FIELD OBSERVATIONS OF VERTICAL PROFILES OF MICROPLASTIC CONCENTRATIONS IN A RIVER

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ABSTRACT

Microplastics (MPs), which are plastic pieces smaller than 5 mm, are causing widespread pollution in the aquatic environments of rivers, oceans, and lakes. Many researchers have measured MP concentrations mainly near water surfaces because the specific gravity of major plastics is lower than 1.0. In order to accurately estimate microplastic flux into oceans via rivers, it is necessary to evaluate the vertical profiles of MP concentrations in rivers. To address this, we conducted field surveys for grasping the vertical distributions of MP concentrations in a river. Two peaks in the vertical profiles of MP concentrations appeared in the surface and bottom layers of the river water. It was also noted that the specific gravity of MPs found in the bottom layer were slightly greater than those of the surface layer, showing that the vertical profiles of MP concentrations were influenced by the specific gravity of MPs. These facts indicate that the microplastics with large specific gravity (>1.0) can concentrate near the riverbed regardless of vertical mixing.

Keywords: *microplastics, vertical profile, river, specific gravity*

1. INTRODUCTION

In recent years, microplastics (MPs), which are smaller than 5 mm, have been found in the oceans; marine ecosystems have been negatively influenced by them (Andrady, 2011). Most MPs in the oceans originated from land. It is urgently necessary to monitor the levels of MPs that are flowing from the land into the oceans via rivers. For this, MP surveys have been conducted to clarify characteristics of the MP pollution in rivers.

MPs in the oceans are believed to be concentrated near the water surface, because the specific gravity of major plastics is lower than 1.0. Reisser et al. (2015) showed that in the oceans, peaks of vertical distributions of MP concentrations appeared near the water surface and decreased exponentially with the water depth. MP samples in rivers are generally collected near the water surface by using a plankton net (Kataoka et al., 2019). However, MPs can also rise or settle vertically because the specific gravity of plastics is 0.9 to 1.4. In order to accurately estimate microplastic flux into the oceans via rivers, it is necessary to evaluate the vertical profile of MP concentrations in the rivers.

The purpose of this study was to understand the vertical profiles of MP concentrations in rivers. For this, we conducted field surveys for understanding the vertical distributions of MP concentrations in the Edo River, Japan. From the measured results, we chose to focus on the peak depths of MP concentrations.

2. RESEARCH METHOD

The field site chosen in this study was the Edo River, a first-class river, flowing into Tokyo Bay. **Figure 1** shows the plane and cross-sectional views of the observation site, Noda Bridge, which is located 39.5 km upstream from the river mouth. This site has a compound cross-section in which the width of the main channel is 60 m to 70 m. The field observation was conducted on October 30, 2018 and November 29, 2018, in which the water levels were 3.79 and 3.61 Y.P. m, respectively, corresponding to low-flow conditions in the Edo River. Y.P. (Yedogawa Peil) is one of reference plane in Japan.

A schematic of the measurement method to collect MP samples at different depths is depicted in **Figure 2**. To measure the vertical distribution of MP concentrations at eight depths, three ropes were installed in the water with a total of eight plankton nets in which the diameters and mesh sizes were 30 cm and 0.35 mm, respectively. It was difficult to strictly install the nets at a predetermined depth, as shown in **Fig. 2**. To solve this issue, water-level loggers were attached to the opening of the nets to measure the depth of each net. At the same time, the vertical distributions of horizontal velocities were measured by an acoustic Doppler current profiler (ADCP, Workhorse1200kHz, manufactured by Teledyne RDI). The vertical distributions of turbidity were also measured by an STD sensor with a turbidity meter (Compact-STD, manufactured by JFE Advantech Co. Ltd.).

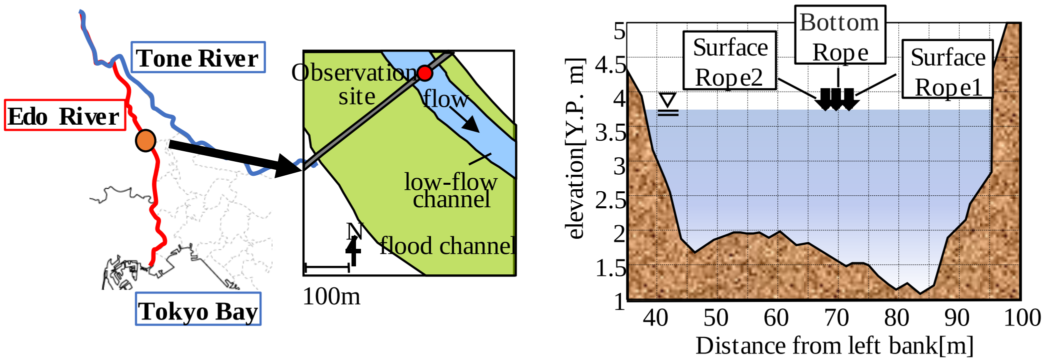

Figure 1. Plane (a) and cross-sectional (b) views of observation site at Noda bridge.

