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Microplastic Concentrations and Fluxes in Urban Compartments: A Systemic Approach at the Scale of the Paris Megacity

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Abstract : Microplastic sources and fluxes in urban catchments are only poorly studied. Most often, the approaches taken focus on a single source and only carry out a description of the contamination levels and type (shape, size, polymers). In order to gain an improved knowledge of microplastic inputs at urban scales, estimating and comparing various fluxes is necessary. The Laboratoire Eau, Environnement et Systèmes Urbains (LEESU), the Laboratoire Eau Environnement (LEE) and the SIAAP (Service public de l'assainissement francilien) initiated several projects to investigate different urban sources and flows of microplastics. A systemic approach is undertaken at the scale of Paris Megacity, and several compartments are considered, including atmospheric fallout, wastewater treatments plants, runoff and combined sewer overflows. These investigations are carried out within the Limnoplast and OPUR projects. Atmospheric fallout was sampled during consecutive periods ranging from 2 to 3 weeks with a stainless-steel funnel. Both wet and dry periods were considered. Different treatment steps were sampled in 2 wastewater treatment plants (Seine-Amont for activated sludge and Seine-Centre for biofiltration) of the SIAAP, including sludge samples. Microplastics were also investigated in combined sewer overflows as well as in stormwater at the outlet suburban catchment (Sucy-en-Brie, France) during four rain events. Samples are treated using hydroperoxide digestion (H_2O_2 30 %) in order to reduce organic material. Microplastics are then extracted from the samples with a density separation step using NaI (d=1.6 $g.cm^{-3}$). Samples are filtered on metallic filters with a porosity of 14 µm between steps to separate them from the solutions (H_2O_2 and NaI). The last filtration was carried out on alumina filters. Infrared mapping analysis (using a micro-FTIR with an MCT detector) is performed on each alumina filter. The resulting maps are analyzed using a microplastic analysis software simple, developed by Aalborg University, Denmark and Alfred Wegener Institute, Germany. Blanks were systematically carried out to consider sample contamination. This presentation aims at synthesizing the data found in the various projects. In order to carry out a systemic approach and compare the various inputs, all the data were converted into annual microplastic fluxes (number of microplastics per year), and extrapolated to the Parisian agglomeration. PP, PE and alkyd are the most prevalent polymers found in storm water samples. Rain intensity and microplastic concentrations did not show any clear correlation. Considering the runoff volumes and the impervious surface area of the studied catchment, a flux of 4*107–9*107 $MPs.yr^{-1}.ha^{-1}$ was estimated. Samples of wastewater treatment plants and atmospheric fallout are currently being analyzed in order to finalize this assessment. The representativeness of such samplings and uncertainties related to the extrapolations will be discussed and gaps in knowledge will be identified. The data provided by such an approach will help to prioritize future research as well as policy efforts.

Keywords : microplastics, atmosphere, wastewater, urban runoff, Paris megacity, urban waters
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