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Use of 2D hydraulic models to develop and improve parameterized 1D models of sediment transport

J. Tunnicliffe (1), M. Hicks (2), P. Ashmore (3), J. Walsh (2), J.T. Gardner (3,4), and M. Duncan (2)

(1) Department of Geography and Environmental Studies, Carleton University, Ottawa, Canada,, (2) National Institute of Water and Atmospheric Research, Riccarton, Christchurch, New Zealand, (3) Department of Geography, University of Western Ontario, London, Canada, (4) Stantec Consulting, Burnaby, British Columbia, Canada

Numerical morphological modelling of river channels is a rapidly expanding field, with a major thrust towards models with 2-D and 3-D hydraulic engines. However, by virtue of their relatively modest input data needs and rapid execution time, 1-D models remain the stock tool for simulating sediment transport and channel morphological evolution at the basin spatial scale and over decadal to millennium time scales. Application of 1-D models requires, however, that fine spatial detail in channel physical and hydraulic characteristics (such as bed texture, shear stress) are appropriately parameterised. This is particularly challenging in braided rivers, which are characterised by spatial variability in form and dynamics.

In this paper, we use output from high resolution reach-scale 2-D fixed-bed models on high-resolution (0.5 to 1 m2 field, 0.003 m2 lab) DEMs in braided and single-thread morphologies to parameterise bed shear stress appropriate for 1-D application. The frequency distributions of the scaled shear stress ( ) show very similar forms amongst all of the braided systems at a range of discharges. The overall distribution for each braided river is shown to be a composite of deeper flow threads in primary and secondary channels and shallower flows over depositional forms such as bars and lobes. The primary channels in the braided systems show a narrower distribution that is similar to single thread meandering rivers.

We show further that, both in the field and laboratory, there is only weak correlation between modelled shear stress and measured substrate texture. These results provide some scope for establishing an improved parameterization of the shear stress distribution of a river, based on the number of channels and whether the system is aggrading or degrading. This can be used to improve predictions of sediment transport within 1-D model frameworks. We emphasize the need for continued work in this vein to improve on the representation of 3-dimensional processes in 1 dimension.