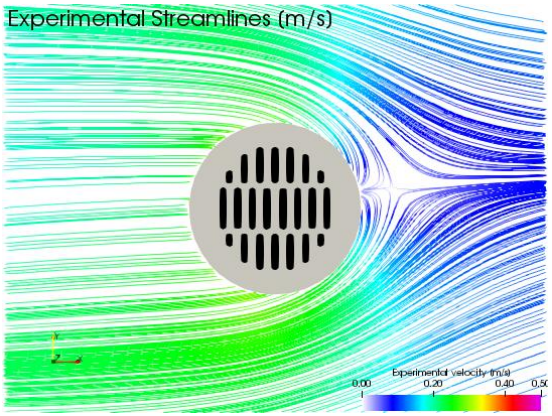
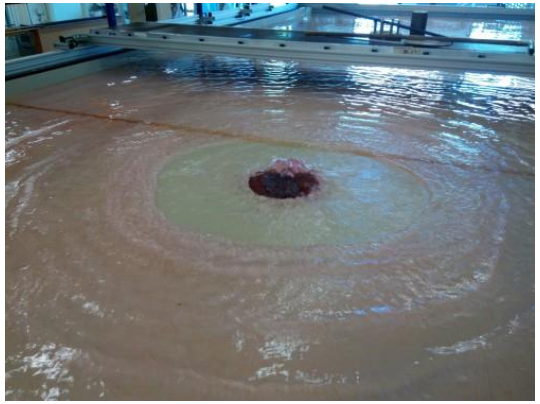
Urban Flood Modelling Dissemination Seminar





25th Jan – University of Sheffield

James Shucksmith

The University Of Sheffield.

TECHNISCHE UNIVERSITÄT MÜNCHEN

UNIVERSITY OF EXETER

EPSRC
Engineering and Physical Sciences Research Council

Aims of the Event

- *Present and discuss ongoing research in the area of urban flood modelling, including*
  1. Direct outputs from EPSRC project ‘Experimental and Numerical Investigation of Flow Exchange in Urban Flood Flows’
  2. Talks from guest speakers

- *Disseminate effectively to a wide audience!*

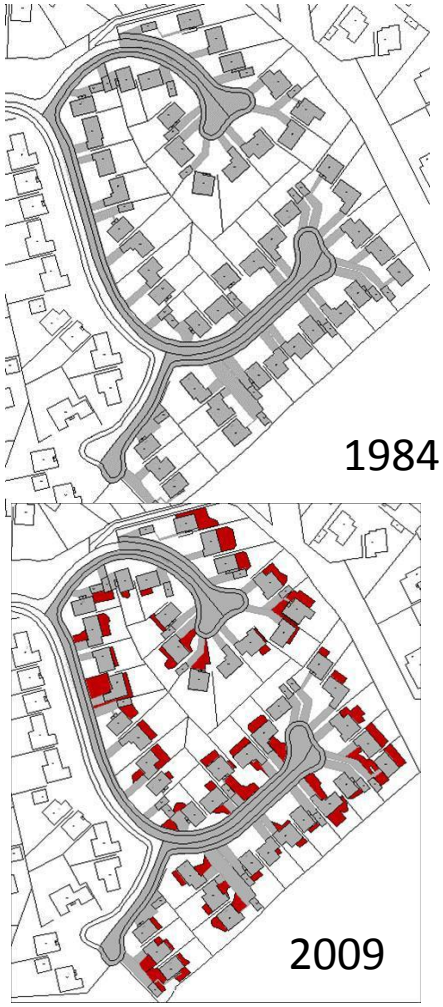
Urban Flooding

Environment › Climate change

Flooding rated as worst climate change threat facing UK

Defra report lists 700 impacts, including flood risk for 3.6 million people, water shortages, soil erosion and wildlife disruption

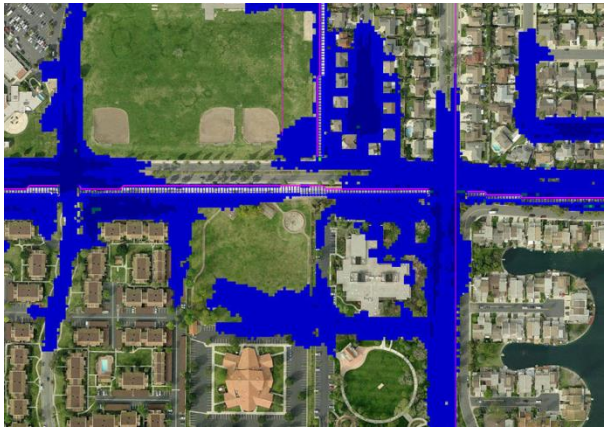
- One in seven UK homebuyers faced a potential flood risk when purchasing a home in 2017 (UK homebuyers report, 2017)
- Risks increasing
  1. There are more of us
  2. Our urban areas are more crowded
  3. We like paving
  4. We (generally) own more stuff
  5. More extreme weather events are happening
- Effects are global

