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New Directions for the Estimation of Extreme Hydrological Events at Ungauged Basins

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Regional frequency analysis is a popular tool for estimating the severity of flood and low flow events at ungauged sites. However, existing regional frequency analysis approaches have several limitations. In this talk, we will present a comprehensive review of existing regional estimation methods, examine the theoretical and practical limitations of these approaches, and present new directions that should be explored in future research. These new approaches are based on promising new developments in the fields of statistics and hydrology. The first focus will be on the development of new methods that can be used in a context of climate change. Indeed, in frequency analysis, data must generally be independent and identically distributed (i. i. d) which implies that they must meet the statistical criteria of independence, stationarity and homogeneity. In reality, the probability distribution of extreme events can change with time, indicating the existence of non-stationarity. The criterion of stationarity can then be jeopardized. The objective of this first direction is to develop efficient estimation methods for the regional analysis of extreme hydrological events in the presence of non-stationarity. The Bayesian framework is privileged for this purpose. The second focus will be on the development of QdF models. QdF allows to estimate flood characteristics as an integrated function of return period and flood duration. QdF models are often applied in regional studies, leading to regional QdF relations derived for hydrologically homogeneous regions. The proposed approach uses regional trend analysis to identify time-dependent parameters of the model, and to estimate and predict flood quantiles in the present and the near future. The third direction will focus on the development of specific approaches that are efficient for very small and very large basins. These types of basins are usually unprivileged by regional estimation methods. We will also focus on the use of rainfall scaling properties in the estimation of regional flood quantiles, and on the use of multivariate copulas for the estimation of several flow characteristics at the same time. All methods proposed are illustrated with applications to case studies.