Over 2 million people in the UK are currently exposed to an annual urban pluvial flood risk of 0.5% or greater and this type of flooding is estimated to cost over £270 million a year in England and Wales. While this calls for improvements in the forecasting and mitigation of floods, the changing climate makes it imperative to revise the design of pipes and storages that are appropriate for future urban flows. Indeed, the Intergovernmental Panel on Climate Change (IPCC) estimates that by 2081-2100, it is very likely (i.e. the probability is at least 90%) that there will be a further increase in heavy precipitation over most of the mid-latitude (temperate) land regions and over wet tropical regions.

Currently, consultants who advise water companies for their designs make use of estimates of future rainfall extremes obtained by applying scaling factors to past estimates under a stationary climate (see the UKWIR CL/10 project report from 2004: https://www.ukwir.org/eng/forefront-report-page?object=66631) or use a stochastic generator that is suitably updated for a future climate (UKCP09: http://ukclimateprojections.metoffice.gov.uk/23261).

While the first approach suffers from limitations that are well-known, namely the fact that antecedent conditions are not taken into account when an extreme event happens, the second has been recognised by many consultants as the way forward. It has the additional advantage of generating extreme rainfall events with a realistic profile. Although the UKCP09 weather generator is likely to be updated, its main shortcoming remains its use of the precipitation projections from Regional Circulation Models (RCMs). Even though there is a fair amount of progress in the quality of rainfall from RCMs, it remains the case that the amounts of precipitation estimated by these models are not derived from the physical equations, but are empirical estimates. Also, although some non-stationarity can be introduced, this modelling approach does not enable this to be driven by the non-stationarity of climatological variables.

The proposal here is to make use of the climatological variables that are physically modelled by RCMs as explanatory variables in the calibration of a stochastic model that is built upon a Poisson-cluster process. This will enable time-series to be generated for future climates to be generated by drawing upon the estimates of sea-level pressure, humidity, temperature, etc. for a future climate under different emission scenarios. These time-series can directly be used in design by consultants.
who can then input them into their hydrological and hydraulic models to test different potential pipe and storage designs.

The project will consider at least three different approaches for the incorporation of the climatological information. A first approach involves combining a regression-based approach to capturing the dependence upon climatological variables at a coarse time-scale with a Poisson-cluster based model in downscaling mode. Using recent research, we can also let the influence of the climatology be defined through neighbourhood relations, so that model parameters are estimated by giving more weight to historical data with relevantly similar climatology. Finally using a recent run of a Numerical Weather Prediction model for present and future climates, we can seeks to obtain a better understanding of the spatial scaling behaviour of key rainfall statistics, and thereby enable point statistics to be inferred to fit rainfall models for the present and the future.

Eligibility and Funding

Applicants should have a degree in Engineering, Mathematics or Physics, a good knowledge of and interest in statistical methods, as well as strong computing skills.

Funding is available for applicants with settled UK status (see https://www.epsrc.ac.uk/skills/students/help/eligibility/ for eligibility). The studentship offers a stipend of approximately £16,000 per annum (tax free) and covers fees at the UK/EU student rate for a period of four years.

Contact

For informal enquires and to request more information, contact Dr Christian Onof

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This PhD studentship is co-funded by the EPSRC CDT in Sustainable Civil Engineering at Imperial College London:

(http://www3.imperial.ac.uk/sustainablecivilengineering)

Deadline

Review of application is now in progress and will continue until suitable candidate is identified. The starting date for this PhD Studentship is 1st of October, 2017.