

Fire role in deforestation across South American ecosystems

Abstract

Fire plays multiple roles in shaping South American ecosystems, yet much of the recent scientific focus has been exclusively dedicated to the Amazon rainforest. Southern Amazonia encompasses diverse ecosystems, including tropical savannas, moist and dry tropical forests, and wetlands. Fires are prevalent in this region, and their characteristics are primarily driven by human activities such as deforestation and land-use changes for agriculture and cattle ranching. These fire events are intensifying with increasing human encroachment on these landscapes. Existing coarse-resolution Burned Area (BA) datasets fail to capture small, fragmented fires widely prevalent in this region. To address this gap, we developed a high-resolution, long-term BA dataset using Landsat imagery for the period 1990–2019, covering an area of approximately 2.10 million km² (extent: 62°W–47°W; 24°S–12°S). Over the study period, newly generated medium-resolution burned area maps detected a cumulative total of approximately 345 million hectares burned, equivalent to an average annual burned fraction of 5.65%, with pronounced interannual variability and the period between 1999 and 2010 being the most extreme. Due to the improved detection of smaller fires, our BA estimates exceeded those of coarse-resolution datasets, being $47.90 \pm 9.84\%$ and $67.51 \pm 16.37\%$ higher than MCD64A1 and FireCCI51, respectively. Our estimates were also substantially higher than other Landsat-based BA products. In fact, we estimate $154.38 \pm 19.32\%$ and $100.75 \pm 24.55\%$ more BA than MapBiomas and GABAM, respectively. The dataset was independently validated using a stratified sampling protocol, achieving a high Dice Coefficient (DC) of over 92%. Omission and commission errors were limited to 6% and 8.36%, respectively. During the same timeframe, more than 24.5 million hectares of forest were lost – representing nearly one-quarter of the 1990 forest extent – with fires accounting for 26% of this loss. Most of these losses have not recovered over time and were subsequently followed by deforestation, with 99% of affected areas converted to pastures and croplands, while recovery rates have remained negligible. Fragmentation and fire history legacy emerged as critical factors influencing the trajectory of forest loss.

Key words: Amazonia, Cerrado, deforestation, Landsat, fire.