

(Micro)plastics and health



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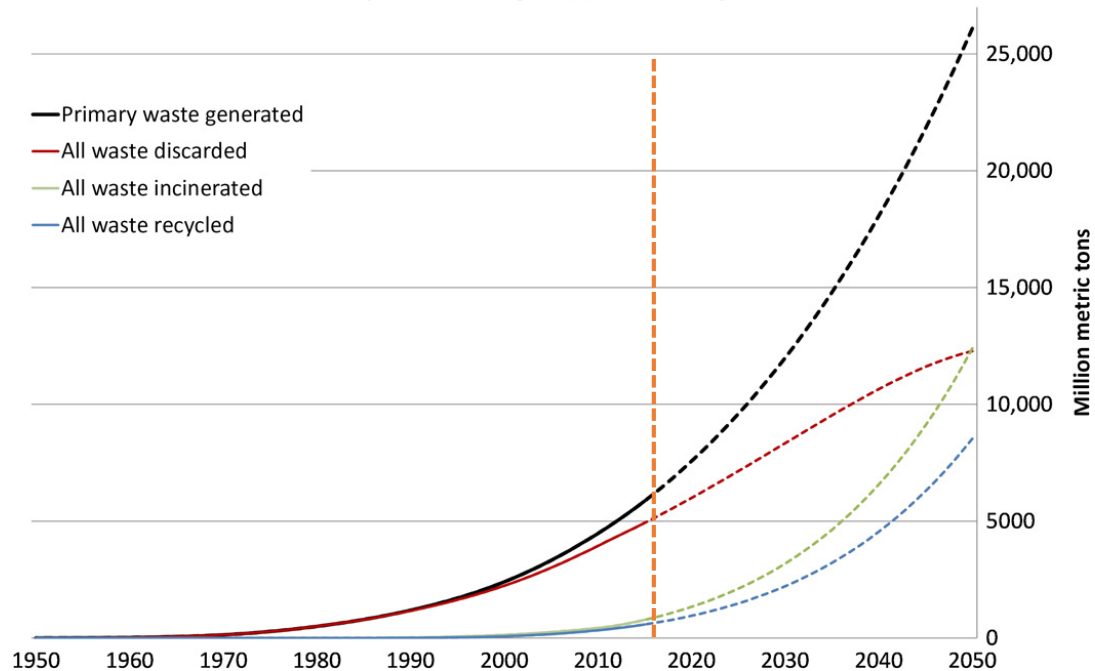
MRC

Toxicology
Unit

A Plastic World



Cumulative plastic waste generation and disposal



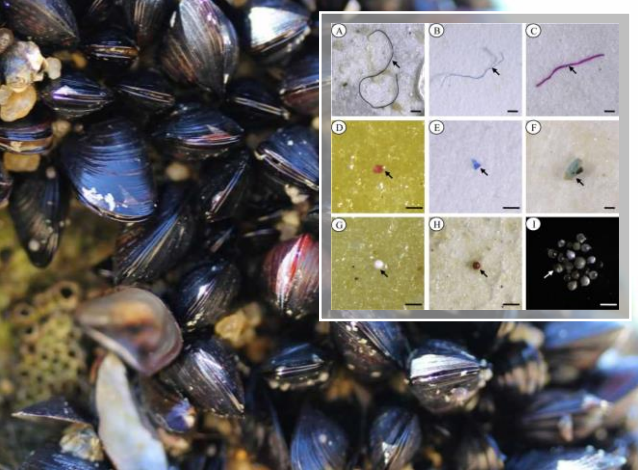
Geyer et al., 2017

A Plastic Ocean



Microplastics: any plastic particle < 1 mm
in size (longest dimension).

