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Rapid Mapping Of Floods Using SAR Data: Opportunities And Critical Aspects

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The potentiality of spaceborne Synthetic Aperture Radar (SAR) for flood mapping was demonstrated by several past investigations. The synoptic view, the capability to operate in almost all-weather conditions and during both day time and night time and the sensitivity of the microwave band to water are the key features that make SAR data useful for monitoring inundation events. In addition, their high spatial resolution, which can reach 1m with the new generation of X-band instruments such as TerraSAR-X and COSMO-SkyMed (CSK), allows emergency managers to use flood maps at very high spatial resolution. CSK gives also the possibility of performing frequent observations of regions hit by floods, thanks to the four-satellite constellation.
Current research on flood mapping using SAR is focused on the development of automatic algorithms to be used in near real time applications. The approaches are generally based on the low radar return from smooth open water bodies that behave as specular reflectors and appear dark in SAR images. The major advantage of automatic algorithms is the computational efficiency that makes them suitable for rapid mapping purposes. The choice of the threshold value that, in this kind of algorithms, separates flooded from non-flooded areas is a critical aspect because it depends on the characteristics of the observed scenario and on system parameters. To deal with this aspect an algorithm for automatic detection of the regions of low backscatter has been developed. It basically accomplishes three steps: 1) division of the SAR image in a set of non-overlapping sub-images or splits; 2) selection of inhomogeneous sub-images that contain (at least) two populations of pixels, one of which is formed by dark pixels; 3) the application in sequence of an automatic thresholding algorithm and a region growing algorithm in order to produce a homogeneous map of flooded areas.
Besides the aforementioned choice of the threshold, rapid mapping of floods may present other critical aspects. Searching for low SAR backscatter areas only may cause inaccuracies because flooded soils do not always act as smooth open water bodies. The presence of wind or of vegetation emerging above the water surface may give rise to an increase of the radar backscatter. In particular, mapping flooded vegetation using SAR data may represent a difficult task since backscattering phenomena in the volume between canopy, trunks and floodwater are quite complex in the presence of vegetation. A typical phenomenon is the double-bounce effect involving soil and stems or trunks, which is generally enhanced by the floodwater, so that flooded vegetation may appear very bright in a SAR image. Even in the absence of dense vegetation or wind, some regions may appear dark because of artefacts due to topography (shadowing), absorption caused by wet snow, and attenuation caused by heavy precipitating clouds (X-band SARs).
Examples of the aforementioned effects that may limit the reliability of flood maps will be presented at the conference and some indications to deal with these effects (e.g. presence of vegetation and of artefacts) will be provided.