

# Microplastics (MP) in sewage sludge and agriculture



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**NIVA**

# Massive global (media) interest in marine plastics and microplastics pollution

Microplastics in marine environments: Occurrence, distribution and effects

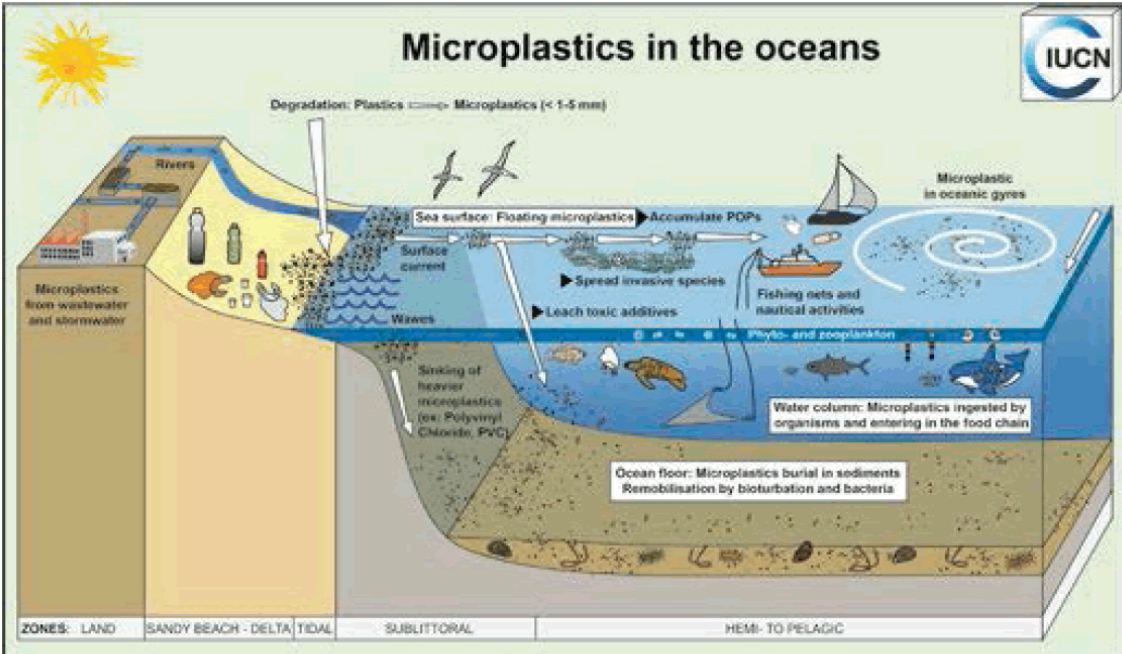
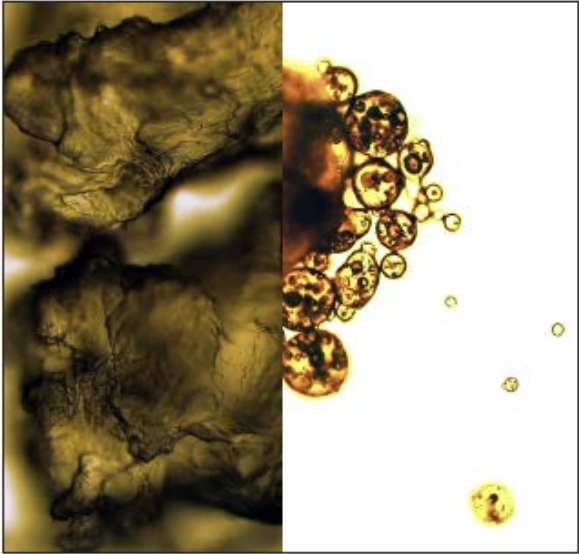


Figure 4: Schematic drawing showing the main sources and movement pathways for plastics debris in the oceans (Source: Florian Thevenon) [1].

