Catching the Downpour: Estimating precipitation at high spatial resolutions using low-cost sensing and weather radar

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Stormwater management in urban areas represents a significant challenge in the face of global climate change. As the frequency and intensity of precipitation changes, a need arises for smart stormwater infrastructure which can autonomously manage sudden and potentially large inputs of water. Smart stormwater infrastructure capable of adaptive management has been slow to develop. Inconsistent coverage and coarse spatial resolution have been significant obstacles as smart stormwater systems require timely, local estimations of rainfall in order to perform effectively. Remote sensing technology typically used to estimate precipitation over large spatial scales monitors at a resolution which is too coarse (weather radar) or is not feasible to deploy at sufficient density (tipping bucket gauge networks). Of the options available, weather radar represents the greatest spatial coverage for rainfall estimation. However, at a resolution of approximately 1 sq. km per pixel, the data is too broad to capture the fine details of the spatial pattern of rainfall over an urban area. Additionally, radar based rainfall estimations are subject to estimation errors based on the distance from the source of measurement and topography. Improving the spatial resolution of weather radar rainfall estimates, such that they are on the scale of a typical urban management unit and representative of surface level conditions, will permit further development of smart stormwater infrastructure. This project seeks to fuse radar-based quantitative precipitation estimates with qualitative rainfall descriptions provided by low-cost sensors that are embedded in the landscape. These embedded sensors categorize rainfall occurring at their location and, due to their low-cost, can be deployed densely across the landscape. A spatial Bayesian statistical model is used to combine the high-spatial resolution, low accuracy estimates from the embedded sensors with the low-spatial-resolution, high-accuracy estimates from the weather radar to create a quantitative precipitation estimate at higher spatial-resolution than available from radar alone.