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System Performance of networks of NFM

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In our attempts to emulate natural flood risk management, we should also pause to learn from nature about system performance, such as beaver-dam failures, cascade failure leading to very high flood peaks, or for example downstream asset blockage from woody debris. This is not to detract from the obvious merits and multiple benefits of NFM, but to try and better appreciate the risks.
One approach has been to develop simple 1d and 2d hydraulic models with fragility assumptions about modelled leaky barriers and explore utilisation of dynamic storage, flood peak synchronisation (Metcalfe et al, 2017), resilience in the face of different spatial extreme rainfall (Hankin et al., 2016) and occurrence of failure. In this paper we explore whether there are better spatial configurations of leaky barriers (main stem or headwater) taking into account of effectiveness to reduce flooding and the possibility of failure and cascade failure using an ensemble of simulations.
The work was undertaken at a Maths Foresees “Environmental Modelling in Industry Study Group”, based on a challenge set by the JBA Trust in April, 2017. A team of mathematicians developed a network-based model of a catchment basin that incorporates the possibility of small-scale runoff attenuation features (‘leaky dams’) being incorporated into each of the edges of the network.
The model is forced by a prescribed runoff to each node and predicts the time series of discharge through-out the network. It can be used to analyse the benefit and risk associated with adding dams at specific network locations. We demonstrate the model using idealised one-dimensional and two-dimensional networks, and explore the risk of cascade failure. We discuss the formulation of an optimisation problem to decide on the best dam placements for a given catchment, and give suggestions for future directions.