Freshwater sediment microplastics from an urban river in the west of Scotland

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INTRODUCTION

- Microplastics (MPs; <0.5 mm), derived directly from manufacturing (primary MPs) or indirectly from fragmentation processes (secondary MPs)[1,2] are contaminants of emerging concern[3,4].
- Small sizes and lack of unified methods makes adequate quantitative and qualitative analysis and risk assessment difficult.
- MPs are well-documented in oceans[3,5]; but contribution of MPs from freshwaters to sea remains largely unknown.
- This research is to generate incisive understanding of the distribution and behaviour of MPs in freshwaters, and to inform mitigation and control measures.

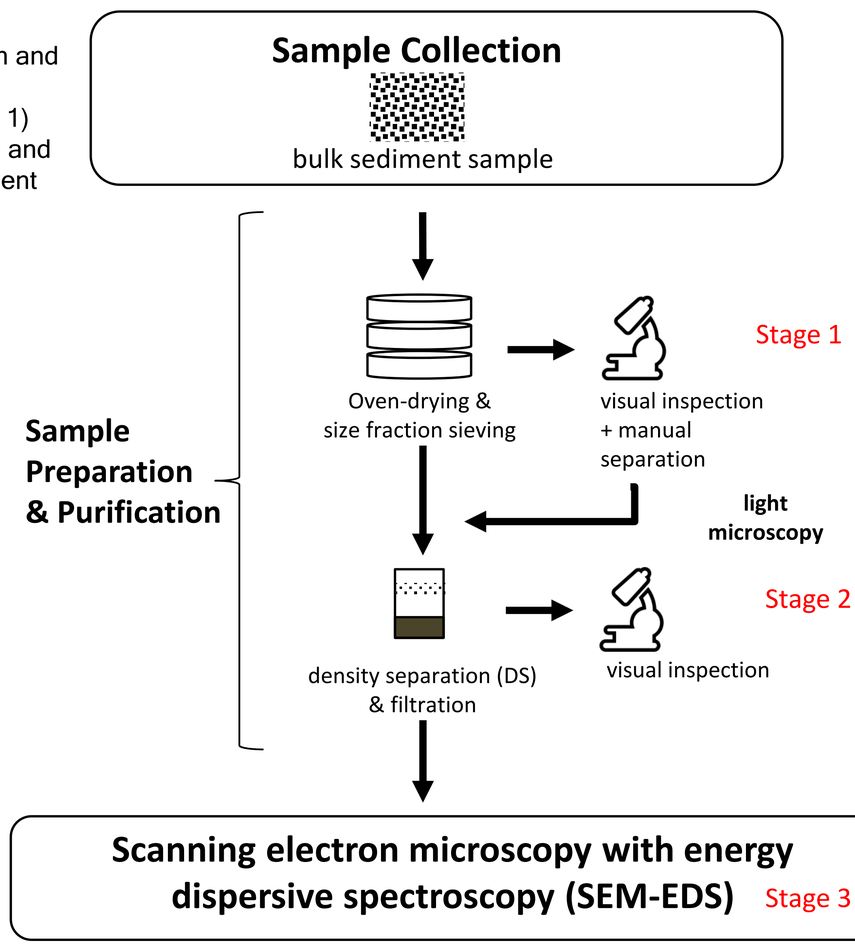
OBJECTIVES

Bank sediment samples were collected from a river bend section in the River Kelvin (photo) in west Glasgow, Scotland to:

1. Optimise extraction-identification protocol
2. Obtain an initial profile of MPs in the local catchment.

METHODOLOGY

Steps for extraction and identification of microdebris (stage 1) and MPs (stages 2 and 3) from river sediment samples.



CONCLUSIONS

- Pellet count decreased, while fibre count increased from visual to chemical characterisation.
- High abundance of micropellets found but none were plastic.
- Secondary microplastics (i.e. fibres and fragments) were predominant.
- Fibres required DS and SEM-EDS for proper quantification.
- Non-plastic pellets and fragments can be misidentified by visual separation.
- Forensic analyses (e.g. SEM-EDS, FT-IR) can help to calibrate protocols and improve accuracy of results.

FUTURE WORK

- The overarching aim of this PhD project is to describe and model the behaviour of micro- and nanoplastics (MNPs) in wastewater treatment systems and natural fluvial waters
- Next step: quantify MPs in sewage treatment plant (STP)
- Future work:
  - Assess impact of MPs on STP efficacy
  - Model transport, degradation, and storage of MNPs in wastewater systems and receiving waters

REFERENCES

1. Thompson et al. 2004. (doi: 10.1126/science.1094559).
2. Arthur et al. 2009. (https://marinedebris.noaa.gov/).
3. GESAMP 2015. (ISSN 1020-4873 (GESAMP Reports & Studies Series).
4. Hartl et al. 2015. (http://www.crew.ac.uk/publications).
5. Wagner et al. 2014. (doi: 10.1186/s12302-014-0012-7).

RESULTS & DISCUSSION

VISUAL INSPECTION

Fig. 1 Light microscopy images of common microdebris, including suspected microplastics in sediment samples from the River Kelvin after oven drying (100°C for 24 hrs) and size fraction sieving (2.8 mm, 2.0 mm, 1.4 mm, 1.0 mm, 0.71 mm, 0.5 mm, 0.355 mm, 0.25 mm, 0.18 mm, 0.125 mm, 0.09 mm, 0.063 mm). Items shown are: pellets (a), fibres (b) and fragments (c).

