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Version: Published Version

Proceedings Paper:

Scutt, S., Shucksmith, J. and Douterelo, I. (2022) Investigating the microbiological risks associated with urban flooding in the UK. In: Access Microbiology. Microbiology Society Annual Conference 2021, 26-30 Apr 2021, virtual. Microbiology Society. ISSN: 2516-8290. EISSN: 2516-8290.

<https://doi.org/10.1099/acmi.ac2021.po0124>

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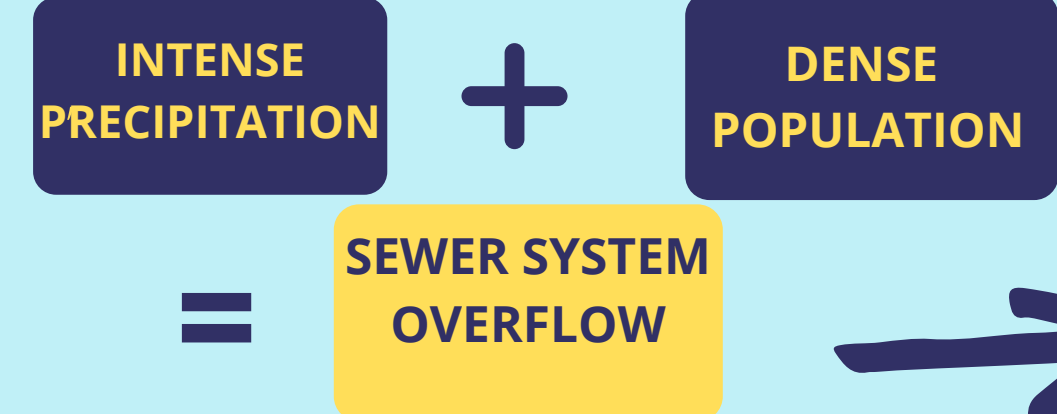
EVALUATING THE MICROBIAL RISKS OF URBAN FLOODING EVENTS

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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).



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

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/surcharging manholes.

MATERIALS & METHODS

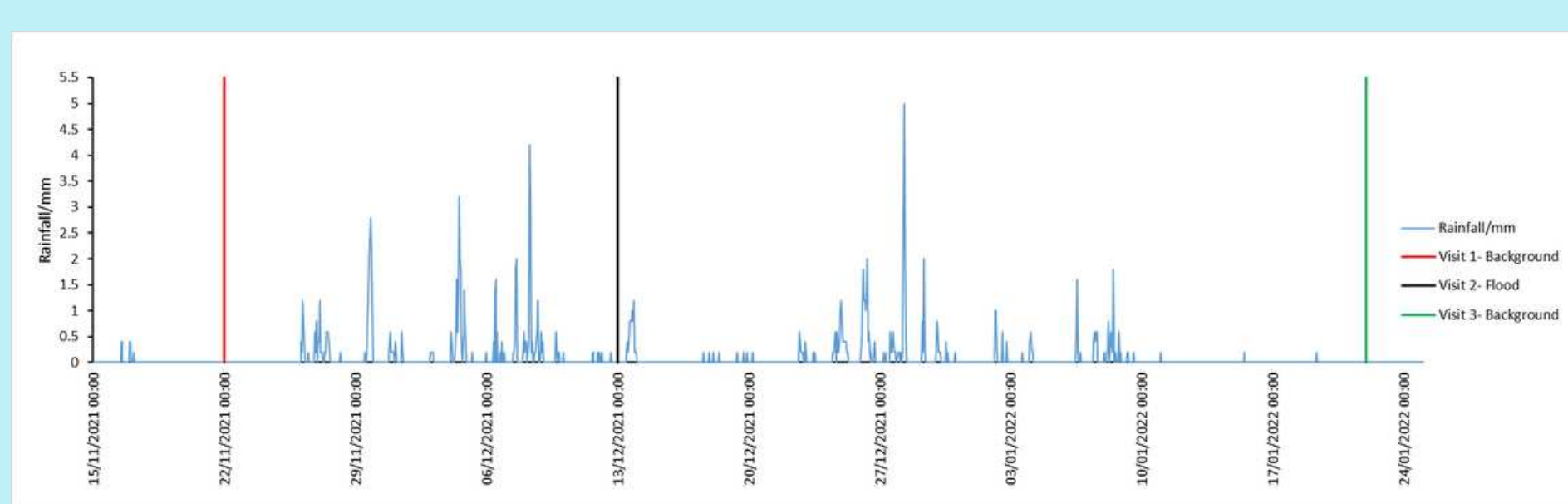


Figure 4. Rainfall data for sample area. Coloured lines indicate site visits. Data recorded using gauge by Detectronics (2021).

