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Quantifying 3-D morphological change within wandering gravel-bed rivers over time: the River Coquet, Northumberland, UK

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Abstract

Clearer understanding of processes governing wandering gravel-bed river dynamics is essential to provide better context for their long-term management. Many studies have documented contemporary processes and factors controlling planform change in UK wandering gravel-bed rivers; however few studies have quantified their subsurface sedimentary architecture. The research described here addresses this gap by quantifying subsurface sedimentary architecture for the River Coquet, Northumberland UK, combining this data with analysis of change in surface channel morphology for the period of the last 160 years using Ordnance Survey maps. By producing a detailed 3-D model of the system at the reach scale, we characterise the sedimentary architecture associated with palaeo-fluvial change and dynamism. Initial steps were to combine detailed topographic surveys with historical maps and aerial imagery and repeat LiDAR analysis. Combining these data sets with a Pulse EKKO Ground Penetrating Radar (GPR) survey and analysis of sediment exposures allows 4-D quantification of reach-scale river channel behaviour - through time and in three spatial dimensions.

River planform adjustment between 1860 and 2016 was quantified over a distance of 20 km for (i) channel width, (ii) rate and style of migration and channel avulsion processes, and (iii) extent of palaeochannel re-occupation and/or instigation of new channels. Long-term instability of the river channel at this position in the catchment is attributed to flood events impacting the low gradient system. This instability is manifest primarily by channel avulsion with contemporary observations of woody debris in the modern system showing it to generate localised river bed scour and sediment deposition, in turn leading to significant localized channel instability. GPR data collected to depths of 10 m provide detailed insights into the relationship between sedimentary architecture and known patterns of reach-scale geomorphological change over time. This study provides a new comprehensive model of UK wandering gravel-bed river evolution.