Geophysical Research Abstracts
Vol. 16, EGU2014-2715, 2014
EGU General Assembly 2014

Investigating morphodynamics of bars in single and multi-thread channels using a numerical model

Umesh Singh (1,2,3), Guido Zolezzi (1), Walter Bertoldi (1), James Brasington (2), and Alessandra Crosato (3)

(1) University of Trento, Department of Civil, Environmental and Mechanical Engineering, Trento, Italy (umesh.singh@unitn.it, guido.zolezzi@unitn.it, walter.bertoldi@unitn.it), (2) Queen Mary University of London, School of Geography, London, UK (j.brasington@qmul.ac.uk), (3) UNESCO-IHE, Netherlands (a.crosato@unesco-ihe.org)

River bars are two dimensional wave structures of the channel bed, with a spatial scale of the river cross-section that result from morphodynamic instability. Bar characteristics are frequently, though non-uniquely, used to differentiate between single and multi-thread channel patterns. The formation and evolution of bars has been studied through a combination of field measurements, analytical models, laboratory experiments and numerical models. Recent developments in physically-based numerical models potentially provide a powerful tool to support the investigation of the temporal evolution of river bars in a precisely controlled manner. Although such models often include a rather simplified description of the complex physical processes, they provide the flexibility to investigate morphodynamics under variable forcing and initial conditions. Recent studies have shown that 2D numerical models are capable of simulating the plan-form dynamics of single-thread and multi-thread channels (e.g., Nicholas, 2013).

This study aims to understand the dynamics of bars in single and multi-thread channels using a fully non-linear, two-dimensional, physics-based numerical model based on the Delft3D code (www.deltares.nl). Emphasis is on the differences between bar and reach scale properties when the channel morphology shifts from single to multiple-thread. Ultimately, this has potential to provide insights on fundamental differences between single and multi-thread channel patterns, as well as on the physical processes that control braided channel dynamics. The numerical model incorporates a subset of the key physical processes necessary to investigate bar dynamics (Schuurman, et al., 2013), and was calibrated and validated on a unique set of flume experiments. These comprised a series of experiments performed in a straight channel with spatially uniform width and characterized by combinations of different values of channel width and discharge. Varying the channel width and the discharge gave rise to a spectrum of different channel morphologies, ranging from single-thread with alternate bars to braiding plan-forms with different braiding intensities. Hydrodynamic calibration was based upon the measured spatial distribution of dry areas at the end of each experimental test whereas morphodynamic calibration was based upon the time series of sediment discharge measured at the downstream boundary. Overall, the numerical investigation enabled insights into the statistical structure and temporal evolution of reach-averaged braiding intensity, bar properties and related hydrodynamic properties across a gradient of channel morphologies, from single- to multi-thread. Sensitivity of the results to several numerical parameters was also investigated.

References
Nicholas, A. P. (2013), Modelling the continuum of river channel patterns. Earth Surf. Process. Landforms, 38: 1187–1196. doi: 10.1002/esp.3431
Schuurman, F., W. A. Marra, and M. G. Kleinhans (2013), Physics-based modeling of large braided sand-bed rivers: Bar pattern formation, dynamics, and sensitivity, J. Geophys. Res. Earth Surf., 118, doi:10.1002/2013JF002896.

This work has been carried out within the SMART Joint Doctorate (Science for the MAnagement of Rivers and their Tidal systems) funded with the support of the Erasmus Mundus program of the European Union.