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Multifractal Extremes and Adaptation of Water Management to Climate Change

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Storm water flood prevention and reduction represent major economical and social goals. In the context of climate change, we discuss some results from the interdisciplinary research project R2DS/GARP-3C concerning future developments of socio-technical systems involved in the storm water flood management in Paris region. The efficiency of these systems strongly depends on the capacity to predict the structure and frequency of forthcoming rainfall events. To considerably reduce the present uncertainties concerning the evolution of hydrological extremes we investigated diverse and numerous rainfall data in Paris region over accumulation durations that range from 1 to 72 hours.

Locally calibrated on the same data, the majority of approaches give similar quantile estimates for the return periods comparable with the length of the data, whereas quantiles estimated by different approaches remain very distinct for much longer return periods and for sub-hourly durations. Upcoming hydrological extremes may become particularly local and intensive under local climate change. Hence better quality small scale rainfall data are needed to detect local trends. In addition, storm water management protocols strongly depend on rainfall patterns.

The estimation of return periods for rainfall extremes requires a model that undertakes the unperturbed statistical behavior of the probability tails and the possible clustering of the extremes, including long-range dependencies. With a limited number of parameters, the multifractal formalism offers a simple framework for the estimation of rainfall quantiles. This stochastic modeling is used to infer the quantiles for the return periods ranging from 1 to 1000 years.

Overall, this presentation discusses how multifractal methods allow to dynamically evaluate rainfall quantiles to be used by water authorities. Increased reliability of the multifractal parameter estimates allows reducing the uncertainty on future evolution of regional hydrological extremes. The results encourage further extensive use of a limited length high resolution rainfall time series together with radar archives for better detection of local climate trends. All this contributes to a « proof collection » that is indispensable for climate change incorporation into operational systems.