Effects of raingage density, position and interpolation on rainfall-discharge modelling

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1 Introduction

Precipitation conventionally observed using raingages or weather stations, is one of the key parameters that has direct influence on runoff generation. Precipitation data require a preliminary spatial interpolation prior to hydrological modelling. The accuracy of modelling result depends on the accuracy of the interpolated spatial rainfall which differs as regard to different interpolation methods. The accuracy of the interpolated spatial rainfall is frequently determined by cross-validation method.

The objective of this study is to investigate the performance of the different interpolation methods for daily rainfall at the catchment scale through hydrological modelling and to explore the best methods that provide a good long term simulation.

2 Materials and methods

Four versions of geostatistics (figure 1): Ordinary Kriging (ORK), Universal Kriging (UNK), Kriging with External Dridft (KED) and Ordinary Cokriging (OCK) and two types of deterministic methods: Thiessen polygon (THI) and Inverse Distance Weighting (IDW) are used to produce 30-year daily rainfall inputs for a distributed physically-based hydrological model (EPIC-GRID) (figure 2).

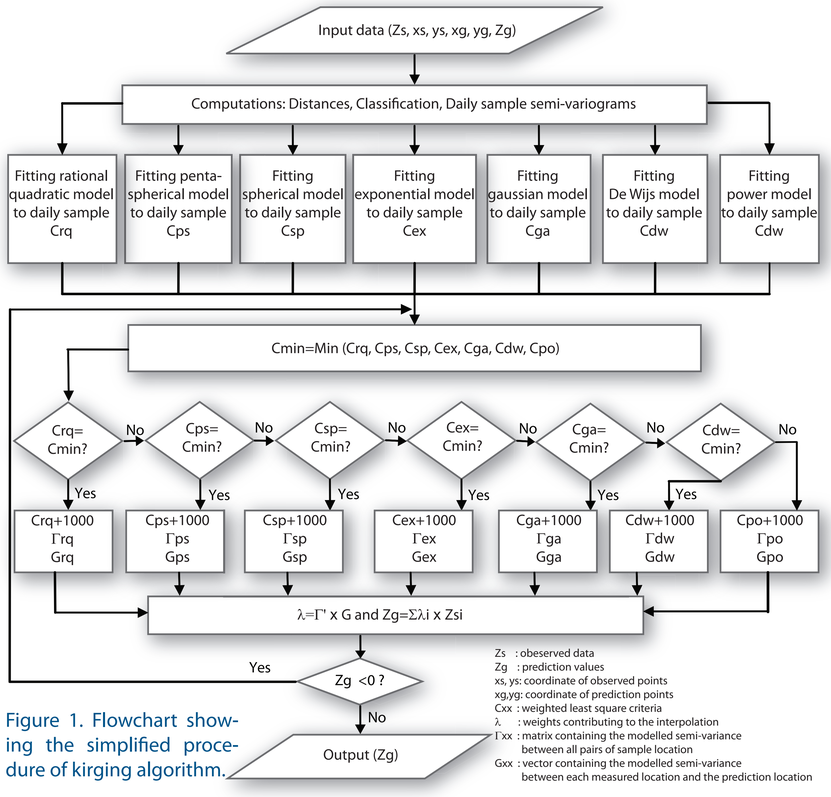

Figure 1. Flowchart showing the simplified procedure of kirging algorithm.

This work is conducted in the Ourthe and Ambleve nested catchments, located in the Ardennes hilly landscape in the Walloon region, Belgium. The total catchment area is 2908 km^2, lies between 67 and 693 m in elevation. The multivariate geostatistics (KED and OCK) are also used by incorporating elevation as external data to improve the rainfall prediction. This work also aims at analysing the effect of different raingage densities and positions used for interpolation, on the stream flow modelled to get insight in terms of the capability and limitation of the geostatistical methods. The number of raingages varies from 70, 60, 50, 40, 30, 20, 8 to 4 stations located in and surrounding the catchment area. In the latter case, we try to use different positions.

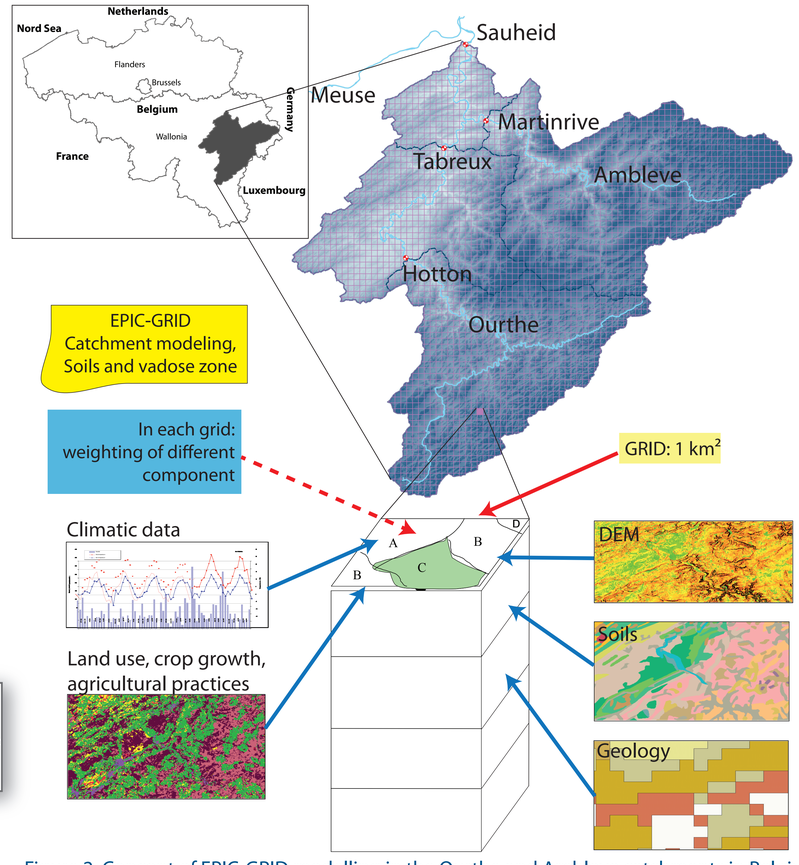

Figure 2. Concept of EPIC-GRID modelling in the Ourthe and Ambleve catchments in Belgium

