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Incipient motion for bimodal mixture of gravel and silt

Emeline Perret, Albert Herrero, Céline Berni,
Kamal El kadi Abderrezzak, Benoit Camenen



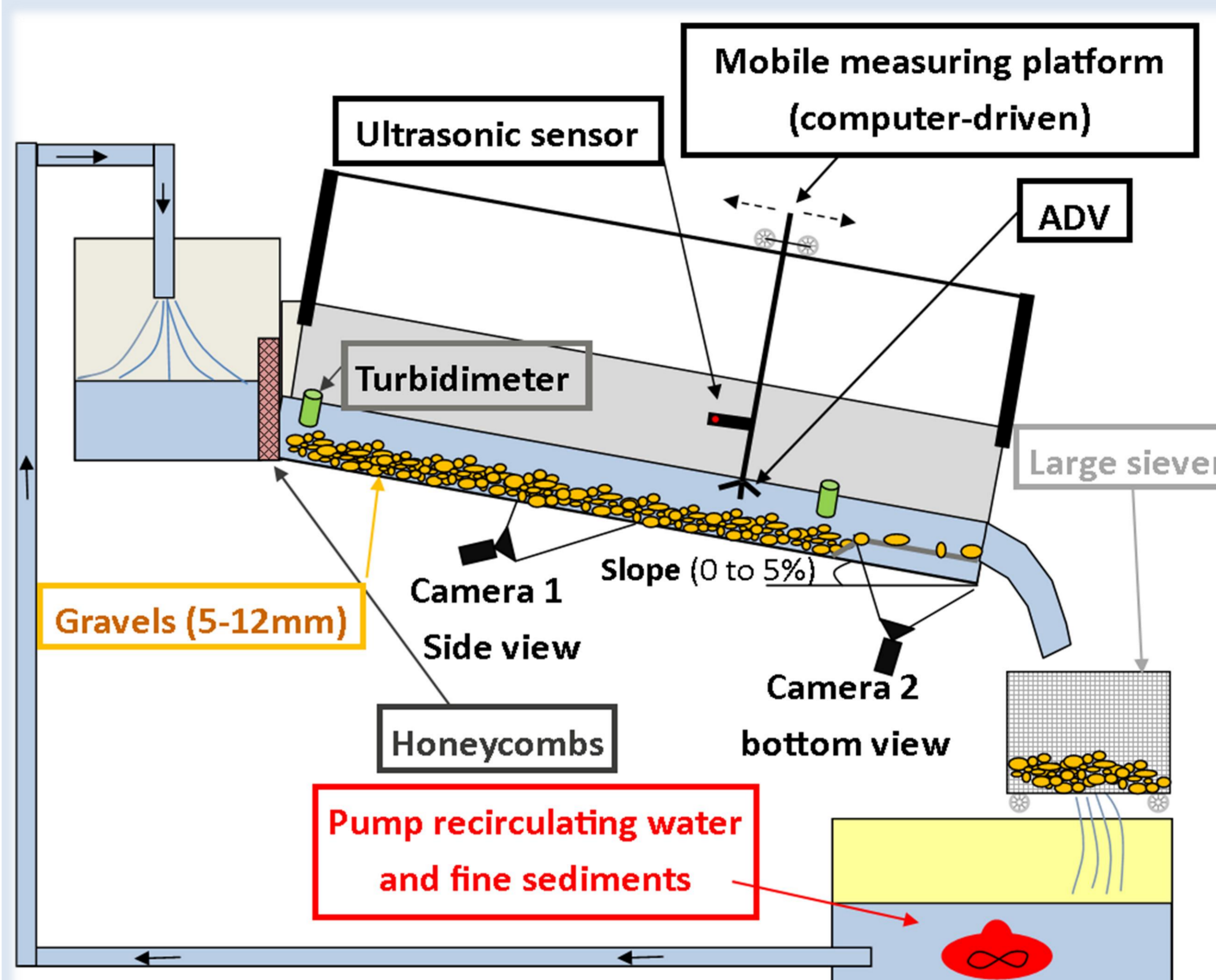
1. Context

- Water and sediment management:
 - socio-economic issues
 - ecological issues
- Sediment transport close to the inception of motion
 - mechanisms not completely understood
 - large uncertainties in the estimation of the critical bed shear stress and sediment transport close to the inception of movement (Buffington and Montgomery, 1997; Camenen and Larson, 2005; Recking, 2013)
 - few studies on bed made of bimodal or multimodal mixture of sediments, especially for a gravel/silt mixture often observed in alpine rivers (Wilcock and Southard, 1988; Patel and al., 2013)
- Complex interactions between fine and coarser sediments:
 - lubrication effects? consolidation effects?
 - Impact on the roughness height

3. Objectives

- Analyzing & understanding processes controlling the incipient motion of a gravel and silt mixture
- Evaluating potential interactions
- Collect a complete data set

