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Grain size segregation in bedload sediment transport

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Bedload, the coarser material transported in contact with the bed by turbulent flow in stream channels, has major consequences for public safety, water resources, and environmental sustainability. Size sorting also named size segregation is responsible for our limited ability to predict sediment flux and river morphology, especially in mountains where steep slopes drive an intense transport of a wide range of grain sizes.

We will first talk generally on a research effort in Grenoble on bedload transport multi-scale size segregation modelling within the framework of the ANR project SegSed (size Segregation in Sediment transport). Using a combination of flume experiments at Irstea/Inrae laboratory and a coupled fluid-discrete element model, it was possible to carry out both 'real'experiments and numerical 'experiments'on a variety of bedload configurations, probing the depth structure and the vertical segregation dynamics. Comparing to 'real'laboratory experiments, discrete models allow access to the internal structure and to variables difficult to measure in the laboratory. These variables allow deriving constitutive relationships and size segregation equations that can be upscaled in Eulerian-Eulerian two-phase flow continuum models.

In a second part, we will focus on size segregation due to finer grain input in bedload transport. Two-size experiments were carried out by A. Dudill (joint UGA/UBC PhD) to study the influence of (1) the grain size ratio (coarse to fine) and (2) the percentage of the fine feed rate in the total feed. Depending on these parameters, the slope of the bed evolved eventually reaching a new two-size equilibrium value either larger (aggradation) or smaller (degradation) than the one-size slope.
Each experiment was recorded using a high-speed camera. Work in progress involve improving our image processing algorithms to analyse depth profiles of particle velocity and concentration of the coarse beads once the two-size equilibrium is reached. Depending on the grain size ratio and the percentage of the finer feed rate in the total feed, coarse grains moved either in concentrated low velocity clusters or individually at higher velocity.

Better understanding of bedload size segregation at the grain scale should ultimately permit improvement of sediment transport and river morphology modelling.

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