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Land cover change detection by integrating object-based data blending model of Landsat and MODIS

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ABSTRACT

Accurate information on land cover changes is critical for global change studies, land cover mapping and ecosystem management. Although there are numerous change detection methods, pseudo changes can occur if data are acquired from different seasons, which presents a significant challenge for land cover change detection. In this study, land cover change detection by integrating object-based data blending model of Landsat and MODIS is proposed to solve this issue. The Estimation of Scale Parameter (ESP) tool under Minimum Mapping Unit (MMU) restriction is employed to identify the optimal scale for Landsat image segmentation. The Object Based Spatial and Temporal Vegetation Index Unmixing Model (OB-STVIUM) disaggregates MODIS NDVIs to Landsat objects using the spatial analysis and the linear mixing theory. Then, the change detection method of NDVI Gradient Difference (NDVI-GD) is developed to detect change and no-change objects considering the NDVI shape and value differences simultaneously. The results of the study indicate that the approach proposed in this study can effectively detect change areas when Landsat images are acquired from different seasons. OB-STVIUM is more suitable for change detection application compared with the Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM) and NDVI Linear Mixing Growth Model (NDVI-LMGM), because it is less sensitive to the number and acquisition time of Landsat images.

1. Introduction

Land cover composition and its changes play an important role in many scientific studies and socioeconomic assessments because they are essential inputs for global climate models (Bontemps et al., 2012a; Yang et al., 2013; Wu et al., 2014), primary references for ecosystem management (Mora et al., 2014; Sun et al., 2015), and fundamental information for understating coupled human and natural systems (Yu et al., 2013; Ban et al., 2015; Lu et al., 2016). Accurate and up-to-date information regarding land cover and its dynamics are increasingly necessary at different spatial and temporal scales (Chen et al., 2015a; Jin et al., 2013).

Remote sensing has become an important tool for gathering and monitoring land cover dynamics, and numerous algorithms have been developed for detecting land cover changes (Hansen and Loveland, 2012; Tewkesbury et al., 2015). One of the main issues in land cover change detection is how to accurately extract change areas while eliminating the pseudo changes caused by phenological differences and other extraneous factors (Chen et al., 2013; Jin et al., 2013; Chen et al., 2015b). Extraneous factors (e.g., atmospheric conditions, soil moisture, and water turbidity) can be avoided by using some appropriate algorithms with images acquired from the same sensor in the same season (Chen et al., 2013; Jin et al., 2013). However, when images are acquired from different seasons, pseudo changes caused by phenological differences are inevitable which presents a significant challenge for land cover change detection. Since NDVI Time series can accurately track the seasonal characteristics and capture information of vegetation phenology, using NDVI time series provides a potential solution to avoid the pseudo changes caused by phenological differences (Jia et al., 2014; Chen et al., 2015b). Most studies have used NDVI time series acquired by moderate resolution sensors (e.g., MODIS, SPOT-VGT, and AVHRR) for land cover change detection because of their frequent revisiting time (e.g., daily revisit) (Lhermitte et al., 2008). However, it is a challenge to detect changes at small scales or heterogeneous landscapes using moderate resolution data. Images from fine resolution sensors like Landsat could provide much more detailed spatial information (Boschetti et al., 2015; Hilker et al., 2009). Although the Landsat archive is open and free, it is difficult to obtain dense Landsat time series due to cloud contamination or revisit cycle limitation (Bontemps et al., 2008; Bontemps et al., 2012b). For example, Kovalskyy and Roy (2013) indicated that the probability of there being at least one cloud-free image in each of the three seasons in the year 2000 was 0.194, 0.742 and

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