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Comparing the movement of three different types of microplastic in a simulated agricultural environment dependent on soil slope and rain intensity

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Agenda

- Introduction and Distribution of Microplastics (MP) into the Environment
- Results of FTIR microscope study
- Results of experiments according to different soil slopes and rain intensities

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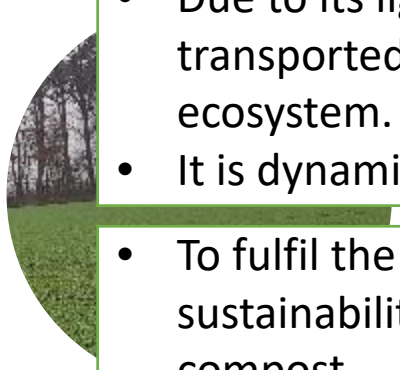
Distribution of microplastic (MP)

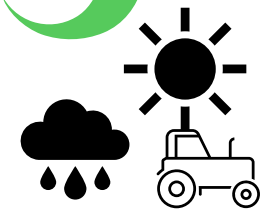
Biowaste

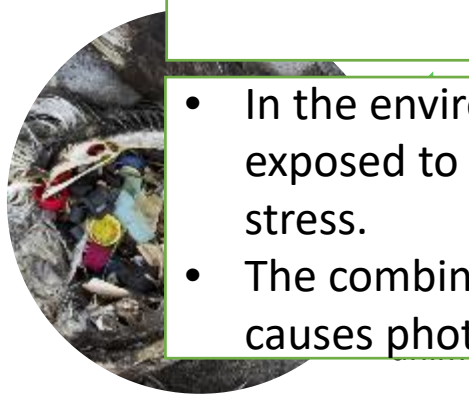
Microplastic



Compost

Macro particles





- Size range of plastic particles from 1 µm to 5 mm.
- Due to its lightweight and small size can be transported from one ecosystem to another ecosystem.
- It is dynamic pollution for the environment.

- To fulfil the needs of circular economy and sustainability, biowaste is recycled to be compost.
- The impurities of biowastes like polymer should be removed.

- In the final product, compost, micro and macro sized polymer particles can be observed.

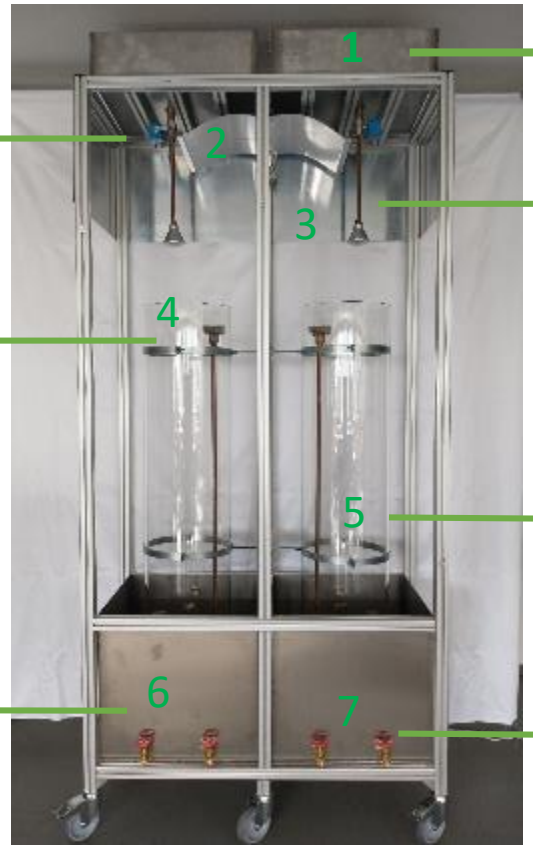
- In the environment, particles of plastic are exposed to the sunlight, rain and mechanical stress.
- The combination of sunlight and oxygen causes photooxidation.

