# Adaptation strategies to pluvial urban flood risk under UKCP18 climate change scenarios

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**CASE Partner:** WSP
**Other Partner:** Leeds City Council

## Science background

The frequency and impact of heavy rainfall associated with summer convective storms and winter frontal storms is projected to increase with future climate change. Higher intensity rainfall poses significant pluvial flooding challenges in urban areas, which have constrained mitigation options due to existing infrastructure and developments. Local authorities need to account for climate change in flood mitigation strategies and currently use regional climate models (RCM's) such as the UKCP09 climate projections issued by the Met Office (Rabb et al, 2017). These model simulations provide projections of how variables such as temperature, rainfall, and humidity may change at a regional level under climate change. RCMs have a number of advantages over more traditional Global Climate Models (GCMs); they provide information at a higher spatial resolution (a few kilometres compared to 20-100km) and they are able to account for smaller scale atmospheric circulations such as those associated with convective thunderstorms, producing more realistic rainfall and flood intensities and frequencies (McGregor, 1996; Rabb, 2017). The UKCP18 climate projections build on UKCP09. UKCP18 has an even finer resolution and provides more sophisticated climate projections, with greater detail at regional scales (Rabb et al, 2017). The RCM data, alongside hydrology and hydraulic modelling, enables an enhanced understanding of how climate change will impact streamflow, river hydrology and flood risk.

Despite these significant advances in climate modelling, there are still major research gaps in terms of how this enhanced resolution climate understanding translates into flooding impacts, as well as how best to utilise this new data in existing flood assessment methodologies and models. This project will specifically address this research gap.

Along with traditional flood defence options, sustainable urban drainage systems, and more recently natural flood management methodologies are all now being utilised as mitigation options to addressing increased flood risk. However, how best to utilise this combination of options in a given urban catchment is not always obvious, given the complexities of real flood defence schemes. As well exploring climate change projections, this project will also look at a range of mitigation options used in real flood defence schemes, with engineering grade flood models provided by partners.

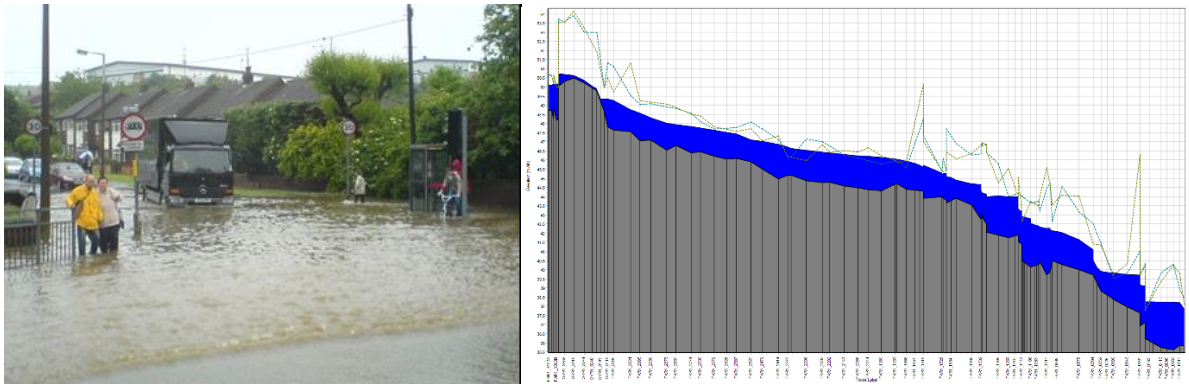

*Figure 1: Flooding in Wortley Beck urban catchment (Leeds) has resulted in damage to local residents, businesses and compromised structural integrity (left). Typical engineering grade hydraulic flood model (right).*

## Objectives

This PhD project provides a unique opportunity for a student to integrate two linked research areas, working at the interface of cutting edge climate modelling and flood risk assessment. The support of partners WSP and LCC provide the opportunity to work with and learn from flood defence professionals, while maximising impact of the research.

