Long-term Fire Reconstruction in Chiquitano Tropical Dry Forest

Julia Bartsch, Master Thesis

Abstract

Fires have been prevalent over the last decades in the biodiversity hotspot of the Chiquitano tropical dry forest located in Bolivia and Brazil. This ecoregion has a high fire risk due to the seasonally dry climate, clearing burns for agricultural expansion, and fire as a management tool. Local burns have destroyed millions of hectares intact forests. To shed light on the understudied fire dynamics, I seek to first reconstruct the Chiquitano's fire history from 1986 to 2021 by mapping annual burned areas based on Landsat data with a machine learning and image segmentation approach. Second, I examine spatio-temporal patterns and trends of the classified burned areas. Third, I investigate land use changes in the burned areas considering multiple global land cover products to provide insights into this region's fire drivers.

The results show an inter-annual variance in burned area extents in the Chiquitano. The classification identified the most burned areas in 2010, covering 22 000 km^2 (9% of the study area). Estimates of burned areas over the Chiquitano classified by this study's algorithm and the Moderate Resolution Imaging Spectroradiometer (MODIS) MCD64A1 Version 6 burned area product presented similar inter-annual variability. However, there were marked differences in the magnitude of the estimates of the total burned area. My Landsat-based burned area classification approach achieved high accuracies after validation (mean overall accuracy: 96%, mean burn user's accuracy: 87%, mean burn producer's accuracy: 49%). Therefore, my product is useful for applications in burned area analysis and provides a regional or temporal method transfer. Of the burned areas identified in the burn years, 34% were over agricultural land use areas. The mean share increased to 49% in 2021, confirming clearing fires for agricultural expansion.

By reconstructing annual burned areas, the results of this study provide insights into the local fire dynamics of the Chiquitano ecoregion, which is under continuous anthropogenic influence and fire risk. The presented long-term burned area classification on a detailed spatial scale and the investigation of post-fire land use meanwhile demonstrate the consequences of fire for agricultural expansion purposes in this valuable ecosystem. Finally, by providing knowledge about fire drivers, this analysis assists in appropriate conservation actions and mitigation of future fires.

