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# Terrestrial Laser Scanning in Fluvial Geomorphology: Retrieving Morphological and Sedimentological Models of Gravel Bed Rivers

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Developments in survey technology have enabled a revolution in the study of river morphology and fluvial processes. Terrestrial Laser Scanning technology offers the potential to acquire rapidly, reach-scale datasets which record topographic information at the resolution of bed grain-scale upwards. Based on time-of-flight or phase-based laser ranging, these instruments are capable of acquiring unprecedented volumes of survey-grade observations at operating frequencies of between 5-500 kHz and over ranges 25-1000 m.

This hitherto unprecedented data-stream presents new opportunities for river science, but also creates significant challenges particularly associated with: data management; regularization of resolution; visualization; and data assimilation with parallel models and data-products. In this paper we present a new methodology designed to analyze large 3d point clouds generated by terrestrial laser scanning. Specifically, the approach generates multi-resolution gridded terrain products from scan data whilst retaining the sub-grid scale information as key statistical attributes. We apply the method in two field sites: (a) a 1 km reach of the River Feshie, Scotland which was scanned in 2007 and (b) a 500 m reach of the actively braided Rees River, New Zealand which was scanned before and after 3 competent events in January 2008. In the first case we evaluate the results from the method through a comparison with independently acquired, spatially dense, GPS surveys of the study reach. The results reveal significant differences in the topographic signatures recorded by the two methods and reveal the value of the enhanced spatial resolution for representing complex morphologies and highlight the potential to retrieve grain-scale sorting patterns from the statistical attributes of the TLS data. In the case of the New Zealand data set, the results demonstrate that TLS can be applied to recover centimetre-scale channel morphology, maps of particle size, sorting, packing and floodplain roughness. Differencing sequential DEMs can then be used to quantify the volumes of erosion and sedimentation revealing the sediment budget and connected sediment transfer pathways at event scale.