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CHARACTERIZING THE FIRE REGIME EVOLUTION AND LAND USE CHANGE IN THE DRY AND WET CHACO BETWEEN 2001 AND 2019

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1) INTRODUCTION

Wildfires play an essential role in the biogeophysical cycles of different world ecosystems, from dry savannas to humid wetlands. During the last decades, fire regimes of several global regions began to present significant alterations due to climate change and human land-use pressure. The South American Gran Chaco ecoregion contains one of the most important reservoirs of native forests and biodiversity in the world, including the largest continuous dry tropical forest and some of the most extensive wetlands. Climate warming, i.e., higher air temperatures, combined with more frequent and intense drought events and extreme precipitation - among other variables - can alter the frequency and intensity of fires through the production of vegetable fuel and the availability of dry biomass.

Earth Observation satellite missions allow scientists to monitor fires from space, and several products mapping burnt areas, radiative power, or carbon emissions are now available. They can be used to analyze time evolution and identify possible fire drivers. In this work, we have used such products over the Gran Chaco and over the last 20 years to assess the seasonality and frequency of fires, identify the main land cover types impacted and analyze links with atmospheric variables such as air temperature and precipitation.

2) STUDY AREA & DATA USED

Our work is focused on the South American Gran Chaco region. It includes the largest continuous dry tropical forest and extensive floodplains. It presents a marked annual precipitation gradient from East with up to 2000mm/year (Wet Chaco; 2001-2019 average) to West with around 450mm/year (Dry Chaco; 2001-2019 average) and a very distinct seasonality:

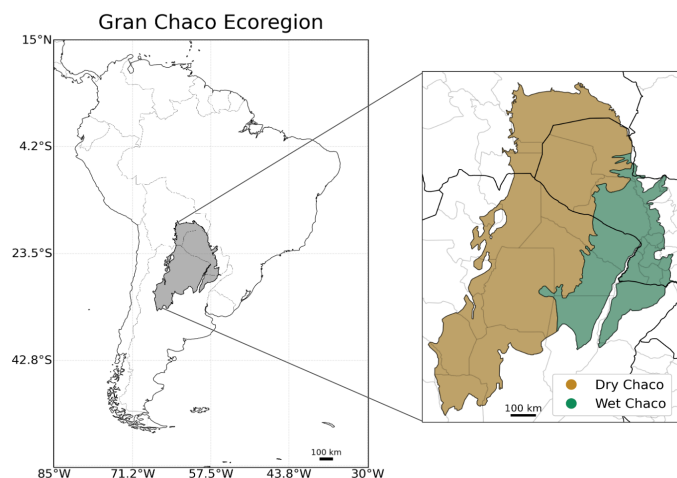


Fig. 1 Gran Chaco, Dry Chaco and Wet Chaco location.

a dry season from May to September and a wet season from October to April. Maximum monthly temperatures range from +15°C to +40°C, with mean annual values of around +22°C.

Land Cover mapping: To map the natural vegetation over the Chaco ecoregion, we used the European Space Agency (ESA) Climate Change Initiative (CCI) medium resolution land cover map (MRLC, v2.0.7, *Defourny, 2017*). The product is available at a resolution of 300m, and global maps are provided yearly (1992 to 2021). The product describes the land surface in 22 land cover classes according to the standard of the United Nations Land Cover Classification System (UN-LCCS) (*Di Gregorio and Jansen, 2005*).

Atmospheric data: To assess the region's climatology, we used the ERA5 atmospheric reanalysis (*Hersbach et al., 2020*). Atmospheric variables such as precipitation, air temperature, and wind speed are available at a resolution of 31 km and hourly time step.

Fire dataset: To map burnt areas, we used the ESA CCI Fire product v5.1 (*Pettinari et al., 2021*). It provides fire detection and burnt land cover classes at 250m resolution with a daily time step (2001 to 2020). It is based on MODIS observations, combining spectral information at 250m resolution and thermal data from the MODIS active fire products.