Ubiquitous | Secondary | Fibres

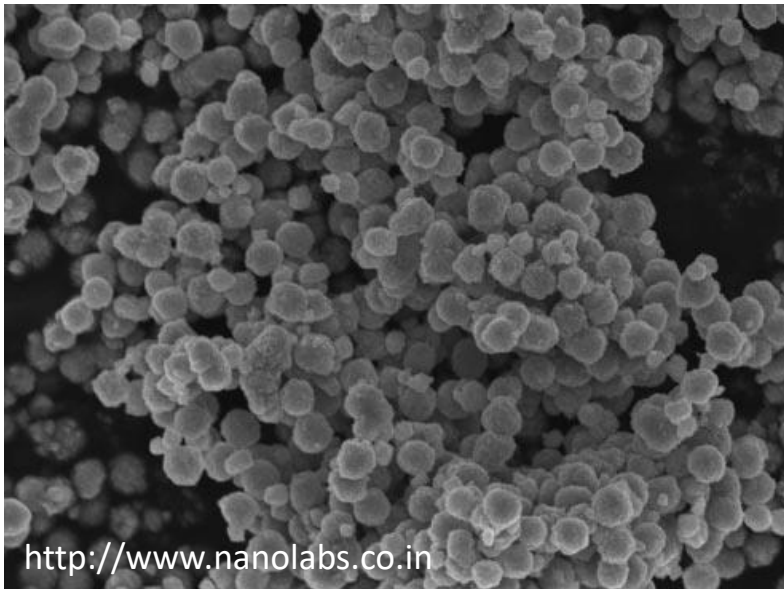


Microplastics in Food

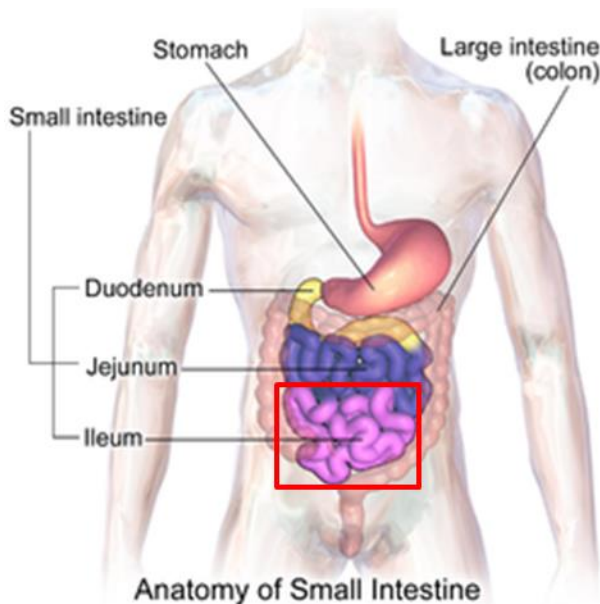
- 100,000/person/yr Chinese shellfish consumer (*Li et al. 2015*)
- 2000/person/yr sea salt (*Kim et al., 2018*)
- 6292/L bottled mineral water (*Ossman et al., 2018*)
 - 691,491/person/yr based on EU consumption statistics (*Statista*)
- 68,416 MP/person/y household dust (*Catarino et al., 2018*)

How Does This Compare?

- Diet: est. 10^{12} – 10^{14} TiO_2 particles ($0.1 - 3 \mu\text{m}$)/person/d via typical Western diet (*Lomer et al., 2004*)



What happens next?



- In rats...
 - Latex beads up to 0.005 mm size (*Le Fevre et al., 1989*) accumulate in Peyer's patches
 - Polystyrene beads (0.00005 mm)...kidney, heart, stomach wall and intestinal wall (*Walczak et al., 2015*)
 - In dogs...
 - PVC particles up to 0.15 mm...blood, bile, urine and cerebrospinal fluid (*Volkheimer 1975*)
 - In humans...
 - Starch particles up to 0.13 mm...blood, urine
 - Low rate (0.002%)
- ...0.13 microplastics/L bottled water...14/y



