



A regional scale analysis of geomorphic channel adjustments in upland rivers over 150 years: English Lake District, UK.

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Upland rivers are active geomorphic systems that undergo frequent changes in channel planform due to the steep channel gradients, flashy discharge regimes and high sediment supply. Traditionally these rivers have been managed on a local ‘piecemeal’ scale. However, identifying historical channel planform adjustments at the larger regional scale (multiple catchments) can indicate regionally consistent longer-term changes in sediment continuity and the controls on channel behaviour. This research analyses historical changes in channel planform and sediment bar movement in upland rivers in the central Lake District, UK (1000 km²), from 1860 – 2017 using historical maps and aerial photographs. We evaluate the type, frequency and location of changes in channel planform and sediment bars in relation to a range of catchment (climate, catchment area), sub-catchment (topography, slope) and reach scale (channel confinement, anthropogenic structure) controls. The study area has a distinctive radial drainage pattern and we analyse 14 catchments, ranging in size from 7 – 360 km². Approximately 85% of channels surveyed have a Strahler stream order between 1 – 3 and mean channel slopes range from 0.0005 - 0.9. The most common forms of channel adjustment observed over the 150 year period were associated with the movement of sediment bars downstream and increases in channel width. Flood events in 2015, 2009, 2005 and 1995 were important in mobilising sediment stored in river channels and causing local changes in channel width. The results show that whilst changes in channel planform were observed at the reach scale over short time periods, catchment controls (i.e. flooding) can influence geomorphic channel adjustments over longer timescales and wider spatial scales. To identify the dominant controls on channel planform change and assess the potential for future change to effectively manage these systems multiple catchment wide spatial and temporal assessments are required.