Description of the novel test bench

2. Lamp to simulate sunlight

4. Water outlet

6. Water tank to simulate groundwater



The novel test bench

1. Water tank to simulate rain

3. Shower head

5. Water outlet

7. Valve outlet from the number 4 & 5

Farmland in Münster (Germany)

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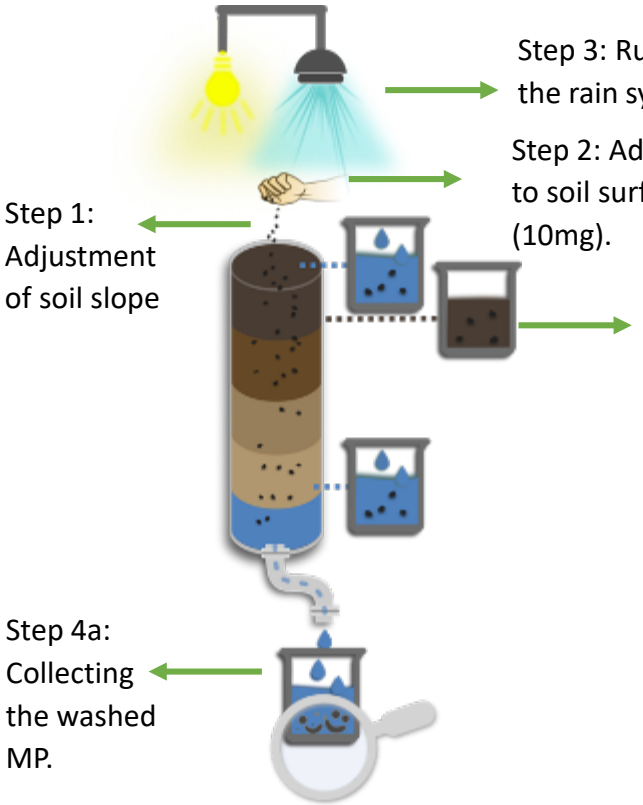
Preparation and process of the sample collection



Step 1: Adjustment of soil slope

Step 2: Adding MP to soil surface (10mg).

Step 3: Running the rain system.

Step 4a: Collecting the washed MP.

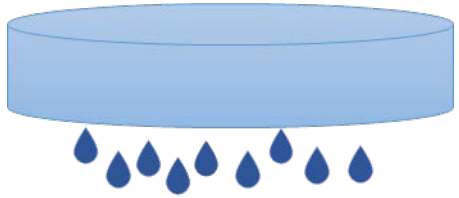
Step 4b: Collecting mixture soil and remaining MP from surface.

1-1:Three different soil slopes:

- 0 °
- 5 °
- 10 °

3-1: Two different rain intensities:

