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Natural variation and planned management in flood risk management: empirical evidence of effects on peak travel times

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The case in principle for natural flood management (NFM) is well established in countries around Europe. When addressing matters of detail, hydrologists are called on to provide estimates of the effectiveness of various possible NFM measures for design purposes. The methods and assumptions to be used are the focus of much scientific debate, not least given the differences in catchment and climatic conditions amongst potential catchments for application.

Field data are of vital importance: in establishing the scope for NFM effectiveness, in the calibration of models for regional application, and also for local application where available. An ideal scenario for evaluation of the effectiveness of installed NFM measures is the BACI (Before-After-Control-Impact) scenario where hydrological data are gathered over a period of years before measures are installed, and then continue to be gathered in the period after installation. However, this is often difficult to achieve in practice: funds for NFM are often limited; money spent on monitoring may be at the expense of the measures themselves at the same site or elsewhere; field equipment needs to be installed and operated according to recognised standards; calibration of flows is often difficult for logistical reasons and there are often questions about representativeness or the transferability of findings from one site to another.

This paper reviews observed evidence of natural and planned hydrological change in the Eddleston catchment in Scotland's Borders region. It benefits from an unusually dense network of 12 stream flow gauges across a 65 km2 catchment area, including 7 gauges on a 12 km main stem. The network has been monitored for 2 years since the first measures were installed, and more than 4 years since.

A set of 32 flow restrictors installed on the 2.3 km2 Middle Burn is associated with a delay of more than one hour in the time of peak water level compared with an adjacent analogue catchment. For flood management, this is an encouraging result and the channel has since benefited from the introduction of additional similar structures.

Meanders were also introduced on some 2.2 km of the main channel Eddleston Water. The re-meandering was targeted primarily at hydro-morphological improvements and was not expected to lead to significant increases in travel time. Empirical analysis of the 6 years of observed data confirms this. However, a major storm over the catchment in the second year of monitoring (and before the re-meandering) was found unexpectedly to be associated with a reduction in flood peak travel times of more than one hour. Bed scour may be at least part of the reason for the observed change. The change has been independently verified by comparison of the timing of flood peaks leaving the outfall of the Eddleston catchment relative to the timing of flood peaks on the confluent River Tweed.

The paper provides a useful contrast between the hydrological effects of naturally occurring and planned interventions. Ongoing work combines modelling approaches with statistical analyses.