BACKGROUND

- The Brazilian Cerrado (Cerrado) is one of the most important global biodiversity hotspots.
- It is, on average, responsible for more than 50% of Brazil’s annual burned area.
- Keep in mind that Brazil is one of the regions with higher fire activity worldwide.
- Cerrado is increasingly endangered: less than 20% of its natural vegetation remains undisturbed; and future projections of a warmer and drier climate put this biome at high risk.

DATA AND METHODS

- Burned Area (BA): MODIS MCD64A1.0 (Giglio et al., 2018).
- Land use (LU): MapBiomas collection 04 (MapBiomas Project, 2019).
- Meteorological fields: daily fields at 18 UTC of surface air temperature, relative humidity, wind speed, and 24-hour precipitation from ERA5 (C3S, 2017).
- Fire danger index (FWI): the Canadian Forest Fire Weather Index (Van Wagner, 1974).

**Methods:**

The study period (2001-2018) was divided and averaged over three sub-periods to analyze each variable over the study region. Then, drivers were evaluated using simple linear regression between interannual values of total BA and each of the variables: dry-season (FWI average) and annual PD. Last, to estimate trends, given the short length of the time series, we used non-parametric methods: the Thiel-Sen regression (Thiel, 1950; Sen, 1968) and the modified Mann-Kendall test (Barnes and Rao, 1998), which accounts for the effects of serial correlation.

CHARACTERIZATION

Here, we present the preliminary results of studying burned area drivers and their recent trends in the Brazilian Cerrado. We found that there is high variability within the biome and, amongst the drivers evaluated, only FWI showed significant results throughout Cerrado, explaining at least 20% of interannual variance of BA; it’s worth emphasizing that climate provides conditions for burning, but fire events are always dependent on ignition, which in Brazil is known to be almost certainly human. The remaining drivers, LU and PD, did not prove to be relevant factors in the vast majority of the biome, with very low values of coefficient of determination and no spatial consistency. They were also found to have much more complex relationships with burned area, heavily dependent on the regional context and other variables not considered here (such as deforestation). Furthermore, north-eastern Cerrado was found to be largely explained by FWI, where some microregions obtained coefficient of determination values beyond 50%. This region also showed positive BA and LU trends, consistent with it being Cerrado’s latest agricultural frontier (also known as MATOFIBA), heavily marked by the clearing of natural vegetation (savanna).

TRENDS

Contrasting spatial patterns were found for BA, LU and FWI in the 2001–2018 period. Conversely, both PD and FWI over the historical period, show widespread positive values in Cerrado. When looking at the latter is clear that there has been a positive trend in Cerrado over the last decades. It’s also worth noting that negative trends achieved for FWI in 2001–2018 are not significant. North-eastern Cerrado shows positive BA and LU trends, consistent with this region being the biome’s latest agricultural frontier (MATOFIBA).

DISCUSSION

Drivers of burned area trends in the Brazilian Cerrado:

**1. Burned Area (BA):**

- The linear relationship of BA and FWI is that of positive slope for all microregions, meaning that when fire danger increases, BA increases as well. FWI significantly explains least 20% of interannual variance of BA in most microregions in Cerrado; higher values are obtained for the north-eastern tip of the biome, as well as central Cerrado, where it explains at least 50%. However, many regions with higher fire activity (Figure 2), namely in the north-east, show relatively low coefficients of determination, suggesting that climate is not the main driver in these microregions but rather an aggravating factor. Moreover, these lower values obtained for the coefficients of determination might suggest that these regions are shifting from a climate-controlled historical fire season to a disturbed regime. On the other hand, BA and LU relationship is much more complex than that of BA and FWI; fire is used to clear native vegetation into arable land, in which case burned area increases; and the use of controlled and seasonal fire in the harvest season and to clear the agricultural fields, in which case burned area decreases. Accordingly, when performing simple linear regression using LU as a predictor of burned area, distinct signals were found, and the vast majority of which were not significant at the 5/10% level. Similarly PD was also found to have very different signals, where these microregions with significant results obtained negative slopes.

**2. Land Use (LU):**

- The spatial distribution of the 172 microregions (light green, each with identifier – ID) across the Cerrado biome (dark green) in central Brazil (Figure 3). The coefficient of determination (R²) between interannual BA and LU was evaluated using Kendall trend test for autocorrelated data. The filled (empty) circles represent significance below the 5 (10)% level. The linear regression values showed that the trend in burned area is positively linear for both LU/LU and LU/PD (Figure 4). The coefficient of determination between interannual BA and LU, as well as an annual BA (first row), annual LU (second row) and annual PD (last row) is fairly consistent. The coefficient between interannual BA and LU was also found to have much more complex relationships with burned area, heavily dependent on the regional context and other variables not considered here (such as deforestation). Furthermore, north-eastern Cerrado was found to be fairly explained by FWI, where some microregions obtained coefficient of determination values beyond 50%. This region also showed positive BA and LU trends, consistent with it being Cerrado’s latest agricultural frontier (also known as MATOFIBA), heavily marked by the clearing of natural vegetation (savanna).

**3. Population Density (PD):**

- The trends in annual BA, LU and PD over 2001–2018, and between 1990-2018 (FWI) (Figure 5). Northeastern Cerrado is an area with a significant increase in population density, mainly due to the expansion of agriculture in this area. It is worth noting that PD in most of the microregions was found to be positively linear for both LU/LU and LU/PD (Figure 4). The coefficient of determination between interannual BA and PD was also found to have much more complex relationships with burned area, heavily dependent on the regional context and other variables not considered here (such as deforestation). Furthermore, north-eastern Cerrado was found to be fairly explained by FWI, where some microregions obtained coefficient of determination values beyond 50%. This region also showed positive BA and LU trends, consistent with it being Cerrado’s latest agricultural frontier (also known as MATOFIBA), heavily marked by the clearing of natural vegetation (savanna).

**4. Characteristics:**

- The characteristics of the Brazilian Cerrado, and its relation to burned area, are shown in Figure 2. The average over three-period periods (2001–2006, 2007–2012, 2013–2018) for annual BA (first row), annual LU (second row) and annual PD (last row). The average values represent their corresponding projections of each category defined as lower (upward) trend and filled (empty) circles represent significance below the 5 (10)% level.

**5. Discussion:**

- This study aimed to explore the human-driven component of burned area variability in the Cerrado biome. It was found that there is significant variability in burned area, with high variability in BA being positively correlated with both LU and PD. However, the main driver of burned area variability was found to be FWI, with a coefficient of determination exceeding 50% in the north-eastern region of Cerrado. This region is characterized by high population density, and it is worth noting that PD in most of the microregions was found to be positively linear for both LU/LU and LU/PD (Figure 4). The coefficient of determination between interannual BA and PD was also found to have much more complex relationships with burned area, heavily dependent on the regional context and other variables not considered here (such as deforestation).

**References:**