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Detection of flooded urban areas in high resolution Synthetic Aperture Radar images using double scattering

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Flooding is a particular hazard in urban areas worldwide due to the increased risks to life and property in these regions. SAR sensors are often used to image flooding because of their all-weather day-night capability, and now possess sufficient resolution to image urban flooding. The flood extents extracted from the images may be used for flood relief management and improved urban flood inundation modelling.

A difficulty with using SAR for urban flood detection is that, due to its side-looking nature, substantial areas of urban ground surface may not be visible to the SAR due to radar layover and shadow caused by buildings and taller vegetation. While most flooding along roads perpendicular to the satellite direction of travel may be detected successfully, a good deal of the flooding along roads parallel to it will remain unseen. Considering the latter, an area of flooded road in front of the wall of a building on the farther side of a road from the satellite track may be allocated to the same range bin as the wall, causing layover which generally results in a strong return, and a possible misclassification of flooded ground as un-flooded. This paper investigates whether urban flooding can be detected in layover regions using double scattering [1]. If the road in a layover region is flooded, backscatter due to the double scattering from sensor to road to wall to sensor (or vice versa) should be stronger than if the road is not flooded. The method estimates double scattering strengths using a SAR image in conjunction with a high resolution LiDAR height map of the urban area. A SAR simulator is applied to the LiDAR data to generate maps of layover and shadow, and estimate the positions of double scattering curves in the SAR image.

Observations of double scattering strengths were compared to the predictions from an electromagnetic scattering model, for both the case of a single image containing flooding, and a change detection case in which the flooded image was compared to an un-flooded image of the same area acquired with the same radar parameters. The method proved successful in detecting double scattering due to flooding in the single-image case, for which flooded double scattering curves were detected with 100% classification accuracy (albeit using a small sample set) and un-flooded curves with 91% classification accuracy. The same measures of success were achieved using change detection between flooded and un-flooded images. Depending on the particular flooding situation, the method could lead to improved detection of flooding in urban areas.

1. Mason DC, Giustarini L, Garcia-Pintado J (2014). Detection of flooded urban areas in high resolution Synthetic Aperture Radar images using double scattering. Int. J. Applied Earth Observation and Geoscience, 28C (May 2014), 150-159.