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A Novel Field-Based Approach for Analysing Bar Reworking: Trialled in the Tongariro River, New Zealand

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Bars are key morphological units within river systems, fashioning the sediment regime and bedload transport processes within a reach. Reworking of these features underpins channel adjustment at larger scales, thereby acting as a key determinant of channel stability. Yet, despite their fundamental importance to channel evolution, few investigations have acquired spatially continuous data on bar morphology and sediment particle size to facilitate detailed investigations on bar reworking. To this end, four bars along a 10 km reach of wandering gravel bed river were surveyed, capturing downstream changes in slope, bed material size and channel planform. High resolution surveys of bar topography and grain-size roughness were acquired using Terrestrial Laser Scanning (TLS). The resulting point clouds were then filtered to a quasi-uniform point spacing of 0.05 m and statistical attributes were extracted at a 1 m resolution. The detrended standard deviations from the TLS data were then correlated to the underlying median grain size (D50), which was measured using the Wolman transect method. The resulting linear regression model had a strong relationship (R2 = 0.92) and was used to map median sediment size across each bar. Representative cross-sections were used to interpolate water surfaces across each bar, for flood events with recurrence intervals (RI) of 2.33, 10, 20, 50 and 100 years, enabling flow depth to be calculated. The ratio of dimensionless shear stress (from the depth raster and slope) over critical shear stress (from the D50 raster) was used to map entrainment across each bar at 1 m resolution for each flood event. This is referred to as 'relative erodibility'. The two downstream bars, which are characterised by low slope and smaller bed material, underwent greater entrainment during the more frequent 2.33 RI flood than the higher energy upstream bars which required floods with a RI of 10 or greater. Reworking was also assessed for within-bar geomorphic units. This work demonstrated that floods with a 2.33 year RI flush material on the bar tail, while 10 year RI floods rework the supra-platform and back channel deposits and only the largest flows (RI of > = 50) are able to entrain the bar head materials. Interestingly, despite dramatic differences between slope, grain-size and planform, all bar heads were found to undergo minimal entrainment (between 10 – 20 %) during the frequent 2.33 RI flood. This indicates that resistance at the bar head during frequent floods promotes the deposition of finer-grained, more transient units in their lee. This process-based appraisal explains channel adjustment at the reach-scale, whereby the proportion of the bar made out of more frequently entrained units (tail, backchannel, supra-platform) relative to more static units at the bar head exerts a direct influence upon the extent of adjustment of the bar and the reach as a whole.