SEM ANALYSIS

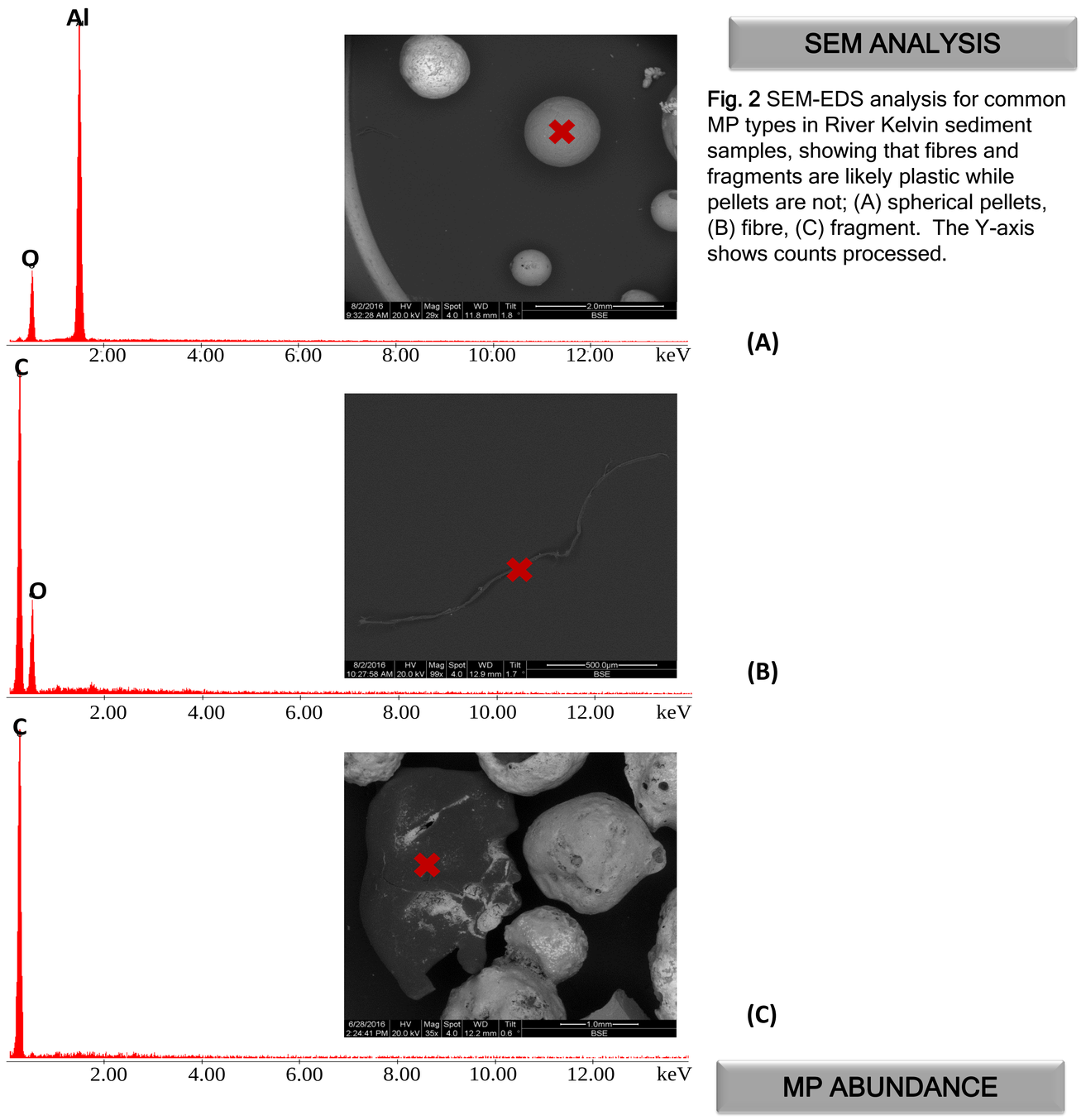


Fig. 2 SEM-EDS analysis for common MP types in River Kelvin sediment samples, showing that fibres and fragments are likely plastic while pellets are not; (A) spherical pellets, (B) fibre, (C) fragment. The Y-axis shows counts processed.

MP ABUNDANCE

Table 1 Microdebris and microplastic counts in River Kelvin sediment sampled December 2015 and February 2016 by category, and total counts and abundance aggregated across all size fractions for stages 0 (before density separation), 1 (after density separation, before SEM-EDS), and 2 (after SEM-EDS).

Stage	Sampling Event	Sample Weight, dry (g)	Microdebris (stage 1) and Microplastic (stages 2 & 3) Count (n)					Abundance (items per kg dry sediment)
			Pellets	Fibres	Fragments	Others	Total	
1	Dec '15	1466.42	313	30	49	1	393	268
	Feb '16	254.48	38	24	2	1	65	255
2	Dec '15	441.49	5	44	23	5	77	174
	Feb '16	254.48	0	84	8	1	93	365
3	Dec '15	441.49	0	44	6	0	50	113
	Feb '16	254.48	0	84	4	0	88	346

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