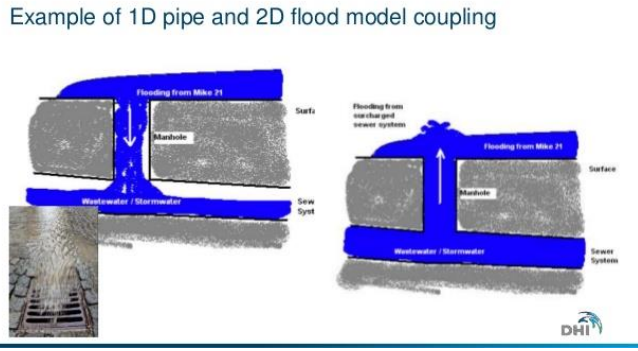


Courtesy of CH2M

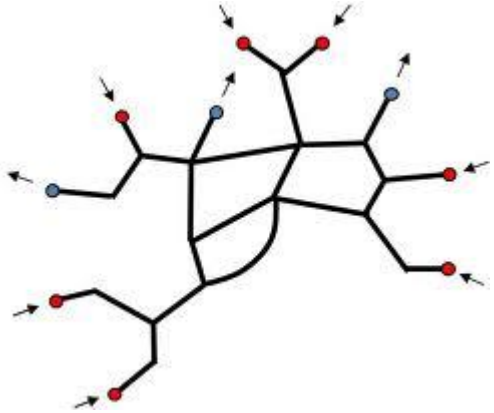
Use of Hydraulic Models

- Hydraulic models can be used for
  - Evaluation of risk to an area or property
  - Infrastructure design or improvement
  - Scenario analysis (e.g. climate change)
  - Real time forecasting and warning (sometimes)
- Modelling of urban areas generally seen as most complex
  - Surface and drainage network
  - Short timescales and more details

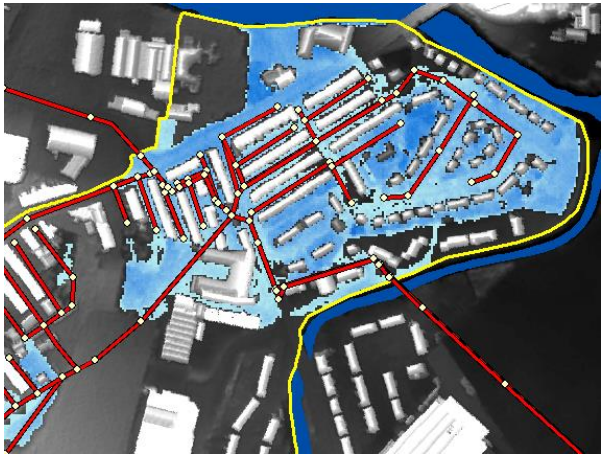




Urban Flood Models



Pipe Network –
1D St. Venant Equations



Pipe Network –
2D St. Venant Equations

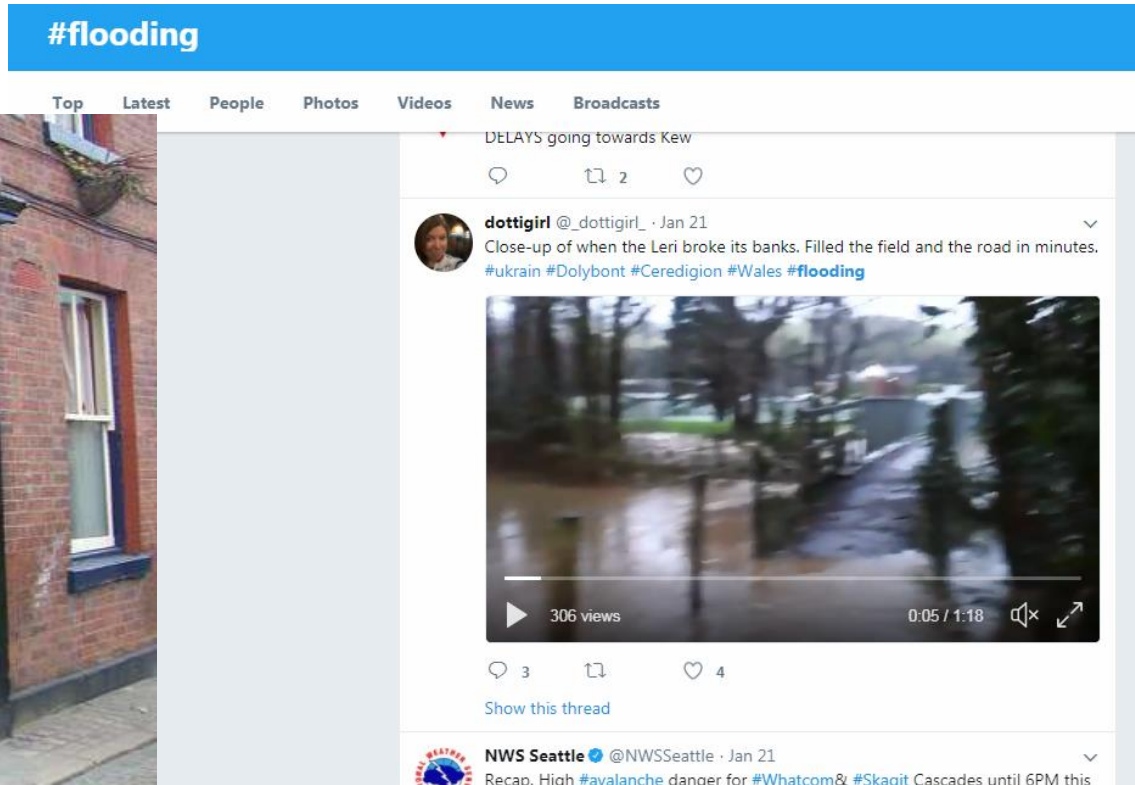
Gully/ Manhole 'Linkage' –
Empirical/Semi Empirical Equations

Inputs/Parameters

Rainfall runoff, pipe network, digital elevation model, roughness and energy loss parameters…….

