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Flood demonstrator 'Wetropolis': extreme rainfall and river flooding in an urban environment

Tom Kent (1), Onno Bokhove (1), Wout Zweers (2), and Tiffany Hicks (1)
(1) School of Mathematics, University of Leeds, United Kingdom, (2) Wowlab at Rombeek Studios, Netherlands

Urban flooding is a major hazard worldwide, brought about by intense rainfall and exacerbated by the built environment we live in. Our tabletop flood-demonstrator 'Wetropolis' illustrates how extreme hydroclimatic events can cause flooding of a city due to peaks in groundwater and river levels following intense rainfall in a simplified modelling environment. It aims to conceptualise the science of flooding in a way that accessible to and directly engages the public and also provides a scientific testing environment for flood modelling, control and mitigation, and data assimilation. As such, it is useful to the scientist, industrial practitioner, and general public.

Physically, it comprises a river channel with parallel canal, a reservoir for water storage, a porous flow cell (analogous to a moor) with observable groundwater flow, and random "rainfall", which may or may not lead to flooding in the idealised urban area of Wetropolis. Rainfall is supplied randomly in space at four locations (in a reservoir, on a moor, at both places, or nowhere) and randomly in time at four rainfall intensities (1s, 2s, 4s, or 9s during a 10s Wetropolis day – this can be adapted by design) via two skew-symmetric discrete probability distributions. These distributions are visualised using two Galton boards and include one 'extreme' event that leads to flooding.

Its design is based on simulations of a one-dimensional numerical model of the dynamics coupled with a stochastic rainfall generator. A simple kinematic model describes the river flow and a depth-averaged nonlinear diffusion equation models the groundwater flow. The mathematical design will be presented here alongside illustrations of Wetropolis in action and ideas for its use as a scientific testing environment. More information (public page): https://www.facebook.com/resurging.flows