Keywords: Burned Area Mapping, Land Use Change, Random Forest, Landsat, Bolivia

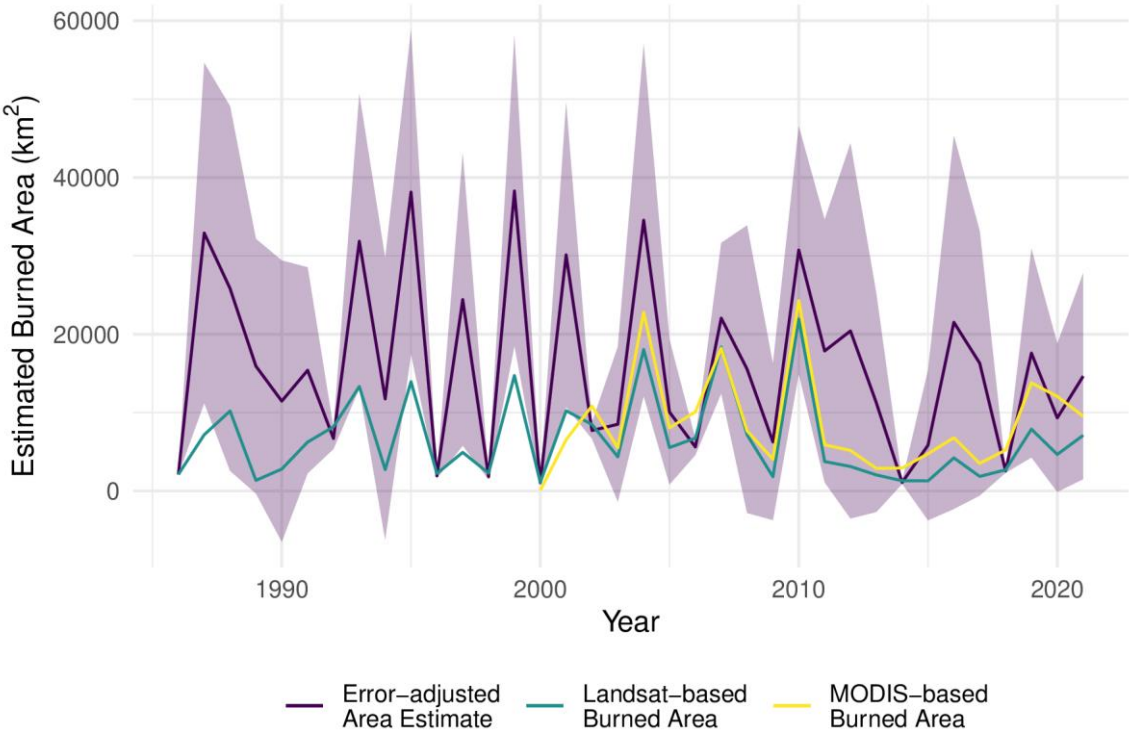

Figure 1 Classified annual burned area, MODIS-based burned area, and error-adjusted burned area estimates, including 95% confidence intervals derived from validation (own work, Julia Bartsch)

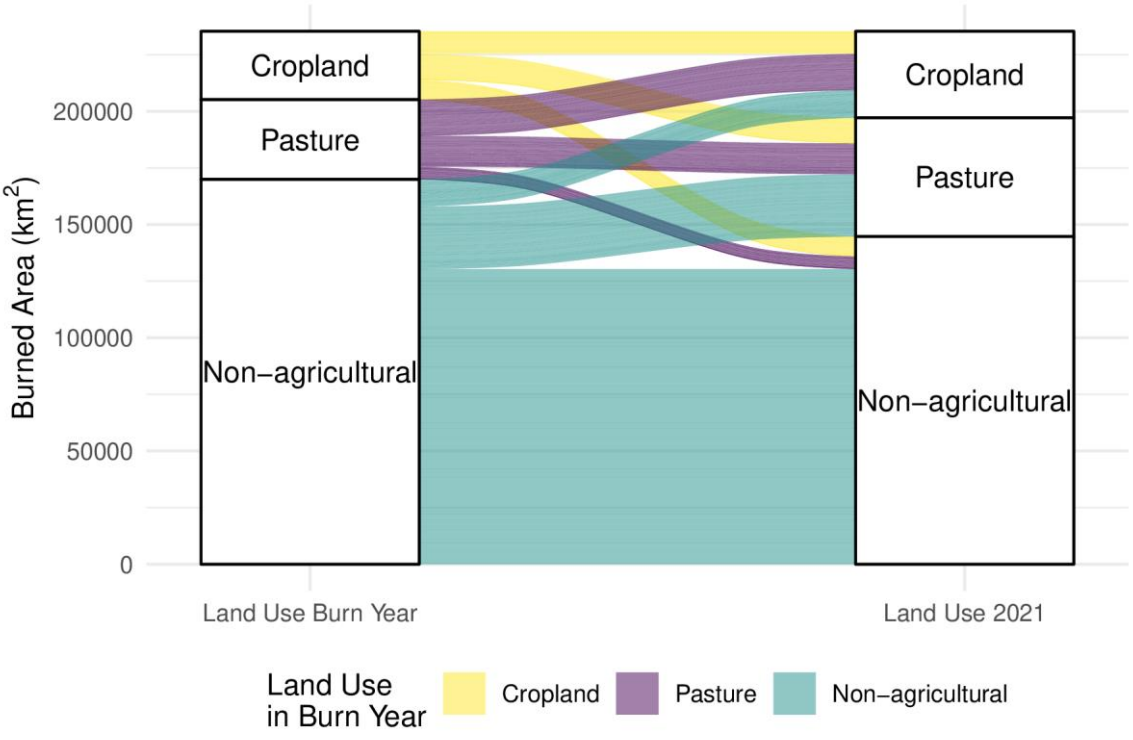

Figure 2 Land use in burned areas in the year of detected burning (left) and land use of the same locations in 2021 (right), including change flows (own work, Julia Bartsch)