Plastic in our environment

Synthetic textiles...clothes, furniture, carpets

Synthetic rubber...tires, shoes

Thermoplastic paints

Construction/buildings

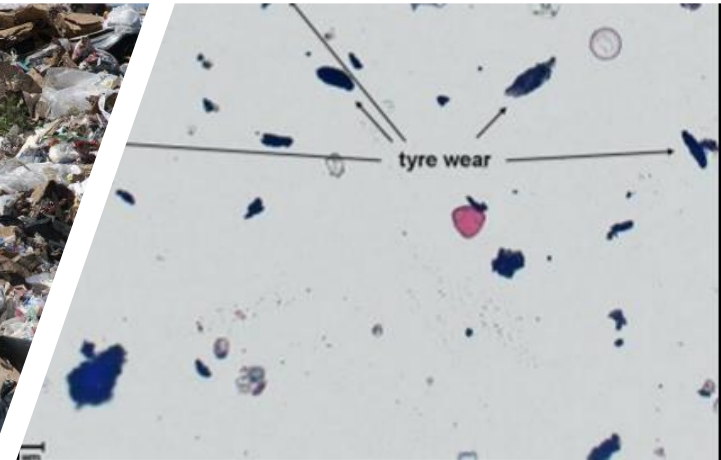
Waste incineration

Landfill

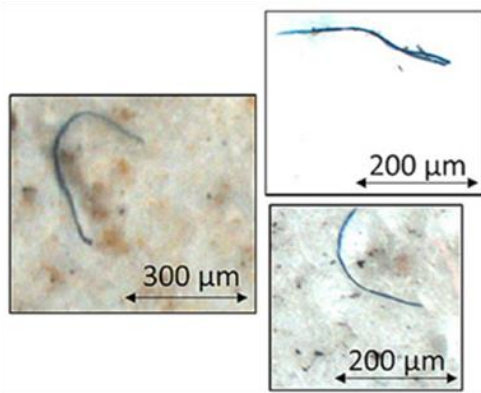
Recycling

Laundry exhausts

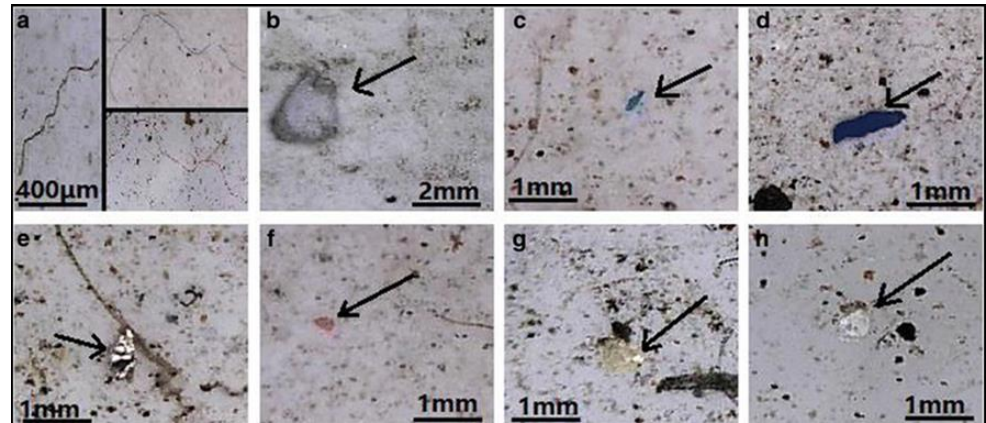
Agriculture



Microplastics in Air



Dris et al. 2016.



Cai et al. 2017.

How Does This Compare?

- Diet: est. 10^{12} – 10^{14} TiO_2 particles ($0.1 - 3 \mu\text{m}$)/person/d via typical Western diet (*Lomer et al., 2004*)
- Inhalation: est. median of 11×10^9 - $\sim 30 \times 10^9$ UFP/ m^3 for Boston (6 o. of. m greater) (*Simon et al., 2017*)
 - Exponential relationship between particle size and abundance
- Gap in knowledge re. microplastic sizes

Only a few studies, still methodologically challenged



What happens next?

- Aerodynamic diameter $\sim 6 \mu\text{m}$ deposited in larger airways
- Aerodynamic diameter $\sim 3 \mu\text{m}$



10 μm polystyrene bead = 10 μm aerodynamic diameter

- Lower airways –
macrophage/slower clearance (1 d) (Carvalho *et al.*, 2011)



