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Determining which land management practices reduce catchment scale flood risk and where to implement them for optimum effect

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The theoretical basis for why changes in land management might increase flood risk are well known, but proving them through numerical modelling still remains a challenge. In large catchments, like the River Eden in Cumbria, NW England, one of the reasons for this is that it is unfeasible to test multiple scenarios in all their possible locations. We have developed two linked approaches to refine the number of scenarios and locations using 1) spatial downscaling and 2) participatory decision making, which potentially should increase the likelihood of finding a link between land use and downstream flooding.

Firstly, land management practices can have both flood reducing and flood increasing effects, depending on their location. As a result some areas of the catchment are more important in determining downstream flood risk than others, depending on the land use and hydrological connectivity. We apply a downscaling approach to identify which sub-catchments are most important in explaining downstream flooding. This is important because it is in these areas that management options are most likely to have a positive and detectable effect.

Secondly, once the dominant sub-catchment has been identified, the land management scenarios that are both feasible and likely to impact flood risk need to be determined. This was done through active stakeholder engagement. The stakeholder group undertook a brainstorming exercise, which suggested about 30 different rural land management scenarios, which were mapped on to a literature-based conceptual framework of hydrological processes. Then these options were evaluated based on five criteria: relevance to catchment, scientific effectiveness, testability, robustness/uncertainty and feasibility of implementation. The suitability of each scenario was discussed and prioritised by the stakeholder group based on scientific needs and expectations and local suitability and feasibility. The next stage of the participatory approach was a mapping workshop, whereby a map of the catchment was laid out and locations where each scenario could feasibly be implemented were drawn on. This was combined with an analysis of historical maps to identify past land covers and a catchment walkover survey to put modelling work in the real world context.

The land management scenarios were tested using hydrological and hydraulic models. Landscape scale changes, such as the effects of compaction and afforestation were tested using a catchment scale hydrological mode, CRUM2D. Channel scale changes, such as re-meandering and floodplain storage were tested using the 1D hydraulic model, iSIS, by altering channel cross sections and creating spills between the channel and floodplain. It is expected that the channel modification and floodplain storage scenarios will have the greatest impact on flooding both at the local and catchment scales. The landscape scale changes are more diffuse and therefore their impact is expected to be less significant. Although, early analysis indicates that the spatial location of changes strongly influences their effect on flooding.