Micro- and nanoplastic in fresh- and wastewater systems

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Hydro Nation Scholars Programme

Introduction

Micro- and nanoplastic (MNP; <0.5 mm and <100 nm, respectively), derived directly from manufacturing (primary MNP) or indirectly from fragmentation processes (secondary MNP), are contaminants of emerging concern. Owing to their small sizes and a lack of unified methods, adequate quantitative and qualitative analysis and reliable risk assessment has been difficult, particularly for nanoplastics. Recently, microplastics have been well-documented in oceans but the role of freshwaters as transport vectors of land-based MNP sources to sea remains largely unknown.

This project aims to describe and model the behaviour of MNPs in wastewater treatment (WWT) systems and natural fluvial waters in an urban catchment with close proximity to the marine environment.

Methods

A *pilot study* was conducted in the River Kelvin to:

- Profile microplastic (MP) distribution in the Clyde catchment.
- Calibrate MP extraction & characterisation protocols:

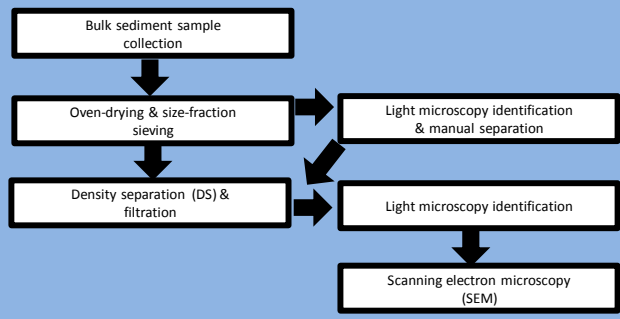

Figure 1 Protocol for extraction and characterisation of MP from River Kelvin sediment sampled in December 2015 and February 2016.

Results

Figure 2 Non-polymer micropellet (left), MP fibres (middle), and non-polymer and MP fragments (right) found in River Kelvin sediment sampled December 2015 and February 2016. Non-polymer pellets and fragments can be misidentified as primary and secondary MP, respectively, by visual inspection alone, while fibres and smaller fragments (secondary MP) need DS & SEM to be quantified properly.

Table 1 Microdebris (pre-DS) and MP (post-DS/pre-SEM; post-SEM) abundances in River Kelvin sediment, aggregated over all fraction sizes and depths at each sampling event. Non-polymer pellets and MP fibres were the most abundant categories. All post-DS pellets and fragments were counted as MP until confirmed otherwise by SEM analysis.

Identification Stage	Sampling Event	Sample Weight, dry (g)	Microdebris/Microplastic Count (n)					Concentration (items per kg dry sediment)
			Pellets	Fibres	Fragments & Flakes	Others	Total	
Pre-DS (light microscopy)	December 2015	1466.42	313	30	49	1	393	268
	February 2016	254.48	38	24	2	1	65	255
Post-DS/Pre-SEM (light microscopy)	December 2015	441.49	5	44	23	5	77	174
	February 2016	254.48	0	84	8	1	93	365
Post-SEM	December 2015	441.49	0	44	6	0	50	113
	February 2016	254.48	0	84	4	0	88	346

Conclusions & Future Work

- Secondary MP were main contributors; no primary MP were observed.
- Suspected MP fragments found in settled material after DS indicate presence of denser polymers.
- Differences between final (post-SEM) and initial MP estimates highlight advantages of forensic approaches (e.g., SEM, Raman, FTIR) to calibrate protocols and improve accuracy and relevance of results.
- Next steps:
  - Calibrate protocol for organic-rich samples
  - Selection of WWT site & sample collection points

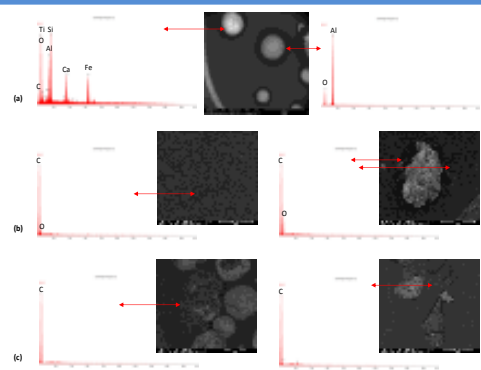

Figure 3 Scanning electron microscopy (SEM) backscatter electron (BSE) images and elemental analysis spectra for pellets (a), fibres (b), and fragments (c) in River Kelvin sediment samples. The Y-axis represents counts processed by the detector and the X-axis shows the energy level of those counts. This data is used to discriminate C-based materials such as plastics from non-polymers as the plastics are made of C and so show a different response to non-plastic material.

Acknowledgements: We are thankful for the support of CREW and the Hydro Nation Scholarship Programme. This research is in conjunction with Scottish Water and SEPA.

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