Microplastics in urban freshwater : a case study in the city of Amsterdam

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1. Introduction

The contamination of freshwaters with microplastics (MPs) has been globally established. From macro to nano-sizes, plastics enter aquatic ecosystems via direct sources such as discharges from waster water treatment plants and drainage outlets and indirect sources such as atmospheric deposition, surface runoff, or human activities. In the environment, plastics undergo degradation and weathering processes depending on the physicochemical properties and environmental conditions [1]. Although the presence of MP in freshwater is an indubitable fact, the degree of MP pollution needs further investigation to understand the effects on the ecosystem scale and society. The aim of this study is to determine the MP abundances in the urban region of Amsterdam (The Netherlands) including a large network of canals and waterways, receiving treated wastewater from wastewater treatment plants, and an average annual rainfall of 844 mm. The sampling was done with a state-of-the-art in-situ volume-reduced sampling pump at 11 locations in the Amsterdam canal network in 2022. The qualification and quantification of the polymers for three size fractions (0.7-10 µm, 10-300 µm and 300µm-5mm) was accomplished in two laboratories at VUA (Amsterdam) and ENPC (Paris) with two complementary analysis methods using pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) and micro Fourier transform infrared (µ-FTIR) imaging.

2. Materials and Methods

Samples were collected in June and July 2022 at 11 locations in Amsterdam including the main canals in the city center and Amstel River, which flows through the city of Amsterdam and feeds the canals. Sampling was done at the water surface layer (0-0.5 m water depth) and samples were in-situ fractionated in size classes of 10-300 µm and 300-5000 µm using the Universal Filtering Object designed by Aalborg University (AAU-UFO) sampling device. From each sampling point, 2 sets of parallel samples were collected for the size fractionation of 10-300 µm for the complementary analysis by Py-GC-MS and µ-FTIR. In addition, 2 L of bulk water samples were collected from the water outlet of the AAU-UFO to analyze the micro and nano plastics (MNPs) in the range of 0.7-10 µm by Py-GC-MS. In addition, conventional water parameters such as conductivity, pH, turbidity, and total suspended solids (TSS) were measured for each sampling site.

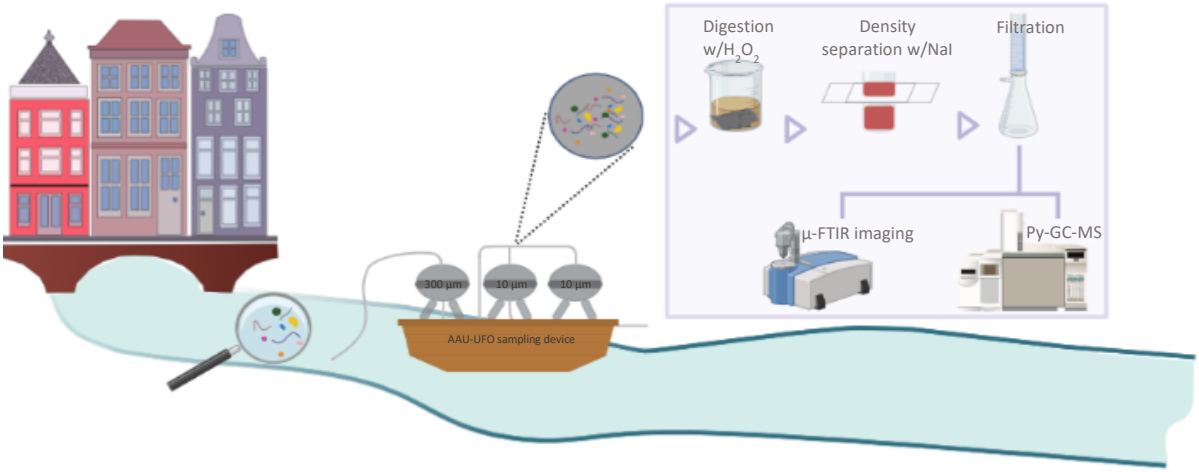

Figure 1: Sampling and analysis method for the freshwater samples

Samples (on metal filters with a mesh size of 10 and 300 µm) were first digested with H_2O_2 (10%) at 30 °C for 18-24 h and rinsed with filtered water. Then, the suspension was filtered through pre-muffled 10 µm stainless steel filters. For the particles remaining on the filter, density separation was applied by using NaI solution (d=1.6-1.7 $g.cm^{-3}$). Finally, the floating particles were filtered through a 0.2 µm Anodisc filter and 0.7 µm glass filter for µFTIR imaging and Py-GC-MS analysis, respectively (Figure 1). The qualitative and quantitative analyses were performed using two complementary methodologies for MP analysis. One parallel set of samples per sampling site was analyzed by double-shot analysis on a multi-shot micro-furnace pyrolyzer EGA/PY-3030D (Frontier Laboratories, Saikon, Japan) coupled with GC/MS (Agilent 6890 GC and 5975C MS, Santa Clara CA, USA). The other set was scanned with the automated µ-FTIR mapping (Nicolet iN10 MX, Thermo Scientific). Measurements were processed by Agilent MassHunter and SiMPle software.

3. Results and Discussion

Samples collected from the canals of Amsterdam (n=11) showed a high variance in TSS within the range of 6.4-54 mg/L. Double-shot Py-GC-MS was optimized and applied to the samples for the analysis of the six major polymer types detected in freshwater systems (PE, PP,PS, PVC, PET, PMMA) [2]. Preliminary data analysis on the samples collected from Lekkanaal for MPs >700 nm showed the presence of all the target polymers in the Amsterdam-Rhine Canal network. The total MP concentrations were found between 4.7 and 103.5 mg/m^3 with PE and PVC as the most abundant polymers. These results will be extended further by the analysis of the canal samples including all the size fractions and µ-FTIR imaging. Results are foreseen to be completed in early 2023.

4. Conclusions and outlook

This study contributes to the knowledge of the occurrence of MPs in urbanized areas by using two complementary analysis methods providing information on both particle number and mass of MPs in different size fractionations. The findings of this study will provide an important basis to understand the extent of MP pollution and the data for the identification of sources of contamination.

5. References

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