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High-Resolution Burned Area Dataset Reveals Fire Dynamics and Human Influence Across Southern Amazonia (1990–2019)

Amin Khairoun[1], Erika Solano[1], Daniela Stroppiana[2], Bhogendra Mishra[2], Matteo Sali[2], Emilio Chuvieco[1]

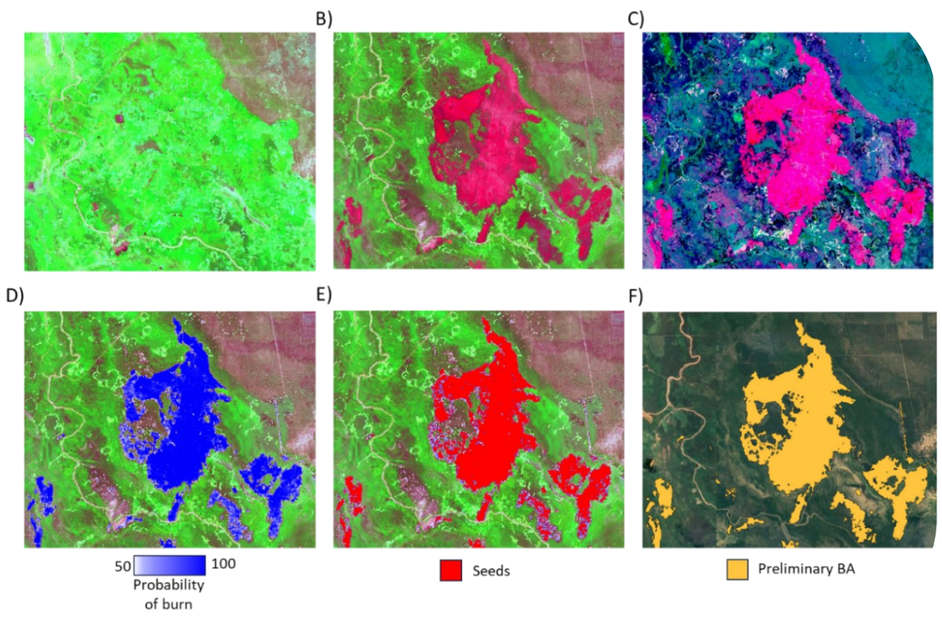
(1) Universidad de Alcalá, Environmental Remote Sensing Research Group, Department of Geology, Geography and the Environment, Alcalá de Henares, Spain
(2) Consiglio Nazionale delle Ricerche – Istituto per il Rilevamento Elettromagnetico dell'Ambiente (CNR-IREA), Via A. Corti, 12 20133 Milano, Italy

1. Introduction

Fire plays multiple roles in shaping South American ecosystems, 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.

2. Burned area generation

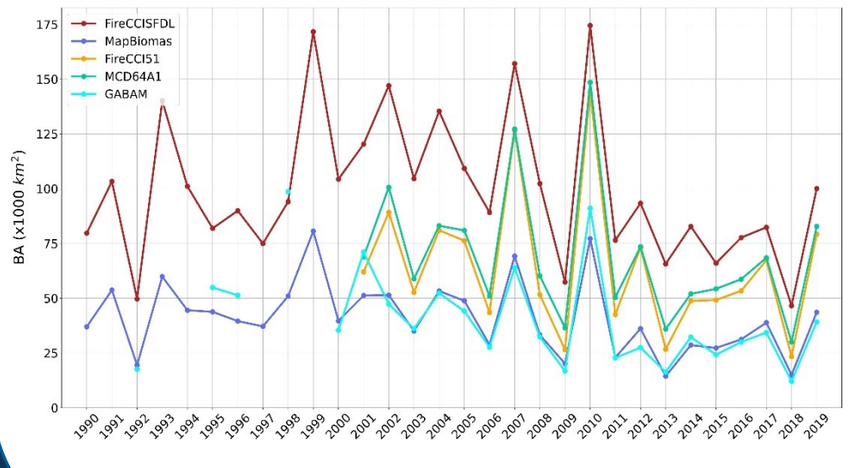
The core BA detection algorithm was based on a random forest model over the differences between Landsat multi-temporal image composites, allowing the highest fire signal to be detected using NBR index. Then, a post-classification refinement is applied to reduce noise and enhance BA patch delineation.



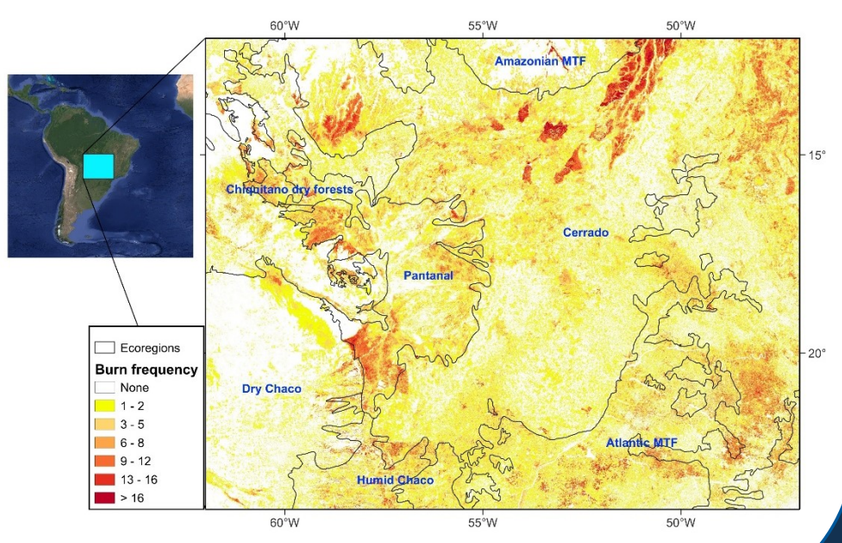
Burned area delineation process; A) Pre-composite (2015-10-01 to 2016-03-31); B) Post-composite (2016-04-01 to 2016-09-30); C) The difference composite; D) RF classification probability; E) Seeds; F) Delineation of preliminary BA patch. All False colour composites use NBR2-NIR-Red band combination.

