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Using Opportunistic Rainfall Sensing to improve Areal Precipitation Estimates and Run-off Modelling – The Case Study of the Ahr Flood in July 2021

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On 14 and 15 July 2021, heavy and prolonged precipitation caused flooding in large areas in western Germany and adjacent regions. The Ahr River valley in the Federal State of Rhineland-Palatinate was particularly affected, with numerous fatalities and large-scale damage. Due to the spatio-temporal variability of precipitation and failure of several gauging stations, the estimation of the flood triggering areal precipitation as well as determination of peak discharges is associated with high uncertainties.

In this study, we present results where data from opportunistic sensors (commercial microwave links (CML) and personal weather stations (PWS)) were used to interpolate hourly precipitation sums for the Ahr catchment. The data from the opportunistic sensors was quality controlled, filtered and interpolated using the methods from Graf et al. (2021). This precipitation data was compared to a gauge adjusted weather radar product from the German Weather Service DWD as well as interpolated rain gauge data. In order to determine the maximum discharges at the gauges in the Ahr, flood was simulated with the water balance model LARSIM (Large Area Runoff Simulation Model) using the aforementioned precipitation products as input data.

The results show that the areal precipitation obtained from opportunistic sensors yielded higher sums than the gauge adjusted radar products and the interpolated gauge data, especially in the northern part of the Ahr catchment where the station density of the conventional rain gauges was not sufficient to capture the spatial variability of this extreme event. Furthermore, the modelled run-offs using the precipitation input from opportunistic sensors yielded higher and more plausible peak discharges than the ones with the gauge adjusted weather radar product. This suggests that the radar underestimated precipitation due to attenuation. The difference in the resulting peak discharges point to the fact that due to the saturated soils any additional precipitation during the flood event in July 2021 lead to a direct run-off effect.

References:

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