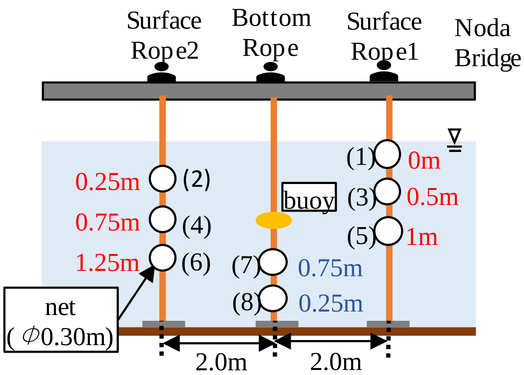

Figure 2. Net placement in the measurement.

This section briefly describes the laboratory analysis for MPs in line with a previous study (Kataoka et al., 2019). The suspended matter trapped in the nets was collected in a stemless bottle and then filtered through the net with a mesh size of 0.1 mm. The residue on the net was immersed in a hydrogen peroxide solution with the concentration of 30% for one week to dissolve natural debris. From the sample, we found MP candidate particles by eye. The mass was measured using an ultra-micro balance (XPR2UV, Mettler Toledo Co. Ltd., Japan) and the size was measured using a stereoscopic microscope (SZX7; Olympus Co. Ltd., Japan) installed with a CCD camera. Finally, polymer material of MP candidates was identified by Fourier Transform Infrared Spectroscopy (FTIR; IRAffinity-1S, Shimadzu Co. Ltd., Japan).

3. RESULTS

Figure 3 indicates the vertical distributions of MP numerical concentrations on October 30, 2018 and November 29, 2018. The height of the riverbed was different because the water levels were not the same on both days, and measuring point were not completely same on both days. The unit of MP numerical concentration is generally pieces/m^3.The results showed that although the MP numerical concentrations had some irregularities in the vertical direction on both days, the MP numerical concentrations were generally high near the water surface and bottom. This means that two peaks appeared in the surface and bottom layers. We compared the peak values of MP concentrations between these layers. On October 30, the peak values of the surface and bottom layer concentrations were almost comparable. In contrast, on November 29, the peak values of the bottom layer were significantly larger than those of the surface layer. This is because the vertical mixing of the river flow on November 29 was smaller than that on October 30. In fact, the depth-averaged velocity of river flow measured by ADCP on November 29 (=0.49 m/s) was lower than that on October 30 (=0.65 m/s).

It was also noted that the specific gravity of MPs found in the bottom layer was slightly greater than that in the surface layer, showing that the vertical profiles of MP concentrations were influenced by the specific gravity of the MPs. This indicates that MPs with larger specific gravity concentrate near the riverbed.

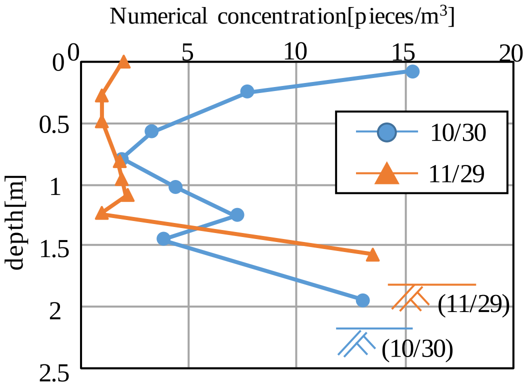

Figure 3. Vertical distribution of MP numerical concentration on Oct. 30 and Nov. 29, 2018.

4. CONCLUSION

In this study, the vertical distributions of MP concentrations were observed to evaluate the inflow of MPs from land into the oceans. In the vertical distributions of MP concentrations, there were two peaks near the water surface and at the bottom; MPs with a lower specific gravity (< 1.0) were relatively distributed on the water surface and bottom, respectively. These indicate that MPs with larger specific gravity concentrate near the riverbed.

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