- 264 L ha^{-1} s^{-1}
- 378 L ha^{-1} s^{-1}



LDPE, PET and multilayer polymer

Milled with a cryogenic grinding

Check the particles size

Add in the surface of soil

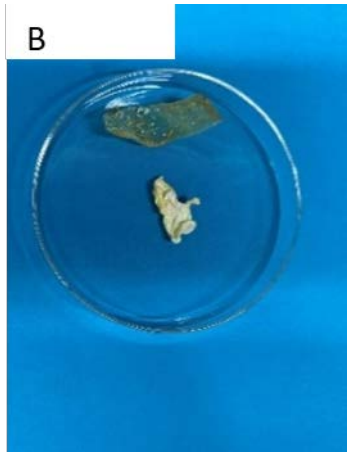
LDPE granules

Cryogenic grinding

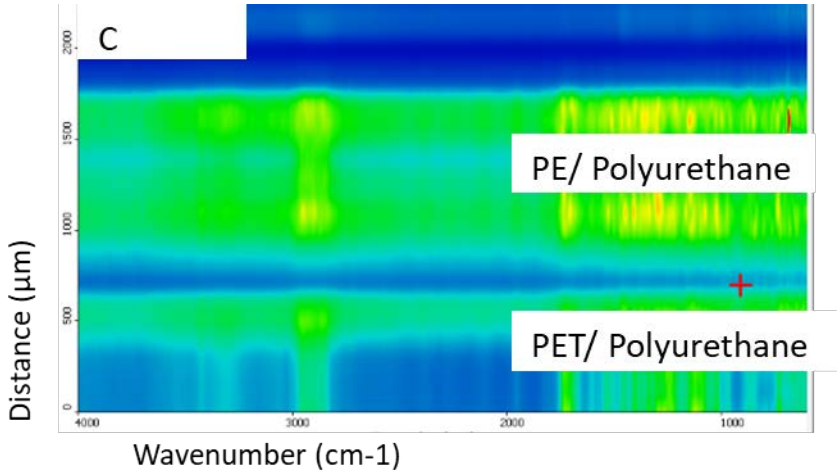
FTIR microscope iN10

Analysis of multilayer polymer packaging

A: the multilayer packaging



B: after dissolving polyurethane

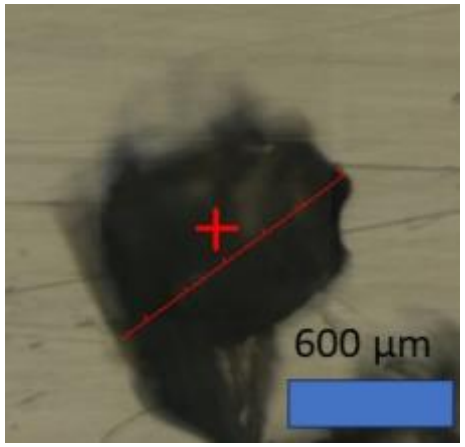


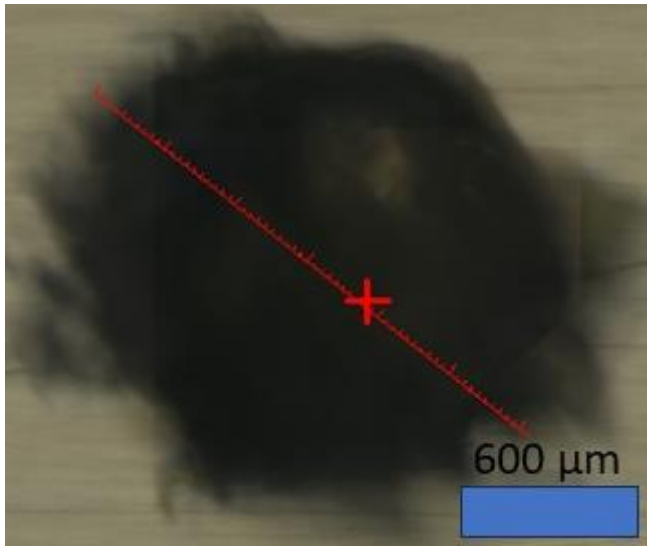
C: The spectrum from particles of multilayer packaging analysed with FTIR microscope

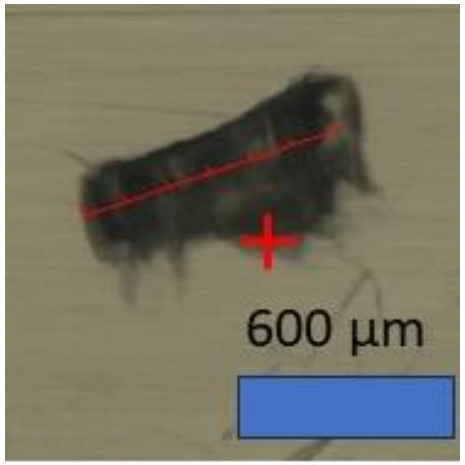
Validation of multilayer polymer packaging material:

- X-ray fluorescence (XRF)-result: No metal
- Separation the layers with formic acid (HCOOH) and ethyl acetate-result: remaining layers checked with FTIR
- FTIR microscope-result: PE/Polyurethane/PET

