Floodplain mapping based on derived synthetic rating curves linked to simulated streamflows.

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Abstract

Rating curves are one of the most applied tools in hydrology for first instance flood analysis. However, there are often few of them in a watershed. One way to fill this gap is to derive synthetic rating curves using the conceptual model HAND (Height Above the Nearest Drainage). Indeed, this model computes the height in the nearest water course required for any location to be flooded using a Digital Elevation Model (DEM). To assess the sensitivity of the computed synthetic rating curves to its forcing parameters, a global sensitivity analysis (GSA) was performed using the VARS (Variogram Analysis of Response Surfaces) framework. Then, an a priori criteria of uniform flow such as Froude number and river reach slopes were added to identify the reaches where the model should be valid. HAND was implemented within PHYSITEL, a specialized GIS for distributed hydrological models. Synthetic rating curves were constructed using the geometric properties of a river segment and the Manning equation, providing a posteriori a mean of linking simulated stream flows to potential inundated areas. As part of the calibration process of the model, the GSA was conducted for four parameters (length of the river segment, Manning coefficients for water, forest and other), the variation of the vertical spatial resolution of the LiDAR data was considered as well for this study. This methodology was tested in two different watersheds in Quebec, Canada. Seven hydrometric stations were used as controls. The results showed that accurate synthetic rating curves can be derived with performance index such as PBIAS less than 20% and RMSE between (0.79m^3/s and 10 m^3/s) during the calibration. Therefore, for first instance, there is a potential to develop flood maps in areas without any hydrometric station or with a lack of high-quality bathymetric data as required by computationally intensive hydraulic models.

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Rating curves are one of the most applied tools in hydrology for first instance flood analysis. However, there are often few of them in a watershed. One way to fill this gap is to derive synthetic rating curves using the conceptual model HAND (Height Above the Nearest Drainage). Indeed, this model computes the height in the nearest water course required for any location to be flooded using a Digital Elevation Model (DEM). To assess the sensitivity of the computed synthetic rating curves to its forcing parameters, a global sensitivity analysis (GSA) was performed using the VARS (Variogram Analysis of Response Surfaces) framework. Then, an *a priori* criteria of uniform flow such as Froude number and river reach slopes were added to identify the reaches where the model should be valid. HAND was implemented within PHYSITEL, a specialized GIS for distributed hydrological models. Synthetic rating curves were constructed using the geometric properties of a river segment and the Manning equation, providing *a posteriori* a mean of linking simulated stream flows to potential inundated areas. As part of the calibration process of the model, the GSA was conducted for four parameters (length of the river segment, Manning coefficients for water, forest and other), the variation of the vertical spatial resolution of the LiDAR data was considered as well for this study. This methodology was tested in two different watersheds in Quebec, Canada. Seven hydrometric stations were used as controls. The results showed that accurate synthetic rating curves can be derived with performance index such as PBIAS less than 20% and RMSE between (0.79m^3/s and 10 m^3/s) during the calibration. Therefore, for first instance, there is a potential to develop flood maps in areas without any hydrometric station or with a lack of high-quality bathymetric data as required by computationally intensive hydraulic models.