Verification

- How do we know models are telling the truth?
  - Comparison with Sewer Flow Data
  - Measured surface extents?
  - Photos?

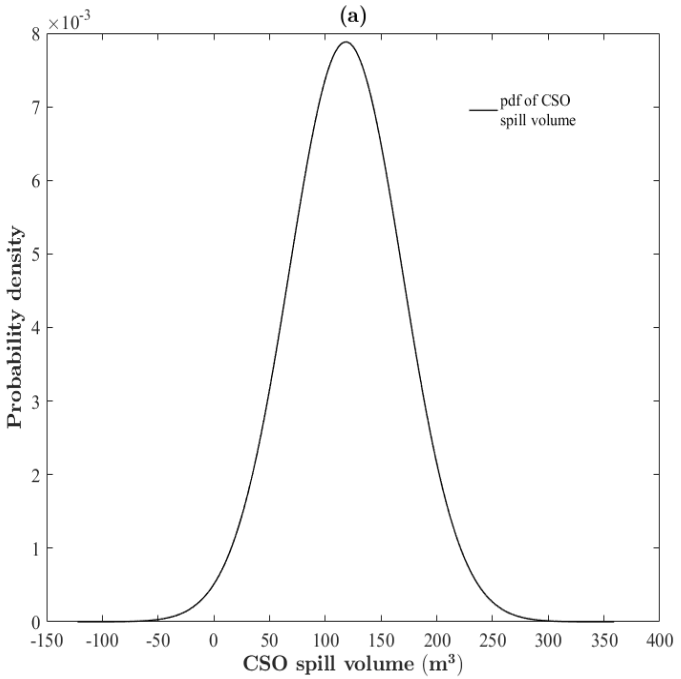


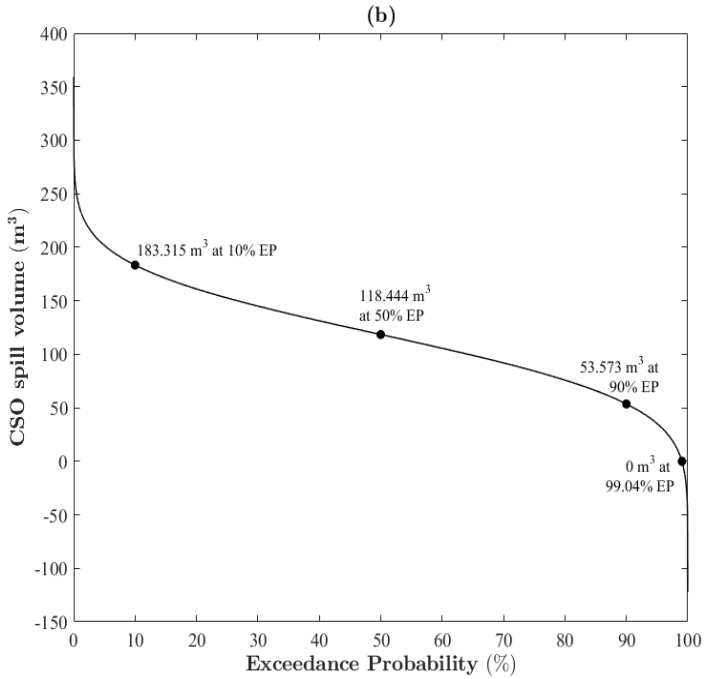
Verification data

- Surface verification data lacking
  - Events are infrequent and difficult to predict
  - Complex models verified at a limited number of points (temporally and spatially)
  - Crude data
- Difficult to directly measure impact of individual model assumptions and parameters
- Does a lack of data hold back development of modelling capabilities?

Uncertainties……

- Urban hydrology
- Rainfall estimation
- In sewer energy losses
- Above/below ground interaction
- Surface roughness
- Model simplifications
- Flow transitions and shocks
- Flow unsteadiness
- More…..





