Sediment Transport in a Narrow Flume with a Granular Bed

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Delivery of final report: June 2024

Context

The physics of sediment transport is characterized by different properties of both fluid and sediment, such as grain size, fluid viscosity, and river bed slope. More than 100 equations have been employed to determine the sediment transport rate using these parameters [1]. However, given that these models are typically restricted to some specific river or set of laboratory conditions [2], their accuracy varies substantially depending on the conditions where they are applied.

Goal and Objectives

The goal of this project is to find an accurate formulation for the sediment transport rate in a narrow flume with a granular bed. For this purpose, the existing sediment transport formulae are to be reviewed and compared to the experimental data.

Required work

The project includes a comprehensive literature review on sediment transport formulae and the processing of experimental sediment transport data through existing particle tracking methods.

The student will participate in different experiments, focus on sediment transport rate analysis, compare it with the existing formulae in the literature, and write a final report (in French or English) outlining the methods and procedures followed during the project and discussing the results.

Methodology

The experiments will be carried out in a 5.8-m-long, 4-cm-wide hydraulic flume with a gravel bed configuration. A camera at the outlet of the flume records the sediment flow. Pascal [3] has already used the TrackMate module of Fiji for analyzing this data (see Figure 1). However, other Particle Tracking Velocimetry (PTV) techniques will also be used and compared for the bedload transport rate calculation.

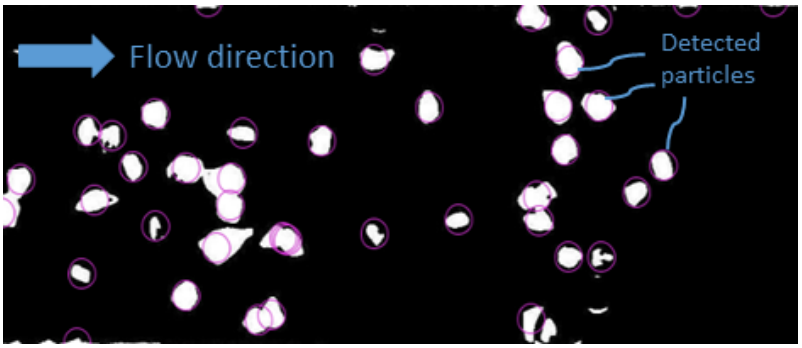

Figure 1: Particles detected by TrackMate of Fiji at the outlet of the flume.

Prerequisites

- Fluid Mechanics,
- Basic concepts of statistics,
- Motivation to learn about tools and programming languages for image processing (e.g. MATLAB, Python, Fiji, etc.).

References

1. Ancey, C. Bedload transport: a walk between randomness and determinism. Part 1. The state of the art. *Journal of Hydraulic Research* **58,** 1–17. doi:10.1080/00221686.2019.1702594 (2020).
2. Wieprecht, S., Tolossa, H. G. & Yang, C. T. A neuro-fuzzy-based modelling approach for sediment transport computations. *Hydrological Sciences Journal* **58,** 587–599. doi:10.1080/02626667.2012.755264 (2013).
3. Pascal, I. Experimental study on bedload transport and antidunes: behaviour and interplay in steep turbulent streams. Ph.D. thesis. *École Polytechnique Fédérale de Lausanne* (2022).