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Applications of high resolution rainfall radar data to quantify water temperature dynamics in urban catchments

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Studies relating rainfall events to river water quality are frequently hindered by the lack of high resolution rainfall data. Local studies are particularly vulnerable due to the spatial variability of precipitation, whilst studies in urban environments require precipitation data at high spatial and temporal resolutions. The use of point-source data makes identifying causal effects of storms on water quality problematic and can lead to erroneous interpretations. High spatial and temporal resolution rainfall radar data offers great potential to address these issues.

Here we use rainfall radar data with a 1km spatial resolution and 5 minute temporal resolution sourced from the UK Met Office Nimrod system to study the effects of storm events on water temperature (WTemp) in Birmingham, UK. 28 WTemp loggers were placed over 3 catchments on a rural-urban land use gradient to identify trends in WTemp during extreme events within urban environments. Using GIS, the catchment associated with each logger was estimated, and 5 min. rainfall totals and intensities were produced for each sub-catchment. Comparisons of rainfall radar data to meteorological stations in the same grid cell revealed the high accuracy of rainfall radar data in our catchments (<5% difference for studied months).

The rainfall radar data revealed substantial differences in rainfall quantity between the three adjacent catchments. The most urban catchment generally received more rainfall, with this effect greatest in the highest intensity storms, suggesting the possibility of urban heat island effects on precipitation dynamics within the catchment. Rainfall radar data provided more accurate sub-catchment rainfall totals allowing better modelled estimates of storm flow, whilst spatial fluctuations in both discharge and WTemp can be simply related to precipitation intensity. Storm flow inputs for each sub-catchment were estimated and linked to changes in WTemp. WTemp showed substantial fluctuations (>1 °C) over short durations (<30 minutes) during storm events in urbanised sub-catchments, however WTemp recovery times were more prolonged. Use of the rainfall radar data allowed increased accuracy in estimates of storm flow timings and rainfall quantities at each sub-catchment, from which the impact of storm flow on WTemp could be quantified. We are currently using the radar data to derive thresholds for rainfall amount and intensity at which these storm deviations occur for each logger, from which the relative effects of land use and other catchment characteristics in each sub-catchment can be assessed.

Our use of the rainfall radar data calls into question the validity of using station based data for small scale studies, particularly in urban areas, with high variation apparent in rainfall intensity both spatially and temporally. Variation was particularly high within the heavily urbanised catchment. For water quality studies, high resolution rainfall radar can be implemented to increase the reliability of interpretations of the response of water quality variables to storm water inputs in urban catchments.