EP36A-06 Beyond the Fixed-bed Paradigm in Flood Modelling: An Analysis of the Terminal Reach of the Po River (Italy)

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Abstract

Flood models are the core of flood forecasting, defence structures design, and flood risk assessment. They are commonly calibrated and used assuming a fixed riverbed. While this is acceptable in the case of highly stable riverbeds, notable cases exist in which the bed dynamics may play a key role in flood propagation. A prominent case is the Po River, the largest river in Italy, responsible for a 1000 km² destructive flooding just 70 years ago. In its terminal reach, the Po is characterized by a sandy bed with a bathymetry which is surveyed during low/moderate flow conditions. Flood models with fixed bed built upon these bathymetric data invariably fail to correctly reproduce the stage-discharge relationship near the peak of high floods, with errors in peak water levels larger than 1 m.

To unravel the causes of this mismatch, we setup a 2D Finite Element model of the last 200 km of the Po River, carrying out a calibration of the spatial distribution of flow resistance coefficients (i.e., Gauckler-Strickler) based on water level and discharge data measured at multiple locations and for different flood events. The results are good only up to a certain discharge, above which modelled water levels are affected by a relevant, systematic overestimation.

We argue that different morphodynamics processes may explain the increase of channel conveyance near flood peak conditions, e.g., the transition from dune to plane bed (and vice versa), the near-bed distribution of turbulent shear stresses due to high sediment transport, and the erosion/deposition processes which likely occur near peak flow conditions during the rising/falling limb of the flood wave. Given the absence of direct measures able to characterize the riverbed configuration near to flood peak, we used numerical simulations to investigate the role that changes in bed configuration (either plane or dune covered) and erosion/deposition processes may have in enhancing river conveyance.

The simulation results provided by the present study suggest the need of going beyond the fixed-bed paradigm in flood modelling, with fundamental implications for flood assessment in large, live-bed rivers. Yet, a proper inclusion of morphodynamic processes in two-dimensional flood models is still a challenging task, which calls for further multidisciplinary efforts.

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