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Analysis of Eutrophication of Yangtze River Yibin Section

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Abstract

Based on 2009-2010 two years continuous monitoring data of section Jingkou and Guagongshan, temperature of water, pH, DO, transparency (SD), TN, TP, chlorophyll a and COD_{mn} are selected to evaluate water quality of Yangtze River Yibin section. The results show that the Yangtze River Yibin section is at the level of eutrophication. Besides, the impact Nitrogen, phosphorus, water temperature, light and pH take on the eutrophication of the Yangtze River Yibin section is analyzed. It turns out that the mean concentration ratio between total nitrogen (TN) and total phosphorus (TP) of Yangtze River Yibin section in 2009 and 2010 is 4.05:1. Generally considered, when TN / TP <14 , nitrogen is the limiting factor of eutrophication. So the nitrogen is the restrictive factor of Phytoplankton growth in Yangtze River Yibin section.

Keyword: Yangtze River Yibin section; eutrophication; assessment of water quality;impact factor

The flow length of Yangtze River in Yibin city is 83.6km. With the construction of Xiluodu Power Plant and Xiangjiaba Power Plant, the water quality, water temperature and water quantity is changed from the upstream; therefore, eutrophication might occur to the Yangtze River Yibin section, which has raised great attention for the water quality safety. Based on the above reasons, this study evaluates and analyzes the eutrophication of Yangtze River Yibin section according to the monitoring data of Guagongshang cross section (entrance) and Jingkou cross section (exit) done by Yibin Monitoring Station from January of 2009 to December of 2010.

1. Analysis of the water quality factors in Yangtze River Yibin section

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1.1. Water temperature

It can be seen from Fig 1 and Fig 2 that the water temperature in Yangtze River Yibin section changes with season. Guagongshan cross section: highest temperature is 26℃, in August of 2009, and 24℃, in June of 2010; lowest temperature is 8.8℃, in February of 2009, and 7.3℃, in January of 2010. Jingkou cross section: highest temperature is 32.1℃, in August of 2009, and 24℃, in June of 2010; lowest temperature is 4.2℃, in February of 2009, and 11℃, in January of 2010. This kind of water temperature is suitable for the growth of algae. According to monitoring, the optimum temperature for algae growth in Yangtze River Yibin section is 20-25℃. It is shown in Fig 1 and Fig 2 that April to October is the best season for algae growing.

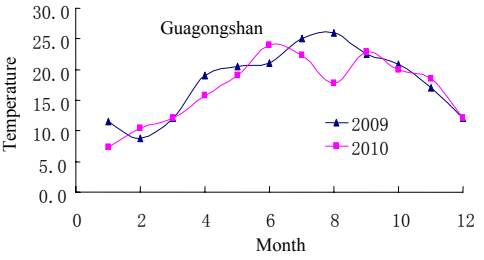


Fig. 1. Monthly water temperature of Guagongshan cross section

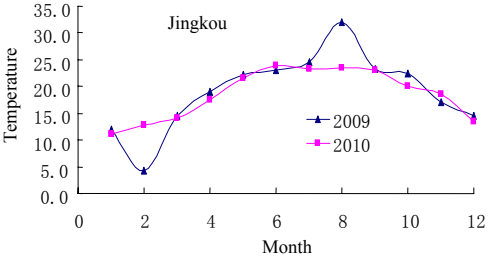


Fig. 2. Monthly water temperature of Jingkou cross section

1.2. Water transparency

As shown in Fig 3 and Fig 4, the change trend of the transparency for both 2009 and 2010 is similar, which shows the transparency of July, September and November is low, and this is because of the mass breeding of the algae. In 2009, the average value of transparency for Guagongshan and Jingkou cross section are 6.86cm and 7.07cm respectively, the lowest value is 3.0cm, in July of both cross sections, and the highest value is in 10cm and 11.5cm respectively. In 2010, the average value of transparency for Guagongshan and Jingkou cross section are 26.1cm and 27.0cm respectively, the lowest value is 3.5cm, in August of both cross sections, and the highest value is 65cm in April for both cross sections. The change trend of transparency is: winter>spring>summer>autumn, which means the transparency of Yangtze River Yibin section is not decided by sunshine, it's decided by the density of algae in the water.

