Fate and transport models for nano- and microplastics

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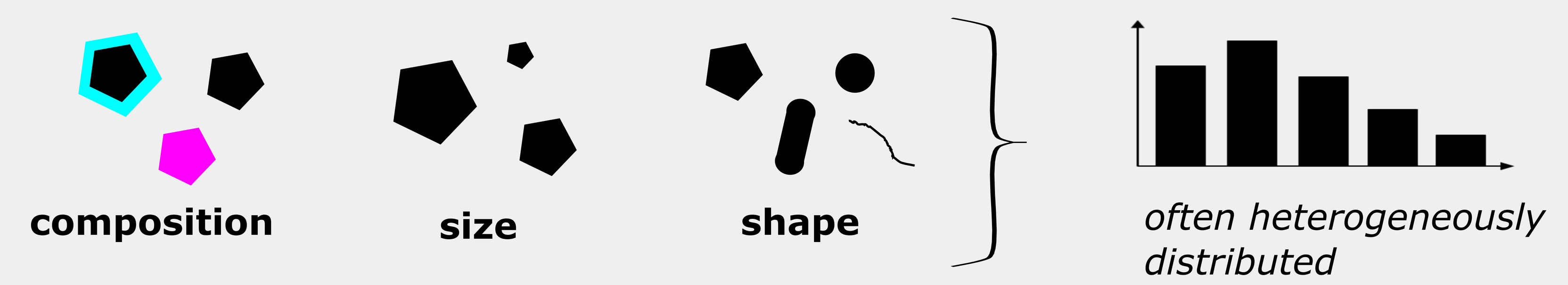
Motivation

- Increasing concern over nano- and microplastic particles in the environment, but currently insufficient measured exposure data for risk assessment
- Environmental fate models can provide much-needed exposure predictions, improve process understanding and evaluate future scenarios
- Existing modelling approaches for engineered nanoparticles provide suitable starting point for nano- and microplastic fate models
- Adjustments required to account for wider size range, the (often) low density of plastic particles and possible weathering and fragmentation

Special considerations for modelling particulate contaminants

behaviour driven by chemical AND physical properties



- No pure chemical substances
- Form (unstable) suspensions in water – behaviour kinetically controlled, equilibrium partition coefficients (e.g K_{ow}) not applicable [1]

Fate processes in aquatic systems

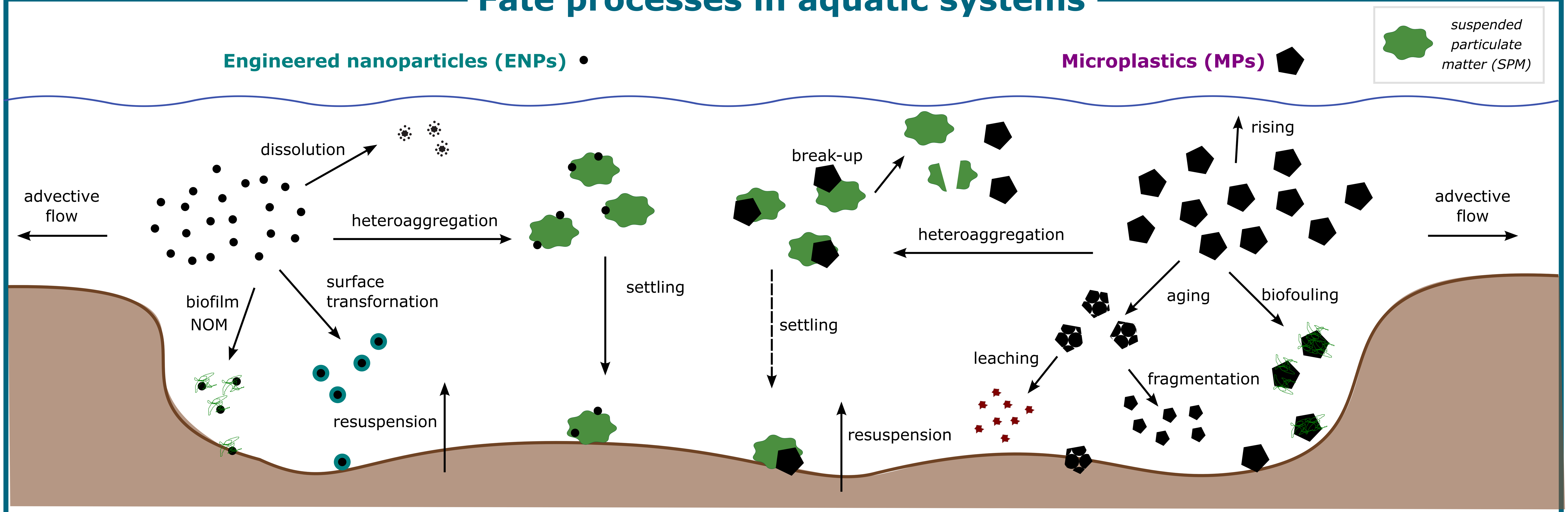
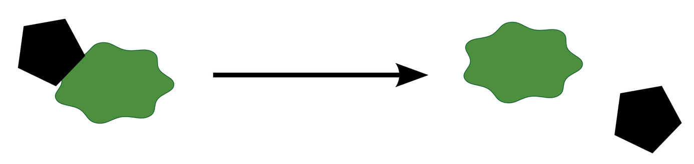


