Geophysical Research Abstracts
Vol. 21, EGU2019-4024, 2019
EGU General Assembly 2019

A method to evaluate the hysteresis effect due to transient flow on rating curves: application to the French hydrometric station network

Michel Lang, Emeline Perret, Jérôme Le Coz, and Benjamin Renard
Irstea, UR Hydrology-Hydraulics, VILLEURBANNE, France (michel.lang@irstea.fr)

Hysteresis effects can be observed on rating curves during flood events. During the propagation of transient flows, the celerity of the pressure wave is smaller than the celerity of the velocity wave, hence smaller than the celerity of the discharge wave. In such case, for the same given stage the discharge is higher during the rising limb than during the falling limb of the event, leading to a non-unique stage-discharge relation. The hysteresis effect is generally greater on low-slope channels and during fast floods (strong water depth gradient). In practice, this phenomenon is often neglected. Yet, substantial biases in flood prediction can arise if ignored (underestimation of the peak discharge, a time lag of the flood hydrograph and an increase of uncertainties of the discharge).

This work aims to identify the French hydrometric stations potentially impacted by the hysteresis phenomenon and to map the risk to provide a tool for better managing flood issues nationwide. A diagnosis of at-risk stations was conducted using the Jones formula, which relates the discharge to the water depth and its time gradient. An automated procedure was developed to calculate the relative discharge error ε(Q) made when ignoring hysteresis for each hydrometric station, using water level times series from the national data bank HYDRO, approximate channel slope from a Digital Terrain Model and assumed bed roughness. For each station, the water depth gradient was computed from the five significant flood events, after a preliminary step which consists in smoothing the water level time series. Stations were defined as at-risk according to various criteria: defining some arbitrary discharge error threshold, using the distribution of ε(Q) or analyzing the number of times the arbitrary threshold is exceeded among the selected flood events.

It was found that the diagnosis results highly depend on the retained value for bed slope and on the chosen stage series smoothing method. They were thus verified and improved with the help of French river managers and by focusing on specific hydrometric stations to provide the final diagnosis. If gaugings during the selected events were available, the BaRatin SGD tool (Mansanarez, 2016) was used to model and estimate the looped rating curve through Bayesian inference. BaRatin SGD enables to estimate the parameters of the Jones model (with their uncertainties) using prior knowledge on the hydraulic controls of the station and available gauging data (with their uncertainties). ε(Q) deduced from the BaRatin SGD model was finally compared with the estimates from the diagnosis, for validation.