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Spaceborne Radar For Mapping Floods: A Pre-Operational Approach Integrating Models And Ancillary Data Applied To COSMO-SkyMed Images

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The potentiality of spaceborne Synthetic Aperture Radar (SAR) for flood mapping was demonstrated by several past investigations. The synoptic view and the capability to operate in almost all-weather conditions and during both day and night are the key features that make the SAR images useful for monitoring inundation events. In addition, their high spatial resolution allows a fairly accurate delineation of the flood extent. However, the temporal repetitiveness of SAR measurements was a critical issue for their operational use, so far. To overcome this problem, the availability of images provided by a constellation of satellite radars can be exploited in order to reduce the revisit time. The COSMO-SkyMed (COnstellation of small Satellites for Mediterranean basin Observation) mission offers a unique opportunity to obtain a large amount of daily acquired images, characterized by high spatial and radiometric resolutions.

Italian Space Agency (ASI) is presently funding some projects aiming at assessing the utility of Earth Observation techniques into an operational flood management system. In the framework of one of these projects, named OPERA, ASI made available some COSMO-SkyMed images of recent flood events, occurred not only in Italy, but also in Pakistan, Albania, and Thailand. This study presents the major findings we obtained in our experience of use of the X band radar images provided by COSMO-SkyMed for flood mapping.

Most of the literature algorithms for flood mapping from SAR data use a threshold applied on an image temporarily close to the event, to separate flooded and non-flooded regions. The threshold is determined either by performing a visual interpretation of the image or in an automatic way. Heuristic segmentation techniques are also employed. Our approach is based on the considerations of the physics of the radar return from flooded areas, since, an analysis accounting for the various electromagnetic mechanisms that determine the radar return in the presence of a water surface may improve the accuracy of flood mapping. Indeed, not only specular reflection, characteristic of bare soil, but also double bounce backscattering, typical of agricultural/forested areas, as well as urban areas, may take place in the presence of an inundation. While a specular surface is characterized by low radar return, the intensity of double bounce backscattering involving stems or trunks is generally increased by the underlying water.

To carry out an accurate inundation map, the variations of the radar return caused by the presence of water surfaces have to be identified. For this purpose, it is useful to analyze not only a SAR observation of the event, but also an image of the monitored area under dry conditions, i.e. preceding the flood, or following it with a sufficiently large temporal interval.

The results obtained through our approach, particularly when dealing with agricultural and forested flooded areas will be stresses in our presentation. The importance of having available also ancillary data such as a digital elevation model and a land cover map will be also underlined. Finally, the possibility to monitor also the temporal evolution of a flood, thanks to the short revisit time of Cosmo-SkyMed data, will be presented making reference to one case study we analyzed throughout our activity.

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