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Hydrological drivers of bedload transport in an Alpine watershed

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Understanding and predicting bedload transport is an important element of watershed management. Yet, predictions of bedload remain uncertain by up to several order(s) of magnitude. In this paper, we use a five-year continuous time-series of streamflow and bedload transport monitoring in a 13.4 km^2 snow-dominated Alpine watershed in the Western Swiss Alps to investigate the hydrological drivers of bedload transport. Following a calibration of the bedload sensors, and a quantification of the hydraulic forcing of streamflow upon bedload, a hydrological analysis is performed to identify daily flow hydrographs influenced by different hydrological drivers: rainfall, snow-melt, and mixed rain and snow-melt events. We then quantify their respective contribution to bedload transport. Results emphasize the importance of mixed rainfall and snow-melt events, for both annual bedload volumes (77% in average) and peaks in bedload transport rate. Results further show that a non-negligible amount of bedload transport may occur during late summer and autumn storms, once the snow-melt contribution and baseflow have significantly decreased (9% of the annual volume in average). Although rainfall-driven changes in flow hydrographs are responsible for a large majority of the annual bedload volumes (86% in average), the identified melt-only events also represent a substantial contribution (14 % in average). Through a better understanding of the bedload magnitude-frequency under different hydrological conditions, the results of this study may help to improve current predictions of bedload transport, and we further discuss how bedload could evolve under a changing climate through its effects on Alpine watershed hydrology.