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Cross-sectional characterization of seismic response and bedload transport in an Alpine braided river

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Braided river reaches show large temporal and spatial variability in morphological change and bedload transport. Whereas the functioning of these reaches is crucial for the storage and transfer of sediment in Alpine catchments, field-based measurements are scarce and typically non-continuous in both time and space. Here, we demonstrate how a rudimentary seismic approach can be used to investigate the magnitude and location of bedload transport during high flow events.

We installed geophones on the banks of a c. 60 m wide, braided reach of the Séveraisse River in the French Alps. Active experiments, consisting of dropping rocks with a known weight and from specified heights, were performed on the (dry) river bed at set distances along a cross section between seismometers located on opposite banks. Based on these, we quantify local (sub)surface wave propagation and attenuation. We retrieve impact locations with a precision of c. 10 m, and determine a Green's function from which the energy associated with the impacts, and thus the size and mass of the stone, can be inverted with an uncertainty of a factor 2. These derivations provide a physical basis for field characterization of seismic response, yielding constraints on the source and spatial extent of response, and on the calibration of bedload fluxes. Based on these insights we explore changes in seismic noise from bedload transport (large individual boulders and total sediment flux) over the course of a flood event and longer-term (seasonal) channel migration, and relate these changes to the morphodynamic evolution of the river bed. In general, we demonstrate that with limited means, in terms of equipment and field effort, detailed information may be acquired covering the temporal and spatial signatures of bedload transport in a braided river.