Differential exposure to climate extremes in two Neotropical agroforestry areas

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Introduction

Agricultural systems in general are **vulnerable to climate extremes** (Anderson et al., 2017, 2018). In South America (SA), extreme climate events are highly influenced by the El Niño Southern Oscilation (**ENSO**) through **teleconnections** between the Pacific Ocean and the continent during its two phases: El Niño and La Niña. However, the effects of the ENSO events on agroforestry systems have not been thoroughly studied, especially, in relation to the magnitude, temporality and the time lags of the ENSO phases over the continent. Climate change will likely increase the precipitation variance of the ENSO events meaning that the El Niño years will be drier and La Niña years will be wetter than pre-industrial conditions (Eyring et al., 2021) further impacting the peasants that depend on the agroforestry systems of the area.

Objective

The general objective of our research is to characterize **the exposure** of two target Neotropical areas to the climatic extremes induced by the ENSO cycles.

The target sites (Figure 1) have contrasting ecologies: The first, Caldas (Colombia), is located between the central and western cordillera of the Andes, with an elevation range from 170 to 5,400 m.a.s.l. and is mostly cultivated with **shade coffee** The second, Manabí (Ecuador), is a coastal zone with an elevation range from 0 to 500 m.a.s.l., and is mostly cultivated with **shade cacao** plantations.
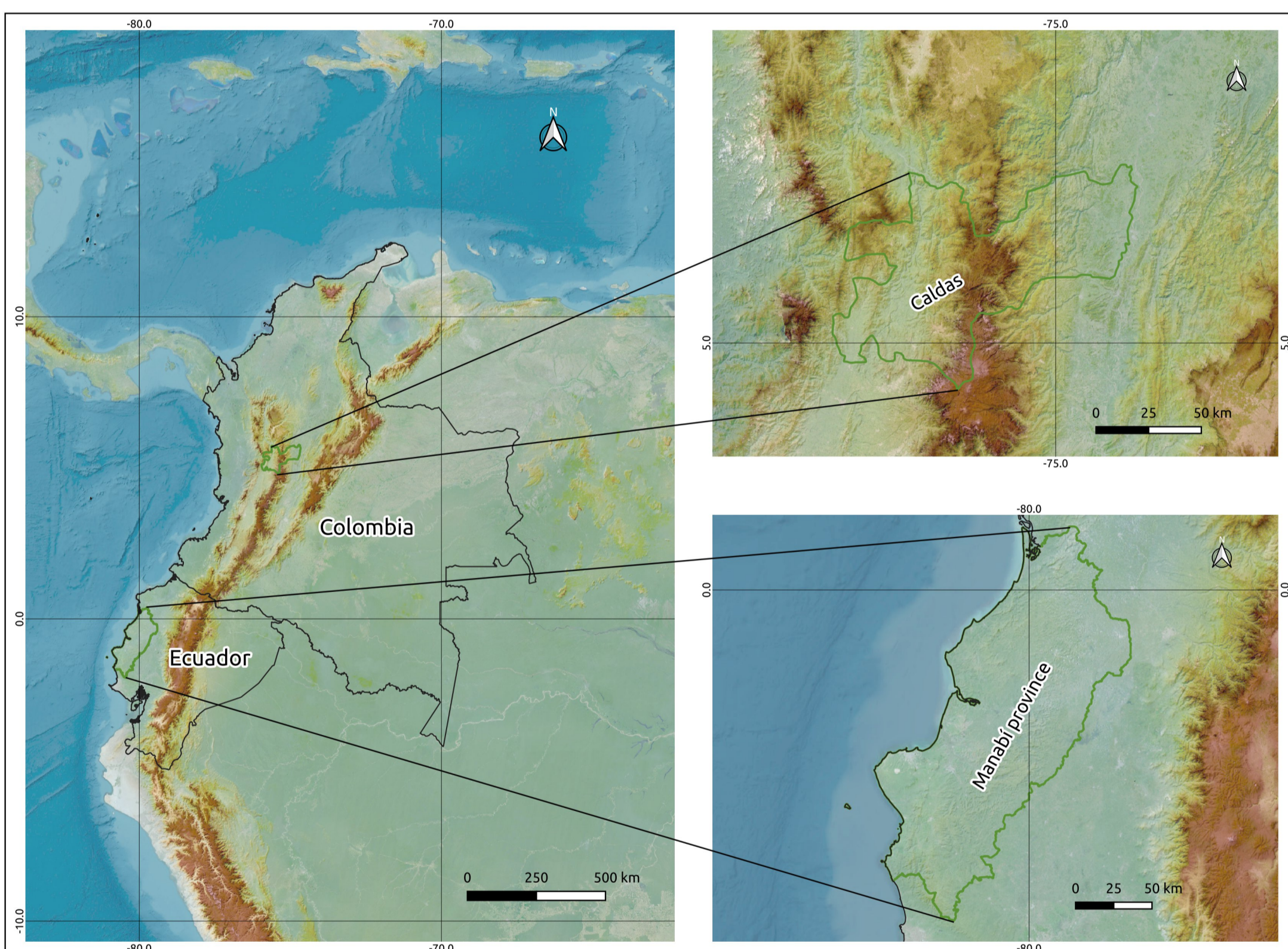

