

# MITIGATING MICROPLASTIC POLLUTION THROUGH INNOVATIVE RESEARCH APPROACHES

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# Mitigating plastic pollution requires navigating the space between science and policy

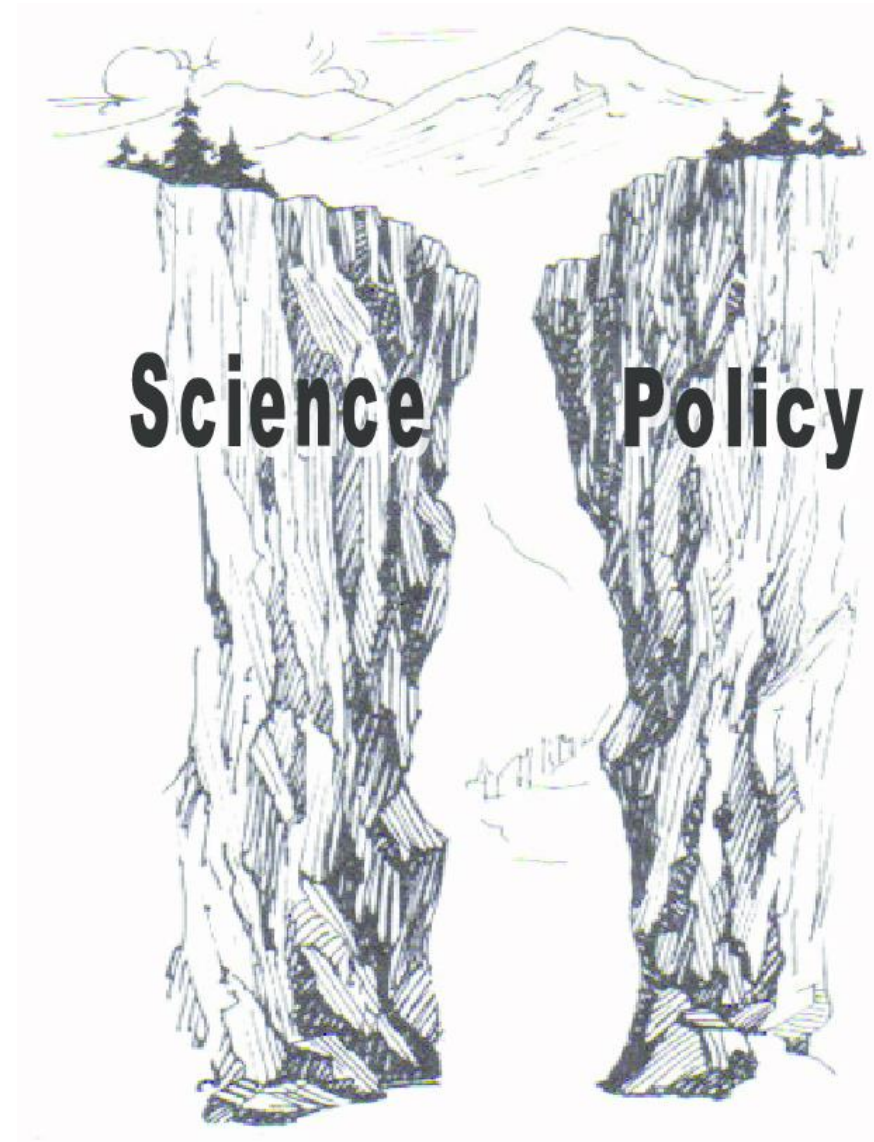
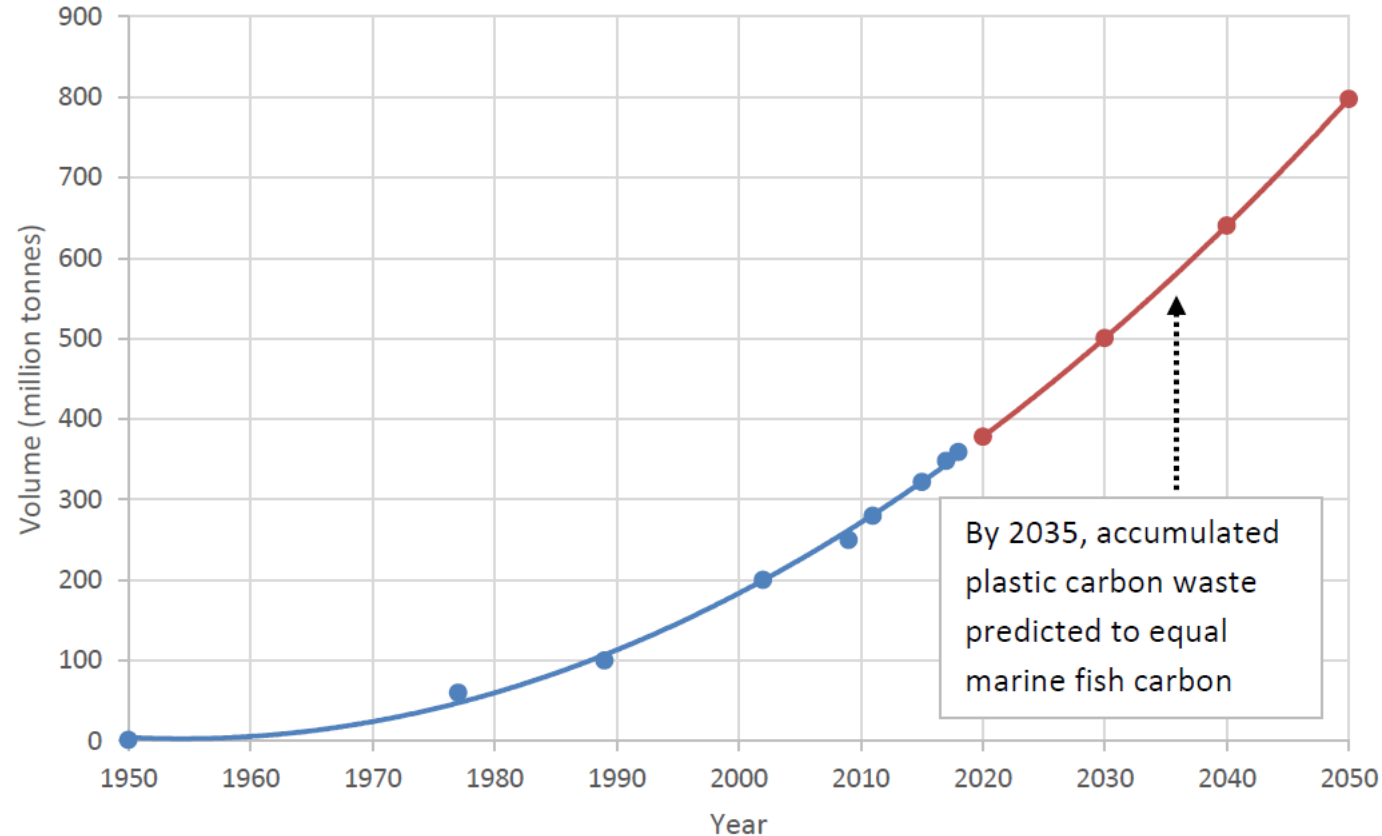


