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Monitoring particle transport at above threshold flow conditions

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This study analyzes the stochastic nature of sediment motion in a domain consisting of a range of flow conditions (from supercritical to subcritical flow, Froude number=0.65-2). Particle transport analysis is conducted by the Particle Tracking Velocimetry (PTV) method, which tracked the movement of a single particle in a flume producing a fair amount of data to have a clear understanding on the trajectory and velocities of the transported particle. Such non-intrusive bedload monitoring techniques are very useful to robustly quantify transport (also Diplas et al. 2010). Furthermore, an attempt to investigate particle translational kinetic energy was made. The purpose of this study is to provide further insight on better estimating bedload transport by increasing knowledge about the nature of bed particle motion.

The experiments are conducted in the Water Engineering Lab at the University of Glasgow on a 12m tilting recirculating flume over a test section of 300x90 cm dimension. Thirteen different discharges near and above threshold of motion been tested. A couple of fake beds, made of well-packed beads of three different sizes have been set up over the test section. Particle motion is captured by two high-speed commercial cameras (120-200fps), responsible for recording the top view covering the full length (3 meters) of the fake beds, over which particle transport is recorded. Particles with four different densities are initially located at the upstream end of the configuration, fully exposed to the instream flow. Using particle tracking velocimetry data and image processing techniques, the location, stramwise and transverse velocities of the particles are derived. Specific consideration is given to appropriately preprocess the obtained videos, as the captured frames need to be flatted and calibrated due to lens distortion. Special effort is made to ensure the center of mass of the particle in each frame is well identified, so that its trajectory comprising of consecutive displacements is accurately defined.

As bedload motion has stochastic nature (Valyrakis et al. 2011), a probabilistic analytical approach is sensible to follow. By using the data from the imaging, particle transport velocity time-series, are produced for each fluvial transport experiment. To that goal empirical probability distribution functions (PDFs) are derived for the particle's motion features that best fits data were estimated.

References

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