Do plastic and microplastics change the soil physical properties? A review

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Objectives

- Establish a clear picture of the effect of plastic contamination on soil physical variables, which has not been reported systematically.
- Increase confidence when extrapolating results under different environmental conditions.
- Identify research gaps that need to be addressed in further studies.
- We expect the uncertainity in the soil physical properties which might subject to plastic charateristics.

Methodology

Data collections

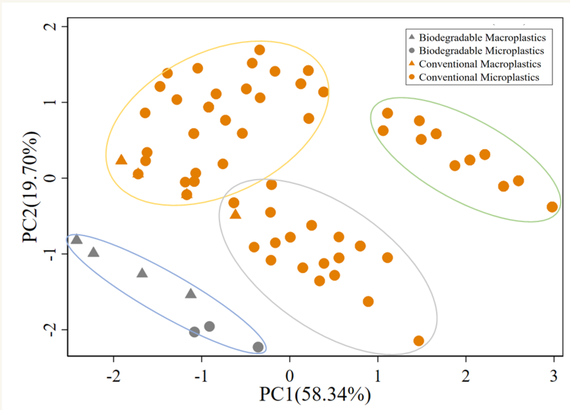
- Keywords "Plastic & soil" are used to search and screen the article in the core collection of the Web of Science.
- 16 research articles were selected which reported the soil's physical properties with 30 distinct experiments.
- Five soil physical properties are selected to include in this systematic review, i.e., porosity, water stable aggregates (WSA), field capacity, saturated hydraulic conductivity (Ks), and dry bulk density.

Data analysis

- Exploratory data analysis was performed by univariate graphical method (Fig.1 & Fig.2) to provide a full picture of the data.
- Principal component analysis (PCA) is used to further identify the main axes of variance within a data set. It allows for easy data exploration to understand the key variables, i.e., polymer types, shapes, sizes, and concentrations in the data, and spot outliers.
- PCA can helps to identify clusters among conventional and biodegradable macro/microplastics.

Plastics characteristics pattern

- PCA plot shows clusters of samples based on their similarity.
- Clusters shows obvious distinction between biodegradable and conventional plastics, which do not mixed.
- PC1 has large postive association with polymer type, shape and concentration, while negative aganist particle size.
- PC2 has negative association with concentration, while postive aganist particle size.



Influencing factors

- **Polymer type** has shows large negative influence on soil physical properties.
- **Particle size**: macroplastics signifies large negative influence along with microplastics.
- **Shape** and input **concentrations** have reflects negative impact.
- **Environemental relevance concentration** (<0.1%) shows minimal or no impacts on soil phyiscal properties.

Discussions

- Plastic size effected the WSA and Ks that leads to change in soil structure and locally recharge or vegetated region.
- Less moisture content at field capacity might influence plant growth and/or create early stress or drought stage in arid/semi-arid regions.
- Soil water erodibility might enhanced by plastic due to less WSA and bulk density.

Future studies

- Plastic particle impact on plant available water content and porosity under different environmental conditions.
- Needs to study the plastic impact on soil thermal properties, which is critical for land surface models.

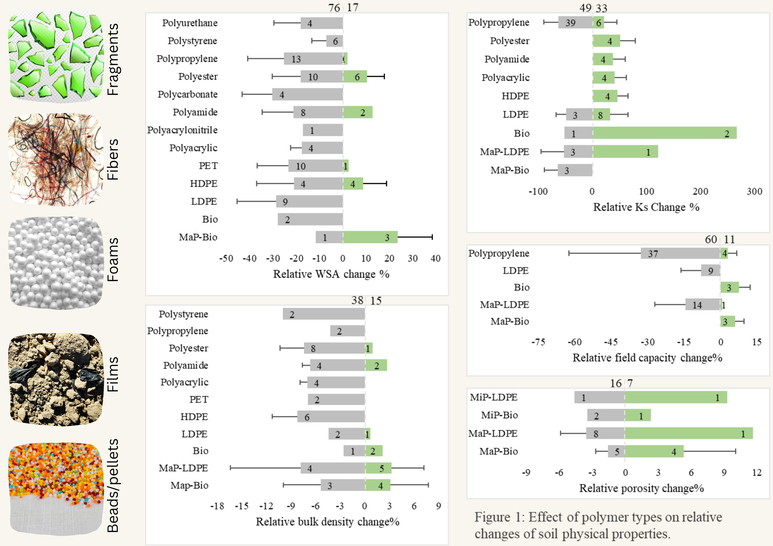


Figure 1: Effect of polymer types on relative changes of soil physical properties.

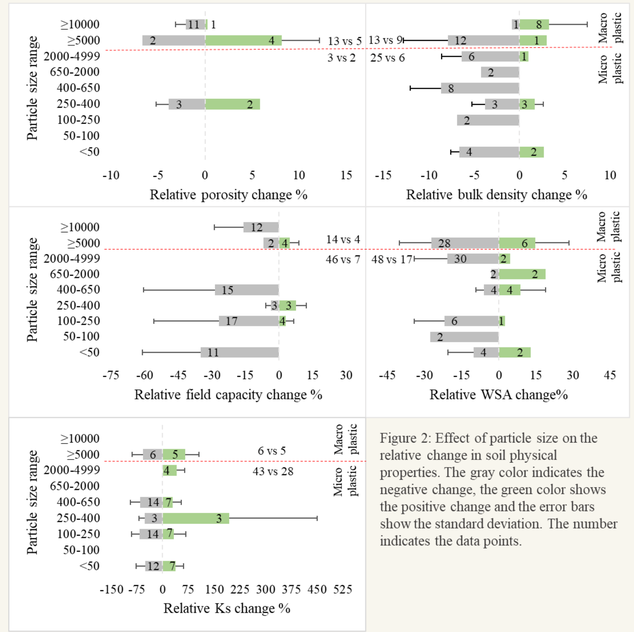


Figure 2: Effect of particle size on the relative change in soil physical properties. The gray color indicates the negative change, the green color shows the positive change and the error bars show the standard deviation. The number indicates the data points.

TAKE HOME MESSAGE

Macroplastics and microplastics affect soil's physical properties, having a large negative impact while minimal positive.

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