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Quick Evaluation of Organic Substances in Environmental Water and Tap Water Using Fluorescence and Absorption Spectroscopy

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K. Sobue, M. Ishigaki, H. Taniguchi, S. Murakami
Shimadzu Corporation, Japan

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Introduction

The daily management and inspection of environmental water and tap water requires an easy and quick analytical method to reduce a time-consuming process typically requiring a variety of analytical methods.

A UV-Visible spectrophotometer and a spectrofluorophotometer can measure the pollution index of organic substances in the water quickly. The absorption in the ultraviolet region is known to have good correlation with COD (chemical oxygen demand) and the absorbance near 250 nm allows organic substances in the water to be detected. Three dimensional florescence spectra have the capability to qualitatively and semi-quantitatively identify fluorescing substances in the water with high sensitivity.

In this report, we demonstrate that the use of a UV-Visible spectrophotometer and a spectrofluorophotometer allows evaluating the daily pollution status of environmental and tap water quickly.

Fluorescence
UV-VIS Absorption

Environmental

Absorption Measurement

Fig.1 shows the absorption spectra of river water collected during the period of October 17, 2016 to January 25, 2017 and 1 ppm humic acid dissolved in water. All measured spectra show a continuous increase of absorption as the wavelength shortens.

Fig. 2 shows the relation between precipitation and absorbance. Absorption near 250 nm is considered to be attributed to organic substances because inorganic ions have little absorption in this region. We confirmed that the absorbance changes with precipitation.

Since the changes in absorbance are very small, there is a possibility that the values significantly fluctuate due to turbidity or scattering of water samples.

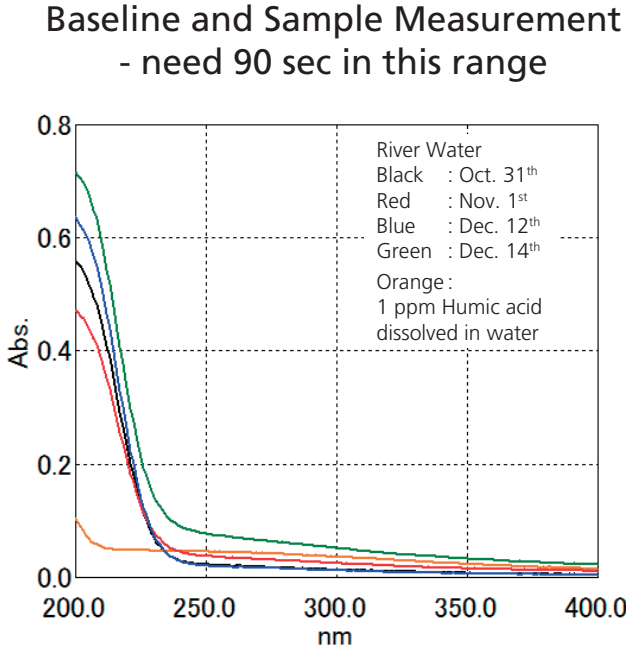

Fig. 1 Absorption Spectra

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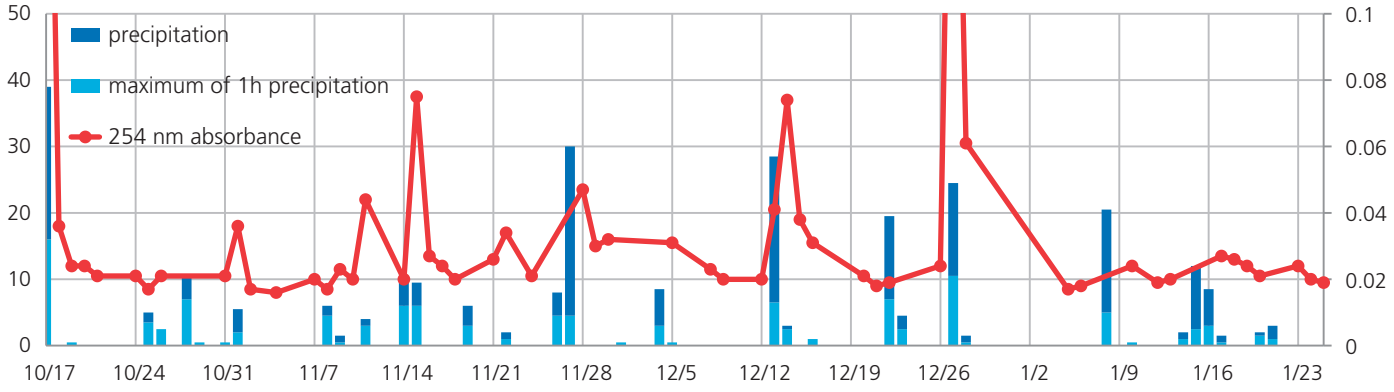