Will vary by shape, size and density of the microplastic



23: Large polypropylene fibres showing fibrils formed on the fibre surface

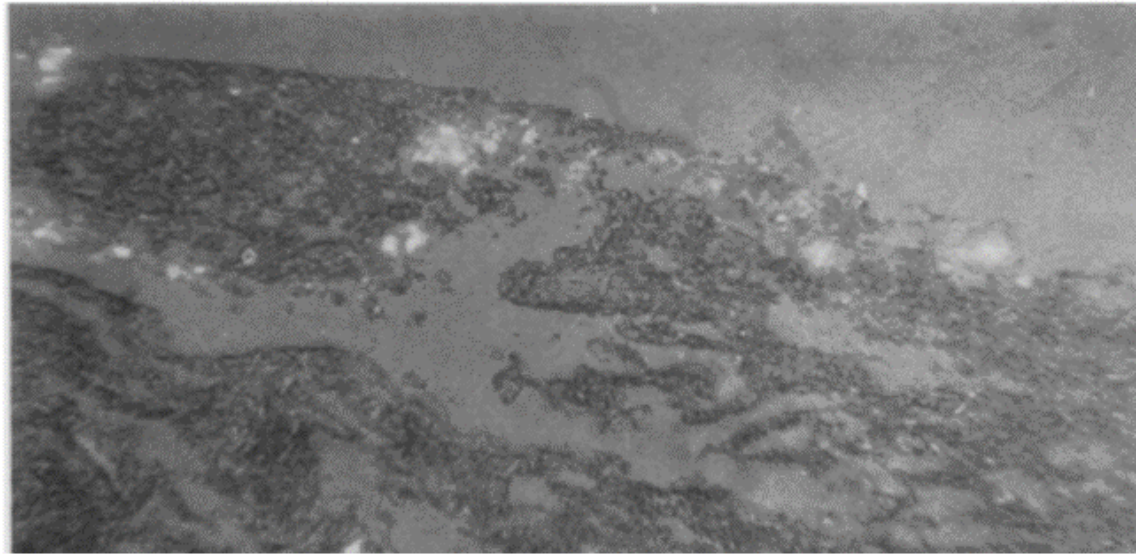
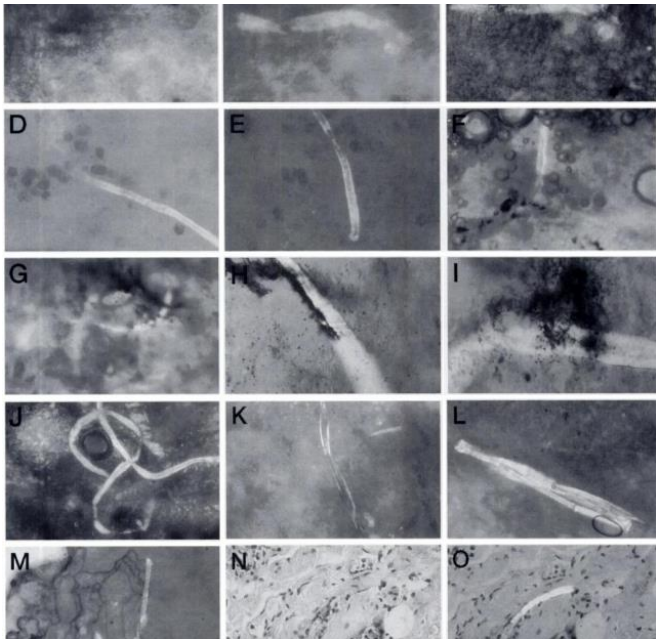


FIG. 10. Case 5. (a) View of a zone of pulmonary lesions. Birefringent inclusions of nylon (polarized light) (H and E $\times 15$). (b) Same area as in (a) after addition of m-cresol



Human Exposure?

Can we capture and identify microplastics in air samples?

Are they small enough to inhale?

What are the sources?

What are the potential health impacts?

UKRI Rutherford Fellow Atmospheric microplastics, their accumulation in vivo and potential toxicity

Are they accumulating in humans?

Impacts?

Physical

Interstitial Lung Disease

- **Flock (nylon) Worker's Lung** (*Kern et al. 1998, 2000, 2003*)
 - Cough; chest pain; infection in the airway; tissue inflammation
- **Other synthetic textiles** (*Pimentel et al., 1975*)
 - Inflammation around acrylic/polyester/nylon dust; respiratory irritation.
- **Plastic prosthetic implant wear debris**