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
- Visualise the relationship/ attachment of pathogens with soil particles
- Sequence the 16s rRNA gene
- Flow Cytometry
- Scanning electron microscope images (SEM).

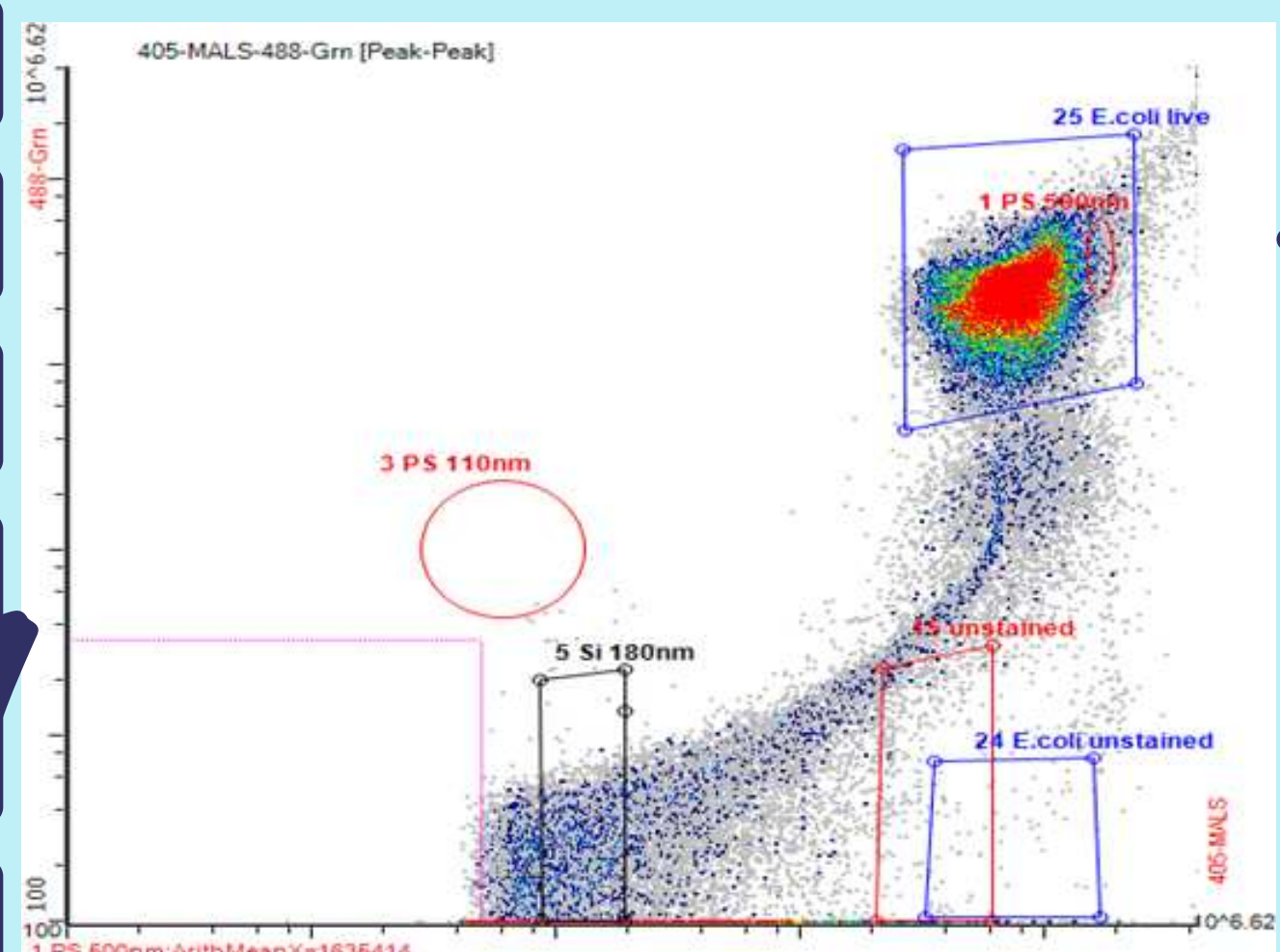


Figure 6. Graph of flow cytometric analysis of *E.coli* cultures. *E.coli* with LIVE/DEAD stains used to set up 'gates' for measuring water and soil samples.

