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Evaluating the microbial risks of urban flooding events

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Introduction

The frequency and occurrence of intense hydrological events has steadily been increasing - a consequence of climate change (Pall *et al.*, 2011; Waters *et al.*, 2010).

INTENSE PRECIPITATION + **DENSE POPULATION** = **SEWER SYSTEM OVERFLOW**

Figures 1 & 2. Combined sewer overflow outlets at two sample sites in Sheffield.

Overflows lead to rainwater contaminated with sewage flowing into urban areas, such as streets and parks- via combined sewer overflow outlets, or surcharging gulleys.

- **Urban floodwater can contain many types of pathogen, including bacteria and viruses that spread via the fecal -oral route (Fewtrell *et al.*, 2011).**
- **Pathogens cause illness ranging from gastrointestinal issues to more severe disease: Cryptosporidiosis, Guillain-Barré Syndrome and Leptospirosis/Weil's Disease (Goodfellow and Taube, 2016).**
- **The true range of pathogen types and species that are common in urban floodwaters is not yet fully understood.**

Figure 3. An urban flood at a sample site, Endcliffe Park, Sheffield, November 2021 .

The Short Term & Long Term Risks

- **Short Term: Direct contact with surface floodwater can result in infection via pathogens.**
- **Long Term Risk: The contaminated flood water has the potential to move into soils and surfaces. Pathogens could survive and infect, long after flood water has retreated.**

AIM: Determine the behaviour, diversity, abundance, and survival rate of pathogens present in urban flood water and urban soils

Materials & Methods

Soil Column Study

- **Run wastewater through column with different soil types, as well as different levels of saturation (flood).**
- **Soil and water samples taken over several days and analysed for physico-chemical characteristics.**

Field Sampling

- **Soil and water samples taken from 2 sample sites over a year.**
- **Sites prone to surface water flooding due to combined sewer overflows/sur charging manholes.**

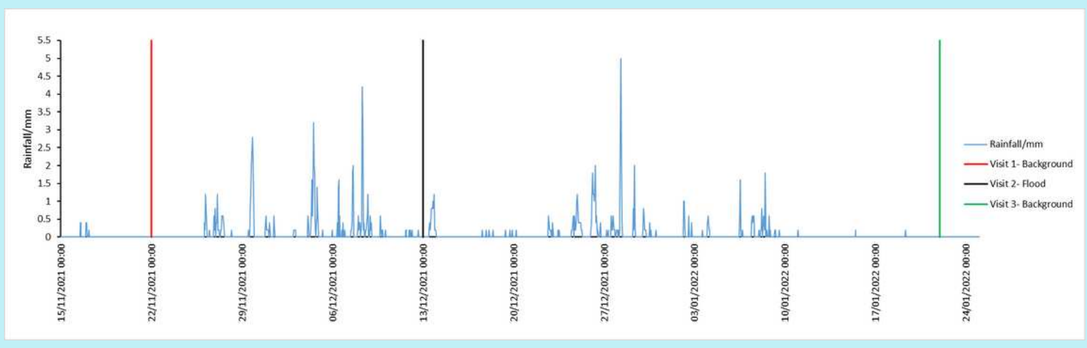

Figure 4. Rainfall data for sample area. Coloured lines indicate site visits.Data recorded using gauge by Detectronics (2021).

Annular Flume Trials

- **Determine how pathogens move between soil and water when water is moving.**
- **Changing: soil types, contamination level of soil and water, depth, velocity.**
- **Measuring flow rate, along with physio-chemical factors of the soil and water during the trials.**

Molecular Analysis of Samples

Determine abundance, species, and survival rate of pathogens

- **Sequence the 16s rRNA gene**
- **Flow Cytometry**

Visualise the relationship/ attachment of pathogens with soil particles

- **Scanning electron microscope images (SEM).**

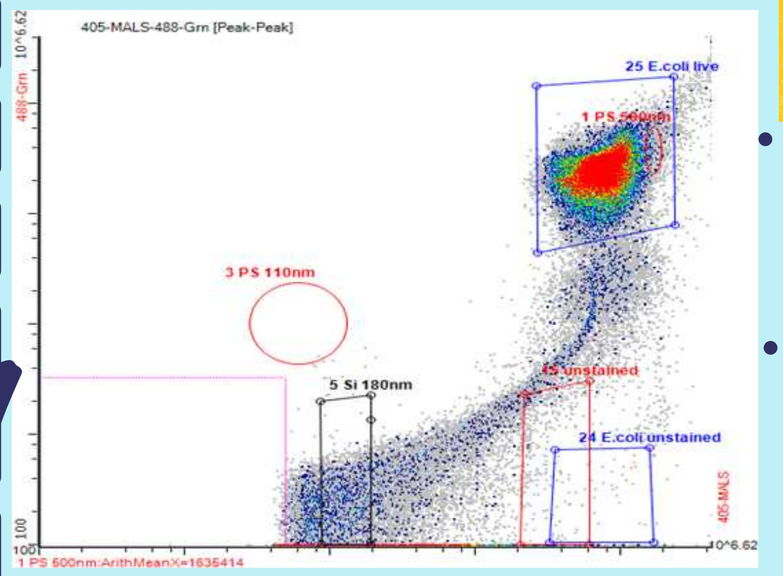

Figure 6. Graph of flow cytometric analysis of *E.coli* cultures. E.coli with LIVE/DEAD stains used to set up 'gates' for measuring water and soil samples.

Results

- **Flow cytometric analysis has commenced with 'gates' set up using E.coli as a control (Figure 6.).**
- **Physico-chemical analysis has also taken place for samples collected so far. Findings visualised using scanning electron microscopy (Figure 7.).**

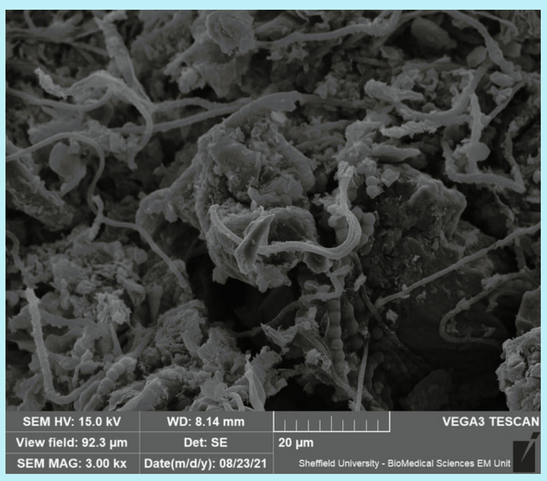

Figure 7. Scanning electron microscope (SEM) images of bacteria and fungi attached to a soil sample from a field site.

Conclusions

From Preliminary Work:

- **2 field sites have been selected and sampling commenced with initial physio-chemical and molecular tests carried out to determine contamination levels and characterise soil profiles at each site.**
- **Initial soil column tests carried out to determine sampling process and appropriate flow rates.**
- **Visualised the attachment of microbes to soil particles via SEM.**
- **DNA extracted from current samples- ready for molecular analysis**

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