STUDY OF ZINC CONCENTRATIONS OF UMEDA RIVER AND ITS TRIBUTARIES, AICHI, JAPAN

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1. INTRODUCTION

Heavy metal contamination in urban river has become the most serious problem in urban environments, and it has attracted increased attention from researchers (Xu, 2017). Especially, zinc is a crucial element for organisms, but its toxicity to aquatic organisms at high concentrations has remained a concern (EU 2010). This study aims at assessing the zinc concentrations on different grain-size fractions of surface sediment and river water at Umeda River, Aichi, Japan.

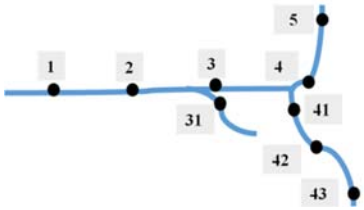

Fig. 1 Schematic sampling site

Table 1. Description of sampling site location

Sampling site	Description of Sampling site location
1	Downstream section of Umeda River
2	Residential area
3	Residential area
4	Residential area
5	Upstream section of Umeda River
31	Ochiai River; Industrial area
41	Sakai River; Industrial area
42	Industrial area
43	Agriculture and residential area

2. MATERIAL AND METHOD

For this study, triplicate surface sediment samples on 250 g weight and 100 ml river water were collected at 9 sampling points of the Umeda River. The description of sampling site location on Umeda river and tributaries is presented in Table 1 and visualized in Fig. 1. The sampling events were conducted every 2 month between July 2019 and January 2020.

For surface sediment, the samples were dried in oven 40°C within 3 days. After sediment samples were dried, then the dried sediment samples were sieved with a mesh size of 600 - 1,000 µm, 300-600 µm and <300 µm.

About one gram (dry weight) of each sample fraction was acid digested with additions of HCl according to EPA method 3050B. After heated up on hot plate at 90°C and diluted to a final volume of 50 mL, the sample was centrifuged at 2,300 rpm for 10 minutes. Once centrifuged, all the samples were decanted and kept immediately in bottles, and ready to be analyzed.

A hundred milliliters of river water sample was preserved by 1.0 ml of HNO_3 and stored at 4°C until analysis. A 20-ml of sample was heated up on hot plate at 205°C for 20 minutes, then was filtered using 0.45 µm pore size of cellulose acetate syringe filter unit (Advantec, Japan).

The concentrations of zinc both for sediment and water were determined by atomic absorption spectrophotometer (AAS) using AA 7000 Shimadzu Machine with four calibration standards ranging from 0–0.5 mg/L (detection limit: 0.005 mg/L). Every sample was analyzed three times, and standard solutions were analyzed every six samples for quality assurance purposes.

3. RESULT AND DISCUSSION

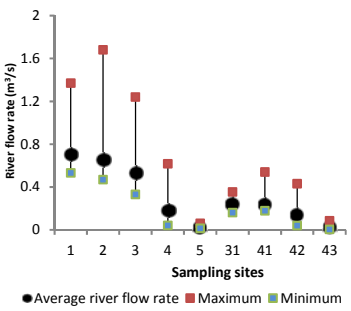

Fig. 2 Average river flow rate on Umeda River each sampling site

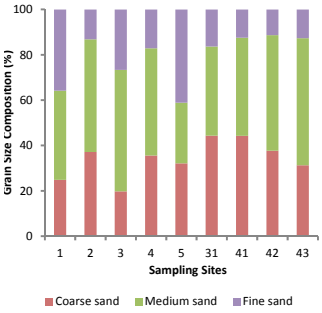

Fig. 3 The variation in particle size composition of surface sediment in the Umeda River

Flow rates at Umeda River and its tributaries at the time of sampling are illustrated on Fig. 2. Umeda River flow rate increased gradually in a downstream direction. However, at site 4 and 41 have similar average values of flow rates.

The distribution of particle size of surface sediment is presented in Fig. 3. In the study area, the most dominated particle sizes of sediment samples were medium sand with average content by 45%, followed by coarse sand 34% and fine sand 21%.

Fig. 4 illustrates zinc concentration in different particles size on surface sediment at Umeda River. The mean zinc

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the other hand, the highest zinc concentration is on site 4. While on tributaries, the highest zinc concentration at site 41 was probably due to discharges treated effluents from industries to Sakai river.

