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Experimental modelling Natural Flood Management interventions at the catchment scale

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Natural Flood Management (NFM) techniques are becoming more popular due to their lower cost execution compared with traditional flood management schemes, and their potential in reducing flood risk in the context of climate change. The predominant aim of NFM is to reduce flood risk downstream within a catchment, by storing stormwater in the upper reaches. However, an additional benefit concerns the possible reduction in the mobilisation of sediment. Although this benefit is often cited to support NFM schemes, there is limited understanding of the impact on sediment dynamics and flux, and thus the longer-term impacts on the evolution of the catchment and the flood hydrograph. Scaled catchment experiments have been performed at the Total Environment Simulator (TES) at the University of Hull, to examine the effect of the introduction of NFM measures on the flood hydrograph, and the associated erosion and sediment dynamics within catchments.

Two catchments were created, each measuring 4.0x4.0m, tapering to a 1.5m wide outlet. The catchments consisted of a central valley with 4% slope, superimposed on a long axis downward slope of 10%. To examine the impact of scaling, the catchments were constructed from two varieties of sand (μ=215microns and μ=458microns). The TES rainfall generator was used, allowing rainfall over both of the catchments. Three rain intensities were achieved, representative of low (35mm/h), medium (92mm/h) and high (125mm/h). This resulted in five different rainfall events, run in the same sequence across three days. Water and sediment was collected at the outlet of the catchments allowing quantified comparisons. TLS scans of the evolved surfaces were also obtained such that the morphological evolution of the catchment under the range of scenarios could be tracked. During the initial phase of these experiments, the catchments consisted of bare sediment, to provide a baseline set of results. Subsequent experiments used alfalfa seeds, to replicate woodland planting, at a range of densities across the catchments. The seeds were spread evenly across the basins and vegetation was allowed to grow for 10 days.

The results show only minor changes to the hydrology but a clear reduction in the sediment outputs when vegetation was added. For the finer sediment, a reduction of 10-20% can be observed between the bare sediment run, and the lower seed density. This increases to a reduction of approximately 40-50% when the seed density is increased. For the coarser sediment, the effect of adding vegetation is greater. A reduction of 20-40% in sediment output is observed in the lower density vegetation, which increases to an 80-90% decrease in the higher density runs. These experiments show the potential of this approach to address long-term quantification of the impacts of NFM interventions. The results indicate that the planting of vegetation has had a significant effect on the geomorphological evolution of the catchments, but only a very small influence on the overall hydrology. In the vegetated catchments, change was focused in the channels between the vegetation, where potentially other NFM measures could be incorporated as part of future work.