EGU23-14867, updated on 30 Oct 2023
https://doi.org/10.5194/egusphere-egu23-14867
EGU General Assembly 2023

Correlating flow field with river bank erosion opposite to an accreting bank: a large-eddy simulation approach

Pratik Chakraborty[1], Daniel Valero[1,2], Andrés Vargas-Luna[3], Francesco Bregoli[1,4], and Alessandra Crosato[1,5]

[1]IHE Delft Institute for Water Education, Water Resources and Ecosystems, Netherlands (pratikchakrabortyihe@gmail.com)
[2]Institute for Water and River Basin Development, Karlsruhe Institute of Technology, Karlsruhe, Germany
[3]Department of Civil Engineering, Pontificia Universidad Javeriana, Bogotá, Colombia
[4]Department of Environmental Science, Radboud University, Nijmegen, The Netherlands
[5]Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands

Bank erosion in riverine systems is one of the most complex, yet rampant, morphodynamic processes with significant implications for riparian activities and thereby the population. Therefore, it is an important aspect of the geomorphological evolution of a river reach that must be taken into consideration by river engineers while planning training, restoration or other engineering works of interest. Erosion of river banks are in essence a result of a combination of bank material entrainment by the river flow and mass failure.

In particular, it has been found that bank accretion on one river side could play an important role in triggering erosion of the opposite bank. Such bank accretion could be a result of a natural bar formation due to morphodynamic instability or even forced by an intervention, such as a groyne. To understand this process, we conducted a computational fluid dynamics (CFD) numerical study. We set up a high-resolution 3D Large Eddy numerical model replicating data-rich experiments which have been previously conducted in a large flume with a mobile bed, where bank erosion has been observed opposite to a bar formation.

The CFD hydrodynamic model takes as input the boundary conditions and the high-resolution bed topography data which had been collected during the experiment at given time intervals. The hydrodynamic simulation runs until steady-state, thus provides the flow field at that given time of the experiment, i.e., for a particular bed topography configuration. Thereafter, the next time-instances, with an updated bed topography, are simulated similarly. This provids a set of flow-field data for each time instance. The evolution of the flow field can then be related to the evolution of the opposite bank erosion. Various flow field variables and parameters such as near-bank velocities and Q-criterion, were analysed so as to determine the process driving factors. Furthermore, the large eddy simulations allowed for the identification of coherent turbulent structures and their role in driving bank erosion. Results are here presented and discussed.