Precipitation monitoring in urban areas by a dense C-Band weather radar network

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High spatial and temporal resolution precipitation data is a crucial factor for hydrological applications in urban areas. Small fluctuations in precipitation fields are of great importance considering the fast response of urban catchments due to the dominance of impervious surfaces. Hence, high resolution precipitation observations are needed in order to characterize these fluctuations. Weather radars provide high spatial and temporal resolution precipitation estimations. However, the quality of these observations in urban environments is significantly degraded by, among other things, ground clutter and beam-blockage. Where feasible, a solution for this problem is weather radar networking, which makes it possible to fill one radars data gaps by using observations from the others.

Very few cities have dedicated weather radar networks. In some cities, like Helsinki, there are several weather radars covering the metropolitan area, but they are operated by different organizations. In this study, we show how such systems can be used to build a network. Additionally, we illustrate the advantage of using weather radar networks for estimating precipitation in urban catchments.

The urban Helsinki area is covered by observations from three individual-purpose C-band polarimetric weather radars (Helsinki University's Kumpula (KUM), Vaisala Oy's Kerava (KER) and Finnish Meteorological Institute's Vantaa (VAN)). Nonetheless, it is challenging to make them observe at the same area at exactly the same time, which could lead to fast changing, short precipitation events being missed. Hence, synchronization and temporal resolution are the main concerns when building a network. Consequently, to decrease the impact of these restrictions in the Helsinki radar network, we propose the use of the optic flow interpolation algorithm to retrieve information in between radar observations. We use the retrieved data set from the three radars to estimate rainfall using the R-Z relation proposed by the Finnish meteorological institute (FMI) for rain and in case of hail the rainfall is estimated based on the KDP. The radar moments and the dual pol moments are retrieved by using the motion vectors of the reflectivity. The accuracy of this method is studied by comparing the composite rainfall estimation made by each radar to ground measurements coming from rain gauges and a disdrometer.