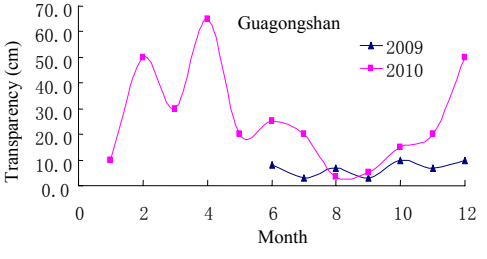


Fig. 3. Monthly transparency of Guagongshan cross section

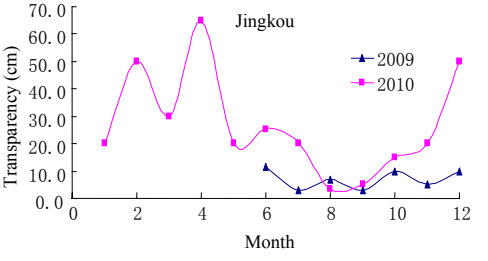


Fig. 4. Monthly transparency of Jingkou cross section

1.3. pH

As shown in Fig 5 and Fig 6, the range of pH is from 7.51-8.43, which is alkalescent all the year. In 2009 and 2010, the pH is comparatively high in July, August and September, this might be because the temperature in these months are higher and good growth of algae and active chemical reaction.

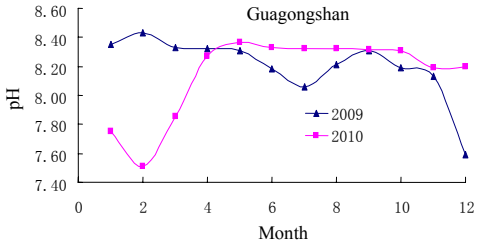


Fig. 5.Monthly pH of Guagongshan cross section

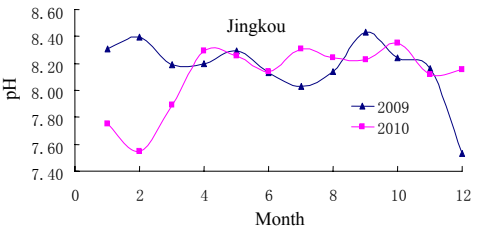


Fig. 6. Monthly pH of Jingkou cross section

1.4. CODmn

As shown in Fig 7 and Fig 8, the average value of CODmn is 3.4mg/l which is not low. The value differs from season change, in summer the value is high, which means the organic pollutants density is high in Yangtze River Yibin section. The max value in 2009 and 2010 is 5.79mg/l and 6.98mg/l occurred in November and September respectively. The value is low in February, April, October and December.

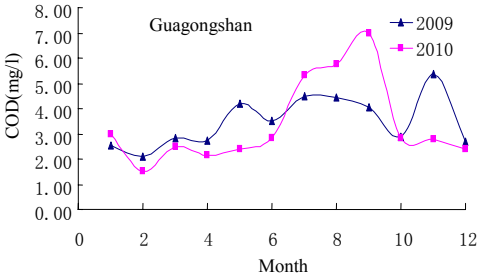


Fig. 7.Monthly CODmn of Guagongshan cross section

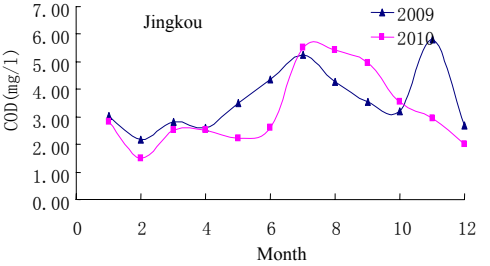


Fig. 8.Monthly CODmn of Jingkou cross section

1.5. DO

As shown in Fig 9 and Fig 10, the dissolved oxygen is high in Yangtze River Yibin section which is 8.93 mg/l, and max value and minimum value is 10.66mg/l and 7.61mg/l respectively. For both 2009 and 2010, the DO is low from June to September, the reason might be the phytoplankton breeds greatly, the growth and decomposition consumes a lot of oxygen, which leads to the low oxygen in the water.

