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Microplastics and tyre wear particles infiltration in the soil of a roadside biofiltration swale

Max Beaurepaire¹, Tiago de Oliveira², Bruno Tassin¹, Johnny Gasperi² Marie-Christine Gromaire¹ and Rachid Dris¹

¹LEESU, Ecole des Ponts, Univ Paris Est Creteil, Marne-la-Vallee, France

²LEE, Universite Gustave Eiffel, Nantes, France

E-mail contact: max.beaurepaire@enpc.fr, rachid.dris@u-pec.fr

INTRODUCTION

While the investigation of microplastic pollution in the environment has gained prominence since 2004 [1], research on microplastic pollution and transfer in terrestrial environments, particularly in soils, is still limited [2,3]. Tyre and road wear particles (TRWP) are intricate particles consisting of elastomeric rubber polymers, fillers, additives, and road mineral incrustations. TRWP are often considered as microplastics by the community [4,5] and included in the discussions of microplastic sources [6], although they are not as often studied.

Sustainable urban drainage systems (SUDS) are stormwater management practices designed to drain stormwater more sustainably than conventional techniques [7]. Some practices, such as retention ponds and rain gardens, have been shown to capture microplastics from stormwater and limit pollution downstream [8]. However, the fate of microplastics once trapped in the soil remains unclear. This work quantifies and compares the infiltration of microplastics and TRWP in a roadside SUDS.

MATERIALS AND METHODS

This study focuses on a single sampling site located alongside a high-traffic 2x2 lanes highway in the north of Paris, close to the Charles de Gaulle International airport and an industrial zone. The site of interest is a 32m long biofiltration swale installed in 2016 and designed to diffusely collect road runoff. In order to assess microplastics and TRWP infiltration into the swale, 10 cores were collected manually at a depth of 35 cm and were each subdivided by depth into four samples ([0-5[, [5-15[, [15-25[, [25-35[cm). Each sample represented a mass of 10g, that was separated into 2 subsamples for separate quantification of microplastics and tyre wear particles.

Samples were prepared separately for quantification of microplastics and quantification of butadiene rubber and styrene-butadiene rubber (SBR+BR) from TRWP. Before μ FTIR analysis, all samples underwent an isolation procedure involving a density-based separation of minerals using NaI, followed by an H_2O_2 oxidative treatment. The microplastic content of each sample was then characterized and quantified using an automated μ FTIR imaging analysis which allowed for the identification of microplastics down to 25 μ m. After acquisition, the maps obtained were analysed using the software for Systematic Identification of MicroPLastics in the Environment (siMPle) [9].

The SBR+BR content of the samples was quantified by Pyr-GC-MS. Before analysis, samples were dried, sieved at 500 μ m to eliminate debris and minerals, and approximately 4 mg was weighed in pyrolysis cups for the quantification of the mass of SBR + BR per mass of soil. The

analysis was conducted using a multi-shot pyrolyzer set at 600°C, coupled with a gas chromatograph and mass spectrometer.

RESULTS

FTIR analyses retrieved significantly higher microplastic abundances in the surface samples than in the deeper soils, with median surface abundances of 47 MP g⁻¹ against 1.8 MP g⁻¹ in the deeper samples, for respective mass concentrations of 93 µg g⁻¹ and 0.78 µg g⁻¹. The overall median was 4 MP g⁻¹. Pyr-GC-MS analyses retrieved a similar distribution for SBR+BR. Median surface concentrations of 2.12 mg g⁻¹ were retrieved, while 18 of the 27 deeper sediments had a median concentration below the limit of quantification. SBR+BR were higher than microplastics concentration sample by sample.

INSIGHTS AND CONCLUSION

The overall higher concentrations in the surface samples suggest that while microplastics and tyre wear particles may infiltrate in the soils of the swale, the majority of them remain trapped in the surface layers.

SBR and BR are a partial component of TRWP, representing 24% of a passenger car tyre, or 11% of a truck tyre. This suggests TRWP concentrations even higher, potentially up to 10 mg g⁻¹ in the surface layers of the soil, which advocates for further investigation of their fate in soils.

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