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Probabilistic calibration of a distributed rainfall-runoff model for the generation of synthetic flood events

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Many flood forecasters believe that a well calibrated rainfall-runoff model can be considered as the best available representation of the hydrological behaviour of a river basin. The accuracy and reliability of flood forecasts depend on the magnitude and quality of available data. Most gauged basins have long, but heterogeneous hydrologic data sets. Daily values have been recorded during the last decades, but only a few years of high resolution rainfall and discharge values are typically available. As a result, data driven models can only use a small number of flood events for calibration, since the rest of the information is available at a different resolution.

In this context, physically-based rainfall-runoff modelling can be used to encode all the available information through the calibration process, which is critical to represent the basin behaviour correctly. Traditional calibration techniques give as a result a fixed set of the parameter values that best characterize mean basin behaviour. In order to account for the ensemble of basin behaviours that have been recorded in the basin, it is necessary to apply a calibration methodology that gives as a result the probability density function of every parameter. Once the model is calibrated probabilistically, a huge amount of synthetic flood events can be generated by coupling it with a stochastic rainfall generator. Different data driven models can thus be applied over the set of synthetic flood events generated. The huge amount of episodes that can be generated by this methodology allows the development of probabilistic flood forecasts.

A methodology based in coupling a stochastic spatially distributed rainfall generator and a distributed rainfall-runoff model is presented. The distributed rainfall-runoff

model has been calibrated by a hybrid method, combining manual and automatic calibrations for heterogeneous data sets, which gives the Pareto set results for every flood event recorded. Every parameter of the rainfall-runoff model has been characterized by a probability density function from all these Pareto data sets. Synthetic flood events have been generated by a Monte Carlo simulation over the parameters of both the stochastic rainfall generator and the distributed rainfall-runoff model. A reservoir operation module has been applied over the discharge results of the rainfall-runoff model, to take into account the flood control effect of reservoirs over the final hydrographs.