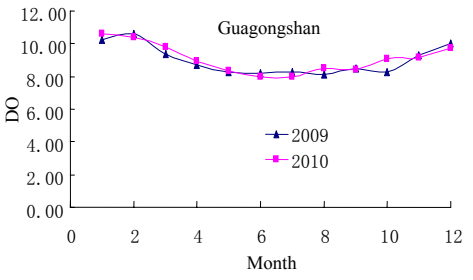


Fig. 9.Monthly DO of Guagongshan cross section

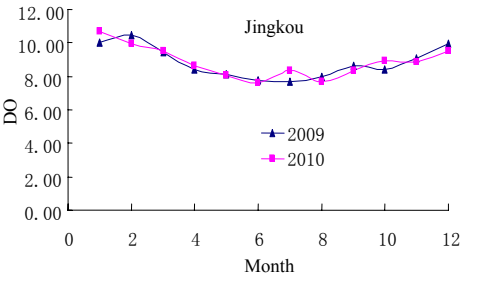


Fig. 10.Monthly DO of Jingkou cross section

1.6. TP

As shown in Fig 11 and Fig 12, for Guagongshan cross section, the lowest TP is 0.148 mg/l and 0.101 mg/l which occurs in March of 2009 and January of 2010 respectively; and highest TP is 0.379 mg/l and 0.466 mg/l which occurs in November of 2009 and July of 2010 respectively. For Jingkou cross section, the lowest TP is 0.140 mg/l and 0.094 mg/l which occurs in May of 2009 and February of 2010 respectively; and highest TP is 0.337 mg/l and 0.440 mg/l which occurs in June of 2009 and August of 2010 respectively.

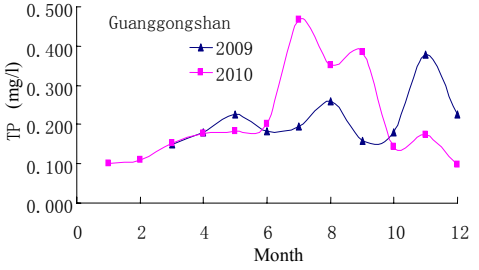


Fig. 11.Monthly TP of Guagongshan cross section

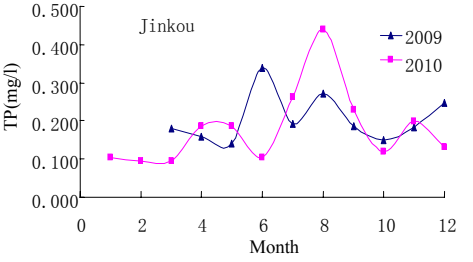


Fig. 12.Monthly TP of Jingkou cross section

1.7. TN

As shown in Fig 13 and Fig 14, the value of TN is high in March, May, July and December, and low in October. The value is decreasing from April to August in 2009, and it's opposite in 2010. The value of both cross sections is increasing from September to December for both 2009 and 2010.

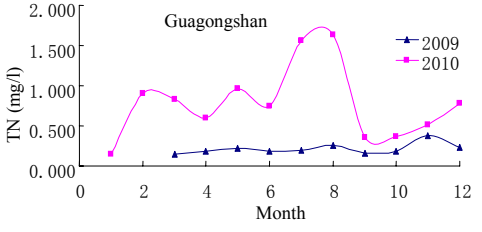


Fig. 13.Monthly TN of Guagongshan cross section

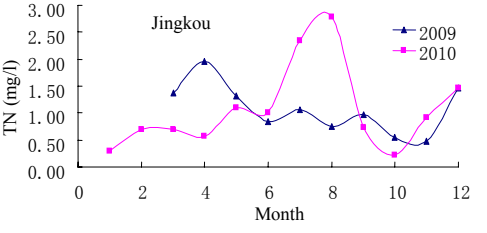


Fig. 14.Monthly TN of Jingkou cross section

1.8. Chla

As shown in Fig 15 and Fig 16, each curve fluctuates frequently, there are many peaks, the max value in each year is in different months, and another peak occurs in June, in 2010, the density of chla differs from January to June. This curve indicates that the monthly value of chla in Yangtze River Yibin section is quite different from ordinary lakes.

