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Rainfall estimates for hydrological models: Comparing rain gauge, radar and microwave link data as input for the Wageningen Lowland Runoff Simulator (WALRUS)

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Several rainfall measurement techniques are available for hydrological applications, each with its own spatial and temporal resolution. We investigated the effect of differences in rainfall estimates on discharge simulations in a lowland catchment by forcing a novel rainfall-runoff model (WALRUS) with rainfall data from gauges, radars and microwave links.

The hydrological model used for this analysis is the recently developed Wageningen Lowland Runoff Simulator (WALRUS). WALRUS is a rainfall-runoff model accounting for hydrological processes relevant to areas with shallow groundwater (e.g. groundwater-surface water feedback). Here, we used WALRUS for case studies in the Hupsel Brook catchment.

We used two automatic rain gauges with hourly resolution, located inside the catchment (the base run) and 30 km northeast. Operational (real-time) and climatological (gauge-adjusted) C-band radar products and country-wide rainfall maps derived from microwave link data from a cellular telecommunication network were also used. Discharges simulated with these different inputs were compared to observations.

Traditionally, the precipitation research community places emphasis on quantifying spatial errors and uncertainty, but for hydrological applications, temporal errors and uncertainty should be quantified as well. Its memory makes the hydrologic system sensitive to missed or badly timed rainfall events, but also emphasizes the effect of a bias in rainfall estimates. Systematic underestimation of rainfall by the uncorrected operational radar product leads to very dry model states and an increasing underestimation of discharge. Using the rain gauge 30 km northeast of the catchment yields good results for climatological studies, but not for forecasting individual floods.

Simulating discharge using the maps derived from microwave link data and the gauge-adjusted radar product yields good results for both events and climatological studies. This indicates that these products can be used in catchments without gauges in or near the catchment.

Uncertainty in rainfall forcing is a major source of uncertainty in discharge predictions, both with lumped and with distributed models. For lumped rainfall-runoff models, the main source of input uncertainty is associated with the way in which (effective) catchment-average rainfall is estimated. Improving rainfall measurements can improve the performance of rainfall-runoff models, indicating their potential for reducing flood damage through real-time control.