Tracking and characterizing human impacts in tropical forests: Can Landsat go it alone?

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Representing a significant portion of the global carbon store as well as countless other ecosystem services, tropical forests have been under threat due to expansion of human activities in recent decades. Following the public release of the entire Landsat data archive - the longest record of earth observation data in existence - a veritable explosion of innovation in forest monitoring methods using Landsat time series (LTS) has occurred. New approaches have emerged allowing for the tracking of forest changes either retrospectively - supporting carbon accounting for REDD+ and other applications - or in near real-time - supporting operational monitoring and enforcement efforts. Methods exploiting all observations in particular have shown that accounting for seasonal fluctuations (ie. those arising from canopy phenology) can enhance the detection and characterization of human-driven changes. Despite the demonstrated promise of LTS in monitoring changes in tropical forests, limitations in the temporal, spectral and spatial resolution of Landsat data raise questions about extent to which methods based on LTS alone are adequate for addressing monitoring needs in tropical forests.

Here, we show that while LTS provide unprecedented detail in forest change studies, specific monitoring objectives in tropical forests call for the integration of LTS with other data sources. To demonstrate this need, we focus on two monitoring targets: (1) the timely detection of changes and (2) characterization of change dynamics over time. First, given that many tropical regions experience perpetual cloud-cover, generating large temporal gaps in LTS, recent research has shown that fusion of LTS with SAR data can improve the temporal accuracy of forest change alerts by up to 47 days. Fusion of LTS with the ESA-Copernicus Sentinel constellation of SAR and optical satellites thus has the potential to significantly improve the near real-time forest monitoring systems. Second, LTS-based methods face limitations when characterizing forest change processes like deforestation and forest degradation. Recent results integrating forest observations from community-based monitoring (CBM) project sites with LTS-based change indicators show that gradual, small-scale degradation of the forest canopy can be detected using LTS, but require regularly acquired *in situ* observations for adequate calibration and validation of change models. These insights show the promise of fusing LTS with other satellite data streams such as SAR image time series, as well as *in situ* observations and measurements, to enhance forest monitoring capabilities in the tropics to support such objectives as REDD+.

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