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Coupled simulation of groundwater and surface river flow in floodplains: A case study

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Numerical simulation is a useful tool for understanding and predicting floodplain system hydrodynamics, a key aspect within hydrological systems. Accurate modeling of groundwater-surface water interactions in floodplains is of special importance not only to properly quantify mass transfer from groundwater to surface water and vice versa, but specially for nutrient and heat transport, in itself an important aspect of water-quality and ecosystem studies.

Surface flow can be efficiently and accurately simulated with 2D shallow-water equations. Groundwater flow is often simulated with the 2D depth-averaged Dupuit model, which provides the location of the phreatic surface. We use a 2D Richards equation model, which, under saturated conditions degenerates naturally to the Dupuit model. The interaction between both domains is done by identifying flooded and dry regions of the surface, followed by pressure transmission from the surface into the groundwater domain under flooded cells and volume exchanges between both domains.

Before predictive capability can be assessed, appropriate calibration and validation is necessary. Field data from relevant hydrological events are necessary to perform validation tests of the numerical model so it can be applied to further uses. Numerical models also require a great deal of parameters and initial and boundary conditions which, ideally, must be obtained or calibrated from field data.

In this work the applicability and the efficiency of such coupled model to simulate river flow events at reach scale is studied. To do this, the numerical results are compared to surface and groundwater flow experimental field data in order to reproduce a correct steady state. From that situation, the field data obtained during a flooding event are used as a reference to evaluate the predicting ability of the coupled model.