Figure 1: Overview of relevant transformation and transport processes for ENPs and MPs in surface waters (incl surface sediments). Scheme adapted from [2].

What is new or special for nano- and microplastics?

Break-up of (hetero-) aggregates

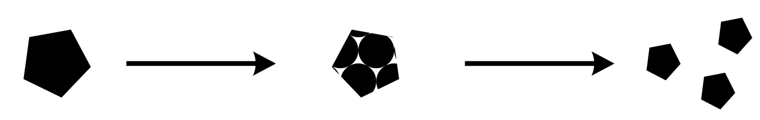


more likely for micro- than for nanometer sized particles due to weaker attachment (also more easily resuspended from sediment)

Buoyancy affected by biofouling

pristine low-density plastic floats whereas surface covered with biofilm leads to increased density and particle settling

Weathering and fragmentation



mechanisms complex to unravel (and to implement in model), limited data. Timescales can differ greatly and might often be much longer than those of other fate processes

Case study: Lake Geneva model

- Under development*
- Multimedia mass-balance model
- Modular framework, can be easily extended with other processes or adapted to different regions or scenarios
- Size distribution from nano- to microplastics represented with discrete size bins
- Model validation planned with available monitoring data [3,4]. *Note: currently no measured data for nanoplastics*
- Model code will be made availabe open-source via GitHub

