N,113°40'40E	52
9	WQZ-1		23°39'58N,113°40'23E	62
10	WQZ-2		23°38'54N,113°38'57E	47
11	WQZ-3		23°37'56N,113°38'19E	37
12	WQZ-4		23°35'80N,113°36'52E	37
13	JK-1		23°31'32 N,113°35'11 E	31
14	JK-2		23°34’36N,113°32'43E	30
15	JK-3	The lower reaches	23°32'47N,113°34'01E	29
16	JK-4		23°34'01N,113°36'22E	29
17	JK-5		23°33'07N,113°35'38E	29
18	JK-6		23°32'15 N,113°35'04E	28
19	JK-7		23°31'42 N,113°34'13 E	24
20	SG-1		23°28'34 N,113°30'03 E	22
21	SG-2		23°29'27 N,113°31'35 E	30
22	SG-3		23°30'29 N,113°32'47 E	18
23	SG-4		23°31'17 N,113°33'30 E	23

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24	TP-1		23°28'31 N,113°29'12 E	22
25	TP-2		23°27'16 N,113°27'52 E	22m
26	TP-3		23°26'13 N,113°28'15 E	15m

3. Result and Discussion

3.1 NH_4^+-N and TN pollution status

The NH_4^+-N concentrations of all the samples ranged from 0.14 mg/L to1.22 mg/L, presented an increasing trend from the upper reaches to the lower reaches (Fig.1). Moreover, the NH_4^+ -N concentrations of the sample from Dongming town in the upper reaches of Liuxi River was only 0.14 mg/L, which means that the water quality meet the quality requirement of China Class I water standard. However, the water quality of the middle and lower reaches of the river was poor, and could only meet the Class III or Class IV water standard. Even worse, the water quality of Renhe and Shijing town in Baiyun District even did not come to the Class V water standard. Therefore, the obtained results revealed that the middle and lower reaches of the river have been polluted by the NH_4^+-N, and there was the security risk as drinking water and ecological risk for developing eutrofizacja.

For all the samples, the TN concentrations were much higher than the NH_4^+ -N concentrations. However, the TN concentrations of all the samples presented a very similar trend with the NH_4^+-N concentrations (Fig.1), and TN pollution in the lower reaches of the river was the most serious. Based on the above results, the conclusion can be drawn that other nitrogen sources had contributed to the TN besides the NH_4^+-N, but the correlation between NH_4^+-N and TN seem be significant.

