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Toward a new methodology for measuring the threshold Shields number

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A number of bedload transport equations involve the threshold Shields number (corresponding to the threshold of incipient motion for particles resting on the streambed). Different methods have been developed for determining this threshold Shields number; they usually assume that the initial streambed is plane prior to sediment transport. Yet, there are many instances in real-world scenarios, in which the initial streambed is not free of bed forms.

We are interested in developing a new methodology for determining the threshold of incipient motion in gravel-bed streams in which smooth bed forms (e.g., anti-dunes) develop. Experiments were conducted in a 10-cm wide, 2.5-m long flume, whose initial inclination was 3%. Flows were supercritical and fully turbulent. The flume was supplied with water and sediment at fixed rates. As bed forms developed and migrated, and sediment transport rates exhibited wide fluctuations, measurements had to be taken over long times (typically 10 hr).

Using a high-speed camera, we recorded the instantaneous bed load transport rate at the outlet of the flume by taking top-view images. In parallel, we measured the evolution of the bed slope, water depth, and shear stress by filming through a lateral window of the flume. These measurements allowed for the estimation of the space and time-averaged slope, from which we deduced the space and time-averaged Shields number under incipient bed load transport conditions.

In our experiments, the threshold Shields number was strongly dependent on streambed morphology. Experiments are under way to determine whether taking the space and time average of incipient motion experiments leads to a more robust definition of the threshold Shields number. If so, this new methodology will perform better than existing approaches at measuring the threshold Shields number.