Photo source: "Bridging the science policy interface: A new era for South African research and the role of knowledge brokering".

# Plastics production outpaces recycling



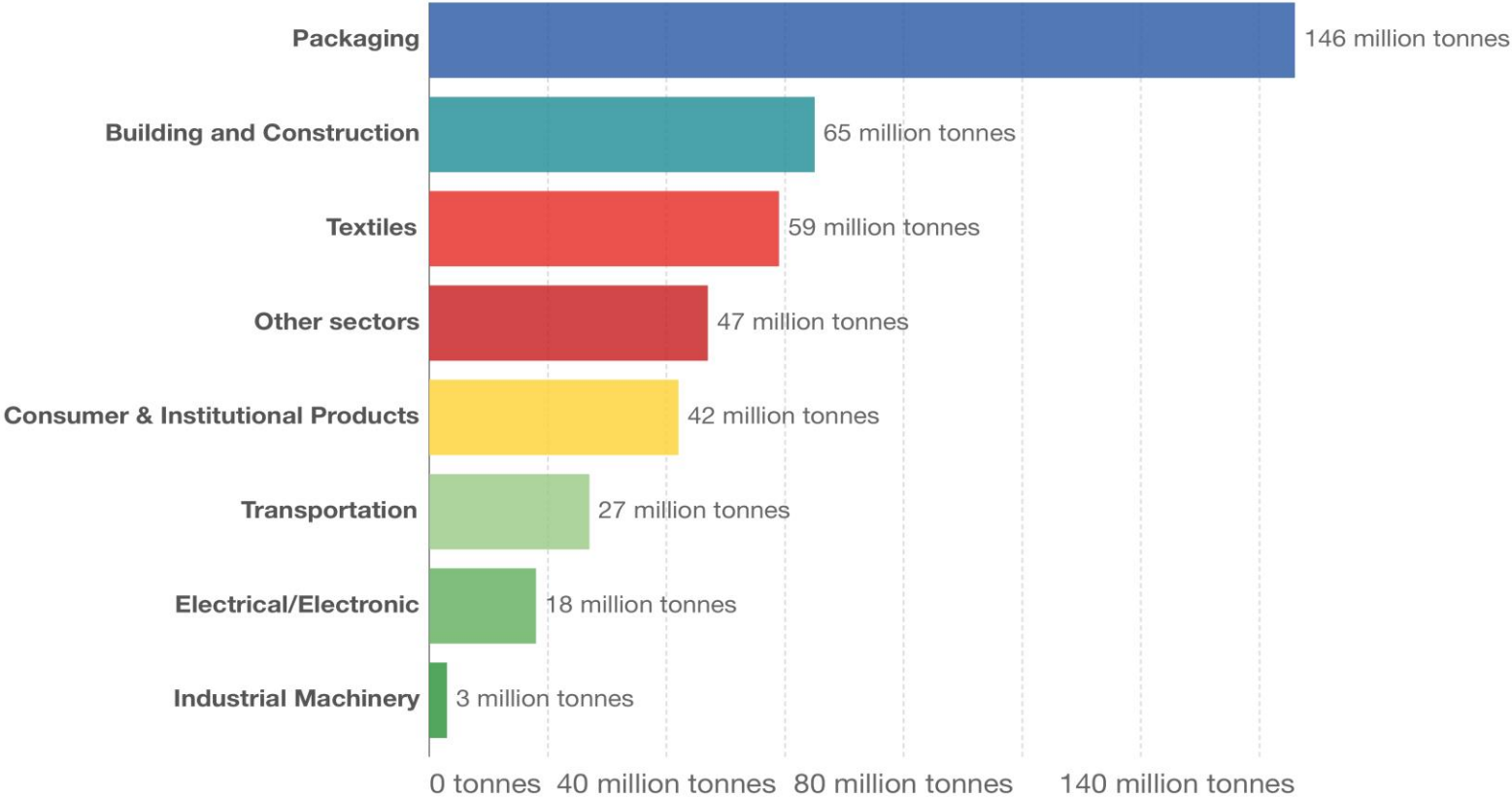
- Global plastics production has been growing exponentially since the 1950s
- Less than 9% of all plastics produced is recycled (OECD 2022)

