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Microplastics in soils – *challenges and concerns*

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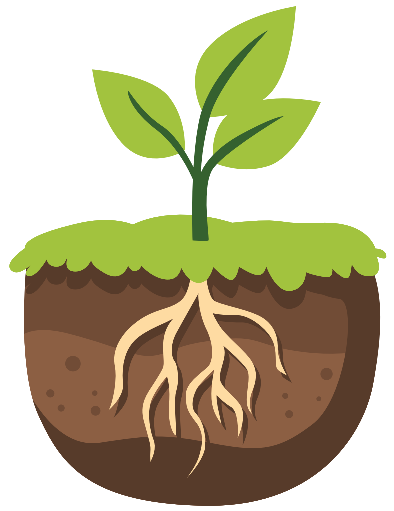
Concerns

MPs represent plastic particles with diameters > 5 mm, transported over long distances via oceanic currents and atmospheric circulation.

- Microplastics (MPs) are recognized as one of the most important global pollutants. Their distribution is largely attributed to the extensive production of synthetic polymeric materials characterized by high chemical stability, durability, plasticity, and corrosion resistance.

- Recent studies identify soil as a predominant environmental sink for MPs, where their persistence is enhanced by the presence of polymer additives. Current estimates suggest that the annual input of MPs into terrestrial ecosystems is **4–23 times exceed their loads in marine ecosystems**.

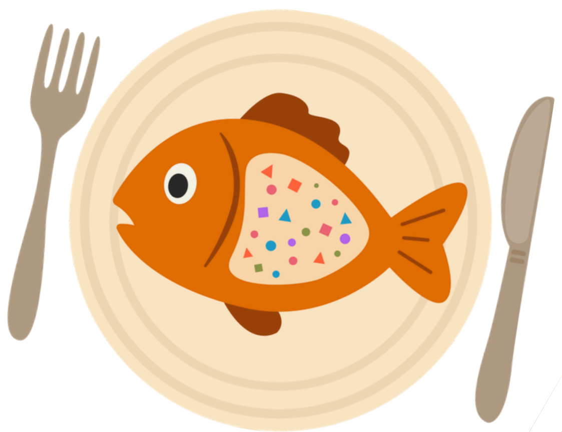
Concerns



- The impact of MPs on soil ecosystems has emerged as an important topic, as MPs can influence not only soil composition and properties but also biological processes, including microbial diversity, and enzyme activity, as well as the cycling of key elements – carbon (C), nitrogen (N), and phosphorus (P).

- Physico-chemical changes, such as fragmentation, increased surface area, roughness, and formation of additional adsorption sites, may enhance MPs' capacity to interact with other soil contaminants. For instance, heavy metals (HMs) can be immobilized through adsorption and complexation on MPs, potentially either mitigating or exacerbating HM-related environmental risks.

Concerns



- The increasing production and widespread use of plastic materials, particularly packaging, and the generation of municipal waste, driven by low-cost production, contribute substantially to environmental contamination.
- With global plastic production projected to continue rising, the load of MPs in the environment is unlikely to decline without mitigation measures.
- In agriculture, the application of sewage sludge, wastewater irrigation, fertilizers, and plastic-based coverings has been identified as a major source of MPs in soils. Once present in soils, MPs may enter crops and subsequently the food chain.

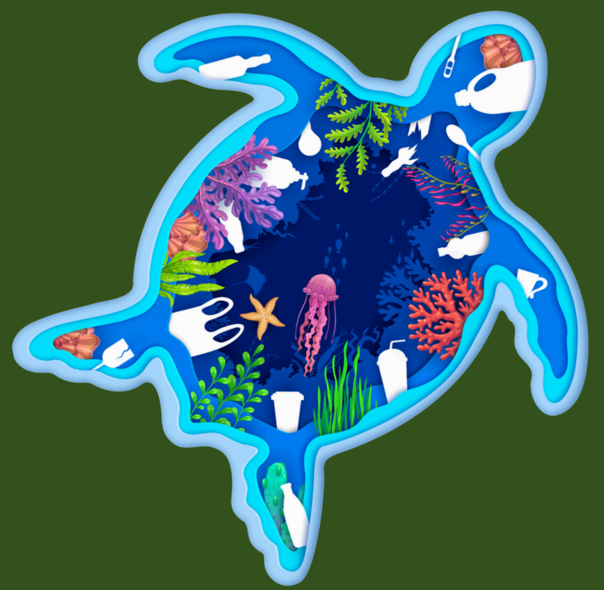
Challenges

Richard C. Thompson, marine biology professor at the University of Plymouth

- The environmental fate of MPs is governed by multiple degradation mechanisms, including physical weathering, photo, and thermal oxidation, biological degradation processes, etc.

- Importantly, different types of plastics have different effects on soil systems. **Conventional**, **biodegradable**, and **aged MPs** can influence soil properties in different ways, particularly biogeochemical cycling, reflecting complex interactions in soil environments.

- Recent studies indicated that **MP type** plays a key role in shaping soil microbial diversity, whereas **MP concentration** primarily affects the overall microbial community composition.



Challenges

Biodegradable MPs may undergo enzymatic fragmentation by soil microbiota, eventually producing mineralization end-products (CO_2, CH_4, H_2O), whereas **conventional** MPs predominantly generate physical changes in soils, including reduced porosity and water retention capacity, which ultimately can disrupt biogeochemical cycling.

Challenges

Dissolved organic matter (DOM) is the most dynamic and bioavailable fraction of soil organic carbon, which interacts with MPs. Consisting of low-molecular-weight organic compounds, microbial metabolites, and humic substances formed during organic matter transformation, DOM represent an additional but still insufficiently understood aspect of MP behaviour in soils.

Therefore, future research should focus on the fate and transformation of MPs in different soil types, as the replacement of conventional with biodegradable plastics is unlikely to mitigate contamination in terrestrial ecosystems, as critical components of the global plastic pollution cycle.

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