Fig. 2 Relation between precipitation and absorbance

Three Dimensional Fluorescence Spectra Measurement

The Shimadzu RF-6000 spectrofluorophotometer is capable of measuring a wide wavelength range in a short time with high sensitivity because it can scan wavelengths at maximum of 60,000 nm/min.

Fig. 3 shows the 3D fluorescence spectra of river waters and 1ppm humic acid dissolved in water. The measured spectra showed signals around 430 nm of the emission wavelength (Em) while moving the excitation wavelength (Ex) in the range from 260 nm to 320 nm. This is thought to originate from corrosive substances included in river water

Fig. 4 shows the relation between precipitation and fluorescence emitted from corrosive substances.
Fig. 5 shows the relation between absorbance at 254 nm and fluorescence at Ex260 nm/Em450 nm.
We confirmed the correlation between them derived by analyzing the corrosive substances.

3D Measurement - need 70 sec in this range

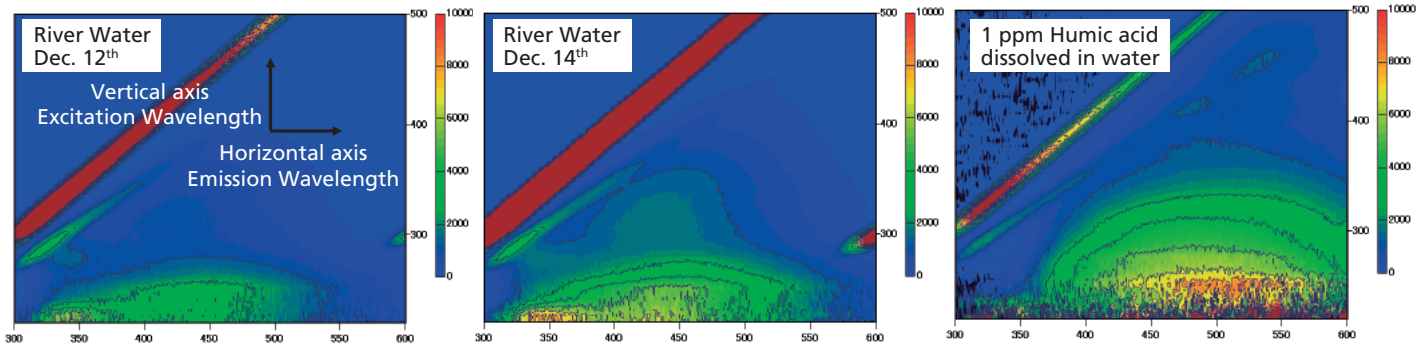

Fig. 3 Three Dimensional Fluorescence Spectra

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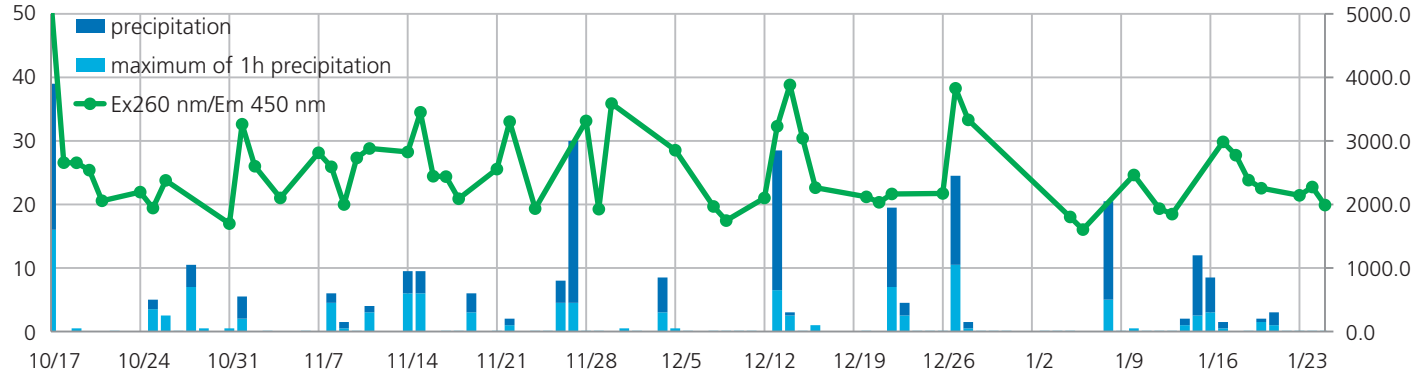