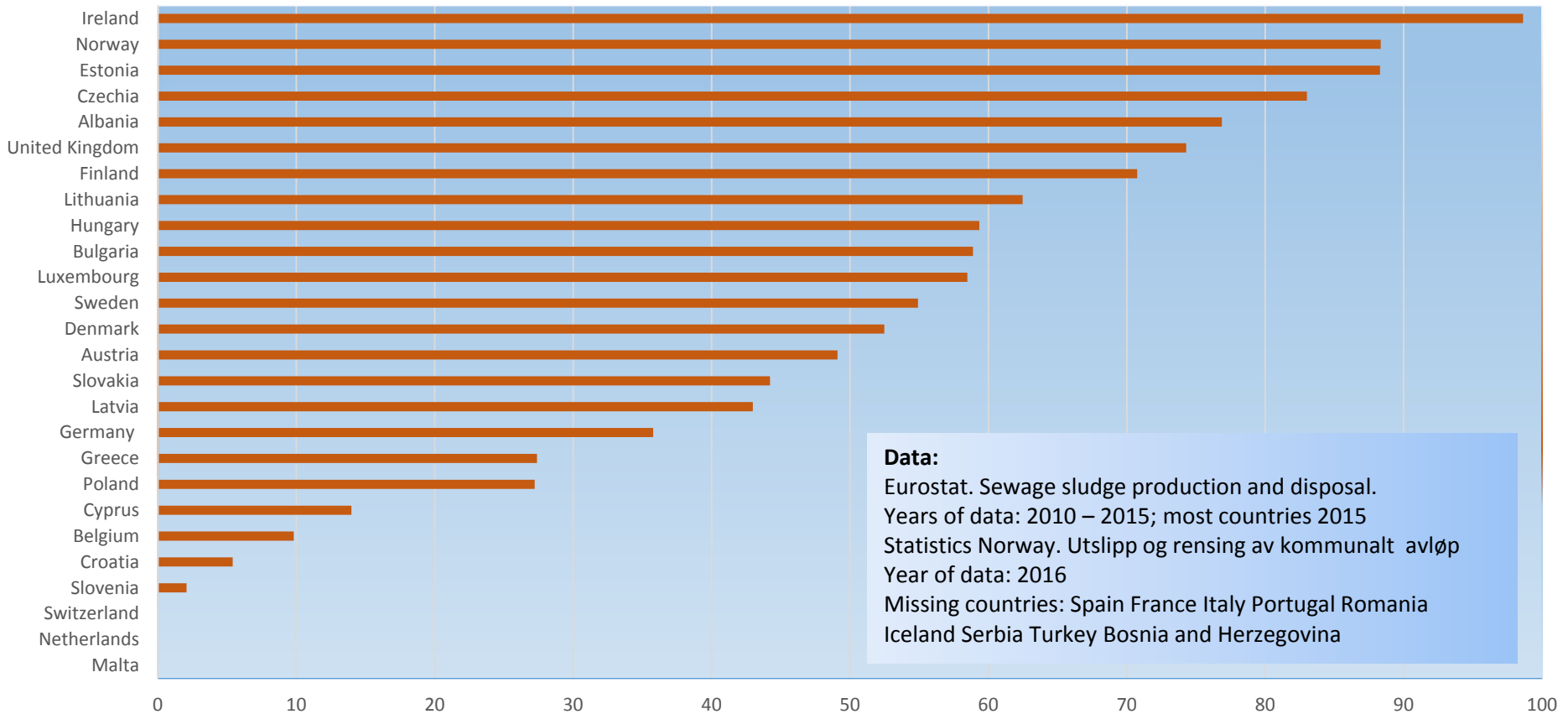


# Agricultural (macro)plastics



# Percentage of sludge produced used in agriculture & compost\*

\* excluded landfill



**Data:**

Eurostat. Sewage sludge production and disposal.

Years of data: 2010 – 2015; most countries 2015

Statistics Norway. Utslipp og rensing av kommunalt avløp

Year of data: 2016

Missing countries: Spain France Italy Portugal Romania

Iceland Serbia Turkey Bosnia and Herzegovina



# Do microplastics spill on to farm soils?

“...A rough extrapolation from data in refs 1–3 produces a total yearly input of 63 000–430 000 and 44 000–300 000 tons MPs to European and North American farmlands, respectively....”

nature  
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## Correspondence

### Do microplastics spill on to farm soils?

Large quantities of microplastic particles from cosmetics, clothing and industrial processes could be ending up on agricultural land that is fertilized with urban sewage sludge. This calls for urgent investigation if we are to safeguard food production and reuse wastewater products.

