Microplastics pollution in a tertiary sewage treatment system

Reina Maricela Blair, e-mail: r.blair.1@research.gla.ac.uk
Supervisors: Susan Waldron, Caroline Gauchotte-Lindsay, Vernon Phoenix
University of Glasgow, Glasgow, G12 8QQ
www.hydronationscholars.scot

Scottish Government gov.scot
Hydro Nation Scholars Programme

Introduction

- Microplastics (MPs, < 5 mm in size) are classed as emerging contaminants worldwide, but currently not regulated
- Quantification and risk assessment is difficult because unlike traditional contaminants, MPs are highly diverse and their distribution in the environment is extremely variable in space and time
- MPs can enter the environment via several pathways (e.g. effluent, storm drains, runoff, CSOs, legacy litter), and management of land-based inputs is key, but their monitoring and regulation is hindered by limited empirical data in fresh- and wastewater systems
- **Aim:** Describe and model the behaviour of MPs in wastewater treatment and fluvial systems

Methods

- Site is a tertiary sewage treatment plant (STP) in Glasgow, UK
- 5-L wastewater samples collected at 8 treatment stages (**Fig 1**)
- 30% H_2O_2 digestion ➔ vacuum filtration (1.2 µm GF filters)
- Stepwise quantification: (1) Visual (light microscopy); and, (2) Chemical (SEM and FTIR-ATR)

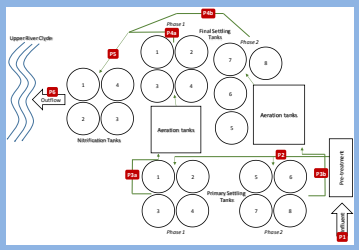


Fig 1. Sampling scheme in the tertiary STP for 8 sampling points: **P1**, influent; **P2**, pre-treatment effluent; **P3a** and **P3b**, primary effluent phases 1 and 2, respectively; **P4a** and **P4b**, secondary effluent phases 1 and 2; **P5**, secondary effluent, mixed liquor; **P6**, final effluent

Results

(1) VISUAL

- MPs found in wastewater, mainly fibres and films
- Overall decrease from input to output but MPs observed in discharge (**Fig 2**)
- High local variability across sampling events (**Fig 2**)
- Total visual counts were 394 and 160 pieces across all sampling points for May and August, respectively

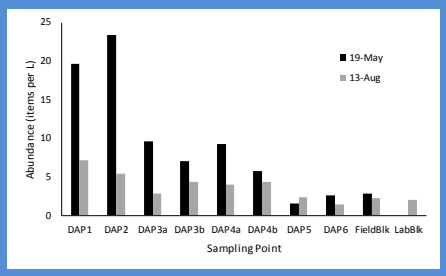


Fig 2. MP abundances in tertiary STP wastewater

(2) CHEMICAL

- Chemical characterisation is needed for accurate MP identification
- SEM can be used to separate C-based materials like plastics from inorganic debris, misidentified as MP during visual inspection (**Fig 3**)
- FTIR-ATR can be employed to discriminate MPs from cellulose and other confounding materials (**Fig 4**)

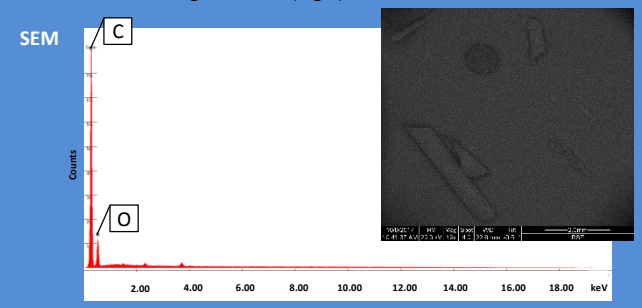
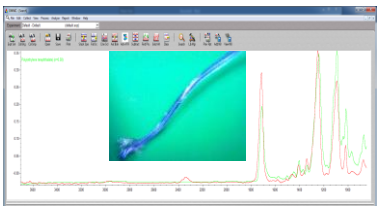


Fig 3. SEM output for suspected MP pieces collected from tertiary STP wastewater; 94% of analysed pieces (n=17) initially identified as MP were C-based

Future

- Expand spatio-temporal dataset for selected STP and recipient channel (Upper River Clyde)
- Lab-based experiments to explore impact on STP efficacy:
  - Toxicity on microbial community (secondary treatment)
  - Blockages in porous media (tertiary treatment)
- This research is to generate incisive understanding of distribution and behaviour of MPs in waste- and freshwaters and determine where controls should be implemented

FTIR-ATR



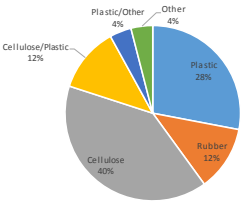


Fig 4. FTIR-ATR analysis of suspected MP pieces collected from tertiary STP wastewater; only 28% of analysed pieces (n=25) were confirmed plastics

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.

University of Glasgow