Andrea Wiget[1], Dominika Kundel[1], Armin Zenker[2], Andreas Fliessbach[1], Moritz Bigalke[3]

Fachhochschule Nordwestschweiz
Hochschule für Life Sciences

Tyre wear particles in soils alongside different roads in the Canton of Solothurn

Implementation of a method for extraction and analysis of tyre wear particles in soil

Introduction

In Switzerland, 9000 tons of tyre wear particles (TWP) enter the environment every year. This corresponds to over 60 % of the total annual microplastic input (Steiner, 2020). Studies about the emission of TPW are mostly based on model calculations and only few direct measurements of TWP loads in soils exist (Baensch-Baltruschat et al., 2020). This lack of empirical data is partly attributed to the limited availability of generally accessible and standardized extraction and analysis protocols.

The aim of the presented work was the implementation of a method proposed by Grunder et al. (2023) and Foetisch et al. (2023) for the cost-effective analysis of TWP in soils at the Research Institute of Organic Agriculture (FiBL).

Sampling

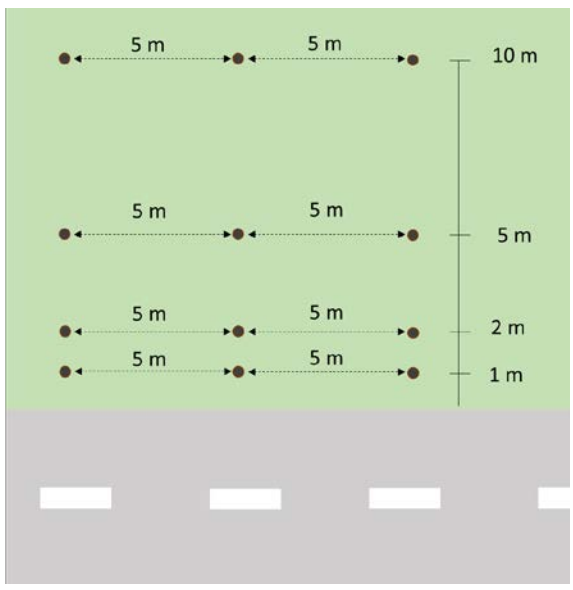

Fig. 1: Sampling scheme considering distances of 1, 2, 5 and 10 m from the road.

Soil samples to be analysed for TWP contamination were collected along 15 roads in the Canton of Solothurn at four distances from the asphalt at a depth of 0 - 10 cm.
Samples from four of those sites were analysed as part of a master's thesis for the Master in Advanced Studies in Environmental Engineering and Management and are presented here.

Extraction and analysis of tyre wear particles

TWPs were extracted from soil following the procedure displayed in figure 2A. The filter holding the extracted TWPs was photographed on a binocular at a magnification of 40x and the resulting approx. 150 images were stitched together (Fig. 2B). Quantification of TWPs on the photographed filter occurred with colour-based approach using a pixel segmentation algorithm (Fig. 2C) and particle analysis.