Sriwastava et al (*In Press, ASCE J. Env. Eng.)*

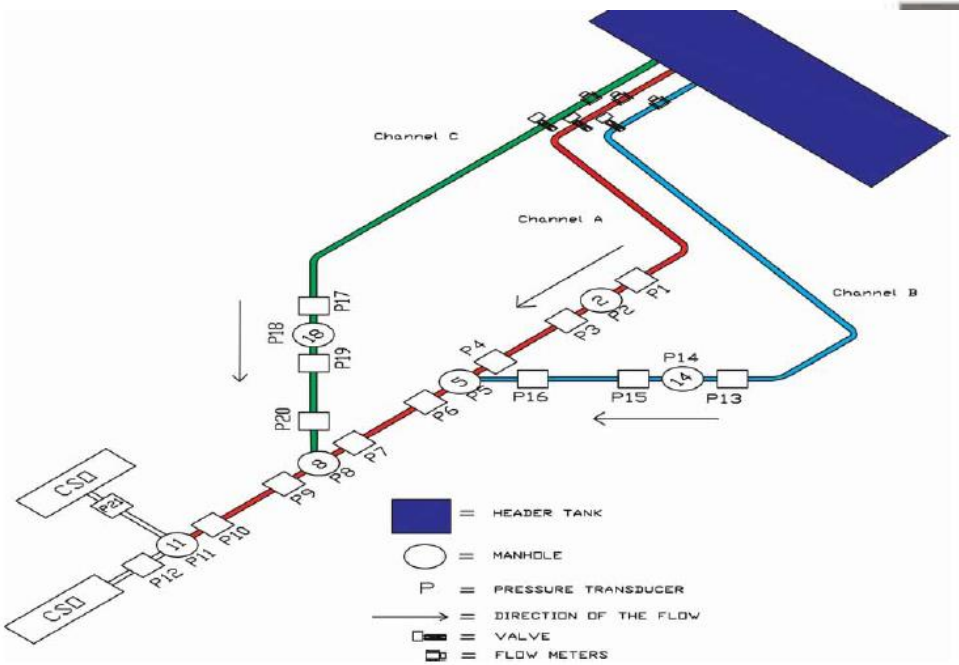
Aim

- Develop a laboratory facility to provide good quality verification data for urban flood models
  - Evaluate some current assumptions within models
  - Provide better data to enhance future model development and testing

- Laboratory approach can provide high resolution data in controlled conditions, at the cost of scale + boundary effects

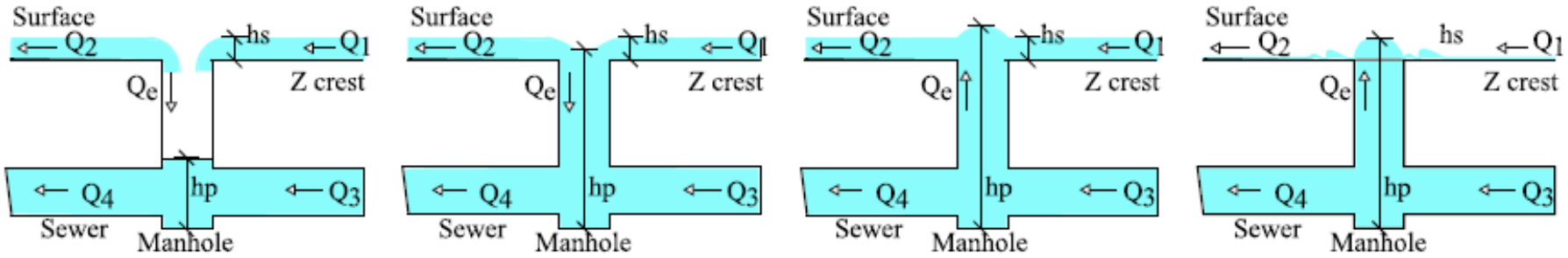
Original facility

- Scaled urban drainage network physical model
- System of linked (scaled) manholes
  - Real time depth, pressure and flow measurements
  - Steady and unsteady hydraulics

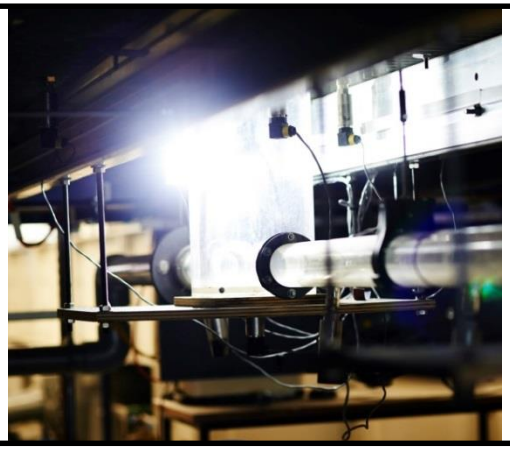


Above/Below Ground Facility

- Conversion into a system to look at the hydraulics of urban flooding
- How flows move between sewer and surface + representation in models

