Effects of different spatial interpolators on the estimate of extreme precipitation

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1 Introduction

The design values of the areal precipitation are needed for engineers to manage vital elements of our infrastructure. The areal precipitation can be generated by different interpolation methods. The problem involves choosing the interpolation method that we should use to estimate the extreme event.
This work aimed at analyzing the effects of different interpolation methods on the estimate of extreme events of daily areal precipitations at catchment scale.

2 Materials and methods

We used thirty-years-long daily time series and different density of rain gages (from 4 to 70 rain gages). Our study is located in the Ourthe and Ambleve catchment area (2908 km²) in the southern part of Belgium (figure 1).

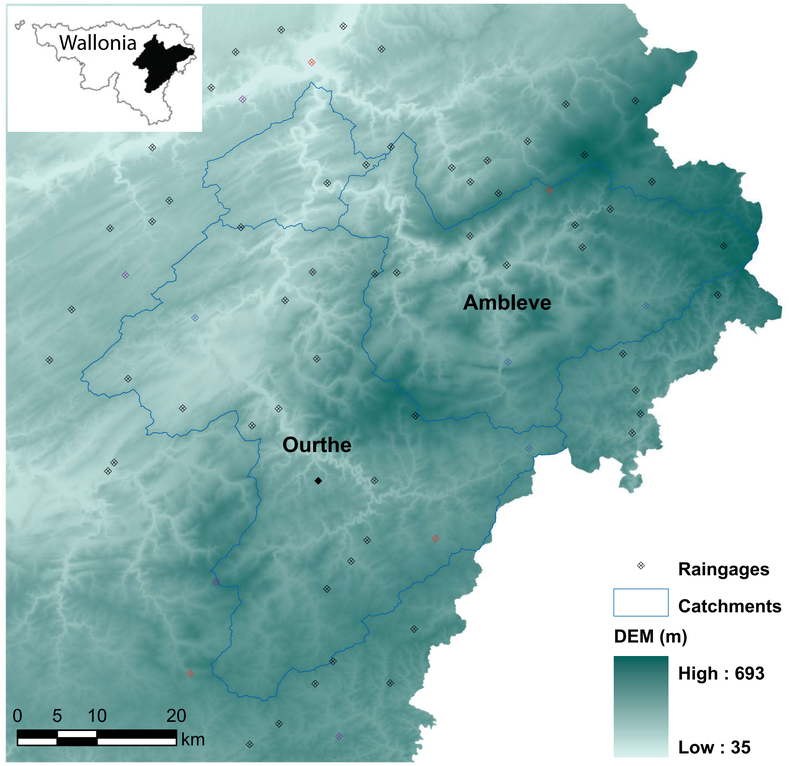

Figure 1. DEM of the Ourthe and Ambleve catchments and location of different sets of available raingages using for spatial interpolation: 70 stations (all), 8 stations (red and blue), 4a stations (red) and 4b stations (pink).

The extreme rainfalls were estimated using areal daily rainfall interpolated by several interpolation methods - deterministic methods: Thiessen polygon (THI) and Inverse Distance Weighting (IDW), and geostatistical methods (figure 2): Ordinary Kriging (ORK), Universal Kriging (UNK), Kriging with an External Drift (KED) and Ordinary Cokriging (OCK).
The extreme daily rainfall, corresponding to return periods of 20, 50 and 100 years, were computed by fitting of a statistical model to the series of maximum annual precipitation. These estimates were conducted using HYFRAN* which allows us to fit 16 different statistical laws, in 2 or 3 parameters (figure 3, 4 & 5). The most known are Gumbel, Gamma, Weibull, exponential, Pareto, lognormal, Pearson III and GEV.

