Improved flood detection by using bistatical coherence data of the TanDEM-X mission

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In this work a fully automatic flood detection approach is proposed which combines amplitude imagery with bistatic coherence data of the TanDEM-X mission. Due to the near all-weather/day-night acquisition capabilities spaceborne Synthetic Aperture Radar (SAR) is a very effective technology for continuous monitoring of the Earth's surface. Especially during flood situations, which often occur during long-lasting precipitation and persistent cloud cover periods, SAR has a major advantage compared to optical instruments, whose visible and near-infrared bands are very sensitive to atmospheric conditions. Due to the sensitivity of the SAR signal to surface roughness specular reflecting open flood surfaces and diffuse scattering non-water areas generally can be well separated in SAR amplitude data. However, flood detection approaches solely based on SAR amplitude may be affected by the appearance of water look-alike areas of low surface roughness (such as bare ground, sand dunes, airport runways, and streets), which reduce the classification accuracy by an increased false alarms rate. Missed alarms caused by wind induced roughening of water surfaces also reduce the quality of flood masks. These errors can be significantly reduced by the additional integration of coherence information in flood mapping approaches. TanDEM-X bistatic coherence is based on phase information of the complex scattering of the TanDEM-X and TerraSAR-X sensor. Therefore, it is not directly dependent on backscatter intensities but on coherent characteristics of the objects itself. As both calm and rough water bodies are characterized by a very low coherence and most of the SAR amplitude water look-alike areas feature high coherence values, flood mapping algorithms can be significantly enhanced by synergistically combining amplitude with coherence information. In this work a Support Vector Machine Classifier with a radial base function kernel is used for improved flood mapping by combining SAR amplitude with bistatic coherence information. The fully automatic approach is divided into three steps: threshold generation, pre-classification and post-classification based on Support Vector Machines. After dividing the amplitude and coherence data into quadratic non-overlapping sub-scenes tiles with high contrasts in gray values are automatically selected, which offer a high probability to contain water and non-water areas. Each sub-histogram of the selected tiles is modeled by bi-modal Gaussian distributions to derive the amplitude and coherence threshold based on the Kittler and Illingworth thresholding algorithm. The computed thresholds are used for generating a segment-based pre-classification, which serves as an initialization of the Support Vector Machine classifier. The results of the pre-classification contain the classes “no water”, “water on coherence and amplitude”, “water on coherence”, “water on amplitude”. To reduce the uncertainties of the pre-classification a refinement of the threshold values by means of quantiles is applied. On the base of the adjusted classification a random selection of classification segments is implemented for constructing a training data set for the Support Vector Machine classifier. This contains 34 features that characterize the image segments for each class. The proposed approach is tested on several scenes of the TanDEM-X mission in Cambodia, France, Germany, the Netherlands and Zambia. For the validation of the classification results Landsat-7 ETM+ data and high resolution GoogleEarth data are used. The experiments show promising results with encouraging overall accuracies up 92%. Especially, the benefit of coherence information is obvious over open water areas which are influenced by wind effects in the amplitude imagery. Furthermore, on short grass field or wet soils the coherence is helpful for separating between water and non-water areas.