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UK Research and Innovation

Plastics in the Environment: Knowledge Sharing Workshop

Perspectives on airborne microplastic policy needs

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18/12/24

BRISTOL GREEN CAPITAL PARTNERSHIP

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UNIVERSITY OF LEEDS

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- Brief overview of airborne microplastics
- Potential health implications
- Sampling: Passive and Active
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Airborne Microplastics

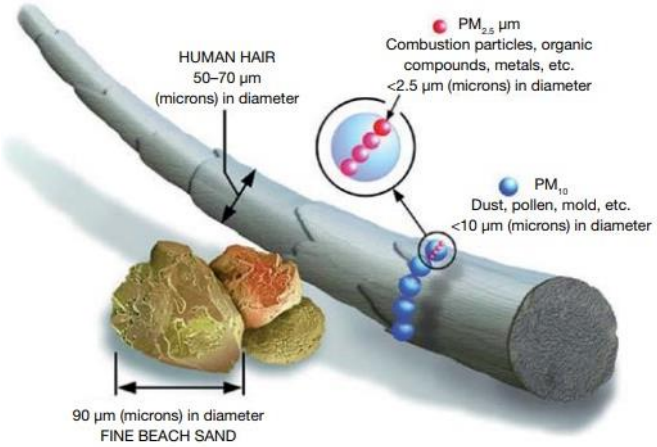
- Found in the Arctic and the Alps (Bergmann et al., 2019).
- Found in both indoor and outdoor air samples (Gasperi et al., 2018).
- Thought to contribute to a small amount of radiative forcing (Revell et al., 2021)
- Microplastics and microrubbers from tyres considered to be a significant source of microplastics to the environment (Kole et al., 2017), including to the air.
- Largely a focus on ambient outdoor air, not much research indoors.

https://www.forcepoint.com/blog/insights/cloud-vs-on-prem

Health implications?

- Inhalation has been associated with health risks such as Chronic Obstructive Pulmonary Disease (Catarino et al., 2018; Dong et al., 2020).
- Presence of non-mineral fibres, including plastic, in lung tissue specimens (Pauly et al., 1998).
- Studies detected microplastics in all regions of human lung tissue (Jenner et al., 2021, breast milk (Ragusa et al., 2022), testis (Zhao, 2023) and in human blood (Leslie et al., 2022).
- Some particles >100µm. How?
- Some journals now limiting studies on microplastic presence, now want accompanying effects.

- Most studies use pristine polystyrene spheres, not reflected in the environment



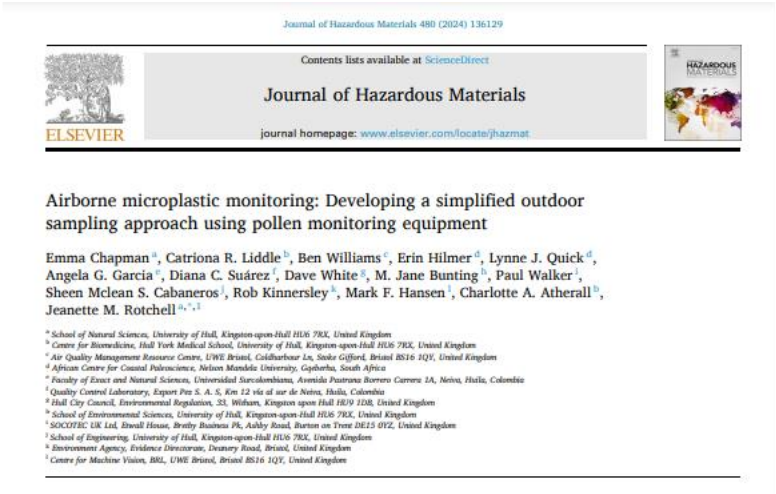
https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

Sampling Approaches: Passive

- Bottles, bowls, bespoke samplers (Klein and Fischer, 2019)
- Rain gauges (Wright et al, 2020)
- Collecting typically for 1 day to 1 month per sample.
- Other passive samplers, e.g. Frisbee Samplers, yet to be explored

http://www.hanby.co.uk/Bergerhoff%20Gauge.htm

Postma, 2022



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Airborne microplastic monitoring: Developing a simplified outdoor sampling approach using pollen monitoring equipment

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Sampling Approaches: Active

- Active sampling instruments used in microplastic studies are typically routine for air quality measurement
- Include TSP or size selective inlets, cascade impactors (Kernchen et al. 2022), and cyclone samplers (Levermore et al. 2020).
- Further opportunities with established instruments, e.g. BAM.
- With both active and passive sampling approaches, extraction and characterisation processes will vary.
- Can learn from the Air PT Scheme for diffusion tube analysis.

