Climatology of extreme rainfall from weather radar

Aart Overeem\textsuperscript{1,2}, Adri Buishand\textsuperscript{1}, Iwan Holleman\textsuperscript{1}, Remko Uijlenhoet\textsuperscript{2}

Hydrology and Quantitative Water Management Group, Wageningen University, Wageningen, Netherlands
KNMI, De Bilt, Netherlands

Abstract

Extreme rainfall events can have a large impact on society and can lead to loss of life and property. Therefore, a reliable climatology of extreme rainfall is of importance, for instance, for the design of hydraulic structures. Such a climatology can be obtained by abstracting maxima from long rain gauge records. Subsequently, a probability distribution is fitted to the selected maxima, so that rainfall depths can be estimated for a chosen return period, which can be longer than the rainfall record.

In general, only few digitized time series from rain gauges are available for subdaily durations. This hampers the study of regional variability in extreme rainfall and the estimation of extreme areal rainfall. In contrast, weather radar data have high temporal and spatial resolutions. An 11-year climatological radar data set of rainfall depths is derived for the Netherlands ($3.55 \times 10^4 \text{ km}^2$) for durations of 15 min to 24 h. This data set has been re-processed using two rain gauge networks by combining an hourly mean-field bias and a daily spatial adjustment method.

A regional frequency analysis, assuming a generalized extreme value distribution, is used to describe the distribution of the annual radar rainfall maxima, which have an area size of 6 km\textsuperscript{2} (a radar pixel). Regional variability in extreme rainfall is studied. Rainfall depth-duration-frequency (DDF) curves describe the rainfall depth as a function of duration for given return periods or probabilities of exceedance. It is shown that radar-based DDF curves are in good agreement with those based on rain gauges. The uncertainties in DDF curves are calculated using the bootstrap method.

A reliable estimation of extreme areal rainfall depths is often hampered by the low spatial density of rain gauge networks, particularly for short durations. Weather radar gives new opportunities for estimating extreme areal rainfall depths. A new method is presented to describe the distribution of extreme areal radar rainfall depths by modeling GEV parameters as a function of both duration and area size. Radar-based rainfall DDF curves can now be obtained for area sizes up to $1.7 \times 10^3$ km\textsuperscript{2}.

Weather radar technology has matured and can be used to derive a climatology of extreme (areal) rainfall. This was done for the Netherlands, a flat country with a temperate climate and relatively small spatial differences in extreme rainfall. Deriving such a climatology from radar will become more complicated for mountainous countries and countries with a cold climate.