Radar-based extreme rainfall analysis for small areas

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Motivation

- Warnings of extreme precipitation averaged over a small area and during a short duration are needed by people and the public services for their safety.
- For these extreme events, accurate statistics can be derived from radar-based precipitation estimation using a regional frequency analysis.
- The extreme statistics can then be combined in realtime with precipitation estimation and nowcasting to provide warnings.
- Web and smartphone applications can be developed to send warnings for selected areas, event durations and warning levels.
- The product will be designed with the users (weather office, hydrological services, cities)

Study area

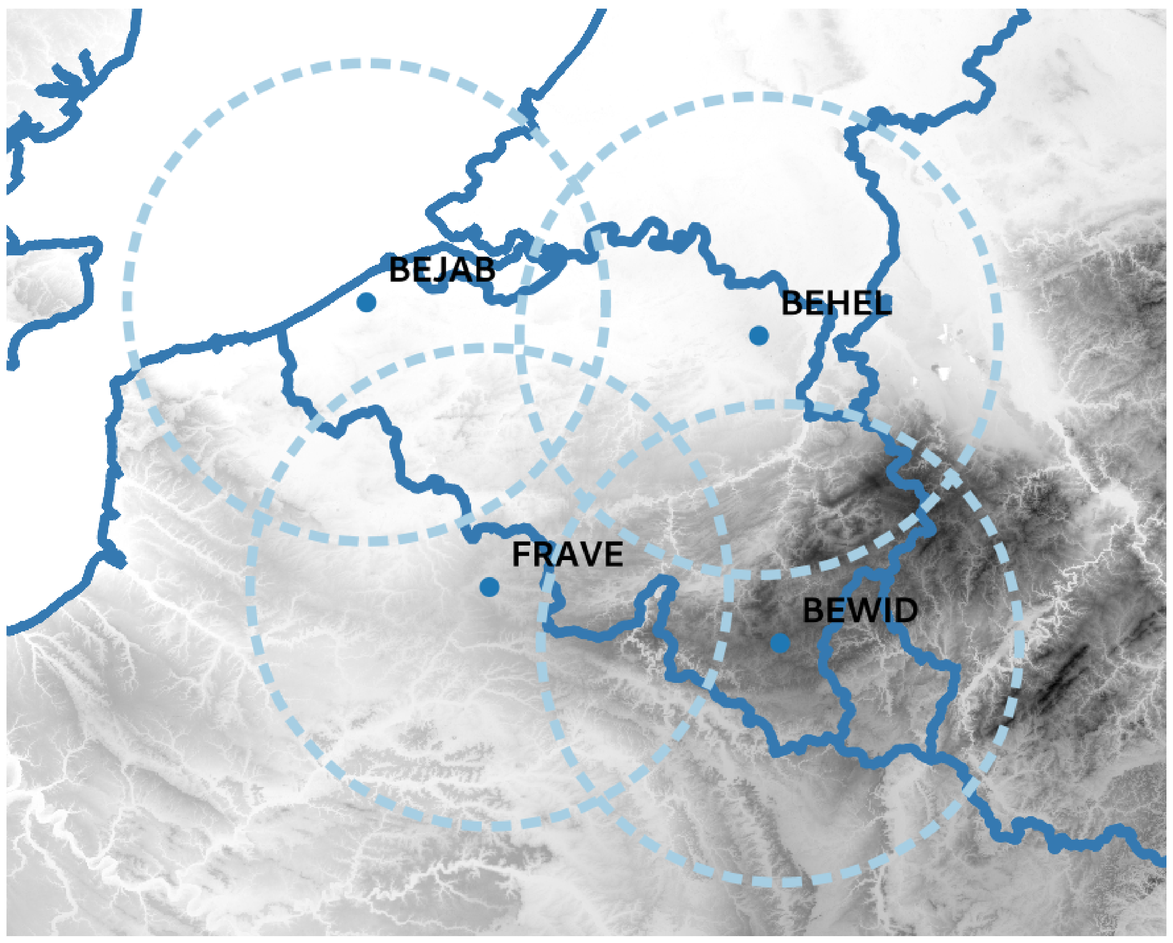

Figure 1. Study area with topography from 0 to 800 m and radar location with 100 km range.

Climatological radar rainfall product

RADCLIM provides high resolution quantitative precipitation estimation for Belgium and its surroundings based on the processing of 4 weather radar measurements. The method includes:

- Removal of non-meteorological signals by static, satellite, texture and vertical filters.
- Conversion of reflectivity into rain rates based on precipitation type (snow, hail, convective rainfall, stratiform rainfall) and orography
- Composite with maximum value of the 3 closest radars within 180 km
- Rainfall accumulation are made using optical flow techniques
- Radar estimation combined with validated rain gauge measurements using Kriging with external drift

Examples of target areas on the gridded product

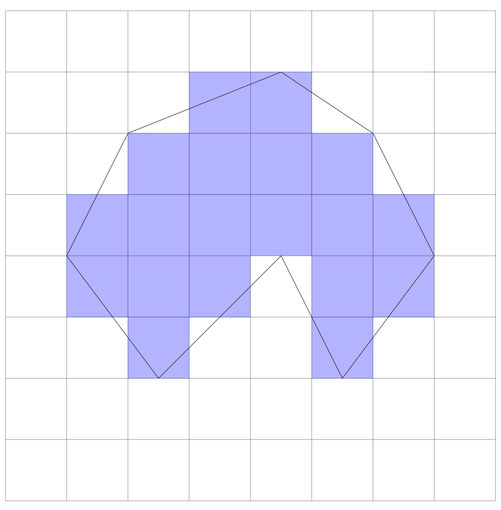

Figure 2. Discretized real area (e.g. catchment)