https://andersencascading.com/types-of-impactors/8-stage-non-viable-aci-andersen-cascading-impactor/

https://uk-air.defra.gov.uk/networks/site-info?site_id=POAR

Analytical approaches and challenges

Approaches

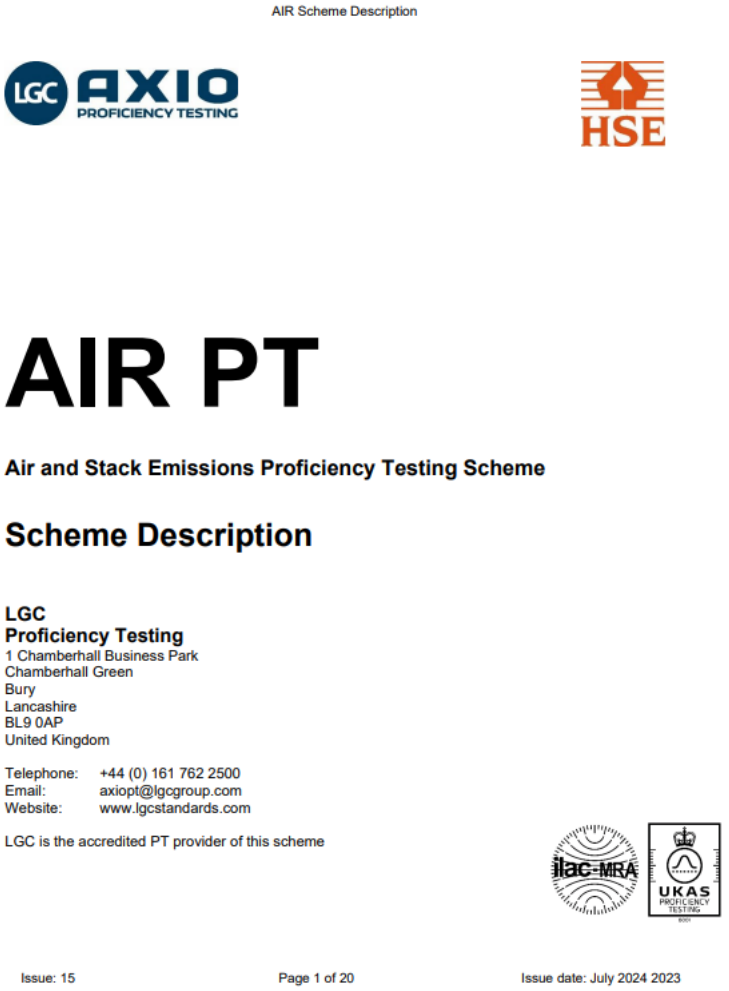
- Optical
  - Microscopy: >100µm
  - SEM-EDS: <1µm
- Infrared or near-infrared micro-spectroscopy
  - FTIR
  - Raman
- Thermal methods
  - Py-GC-MS
  - TD-GC-MS
- Real-time?
  - Potential for SIBS/WIBS (current use for bioaerosols)

Challenges

- Optical characterisation fine for larger particles, not particularly well-suited for widespread characterisation of particles <10 µm
- Similar challenges with Infrared <2.5 µm, particularly with complex matrices, but doable
- Current passive collection methods not suitable for health-based assessments.
- Laboratories have many sources of MNPs (Jones et al., 2024)

Air And Stack Emissions Proficiency Testing

- Testing is independent of any laboratory using the scheme
- Aim is to monitor laboratory performance and compare with their peers.
- AIR PT also aims to provide information to participants on technical issues and methodologies relating to testing of these test materials.



AIR Scheme Description

LGC AXIO PROFICIENCY TESTING

HSE

AIR PT

Air and Stack Emissions Proficiency Testing Scheme

Scheme Description

LGC
Proficiency Testing
1 Chamberhall Business Park
Chamberhall Green
Bury
Lancashire
BL9 0AP
United Kingdom

Telephone: +44 (0) 161 762 2500
Email: axiopt@lgcgroup.com
Website: www.lgcstandards.com

LGC is the accredited PT provider of this scheme

ilac-MRA UKAS PROFICIENCY TESTING

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https://tinyurl.com/2usu6ues

