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| Errors and spatio-temporal variability of urban rainfall |
| **Project Outline** |
| Flooding and maintaining clean surface water are major engineering and societal challenges. One of the biggest sources of uncertainty in predicting flooding and managing water quality is our knowledge about rainfall. Rainfall is surprisingly difficult to measure, because it varies significantly in both space and time, it can vary by 30% from one roof to another only 100s metres away[[1]](#footnote-1). Interactions between rainfall variability, urban catchment heterogeneity, and hydrological response at multiple urban scales remain poorly understood[[2]](#footnote-2).  This can lead to considerable errors in urban drainage simulation models, which are used to design urban flood protection measures, or systems to reduce surface water pollution from urban drainage systems. The UK Water Industry invests billions in its sewerage services, (£39bn between 1990 and 2015[[3]](#footnote-3)), and investment decisions are mostly made based upon modelling results.  Measuring rainfall in urban areas is further complicated, due to the influence of buildings, and the errors that arise from this have rarely been studied before. Hence this project aims to better understand the sources of errors in urban rainfall measurement and to analyse how street scale spatial and temporal variation of rainfall could translate into errors in the modelled hydrological responses from urban surfaces.  A high density paired rainfall network set-up in Sheffield (and a similar one previously sited in Bradford) is unique as far as the supervisors are aware. Analysis of the data from this network has so far focussed on analysing the spatial variability of rainfall, but the impact of this variability on local urban hydrology, and the potential for it to lead to force-fitting of models, has not been studied yet. The student would be expected to continue rainfall data collection and maintain and recalibrate the rain gauge network. The student would then be expected to study different techniques for analysing rainfall spatial variability and measurement errors, and the implication of errors and variability on rainfall runoff modelling. The student would furthermore be expected to review the latest UK water industry code of practice on use of rainfall data, and urban hydraulic modelling. The student would then look to find pragmatic methods of implementing uncertainty in rainfall data due to spatial variability and errors into practitioners’ modelling workflow. |
| **Primary supervisor** |
| Alma Schellart, Civil and Structural Engineering, Theme 2  *Email: a.schellart@sheffield.ac.uk* |
| **Other members of the supervisory team** |
| Virginia Stovin, Civil and Structural Engineering, Theme 4 |
| **How the proposed project adds value to TWENTY65** |
| TWENTY65 Theme 4 aims to model and understand the potential to employ rainwater harvesting alongside sustainable drainage systems to efficiently integrate potable water supply with stormwater management. The PhD links this work to raingauge network and data collected as part of the QUICS ITN project, and the Urban Observatory led by Martin Mayfield.  The project aims to translate the spatial rainfall statistics into simple rules of thumb and clear guidance for Water Utilities and consultants, as this kind of guidance is currently lacking from the CIWEM UDG rainfall guide and Code of Practice for Hydraulic Modelling. |
| **Suggest titles and journals for two 4\* papers that you expect to arise from the project** |
| *Paper 1*  Interactions between rainfall variability and urban hydrological response at multiple urban scales  *HESS or Advances in Water Resources*  *Paper 2*  Not a 4\* paper but a good industrial impact paper on effect of current rainfall measurement practice on model force fitting. |

1. Muthusamy M., (2017). Geostatistical upscaling of rain gauge data to support uncertainty analysis of lumped urban hydrological models. HESS. https://www.hydrol-earth-syst-sci.net/21/1077/2017/ [↑](#footnote-ref-1)
2. Christiano et al. (2019) Spatial and temporal variability of rainfall and their effects on hydrological response in urban areas – a review. HESS. https://www.hydrol-earth-syst-sci.net/21/3859/2017/ [↑](#footnote-ref-2)
3. Waste water treatment in the United Kingdom – 2012 Implementation of the European Union Urban

   Waste Water Treatment Directive 91/271/EEC, Defra, 2012.

   https://www.gov.uk/government/uploads/system/uploads/attachment\_data/file/69592/pb13811-waste-water-2012.pdf [↑](#footnote-ref-3)