Microplastic exposure assessment from the perspective of nanoparticle research

Thorsten Hüffer

Antonia Praetorius

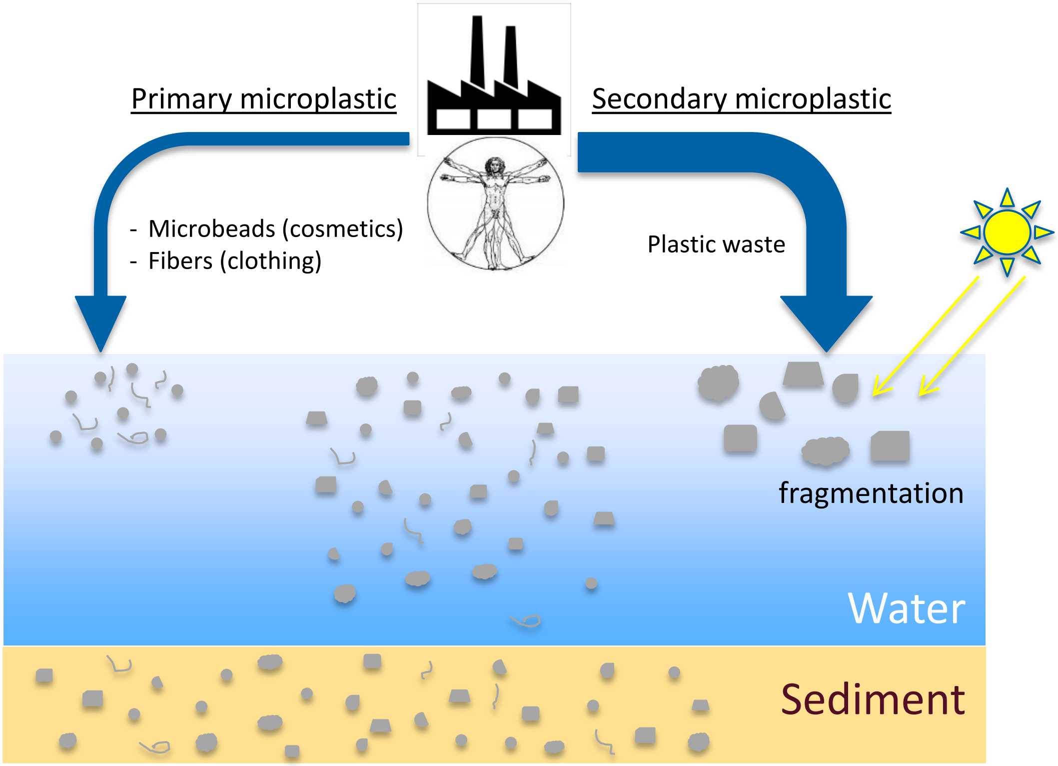
Stephan Wagner

Frank von der Kammer

Thilo Hofmann

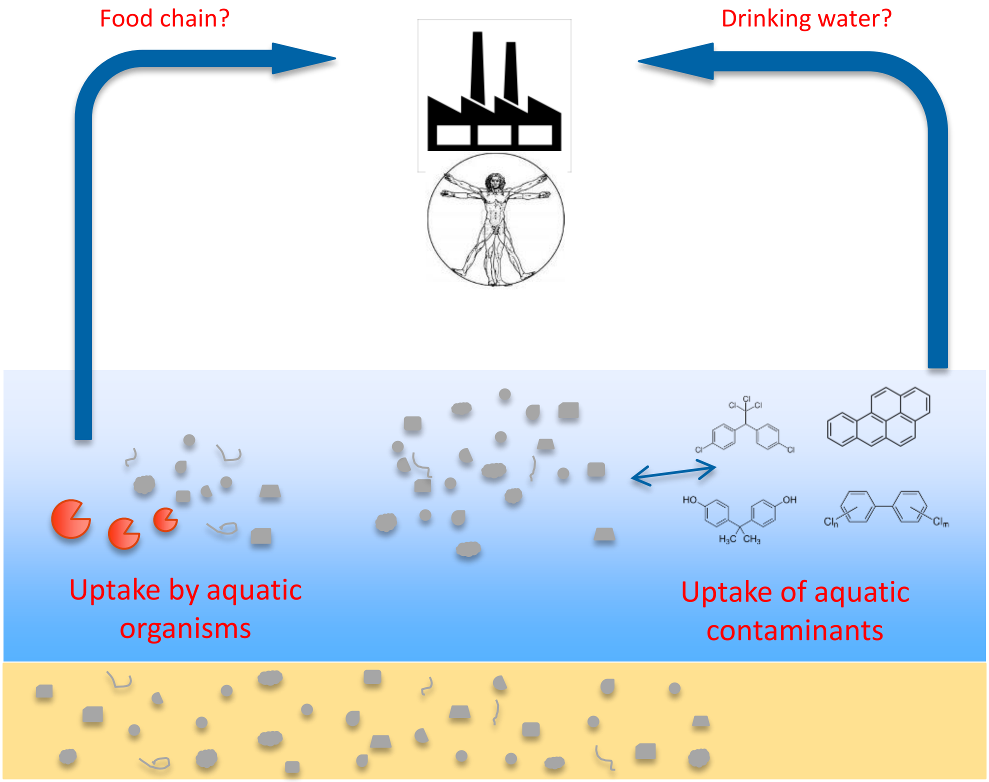
What is microplastic

universität wien



Adapted from Fraunhofer UMSICHT

