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Using seismic and timelapse camera observations to study flood-induced morphological changes on an alpine gravel-bed reach

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Morphological changes in alluvial rivers are very active and remain very complex to predict because of the high spatio-temporal variability of bedload. This strongly limits the ability of river managers to assess risk or conduct ecological restoration. With the recent development of non-intrusive methods to monitor bedload, such as seismic or acoustic tools, acquisition of data has been highly facilitated compared to direct measurement methods involving in-situ sampling. The challenging task remains in the interpretation of the signals during phases of intense bedload transport which are responsible for major morphological changes. The analysis of such signals requires a good understanding of the underlying physics as well as in-situ field observations to confort interpretation. In this work, we combine seismic with timelapse camera observations with the objective to have a better understanding of bedload behavior and its consequences on the morphology during floods on an alluvial reach of the Severaisse river in the French Alps. Data consists in 3 seismic sensors continuously recording at 200Hz from upstream to downstream along the reach, as well as data from 2 cameras taking timelapse photos of the reach at a 10 min interval during flood. We We find that high frequency seismic power, attributed to bedload, exhibits a characteristic scaling relationship against discharge, materialized by two different phases: a scaling of about 5 from above the threshold of motion (around 12m3/s water discharge) up to a critical discharge of 25 m3/s, and a scaling of about 1.4 above 25 m3/s. We interpret the first scaling to be due to bedload occurring in a diluted regime as described in previous models, and the second scaling to be due to bedload in an intense transport phase. This shift only occur during floods where we observe channel shifting or important re-working of the bed and we suppose that it represents a phase of intense transport responsible for morphological changes. Interestingly, for the most extreme flood with a return period of 50-years, the seismic power versus discharge relationship shows a distinct behavior form the other floods, materialized by a particularly larger and singular hysteresis. Next steps include understanding why this distinct signature occurs, quantify the morphological changes by calculating indexes from image analysis and investigate how bedload and hence the morphological changes depends on the season, characterized by a snow-melting spring and summer and rainy autumn and winter through a multi-year scale.