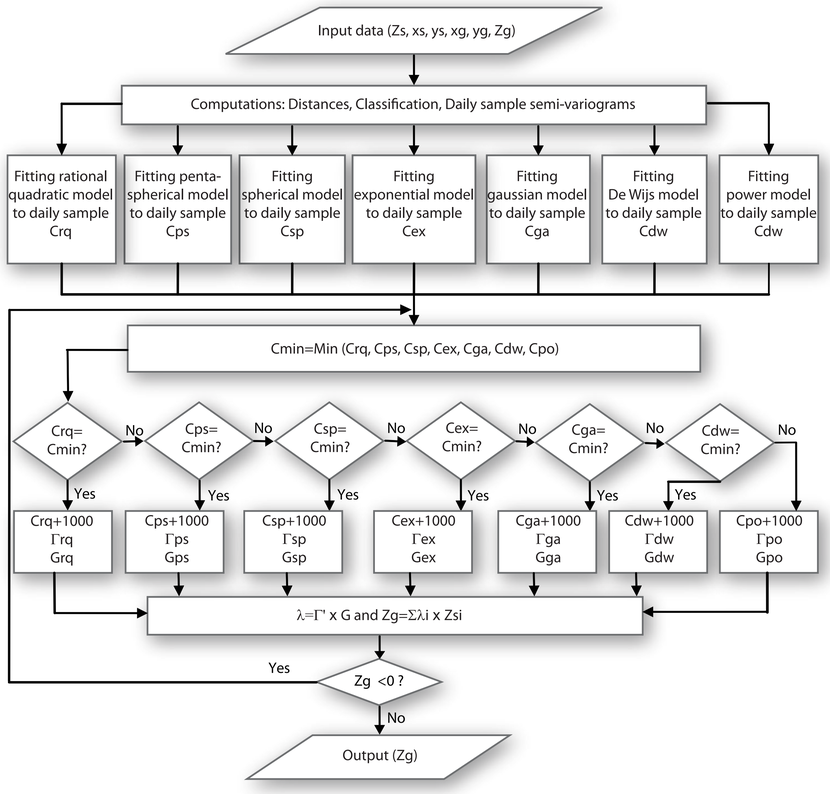

Figure 2. Flowchart showing the simplified procedure of kirging algorithm.

3 Analyses and results

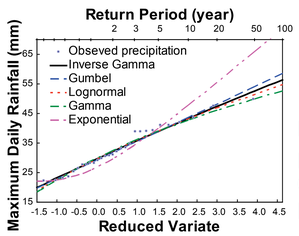

Figure 3. Observed (interpolated) and estimated daily precipitation with five best classified models for the Ourthe and Ambleve catchment area: spatial interpolation by Thiessen polygon and 70 stations.

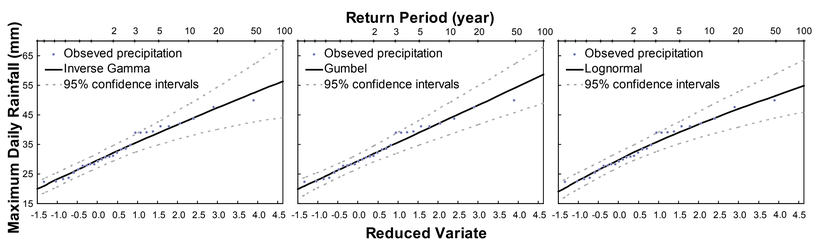

Figure 4. Observed (interpolated) and estimated daily precipitation (3 best classified models) and 95% confidence intervals for the Ourthe and Ambleve catchment area: spatial interpolation by Thiessen polygon and 70 stations.