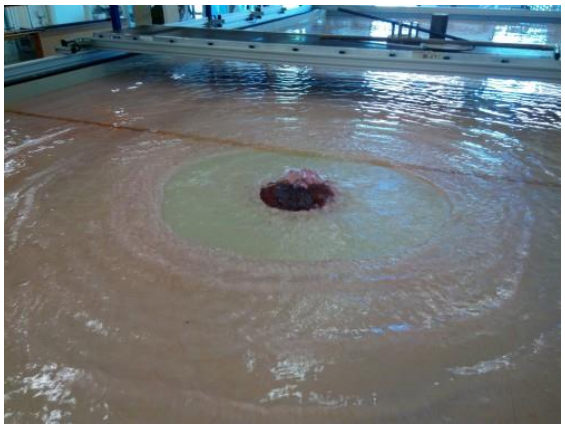


Below-ground system



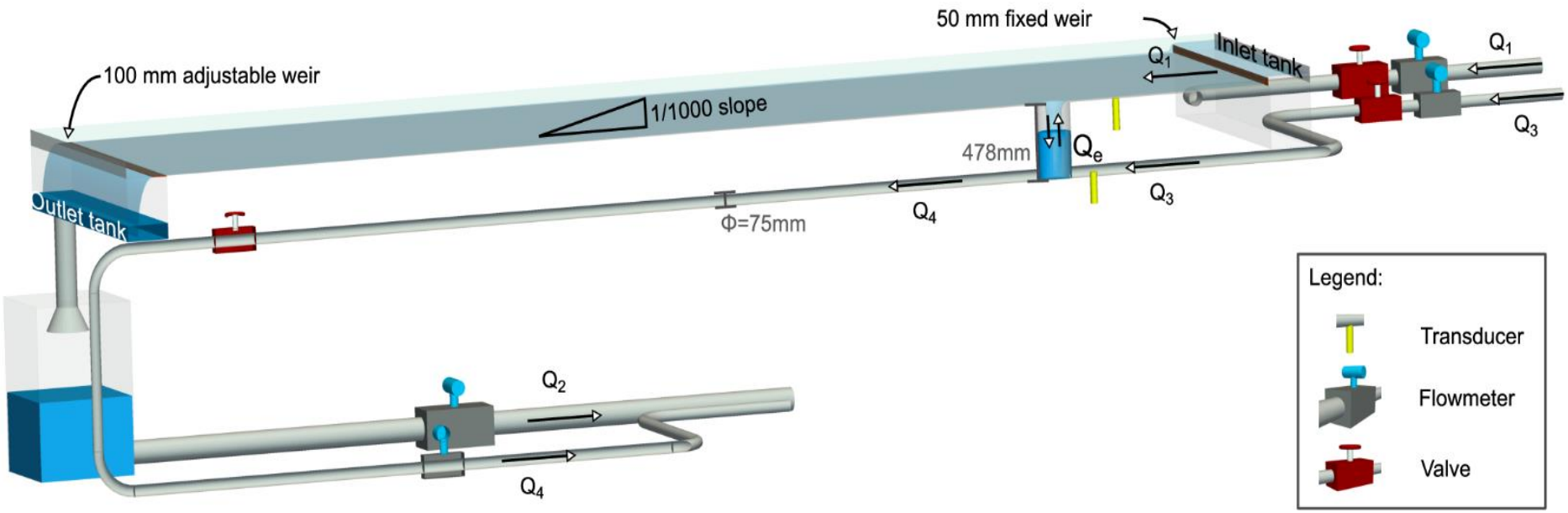
- 75mm pipes, 240mm manholes
- Flow meters
- Pressure transducers
- Steady and unsteady flow inputs

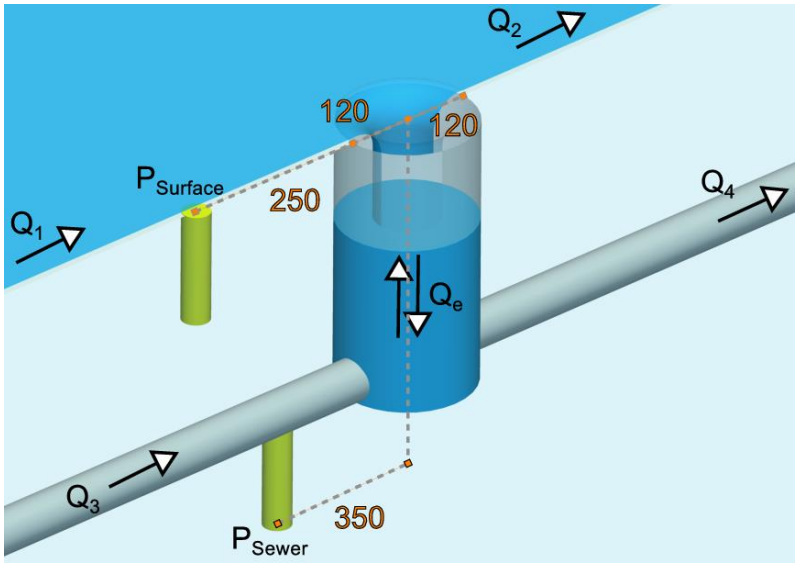
Above-ground system



- 4m by 8m flume
- Flow meters
- Pressure transducers (point depth measurements)

Experimental facility





EPSRC Project Objectives

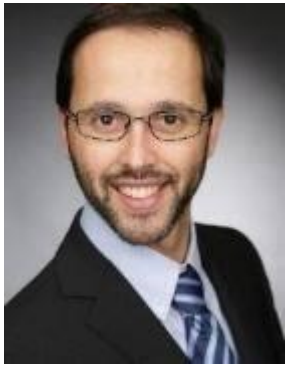
Develop and use a new urban flooding physical scale model facility in order to

1. Develop a better understanding of surface/sewer flow interaction during flood events
2. Develop a new understanding of soluble pollutant transport in urban flood waters
3. Provide datasets to validate state of the art urban flood numerical models

