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Spatial patterns and seasonal precipitation trends in the Netherlands during 1951-2009

Emma Daniëls - PhD student Wageningen UR (Jan 2011 - Dec 2015)
Supervision: dr. Ronald Hutjes (ESS-CC), Geert Lenderink (KNMI), prof. dr. Bert Holtslag (MAQ) and prof. dr. Pavel Kabat (ESS-CC)

Background

This is the first part of a broader PhD study into the effect of the land surface on precipitation events in the Netherlands.

Objective

To gain insight in the occurence of precipitation change and maxima, and to assist in the choice of case studies for later model simulations.

Introduction

Buishand et al. (1) show increasing trends in several precipitation characteristics (see e.g. fig. 1), especially winter precipitation and the number of days with more than 20 or 30 mm rain. Overall, the largest trends can be seen in the coastal area. Extending their work, this study investigates several different indices and analyzes the spatial distribution and regional differences.

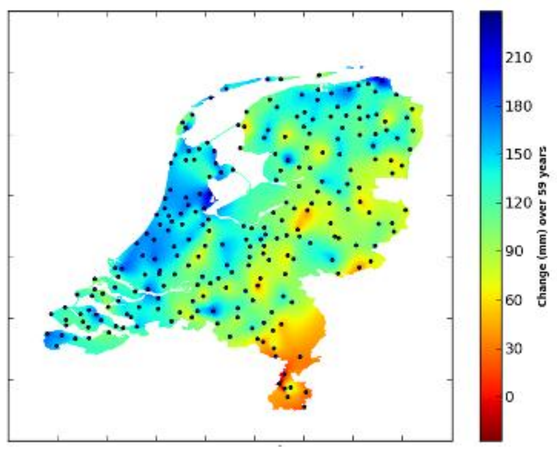

Figure 1. Changes in annual precipitation (mm) over the period 1951 – 2009. Black dots indicate the station positions. Copied from Buishand et al. 2012.

Results

Even though the Netherlands is a relatively small country, there are regular regional variations. For example, the spatial distribution of precipitation throughout the seasons (see fig. 2 and 3). To investigate these changes, we divided the country into 6 regions (see table 1).

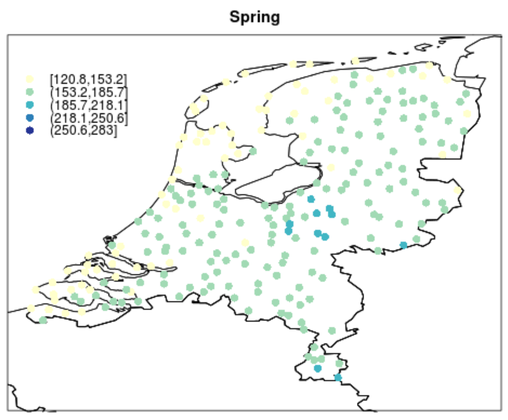

Figure 2. Mean spring (MAM) precipitation for the period 1951-2009.

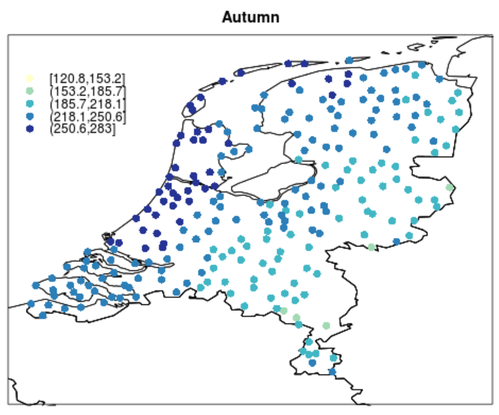

Figure 3. Mean autumn (SON) precipitation for the period 1951-2009.

Table 1. Main characteristics of the 6 regions. Significant linear regression changes are bold.

Region	Main soil type	Mean height (m)	Mean precipitation (mm)	Precipitation change (%)
Veluwe	Sand & loam	54	881	9.0
South-west	Clay	2	791	**17.8**
West	Clay & peat	0	831	**19.6**
South-east	Sand	19	777	12.5
East	Sand	12	813	13.0
North	Sand & peat	4	814	**15.9**

