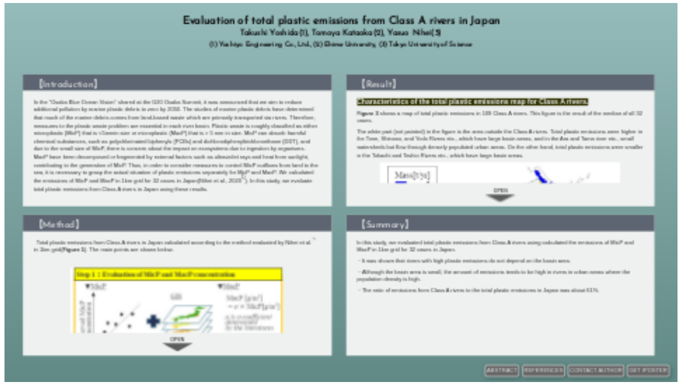
Evaluation of total plastic emissions from Class A rivers in Japan



Takushi Yoshida(1), Tomoya Kataoka(2), Yasuo Nihei(3)

(1) Yachiyo Engineering Co., Ltd., (2) Ehime University, (3) Tokyo University of Science

PRESENTED AT:

【INTRODUCTION】

In the "Osaka Blue Ocean Vision" shared at the G20 Osaka Summit, it was announced that we aim to reduce additional pollution by marine plastic debris to zero by 2050. The studies of marine plastic debris have determined that much of the marine debris comes from land-based waste which are primarily transported via rivers. Therefore, measures to the plastic waste problem are essential in each river basin. Plastic waste is roughly classified as either microplastic (MicP) that is <5mmin size or microplastic (MacP) that is > 5 mm in size. MicP can absorb harmful chemical substances, such as polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT), and due to the small size of MicP, there is concern about the impact on ecosystems due to ingestion by organisms. MacP have been decomposed or fragmented by external factors such as ultraviolet rays and heat from sunlight, contributing to the generation of MicP. Thus, in order to consider measures to control MicP outflows from land to the sea, it is necessary to grasp the actual situation of plastic emissions separately for MicP and MacP. We calculated the emissions of MicP and MacP in 1km grid for 32 cases in Japan(Nihei et al., 2020[1)]). In this study, we evaluate total plastic emissions from Class A rivers in Japan using these results.

【METHOD】

Total plastic emissions from Class A rivers in Japan calculated according to the method evaluated by Nihei et al.[1)] in 1km grid(**Figure 1**). The main points are shown below.

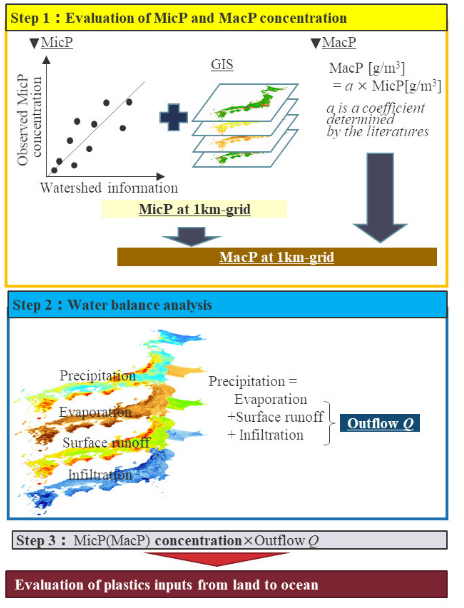


Fig.1 Schematic of the conceptual framework used to evaluate plastic inputs from the land to the sea

【STEP 1】

We analyzed the observation results under low-flow conditions and basin information of MicP at 90 rivers and 90 sites across Japan. As a result, the number and mass concentration of MicP were related to the urbanization rate and population density. We evaluated the four equations of the approximate curve, the 95% confidence interval of the approximate curve, and the approximate curve obtained from the moving average value. In this study, MicP mass concentration data is used, and the correlation between population density and mass concentration shown in **Figure 2**.