Fig. 4 Relation between precipitation and fluorescence

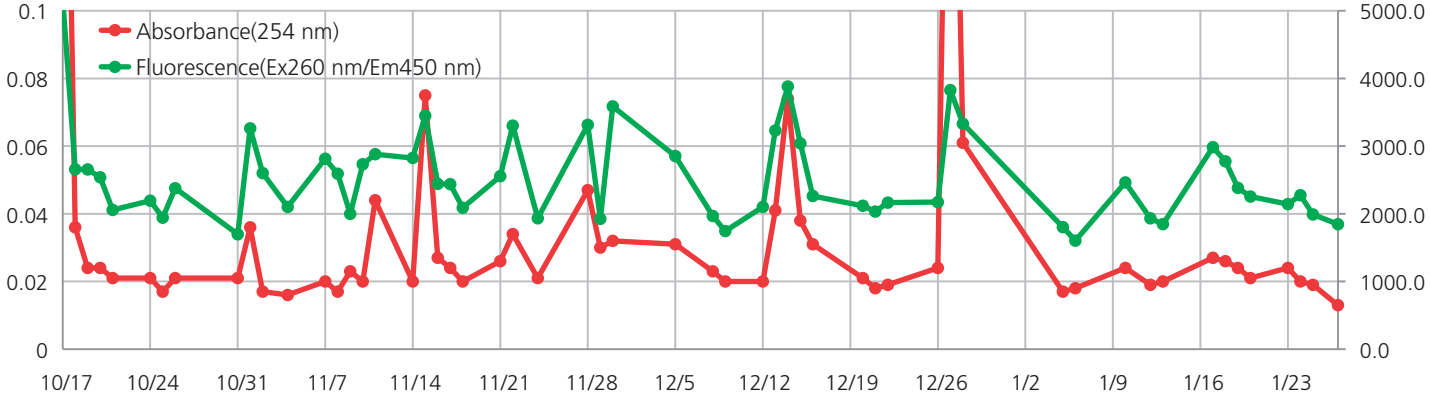

Fig. 5 Relation between absorbance and fluorescence

Various River and Tap Water

Fig. 6 shows fluorescence and absorbance spectra of tap water collected at different points. The measured fluorescence spectra showed very weak signals for corrosive substances because they are considered to be removed by a purification treatment. It is thought that the high absorbance at 254 nm of tap water is attributed to turbidity generated from surface excrescences in a water pipe.

Fig. 7 and Fig. 8 show the effect of filtration to fluorescence and absorbance. In the case of clean river water, the absorbance didn't show big differences before and after the filtration. Since the fluorescence measurement was performed with much higher sensitivity than the absorbance measurement, fluorescence derived from the filter was sometimes observed with high intensity.