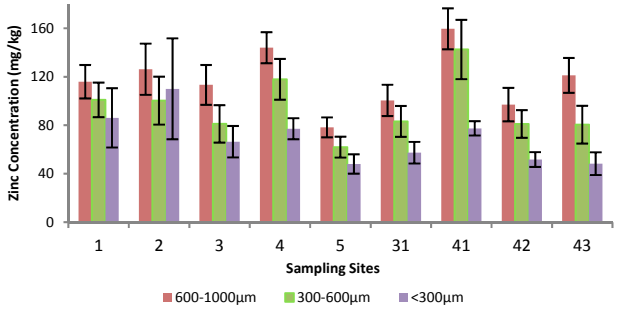

Fig. 4 Zinc concentration in each particle size of sediments collected at Umeda River

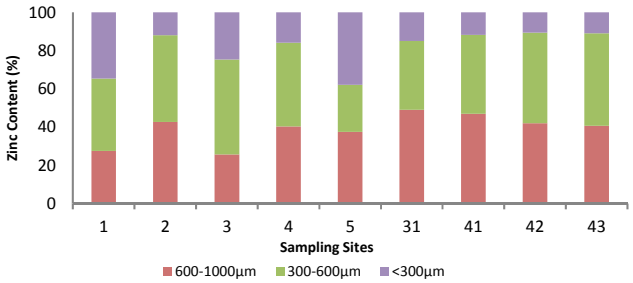

Fig. 5 Zinc content (%) in surface sediment at Umeda River

The zinc contents in surface sediment were presented in Fig.5. The highest zinc content was available in 300-600 µm grain size by 42%, 600-1,000 µm grain size by 39% and on <300 µm grain size by 19%.

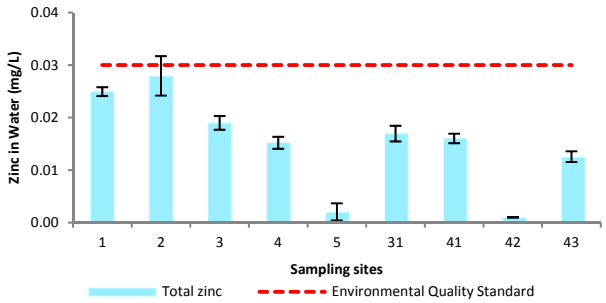

Fig. 6 Zinc concentration of river water at Umeda river

Furthermore, zinc concentrations in river water presented in Fig. 6, the highest zinc concentration was at sampling site 2, followed by site 1, and the lowest was site 5 which was the most upstream of the river. In addition, according to Ministry of Environment, Japan, the environment quality standard of total zinc in rivers is ≤0.03 mg/L on annual average. Based on this study, all of the samples varied from 0.005 to 0.028 mg/L were within the permissible standards and suitable for aquatic life habitat conditions. However, zinc concentrations at site 2 and site 1 almost exceeded the environment quality standard. Hence, those sites should be monitored frequently.

Fig.7 presents the coefficient determination value which implies that the relationship between total zinc in surface sediment and total zinc concentration in water for 0.24 variation. In addition, p value = 3.43E-10 which is $p \leq 0.01$, indicated as statistically significant.

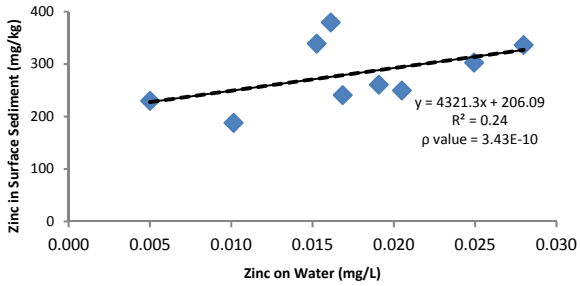

Fig. 7 Plot of correlation between zinc concentration in surface sediment and river water

4. CONCLUSIONS

The surface sediments in Umeda River contained 48 to 159 mg/kg of zinc. In addition, zinc concentration in river water ranged from 0.005 to 0.028 mg/L, which the value were within the environment quality standard for aquatic life habitat. However, due to the zinc concentration on the downstream section of Umeda River is almost exceeded the environment quality standard, hence those should be monitored frequently to maintain the quality of water.

Furthermore, it may be concluded that zinc concentrations both in surface sediment and river water have been influenced by anthropogenic activities such as industrialization, urbanization and others because the zinc concentrations were increased in a downstream direction. The statistical analysis showed that was positive correlation between the zinc concentration in surface sediment and river water.

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