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Interpretation of the Cosmo-SkyMed observations of the 2009 Tanaro river flood

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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. The Cosmo-SkyMed (COnstellation of small Satellites for Mediterranean basin Observation) mission offers a unique opportunity to obtain radar images characterized by short revisit time, so that an operational use of Cosmo-SkyMed data in flood management systems can be envisaged. However, the interpretation of SAR images of flooded areas might be complex, because of the dependence of the radar response from flooded pixels on land cover, system parameters and environmental conditions. An example of radar data whose interpretation is not straightforward is represented by the Cosmo-SkyMed observations of the overflowing of the Tanaro river, close to the city of Alessandria (Northern Italy), occurred on April, 27-28 2009. Within the framework of a study, funded by the Italian Space Agency (ASI), aiming at evaluating the usefulness of Earth Observation techniques into operational flood prediction and assessment chains (named OPERA, civil protection from floods), ASI provided a number of Cosmo-SkyMed images of the Tanaro basin. In this study, we use three images that were acquired during three days in succession: from April, 29 to May, 1 2009, as well as other two acquisitions performed two weeks later (May, 16 and May, 17 2009), when the effects of the flood were disappeared.
In this work, we firstly extract information on the spatial extension of homogeneous objects present in the scene through a segmentation procedure. In this way we cope with the speckle noise characteristic of SAR images and produce, from the multi-temporal series of five imagery we employ, a map formed by homogeneous regions. Among these regions we single out some areas presenting a fairly complex temporal evolution of the radar return. To correctly explain the multi-temporal radar signature of these segments, we use of a well-established electromagnetic model. Some reference multi-temporal backscattering trends are analyzed with the aid of the theoretical model to associate the segments to the classes of flooded or non-flooded areas. Using these reference trends as a training set, a classification algorithm is also developed to generate a map of the flood evolution. This study aims at demonstrating the importance and the feasibility of a method based on a joint use of a well-established electromagnetic scattering model and an advanced image processing technique to reliably interpreting SAR observations of floods.