Results

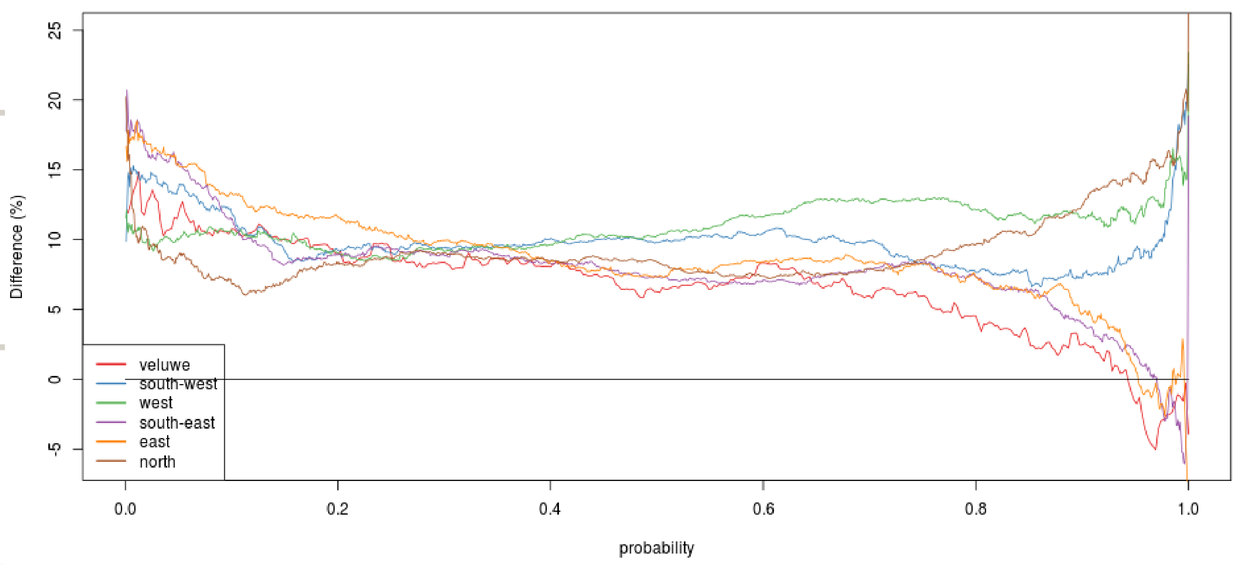

Figure 4. Quantile differences in yearly mean precipitation in the Netherlands between the period 1951-1980 and 1980-2009 in percentage for each of the regions against probability.

The Veluwe region has seen the smallest increase in precipitation and has become less of an outstanding region in the Netherlands. Further consistent different behaviour between the coastal and inland regions was found (e.g. see fig. 4). Therefore we calculated the distance to the coastline for every station and grouped the stations at four different distances from the coast such that each group contained about a quarter of the stations. A decreasing trend in mean precipitation with respect to distance to the coast can be observed (see fig. 5). Apart from the spring months, the coastal area has consistently become wetter compared to the inland area (see fig. 6). The largest differences between the coastal and inland areas are found for extreme events in summer (see fig 7 for the 99th percentile).

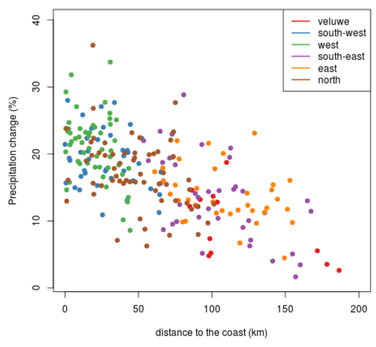

Figure 5: Station-wise mean precipitation change 1951-2009.

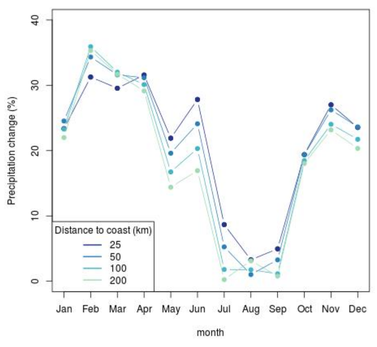

Figure 6: Mean precipitation change 1951-2009, 3 month averaged.

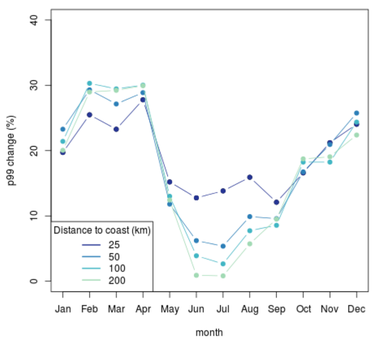

Figure 7: Extreme precipitation change 1951-2009, 3 month averaged.

Conclusions

- Both mean and extreme precipitation have increased between 1951 and 2009.
- Changes are largest in spring and winter, while absolute amounts are highest in summer and autumn.
- Positive changes are found over the entire county (nearly 90% significant). The largest increases are found along the west-coast.
- The coastal regions show different characteristics than the inland regarding extreme precipitation on both daily and yearly timescales.
- Distance to the coast seems to explain most of the variance in the dataset.

Knowledge for Climate

Emma E. Daniëls, MSc.
Earth System Science and Climate Change group
Wageningen University and Research center
P.O. Box 47, 6700 AA Wageningen
Contact: emma.daniels@wageningenur.nl
T + 31 (0)317 485 767

References
(1) Buishand TA, De Martino G, Spreeuw JN, Brandsma T. 2012. Homogeneity of precipitation series in the Netherlands and their trends in the past century. International Journal of Climatology. doi: 10.1002/joc.3471.