An approach to estimate rainfall at ungauged location by merging the radar and gauge estimates

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Abstract: One of the key challenges in hydrology is the accurate representation of the spatial and temporal distribution of rainfall, especially at ungauged locations. In this research, we ask, "What is the best way of getting accurate estimates of rainfall in a watershed?" Theoretically, we could place enough gauges to eliminate errors in any spatial interpolation, but that would be prohibitively expensive. A better solution is to use radar rainfall estimates from radar reflectivity in conjunction with the existing rain gauge network.

In this study, we propose two new developments to advance this area of research. First, we have proposed a novel approach to estimate rainfall from radar reflectivity and tested whether this approach can provide better estimate compared to traditional power law method. It is a nonparametric Z-R relationship (NPZR) approach based on the conditional probability distribution of the rainfall and reflectivity.

Second, we have developed a combination method to find rainfall at ungauged locations by merging the spatially interpolated gauge rainfall with the NPZR estimates. The merging is done by applying dynamic weights calculated for both of the methods. This weight at any particular pixel for a rainfall event is calculated from the error covariance matrix of historical similar events from nearby gauged locations. The proposed method has been tested by leave-one-out cross validation.

The NPZR method is applied to the data from the densely-gauged Sydney Terrey Hills radar, where it reduces the overall error in the rainfall estimates by 16%, with improvement observed at 90% of the gauges. The combination method shows excellent performance by reducing the estimation error (about 23%) compared to a traditional power law method. The estimates are also improved compared to spatially interpolated point measurements in sparsely gauged areas.

Keywords: Radar rainfall, spatial interpolation, weighted combination