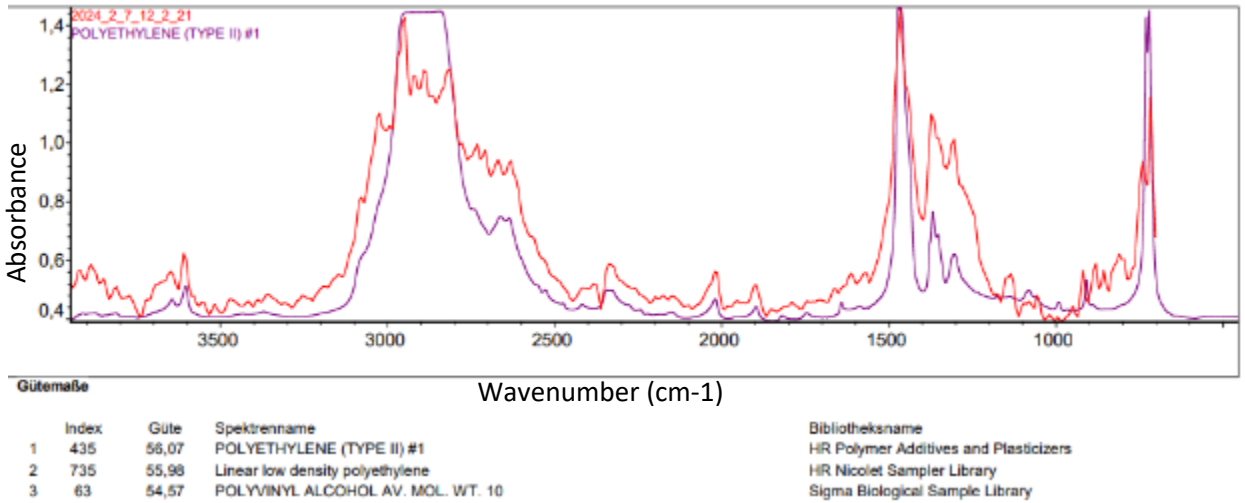
Analysis of MP: Validation of particle size and material before the experiment







Micro particles of LDPE after cryogenic milling



Gütemaße

	Index	Güte	Spektrenname	Bibliotheksname
1	435	56,07	POLYETHYLENE (TYPE II) #1	HR Polymer Additives and Plasticizers
2	735	55,98	Linear low density polyethylene	HR Nicolet Sampler Library
3	63	54,57	POLYVINYL ALCOHOL AV. MOL. WT. 10	Sigma Biological Sample Library

Validation of the material of the particles by FTIR microscope spectroscopy with reflection collection mode (iN10) according to the data base of HR polymer additives plasticizer

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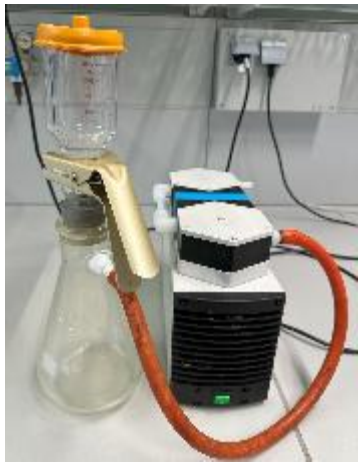
Analysis of MP: Quantification and qualification

