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Morphological modelling of gravel rivers with vegetated banks and floodplain

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Bank vegetation can exert a substantial control on channel geometry, as evidenced by field and laboratory observations. This paper investigates the influence of vegetation on the meandering and braiding of a gravel-bed river by means of numerical modelling. The influence is quantified by varying the critical shear stress and hydraulic roughness for the bank and floodplain sediment. This parameterization takes into account that vegetation helps stabilize the bank sediments and also reduces near-bank and floodplain velocities. We consider an initially straight and single-thread channel with a wide, submerged floodplain. For given conditions of bank and floodplain vegetation, channel slope, bank-full discharge and median grain size, the subsequent morphological change of the channel is predicted. Numerical computations are used to determine depth-averaged, 2D flow, distributed gravel transport and continuously updated bed levels. The model has a scheme to deal with the wetting and drying of cells, and therefore allows bars to form and the channel to migrate laterally and become braided. Model results show the formation and upstream migration of gravel bars, confluence scouring and, in some cases, transitions to meandering and braiding channel patterns. In the cases where the given conditions cause the channel to be unstable, the instability grows out of bar formation, and the resulting braiding patterns are similar to the analytical results from instability analyses. The transition to meandering and braiding is sensitive to the imposed vegetation parameter as well as to the channel slope. Vegetation control on channel width and the transition from meandering to braded in a quasi-equilibrium state are discussed in the paper.