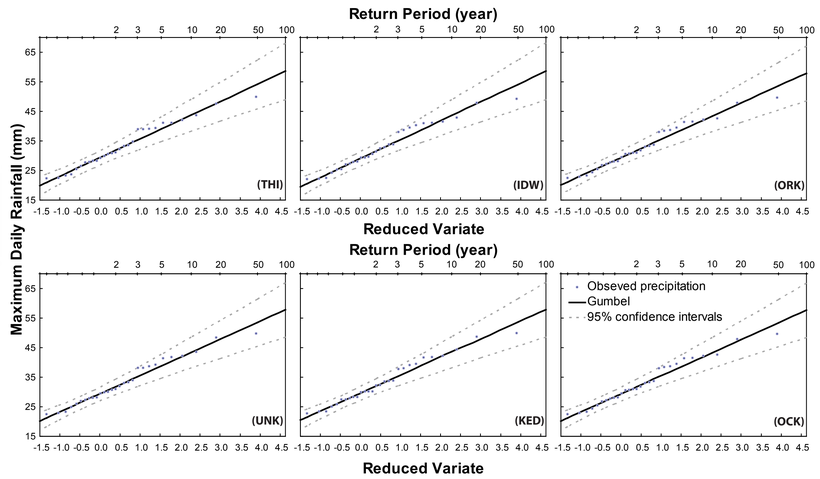

Figure 5. Observed (interpolated) and estimated daily precipitation and 95% confidence intervals for the Ourthe and Ambleve catchment area: spatial interpolation by the six methods and 70 stations.

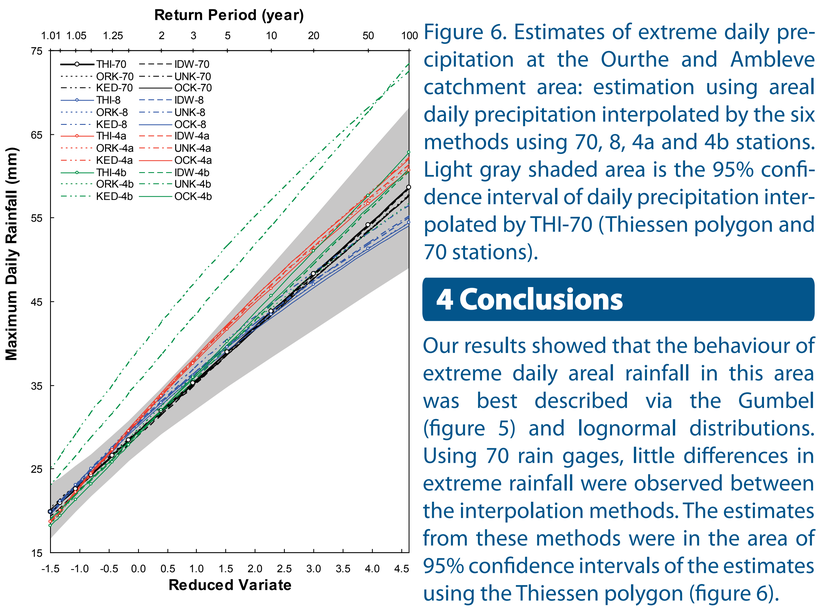

Figure 6. Estimates of extreme daily precipitation at the Ourthe and Ambleve catchment area: estimation using areal daily precipitation interpolated by the six methods using 70, 8, 4a and 4b stations. Light gray shaded area is the 95% confidence interval of daily precipitation interpolated by THI-70 (Thiessen polygon and 70 stations).

4 Conclusions

Our results showed that the behaviour of extreme daily areal rainfall in this area was best described via the Gumbel (figure 5) and lognormal distributions. Using 70 rain gages, little differences in extreme rainfall were observed between the interpolation methods. The estimates from these methods were in the area of 95% confidence intervals of the estimates using the Thiessen polygon (figure 6).
However, when the number of rain gages diminishes, the Universal Kriging and Kriging with External drift methods produced extreme estimates outside the area of 95% confidence intervals of the estimates using the Thiessen polygon with all available stations. The analysis described here provides a means to choose the interpolation method in view to calculate extreme events. It shows to engineers or hydrologists the need for a particular care when working in the regions of sparse data.

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* HYFRAN is developed at the National Institute of the Scientific Research, University of Quebec.