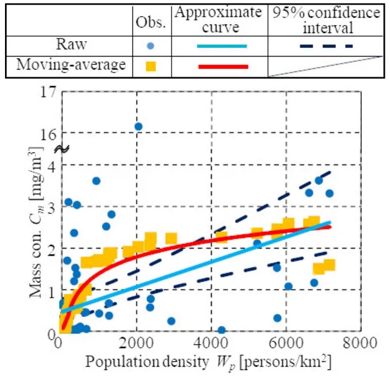


Fig.2 Correlation between MicP concentrations and population density for raw and moving average data. The stippled line represents the 95% confidence interval around the linear approximation.

Next, the number and mass concentration of MicP are calculated from the basin information in 1km grid in Japan. The ratio of the mass concentration of MacP and MicP was calculated using the result of Lebreton et al.[2] (4 cases of 2.24, 3.13, 7.66, 8.50), and the MacP mass concentration was evaluated from the MicP mass concentration and this ratio.

From the above, we calculated the sum of MicP / MacP emissions in a total of 32 cases

【STEP 2】

The annual outflow Q (sum of surface runoff and infiltration) of 1km grid is obtained from the water balance analysis in each grid.

【STEP 3】

By multiplying the MicP and MacP mass concentration obtained in STEP 1 by the annual outflow Q obtained in STEP 2, the total plastics (MicP and MacP) emissions of each mesh are calculated.

Using the results obtained from the above, we evaluate the total amount of plastic emissions from Class A rivers in Japan.

【RESULT】

Characteristics of the total plastic emissions map for Class A rivers.

Figure 3 shows a map of total plastic emissions in 109 Class A rivers. This figure is the result of the median of all 32 cases.

The white part (not painted) in the figure is the area outside the Class A rivers. Total plastic emissions were higher in the Tone, Shinano, and Yodo Rivers etc., which have large basin areas, and in the Ara and Tama river etc., small watersheds but flow through densely populated urban areas. On the other hand, total plastic emissions were smaller in the Tokachi and Teshio Rivers etc., which have large basin areas.

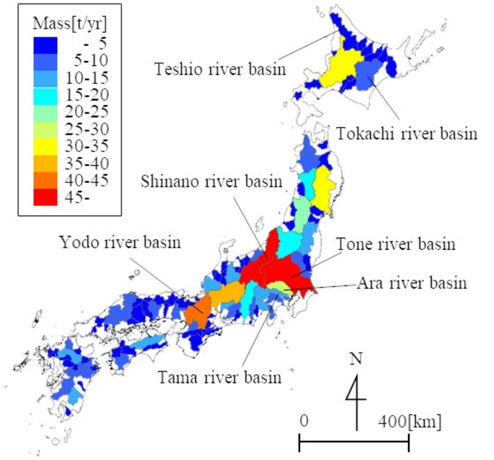


Fig.3 Evaluation of total plastic emissions from Class A rivers in Japan

Ratio of Class A rivers to total plastic emissions in Japan

The ratio of emissions from Class A rivers to the total plastic emissions in Japan was about 61%(**Figure 4**) . The top 20 first-order Class A rivers accounted for more than one-third of the total plastic emissions in Japan. It was shown that measures to reduce plastic debris in such river are useful.

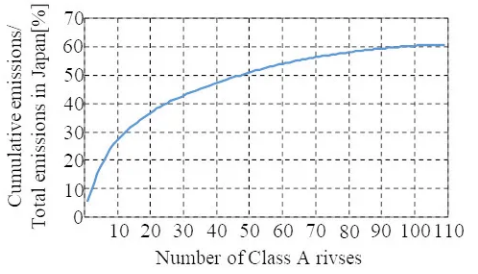


Fig.4 The ratio of emissions from Class A rivers to the total plastic emissions

【SUMMARY】

In this study, we evaluated total plastic emissions from Class A rivers using calculated the emissions of MicP and MacP in 1km grid for 32 cases in Japan.

・It was shown that rivers with high plastic emissions do not depend on the basin area.

・Although the basin area is small, the amount of emissions tends to be high in rivers in urban areas where the population density is high.