Unlike microplastics that pollute the oceans, little is known about the particles' prevalence and potential effects in terrestrial and freshwater environments.

Because they are retained in sewage and domestic waste water after treatment in municipal plants (S. A. Carr *et al.* *Water Res.* **91**, 174–182; 2016), they could be contaminating agricultural soils — with unknown consequences for farm ecosystems and food security.

We estimate from emissions data (see, for example, [go.nature.com/2ce0z6l](http://go.nature.com/2ce0z6l)) that 63,000–430,000 and 44,000–300,000 tonnes of microplastics could be being added annually to farmlands in Europe and North America, respectively.

This figure exceeds the estimated global burden of microplastics in oceanic surface waters of 93,000–236,000 tonnes (E. van Sebille *et al.* *Environ. Res. Lett.* **10**, 124006; 2015).

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### Are Agricultural Soils Dumps for Microplastics of Urban Origin?

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filtration treatment effectively removes larger floating particles, while smaller and lighter particles, expectedly, are released with wastewater effluents.

The use of sewage sludge as fertilizer for agricultural applications is often economically advantageous and is common in many developed regions. In Europe and North America about 50% of sewage sludge is processed for agricultural use. Using national data on farm areas, population and sewage sludge fate (<http://ec.europa.eu/eurostat>), with estimates of MP emissions<sup>1–3</sup> and applying broad but conservative uncertainty ranges, we estimate that between 125 and 850 tons MP/million inhabitants are added annually to European agricultural soils

# Transfer of microplastics to sludge

- Trapping efficiencies of WWTPs have been shown to vary, although some are as high as 99%<sup>1,2</sup>
- Many of these captured particles are transferred to the sludge phase
- Existing studies point towards the early stages of wastewater treatment (e.g. primary, secondary) as important processes for the trapping of microplastic particles<sup>3</sup>
- However, the fate of particles is determined by practices specific to WWTPs – e.g. whether the grease skimming step is transferred to the sludge or sent to landfill
- Size is likely to be an important control on the transfer of plastic particles to sludge
- Preliminary screening will trap larger particles – although mesh sizes vary from plant to plant

# Method for extraction and quantification of MP from complex matrices

## Validation of a Method for Extracting Microplastics from Complex, Organic-Rich, Environmental Matrices

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*Environ. Sci. Technol.*, 2018, 52 (13), pp 7409–7417

DOI: 10.1021/acs.est.8b01517

Publication Date (Web): June 9, 2018

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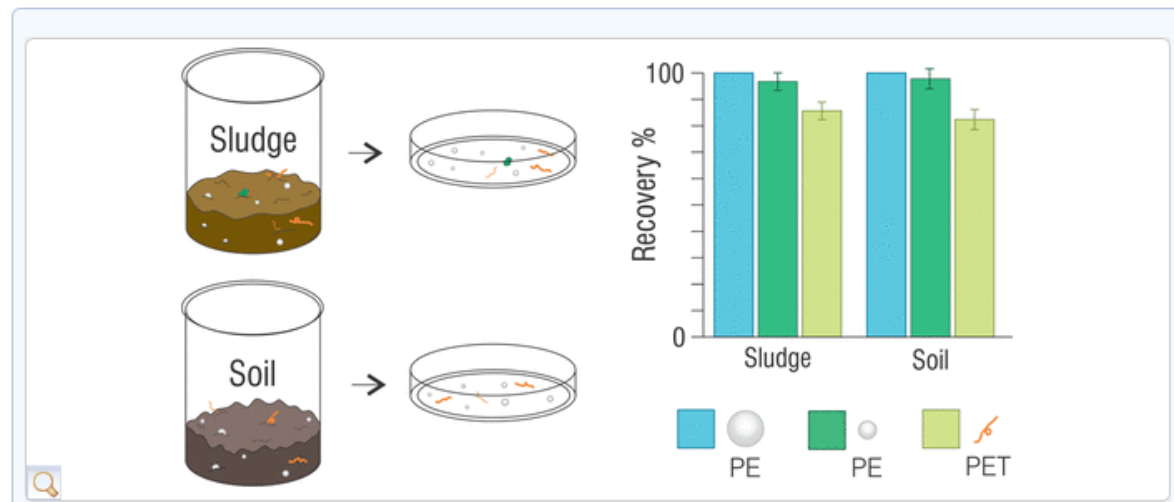
 Cite this: *Environ. Sci. Technol.* 52, 13, 7409-7417