*progress delayed due to Covid-19 situation

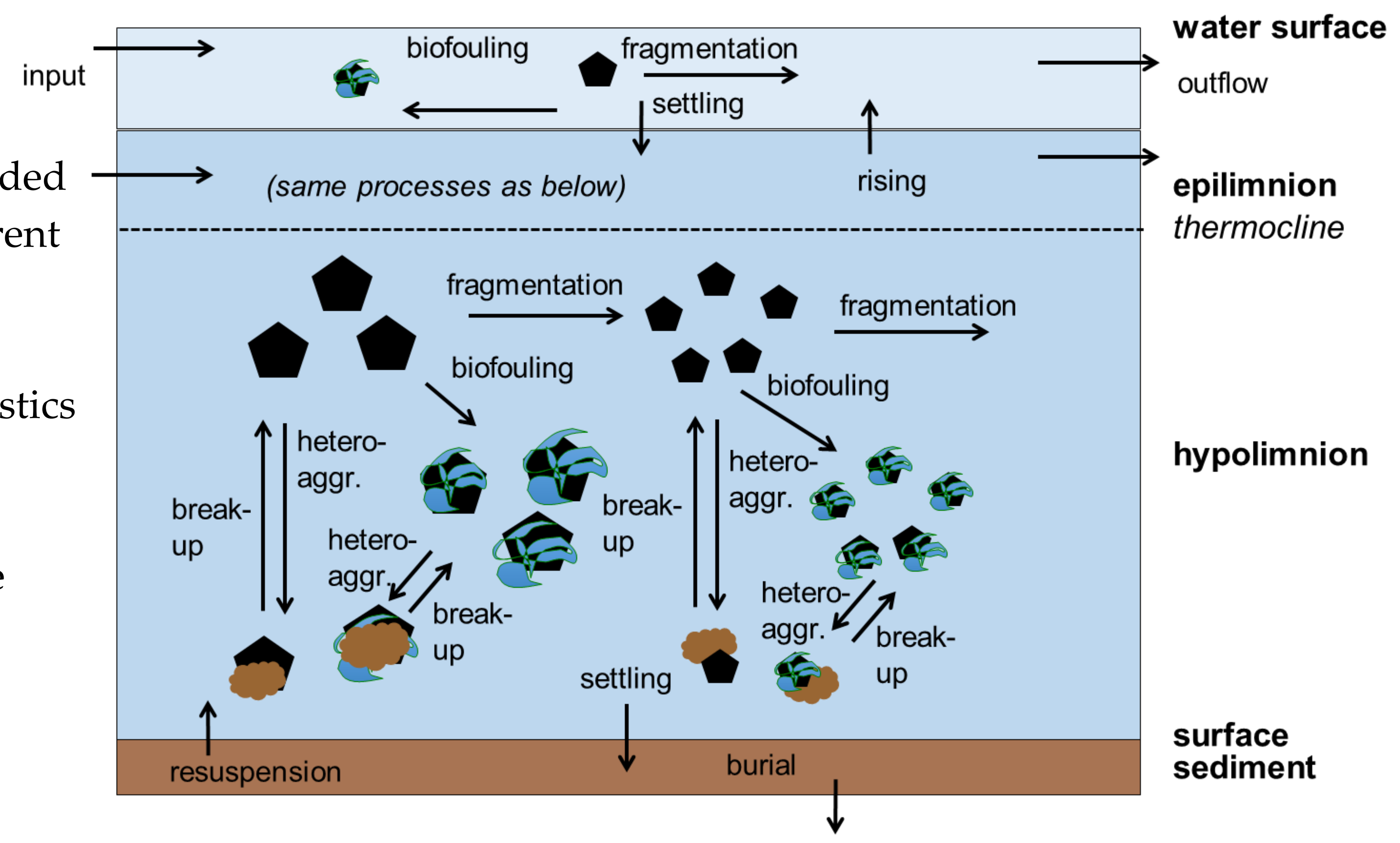


Figure 2: Processes and compartments integrated in current version of Lake Geneva model

Lake Geneva (Lac Léman) Switzerland

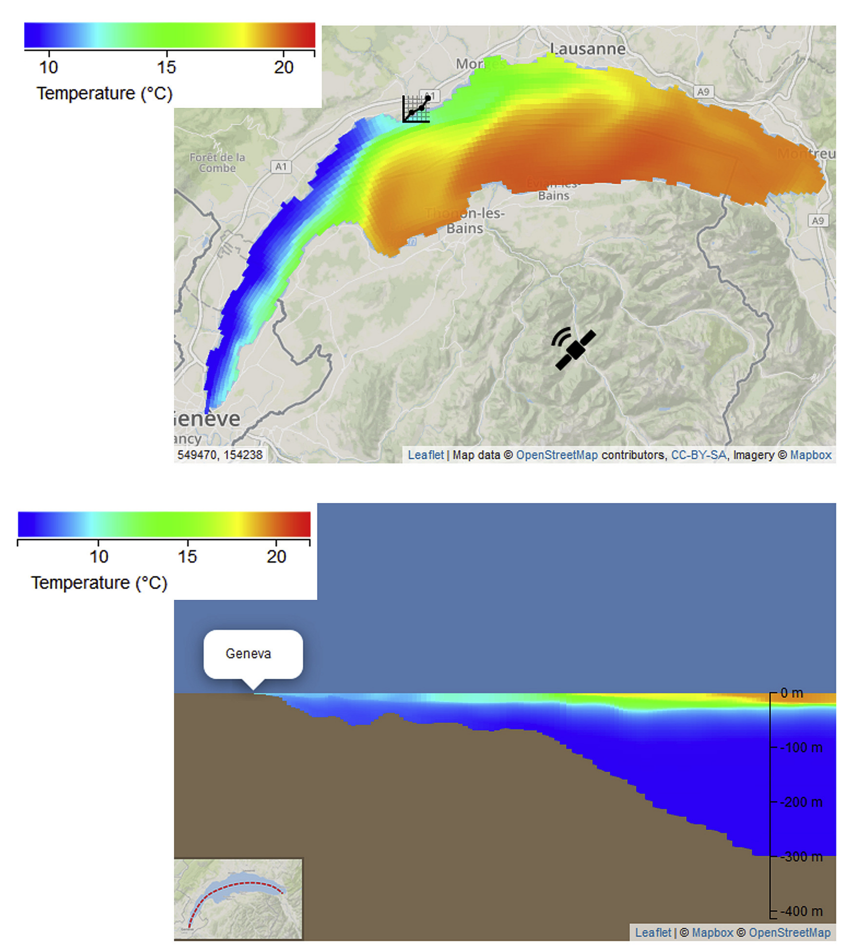


Figure 3: Lake Geneva temperature map from [5] as an example of the data used for model parameterisation and obtained via Meteolakes (http://meteolakes.ch/#!/hydro/geneva)

References

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[3] Faure, F. et al. **2015**. DOI: 10.1071/EN14218
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