Global production volume of plastics. Data; 1950 to 2016 (Plastics Europe 2016); 2017-2018 (Plastics Europe (2019)). Forecast 2020 to 2050 (Rouch, D. 2021)

# Plastics are ubiquitous in daily life

## Primary plastic production by industrial sector, 2015

Primary global plastic production by industrial sector allocation, measured in tonnes per year.



Geyer et al. (2017) *Science Advances* 3, 1700782.

# Potential ecological and human health impacts



<https://www.rollingstone.com/culture/culture-features/plastic-problem-recycling-myth-big-oil-950957/>

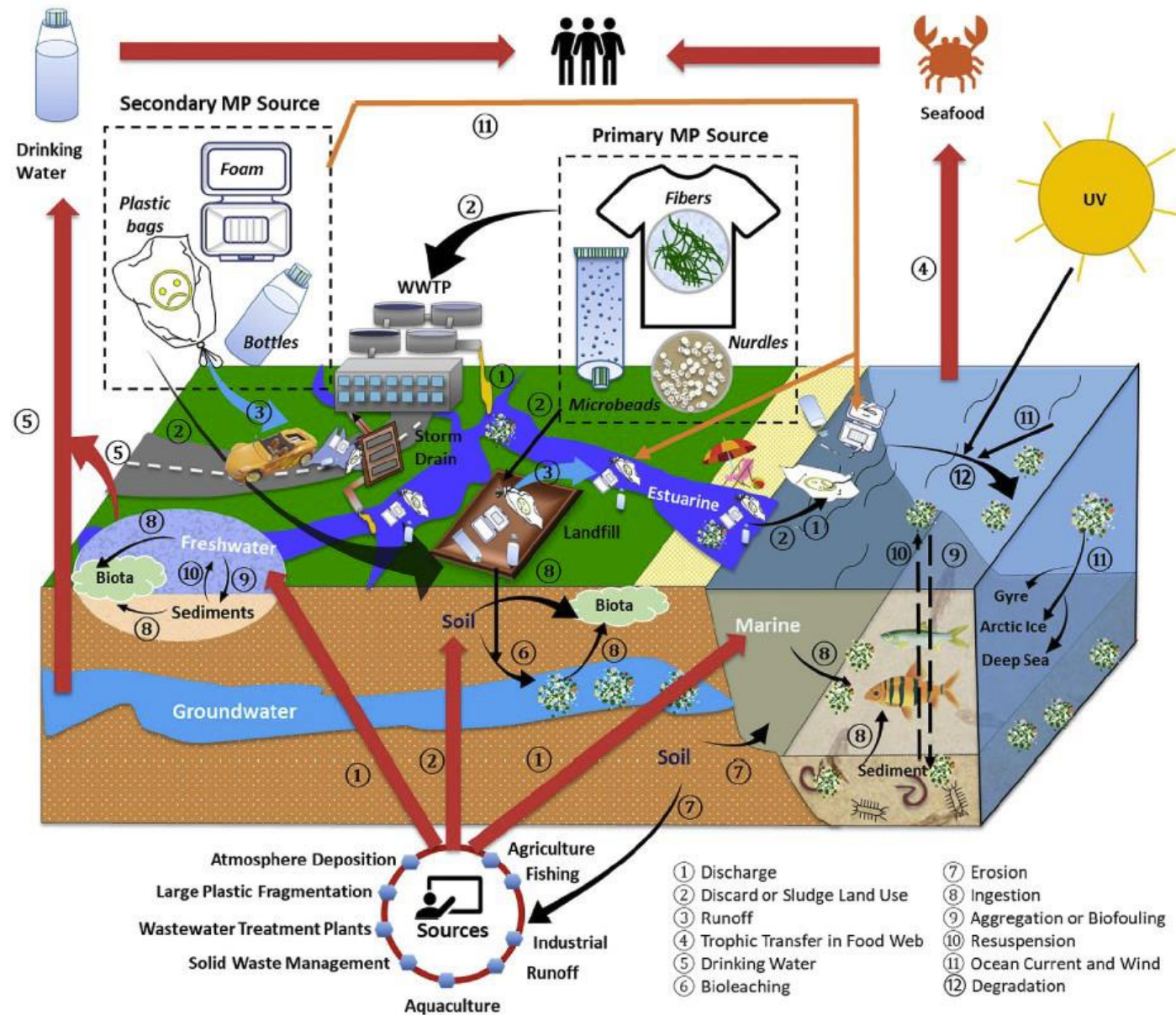
- If plastic pollution continues at the current rate, by 2050 there will be more plastic than fish in the oceans
- The average person eats 70,000 microplastics each year (Catarino et. al 2018)
- Plastic particles have been found in human blood and placentas
- Nanoplastics are cause for concern for human health