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### Abstract

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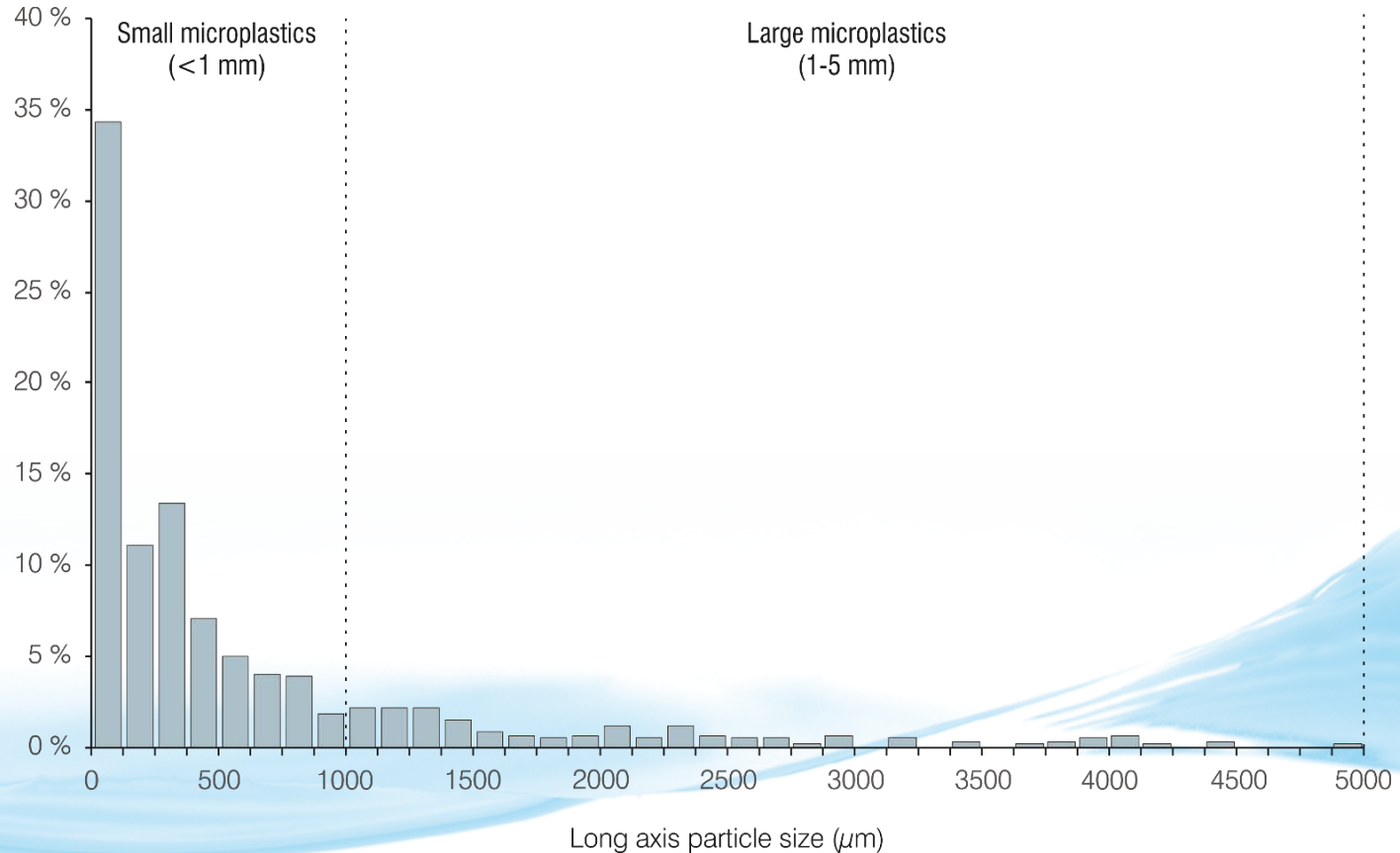
# Concentrations of microplastics in sewage sludge

