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A robust algorithm for detecting flood water in urban areas using Synthetic Aperture Radar images.

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Flooding is a major hazard in both rural and urban areas worldwide, but it is in urban areas that the risks to people and the economic impacts are most severe. High resolution SAR sensors are now commonly used for flood detection because of their ability to image flood extent on a 24/7 basis, and have sufficient resolution to detect flooding in urban areas. Importantly, the flood extent from SAR images, if obtained in near real-time, can be used as a tool for operational flood relief management. Further, these near-real time flood extent observations can provide data for assimilation into urban flood inundation models.

Several organisations (e.g. Copernicus EMS) have developed semi-automatic systems to extract the flood extent from a SAR image. These systems tend to work well in rural areas, but poorly in urban areas. A difficulty of urban flood detection using SAR is that substantial areas of urban ground surface may not be visible to the SAR due to radar shadowing and layover caused by buildings or taller vegetation. Shadow will appear dark, similar to most water, so may be misclassified as water. Layover will generally appear bright, possibly leading to misclassification of flooded ground as un-flooded.

Mason et al. (2012) developed a near real-time algorithm for flood extent delineation in both urban and rural areas of a high resolution SAR scene, but the method was only tested on a single flood event. Current work, funded under the UK EPSRC Data Assimilation for the Resilient City (DARE) project, is involving further testing of the algorithm on other events to make the method more robust. To cope with the shadow/layover effect, the algorithm uses the RaySAR SAR simulator (Auer, 2011) to estimate regions in the SAR image in which water will not be visible due to shadow or layover.

The method first detects the flood extent in the rural areas of the SAR image, employing image segmentation to extract regions of homogeneous backscatter. A threshold on the region mean SAR backscatter is determined such that regions having mean backscatter below the threshold are classified as flooded, and others as un-flooded. The initial rural flood classification may be improved by refining it.

The urban flood detection is guided by the rural flood detection, using the local waterline heights in the rural areas, and assuming that flooding in urban areas should not be at a substantially higher level. Urban pixels having a backscatter less than the threshold and a height similar to or less than that of nearby rural flooding are clustered together into urban flood regions using a region-growing process. Regions of shadow and layover are masked out in this process.

The method has been used to detect flooding in 2 COSMO-SkyMed images of the Thames flood in West London in February 2014 and a Terrasar-X image of the flood in Tewkesbury, UK, in July 2007. Flood detection accuracies of 80% or better have been achieved.