Shi et al. (2022) Toxicity *in vitro* reveals potential impacts of microplastics and nanoplastics on human health: A review. *Critical Reviews in Environmental Science and Technology*, **52**, 3863-3895, DOI: [10.1080/10643389.2021.1951528](https://doi.org/10.1080/10643389.2021.1951528).

European Chemicals Agency: <https://echa.europa.eu/documents/10162/05bd96e3-b969-0a7c-c6d0-441182893720>

# RESEARCH GAPS

# Plastics cycle

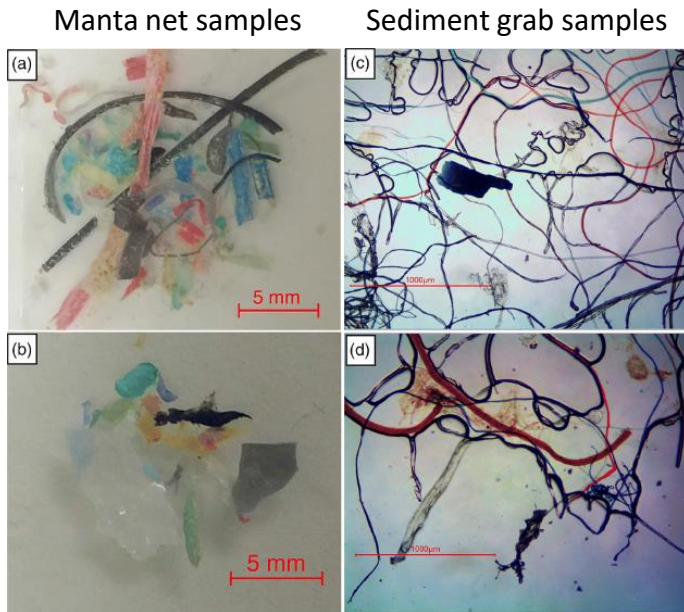
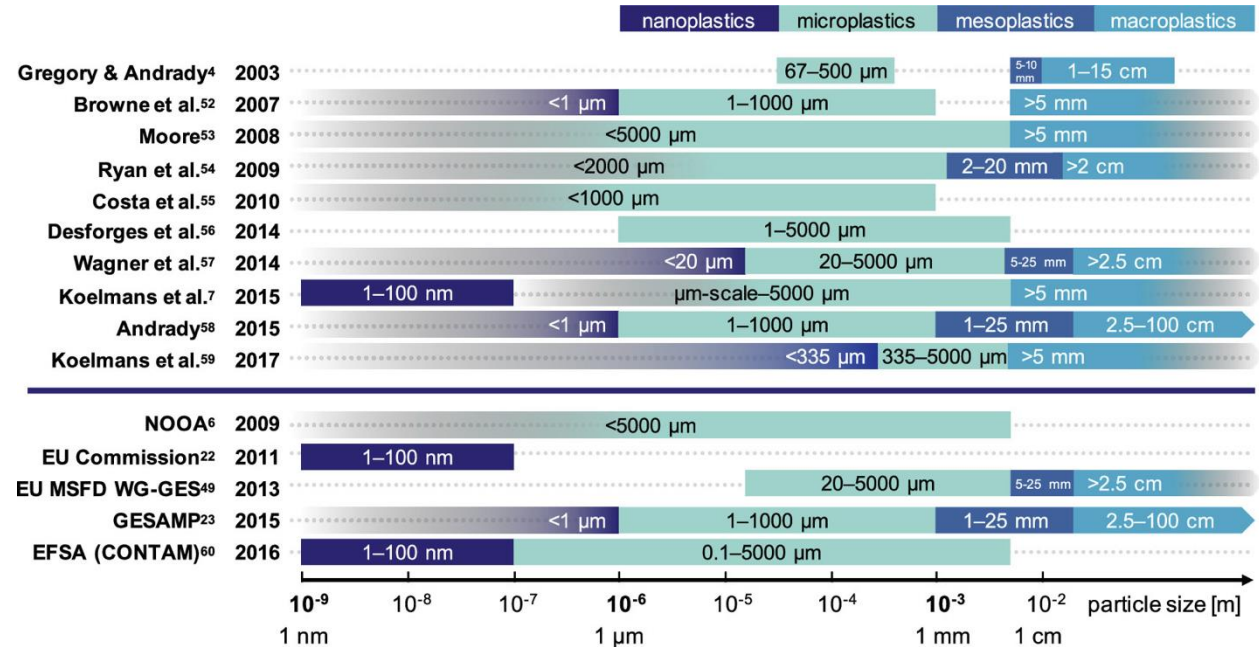


Rouch, D. A. (2021) Plastic future: How to reduce the increasing environmental footprint of plastic packaging. Working Paper No. 11, Clarendon Policy & Strategy Group, Melbourne, Australia.