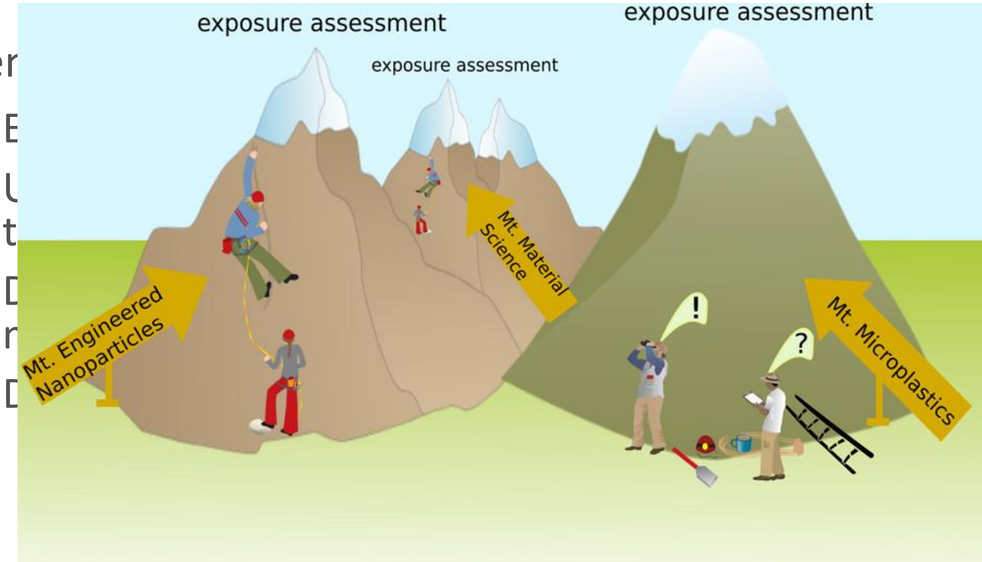
Relevance of microplastic



Adapted from Fraunhofer UMSICHT

Lessons from nano?

– Oper
  - E … s
  - U … n and t
  - D … d r
  - D



Over a decade, we have addressed similar questions & challenges on engineered nanoparticles

Hüffer et al., ES&T, 2017.

