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On the usefulness of remote-sensing data for numerical hydraulic modelling

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The calibration of hydraulic models traditionally considers local data collected at stream gauging stations, which are generally costly to set-up, maintain and run. Moreover, the density of stream-gauging networks varies significantly worldwide, being particularly sparse or entirely absent in wide regions of the globe, which, for instance, may hamper the modelling of large transboundary river systems. The acquisition, processing and availability of spatially distributed and remotely sensed data are steadily increasing, and recent studies demonstrate the feasibility and great potential of satellite sensors for several hydrological applications. In particular, recent advances in radar-altimetry technology have improved significantly the accuracy of water-level monitoring in rivers and lakes located in ungauged or poorly gauged regions. The main objective of our study is to investigate the usefulness of water surface elevation data provided by ERS-2 and ENVISAT satellites for (i) calibrating a numerical model aimed at reproducing the unsteady hydraulic behaviour of a large river for intermediate streamflow conditions and (ii) predicting the discharge value in un-gauged cross-sections of the investigated river. We consider a 350-km reach of the middle-lower portion of the Po River (the longest Italian river), in light of the abundance of topographic and conventional (i.e. in-situ) hydrometric data. Using this information we set up an unsteady quasi-twodimensional (quasi-2D) hydraulic model, which we then calibrate by considering in turn in-situ and remotely sensed water surface levels collected in the time span from 1995 to 2011. Manning roughness coefficients obtained from the different calibrations are then compared one another to better understand the value of remotely sensed data. Finally, we use the quasi-2D model to assess the possibility of predicting instantaneous streamflow values at several streamgauges on the basis of the remotely sensed information alone and we quantify the accuracy of these predictions. Our study highlights the importance of remote-sensing for integrating existing streamgauging networks and for providing hydrometric information in large ungauged rivers.