Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.20652

Is microplastic transported into deep soil layers? Analysis of agricultural soil using hyperspectral imaging and artificial neural networks

MISATO TODA, RAFFAEL MICHAEL SCHREIBER AND PETAR MANDALIEV

University of Applied Sciences and Arts Northwestern Switzerland

Presenting Author: misato.toda@fhnw.ch

Agricultural ecosystems are vulnerable to plastic pollution due to intensive human activities within and around farmland. Plastic debris originating from such activities can be fragmented into microplastics (MPs, particle size< 5 mm). Despite its growing concern, the occurrence of MPs in soil remains largely undetermined. This research gap is attributed to the large special heterogeneity in soil and the lack of a fast quantification method. Here we examined the distribution of MPs from topsoil to subsoil layers in agricultural soil. Furthermore, we tested the possible application of hyperspectral imaging (HI) technology coupled with a machine learning algorithm for a rapid quantification of MPs.

A total of 90 core soil samples were collected in October 2022 from a farmland in Switzerland (30 sampling points × 3 depths; 0–30 cm, 30–60 cm and 60–90 cm). Soils were dried at 40°C and sieved with 2 mm sieve for downstream analysis. About 5 g of subsample was used for a traditional extraction method followed by polymer identification by FTIR spectroscopy (Frontier, Perkin Elmer, U.S.A) to ensure in-depth analysis. For HI analysis, about 15 g of soil sample were scanned by a Specim FX17 hyperspectral camera (Specim, Spectral Imaging Ltd., Finland) with spectral wavelength of 900–1700 nm and a total of 224 spectral bands. Then, the collected HI data was analyzed with spectral libraries and machine learning algorithms in a python code.

First results showed that the HI system could distinguish aged plastic debris (4–14 mm in size) from soil background in near real time, however, no smaller particles (<4 mm) were detected (Fig. 1). Thus, the HI system would be a powerful tool to quantify rather bigger MPs particles which would be dominant on topsoil layers. Current analysis by chemical extraction method supplements our result as it focuses on a possible correlation between subsoil and topsoil MPs as well as size distribution along the soil depth. This may ultimately enable us to estimate vertical distribution of MPs based on surface soil investigation by HI system and develop successful protection measures against MPs contamination in groundwater.

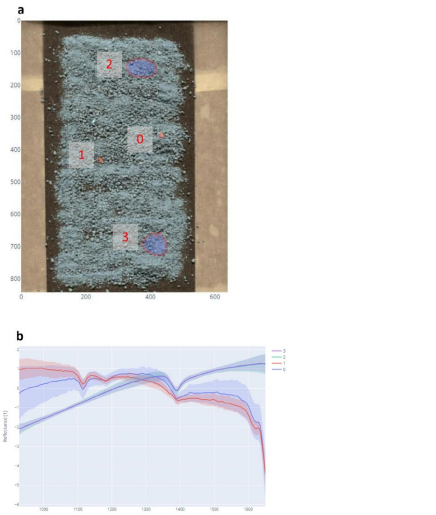

Figure 1. Hyperspectral image of a soil sample with plastic debris deposited on top (a) and the mean reflectance recorded in the selected regions (b). The reflection of spectral wavelength at 929 nm, 1291nm and 1650 nm were color coded in (a) as red, blue, and green, respectively. The number of 0 and 1 are plastic pieces while 2 and 3 are soil background.