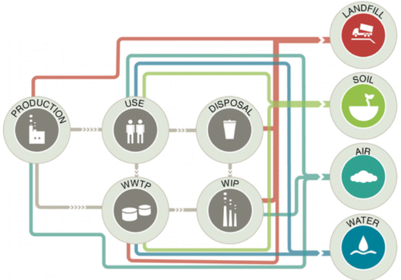
Similarities

ENP characteristics	MP characteristics	Transferrable knowledge from ENPs
Sources and emission pathways		
intentional release: agriculture, remediation; unintentional release: surface run-off, WWTPs, direct release (e.g. sunscreen from bathing);	unintentional release: dominated by secondary MPs (via fragmentation of macroplastic), primary MPs via WWTPs;	mass flow models for ENPs transferrable for primary MPs (e.g. microbeads from cosmetics). Fragmentation data needed to assess secondary MP emissions;
Environmental transformation and transport		
particle size < 100 nm; density often > 1 g/cm^3; fate processes: dissolution, interaction with biofilm/NOM, heteroaggregation, surface transformations;	MPs: particle size 1 µm - 5 mm; nano-plastics: < 100 nm; density typically 0.9-1.1 g/cm^3; fate processes: fragmentation, interaction with biofilm/NOM, heteroaggregation, surface transformation, additives leaching;	kinetic fate descriptors essential; particle characteristics & properties of the surrounding medium affect fate; adaptation of ENP models with MP-specific properties particle ageing has to be accounted for;
Analytical methods for characterization & monitoring strategies		
size distribution; particle number concentration; surface area & chemistry (e.g. type of coating);	size distribution; particle number/mass concentration; types and concentrations of additives;	importance of particle size and number concentration; sample preparation essential for particle analysis & characterization methods;
Representative laboratory experiments		
particulate nature requires special considerations; stable dispersion due to electrostatic or steric stabilization;	particulate nature requires special considerations; usually low density combined with large particle size;	use of reference materials and elucidation of fate under well-defined & realistic conditions; use of aged particles; importance of particle concentration; strategies for keeping particles in suspension;

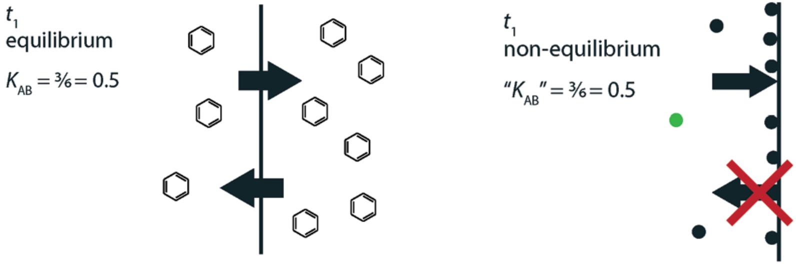
Hüffer et al., ES&T, 2017.

Transferable knowledge

- Mass flow models for ENPs transferable for primary MPs



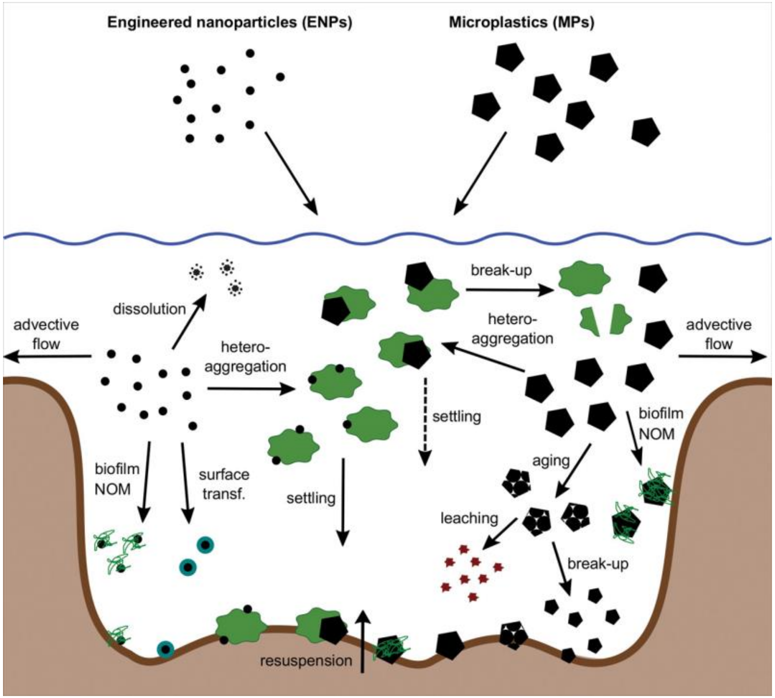
- Kinetic fate descriptors essential



Keller & Lazareva, ES&TLett, 2014; Praetorius et al., ESnano, 2014.

