Kennis voor Klimaat

Knowlege for Climate

6.2.2. Analysis of extremal behavior under non-stationary climate conditions

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A regional peaks-over-threshold model in a non-stationary climate

Introduction

Knowledge about extreme precipitation and associated trend behavior is critical for the design of e.g. dams and sewage systems. Climate change increases the need for advanced statistical models, that are capable to incorporate trends. Because of the large estimation uncertainty, the available data should be used in the most efficient way. Hence, we propose to use a regional modeling approach together with peaks-over-threshold (POT) data.

We applied the proposed model to observed, gridded, daily precipitation data for the winter (DJF) periods from 1950-2010 over the Netherlands (EOBS data v. 5.0).

Peaks-over-threshold

For the estimation of extremes one can not use all daily precipitation data but has to focus on data that represent precipitation extremes. The two basic methods are the block maxima (BM) approach, which considers maxima of distinct blocks, e.g. annual maxima, and the POT approach, that takes into account all values above a high threshold. The POT approach considers usually more data, see Figure 1, thus reducing the estimation uncertainty compared to BM.

A positive trend in extreme precipitation would lead to an unbalanced sampling in the case of a fixed threshold, i.e. fewer peaks in an earlier period than in a later period. We considered a linear trend in the threshold, which yields approximately the same number of peaks for each period, see Figure 2.

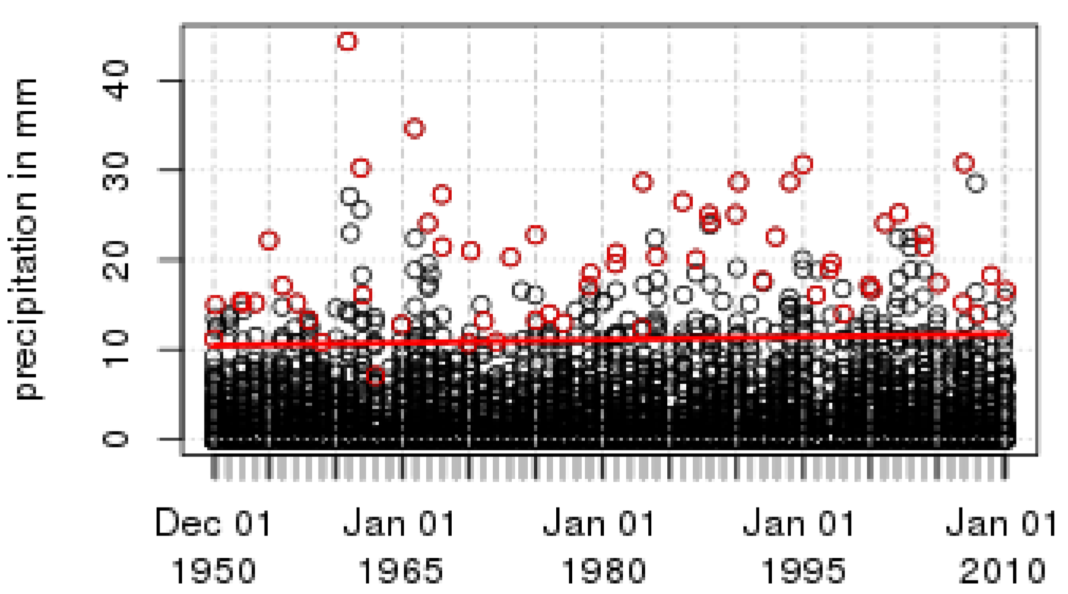

Figure 1: Precipitation data for De Bilt, the red solid line represents the threshold and the red dots the winter maxima.

