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Extreme flood estimation for a large catchment by coordinated stochastic rainfall-runoff simulations of its main tributaries

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The SCHADEX method for extreme flood estimation, proposed by Paquet et al. (2013), is a so-called "semi-continuous" stochastic simulation method in that flood events are simulated on an event basis and are superimposed on a continuous simulation of the catchment saturation hazard using rainfall-runoff modeling. A complete CDF of daily discharges and flood peak values is build up to extreme quantiles with several millions of simulated events.

The application of SCHADEX to a large catchment (area greater than 5000 km^2) or whose floods are affected by significant hydraulic effects (flood plains, artificial reservoir) can pose a problem with some of the hypothesis of the method (e.g. hydro-climatic homogeneity within the catchment, no significant hydraulic damping of flood peaks).

To overcome this limitation, a coordinated stochastic simulation method is proposed. Firstly, several tributaries of the large catchment are selected based on their hydro-climatic features (among them homogeneity) and the availability of data. Then the main SCHADEX components are set up for these catchments (hydrological model, probabilistic model for extreme rainfall, and peak-to-volume ratio), as well as for the large one. The SCHADEX stochastic simulation is ran for the large catchment. Each randomly drawn precipitation event (at the large ctachment's scale) is disaggregated to the catchment of each tributary thanks to the observed rain field shape of an historical day of similar synoptic situation. The rain fields are reconstructed at a 1 km^2 resolution for the whole area thanks to the SPAZM method (Gottardi, 2012). The synoptic situations are characterized thanks to a rainfall-oriented classification (Garavaglia, 2010). For a given precipitation event, all the catchment's saturations (and snowpack conditions) are kept synchronous by superimposing the simulated event on the conditions of the same day for all catchments. Several millions of flood events are simulated this way.

At the end, for a given return time (estimated for the whole catchment), numerous hydrological scenarios (i.e. contributions of the tributaries) are provided by the coordinated simulations. These scenarios can feed a hydraulic model to account for flooding in valleys or flat areas. The distributions of the contributions of tributaries conditional to a flood of a given return period at the global scale can be built as well.

The presentation will be illustrated by an application of the method to the Isère River at Saint-Gervais (French Alps, 9910 km^2) and its main tributaries.

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