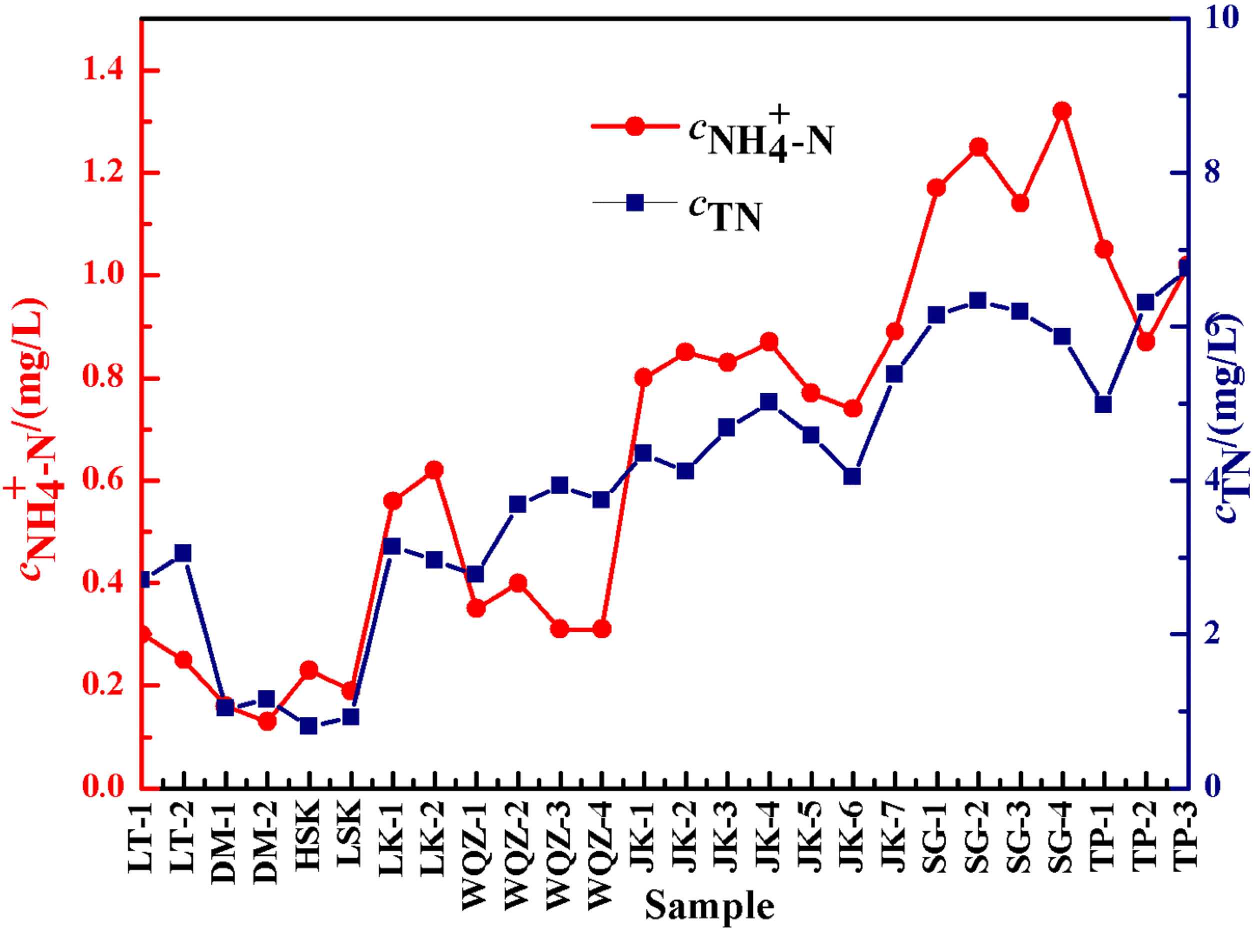

Fig. 1 The NH_4^+-N and TN concentrations of the samples in the Liuxi River

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3.2 COD and DO in the Liuxi River

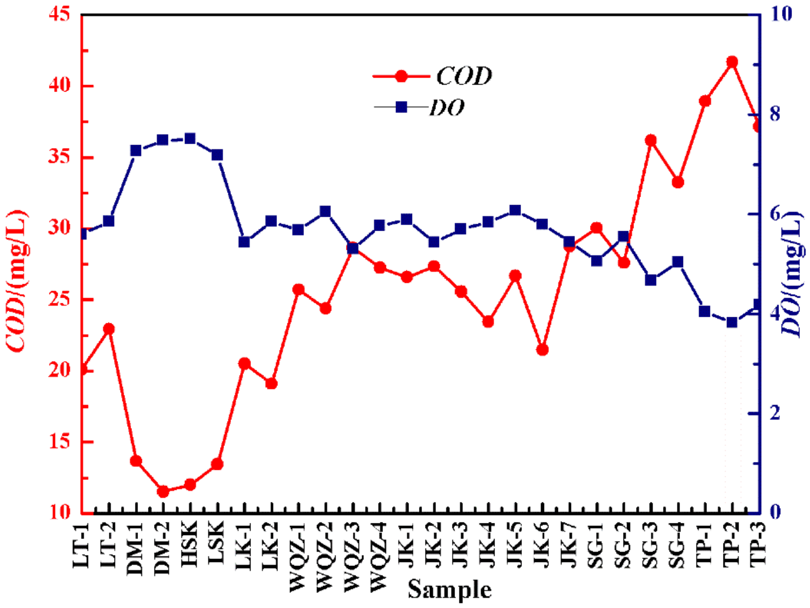

Fig. 2 The COD and DO values of the samples in the Liuxi River

The average values of COD in the sample sites at the upper, middle and lower reaches were 15.62 mg/L, 24.27 mg/L and 30.33 mg/L, respectively. Moreover, by the COD value, the water quality of some sample sites at the lower reaches was so poor that exceed Class V water standard, which might be caused by the agricultural non-point source pollution near the river. Also, the COD values presented the presented a very similar trend with the NH_4^+-N concentrations (Fig.1 and Fig.2). The DO index of the samples indicated that the lower reaches of the Liuxi River were polluted serious, and showed the contradictory trends with the NH_4^+-N concentrations (Fig.1 and Fig.2). Therefore, the obtained results that the lower reaches of the Liuxi River were polluted more serious than other parts of the river, and the COD and BOD value qualitatively behaved correlation with the NH_4^+-N concentrations.

