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Non-invasive calibration technique of a 2D hydrodynamic model based on pattern recognition and digital mapping

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Hydrodynamic models are important tools in civil and environmental engineering. When properly calibrated, numerical flow simulations are helpful to study the impact of floods as natural hazards for the built environment, or as inundation dynamics connecting riparian corridors (e.g., restored) and the surrounding floodplain. However, measuring flow variables in large rivers during high flows is problematic, thus limiting the calibration and the performances of 2D models specifically to low flow conditions.

In this work we use automatic pattern recognition analysis together with digital mapping, to design and test a low cost non-invasive calibration technique for 2D hydrodynamic models. The novelty and advantage of this method is that it does not require previous image orthorectification, which is known to be problematic in the case of low viewpoint shooting angles. We used a sequence of high-resolution photographs of the Thur river restored reach near Altikon (Switzerland), which were taken from an observation tower during the recession limb of a flood. A quasi-automatic algorithm for pattern recognition was developed to first recognize and isolate from the digital pictures the current amount of exposed gravel bars at each flowrate. The next step was to convert the size of the pixels of the digital picture into the effective exposed area by using an experimentally built 3D mapping function together with the actual Digital Terrain Model of the river reach. The inundation patterns resulting from flow simulations obtained for different roughness coefficients from the 2-D hydrodynamic model BASEMENT (http://www.basement.ethz.ch/) were then compared with those obtained from the digital photographs. This allowed for building an error function that uses the amount of simulated versus actual exposed area of gravel bars as the flow (and time) dependent variable for calibrating the roughness coefficient over the entire range of observed flows.

The interesting results from this cheap and limited time consuming approach make its use promising and of broader application than just in the REstored CORridor Dynamics Project (RECORD, http://www.cces.ethz.ch/projects/nature/Record) where it has been developed.