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Assessing the performance of multi-purpose channel management measures at increasing scales

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In addition to hydroclimatic drivers, sediment deposition from high energy river systems can reduce channel conveyance capacity and lead to significant increases in flood risk. There is an increasing recognition that we need to work with the interplay of natural hydrological and morphological processes in order to attenuate flood flows and manage sediment (both coarse and fine). This typically includes both catchment (e.g. woodland planting, wetlands) and river (e.g. wood placement, floodplain reconnection) restoration approaches.

The aim of this work was to assess at which scales channel management measures (notably wood placement and flood embankment removal) are most appropriate for flood and sediment management in high energy upland river systems. We present research findings from two densely instrumented research sites in Scotland which regularly experience flood events and have associated coarse sediment problems. We assessed the performance of a range of novel trial measures for three different scales: wooded flow restrictors and gully tree planting at the small scale (<1 km2), floodplain tree planting and engineered log jams at the intermediate scale (5-60 km2), and flood embankment lowering at the large scale (350 km2).

Our results suggest that at the smallest scale, care is needed in the installation of flow restrictors. It was found for some restrictors that vertical erosion can occur if the tributary channel bed is disturbed. Preliminary model evidence suggested they have a very limited impact on channel discharge and flood peak delay owing to the small storage areas behind the structures.

At intermediate scales, the ability to trap sediment by engineered log jams was limited. Of the 45 engineered log jams installed, around half created a small geomorphic response and only 5 captured a significant amount of coarse material (during one large flood event). As scale increases, the chance of damage or loss of wood placement is greatest. Monitoring highlights the importance of structure design (porosity and degree of channel blockage) and placement in zones of high sediment transport to optimise performance.

At the large scale, well designed flood embankment lowering can improve connectivity to the floodplain during low to medium return period events. However, ancillary works to stabilise the bank failed thus emphasising the importance of letting natural processes readjust channel morphology and hydrological connections to the floodplain.

Although these trial measures demonstrated limited effects, this may be in part owing to restrictions in the range of hydroclimatological conditions during the study period and further work is needed to assess the performance under more extreme conditions. This work will contribute to refining guidance for managing channel coarse sediment problems in the future which in turn could help mitigate flooding using natural approaches.