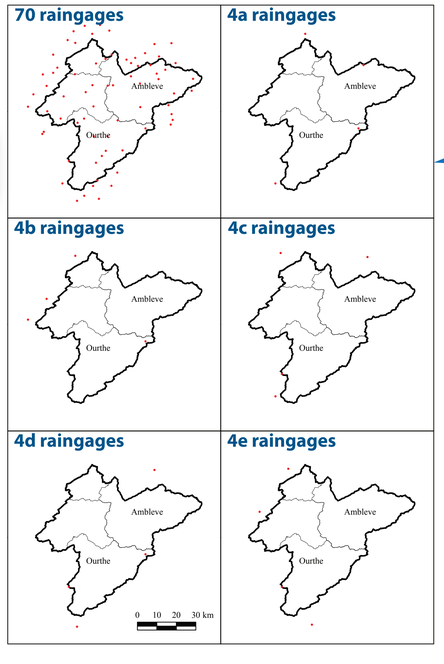

Figure 3. Different degenerated densities and spatial locations of raingages used for geostatistical interpolations of rainfall

3 Analyses and results

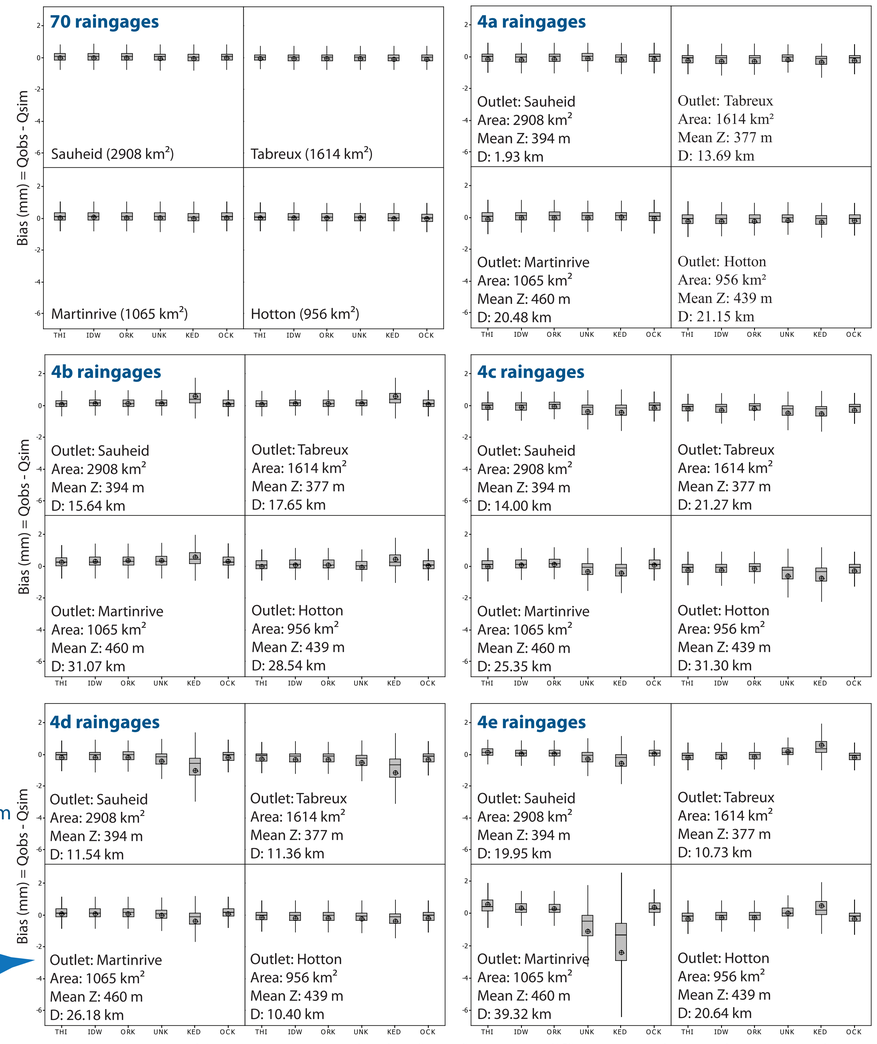

Figure 4. Boxplot of the bias for different gauging stations and interpolation methods of rainfall using different number and position of raingages. The median and mean of the distribution of the bias for each method indicated by horizontal lines and circle with cross respectively inside the box. The first and third quartiles are the bottom and top values of the box respectively. The upper and lower whiskers extend to the maximum and minimum bias within 1.5 box heights from top and bottom of the box respectively. Mean Z is mean elevation of the catchment, D is distance between the centroids of the raingage polygon and the catchments.

4 Conclusions

When using 70, 60, 50, 40, 30, 20, 8 raingages in the catchment area (2908 km^2), no substantial differences in model performance are observed.

The result shows that the simple method like THI can not well capture the rainfall to produce good flow simulation in all cases using 4 raingages. UNK and KED methods are sensitive to raingage position and catchment characteristics and have very strong effect on the modelling performance. However, the three methods (IDW, ORK and OCK) can overcome all problems since they are more robust and can provide good performance of simulation for all raingage densities and positions and all catchment characteristics and sizes.

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