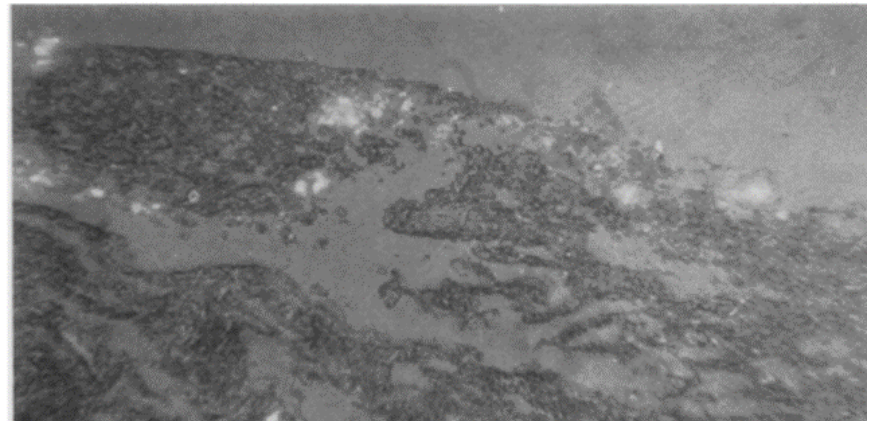


FIG. 10. Case 5. (a) View of a zone of pulmonary lesions. Birefringent inclusions of nylon (polarized light) (H and E $\times 15$). (b) Same area as in (a) after addition of m-cresol.

Impacts?

Chemical

- Unreacted monomers, additives, dyes and pigments
 - MPs ingested via mussels contribute est. 3.4×10^{-5} g BPA/person/y (Rist et al.)
 - ↑ abundance of BPA in mussels (1) due to (4)
 -
 -
- Sorbed HOCs/metals...particles!
 - Microplastic ingestion via 225 g Chinese mussels – 0.006% ↑ PCBs and 0.004% ↑ PAHs (EFSA, 2016)

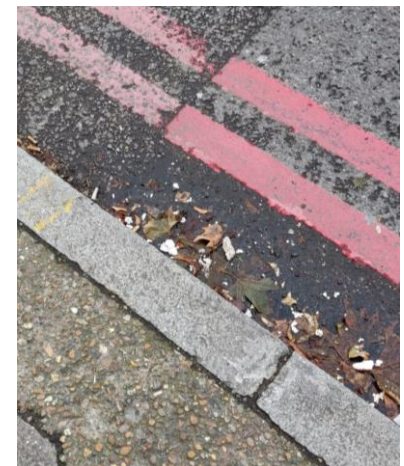
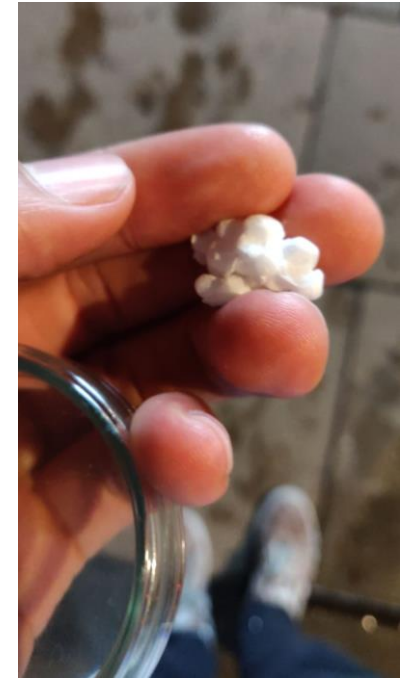
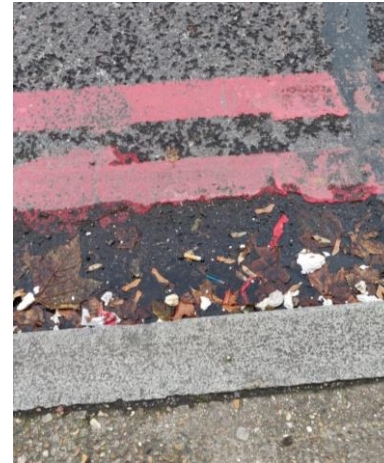


