Tracking microplastic contamination

From sewage sludge to the oceans: Three European case studies

1. Microplastics in sewage sludge

Microplastics abundance in **Norwegian** sludge and implications for environmental release

2. Microplastics in agricultural soil

Fate of microplastic particles released to agricultural soils from sludge application in **Spain**

3. Microplastics in river systems

Dynamics of microplastic contamination in a **British** river system following a flood event

From WWTPs to fields to aquatic environments

- WWTPs are capable of **trapping** a large proportion of microplastics – up to 99%[1].
- However, many of these particles are concentrated into the **sludge phase**[2].
- Final sludge is often applied to **agricultural soils as a fertiliser.**
  - Estimates suggest that 63 000 – 430 000 tons of microplastic are added to European farmlands each year[3].
- Microplastics may accumulate in soils or be transferred to aquatic environments via erosion/runoff.

[1] Talvitie et al. 2017; Water Res. vol. 109
[2] Carr et al. 2016; Water Res. vol. 91
[3] Nizzetto et al. 2016; ES&T vol. 50

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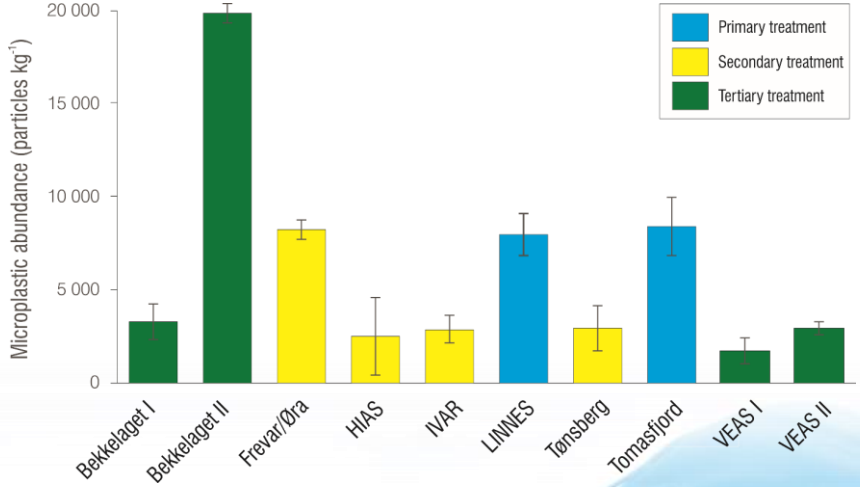
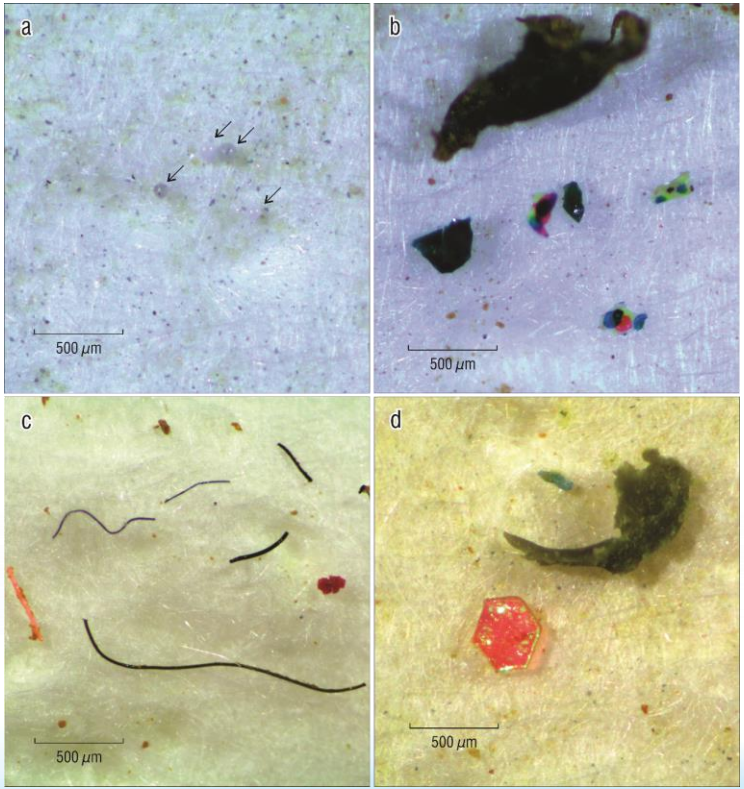
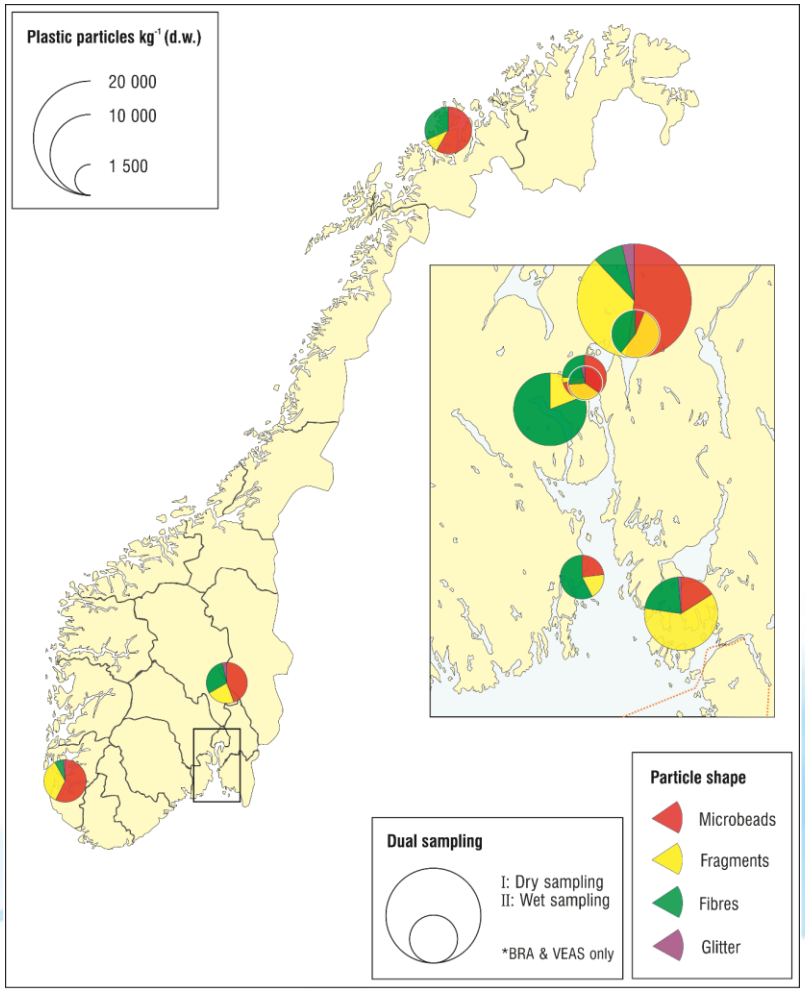