- Typical concentrations range **between 1,000 – 20,000 particles per kg of sludge** (dry weight) (However, studies utilise different lower size limits for the isolation and detection of microplastic particles; lower limits range between 0.48 – 250  $\mu\text{m}$ )
- Concentrations become significantly higher when smaller particle sizes are analysed, e.g. 495,000 particles per kg sludge (d.w.) (0.48 – 5000  $\mu\text{m}$ )<sup>1</sup>
- Studies point towards heterogeneity in sludge concentrations and composition (dominant particle morphologies and polymer types)
- Effects of sludge treatment may influence this; Lime stabilisation may potentially shear microplastic particles, whilst anaerobic digestion may help to reduce concentrations<sup>2</sup>

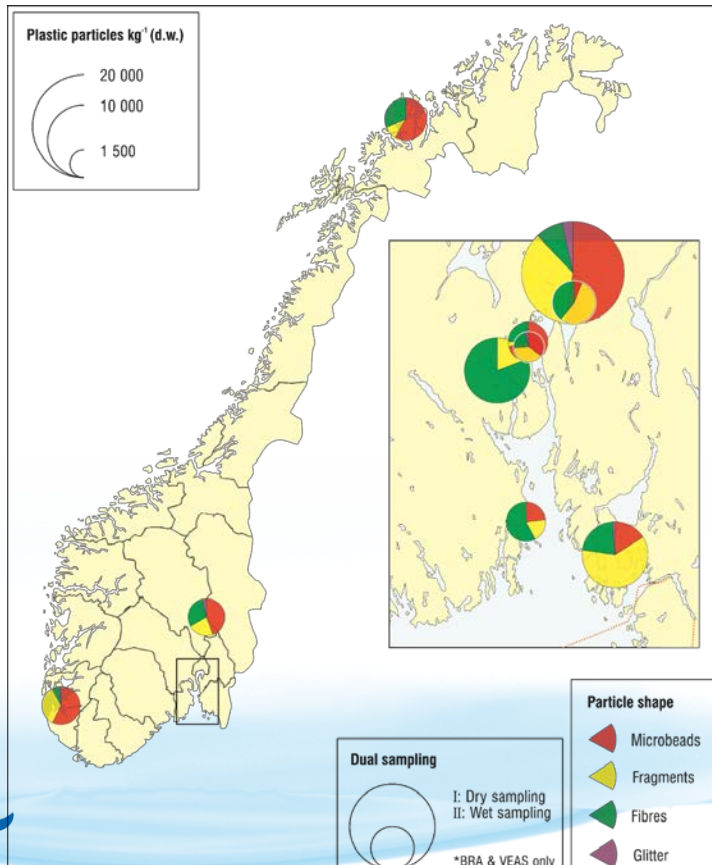
1 Sujathan et al., 2017; Arch. Environ. Contam. Toxicol.; 2 Mahon et al., 2016; Environ. Sci. Technol.