- Water
- Peristaltic pump
- Vacuum pump

Density Separation 1



Density separation 2

- Salt (NaCl or NaBr)
- Vacuum pump

- Sieving with mesh size of 1, 0,7, 0,5 and 0,35 mm

Sieving

Qualification

- FTIR microscope

- Balance

Quantification

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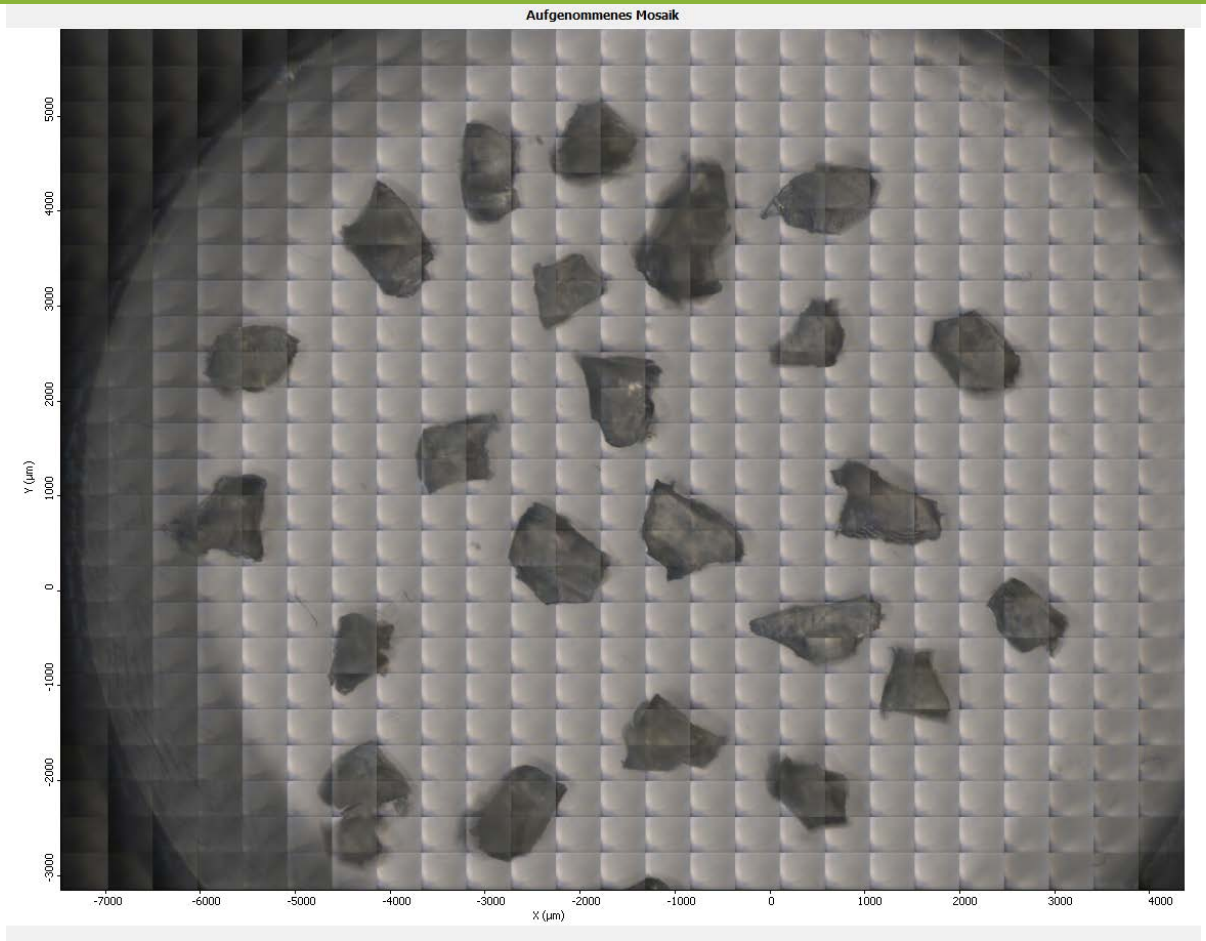
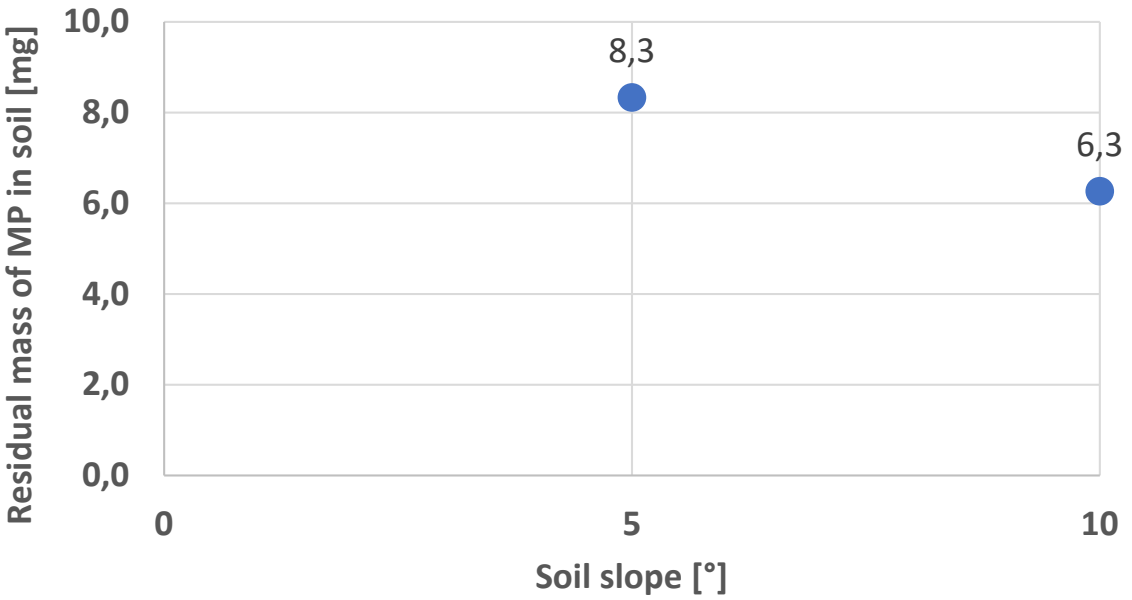
Analysis of MP: Validation of particle size and material after sieving



