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Validation of 2DH hydrodynamic and morphological mathematical models. A methodology based on SAR imaging

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The objective of the present work is to devise a methodology to validate 2DH shallow-water models suitable to simulate flow hydrodynamics and channel morphology. For this purpose, a 2DH mathematical model, assembled at CEHIDRO, IST, is employed to model Tagus river floods over a 70 km reach and Synthetic Aperture Radar (SAR) images are collected to retrieve planar inundation extents.

The model is suited for highly unsteady discontinuous flows over complex, time-evolving geometries, employing a finite-volume discretization scheme, based on a flux-splitting technique incorporating a reviewed version of the Roe Riemann solver. Novel closure terms for the non-equilibrium sediment transport model are included. New boundary conditions are employed, based on the Riemann variables associated the outgoing characteristic fields, coping with the provided hydrographs in a mathematically coherent manner. A high resolution Digital Elevation Model (DEM) is used and levee structures are considered as fully erodible elements. Spatially heterogeneous roughness characteristics are derived from land-use databases such as CORINE LandCover 2006.

SAR satellite imagery of the floods is available and is used to validate the simulation results, with particular emphasis on the 2000/2001 flood. The delimited areas from the satellite and simulations are superimposed. The quality of the adjustment depends on the calibration of roughness coefficients and the spatial discretization of with small structures, with lengths at the order of the spatial discretization. Flow depths and registered discharges are recovered from the simulation and compared with data from a measuring station in the domain, with the comparison revealing remarkably high accuracy, both in terms of amplitudes and phase. Further inclusion of topographical detail should improve the comparison of flood extents regarding satellite data.

The validated model was then employed to simulate 100-year floods in the same reach. The inclusion of mobile bed and levees produces significant impacts on the solution, namely on the inundation extent, once the latter are breached. Important morphological changes are registered in the vicinity of breached structures. The impact of mesh refinement on the solution is also assessed. The results show that the solution is strongly mesh-dependent only in the near-field of breached structures.