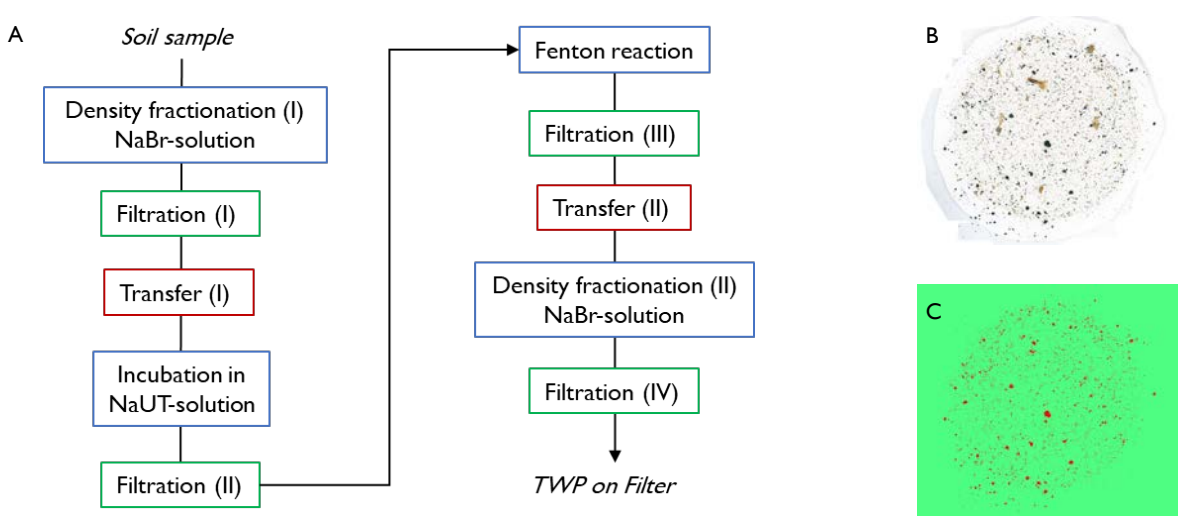

Fig. 2: Extraction procedure (NaUT: Urea-thiourea-sodium hydroxide solution) (A), stitched picture of the filter holding TWPs after extraction (B) and the classification of TWP (red) and non-TWP (green) areas generated by the pixel segmentation (C).

Results and discussion

At the four analysed sites, on average 200'000 TWPs kg^{-1} soil resp. 120 mg TWP kg^{-1} soil were found. Differences between sites were only marginally statistically significant (Fig. 3A). However, a considerable decrease of TWPs was observed between 1 m and 2 m distance from the road (Fig. 3B). This resembles the pattern observed by Müller et al., 2020.

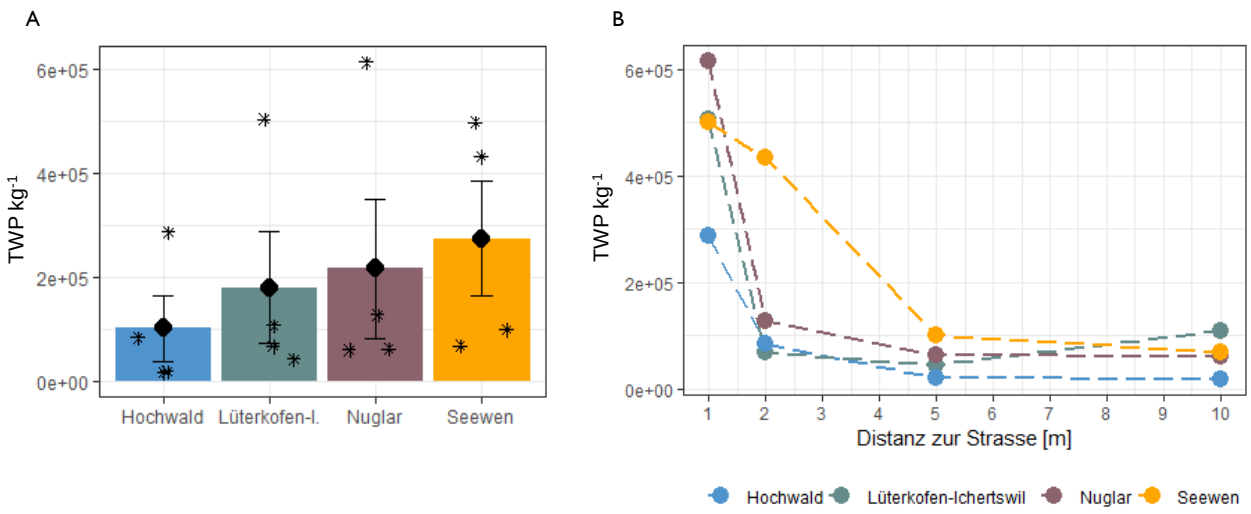

Fig. 3: Count of TWPs kg^{-1} soil at the four studied sites averaged across all sampled distances (A) and at each sampled distance (B).

Evaluating the remaining 11 sampled road sites, will allow to verify the patterns found at these four sites and identify potential relationships between site-specific characteristics and TWP contamination on the roadside. The TWP extraction and analysis method was successfully implemented, but remains time-consuming. However, it can be optimized by automating specific steps. Thus, this method can potentially make a considerable contribution towards the urgently needed improvement of the empirical data basis of TWP pollution in the environment.

Literature
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[1] Forschungsinstitut für biologischen Landbau (FiBL)
[2] Fachhochschule Nordwestschweiz (FHNW)
[3] Technische Universität Darmstadt

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