4.20 SPATIAL RESOLUTIONS IN AREAL RAINFALL ESTIMATION AND THEIR IMPACT ON HYDROLOGICAL SIMULATIONS OF A LOWLAND CATCHMENT

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Many studies suggest that high-density rain gauge networks are required to capture the rainfall heterogeneities necessary to accurately describe the components of the hydrological cycle. However, equipping and maintaining a high-density rain gauge network will also involve high costs. Although many studies provided useful insights on the required accuracy of rainfall estimates to accurately describe the components of the hydrological cycle, most of these studies focused on streamflow simulations, large river basins or urban environments. The objective of this study is therefore to evaluate the impact of areal rainfall, estimated at several spatial resolutions, on hydrological simulations of a small 6.5 km2 rural lowland catchment. The approach followed in this study is to force a calibrated spatially-distributed hydrological model (SPHY) with rainfall retrieved from an X-band radar and various synthetic rainfall products, calculated using bootstrap samples of a varying number of radar pixels, treated as virtual rain gauge locations within the catchment. This enables us to determine the most appropriate resolution of rainfall data to accurately describe the hydrology of a small rural lowland catchment. The novelty of this study is the combined approach of a spatially distributed model forced with bootstrapped rainfall fields from an X-band radar with ultra-high spatial (120 m range; 1.875 degrees in azimuth) and temporal (16 s) resolutions, which is unique in the sense that the majority of weather radars used in other studies have much coarser spatial and temporal resolutions. We found that the use of one rain gauge to estimate the catchment's areal rainfall may lead to a potential error of 0.56 mm/h. This may lead to uncertainties in simulated discharge that approach 60% of the average hourly discharge. More than 40 rain gauges are required to reduce the potential error in areal rainfall estimation to values <0.1 mm/h. The associated uncertainty in discharge simulations is 20% if 10 rain gauges are used, and 10% if 40 rain gauges are used. The simulation of soil moisture contents and evapotranspiration rates are hardly affected by the number of rain gauges used to estimate the areal rainfall, which is due to the high saturated hydraulic conductivities of the top-soil. Approximately 2/3 of the radar pixels need to be covered with rain gauges in order to capture the spatial rainfall variation that is present in radar rainfall estimates. Analysis of an individual 18-hour rainfall event revealed that the uncertainty in peak areal rainfall estimated using one rain gauge may range between 100% and +600%. The associated uncertainty in simulated discharge for this event ranges between 67 and

+233%. With 25 rain gauges the uncertainty in simulated discharge is still in the range of 17 to +33%.