3. Statistics of burned area record

Over the 30-year period, we found that the annual BA averages up to 10 million hectares per year (9.93 ± 1.71 Mha.year^{-1}), with the period 1999–2010 being the most devastating. Due to the improved detection of smaller fires, our BA estimates largely exceeded those of coarse-resolution datasets. Our estimates were also substantially higher than other Landsat-based BA products.



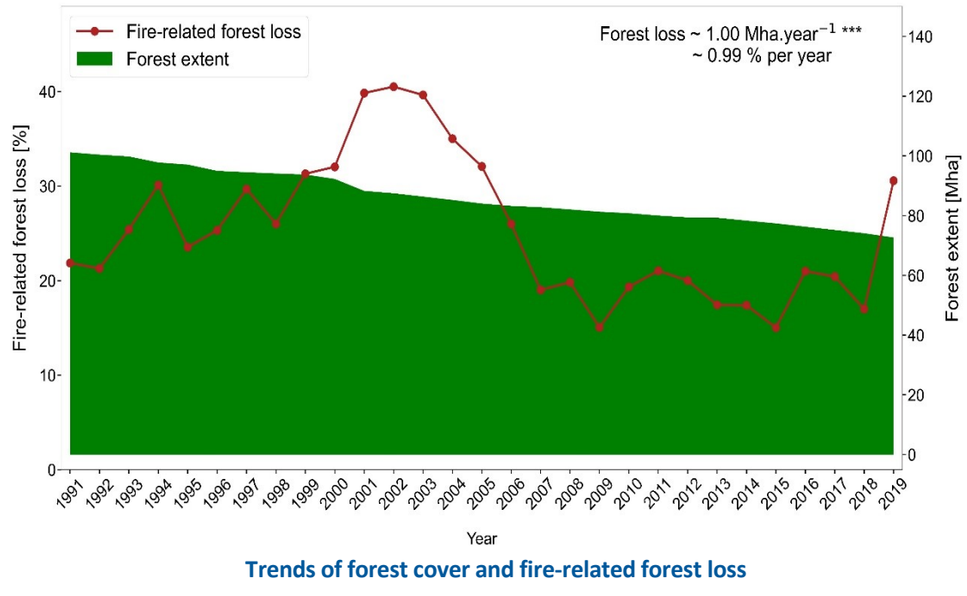
Comparison of burned area datasets



Spatial distribution of fire frequency

4. Fire-related forest loss

Up to 1 Mha of forest is lost every year, of which 26% were fire-related. An increasing trend of fire use was observed until 2003. Law enforcement policies perhaps constrained this trend afterwards but the year 2019 was alarming.



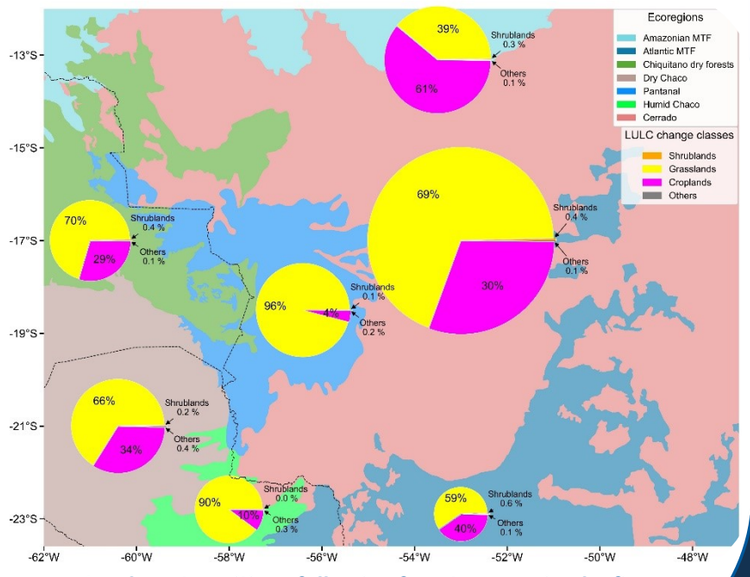
Trends of forest cover and fire-related forest loss

5. Fate of burned forests

The largest forest loss Is observed in humid chaco, while fires are largely used to clear intact tree cover in Amazonian moist tropical forests. Forest clearing for human-related land uses, particularly croplands and pastures, is widespread across all ecosystems. In intact Amazonian forests, these transformations predominantly result in agricultural expansion.

Forest loss and fire-related forest loss per ecoregion

Ecoregion	Forest loss (%)	Fire-related (%)
Amazonian MTF	22.57	43.78
Atlantic MTF	23.66	22.56
Chiquitano dry forests	13.38	26.72
Dry Chaco	27.01	14.18
Pantanal	24.93	33.08
Humid Chaco	36.24	32.80
Cerrado	26.37	26.33



Land use transitions following forest conversion by fire

6. Conclusion

- Human activities remain the main forest loss driver in Amazonian ecosystems
- The use of fire as a land management tool has significant impacts on moist tropical forests.
- Burning practices exert a considerable influence on humid ecosystems.
- Law enforcement policies might have significant impacts on the extent of forest burning

Contact: Amin Khairoun, University of Alcala, Spain
amin.khairoun@uah.es