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Modelling the Impacts of Land Use and Management Change on Flood Risk using Information Packets

G. M. O'Donnell, J. Ewen, P. E. O'Connell

School of Civil Engineering and Geosciences, University of Newcastle Upon Tyne, Newcastle Upon Tyne, UK (g.m.o'donnell@ncl.ac.uk / Phone ++44 191 222 6405)

Distributed hydrological and hydraulic simulations generate an overwhelming amount of information on the spatial and temporal variations in runoff generation and flow, much of which is usually disregarded. For example, detailed simulations are sometimes run when evaluating the flood impact of a given change in land use or land management, but the analysis often simply involves comparing pre-change and post-change hydrographs at a couple of downstream locations in the catchment. There is considerable potential to use the disregarded information to learn more about how floods are generated. It can, for example, be used to show the sensitivity of the hydrographs to changes in the spatial patterns of runoff generation.

One approach to tracking information within a distributed model involves injecting packets of information wherever runoff is generated, and tracking the packets as they move downstream. In its very simplest and least efficient form, this involves injecting a packet with each unit volume of water generated, and allocating to each packet the time and location of its generation. The packets are then tracked through the river network, assuming they travel at the flow velocity. To recover the information, the packets travelling past particular points in the network are interrogated. The recovered information can be used in many ways. For example, it is possible to create spatial maps associated with a flood peak, showing the runoff source locations and intensities associated with the peak, or to break down the hydrograph into contributing hydrographs, one per subcatchment or per area undergoing change. An application of this type is demonstrated for the upper Eden Catchment, UK.

Sophisticated approaches are possible, which take better account of the way that information and perturbations propagate in river channels (modelled using the Saint

Venant equations). Any type of constant or time varying information can be tracked using information packets, so there are several potential uses for the approach, such as investigating the propagation of uncertainty. Another potential use is where models that are expensive to run are to be used in ensemble or Monte Carlo simulations. Information on sensitivity, along the lines described above, can be used to make the process of selecting parameter sets more efficient and effective.