Case Study 1: Norwegian sewage sludge





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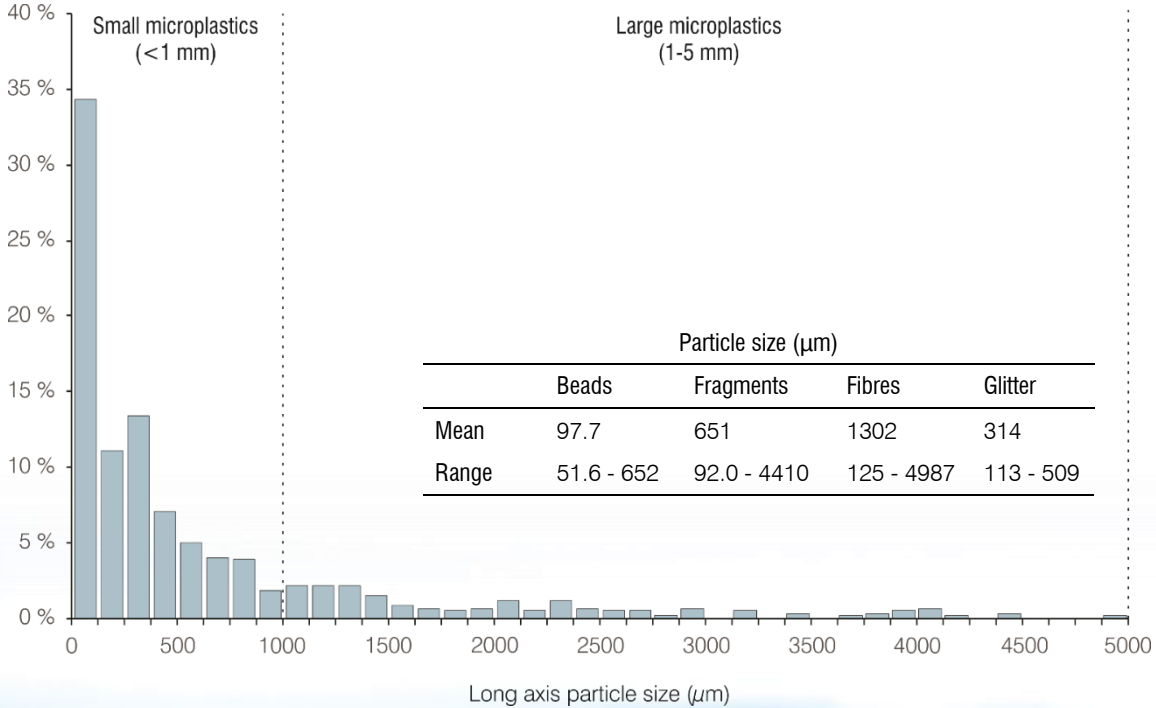


Particle size (μm)

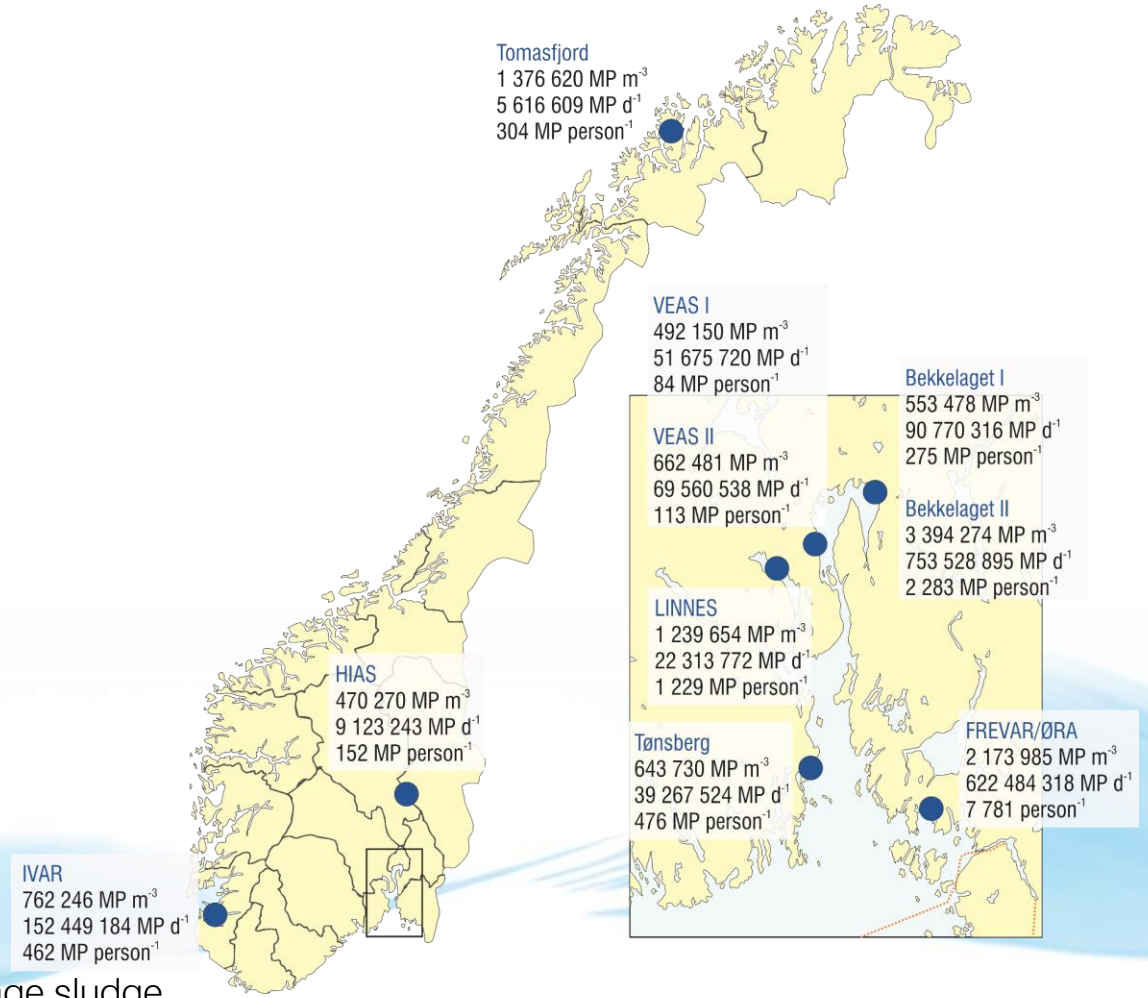
	Beads	Fragments	Fibres	Glitter
Mean	97.7	651	1302	314
Range	51.6 - 652	92.0 - 4410	125 - 4987	113 - 509