3.3 The chlorophyll-a concentration in the Liuxi River

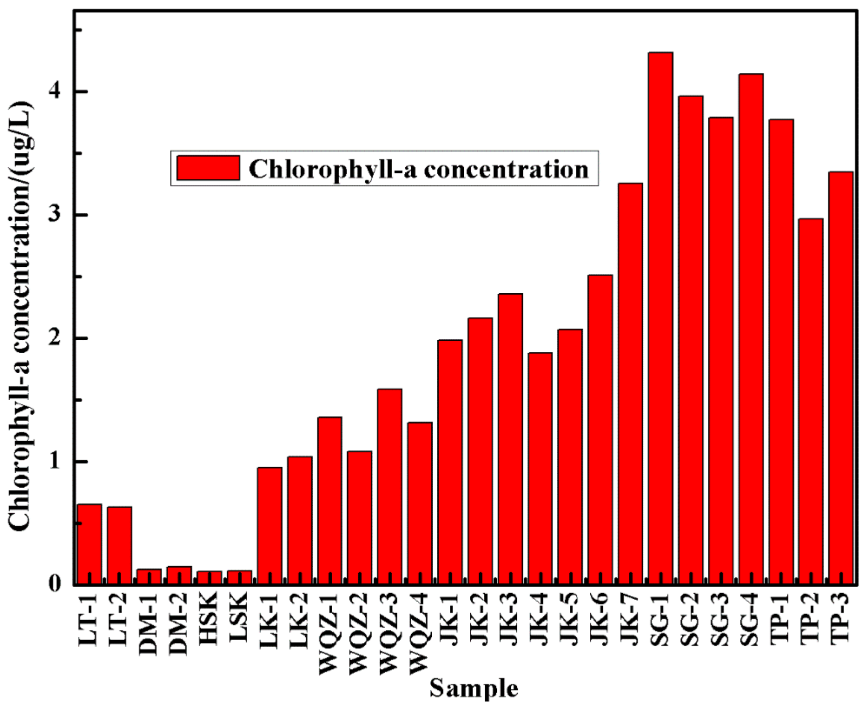

Fig. 3 The chlorophyll-a oncentrations of the samples in the Liuxi River

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The average values of chlorophyll-a oncentrations in the sample sites at the upper, middle and lower reaches were 0.297μg/L, 1.222μg/L and 3.035μg/L, respectively. The obtained results indicated that the pollution degree of eutrophication became more and more seriously from upper reaches to lower reaches, also, meet the trends of the NH_4^+-N concentrations (Fig.1 and Fig.3).

3.4 The correlation analysis between NH_4^+-N and TN, COD, DO as well as chlorophyll-a in the Liuxi River

In the above discussion, the correlation between NH_4^+-N and TN, COD, DO and chlorophyll-a have been respectively qualitative analyzed. In order to comprehensively research the NH_4^+-N influence on the other indicators, the SPSS Pearson Correlation analysis was adopted in the correlation analysis between NH_4^+-N and TN, COD, DO as well as chlorophyll-a were quantitatively studied using (Table 2). The NH_4^+-N concentrations of the samples had positive correlation with TN, COD and chlorophyll-a, but had negative correlation with DO. Given the P value less than 0.01, a significant correlation was confirmed between NH_4^+-N and TN, COD, DO and chlorophyll-a.

Table 2 The coefficients of the correlation analysis between NH_4^+-N and TN, COD, DO as well as chlorophyll-a

Indicators		TN	COD	DO	Chlorophyll-a
NH_4^+-N	Pearson correlation coefficient	0.896	0.732	-0.695	0.948
	P	6.434×10^{-10}	2.134×10^{-5}	8.021×10^{-5}	1.888×10^{-13}

4. Conclusion

The middle and lower reaches of the Liuxi River have been seriously polluted by the NH_4^+-N, and resulting in the over state standard problems of TN, COD, DO and chlorophyll-a. The study confirmed that the NH_4^+-N in the Liuxi River had a remarkable correlation to N, COD, DO and chlorophyll-a, which would be conducive to the contamination tracing and pollution treatment.

Acknowledgments

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