Result:
Majority of the particles meet the size and material specifications.

The impact of various soil slopes on the movement of PE MP

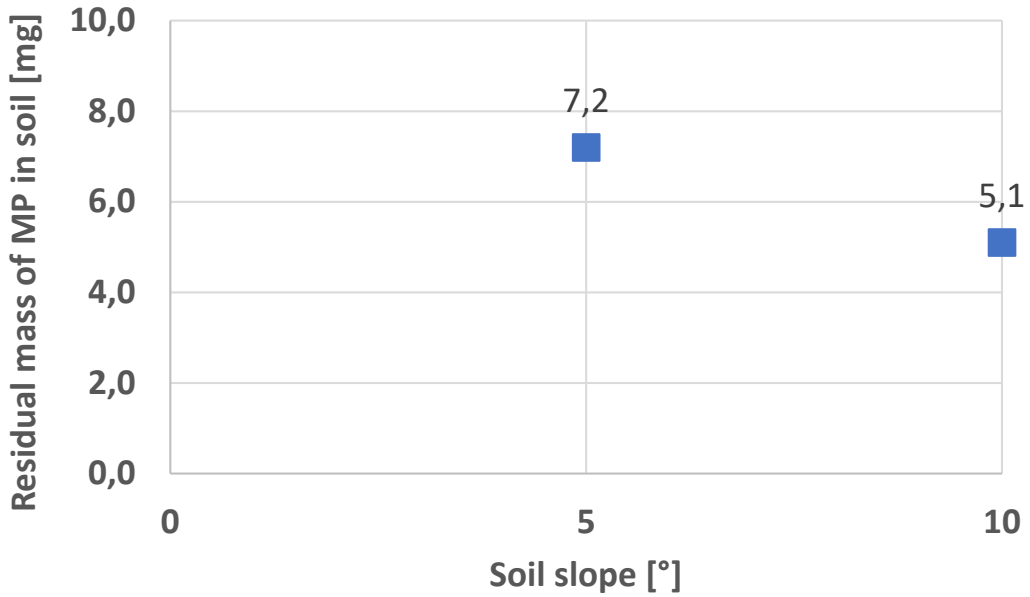


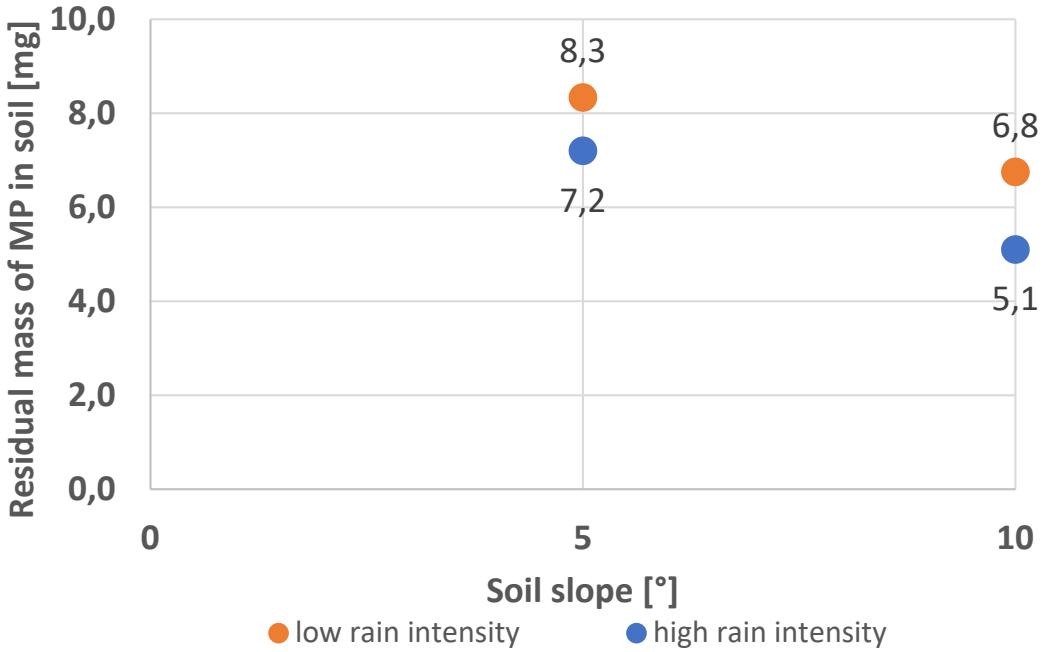
The residual mass of MP (mg) in soil under the condition of two different slope 5° and 10° with the same rain intensity 264 L ha^{-1} s^{-1}

With an increase in soil slope, more MP is washed from the soil surface by rain

Surface of soil

The impact of various rain intensities on the movement of PE MP





The residual mass of MP (PE) in soil under condition of two different slope 5° and 10° and same rain intensity 378 L ha^{-1} s^{-1}

- By increasing the rain intensity to 378 L ha^{-1} s^{-1} at a given soil slope of 5° and 10°, the average remaining MP in soil decreases to 7,2 and 5,1 mg, respectively, which is about 13% and 19% less than the values measured for the lower rain intensity in the same soil slope