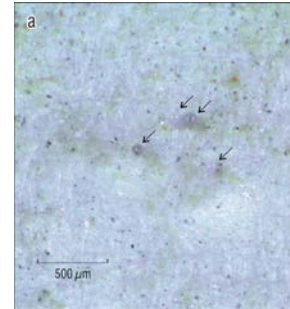
# Size distribution - microplastics in sewage sludge



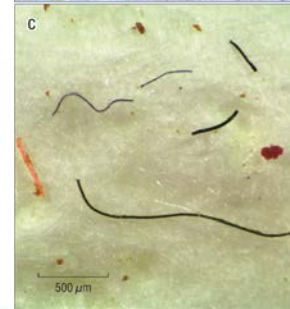
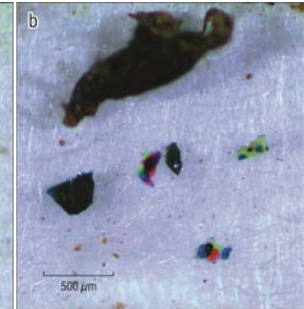
# Types of microplastics in sewage sludge - Norway



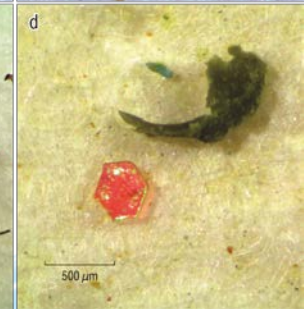
## Microbeads



## Fragments



## Fibres



## Glitter

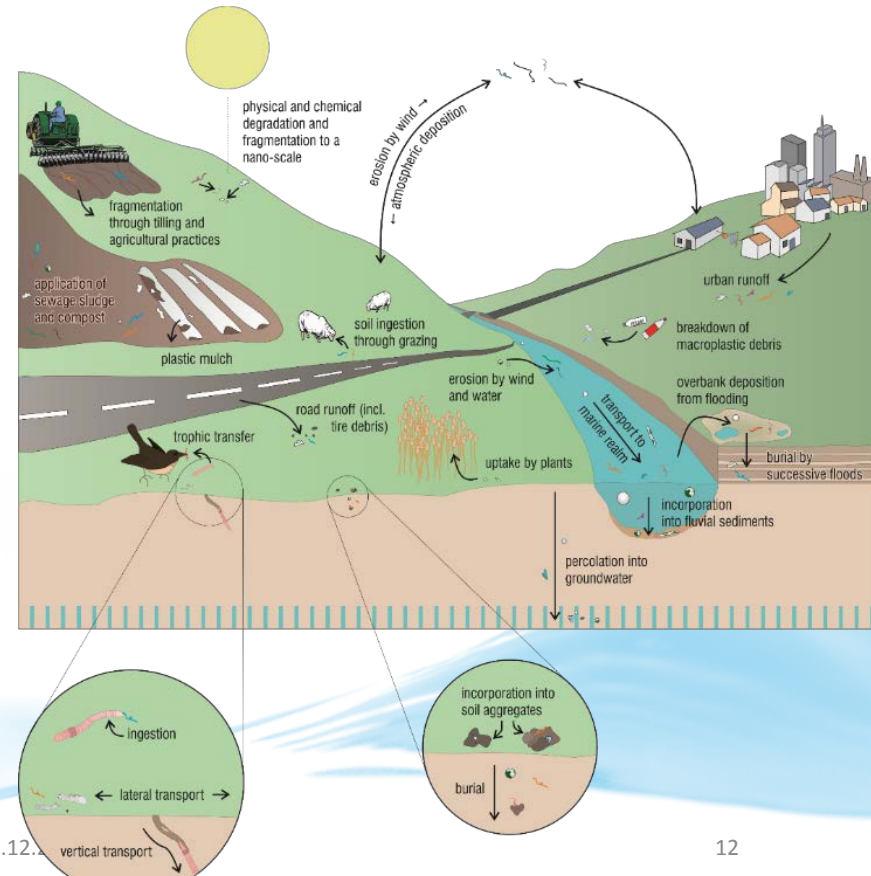
# Key challenges and knowledge gaps

- No two WWTPs are identical:
  - Population equivalent/influent volumes
  - Connectivity of wastewater system
  - Wastewater treatment processes
  - Sludge treatment process
- Sources of microplastics to WWTPs are likely to be numerous and may operate across different temporal timescales
- The effect of different wastewater and sludge treatment processes on determining microplastic concentrations, morphologies, or sizes delivered to sludge is still under-investigated
- The potential to compare between studies is hindered by lack of standardised methodologies
- A full size distribution of plastic particles in sludge has not been established – where nanoplastics may also be relevant

