UV Absorption Spectral Characteristics of Dissolved Organic Matter in Fen River of Taiyuan in China

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Abstract. UV absorption is one of the important properties of chromophoric dissolved organic matter (CDOM). The UV absorption spectral characteristics of dissolved organic matter (DOM) were analyzed to infer the main components in Taiyuan urban section. Based on the UV absorption spectral characteristics of the CDOM, and relationship between DOC concentration and UV absorbance, conclusions were drawn: (1) Content of DOM in the treated section was at a low degree and constituent.The anthropogenic pollution accounted for a major role. (2)DOM constituents in Taiyuan section in May, July and November were relatively simple. The molecular structure of mainly CDOM was simple with mostly two or three species among the hydroxyl, carboxyl and phenyl. However, DOM constituent in September was more complicated, there were more non-fluorescent substances besides CDOM .

1 Introduction

Dissolved organic matter (DOM), as the largest organic carbon pool, plays an important role in water carbon cycle. Chromophoric dissolved organic matter (CDOM) is also known as soluble organic chromophores. It is a kind of DOM that can be measured in optics. As an important part, CDOM has been proven that it had an impact on aquatic ecosystem[1,2] . CDOM also have optical properties, including ultraviolet-visible (UV) absorption properties. Due to the complex structure, composition and unknown components, a precise determination of DOM would be much difficult, so the study of CDOM to represent the former was needed [3,4].

In this article, we used UV absorption spectroscopy to study the qualitative and quantitative of DOM to infer the source composition, molecular structure, maturity and other information of DOM. At the same time,by doing the correlation analysis with dissolved organic carbon (DOC), we can have a better understanding of the source and composition of organic matter.

2 Sampling and Methods

Taiyuan section of Fen River (N34~38°, E110~113°)covers a distance of 188km and an area of 6288km^2, flowing through the Taiyuan City from the north to the south. Along the river flows from up stream to downstream, it was divided into three sections as upstream, treated section and non-treated section; also ten sampling points were set (Fig.1). In the level period (May), wet season (July and September) and the dry season (November) sampling at each sampling point. All the samples were performed by using 0.45m membrane filtration, sealed in a bottle and stored in a refrigerator at 0-4℃. The DOC concentration was measured by using a high-temperature catalytic oxidation method (Elementar Vario TOC). UV absorption spectra were determined by the UV-VIS Spectrophotometer.

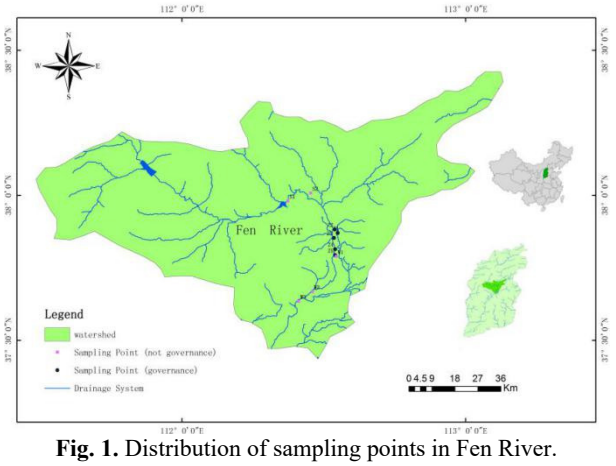

Fig. 1. Distribution of sampling points in Fen River.

3 Results and Discussion

3.1 The Relationship between DOC Concentration and UV Absorbance

The source of CDOM is both endogenous and exogenous. Exogenous are mostly from soil and plants that are washed into the waters, as well as the human organic emissions[5]. Some main components of DOM such as humic acid, fulvic acid and some aromatic amino acids contain phenyl, hydroxyl, phenyl carboxyl groups and have strong absorption at wavelength of 254nm and 280nm[6]. Do the correlation analysis between DOC concentration and absorbance at 254nm and 280nm

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respectively, shown in Fig. 2. The Correlations in May, July and November were significant; however in September was not significant. The figure shows that absorbance at 254nm and 280nm increase with the rise of DOC concentration in May, July and November, implying that DOM of the water may contains phenyl, hydroxyl, benzene carboxyl groups. While in September, with the increase of DOC concentration, absorbance at 254nm and 280nm has fluctuations, indicating that components of DOM are more complex than the other three months. The reason is highly possible other non-fluorescent substances in addition to components of CDOM , which caused the poor correlation.

3.2 UV Absorption Spectrum Characteristic

E_3/E_4 value is the ratio of absorbance at 300nm and 400nm wavelength. As shown in Fig. 3. Generally, with the decrease of the value of E_3/E_4, the degree of humification and molecular weight increased, and aromaticity enhanced[7]. Studies have found that if E_3/E_4 value is less than 3.5, and it indicates that the degree of humification and aromaticity is high and more structures of phenyl ring are contained with mainly macromolecule organic matters[8]. The range of the E_3/E_4 values was 3.24-6.47 in four seasons. As shown in Fig. 3,values at upstream section and treated section were much higher than 3.5, suggesting a low degree of humification and aromaticity and constituents were mainly small molecule organics, which reflected that the treatment in governance section had a certain effect on the environment. In addition, all values of the wet season were generally lower than the other two months with the dry season the highest, implying that with the infusion of rain that expanded the water amount, CDOM were diluted and consequently the concentration decreased. Hence the degree of humification and aromaticity as well as the molecular weight were reduced. As to the non-treated section, values were near the standard line, which confessed the fact of highly-degreed humification.

