Obtaining DDF Curves of Extreme Rainfall Data Using Bivariate Copula and Frequency Analysis - DTU Orbit (08/08/2019)

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The traditional rainfall intensity-duration-frequency (IDF) curve is a reliable approach for representing the variation of rainfall intensity with duration for a given return period. In reality, rainfall variables intensity, depth, and duration are dependent, and therefore a bivariate analysis using copulas can give a more accurate IDF curve. We study IDF curves using a copula in a bivariate frequency analysis of extreme rainfall. To be able to choose the most suitable copula among candidate copulas (i.e., Gumbel, Clayton, and Frank), we demonstrated IDF curves based on variation of depth with duration for a given return period and name them DDF (depth-duration-frequency) curves. The copula approach does not assume the rainfall variables are independent or jointly normally distributed. Rainfall series are extracted in three ways: (1) by maximum mean intensity; (2) by depth and duration of individual rainfall events; and (3) by storage volume and duration. In each case, we used partial duration series (PDS) to extract extreme rainfall variables. The DDF curves derived from each method are presented and compared. This study examines extreme rainfall data from catchment Vedbæk Renseanlæg, situated near Copenhagen in Denmark. For rainfall extracted using method 2, the marginal distribution of depth was found to fit the Generalized Pareto distribution while duration was found to fit the Gamma distribution, using the method of L-moments. The volume was found to fit a generalized Pareto distribution and the duration was fit with a Pearson type III distribution for rainfall extracted using method 3. The Clayton copula was found to be appropriate for bivariate analysis of rainfall depth and duration for both methods 2 and 3. DDF curves derived using the Clayton copula for depth and duration of individual rainfall events (method 2) are in agreement with empirically derived DDF curves obtained from maximum mean intensity (method 1) for a 10-year return period. For a 100-year return period, the estimates differ by 2.5 cm for a 5 hr duration. This difference diminishes to almost zero for a 50 hr duration. If rainfall series are extracted by storage volume and duration (method 3), the difference between DDF curves derived from the Clayton copula and the empirical DDF curves are more appreciable and in general, DDF curves derived from method 3 show a smaller depth for the same duration for any selected return period. The differences between DDF curves illustrate that the method of extracting extreme rainfall as well as the frequency analysis approach have a considerable effect on the resulting DDF curves.

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