- Lower limit: 50 μm
- Average particle size: 644 μm; D_{50}: 297 μm
- Particles concentrated in finest size fraction, indicating a potential underestimation of total microplastic content

Based on this **snapshot**:

- On average, 181 679 012 microplastic particles captured by one WWTP and transferred into the sludge phase each day
- On average, 1316 MPs per individual per day (median: 383)
- Extrapolated to Norwegian population:

Approx. 6.8 billion microplastics per day



446 bn MPs spread on agricultural soils

27 bn MPs added to green areas

112 bn MPs sent to soil producers

584 bn MPs released into the Norwegian environment via sewage sludge each year

Fate of microplastics added to soils

- Testing of runoff material (water & soil) at three experimental plots:
  - **Control**: no sludge treatment
  - Soil treated with sludge in **2013**
  - Soil treated with sludge in **Nov 2017**

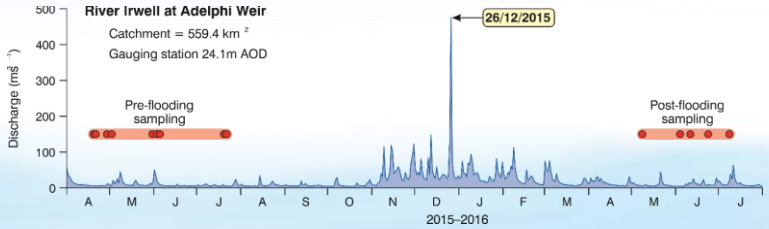
Results available soon

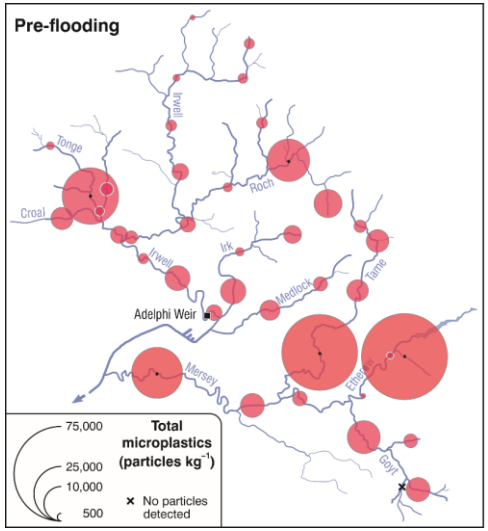
- Other processes such as aggregation, agricultural practices (tilling etc.), and burial due to successive flooding *may* lead to the accumulation of microplastics into the soil profile