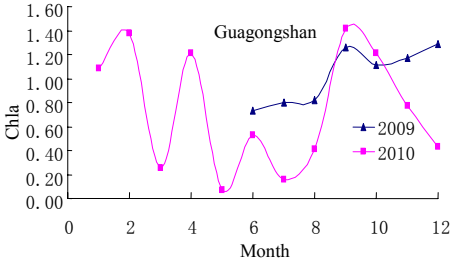


Fig. 15.Monthly Chla of Guagongshan cross section

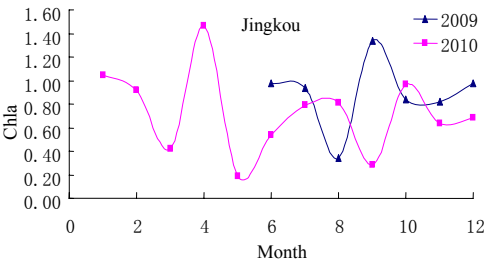


Fig. 16.Monthly Chla of Jingkou cross section

2. Evaluate the eutrophication of Yangtze River Yibin section

Using the grades marking method in 《Investigation standard for eutrophication of lakes》(2nd edition), evaluation results are achieved.

Table 1 Eutrophication degree of Yangtze River Yibin section

Cross section	Chla(mg/m3)	TP(mg/l)	TN(mg/l)	CODMn(mg/l)	SD(m)	Point	Nutrition status
Guagongshan	0.85	0.212	0.968	3.43	0.19	62	Rich nutrition
Jingkou	0.79	0.191	1.07	3.4	0.70	54	Rich nutrition

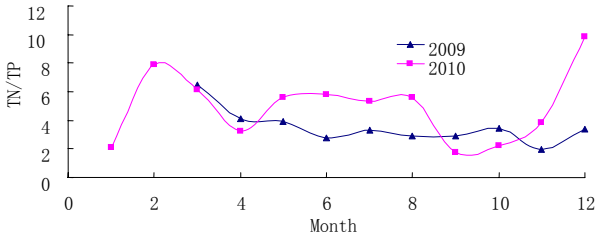
The comprehensive evaluation results are shown in table 2, the water in both cross section of Yangtze River Yibin section is in rich nutrition status. From Guagongshan cross section to Jingkou cross section, the density is decreasing for salt index (TP, etc), organic pollutants (COD), and chlorophyll a, and the physical index (SD) in increasing. This result is related to the upstream water has nutrition and organic pollutants, when the water flow into Yangtze River Yibin section, these substance settle down and resolved. Meanwhile, the DO and SD is getting better from upstream to downstream. Normally, in the high flow period of summer, there are more dust and nutrition into the water, which causes the increasing of the COD, TN, TP, etc, and they will reach the peak of a year, however, SD and DO will go down to the bottom of a year. While, in the low water period of winter, COD, TN, TP, etc, will go down to the bottom of a year and DO and SD will reach the peak. In Yangtze River Yibin section, COD, TN, TP are in high density, generally the water is in rich nutrition status.

3. Analysis of the factors affecting the eutrophication of Yangtze River Yibin section

3.1. The affection caused by nitrogen and phosphorous for eutrophication

According the "experience molecular formula" of algae: $C_{106}H_{263}O_{110}N_{16}P$, compared to the nitrogen-atoms to phosphorous-atoms: 16:1, their mass concentration ratio is 7.2:1. Therefore, if the mass concentration ratio of nitrogen and phosphorous in the water is less than 7, then nitrogen is the limiting salt for algae, if it is higher than 7, phosphorous will be the limiting salt, if it is equal or close to 7, then both nitrogen and phosphorous can be limiting salt.

The ratio of TN and TP in 2009 and 2010 is shown in Fig 17. Table 2 shows the average mass concentration of TN and TP and their ratio from the sample taken from March of 2009 to December of 2010. The average ratio of TN and TP is 4.05:1, and the monthly mass concentration ratio of TN and TP is less than 14:1. It is normally thought that in the water which TN/TP<14, then the nitrogen is the



limiting factor for algae growing. This rule indicates that in the massive growing season of algae, the algae is depending on the nitrogen in the water, therefore, nitrogen probably is the limiting nutrition salt for eutrophication of Yangtze River Yibin section.