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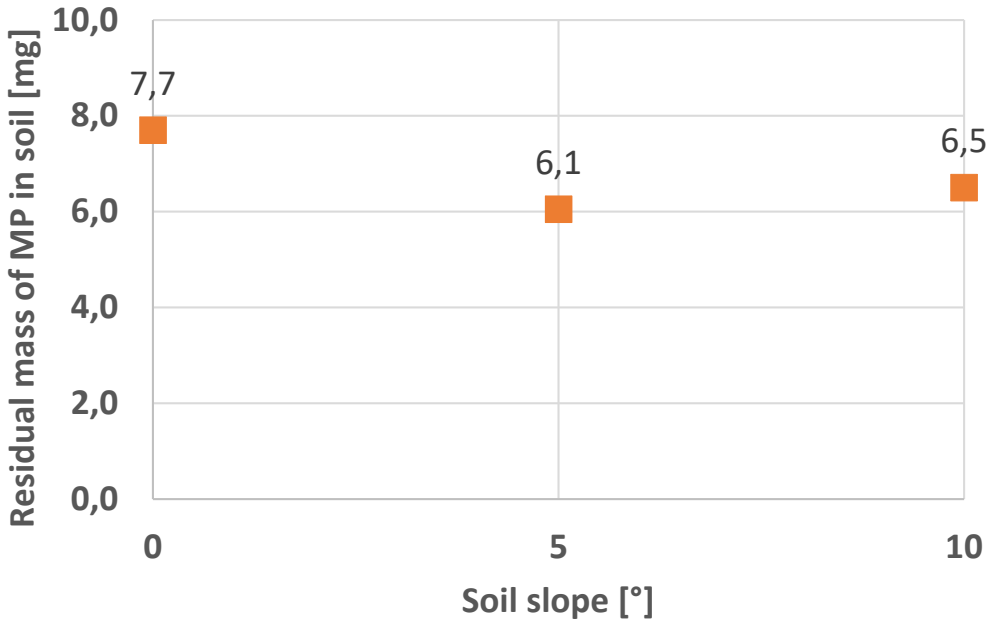
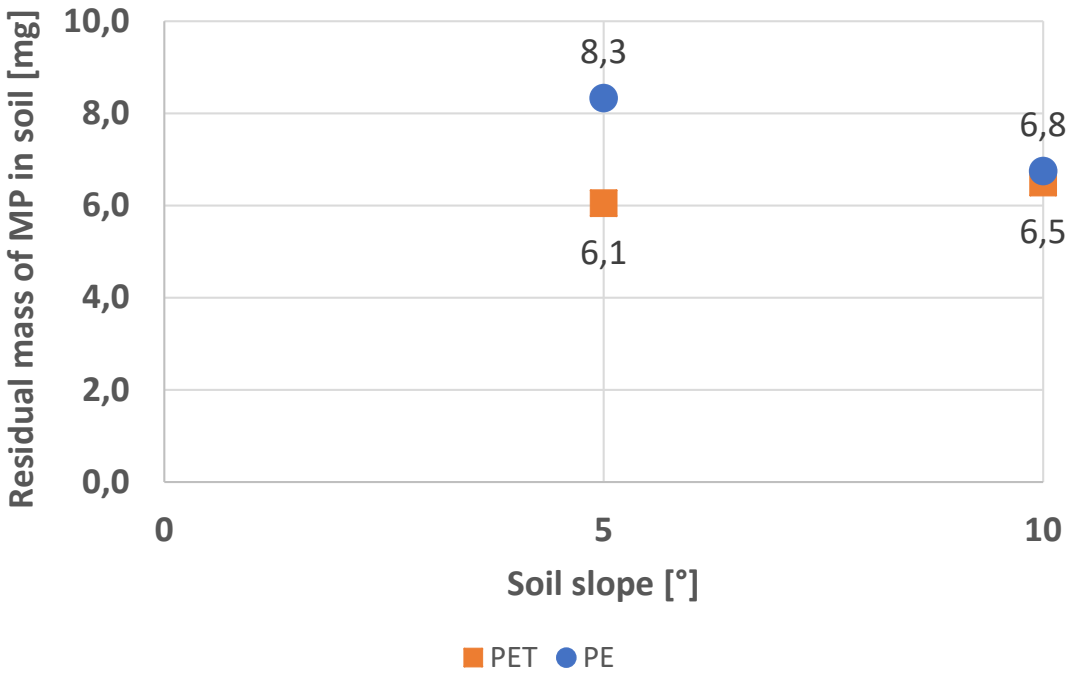
The impact of various soil slope on the movement of PET MP





The residual mass of MP (PE and PET) in soil under condition of two different slope 5° and 10° and same rain intensity 264 L ha^{-1} s^{-1}

Conclusion and outlook

Conclusion:

- A test bench was developed to affect the samples with extreme conditions to accelerate the environmental impacts on the movement of MP in soil
- Efficient procedure to separate plastic from soil compared to typical organic separation
- Even with high slope and high rain intensity still MP remained in soil

Outlook

- Continue the experiment with different soil slope and rain intensity to finalize the study
- Investigate microplastic from multilayer packaging polymer and bio polymers

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