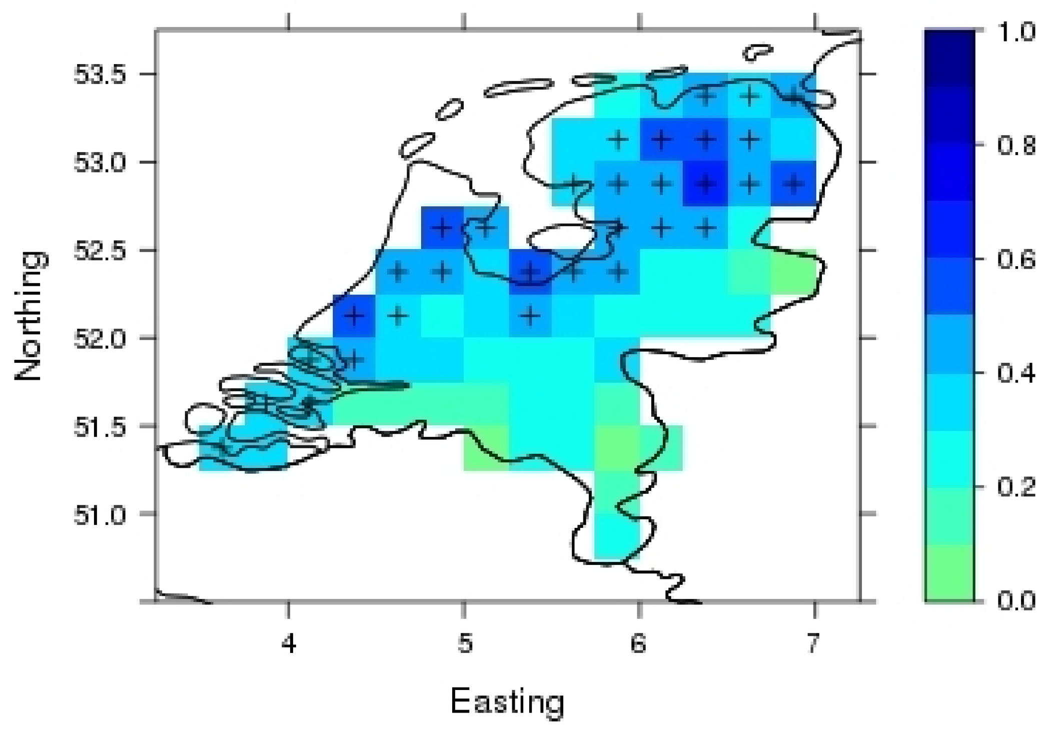

Figure 2: Trend of the threshold for the 1950-2010 period in mm per decade.

Regional modeling

We assume that all site-specific distributions are equal after scaling with a site-specific factor, the index variable. Several studies indicate that this assumption is justifiable for the Netherlands. The parameters of the common distribution are estimated using the data from all sites across the region.

Spatial dependence

The parameters are estimated as if there is no inter-site dependence, but spatial dependence is taken into account for the evaluation of the uncertainty.This is done using the composite likelihood framework.

Change in extremes

The relative change of the 100-year return level, i.e. the value that is exceeded with probability 0.01 in a year (winter season), during the observed period is mapped in Figure 3. We see as in Figure 2 a coastal gradient.