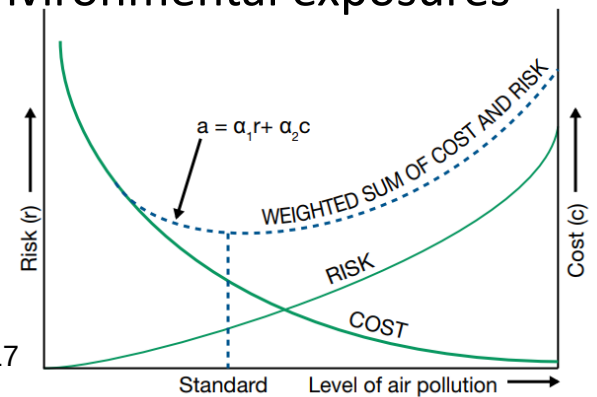
Research required to support policy development

Sources

- Identify key sources of airborne microplastics
  - Any key locations?
  - Any key materials?
- Refine spatio-temporal variation in microplastics concentrations, including seasonal and meteorological variations
- Increase measurements in the <10µm and 2.5µm fraction
- Any key interactions with other pollutants and chemicals?

Health impacts

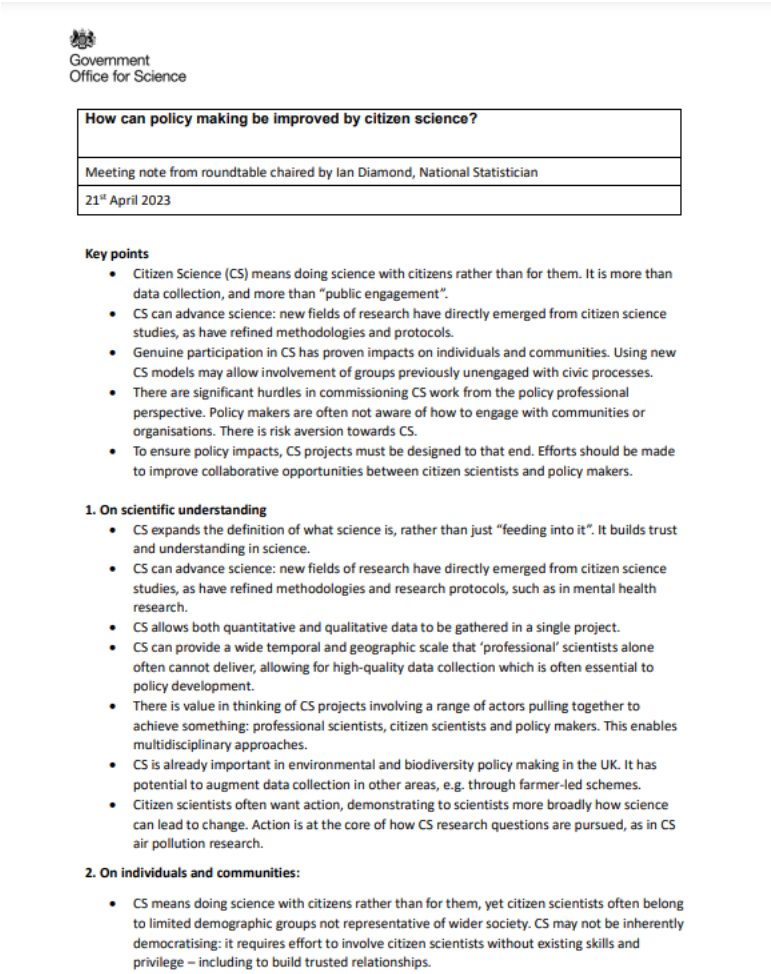
- Broaden the range of microplastic polymers, shapes, concentrations to better understand toxicological impact
- Better understand dose/response
- Explore additive effects of associated chemicals
- Make studies relevant to environmental exposures



WHO, 2017

‘Citizen Science’ and its value to policymaking

- Multiple definitions without a settled description, often described as Participatory research, community research.
- It’s not just public engagement and can go beyond just data collection.
- Citizen Science allows us to build broader trust in science
- Co-creation allows research to be done with citizens, instead of ‘for’ or ‘to’ them
- Ca. 50-60% of studies provide research grade data (Aceves-Bueno et al., 2017)



Government
Office for Science

How can policy making be improved by citizen science?