People Involved

Dr James Shucksmith

Dr Georges Kesserwani

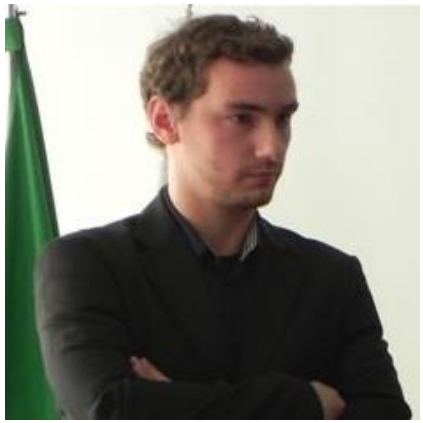


Dr Jorge Leandro

Prof Slobodan Djordjevic

Dr Matteo Rubinato

Dr Seungsoo Lee



Dr Ricardo Martins

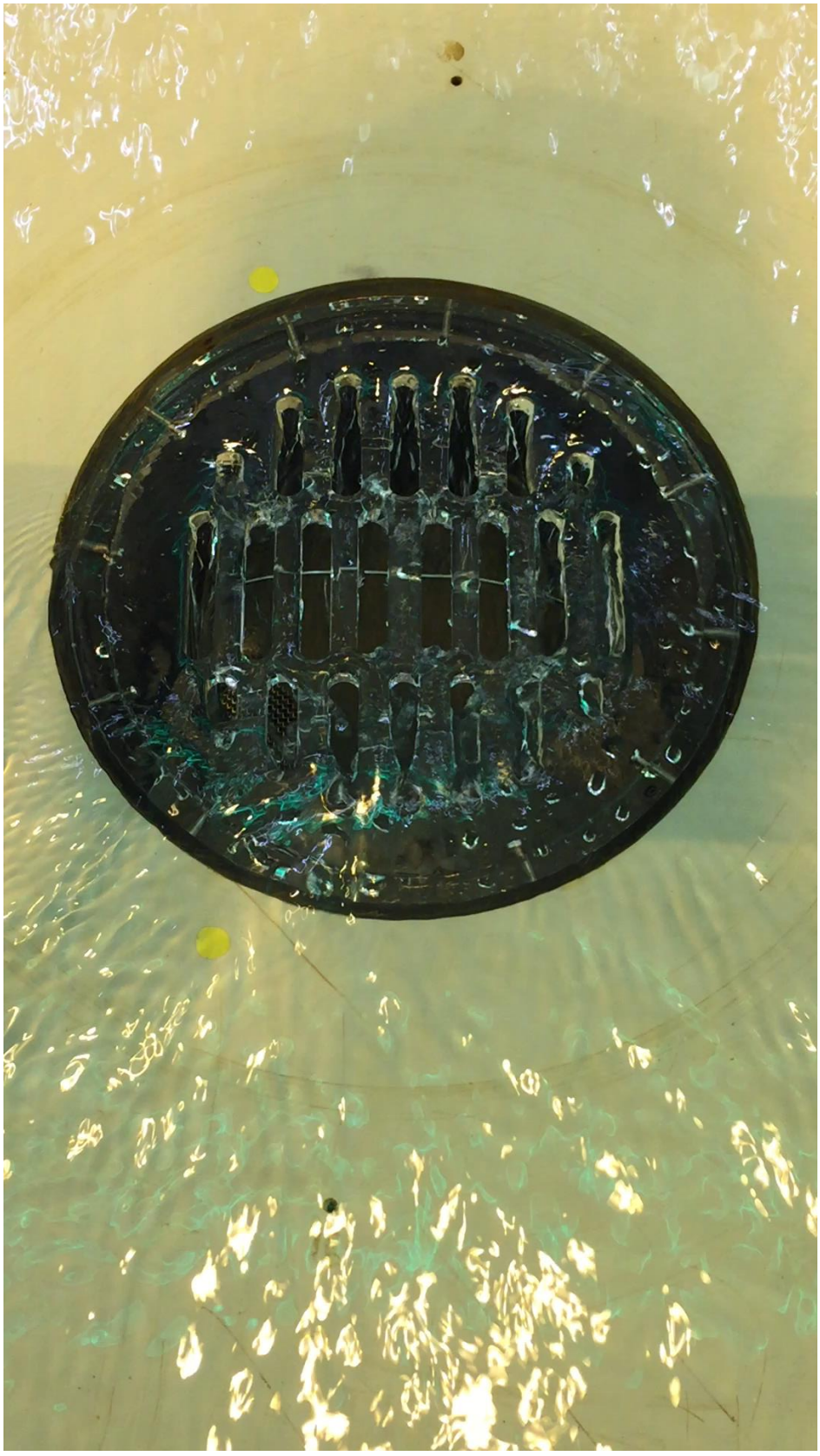
Industrial partners

Facility Development

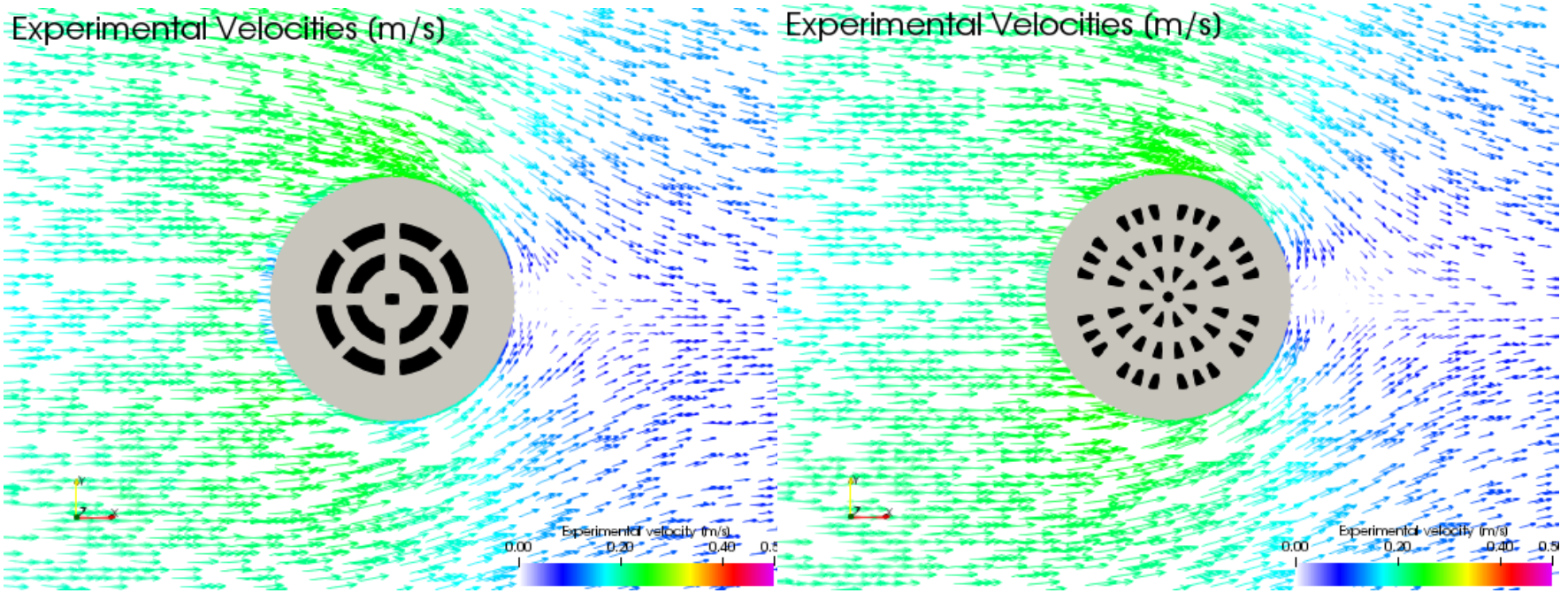
- Facility required further development and instrumentation to meet project objectives
  - Velocity measurement over a large spatial area
  - Adjustable surface ‘features’ to simulate street profiles and urban setups for model verification
  - Track the transport and concentration of a soluble ‘pollutant’ within the facility

Surface 2D Velocity

- Simple PIV developed by Weitbracht et al (2002)
- Tracks floating particles (i.e. acquires surface velocity field)
  - No lasers required
  - Wide view cameras
- Suitable for the study of shallow flows (like floods) over a relatively large field of measurement

