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Estimation of Return Periods of daily Extreme Precipitation in Germany 1951 - 2000

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Extreme daily precipitation may cause extreme damages to human life and properties and thus has a considerable economic effect. However, extreme precipitation events are by nature rare events and therefore the estimation of their statistical features may be biased by observational deficits.

In the case of Germany there are 1769 meteorological stations for which observed daily precipitation records for the period 1951 to 2000 exist. We fit Gumbel distributions to the series of annual maxima of daily, two-day and three-day precipitation sums. The coefficients of determination are high, above 98% for half of the stations and above 95% for 9 out of 10 stations. This confirms that the Gumbel distribution adequately describes daily extreme precipitation in Germany.

We investigated the spatial dependence of the parameters of the Gumbel distribution and found that the position parameter is strongly altitude dependend while the scale parameter shows no clear spatial structure. The results allowed to develop a software for the estimation of return periods with respect to different thresholds for arbitrary locations in Germany (see http://user.uni-frankfurt.de/˜grieser/downloads/ExPrec/ExPrec.htm). Since the link between thresholds and respective return periods is unique, the software also allows to estimate thresholds according to given return periods.

The parameters of the Gumbel distribution are estimated from observations and thus prone to observation errors and the specific realisation of one time series per station. Furthermore, the function relating return periods with thresholds is strongly non-linear. This leads to the effect that the estimation of return periods for provided thresholds is much more uncertain (in terms of relative errors) than the estimation of

thresholds for given return periods. Errors in the estimated thresholds are below 10% even for large return periods. Relative errors in estimated return periods, however, are hardly below 30% and may easily reach 100% and by that making statements on estimated return periods senseless.

We like to stress that this may have implications for the use of return periods not only while designing and managing rain water related facilities but also for the discussion of climate-change related changes in extreme precipitation.