Figure 1. Target agroforestry areas

Methods

Correlation analyses (Spearman's rank correlation) of meteorological variables of Equatorial America areas and the ENSO3.4 index of the Pacific Ocean were carried out to detect the degree of exposure of the agroforestry systems to ENSO phases. For doing so, time series of maximum temperature, annual precipitation and aridity index were constructed using the same 3 month running mean of the NOAA-ENSO databases. Terrestrial anomalies were estimated using a moving 5-year period for a 30 year window average. The analyzed period was 1970-2020. The Terra-Climate database was used through the Google Earth Engine platform.
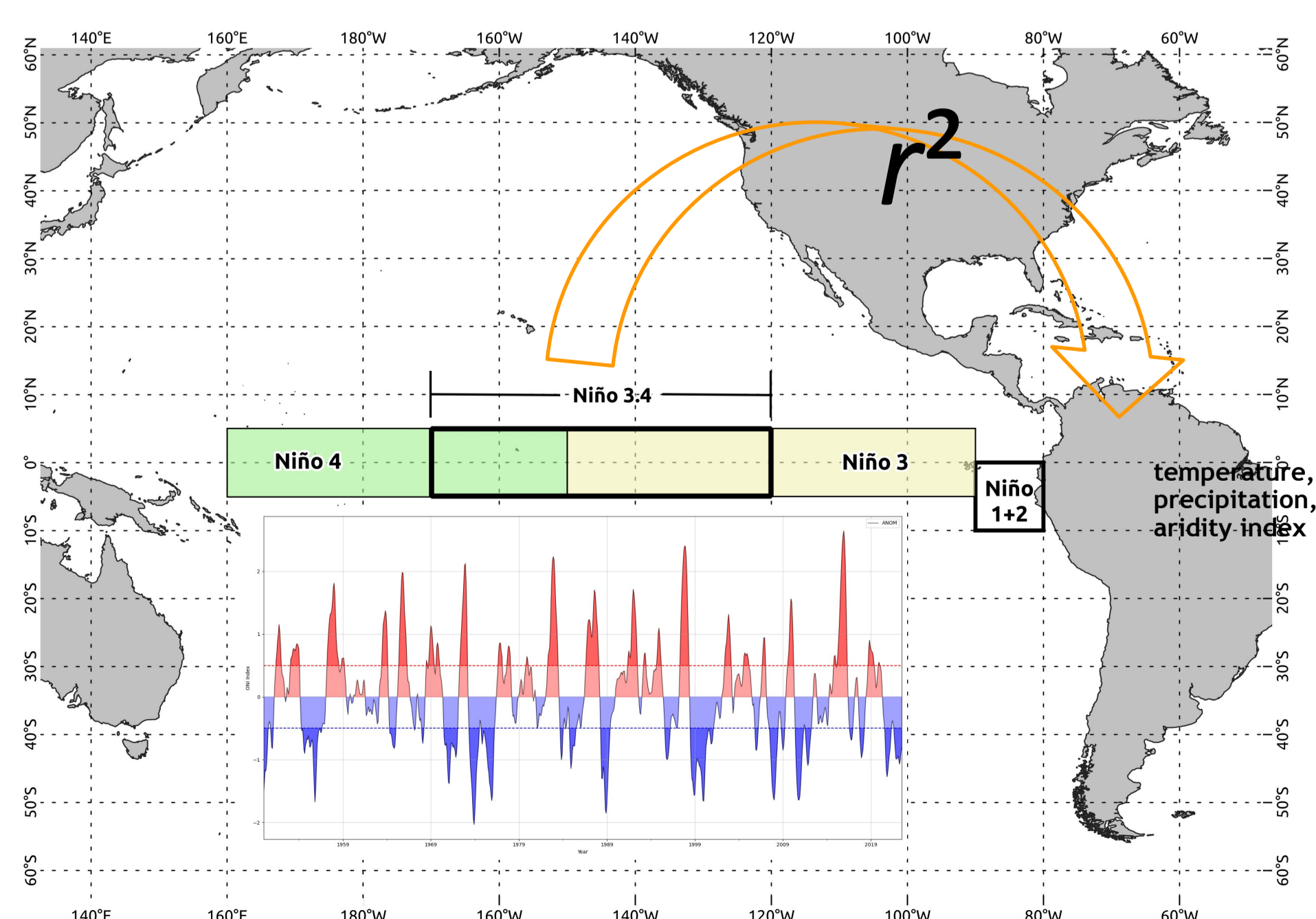
Preliminary results

The difference in exposure between Caldas and Manabí is expressed in four variables: Maximum Temperature, Precipitation, Palmer Drought Severity Index (PDSI) and Soil Moisture (Figure 2). While Manabí shows stronger positive correlations in maximum temperature and precipitation with the El Niño phenomenon, Caldas shows a strong positive correlation in maximum temperature, but a negative correlation in precipitation, meaning that in both zones temperatures are higher during a Niño, but the **effect is reversed in precipitation**. Consequently, in Caldas a strong negative correlation is observed with the PDSI and the soil moisture variable, indicating greater water stress in this area. These effects are reversed when the La Niña phenomenon is taken into account.

Figure 2. Correlation (r^2) between meteorological variables and ENSO3.4 as a proxy of exposure to climatic extremes for the 1970-2020 period

Future work

Future work of the research will include the ecosystemic response of the agroforestry areas using remote sensing data (eg. NDVI) in selected ENSO episodes (e.g., 1982-83, 1997-98, or/and 2015-16) to conduct a *before* and *after* analysis

References

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