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A regional method for the prediction of flood hazards in France

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Usually, the choice of the statistical method used in a flood frequency analysis (FFA) depends on the available data. The extrapolations provided by different statistical methods often lead to different estimates of flood discharges for the same return period. Furthermore, local FFA can prove uneasy to carry out due to either the lack of data, or the limited length of the discharge data when available. This emphasizes the need for regional methods able to deliver consolidated flood quantiles, in particular for ungauged catchments.

The Cemagref institute has developed an original flood prediction method called the SHYPRE [1] method. It implements:
- an hourly rainfall generator which consists of a stochastic rainfall model (based upon the geometric description of temporal rainfall signals),
- a lumped conceptual rainfall-runoff model.
A regional version of the SHYPRE method (SHYREG [2]) has been developed in order to provide a regional knowledge of rain and flood hazards. The parameters of the rainfall generator and the rainfall-runoff model were regionalized at the spatial resolution of 1 km^2 thus allowing the implementation of both models in each 1 km^2 pixel. Frequency distributions have been derived then in each pixel from the simulated events. The results can be shown as maps of statistical estimates of rainfall and flood discharge of various duration (up to 72 hours) and return periods (from 2 to 1000 years).

The purpose of the study is to estimate the flood discharge quantiles at the outlet of a catchment knowing this distributed information: the simulated flow distributions in each pixel of the catchments. We are faced with the fact that the quantile at the outlet which can not be equal to the sum of the quantiles of each pixels of the catchment. We need then to aggregate this distributed statistical hydrological data in order to calculate flood discharges quantiles at any point of the hydrographic network of the studied area.

We address this question thank to a discharge areal reduction function DARF [2]. This aggregation combines two distinct hydrological phenomena: the areal reduction of rainfall and the discharge attenuation in the channel network. Its implementation enables us to calculate flood quantiles at any point of the hydrographic network of the studied area. The principle of the DARF is to apply a reduction factor to the sum of the quantiles of each pixels of the catchment. This reduction factor is a function of the catchment area: the bigger the catchment is, the more important the factor. The shape and parameters of the DARF were calibrated on 1723 catchments evenly located over the French metropolitan territory, with sizes ranging from 2 km^2 to 120 000 km^2.

The DARF function applied to SHYREG discharges quantiles leads to promising results. Indeed a comparison with flood quantiles estimated on gauged catchments by local FFA (Extreme value theory, historical data and design floods) shows the SHYREG outlet quantiles perform well. Firstly, they are in an order of magnitude in agreement with those quantiles provided by the local approaches. Secondly, they are less sensitive to sampling effects for current events as well as for extreme ones.
What must be stressed out is the interesting application of the SHYREG methodology. Being a regional approach it provides prediction of flood discharge anywhere in the studied area, for gauged catchments as well as ungauged ones.

[1] Arnaud P, Fine J-A, Lavabre J, An hourly rainfall generation model applicable to all types of climate, Atmospheric Research, 85(2), 2007
[2] Lavabre J, Folton N, Ronsoux C, Prédétermination régionale des débits de crue. Cas de la zone méditerranéenne française, Conference Proceeding, IASH, 2002