3) RESULTS

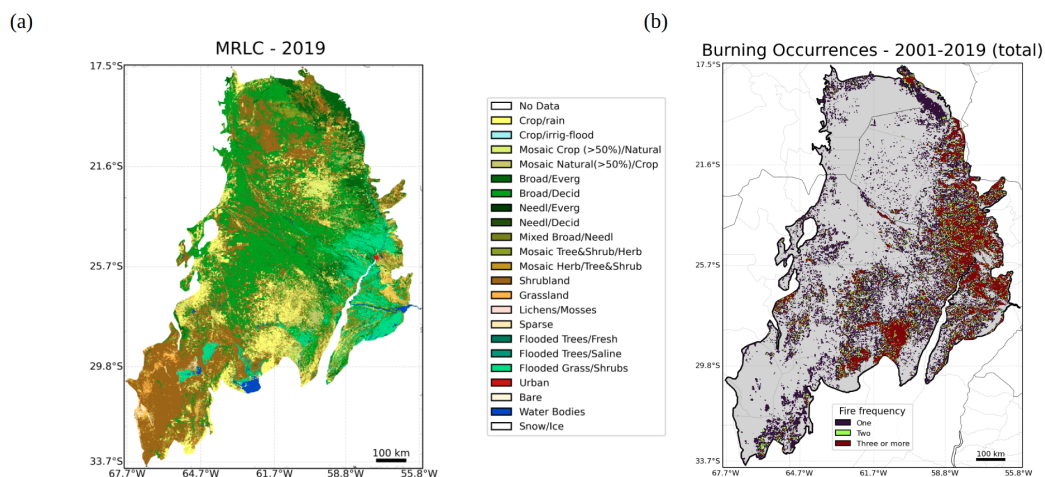


Fig. 2 MRLC land cover classes for 2019 (a) and FIRE CCI 5.1 total fire detections divided into three frequency categories for 2001-2019 (b).

Figure 2 shows that the land cover and the fire regime are different in the Wet and Dry Chaco. Related to the humid climatic and edaphic conditions, the vegetation found in the Wet Chaco shows a predominance of grasslands and flooded vegetation that tends to burn every year (Figs. 2(a) and 3(b)), suggesting a rapid recovery of vegetation. This could be related to farmers' fire management to promote the re-sprouting of nutritious and palatable grasses for cattle grazing, as described by *Cano and Leynaud (2010)*.

In contrast, the drier conditions of the Dry Chaco and the larger presence of xerophytic shrubs and trees might explain part of the lower frequency of fires found in the area. Also, its more considerable amount of one-time fires suggests the occurrence of (a) rare historical wildfires developing only under particular climatic conditions, or (b) deforestation fires (replacement of forest by grasslands or shrublands used for ranching or by croplands - mainly used to grow cereals like soy).

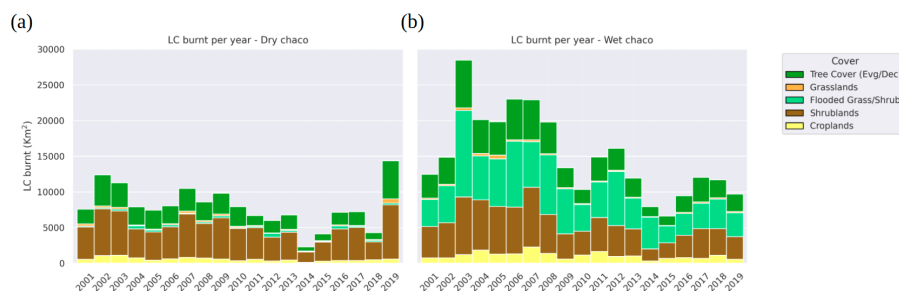


Fig. 3 Burnt land cover classes for Dry (a) and Wet (b) Chaco per year.

Comparisons between post-winter burnt areas and precipitation anomalies accumulated over the three months before fire season (Fig. 4) suggest that wildfires in the Wet Chaco are more sensitive to changes in precipitation than those occurring in the Dry Chaco. This could be related to the stronger variability in rainfall and its impacts on the more herb-predominant land cover in this region.

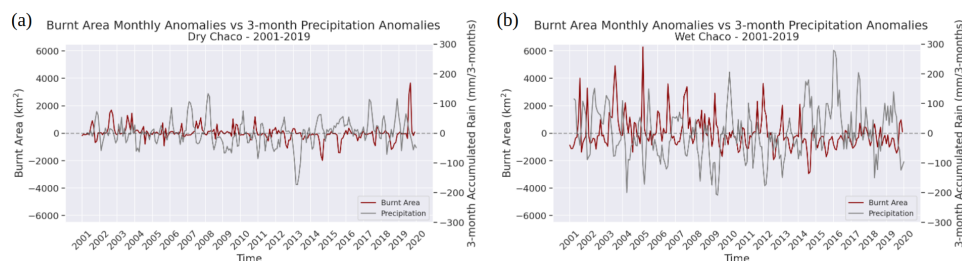


Fig. 4 Comparisons between burnt area and precipitation anomalies. 3-month burnt area vs. 3-month accumulated precipitation for Dry (a) and Wet (b) Chaco.

4) CONCLUSION

We used satellite products combined with atmospheric reanalysis to explore the characteristics of burnt areas in the South America Gran Chaco. Preliminary results highlighted different features in the two subregions (Wet and Dry Chaco), suggesting that the main drivers may be distinct, especially concerning the meteorological variables. Our following work will focus on identifying the key predictor variables using machine learning methods to understand fires' origin and dynamics better. This will help to preserve the Chaco region in the context of climate warming, fire management, and agricultural expansion.

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