

How simultaneous occurrence of heavy rainfall and wet initial conditions leads to peak discharges

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The severity of pluvial floods is determined by both the rainfall event and the initial catchment wetness. In this study, we investigate which combinations of rainfall sum and initial groundwater level lead to high discharges and how the occurrence probabilities of the two factors and the resulting discharge are affected by climate change.

We used the Wageningen Lowland Runoff Simulator (WALRUS) to simulate discharge in eight Dutch lowland catchments. As forcing, we used 109-year time series of rainfall and potential evapotranspiration from the current climate (de-trended observations) and eight climate scenarios (four KNMI'14 scenarios for 2050 and 2085). For each discharge peak, we computed the precipitation surplus (precipitation minus evapotranspiration) of the preceding 48 hours and the groundwater level 48 hours before the peak and several metrics to quantify the peak discharge (e.g. peak height and volume).

Despite large differences in catchment characteristics (size, soil, slope), the annual distributions of discharge and groundwater levels were comparable, and all catchments showed a similar relation between 48-hour sum of precipitation surplus, initial groundwater level and peak discharge. Peak discharges can be predicted well from the combination of 48-hour precipitation surpluses and initial groundwater levels. This provides opportunities for water managers who are facing a heavy rainfall event and want to make a quick estimate of the expected flood peak.

With climate change, extreme precipitation events and wet initial soil conditions will occur more often simultaneously, leading to higher peak discharges. Of all results, the most extreme KNMI'14 climate scenario, the 2085 WH scenario, led to an increase in discharge peaks of up to 30%. In addition, the timing of the floods will change: winter and spring will be wetter, resulting in higher and more frequent floods, while in summer and the beginning of autumn the conditions will be drier, resulting in fewer floods.