・The ratio of emissions from Class A rivers to the total plastic emissions in Japan was about 61%.

ABSTRACT

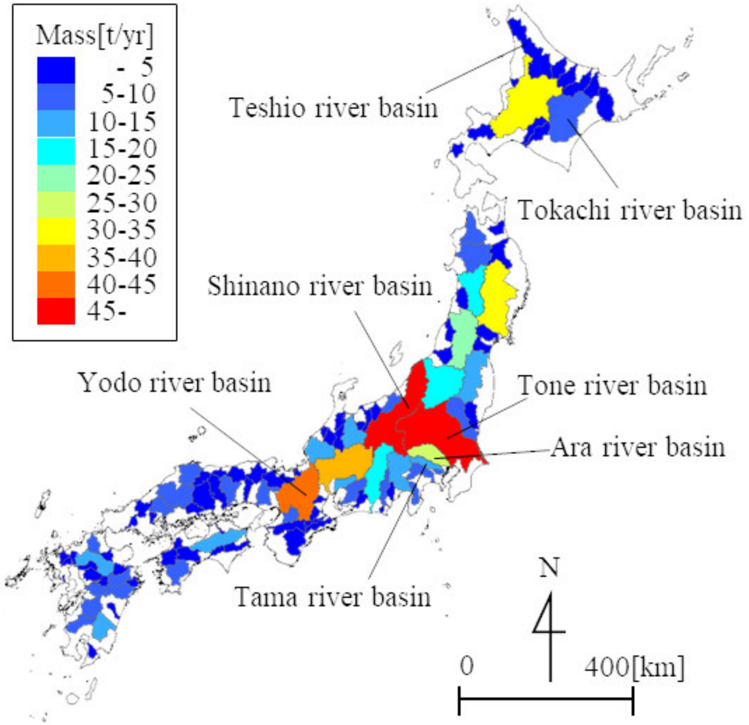
In the "Osaka Blue Ocean Vision" shared at the G20 Osaka Summit, it was announced that we aim to reduce additional pollution of marine plastic debris to zero by 2050. Previous studies of marine plastic debris showed that most of the marine debris comes from land-based waste which are primarily transported via rivers. Therefore, measures to the plastic waste problem are essential in each river basin. Plastic waste is roughly classified as either microplastic (MicP) that is <5mm in size or microplastic (MacP) that is > 5 mm in size. MicP can absorb harmful chemical substances, such as polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT), and due to the small size of MicP, there is concern about the impact on ecosystems due to ingestion by organisms. MacP have been decomposed or fragmented by external factors such as ultraviolet rays and heat from sunlight, contributing to the generation of MicP. Thus, in order to consider measures to control MicP outflows from land to the sea, it is necessary to grasp the actual situation of plastic emissions separately for MicP and MacP.

We calculated the emissions of MicP and MacP in 1km grid for 32 cases in Japan (Nihei et al., 2020). In this study, we evaluate total plastic emissions from Class A rivers in Japan using these results. The median values for all 32 cases are summarized in the following trends.

-Total plastic emissions were higher in the Tone, Shinano, and Yodo Rivers etc., which have large basin areas, and in the Ara and Tama river etc., small watersheds but flow through densely populated urban areas.

-On the other hand, total plastic emissions were smaller in the Tokachi and Teshio Rivers etc., which have large basin areas.

-The ratio of emissions from Class A rivers to the total plastic emissions in Japan was about 61%. The top 20 first-order Class A rivers accounted for more than one-third of the total plastic emissions in Japan. It was shown that measures to reduce plastic debris in such river are useful.



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1) Nihei, Y., Yoshida, T., Kataoka, T., and Ogata, R. : High-resolution mapping of Japanese microplastic and macroplastic emissions from the land into the sea, *Water,* 2020, 12, 951.

2)Lebreton, L.C.M.; van der Zwet, J.; Damsteeg, J.-W.; Slat, B.; Andrady, A.; Reisser, J. River plastic emissions to the world’s oceans. Nat. Commun. 2017, 8, 15611.