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Automatic detection of inundation-related change areas in TerraSAR-X data using Markov image modeling on irregular graphs

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The worldwide increasing occurrence of flooding and the short-time monitoring capability of the new generation of high resolution synthetic aperture radar (SAR) sensors (TerraSAR-X, COSMO-SkyMed) require accurate and automatic methods for the detection of flood dynamics. This is especially important for operational rapid mapping purposes where the near-real time provision of precise information about the extent of a disaster and its spatio-temporal evolution is of key importance to support decision makers and humanitarian relief organizations.
A split based parametric thresholding approach under the generalized Gaussian assumption is developed on normalized change index data to automatically solve the three-class change detection problem in large-size images with small class a priori probabilities. The thresholding result is used for the initialization of a hybrid Markov model which integrates both scale-dependent and spatial context into the classification process by combining hierarchical with noncausal Markov image modeling on irregular graphs. Hierarchical Markov modeling is accomplished by hierarchical maximum a posteriori (HMAP) estimation using Markov Chains in scale. Since this method requires only one bottom-up and one top-down pass on the graph, it offers high computational performance. To reduce the computational demand of the iterative optimization process related to noncausal Markov image models, we define a partial Markov Random Field (MRF) approach, which is applied on a restricted region of the lowest level of the graph. The selection of this region is based on a confidence map generated by combining the HMAP labeling result from the different graph levels.
The proposed unsupervised change detection method is applied on a bi-temporal TerraSAR-X StripMap data set (3 m pixel spacing) of a real flood event. The effectiveness of the hybrid Markov image model in comparison to the sole application of the HMAP estimation is evaluated. Additionally, the impact of the graph structure and the chosen model parameters on the labeling result as well as on the performance is discussed.