Meeting note from roundtable chaired by Ian Diamond, National Statistician

21st April 2023

Key points

- Citizen Science (CS) means doing science with citizens rather than for them. It is more than data collection, and more than “public engagement”.
- CS can advance science: new fields of research have directly emerged from citizen science studies, as have refined methodologies and protocols.
- Genuine participation in CS has proven impacts on individuals and communities. Using new CS models may allow involvement of groups previously unengaged with civic processes.
- There are significant hurdles in commissioning CS work from the policy professional perspective. Policy makers are often not aware of how to engage with communities or organisations. There is risk aversion towards CS.
- To ensure policy impacts, CS projects must be designed to that end. Efforts should be made to improve collaborative opportunities between citizen scientists and policy makers.

1. On scientific understanding

- CS expands the definition of what science is, rather than just “feeding into it”. It builds trust and understanding in science.
- CS can advance science: new fields of research have directly emerged from citizen science studies, as have refined methodologies and research protocols, such as in mental health research.
- CS allows both quantitative and qualitative data to be gathered in a single project.
- CS can provide a wide temporal and geographic scale that ‘professional’ scientists alone often cannot deliver, allowing for high-quality data collection which is often essential to policy development.
- There is value in thinking of CS projects involving a range of actors pulling together to achieve something: professional scientists, citizen scientists and policy makers. This enables multidisciplinary approaches.
- CS is already important in environmental and biodiversity policy making in the UK. It has potential to augment data collection in other areas, e.g. through farmer-led schemes.
- Citizen scientists often want action, demonstrating to scientists more broadly how science can lead to change. Action is at the core of how CS research questions are pursued, as in CS air pollution research.

2. On individuals and communities:

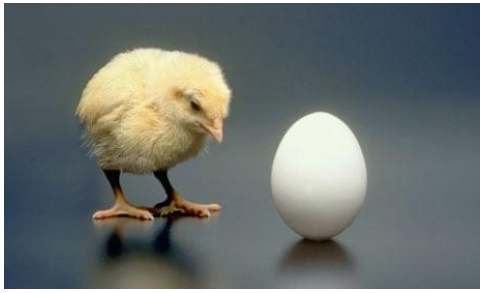
- CS means doing science with citizens rather than for them, yet citizen scientists often belong to limited demographic groups not representative of wider society. CS may not be inherently democratising: it requires effort to involve citizen scientists without existing skills and privilege – including to build trusted relationships.

Perfect

Imperfect

https://tinyurl.com/4rveh4wn

A step on the policy pathway



https://www.theguardian.com/science/2010/jul/18/chicken-and-egg-conundrum-solved

Define Evidence Need

The method by which airborne microplastics are collected will likely vary by policy need.

Develop Appropriate Methodologies

Appropriate sampling methodologies, verified via field intercomparison exercises, should be undertaken to support comparable and robust measurement.

Laboratory standardisation

Laboratory standardisation and regular contamination reviews, similar to the Air NO_2 PT Scheme should accompany robust field measurements

Cautionary tale from air pollution policymaking

- CO_2 from vehicles identified as a significant contributor to climate change
- Significant research and media interest in the problem and a need to resolve it, ca. 2000.
- In 2001, government introduce Vehicle Excise Duty (VED) sliding scale encouraging lower CO_2 vehicle purchases
- Caused a rise in diesel vehicle sales, increasing NO_2 concentrations.
- 2012 IARC declared diesel exhaust emissions as carcinogenic.

International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 213

12 June 2012

IARC: DIESEL ENGINE EXHAUST CARCINOGENIC

Lyon, France, June 12, 2012 -- After a week-long meeting of international experts, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO), today classified diesel engine exhaust as **carcinogenic to humans (Group 1)**, based on sufficient evidence that exposure is associated with an increased risk for lung cancer.

The last straw: Characterization of per- and polyfluoroalkyl substances in commercially-available plant-based drinking straws

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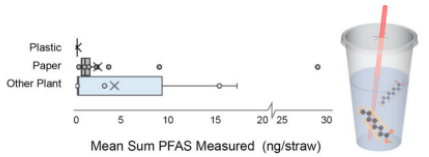
Center for Environmental and Human Toxicology, Department of Physiological Sciences, University of Florida, USA

HIGHLIGHTS

- Per- and polyfluoroalkyl substances were found in plant-based drinking straws.
- Both short- and long-chain species were detected.
- PFOS and PFOA were detected repeatedly despite voluntary phase-out in the US.
- Some compounds leached into water at different temperatures.
- Most plant-based straws are not a fully biodegradable alternative to plastic.

