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Flume-based calibration of different surrogate devices for bedload monitoring

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Bedload assessment is important for geomorphological, engineering, and ecological studies of gravel-bed rivers. Bedload is usually assessed using portable traps, which allows measuring instantaneous transport rates, but at a single point and at high costs and operational risks. Slot traps or other fixed devices allow measuring bedload rate for longer periods, but require expensive maintenance. The need of measuring continuously bedload intensity and dynamics has therefore increased the use and enhancement of surrogate methods, such as geophones, hydrophones, and acoustic sensors. However, converting the signals recorded by these instruments to actual bedload fluxes, direct bedload measurements are needed to obtain a calibration relationship. Even if some noticeable examples are available in literature, only few flume experiments have been undertaken to calibrate rate and grain size of transported sediments, and to explore rigorously the sensitivity and signal dampening effects of various surrogate devices. Here we present some preliminary results obtained from a set of flume experiments on which different devices have been used. We have tested a 1m-long Japanese acoustic pipe sensor, a 150×130×6 mm steel plate linked to an accelerometer and a count input data logger, and a hydrophone. Experiments were made in a 0.8m-wide flume, using 4 homogeneous (4, 8, 32, and 45 mm) sediment mixtures. These fractions were then combined in order to obtain 3 further heterogeneous mixtures. Experiments with different discharges and slopes were performed, allowing to observe a wide range of shear stresses and transport rates. All transported sediments were captured with traps, weighted, and then manually recirculated at the upstream end of the flume. Preliminary results show that devices have different sensitivity to lower grain size that could be detected, being the transport of 4 mm particles detected relatively well only by the impact plates. Intense transport of 8 mm particles causes dampening of acoustic signal at the most sensitive frequency channels of the Japanese pipe sensor, but signals collected by the lower sensitive channels are well related to the actual transport rates. Because the plate sensor connected to the accelerometer simply counts the impacts overtime, the signal is easily dampened at the highest transport rates, preventing a proper calibration under this conditions. Instantaneous particle transport and size measured using a video-based technique are being used to calibrate the devices at a much lower time step (5 sec).

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