# No universally accepted definition of size and shape

Most commonly used:

- Microplastics:  $\leq 5 \mu\text{m}$  (1 mm)
- Nanoplastics:  $\leq 1 \mu\text{m}$  (0.1  $\mu\text{m}$ )



Ottawa River: Vermaire et al. (2017) *FACETS* 2, 301-314.

fibers  
fragments  
beads  
films  
foams

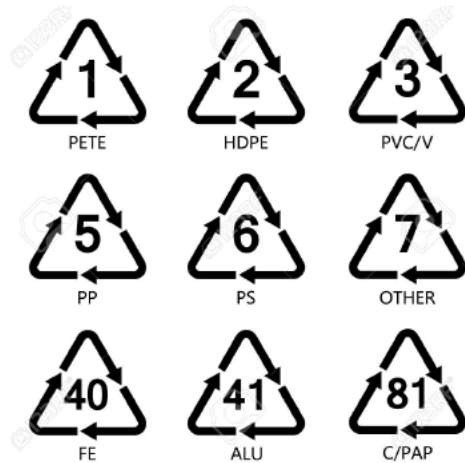


Typically decreasing abundance  
in soils and sediments



# Plastic composition provides clues to origin

## Human-made material



+

### Additives:

- functional
- colorants
- fillers
- stabilizers

+

## Environmental modifications

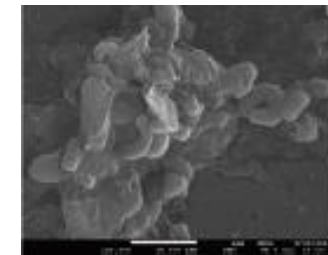
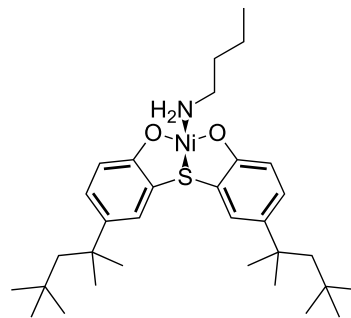
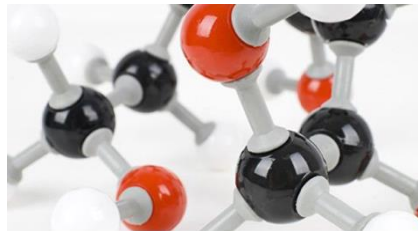
### Sorbates:

- organics
- metals
- pathogens

+

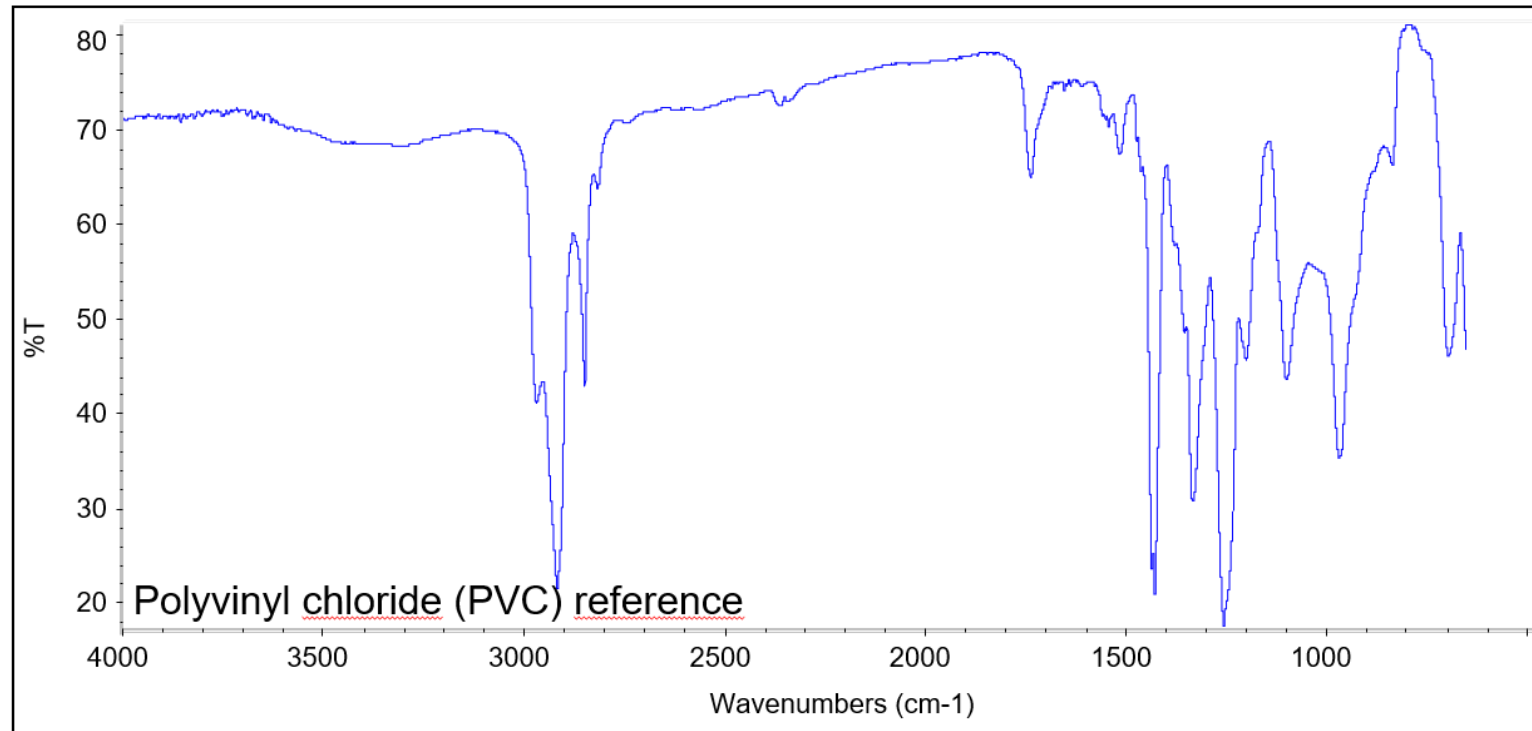
### Aggregates:

- minerals
- EPS
- biofilms



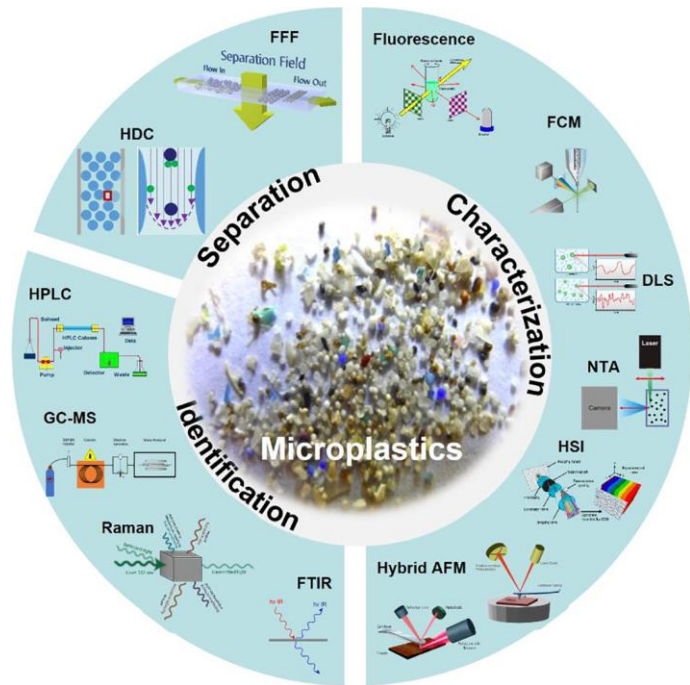
"plastic sphere"

# Fingerprinting to determine source



FTIR-spectrum for polyvinyl chloride (PVC).

# Multiple techniques for characterization & identification



## Most common methods

Technique	Advantages	Drawbacks
Optical techniques	Easy, inexpensive	Time- and labor-intensive consuming, no data on chemical composition
FT-IR spectroscopy	Non-destructive, fast, reliable, detection limit $\sim 20 \mu\text{m}$ , databases on polymers	Expensive, highly trained personnel
Raman spectroscopy	Non-destructive, smaller particles (1- 20 $\mu\text{m}$ ), fast chemical mapping	Expensive, highly trained personnel
Pyrolysis-gas chromatography	Fast identification, databases on polymer composition and additives	Expensive and destructive

\*Fu W. et al. (2020) *Sci. Total Environ.* **721**, 137561.

Koyuncuoğlu P. and Erden G. (2021) *Environ. Monit. Assess.* **193**, 175.

Caputo F. et al. (2021) *J. Colloid Interface Sci.* **588**, 401-417.