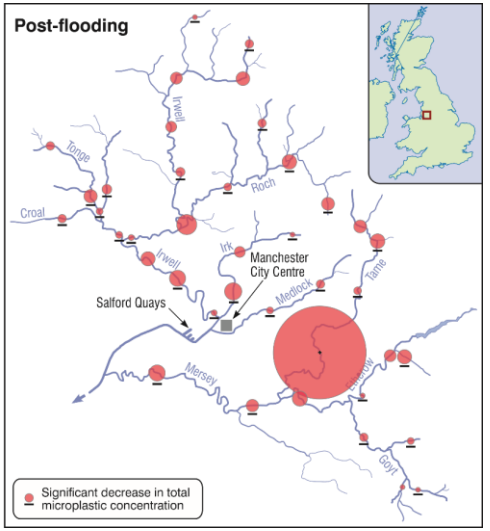
- Microplastics in the soil profile may be leached to groundwater aquifers, but this has not yet been

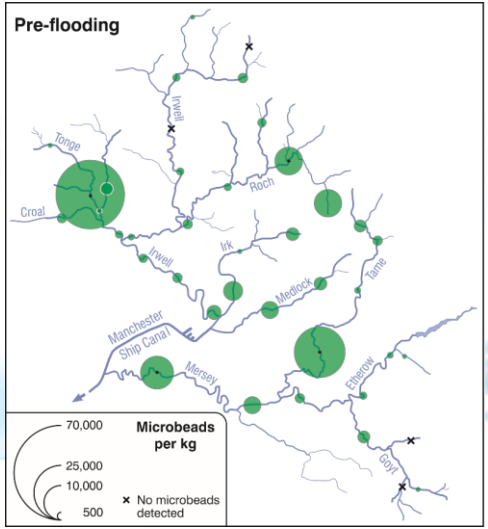
From the river to the ocean

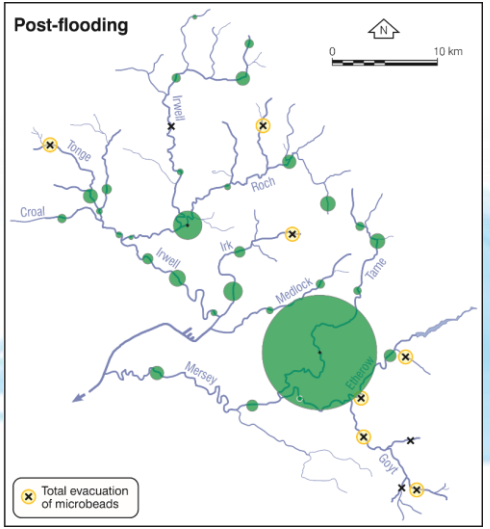
- Microplastics contamination in bed sediments across the Manchester river network is high and spatially complex.
- Following a high magnitude flood event, this contamination was significantly reduced.
- Microbead contamination also fell, with the exception of a site which presented the highest level of contamination thus far reported.

