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Towards large scale stochastic rainfall models for flood risk assessment in trans-national basins

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While extensive research has been devoted to rainfall-runoff modelling for risk assessment in small and medium size watersheds, less attention has been paid, so far, to large scale trans-national basins, where flood events have severe societal and economic impacts with magnitudes quantified in billions of Euros. As an example, in the April 2006 flood events along the Danube basin at least 10 people lost their lives and up to 30 000 people were displaced, with overall damages estimated at more than half a billion Euros. In this context, refined analytical methods are fundamental to improve the risk assessment and, then, the design of structural and non structural measures of protection, such as hydraulic works and insurance/reinsurance policies. Since flood events are mainly driven by exceptional rainfall events, suitable characterization and modelling of space-time properties of rainfall fields is a key issue to perform a reliable flood risk analysis based on alternative precipitation scenarios to be fed in a new generation of large scale rainfall-runoff models. Ultimately, this approach should be extended to a global flood risk model.

However, as the need of rainfall models able to account for and simulate spatio-temporal properties of rainfall fields over large areas is rather new, the development of new rainfall simulation frameworks is a challenging task involving that faces with the problem of overcoming the drawbacks of the existing modelling schemes (devised for smaller spatial scales), but keeping the desirable properties. In this study, we critically summarize the most widely used approaches for rainfall simulation. Focusing on stochastic approaches, we stress the importance of introducing suitable climate forcings in these simulation schemes in order to account for the physical coherence of rainfall fields over wide areas. Based on preliminary considerations, we suggest a modelling framework relying on the Generalized Additive Models for Location, Scale and Shape (GAMLSS). This approach allows exploiting climate variables to improve the simulation of the spatio-temporal rainfall structure through dynamically varying marginal and joint distributions. The preliminary results of the spatio-temporal analysis and modelling of a large data set of daily rainfall time series from 15 countries in the Central Eastern Europe are shown. Finally, indications are given of how the model outputs will be used with rainfall runoff models for estimating collective flood risk across the Danube basin.