Fig. 17.Monthly value of TN/TP in 2009 and 201**0**

Table 2 Mass concentration and it's ratio of TN and TP in both cross section of Yangtze River Yibin section

section	TP (mg/l)	TN（mg/l）	TN :TP
Guagongshan	0.968	0.212	4.56:1
Jingkou	1.070	0.191	5.61:1

3.2. Relative analysis of the density of chlorophyll a and nitrogen and phosphorous

Chlorophyll a is the key factor for evaluating the existing phytoplankton, and nitrogen and phosphorous is the important elements for the growing of phytoplankton. The relation between the three factors are important for determine the limiting factor of eutrophication. The relationship between the three factors is established from the monitoring data from January to December of 2010 in Yangtze River Yibin section:

$$\begin{bmatrix} \rho(chla) = 0.9324 - 0.2137\rho TN; (r = 0.326, n = 24) \\ \rho(chla) = 0.8421 - 0.5488\rho TP; (r = 0.143, n = 24) \end{bmatrix}$$

From the above equation, it can be seen that the coefficient between chla and TN, chla and TP is very small, especially for TP, therefore, the relationship is not tight. With the increasing of TN and TP, the

algae in the water of Yangtze River Yibin section will decrease accordingly. As the TP density in Yangtze River Yibin section is sufficient, therefore, the density of phosphorous has small affection to the growth of algae than nitrogen. The density of TN, TP and chla in 2010 is shown in Fig 18.

3.3. The impact of water temperature on the eutrophication of Yangtze River Yibin section

The growing of phytoplankton requires certain temperature, and the change of temperature causes the change of other factors, eg. pH. The change of these factors will affect the growth and breeding of phytoplankton, therefore, temperature has an important impact on the phytoplankton. According to monitoring data of Guagongshan and Jingkou cross section in 2009 and 2010, the average temperature is 18.1℃, highest temperature is 32.1℃ and lowest temperature is 4.2℃. According to that the optimum temperature for phytoplankton is 18-28℃, the temperature in Yangtze River Yibin section is very suitable for the growing of phytoplankton. Therefore, water temperature is never the limiting factor for the growth of phytoplankton.

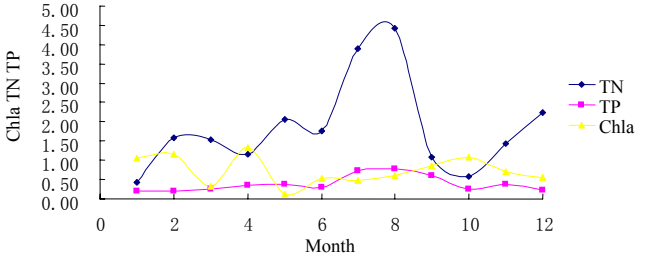


Fig. 18.Chla, TN, TP in 2010

3.4. The impact of pH and sunshine on eutrophication of Yangtze River Yibin section

Sunshine is an important factor for the water ecosystem. The transparency for Yangtze River Yibin section from June of 2009 to December of 2010 is shown in Fig 3 and Fig 4, from which it is clear that when the growth of algae is rapid, the transparency is lower than winter, therefore, the impact of sunshine on the growth of algae is not obvious. In Yangtze River Yibin section, the sunshine is always sufficient, therefore, sunshine is not the limiting factor for growth of algae.

The water of Yangtze River Yibin section is alkalescent all year long, after analyzing the data of chla and pH for both years, it is obvious that there's a negative correlative between the chla and pH, the coefficient is small. And suitable pH for algae growth is 7.5-8.3, therefore, the pH in Yangtze River Yibin section is suitable for algae growth.

4. Summary

In the whole five evaluation factors, chla is in poor nutrition status, CODmn is in middle nutrition status, SD, TP and TN is in rich nutrition status. The comprehensive evaluation result shows that the water quality in Yangtze River Yibin section is bad, and is in eutrophication level, nitrogen is the main limiting factor for eutrophication of Yangtze River Yibin section.

Acknowledgements

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