Geophysical Research Abstracts
Vol. 20, EGU2018-1002, 2018
EGU General Assembly 2018

River bathymetry estimation from satellite derived digital terrain model

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The improvement of satellite instruments in the last decade has allowed a greater availability of new global data sources, with an unprecedented coverage even in data-sparse regions and remote areas. Nevertheless, sensors on-board satellite are not capable to pass through the water column (if not in clear shallow waters) and do not provide information concerning river bathymetry. This represents a relevant limitation and a source of uncertainty for many hydrological and hydraulic modelling. This study investigates the Slope Break (SB) approach to include bathymetry into river cross-sections geometry extracted from satellite derived Digital Terrain Model (DTM). The SB approach is tested for two different case studies: 1) a 140 km-stretch of the Po River (Italy); 2) a 164 km-stretch along the Limpopo River (Mozambique). The analysis considers the globally available satellite derived SRTM (Shuttle Radar Topography Mission) and compares the performance of the two SRTM spatial resolution: 30 m and 90 m. The study provides a methodology that enables one to (i) automatically modify satellite derived cross-sections for the submerged portion and (ii) evaluate several hydraulic parameters, such as flow area, wetted perimeter and hydraulic radius. Estimated river geometry and hydraulic parameters are compared with real ones derived from detailed topographic survey (e.g., 2 m resolution DTM for the Po River and topographically surveyed cross sections for the Limpopo River) providing encouraging results. Average errors obtained for the river bathymetry are equal to 0.15 m and 1.83 m for the Po and Limpopo rivers, respectively. To further verify the potential of the implemented methodology the modified river cross sections are employed to run a 1D hydraulic model of the Po River for the simulation of a major flood event. Simulation results highlight the suitability of the proposed methodology and prove that the model provides a better reproduction of the river behavior in case of extreme events relative to the model implemented using the SRTM data only (Nash-Sutcliffe efficiency equal to 0.99).