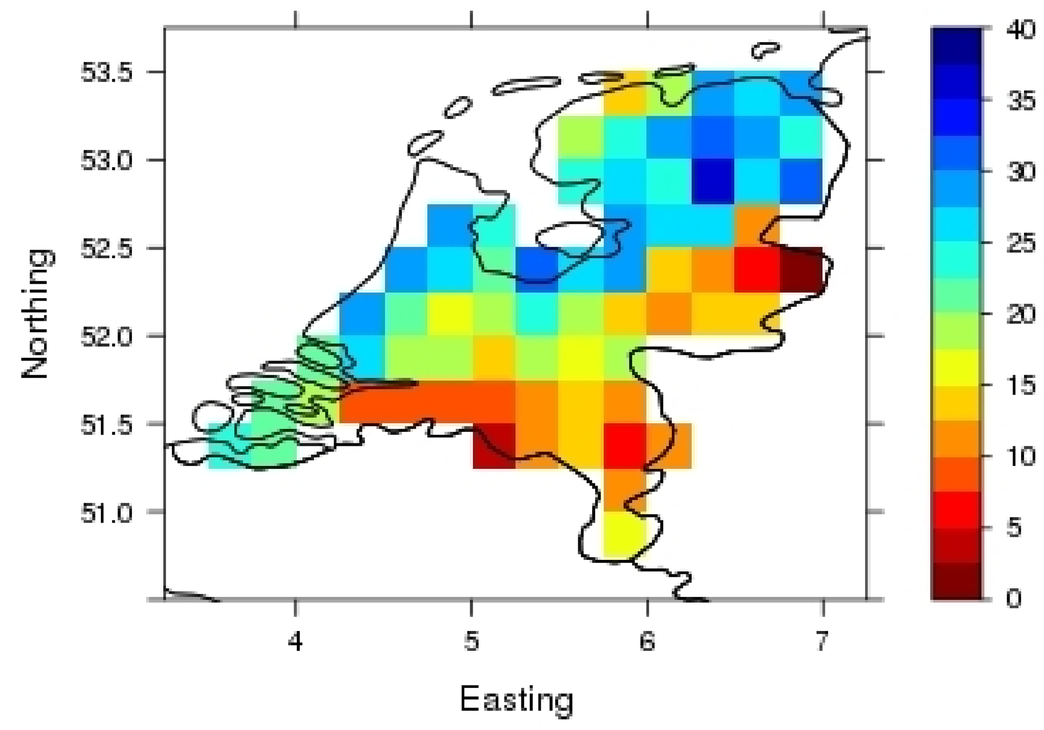

Figure 3: Relative change (in %) in the 100-year return level over the observed time period.

Uncertainty reduction

In Figure 4 we visualize the 100-year return level for De Bilt, estimated with the regional approach and the normal at-site approach. Though both approaches yield about the same return level, the associated uncertainty is reduced by about 35% in the regional approach compared to the site-specific estimation.

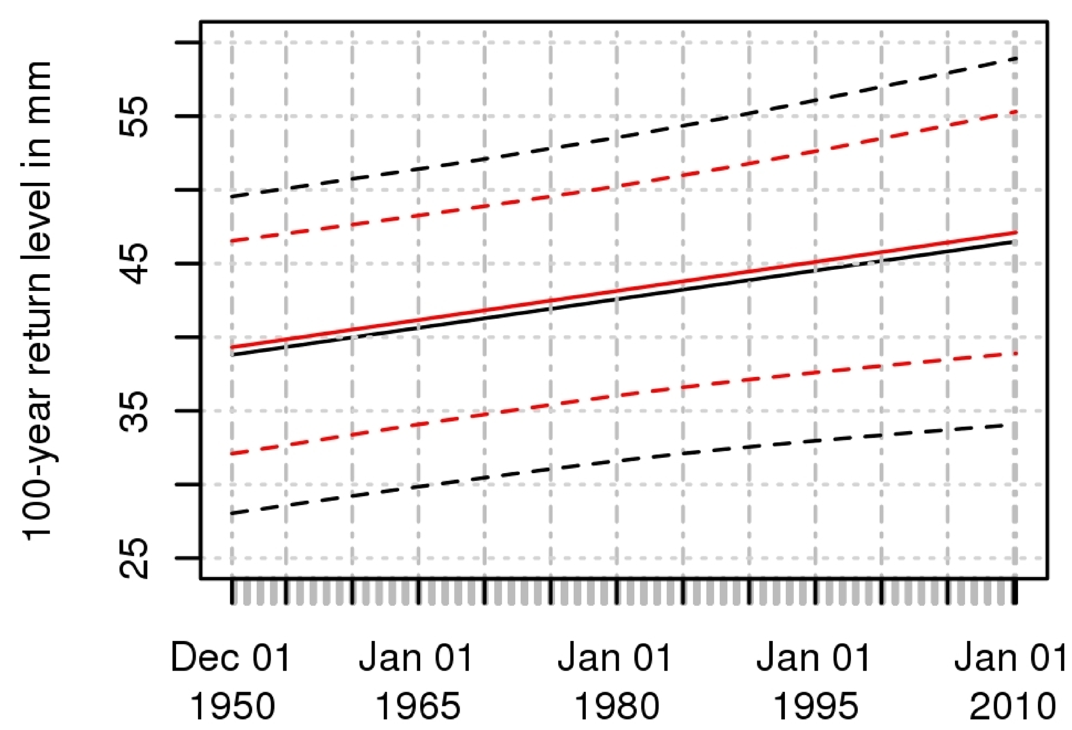

Figure 4: Absolute change of the 100-year return level in mm for De Bilt together with 90% confidence bands (black - at site, red - regional).

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