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Identification of Silvicultural Practices in Mediterranean Forests Integrating Landsat Time Series and a Single Coverage of ALS Data

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摘要 Understanding forest dynamics at the stand level is crucial for sustainable management. Landsat time series have been shown to be effective for identification of drastic changes, such as natural disturbances or clear-cuts, but detecting subtle changes requires further research. Time series of six Landsat-derived vegetation indexes (VIs) were analyzed with the BFAST (Breaks for Additive Season and Trend) algorithm aiming to characterize the changes resulting from harvesting practices of different intensities (clear-cutting, cutting with seed-trees, and thinning) in a Mediterranean forest area of Spain. To assess the contribution of airborne laser scanner (ALS) data and the potential implications of it being after or before the detected changes, two scenarios were defined (based on the year in which ALS data were acquired (2010), and thereby detecting changes from 2005 to 2010 (before ALS data) and from 2011 to 2016 (after ALS data). Pixels identified as change by BFAST were attributed with change in VI intensity and ALS-derived statistics (99th height percentile and forest canopy cover) for classification with random forests, and derivation of change maps. Fusion techniques were applied to leverage the potential of each individual VI change map and to reduce mapping errors. The Tasseled Cap Brightness (TCB) and Normalized Burn Ratio (NBR) indexes provided the most accurate results, the latter being more precise for thinning detection. Our results demonstrate the suitability of Landsat time series and ALS data to characterize forest stand changes caused by harvesting practices of different intensity, with improved accuracy when ALS data is acquired after the change occurs. Clear-cuttings were more readily detectable compared to cutting with seed-trees and thinning, detection of which required fusion approaches. This methodology could be implemented to produce annual cartography of harvesting practices, enabling more accurate statistics and spatially explicit identification of forest operations.

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