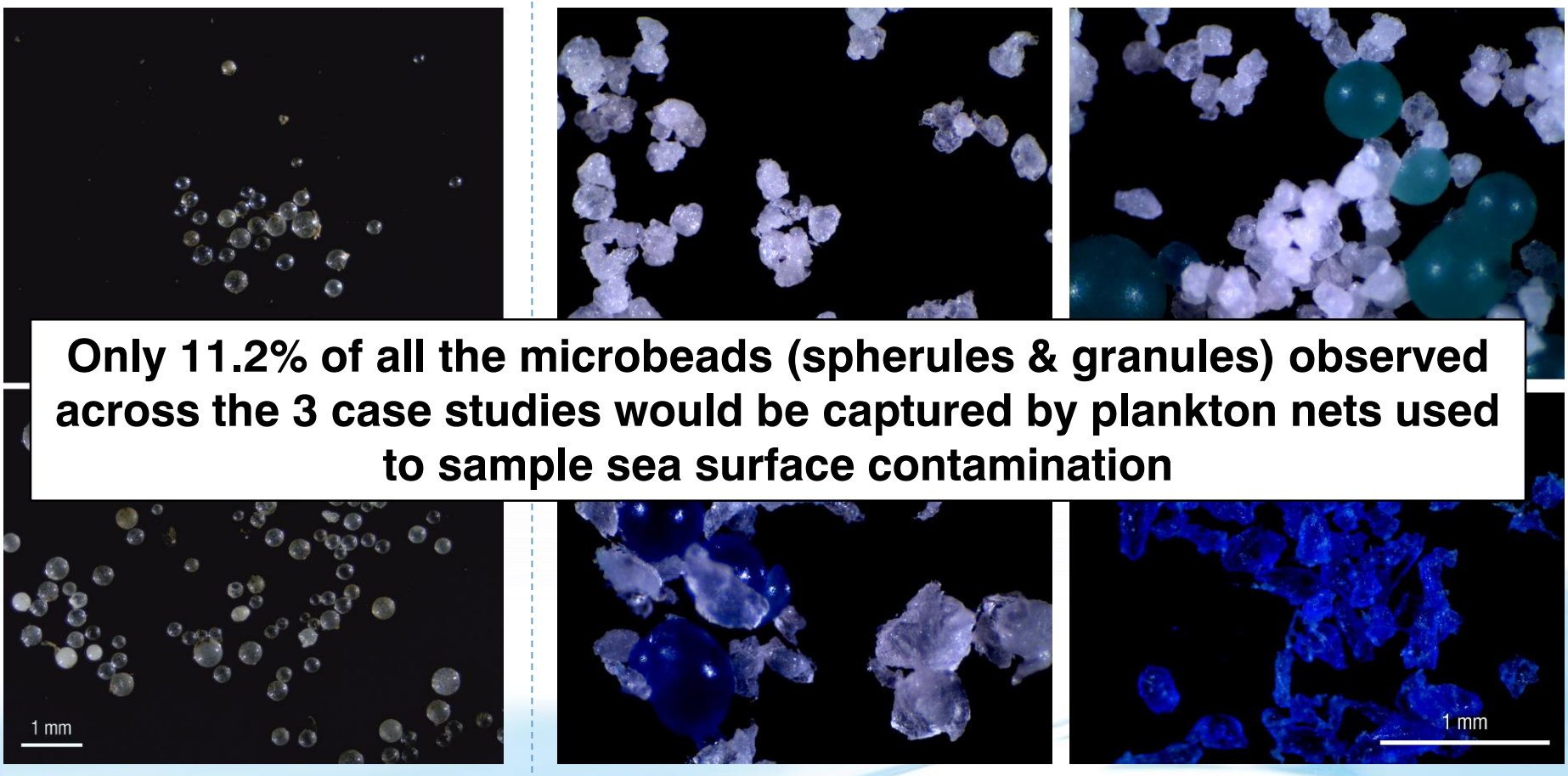








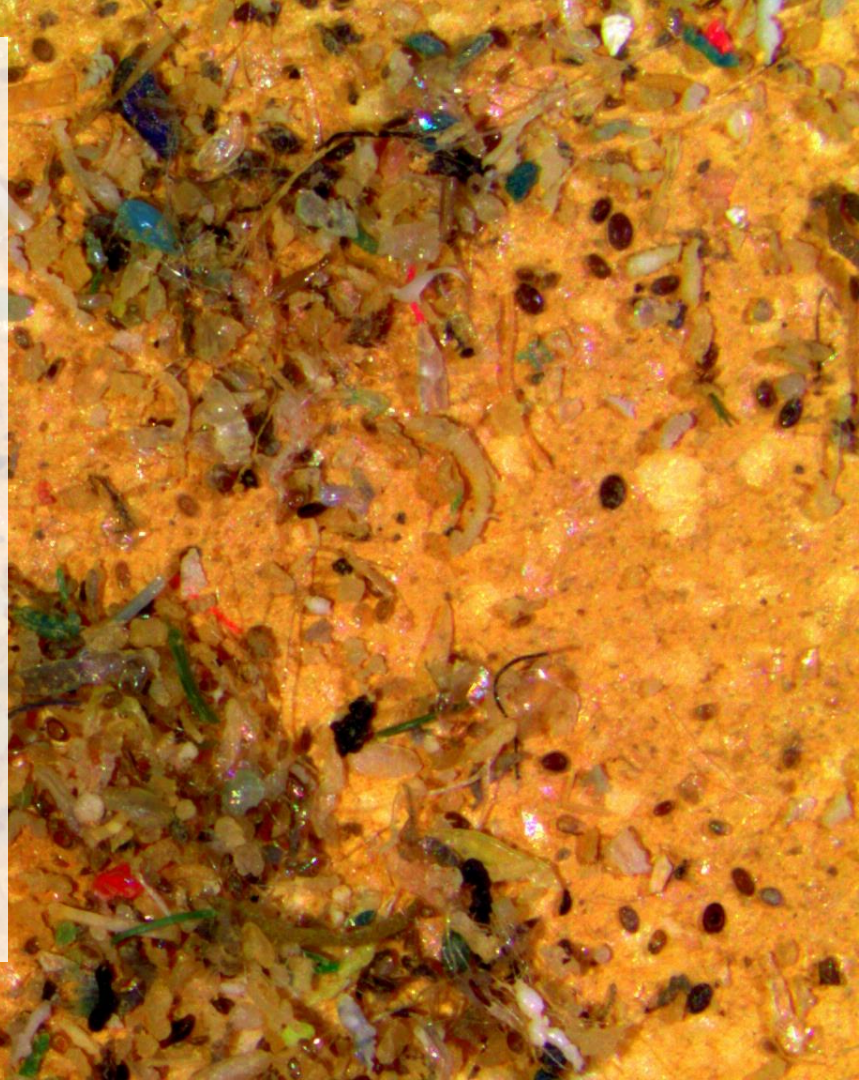




Only 11.2% of all the microbeads (spherules & granules) observed across the 3 case studies would be captured by plankton nets used to sample sea surface contamination

Potential sources of microplastic particles

- Attributing potential sources of microplastic contamination is complex
- Beads may be derived from personal care products, but could also have an industrial source
- Fibres are produced during washing, drying or natural wear of synthetic textiles. A large proportion of these are likely to enter the wastewater treatment system.
- It is very difficult to identify potential sources of fragments, especially as we don't fully understand the processes of fragmentation in different environments.
- Glitter is generally used for decorative purposes.
- Pathways to the environment are varied and dependent on particle type.



Interactions with organisms

- Adverse effects
  - e.g. reduction in growth and reproduction in collembolans[1], histopathological damage in earthworms[2]
  - transfer of contaminants e.g. PBDE[3]
- Evidence of microplastic transport through predator-prey relationships – microplastics pass up through the food chain[4]
- Fragmentation of microplastics in earthworm gut[5]
- Evidence of trophic transfer that may potentially introduce microplastics to the human food chain
  - MPs in poultry (10.2 MPs per gizzard)[6]

[1] Zhu et al. 2018. Soil Biol. Biochem. vol. 116; [2] Rodriguez-Seijo et al. 2017. Env. Pollut. vol. 220; [3]Gaylor et al. 2013. Env. Sci. Technol. 47; [4]Zhu et al. 2018. Env. Pollut. vol. 235; [5] Huerta Lwanga et al. 2016. Env. Sci. Technol. vol. 50; [6] Huerta Lwanga et al. 2017. Sci Rep. vol. 7

Summary

- Estimates for the scale of MPs released via sludge highlight that **reuse practices are potentially a major source of MPs to the environment**
- Microplastic contamination is **mobilised from soils** and that this **represent a source to aquatic environments**
- River sediments have **high levels of contamination** that are strongly influenced by hydrological processes, which can transfer significant loads downstream to the ocean
- Source dynamics are likely to be complex
- Next challenges:
  - Size
  - Mass
  - Risk

Microplastic types such as **microbeads and glitter** represent a significant component of the contamination issue

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