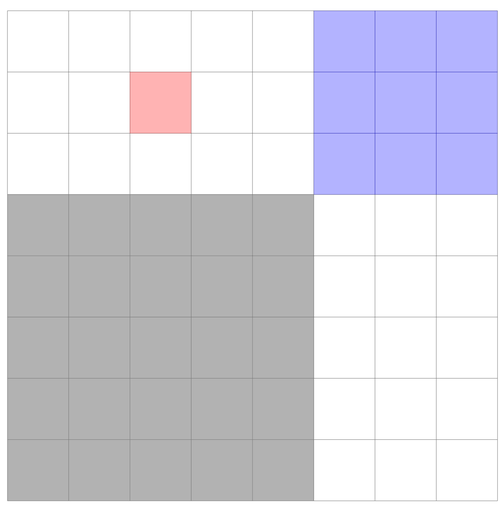

Figure 3. Standard areas

Regional extreme rainfall analysis

1. Define a polygon representing a small target area, like the catchment of a small river.
2. Approximate the area by selecting all 1km radar pixels included by at least 50% in the polygon.
3. Translate the small area in a neighborhood where similar statistics are assumed.
4. For each possible translation, compute the maximum rainfall accumulation over the year.
5. If several annual maxima happen during the same convective event, select one of them randomly.
6. Fit a General Extreme Value (GEV) model to the selected rainfall data.

Data: hourly accumulations for the year 2021

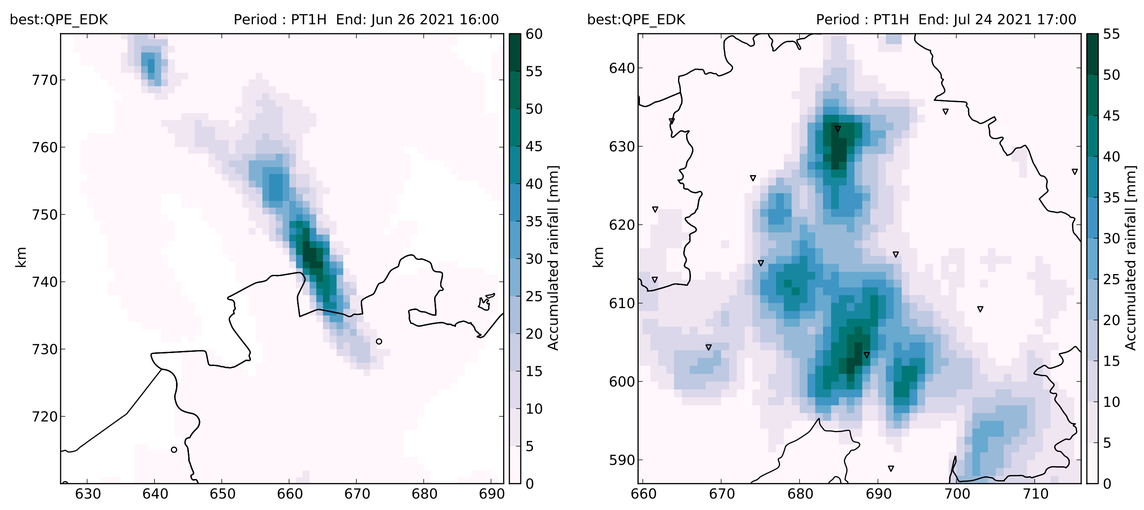

Figure 4. Two highest values for 3x3km squares: 55.3 mm and 50.4 mm

Preliminary results

- Independence: minimum 10 hours between extremes
- Neighborhood: maximum 50 km distance from location

Return period	1x1 km	3x3 km	5x5 km	3x8 km	8x3 km
5 years	17.3	15.5	14.1	13.2	13.8
10 years	21.6	18.2	16.0	14.9	15.5
20 years	26.6	21.1	17.7	16.6	17.0
50 years	34.6	24.9	19.7	18.6	18.7
100 years	41.8	28.1	21.1	20.1	19.9

Table 1. Return levels at BEJAB location (3.064, 51.191)

Return period	1x1 km	3x3 km	5x5 km	3x8 km	8x3 km
5 years	19.6	17.2	15.5	15.5	16.5
10 years	23.4	19.9	17.6	17.7	18.1
20 years	27.4	22.7	19.8	20.0	19.6
50 years	33.2	26.6	23.0	23.1	21.5
100 years	38.0	29.7	25.7	25.7	22.8

Table 2. Return levels at BEHEL location (5.406, 51.069)

Return period	1x1 km	3x3 km	5x5 km	3x8 km	8x3 km
5 years	19.0	17.0	15.4	15.0	16.9
10 years	23.5	19.8	17.7	16.9	20.1
20 years	28.8	22.7	20.4	18.7	24.1
50 years	37.9	27.0	24.4	21.2	30.7
100 years	46.7	30.5	28.0	23.2	37.2

Table 3. Return levels at BEWID location (5.504, 49.913)

Return period	1x1 km	3x3 km	5x5 km	3x8 km	8x3 km
5 years	19.1	17.6	15.5	16.2	16.0
10 years	22.9	19.9	17.3	18.4	18.3
20 years	27.1	22.1	19.2	20.5	20.8
50 years	33.4	24.9	21.8	23.4	24.4
100 years	39.1	27.1	23.9	25.6	27.6

Table 4. Return levels at FRAVE location (3.811, 50.128)