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A new approach for river flood extent delineation in rural and urban areas combining RADARSAT-2 imagery and flood recurrence interval data

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When a flood hits an inhabited area, managers and services responsible for public safety need precise, reliable and up to date maps of the areas affected by the flood, in order to quickly roll out and to coordinate the adequate intervention and assistance plans required to limit the human and material damages caused by the disaster.
Synthetic aperture radar (SAR) sensors are now considered as one of the most adapted tool for flood detection and mapping in a context of crisis management. Indeed, due to their capacity to acquire data night and day, in almost all meteorological conditions, SAR sensors allow the acquisition of synoptic but detailed views of the areas affected by the flood, even during the active phases of the event. Moreover, new generation sensors such as RADARSAT-2, TerraSAR-X, COSMO-SkyMed, are providing very high resolution images of the disaster (down to 1m ground resolution). Further, critical improvements have been made on the temporal repetitivity of acquisitions and on data availability, through the development of satellite constellations (i.e the four COSMO-Skymed or the Sentinel-1A and 1B satellites) and thanks to the implementation of the International Charter “Space and Major Disasters”, which guarantees high priority images acquisition and delivery with 4 to 12 hours.
If detection of open water flooded areas is relatively straightforward with SAR imagery, flood detection in built-up areas is often associated with important issues. Indeed, because of the side looking geometry of the SAR sensors, structures such as tall vegetation and structures parallel to the satellite direction of travel may produce shadow and layover effects, leading to important over and under-detections of flooded pixels. Besides, the numerous permanent water-surfaces like radar response areas present in built-up environments, such as parking lots, roads etc., may be mixed up with flooded areas, resulting in substantial inaccuracies in the final flood map.
In spite of the many efforts recently done toward the improvements of the accuracy of the processing algorithms for flood detection in urban areas with high resolution SAR imagery, these algorithms still encounter difficulties to detect urban flooded pixels with precision. The difficulties do not seem to be only ascribable to the choice of SAR image processing methods, but can also be imputed to the limitations of the SAR imaging technique itself in urban areas.
We propose a fully automatic and effective approach for near-real time delineation of urban and rural flooded areas, which combines the capacity of SAR imagery to detect open water areas, and explicit hydrodynamic characteristics of the region affected by the flood, expressed through flood recurrence interval data. This innovative approach has been tested with RADARSAT-2 Fine and Ultrafine Mode images acquired during the 2011 Richelieu River flooding, in Canada. It proved successful in accurately delineating flooding in urban and rural areas, with a RMSE inferior to 2 pixels.