Flow Field over Bedforms in Long and Narrow Hydraulic Flume

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Context

Studying shallow water flows on steep and granular beds is crucial for understanding the behavior of mountain streams. River bed dynamics are the key to exploring the development of alluvial environments [1]. River bedforms are mainly categorized according to the flow regime, and in other respects, they also influence the flow field. One of the curious bedforms under supercritical (or near-critical) flow conditions is called "antidune." Such bedforms are characterized by a sinusoidal shape in phase with the water surface and usually migrate upstream [2] (see Figure 1).

Goal and Objectives

Our goal is to improve our knowledge of shallow flows on coarse-grained beds. We aim to measure and analyze the flow field over a granular bed by recording the topography and tracers in the flow.

Required work

We propose analyzing the near-bed flow dynamics over antidunes. It involves drawing out the velocity field and bedform-induced turbulence. The project also includes processing the data obtained from imaging techniques.

The student will participate in the experimental work 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 flume with a granular bed configuration, following the work conducted by Pascal [3]. Concerning the velocity measurements, we record the flume with backlight panels and a high-speed camera equipped with a macro lens placed on the flume side. This allows us to measure tracer motion in the flow field using Particle Tracking Velocimetry (PTV) or Particle Image Velocimetry (PIV) techniques. [4].

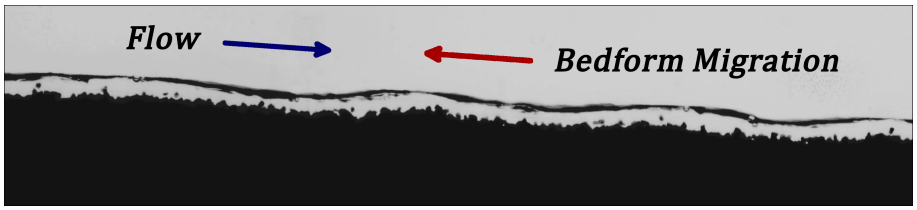

Figure 1: Antidune migration in a flume from the side view.

Prerequisites

The project requires some knowledge of the following:

- Hydraulics/Fluid Mechanics,
- Tools and programming languages for image processing (e.g. MATLAB/Python/Fiji).

References

1. Church, M. Bed material transport and the morphology of alluvial river channels. *Annual Review of Earth and Planetary Sciences* **34,** 325–354 (2006).
2. Kennedy, J. F. The Formation of Sediment Ripples, Dunes, and Antidunes. *Annual Review of Fluid Mechanics* **1,** 147–168 (1969).
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).
4. Brunelle, C. *et al.* X-Ray Computed Tomography to Measure Bed Density in Sand Transport. *Journal of Hydraulic Engineering* **148** (2022).