GRAPHICAL ABSTRACT



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PFAS leaching

abstract

Paper and other plant-based drinking straws are replacing plastic straws in commercial settings in response to trending plastic straw bans and the larger global movement for reducing plastic pollution. The water-resistant properties of many plant-based straws, however, may be attributed to the use of per- and polyfluoroalkyl substances (PFAS) during manufacturing. In this study, 43 brands of straws (5 plastic, 29 paper, 9 other plant-based) were analyzed for the presence of 53 semi-volatile PFAS using ultra high-performance liquid chromatography tandem mass spectrometry. While the plastic straws had no measurable PFAS, 21 PFAS were detected in the paper and other plant-based straws, with total mean PFAS concentrations (triplicate analysis) ranging from 0.043 ± 0.004 ng/straw to 29.1 ± 1.66 ng/straw (median = 0.554 ng/straw). Perfluorobutanoic acid (PFBA), perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) were the most frequently detected species. In a follow-up experiment, the brand with the highest PFAS levels and most diversity was tested for leaching in water at initial temperatures of 4 °C, 20 °C, and 90 °C. Approximately 2/3 of the total extractable PFAS leached compared to the initial methanol extraction. Semi-volatile PFAS concentrations measured in this study may be the result of manufacturing impurities or contamination, as PFAS approved for food-contact use are, typically, polymeric species. The presence of PFAS in plant-based drinking straws demonstrates that they are not fully biodegradable, contributing to the direct human ingestion of PFAS and to the cycle of PFAS

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Just Transitions and Inequalities

3.5
million tonnes
Plastic materials processed

1.7
million tonnes
Plastic materials produced

150,000
People directly employed

400k
Total employment including indirect jobs (approx)

£28.7
billion
Plastics industry turnover

5,700
Companies in the plastics industry

+10%
Increase in Export Sales (2021-2022)

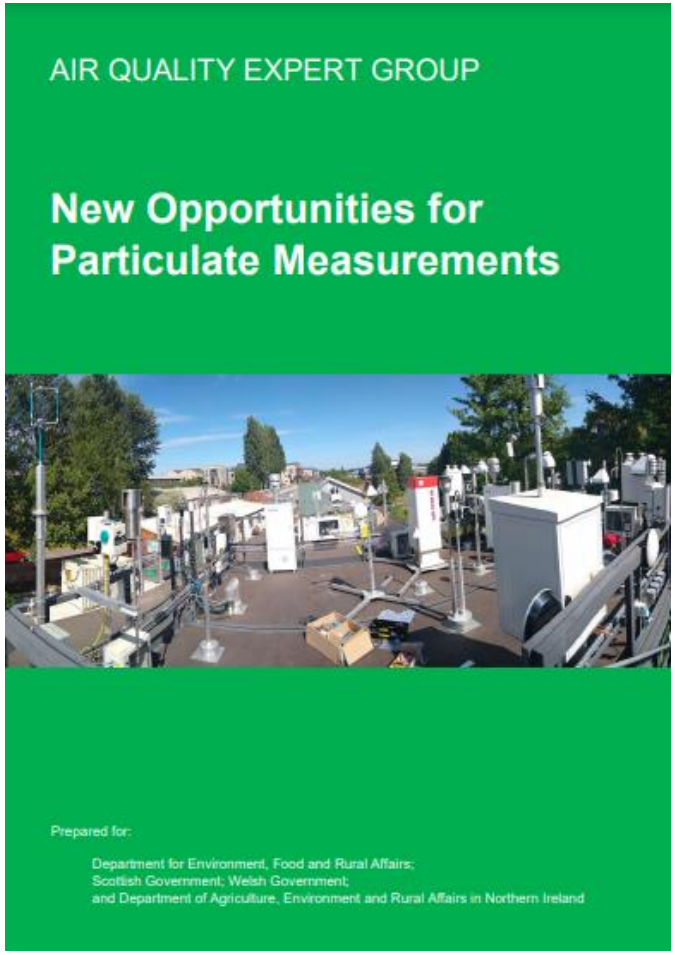
Top 10
Plastics are one of the UK's Top 10 Exports

https://www.bpf.co.uk/industry/Default.aspx

- Is there an exposure inequality?
  - Occupational
  - Cultural
  - Social
  - Gender
  - Ethnicity

Summary

- Range of sampling methods being used, coupled with a range of analytical methods being applied
- Currently at a stage where **harmonisation** of measurement is more valuable than standardisation. Balance will likely change when policy development, if needed, kicks in.
- Need to ensure we don't substitute plastics for other materials without first understanding consequences.
- Should investigate inequalities of exposure from the off, not let it be an afterthought.



https://uk-air.defra.gov.uk/assets/documents/reports/cat05/2411071334_PM_measurement_AQEG_submitted_19jun2023.pdf