# Data reporting & data management

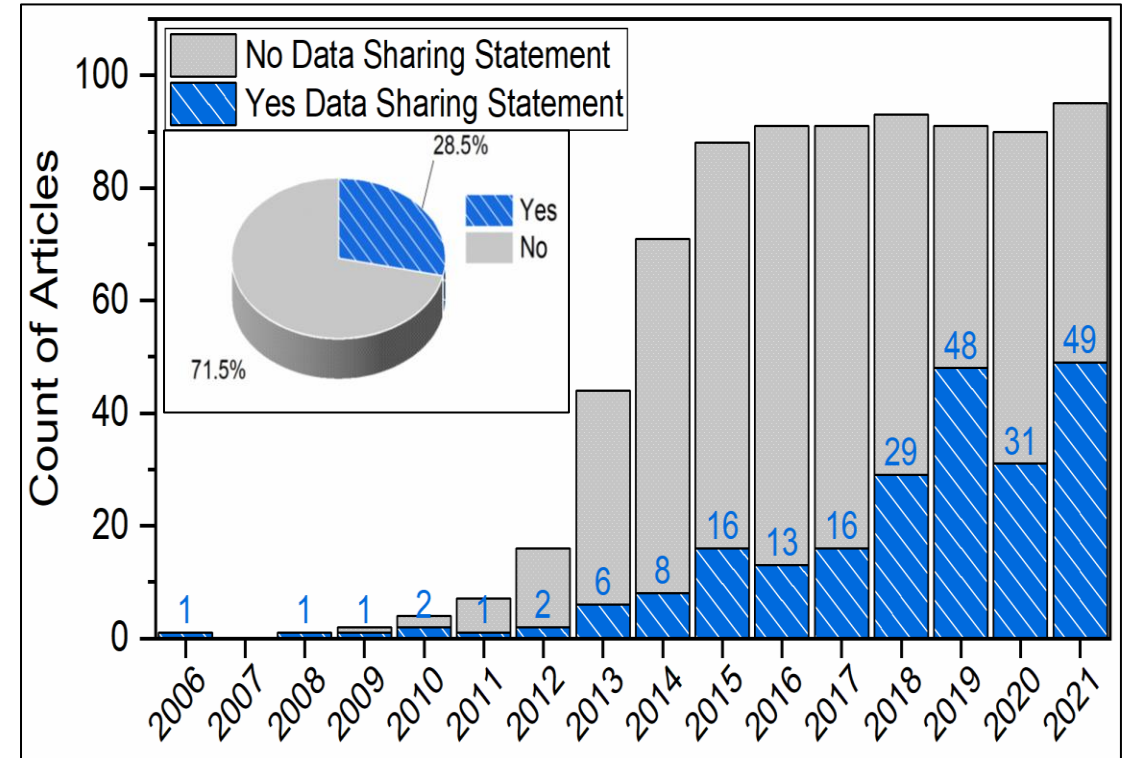


## Metadata

- Field sampling
- Sample preparation

+

- Abundance
- Mass concentration
- Size, shape and color
- Surface morphology
- crystallinity
- Polymer identification
- Additives
- Sorbates



Jenkins T. et al. (2022) Current State of Microplastic Pollution Research Data: Trends in Availability and Sources of Open Data. *Frontiers in Environmental Science*, 10:912107

# Implications for science policy

- Many different methods (comparing apples and oranges ...?)
- Lack of standardization in metadata & data reporting (what, how, and where)

Hence...

- Hinders comparability, reproducibility, reuse of microplastics data
- Complicates translation scientific results into policy/regulation

## **Premature or precautionary? California is first to tackle microplastics in drinking water**

California is poised to issue the world's first guidelines for microplastics in drinking water despite no data on how plentiful they are in the state, no scientific agreement on how to test water for them and little research on their health risks.

CALmatters, March 15, 2021, updated August 3, 2021

<https://calmatters.org/environment/2021/03/california-microplastics-drinking-water/>



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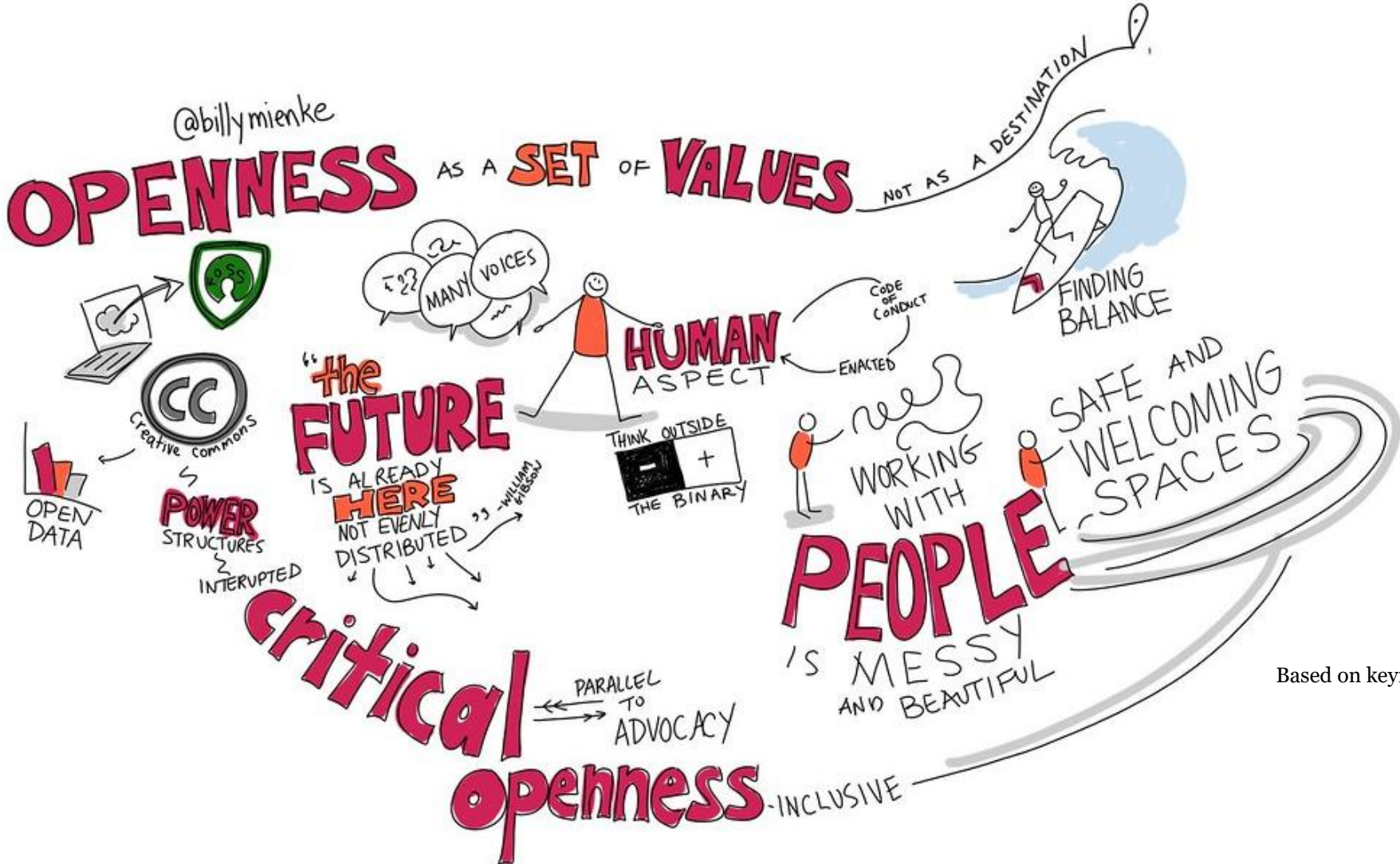
# **STRATEGIES FOR NAVIGATING ACADEMIC-PRACTITIONER PARTNERSHIPS**

