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Regionalization of Intensity-Duration-Frequency Curves for different data types in Germany

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Rainfall intensity-duration-frequency (IDF) curves are required for the design of several water systems and protection works. These curves are typically generated from the station data by fitting a theoretical distribution either to the annual extremes (AMS) or partial extremes (PE) series. Nevertheless, two main problems arise: i) for generating intensity depth for high return periods, long time series are needed (more than 40 years). While this is the case mainly for daily recordings, for sub-hourly time series only few point measurements are available. ii) as the station data are only local measurements, there is a need for regionalization of the of IDF curves to ungauged locations. Thus, the aim of this study is to investigate the use of different data types and methods in generating reliable IDF curves for ungauged locations.

For this purpose, the available gauge data from the German Weather Service (DWD) in Germany are employed, which include: 5000 daily stations with more than 40 years available, 1100 sub-hourly (5min) recordings with observations period shorter than 20 years, and finally 89 sub-hourly (5min) recordings with 60-70 years of observations. Annual extremes are extracted for each location for different durations D=5, 10, 15, 30, 60, 120, 180, 240, 360, 720, 2880 minutes, and a Generalized Extreme Value (GEV) probability distribution is fitted to each duration level as well as across all duration levels by the methods of the L-moments and Maximum-Likelihood, in order to derive the intensity quantiles for the given return periods Ta=2, 10, 20 and 100 years. First, a disaggregation scheme to 5 min resolution is performed on the daily recordings in order to investigate if disaggregated daily data can be useful for the IDF estimation of sub-daily durations. Then, the rainfall extremes of short observations are corrected by a correlation-based augmentation method. Finally, as the extreme intensities and durations are co-dependent, a normalization of the AMS over all the durations is performed.

To evaluate the regionalization of the IDF curves to ungauged regions, three methods are investigated: i) flood index method ii) regionalization with normalization of extremes over the durations and ii) kriging interpolation (ordinary and external drift kriging) of local AMS quantiles or parameters of the fitted distribution. The performance of these regionalization techniques is then evaluated by cross-validation, where the local IDF from the long sub-hourly time series are considered the true reference. Based on the relative bias, rmse and correlation the best method is

selected and used for the regionalization of the IDF curves in Germany. Different data products are fed in the regionalization methods to answer the following questions: are the disaggregated long time series useful in regionalizing sub-hourly IDF? Can space be traded for time (and vice versa) when regionalizing IDF? What is the best incorporation of different data sets for the regionalization of the IDF? Lastly, a bootstrap method is as well employed to account for the uncertainties in estimation intensity-duration extremes for the given return periods.