Numerical modelling and theoretical analysis of geometrically-controlled flow instabilities in rectangular basins

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Free surface flows in several shallow rectangular basins have been analyzed numerically and theoretically. Different geometries, characterized by different widths and lengths, are considered as well as different hydraulic conditions (varying water depth). The presentation will be divided into three parts.

First, the results of experimental tests conducted by Kantoush at EPF Lausanne [1] will be very briefly depicted. They reveal that, under clearly identified hydraulic and geometrical conditions, the flow pattern in the rectangular basin is found to become non-symmetric, in spite of the symmetric inflow conditions, outflow conditions and geometry of the basin. This non-symmetric motion results from the growth of small disturbances actually present in the experimental initial and boundary conditions.

Secondly, numerical simulations are conducted with the hydrodynamic model *WOLF 2D*, based on a depth-averaged approach and a finite volume scheme. The simulation results reproduce satisfactorily the global pattern of the flow observed experimentally and succeed in predicting the stability or instability of a symmetric flow pattern for all tested configurations. Besides, the results are interpreted in terms of a *bifurcation* diagram, and a *hysteresis* behaviour of the flow is highlighted by the numerical simulations.

Finally, an analytical linear stability analysis provides mathematical insights into the conditions under which the symmetric flow pattern becomes unstable, and clarifies the governing physical processes.

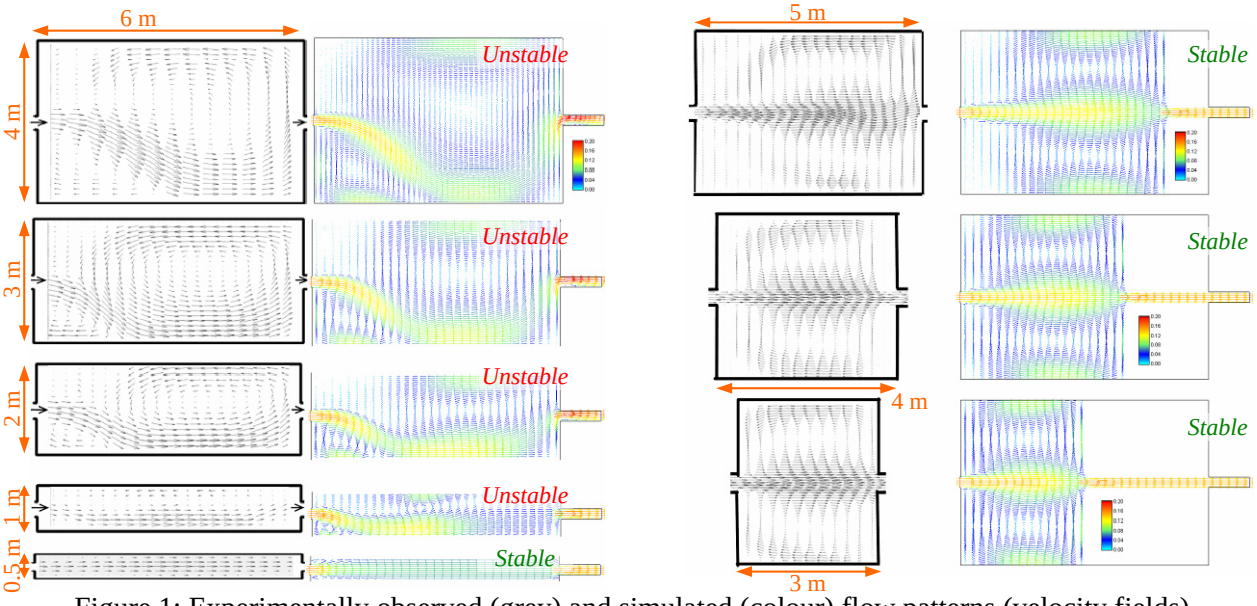

Figure 1: Experimentally observed (grey) and simulated (colour) flow patterns (velocity fields) in rectangular basins of varying width (left column) and varying length (right column).

Reference

[1] B.J. Dewals, S.A. Kantoush, S. Erpicum, A. Schleiss and M. Pirotton. Experimental and numerical analysis of flow instabilities in rectangular shallow basins. *Environ. Fluid Mech.*, accepted.