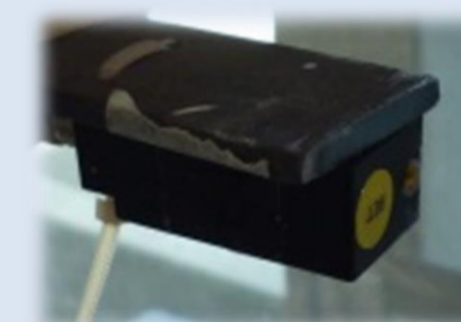
2. Experimental set-up



Measurements

- Water depth + Bed slope

Ultrasonic sensors



- Velocity

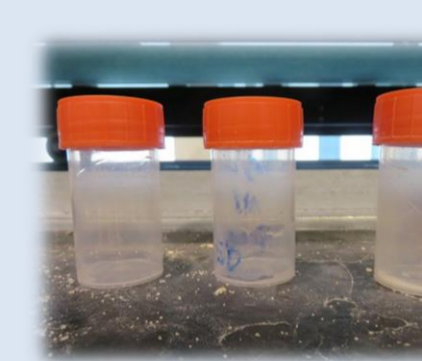
ADV



- Fine concentration



Turbidimeter



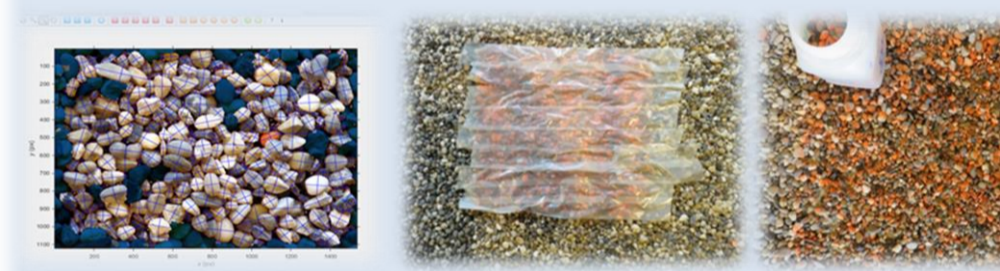
Sampling

- Bed load samples

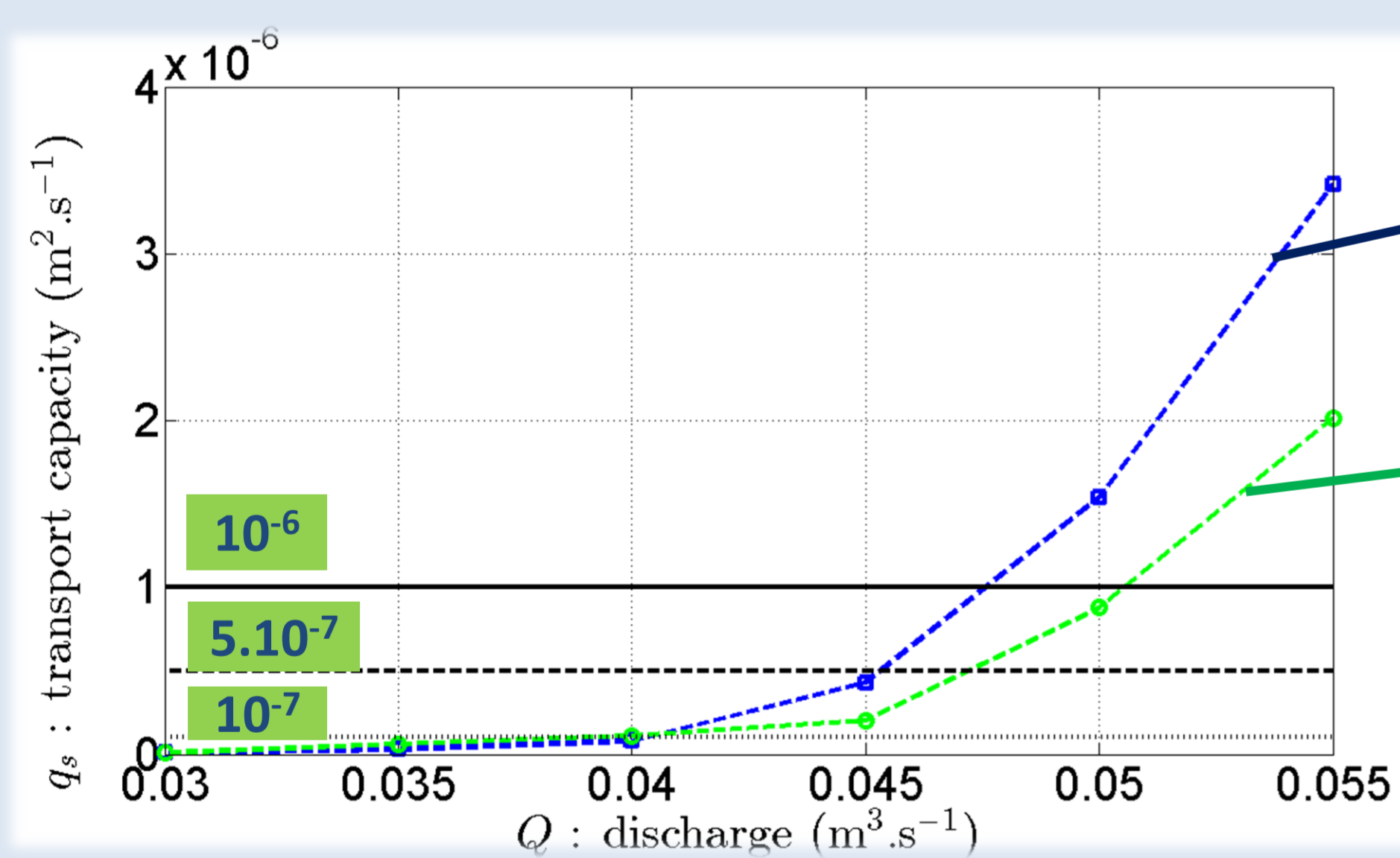
Large sieve & Image processing



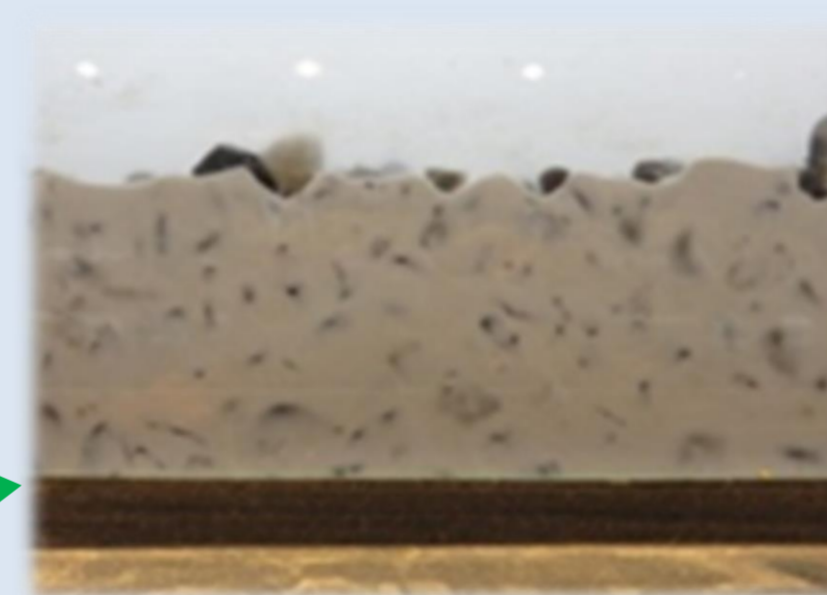
- Bed-surface analysis (grain size distribution, roughness, topography)