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.).

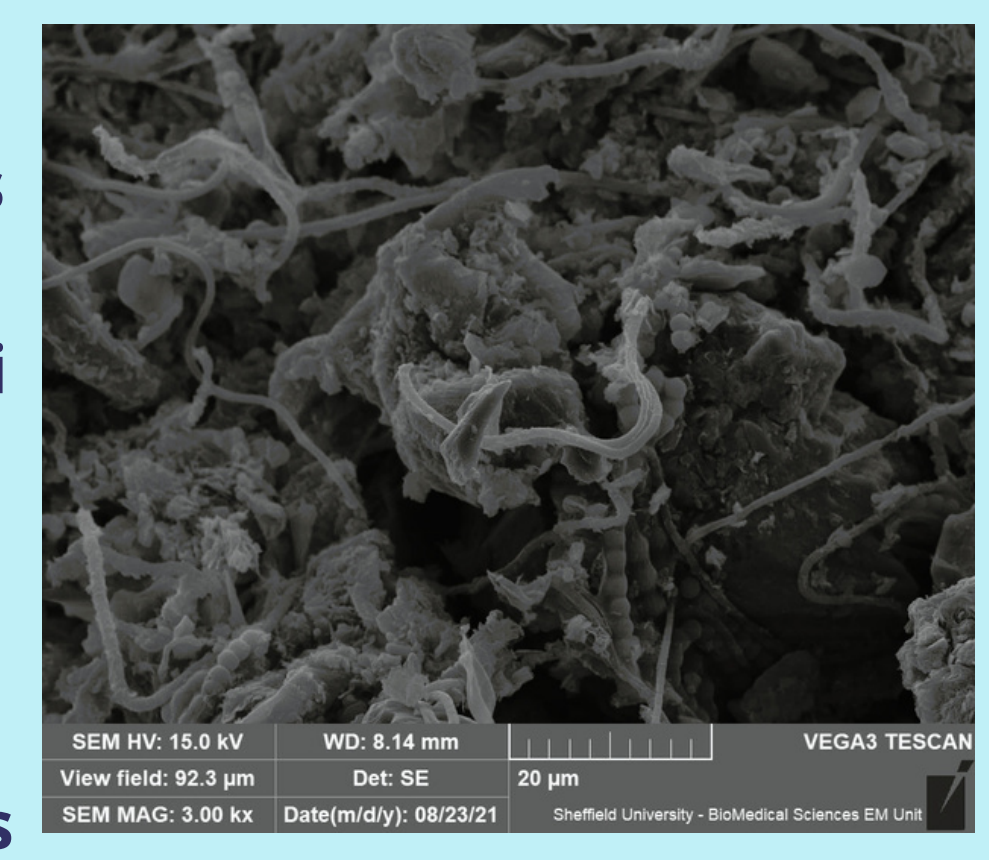


Figure 7. Scanning electron microscope (SEM) images of bacteria and fungi attached to a soil sample from a field site.

CONCLUSIONS

- 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

From Preliminary Work:

ACKNOWLEDGEMENTS: THE RESEARCH REPORTED HERE WAS SUPPORTED BY THE UK ENGINEERING AND PHYSICAL SCIENCES RESEARCH COUNCIL (EPSRC), AS WELL AS BY THE NATURAL ENVIRONMENT RESEARCH COUNCIL (NERC). THANKYOU TO KASIA EMERY FOR TRAINING AND GUIDANCE DURING FLOW CYTOMETRY ANALYSIS, AS WELL AS TO DR ESTHER KARUNAKARAN FOR USE OF LAB SPACE AND EQUIPMENT, AND CHRISTOPHER J HILL FOR CREATING THE SEM IMAGES. LAB BASED SOIL COLUMN TRIALS CARRIED OUT WITH ASSISTANCE FROM MARIA ANGELES HERRERA. RAIN GAUGE INSTALLED AND SOFTWARE PROVIDED BY DAVE WALKER AT DETECTRONICS.

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