# 1. Establish Mutual Understanding



Flickr @ Dean Wissing

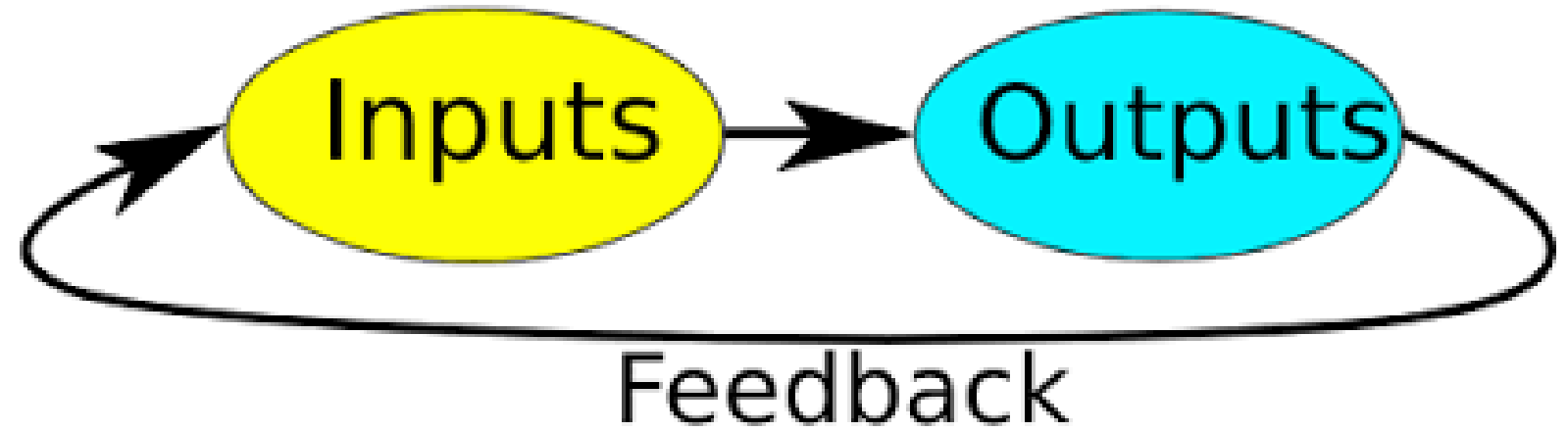
# Establish a culture of openness



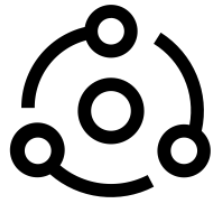
Based on keynote from @BillyMeinke



# Be patient and provide feedback



# Practical tips



## Connect

Set expectations early; meet regularly



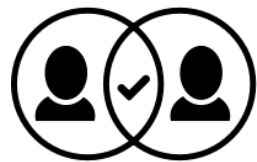
## Ask Questions

Practitioners: ask lots of questions



## Respond

Researchers: respond in a timely manner



## Dialogue

Leave lots of time for conversation and dialogue



## Knowledge brokers

Facilitate relationship building



## Listen

Demonstrate value of input received

The background features a dark grey fingerprint pattern. On the left, there is a blue-tinted image of a person in a white lab coat and gloves, holding a glass vial. In the center, a plastic bottle is depicted as a cluster of small blue dots, with more dots falling from its base. Below the bottle, a blue circular area contains a black silhouette of a map of Canada. The title 'Microplastics Fingerprinting' is written in large, bold, white sans-serif font on the right side of the fingerprint background.

# Microplastics Fingerprinting

**Learn more and subscribe to our newsletter**

<https://uwaterloo.ca/microplastics-fingerprinting-research-project>

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Get in touch!  
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