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Total and fractional bedload transport in alpine streams approximated by different surrogate measurement systems

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Knowledge about bedload transport in rivers is of high importance for many hydraulic engineering applications, in particular related to flood protection measures. Passive acoustic surrogate measurement techniques provide useful continuous estimates of bedload transport in terms of total mass, as well as for different grain-size classes.

We compare different surrogate measurement systems regarding their performance in quantifying total and fractional bedload transport in three alpine streams. The investigated measurement systems are the well-established Swiss plate geophone (SPG), an equivalent system in which the geophone sensor is replaced by an accelerometer sensor, and the miniplate accelerometer (MPA) system. The latter is a more recent device and consists of four small square metal plates embedded in elastomere elements. While the signal recorded with the SPG is known to be proportional to the transported bedload mass, we find that the MPA-signal shows a non-linear dependency. In addition, the MPA reacts more sensitively to small grain size classes than the other two systems, indicating a possible alternative to improve the quantification of bedload transport consisting of those classes.

Based on the raw signal recorded with the SPG and the MPA in a flume experiment, we test the ability of different empirical models to predict the known weight of the impacting particle. We show that it is possible to identify the particle weight with high accuracy with relatively simple models using data of either of the two measurement systems. One remaining challenge is to account for the site-to-site variability in the (amount of) signal caused by the combination of differing numbers of plates in the measurement setup and the lateral transmission of the signal across multiple plates, especially for the SPG system.