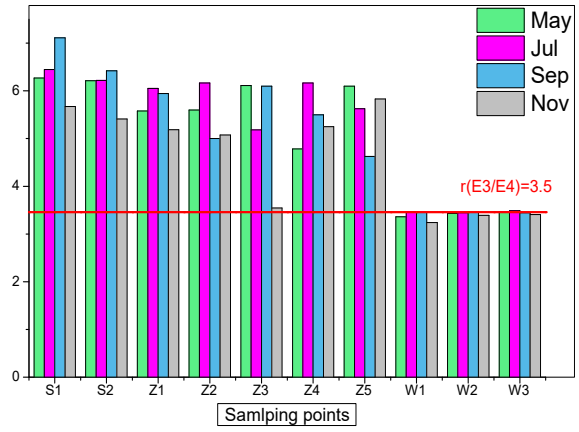

Fig. 3. E_3/E_4 values.

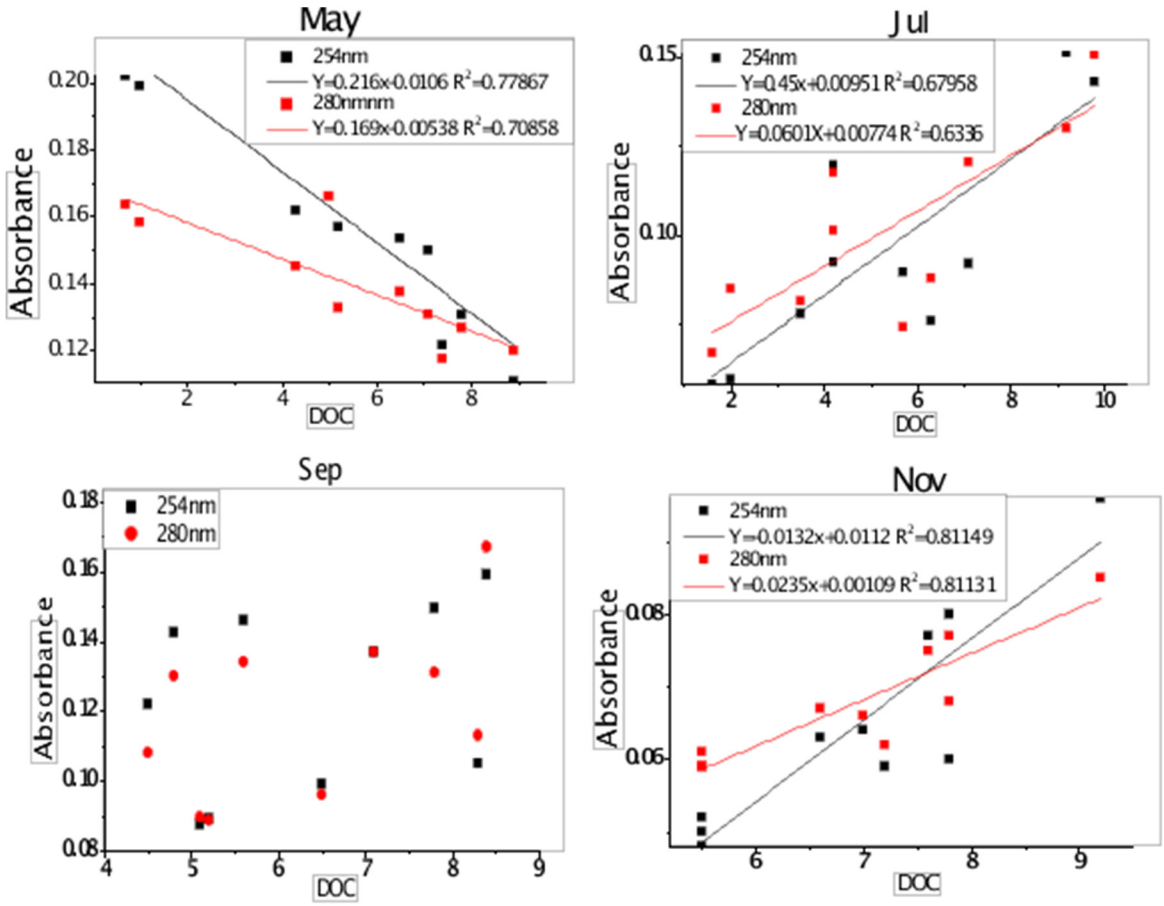

Fig.2. Correlation analysisbetween DOC concentration and absorbance at 254nm, 280nm

4 Conclusions

From the above analysis of E3/E4 value, a(355) and the relationship between DOC concentration and UV absorbance, we can get the following conclusions.

(1) Concentration of DOM in the treated section was at a low degree of humification and aromaticity. Constituents were mainly small molecule organics, which reflected treatment on Fen River had made a certain environmental benefit, but anthropogenic pollution accounted for a major role.

(2) DOM constituents in Taiyuan section of Fen River in May, July and November were relatively simple with mainly CDOM substances. The molecular structure were simple with mostly two or three species among the hydroxyl, carboxyl and phenyl. However, DOM constituent in September was more complex with more non-fluorescent substances besides CDOM.

Acknowledgements

The authors thank the financial supported from Scientific and Technological Innovation Programs of Higher Education Institutions in Shanxi (2017111), Fund of China Scholarship Council and Applied Basic Research Project in Shanxi (201701D221021).

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