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Quantifying the influence of flow stage on the modulation of near-bank flow by 'slump blocks'

Christopher Hackney and Daniel Parsons
University of Hull, Geography and Geology, Hull, United Kingdom (c.hackney@hull.ac.uk)

River bank erosion is primarily controlled by the rate of hydraulic action at the bank toe. Previous research has suggested that blocks of failed material (henceforth 'slump blocks') reduce hydraulic action at the bank toe through the delivery of protective material base of the bank resulting in the deflection high velocity flow away from the near-bank region. However, recent field observations have shown that when fully submerged, slump blocks may deflect flow up, over and toward the bank, enhancing rates of bank erosion. Understanding how varying flow stage affects the impact of slump blocks on the 3D flow field is vital for robustly predicting and thus managing river bank erosion rates. Yet, observations of the full 3D flow field around blocks at varying flow stages is currently lacking.

Here, we report on results from surveys conducted on the River Severn, Shropshire, UK across a range of flow stages (bank full flow, mean flow and low flow). Repeat acoustic Doppler current profiler data highlights how the near-bank flow field changes with both discharge and the interaction with submerged topographic features. High-resolution terrestrial laser scanning of the bank reveals loci of bank erosion as well as the residence time and life-cycle of failed slump blocks at the toe of the bank. Links between variations in bed and bank shear stresses and morphological change on the bank and blocks are identified, highlighting new interactions between toe material, flow stage and rates of bank erosion.