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Hydraulic zoom: a hydrological/hydrodynamic downscaling framework from regional to local scale

Gabriel Narváez[1] and Rodrigo Paiva[2]
[1]Water Research Institute, Federal University of Rio Grande do Sul, Porto Alegre, Brasil (gabriel.narvaez.campo@gmail.com)
[2]Water Research Institute, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil (rodrigocdpaiva@gmail.com)

Flooding is the most damaging natural hazard in terms of economic and population affected. Hydrological-hydraulic models are essential tools for evaluating the risks associated with flooding since they provide a physically based approach. In this work, we propose a novel approach that takes advantage of the coverage advantages of large-scale modeling and the accurate representation of local modeling, where high-resolution data are available. A dynamic downscaling framework, so-called *hydraulic zoom*, has been created by coupling the local relevant discharge estimation of the large-scale models with the detailed local representation of the reach-scale models. The large-scale hydrological model (MGB) is employed for estimating the inflow, rainfall excesses, infiltration, and evaporation from open water in order to use as input into an area in which the flow is solved through the full shallow waters formulation. The HEC-RAS 2D 6.1 is applied for solving the 2D dynamic equations. Besides, HEC-RAS enables forcing rainfall excess distributed inside the 2D area by the rain-on-grid approach while also allowing incorporate evaporation and infiltration.

The hydraulic zoom is applied in the Itajai-Açu river basin of 15000 km^2 in Southern Brazil in the Santa Catarina State. The 2D area is about 833.6 km^2, considering 95 km of the main river until the outlet into the sea. The 2D area modeled is highly prone to floods, recording flood events with more than 53 deaths and more than 1 million affected people only between 1983 and 2011.

Estimations from MGB and from HEC-RAS 2D (fed with the MGB outputs) are compared against observed water surface level (WSE), WSE anomalies, and flood extent. The results reveal that streamflows estimated by a regional hydrological model can be incorporated into a local model improving in mean the estimations in about 41% (0.8 m) for WSE, 29% (0.35m) for WSE anomalies, and 10% of the Fit metric for flood extent. This hydraulic zoom framework reveals greate potential of producing high-resolution flood hazard maps allowing also representing pluvial floods, with regional distribution but local resolution.