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Locating bed load transport in rivers from the correlation of the induced high-frequency seismic noise

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Monitoring the high-frequency seismic noise induced by rivers reveals a great potential for the study of sediment transport. Indeed, recording and analysing ground vibrations produced by particle impacts can be used to survey the river bed load transport. Despite its influence on the evolution of river morphology, this parameter remains highly difficult to assess with common geomorphic methods. To increase our knowledge on bed load transport, we explore the ability of cross-correlating long time-series of river seismic noise to extract some coherence from the seismic signal. We then extend the use of Noise Correlation Functions (NCFs) to locate stream segments of the trans-Himalayan Trisuli River that are responsible for the large high-frequency seismic noise observed at Hi-CLIMB stations. To locate these river sources, we perform a migration of a selection of NCF envelopes filtered at frequencies ranging from 2 to 6 Hz. We produce a set of coherence maps at each frequency and for various apparent velocities to determine the regions which best explain the observed NCFs. The highest coherences are always located along restricted portions of the Trisuli River and are generally obtained for an apparent velocity of 3 km/s. We also carry out a set of synthetic tests based on a full forward modelling approach for different distributions of sources. These simulations indicate that the observed NCFs are dominated by Rayleigh surface waves and that the sources are effectively located along the Trisuli River. These tests also reveal some artefacts induced by the linear geometry of the Hi-CLIMB network. By taking into account these artefacts, we determine that the sources of seismic noise are mostly concentrated along the steepest portion of the Trisuli River with a maximum at the front of the High Range. The distributions of river sources, presumably linked to the impacts of sediment particles on the channel bed, are in good agreement with incision rates along the river. Therefore, our study reveals the ability of locating zones of high river sediment transport and bedrock erosion based on the analysis of seismic noise recorded outside the stream.