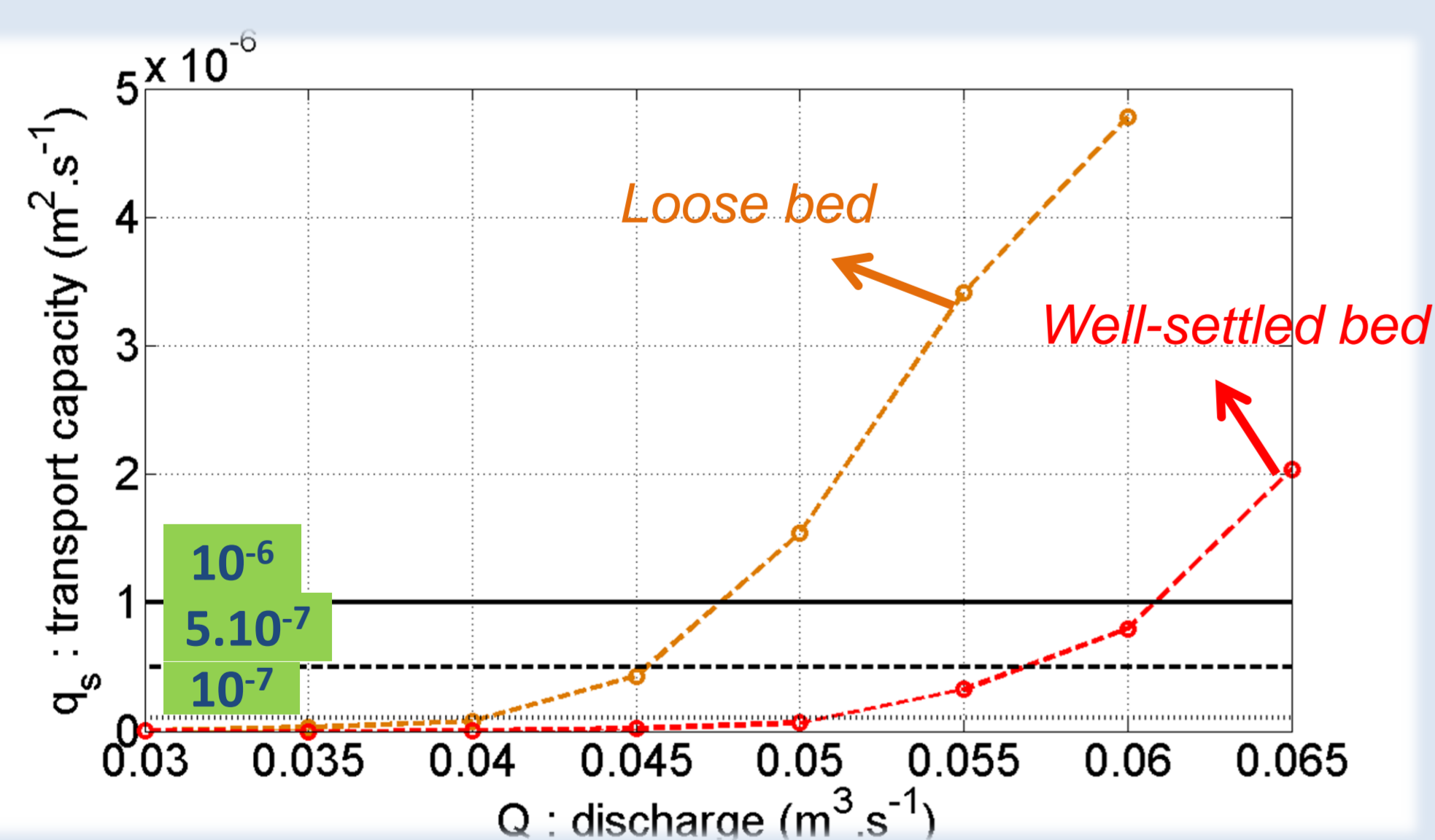
4. Results



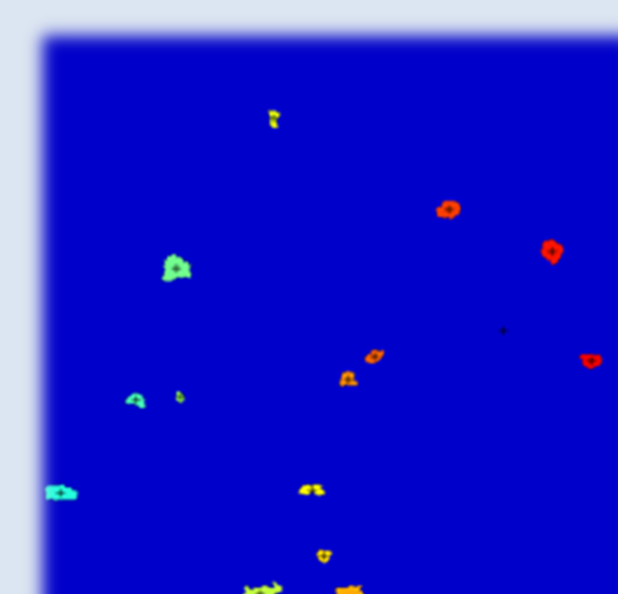
Clean bed
Gravel only



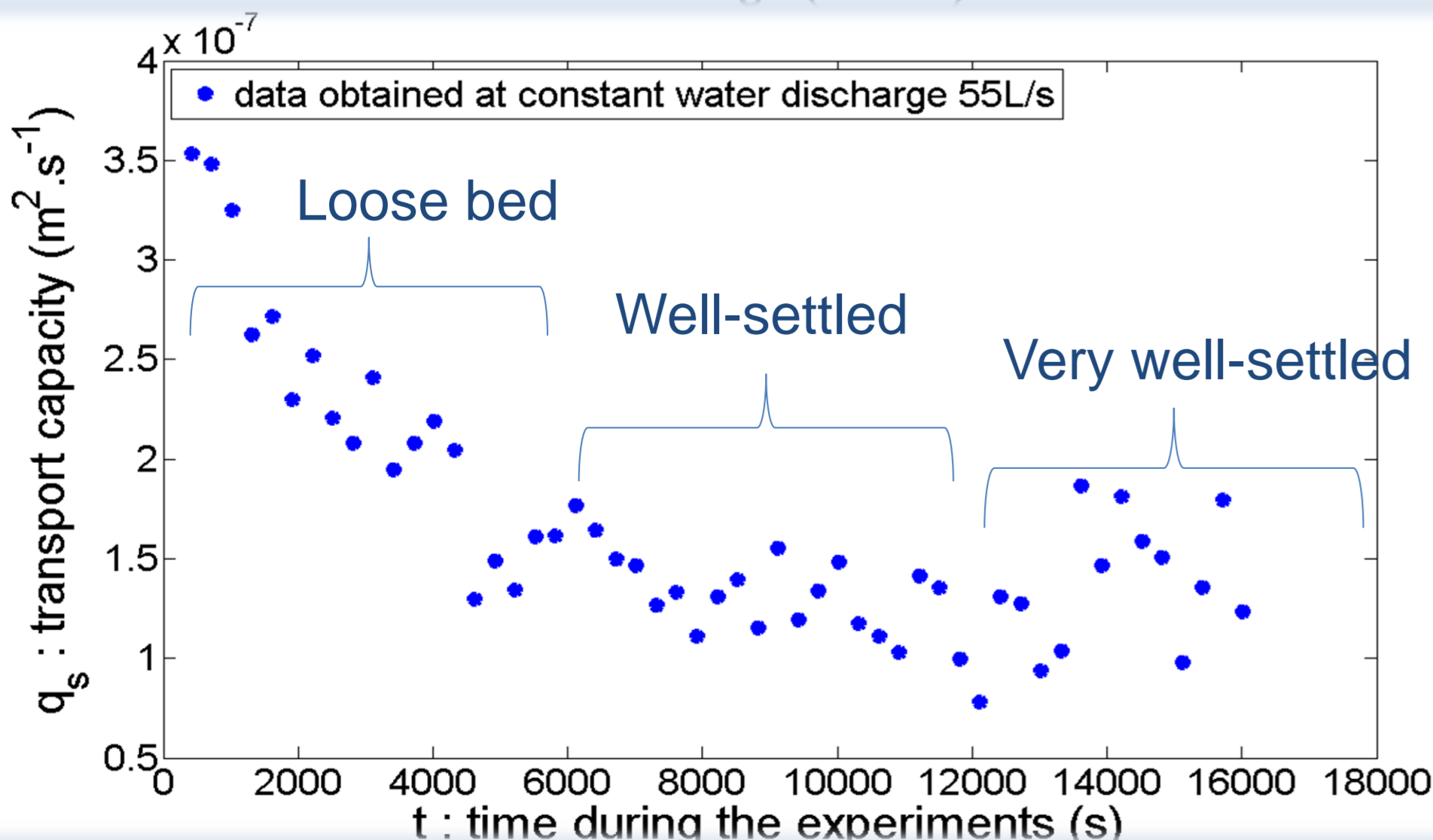
Clogged bed
Gravel+silt



Grains arrangements
imbrication



Detection of grains by
image processing



Critical bed shear stress τ_c :

- Increase of the τ_c when the bed is clogged
- Increase of the τ_c when the bed is well-settled
- Variations in function of time at constant discharge depending on the arrangement of the bed
- Stable value (settled bed)

5. Discussion

- Dependence on methods used to characterize the critical bed shear stress
- Importance of the initial bed arrangement
- Difficulties to reproduce experiments
- Difficulties to quantify the experimental uncertainties
- Description of the incipient motion with a range of values of critical bed shear stress?
- Difficulties to characterize u^*

6. References

Buffington, J.M., and D.R. Montgomery (1997), A systematic analysis of eight decades of incipient motion studies, with special reference to gravel-bedded rivers. *Water Resour. Res.*, 33(8), 1993-2029.

Camenen B. & Larson M. (2005). A bed-load transport formula for the nearshore, *Estuarine Coastal and Shelf Science*, 63: 249-260.

Patel and al.(2013), Threshold for initiation of motion of unimodal and bimodal sediments. *Int. Jour. of Sed. Res.*, 28(1), 24-33

Recking, A. (2013), A simple method for calculating reach-averaged bedload transport. *Journal of Hydraulic Engineering*, 139 (1).

Wilcock, P.R., and J.B. Southard (1988), Experimental study of incipient motion in mixed-size sediment. *Water Resour. Res.*, 24(7), 1137-1151.