Improving the estimation of microplastic concentrations in freshwater environments

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Most plastics end up in the oceans and fragment into tiny microplastic particles. Despite being a global concern, microplastic pollution is lacking a standard assessment protocol. In a new study, TUS scientists have now addressed this issue, proposing a method that estimates the sampling requirements for accurate assessment of microplastic contamination in rivers. Credit: Snemann from Openverse

The extent of plastic pollution remains largely hidden from view in the form of microplastics (MPs): plastic particles with diameters less than 5 mm. Since plastics are slow to degrade, they fragment into tiny particles that end up contaminating entire ecosystems. In the years since their discovery in the early 1970s, MPs have become a ubiquitous and global concern. MPs are found in land, air, water, and the food that we eat, especially seafood. This is because freshwater sources, such as rivers, often carry off MPs into the oceans, where they accumulate.

Despite its pervasiveness, however, there is currently no standard procedure to measure and quantify MP concentration in rivers. Plankton nets, originally designed to collect plankton samples, are commonly used to capture MPs in rivers. To prevent these nets from getting clogged and ensure a large sample size, multiple samples are collected at fixed locations along the river and the MP concentration is calculated as the average of all the sampling results. Most studies, however, do not take uncertainties and sampling errors into account, resulting in an erroneous assessment of MP concentrations, particularly in terms of the amounts of samples required for accurate MP assessments.

Now, in a recent study published in *Environmental Pollution*, Dr. Mamoru Tanaka and Professor Yasuo Nihei from Tokyo University of Science along with Associate Professor Tomoya Kataoka from Ehime University in Japan have improved upon the estimation of the MP concentration by accounting for the variability between estimations obtained from different samples. The variance can help estimate the appropriate number of samples required for an accurate representation of MP contamination. "For an on-site sampling of microplastics, we have proposed a method for determining the appropriate number of iterations in each contamination situation," says Dr. Tanaka.

Additionally, the variance can provide insight into how MPs are distributed in the waterbody. For instance, if they are uniformly

distributed in the river, the variances between the samples would be low. On the other hand, a high variance would indicate a non-uniform clumped distribution.

To evaluate the inter-sample variances in MP concentration, the scientists borrowed another method originally intended for zooplankton. "It turns out that the numerical concentration ranges of riverine microplastics overlap with those of zooplankton," explains Dr. Tanaka, regarding the similarity of both the sampling procedure and the concentration estimations between MPs and zooplankton. According to this method, the inter-sample variance is proportional to the average or mean of the concentration estimations.

For the MP concentrations, the team collected 10 samples in plankton nets at two sites along the Ohori River and Tone-unga (Unga) canal in Chiba, Japan—two waterbodies that flow through urban areas and contain a high concentration of plastic waste. They identified a total of 1333 MP particles at the sampling sites. The average concentrations of the MPs, which were measured to be 5.23 particles/m^3 in the Ohori and 15.22 particles/m^3 in the Unga, were higher than the reported average of MPs in Japanese rivers (4.3 particles/m^3). Furthermore, the calculated averages and variance at both locations matched up with a simple linear regression. "Variance steadily increased with an increase in the mean numerical concentrations," points out Dr. Tanaka. Regression analysis further suggested that the MPs in the rivers do not interact with one another, resulting in random particle distributions.

Most importantly, the team found that at high MP concentrations, two replicate samples are sufficient to measure the MP concentrations accurately. "We found that the mean of two replicates maintained sufficient precision of less than 30% for conditions with high concentrations of more than 3 particles/m^3," says Dr. Tanaka.

The problem of MPs has been recognized in recent years and various countries including Japan have passed legislation to ensure better monitoring and control of MPs in the environment. In this light, this study could help improve the sampling methodology, reducing the time and resources invested in MP assessment surveys.

More information: Mamoru Tanaka et al, Variance and precision of microplastic sampling in urban rivers, *Environmental Pollution* (2022). DOI: 10.1016/j.envpol.2022.119811

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