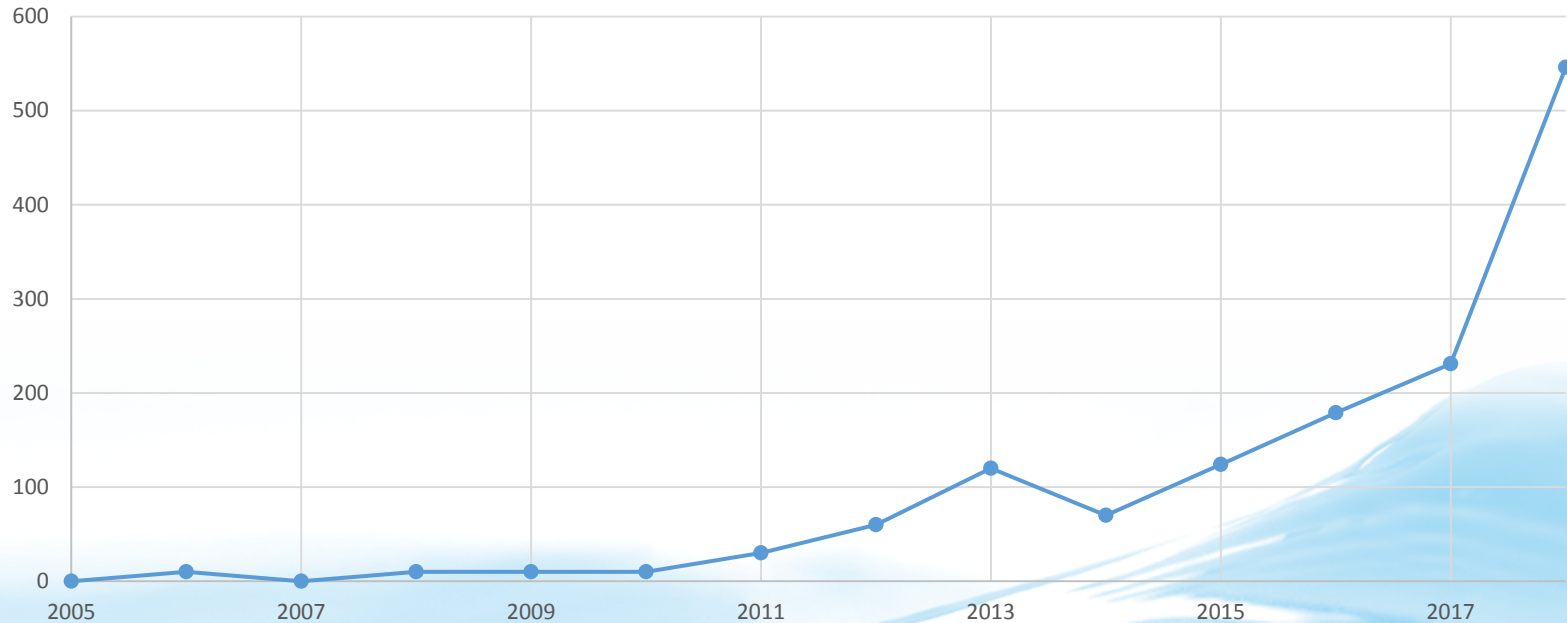
# Impact of microplastic on sludge re-use

The fate of microplastic particles once they have been released into the environment via sewage sludge remains largely unknown

- Potential for transfer to aquatic environments
  - Propagation of contamination across larger spatial scales
- Potential interactions with soil and freshwater biota
- Potential entry of particles or associated contaminants into the human food chain, yet most likely not until nanosized MPs are concerned



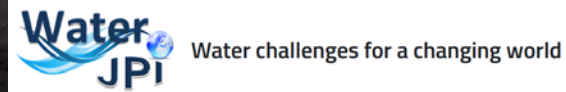
# Google Scholar Number of new science documents found annually containing “microplastics AND sludge”





# Thank you for listening

Supported by:



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