EGU22-10014
https://doi.org/10.5194/egusphere-egu22-10014
EGU General Assembly 2022

Linking sediment transport and river morphology

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River channel patterns and associated morphology are determined by a variety of factors: sediment supply and grain sizes are significant factors together with channel confinement and channel gradient. From decades we develop empirical and hydraulic equations which help us to link water discharge and channel geometry (and then indirectly its pattern) with transported sediment. Water discharge determines mostly the channel dimensions (width and depth), slope provides the rate of energy expenditure, and river morphology is eventually shaped by amount of sediment supply and its caliber. Notwithstanding that, our ability to quantify functional links between sediment connectivity, meant as amount, frequency, sizes and origins of transported sediment, and channel morphology is still pretty limited and mostly qualitative. For instance, we hardly can provide thresholds in sediment transport regimes for channel type shifts from braided to single channel or vice-versa. More in general, we still have limited ability to quantify the sensitivity of channel morphological alterations to changes in water and sediment fluxes.

In this contribution, we aim to discuss our findings linking the output of a network-scale sediment transport model (CASCADE) to river morphology in two different basins: the braided Vjosa River in Albania and a predominantly mixed load river system the Richmond River Catchment, in New South Wales, Australia. In the Richmond River we identified various controls linked to the simulated sediment fluxes: in-stream sediment storage units, junctions between different geomorphic river types, tributary confluences and sediment storage units within partly confined floodplain units. Such analysis lays the foundation for network scale identification and quantification of potential hotspots of geomorphic adjustment. In the Vjosa river we used the modeled sediment fluxes as input to a set of theoretically derived functions that successfully discriminate between multi-thread and single-thread channel patterns. This finding proves a clear connection between modeled sediment concentrations and observed river morphology. We were also able to observe that a reduction in sediment flux of about 50% (e.g., due to dams) would likely cause existing braided reaches to shift toward single thread morphology.

Our results highlight opportunities and limits, which arise integrating the outputs of recently available network-scale sediment transport models with river morphology mapping derived by emerging remote sensing technology. These new data and methods can potentially significantly advance our ability to understand and formally quantify functional links between water and sediment fluxes and associated channel morphology, and use this understanding for management applications.