Specifically, the project will address the following objectives:

- Undertake an evaluation of present-day mean and extreme rainfall in UKCP18 (and UKCP09) over the Leeds region against radar and rain gauge observations. It is really important to gain an understanding of any biases and errors before using the climate models to drive flood hydrology and hydraulic models. This analysis will also demonstrate the added-value of the high resolution RCM simulations.
- Investigate the differences between the rainfall projections in UKCP09 and the UKCP18 for pluvial flooding to inform the flood modelling community of the implications as they adopt UKCP18 data for national flood risk assessments.
- Carryout hydrology and hydraulic modelling for multiple urban catchments that are sensitive to pluvial flooding across the study region using UKCP09 and UKCP18 projections and identify implications for flood risk practice, particularly of the enhanced resolution. These models will be professional consultancy models provided by WSP in agreement with LCC.
- Geographical scope will be expanded through other iCASP project partners, possibly to Sheffield and York for example. The Yorkshire Integrated Catchment Solutions Programme (iCASP) is an ambitious and exciting programme to generate benefits for Yorkshire by applying environmental science to catchment challenges (https://icasp.org.uk/).
- Within the above context, explore our understanding of current Sustainable Urban Drainage (SUDS) and Natural Flood Management (NFM) strategies and their optimisation within the chosen study catchments. This will require creative and innovative approaches to implementing complex options efficiently within engineering flood models.

## Student profile

The student should have a strong interest in environmental problems related to meteorology, climate and flood risk. Ideally they will have a strong background in a quantitative science (math, physics, engineering, environmental sciences) and a flair for, or a good familiarity with, programming and scientific computing.

## Training

The student will work under the supervision of Dr Mark Trigg (Flood Risk and NFM), Dr Christian Berretta (SUDS and drainage), Dr Cathryn Birch (Climate modelling), Paul Lambert (WSP, Flooding & Drainage), and Matt Sherwood (LCC, Flood Risk). The student will benefit directly from an existing partnership between UoL, WSP and LCC as well as the iCASP project and water@leeds network for wider partnerships and opportunities.

The student will receive a high-level of training in:

(1) Meteorology and climate science
(2) Hydrology and hydraulic processes
(3) SUDS and NFM approaches
(4) Professional flood and drainage modelling software, such as Floodmodeller, TuFLOW and Infoworks.
(5) Experience of professional flood risk assessment practice
(6) The use of state-of-the-art model simulations and observational data sets to understand atmospheric processes
(7) Computer programming and scripting languages (e.g. Python, javascript, R)
(8) Effective written and oral communication skills.

There will be the opportunity for international travel to conferences to share findings with the international science community and for research visits to other universities, such as the Universities of Sheffield and York, amongst others.

## UoL, WSP and LCC Partnership

WSP and Leeds City Council (LCC) have been working closely with the University of Leeds on pluvial flooding research over the past year and this PhD project benefits from that collaboration through access to current case studies, professional flood models and relevant data. This means the student will have access to required data and models immediately and can focus on developing an innovative and groundbreaking research project. WSP are the CASE partner for this project and WSP will also provide a student placement at their Leeds office in order for the student to gain an important grounding in professional flood risk practice. LCC are also important partners as they are a Lead Local Flood Authority and therefore have a duty to investigate flooding.

## References and further reading


- Rabb, B., Norman, J. and Dessai, S. (2017). Pathways to Assess Future Intense Rainfall and Flood Risk in Yorkshire Using the Latest UK Climate Change Projections. Yorkshire Integrated Catchment Solutions Programme, iCASP report.
- Ahilan, S., Wright, N., Sean, T. and Sleigh, A. (2014). Flood risk management of a small urban river using a sustainable urban drainage system: Wortley beck, Leeds, uk. 11th International Conference on Hydroinformatics. New York, USA.
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- Fowler, H. J. and Ekstrom, M. (2009) Multi-model ensemble estimate of climate change impacts on UK seasonal precipitation extremes. Int. J. Clim., 29, 385–416, doi:10.1002/joc.1827.
- Pitt, M., “Learning lessons from the 2007 floods”, The Cabinet Office, London (2008)