Fluvial sediment dynamics in a changing climate and environment

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The episodic transport of sediment forming a riverbed during competent hydrological events is one of the most important processes determining the morphodynamic evolution of an alluvial channel (Church, 2006). Accurately characterizing and quantifying this process is essential for addressing several scientific and management questions, such as how frequently sediment moves and how much sediment is transported along the river network. Over the last decades sediment regime has been altered by human interventions (e.g., dams, sediment mining) in many rivers worldwide, and climate change is playing, and will play, a major role on sediment dynamics. As for river management, it is crucial to develop models that represent and quantify sediment dynamics. Such models are needed for mitigation of flood risk, restoration of riparian environment and management of coastal environments (e.g., beach retreat, sinking of deltas).
Despite significant advances in the study of sediment dynamics (e.g., using different types of tracers) and estimate of sediment transport (e.g., use of geophones, hydrophones, and acoustic Doppler profiling) major gaps and limitations still remain. As suggested by Gomez and Soar (2023) there is a need for a paradigm shift: less efforts should be put on estimate of sediment transport during individual events (often affected by poor representation of spatial and temporal variability and large uncertainties, specifically by using formulae), whereas characterization of bed material and textural changes should be increased. Similarly, major insights on sediment dynamics and their temporal modifications could be obtain from evolutionary trajectories of channel morphology, both using planform data (Brenna et al., 2022) and DEMs (Vericat at al., 2017).
The main research questions of this PhD project are: what type of data we really need to understand and estimate sediment dynamics in fluvial systems from the reach (local) to the river network (catchment) spatial scale? How can we link sediment dynamics and channel morphology on more solid basis and better explain their functional links? Besides, which methods are most effective and reliable to analyse and measure sediment dynamics at different spatial and temporal scales? The project will be focused on the reach and network scale and could benefit of an on-going project (start of the project is schedule in spring 2025) dealing with sediment management in the Piave River (Eastern Alps, Italy). Within this project a wide range of data will obtained about channel morphology, evolutionary trajectory, sediment characteristics and mobility, estimate of sediment transport at reach scale (using the “morphological method”; Vericat et al., 2017) and network scale (using D-CASCADE numerical model; see Figure 1).

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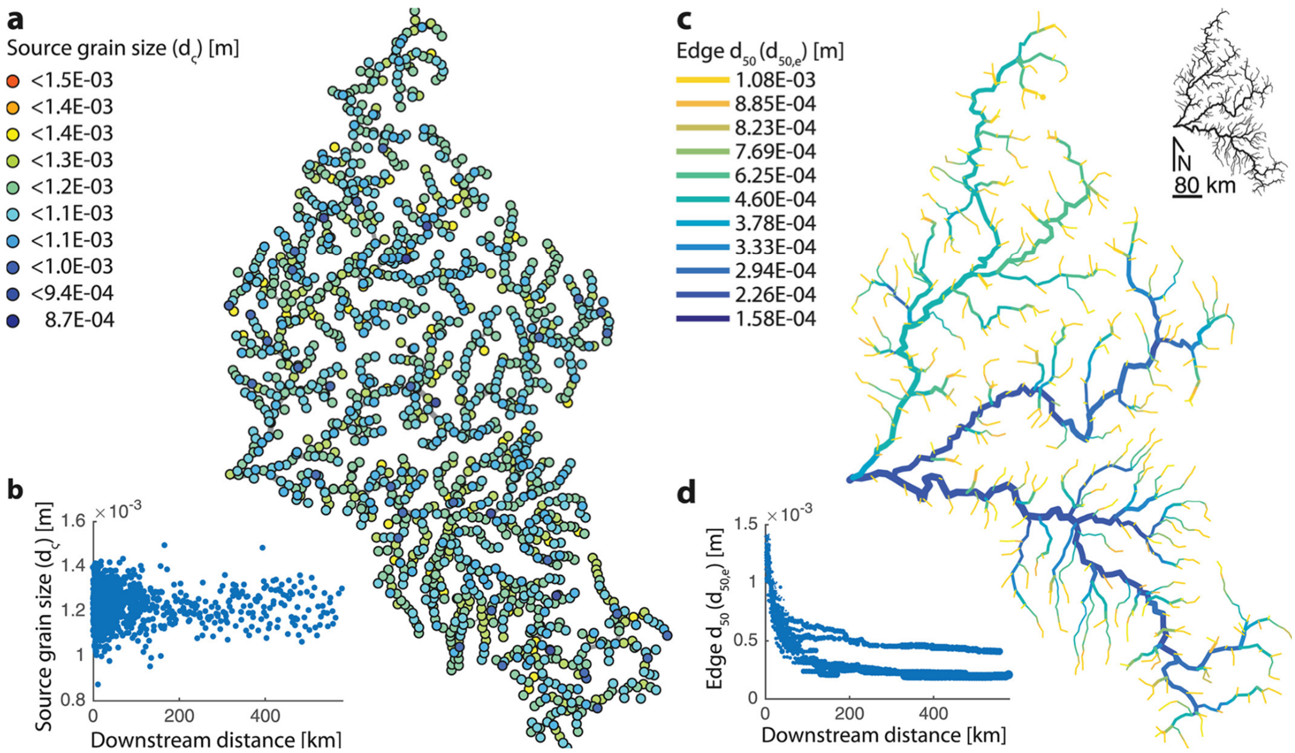

Figure 1. (a) Mean source grain size over the ensemble of accepted realizations. Grain sizes are randomly assigned to reaches. (b) Therefore, there is no downstream fining pattern in source grain sizes, dς (b). (c) Modeled median grain sizes in the bed material of reaches (d50,e) show a clear spatial organization, and (d) a clear correlation between the mean distance of a reach from its sources and the resulting median grain size. All panels show the mean over the accepted realizations. Small inset network map for scale and orientation. (from Schmitt et al., 2018)