

Short-term detection of urban land development using radar remote sensing data

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Abstract

Unauthorized construction land expansion has caused considerable irreversible damage to the environment in many developing countries because it is difficult to be prevented using conventional long-term (annual or multi-year) land use change detection with optical remote sensing data. Radar remote sensing which is independent of weather conditions is a promising tool to detect land developments on a short-term (monthly or multi-month) basis for preventing unauthorized ones early on. However, few studies have been conducted on this theme and seasonal growth of agricultural vegetation may present a big challenge to such studies. Crop harvest creates changes from vegetation to barren land which may obscure land bulldozed for development, and the planting of the crops that are easily confused with buildings in radar imagery may produce false alarms in the detection of construction sites. This paper presents a novel method that utilizes time series of RADARSAT-2 polarimetric SAR (PolSAR) data to detect land developments every 24 days as well as suppresses the effect of seasonal agricultural vegetation growth. The method is based on the seasonal rules that specify the suitable number of successive images used for land development detection at different times throughout a year. The rules are created on the basis of the growth calendar of the crops that can introduce errors. Three images are required in the periods when the growth of crops yields numerous false alarms, while two images are employed in the other periods. Land developments are detected by detecting changes from vegetation to barren land and from non-built-up to built-up areas. Change vector analysis (CVA) is combined with post-classification comparison (PCC) to detect land cover changes from two successive images on the basis of object-oriented image analysis (OOIA). The combination of CVA and PCC attempts to detect different change types and reduce the effect of the classification errors on the change detection. OOIA aims on decreasing the effect of speckle noise in PolSAR images and extracting textural and spatial features to support PolSAR image classification. Land developments are detected from the first and second images in the detection with three successive images, and the false alarms introduced by vegetation growth are identified according to the land cover classification result of the third image. Given that the changes induced by growing crops often change back to vegetation in a short term such as a month because of the vegetation growth, detected land developments that turn into vegetation in the third image are determined as the false alarms. Land development detection was performed by using each pair of successive images, each triplet of successive images, and the proposed method, respectively. The average overall error rates of the three methods were 0.55%, 0.25%, and 0.24%, respectively. The errors in the detections with two images were mainly the false alarms introduced by seasonal growth of agricultural vegetation such as paddies. Although the use of three images significantly suppressed these false alarms, it reduced the detection accuracies by introducing the classification errors of the third image and prolonged the time to produce the results. By determining suitable number of images used in the detection at the different times, the proposed method achieved the minimum average overall error rate and substantially preserved the ability of producing timely results.

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