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Estimation of extreme daily precipitation: comparison between regional and geostatistical approaches.

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We study the extreme rainfall regime of the Island of Sardinia in Italy, based on annual maxima of daily precipitation. The statistical analysis is conducted using 229 daily rainfall records with at least 50 complete years of observations, collected at different sites by the Hydrological Survey of the Sardinia Region. Preliminary analysis, and the L-skewness and L-kurtosis diagrams, show that the Generalized Extreme Value (GEV) distribution model performs best in describing daily rainfall extremes. The GEV distribution parameters are estimated using the method of Probability Weighted Moments (PWM).

To obtain extreme rainfall estimates at ungauged sites, while minimizing uncertainties due to sampling variability, a regional and a geostatistical approach are compared. The regional approach merges information from different gauged sites, within homogeneous regions, to obtain GEV parameter estimates at ungauged locations. The geostatistical approach infers the parameters of the GEV distribution model at locations where measurements are available, and then spatially interpolates them over the study region. In both approaches we use local rainfall means as index-rainfall.

In the regional approach we define homogeneous regions by applying a hierarchical cluster analysis based on Ward's method, with L-moment ratios (i.e. L-CV and L-Skewness) as metrics. The analysis results in four contiguous regions, which satisfy the Hosking and Wallis (1997) homogeneity tests. The latter have been conducted using a Monte-Carlo approach based on a 4-parameter Kappa distribution model, fitted to each station cluster. Note that the 4-parameter Kappa model includes the GEV distribution as a sub-case, when the fourth parameter h is set to 0. In the geostatistical approach we apply kriging for uncertain data (KUD), which accounts for the error variance in local parameter estimation and, therefore, may serve as a useful tool for spatial interpolation of metrics affected by high uncertainty. In addition, KUD avoids separation of the study region in contiguous areas, allowing for a continuous representation of the spatial variation of distribution parameters.

Comparisons based on different error metrics, conducted with the method of cross-validation, show better performance of the geostatistical approach relative to the regional one. In addition, the geostatistical approach better represents local features of the spatial variability of rainfall, while overcoming the issue of abrupt shifts of distribution parameters at the boundaries between contiguous homogeneous regions.