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Disco Gravel: Image-based bedload tracking in shallow water flume experiments

Fatemeh Asal Montakhab, Megan Iun, and Bruce MacVicar
University of Waterloo, Waterloo, Canada (fmontakh@uwaterloo.ca)

Previous experiments on the restoration of sediment cover in semi-alluvial channels with irregular boundaries have shown that coarse size fractions of the bedload are dispersed faster over a bare bed than the finer fractions, and that the coarse fraction helps to build a set of skeleton bars that are later covered by finer sediment. Unsteady flow experiments in the same channel confirmed these trends over a bed of mobile sediment and further indicate strong spatial gradients in bedload transport and deposition. Despite these advances, a methodological gap remains in the tracking of bedload sediment during the experiments. In this study we advance a tracking technique for obtaining vectors of particle displacements during unsteady flow experiments. Methods involve painting the coarsest three sediment fractions with different colours of fluorescent paint and illuminating a region of interest within the flume with ultraviolet lights (wavelength 400-410 nm) during the experiment, which results in the painted gravel appearing in bright neon colors while the water remains transparent and dark (i.e. the 'Disco'). We use a Panasonic BGH1 camera recording at 60 fps and a resolution of 1080 x 1920 pixels to film a region of interest in the channel roughly 0.25 m wide 1.0 m long. With this technique we are able to identify the displacements of the two coarsest size fractions. For the third size fraction the tracers were too numerous and too small to be tracked with confidence. Analysis of the videos occurred in three steps: 1) color segmentation to isolate the size class of interest, 2) application of TracTrac algorithm (Heyman, 2019) to identify particle paths, and 3) post-processing to reduce two types of error. The errors are likely related to the irregular water surface, which can result in particles appearing to 'vibrate' in place when they are not moving, and also result in a continuous tracer path being broken into a series of shorter discontinuous paths. Overall the technique appears to be useful for characterizing spatial variability at the threshold of motion and delimiting preferential transport pathways. Future improvements in resolution and tracer concentration should help to reduce the minimum size of tracer that can be tracked with confidence.