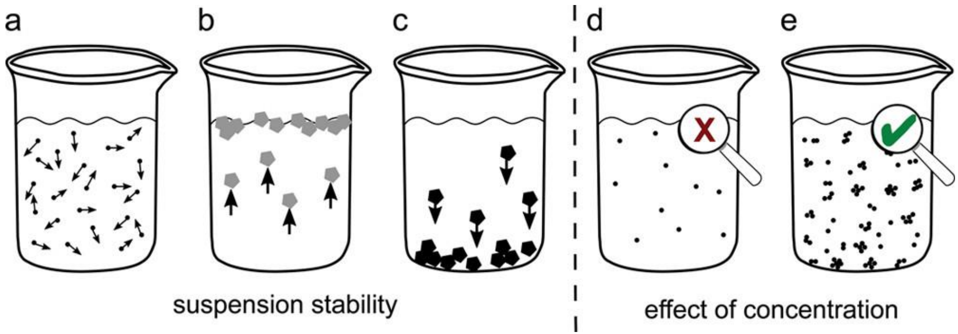
Environmental transport

- lab & mesocosm studies with varying realism & spatial resolution for ENPs
- Processes affecting fate (figure) influenced by surrounding medium
- Account for specific differences (density, size) when extrapolating to MPs



Hüffer et al., ES&T, 2017.

Laboratory experiments

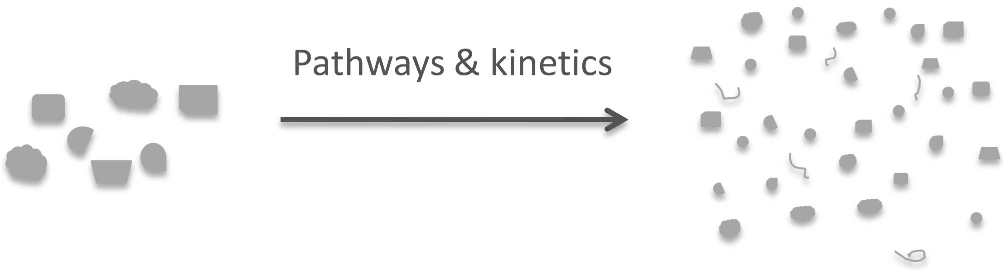


- Dispersion stability of particulate contaminants crucial
- Important aspects of ENP fate assessment
  - Use of well-defined and reproducible aquatic media
  - Detailed knowledge of particle characteristics
- Challenge: representative particle concentrations

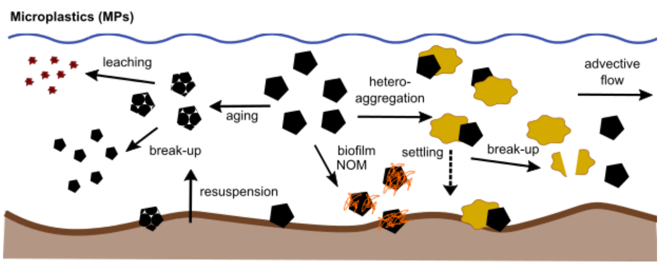
Hüffer et al., ES&T, 2017.

Differences

- Fragmentation for secondary MP emissions



- Particle properties (lower density & larger particle size)



Hüffer et al., ES&T, 2017.

Research priorities?

universität wien

- Fragmentation processes of macroplastics and rates of secondary MP formation
- Definition of particle size distribution range(s) and related biological and chemical relevance
- Evaluation of the leaching of additives, and their effects on particle properties and ecosystems
- Establishment of an analytical framework for defined particle size fractions and analytical parameters
- Definition of protocols for stable MP dispersions accounting for the large variety of MP particle properties and sizes

Hüffer et al., ES&T, 2017.

universität wien

Thank you for your attention!