Study of Morphological Evolution in Gravel-bed Braided Rivers by Numerical Simulations

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Braided rivers are characterized by multiple, unstable channels and ephemeral bars formed by intense bed-load transport, and a set of very active channel processes. They exist in a range of environments associated with high-energy, coarse-bedded rivers with limited development of riparian vegetation (Ashmore, 1982).

In braided rivers a high morphological complexity arises from the coexistence of several spatial structures, controlled by different spatio-temporal scales. These dimensions interact strongly in the development of braided patterns and give rise to strong fluctuations both in time and space (Bertoldi, Zanoni, and Tubino, 2009). The issue of predicting braided stream morphology is largely unresolved, and there is not enough convergence on which are the key parameters controlling the evolution.

During the last three decades, significant advances in the understanding of the morphodynamics of braided rivers have been made through a combination of field and physical experimentation. More recently, the emerging field of numerical modeling has created a new avenue to investigate the processes governing channel dynamics. While this methodology offers significant promise through the construction of virtual experiments that examine the spectrum of drivers and responses of river systems, such models require careful and critical evaluation before they can be used to guide management practice (Baral, 2018).

The main goal of this project is testing the ability of Iber, a novel numerical model (Bladé et al., 2014), for estimating bed load transport and morphology evolution of a physically scaled braided river experiment starting from a defined initial condition. Some previous work has been done using other software (Javernick, Redolfi, and Bertoldi, 2018; Schuurman, Marra, and Kleinhans, 2013), and we would like to replicate their procedure on our setup as a starting point of research on this topic. We already have some results that will be used as starting point (see Figure 1).

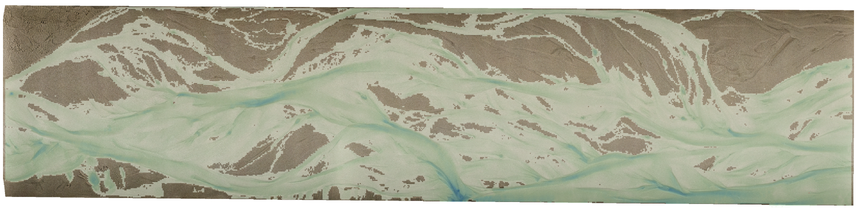

Figure 1: Steady flow simulation results.

For a proper discussion of this project, some previous knowledge is required or desirable. The selected student(s) should handle the following topics:

- Matlab or Python,
- Iber (recommended),
- River hydraulics and sediment transport basic knowledge.

The student(s) will write a report describing the process and techniques used during the project. The document should include at least: the numerical setup and procedure, results, analysis of metrics describing the channel network, and possible future work.

References

Ashmore, Peter (1982). "Laboratory modelling of gravel braided stream morphology". en. In: *Earth Surface Processes and Landforms* 7.3, pp. 201–225. doi: 10.1002/esp.3290070301.

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Bertoldi, Walter, Luca Zanoni, and Marco Tubino (2009). "Planform dynamics of braided streams". In: *Earth Surface Processes and Landforms* 34.4, pp. 547–557. doi: 10.1002/esp.1755.

Bladé, E. et al. (2014). "Iber: herramienta de simulación numérica del flujo en ríos". In: *Revista Internacional de Métodos Numéricos para Cálculo y Diseño en Ingeniería* 30.1, pp. 1–10. doi: 10.1016/j.rimni.2012.07.004.

Javernick, Luke, Marco Redolfi, and Walter Bertoldi (2018). "Evaluation of a numerical model's ability to predict bed load transport observed in braided river experiments". In: *Advances in Water Resources* 115, pp. 207–218. doi: 10.1016/j.advwatres.2018.03.012.

Schuurman, Filip, Wouter A. Marra, and Maarten G. Kleinhans (2013). "Physics-based modeling of large braided sand-bed rivers: Bar pattern formation, dynamics, and sensitivity". In: *Journal of Geophysical Research: Earth Surface* 118.4, pp. 2509–2527. doi: 10.1002/2013jf002896.