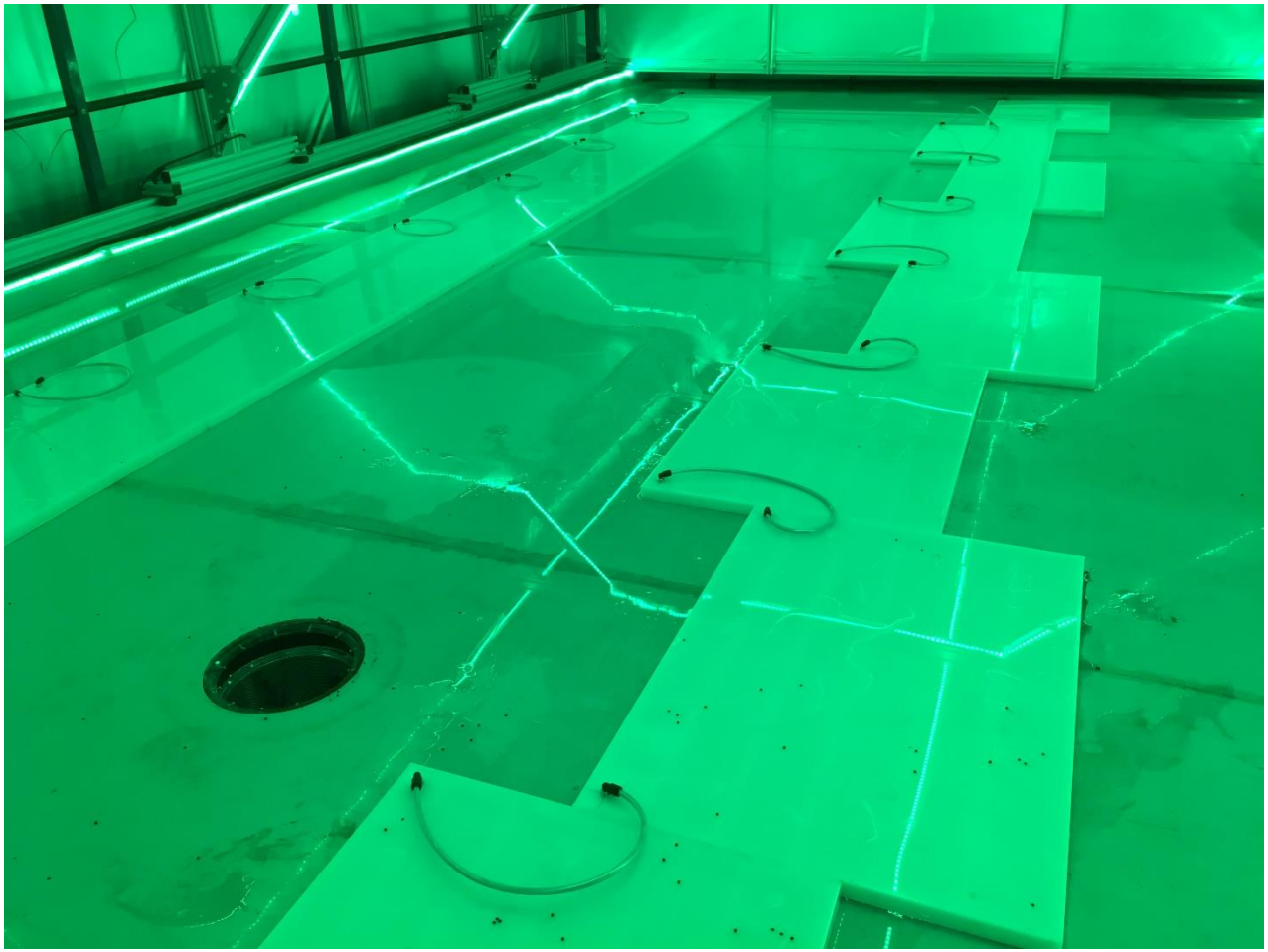


Data Examples



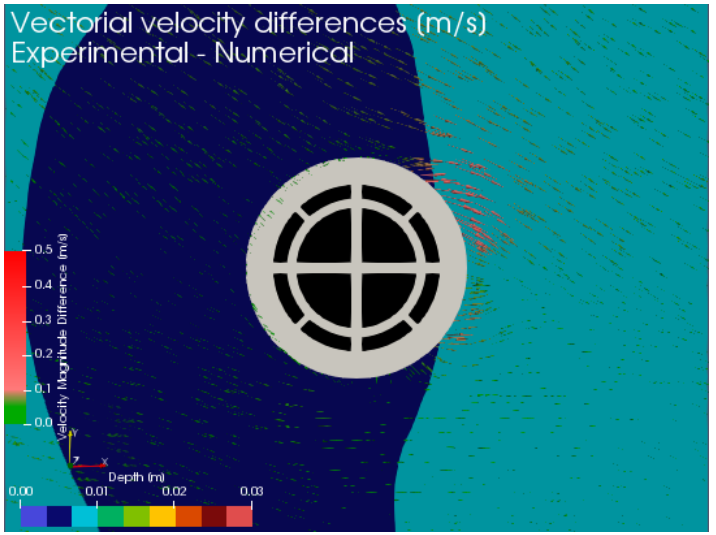
- Fast generation of 2D velocity data for a range of street setups
  - Model testing and verification

Surface Obstructions



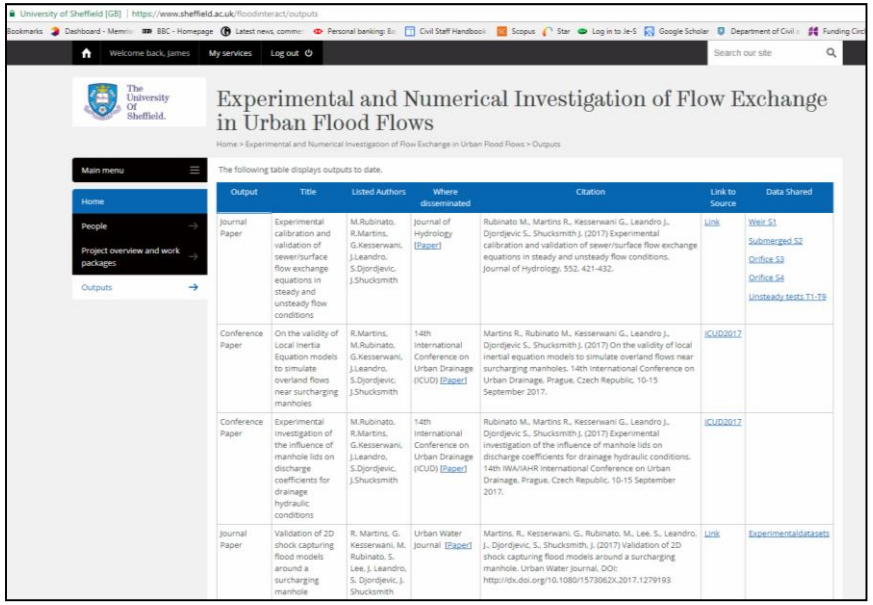
Work to Date

- Sewer/Surface Interaction – *Mostly completed*
- Soluble Pollutant Transport - *Lab setup and initial model developed. Data collection in progress!*
- Model Verification – *Some work completed but some still to do.*
- Lots of opportunities and potential for future work……



Open Data, Resources and Findings

- Papers are open access
- Raw data is open access
- Work ongoing – material will be added throughout 2018-2019



https://www.sheffield.ac.uk/floodinteract/outputs

Questions?