Summary

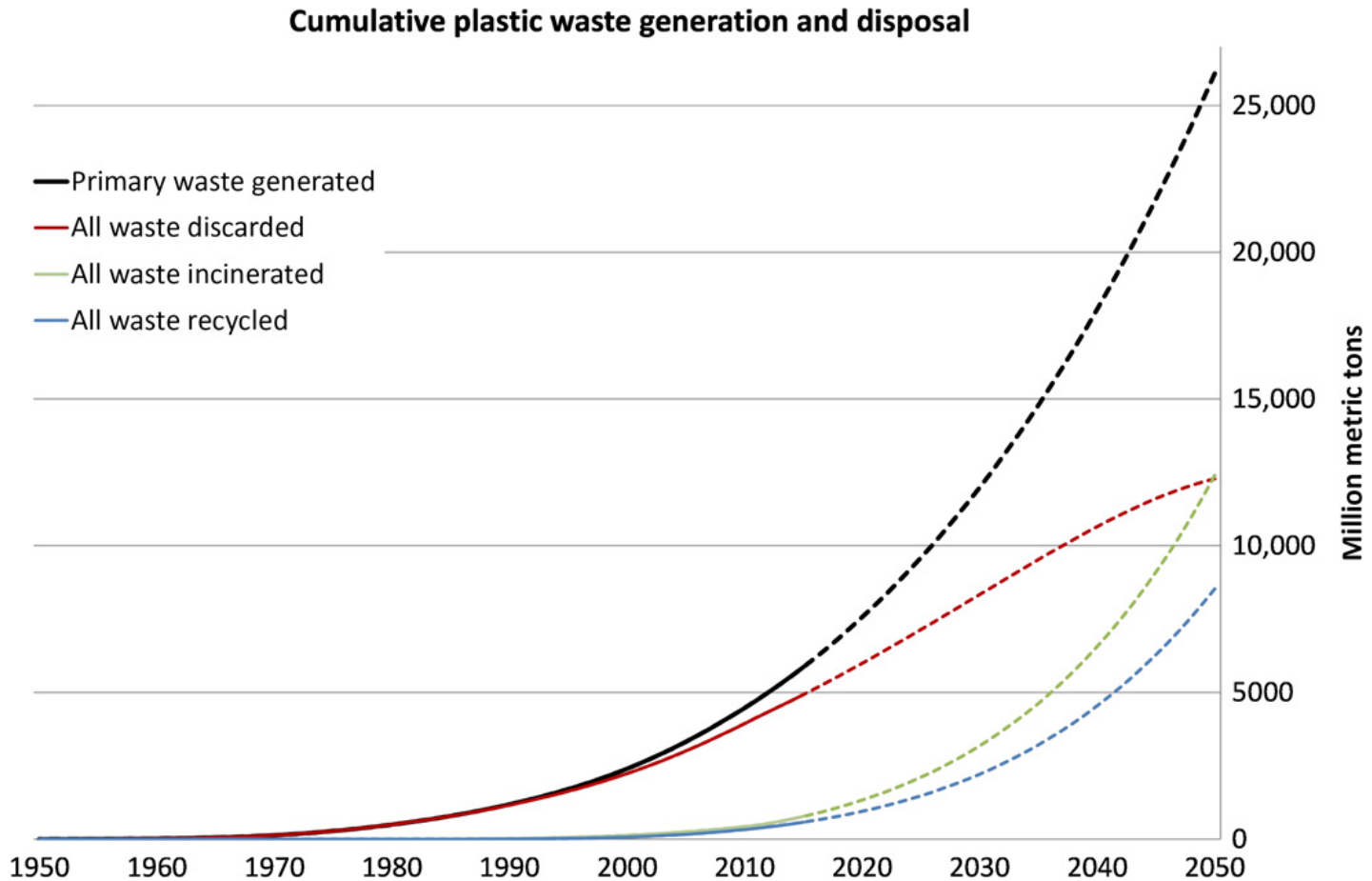
- Sparse evidence for dietary and airborne microplastic exposure
- Different modes of particle uptake are plausible, although unstudied for representative microplastics
- Nano-PS distributes beyond portal of entry to secondary tissues
- Exposures (18 months +) to high concentrations cause occupational lung disease
- Plastic wear debris causes inflammation in joint tissues
- Potential contribution to chemical additive burden?

Can the construction industry help?

- Range of sources on-site, with potential for microplastic emissions
- Microplastics added to building materials
 - Polyacrylonitrile



Is plastic a health crisis?



Geyer et al., 2017

Thank you

KCL

Prof Frank Kelly
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Mr Joseph Levermore
Dr Ana Oliete

MRC Toxicology Unit

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Prof Marion MacFarlane
Dr John Le Quesne

PHE

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Dr Tim Gantt