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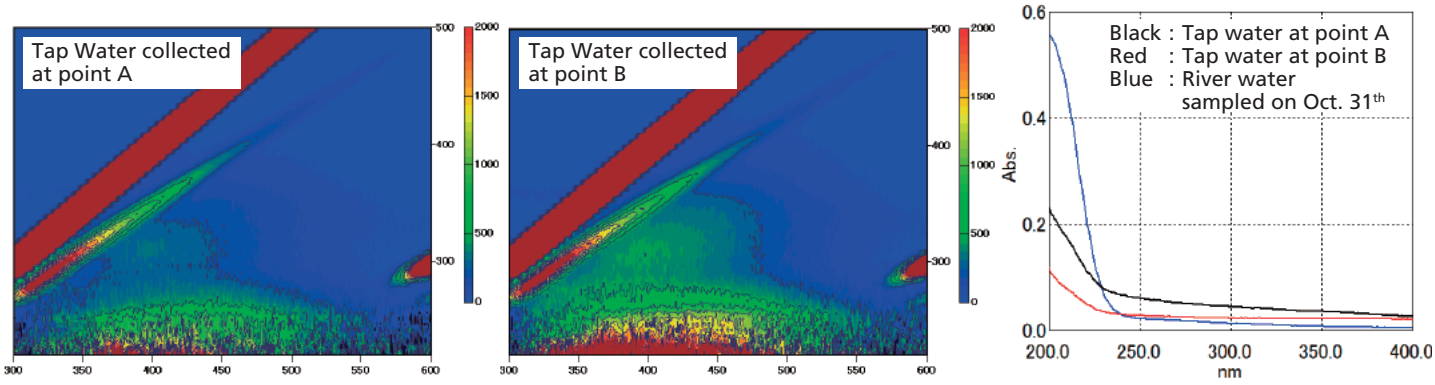

Fig. 6 Three Dimensional Fluorescence Spectra and Absorbance of tap water

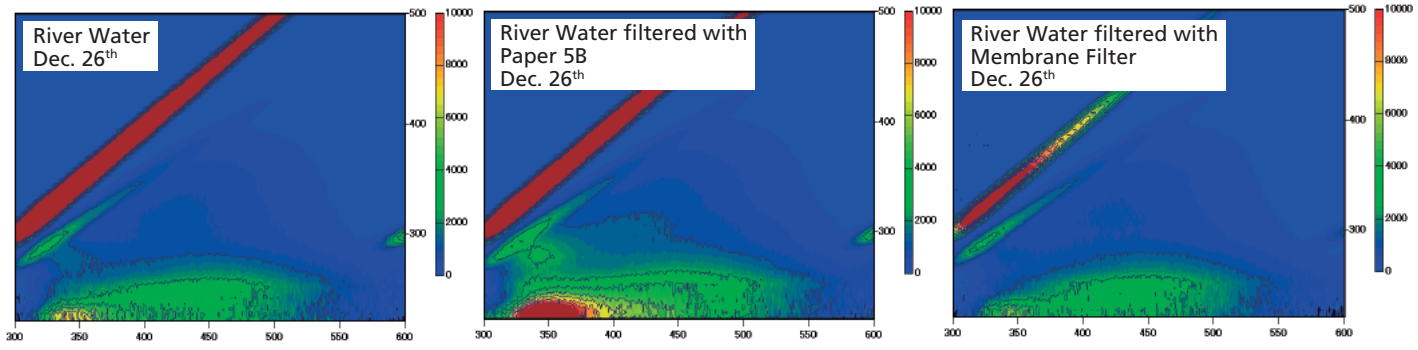

Fig. 7 Effect of filtration for fluorescence measurement

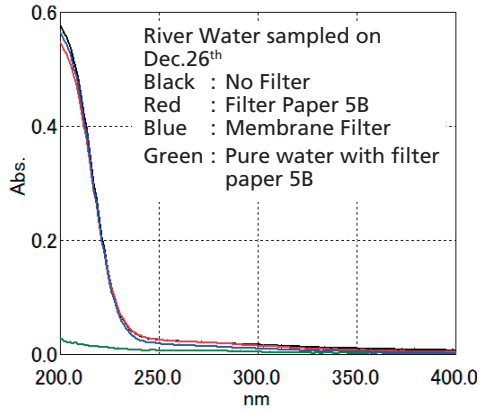

Fig. 8 Absorption Spectra

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Summary

Absorbance measurements and fluorescence measurements of environmental and tap water were carried out. The daily measurement of river water indicated the strong correlation between the absorbance and the three dimensional fluorescence spectra regarding corrosive substances. Also, the relation between the absorbance/fluorescence and precipitation was confirmed.

This work demonstrates that the use of a UV-Visible Spectrophotometer and a spectrofluorophotometer allows quickly evaluating the pollution status of organic substances in water.

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