Topography as a barrier against fire spread in the Ecuadorian Andes

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1. Introduction

Wildfires are a global phenomenon that has had a historical impact on ecological processes, altering animal habitat, nutrient cycling and hydrology. (Bowman et al. 2009; Holsinger, Parks, & Miller 2016). According to Judson (2017), the presence of three essential elements: biomass (what burns), oxygen (needed for the combustion process), and ignition sources (heat for fires to start) is necessary for fire production. At small spatial and temporal scales, as in the case of local microsites, these factors can determine fire initiation and spread. However, as the scale of the fire increases, other factors such as topography, climate and available fuels become relevant. These elements operate at broader spatial and temporal scales, ranging from local to landscape and from days to years. (Oddi 2018).

While climate plays an important role in the control of fire regimes (fire severity, frequency and time of year), it also plays an important role in the control of fire regimes (severity, frequency and time of year of fires). (Keeley & Syphard 2016), studies at different spatial scales, mainly in the United States, have shown that topography influences both directly and indirectly the spread of fires by affecting the nature and structure of fuels, the location of barriers to fire spread, and the transfer of energy from flaming fronts to fuels on hillsides. (Harris & Taylor, 2017; Taylor & Skinner, 2003). Considering the above, the main purpose of this study was to determine the characteristics that prevent the spread of fires on the boundaries of burned areas along the inter-Andean region of Ecuador (Fig. 1).

2. Methods

For this I used the Global Annual Burned Area Maps (GABAM) for the year 2015 to 2023. These maps represent the spatial extent of fires occurring in an entire year with a resolution of ~30 m and is composed of 10°x10° grids spanning between 80°N-60°S and 180°W-180°E. In addition to the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) at ~30 m resolution and the Landsat 7 Collection 1 Tier 1 NDVI dataset from the Landsat 7 Collection 1 Tier 1 satellite, which combines information from all scenes from every 8-day period throughout the year.

Each burned area from the GABAM data was divided into two zones: the boundary of the burned area itself and a surrounding perimeter (Fig. 2). Then, I converted the pixel data from both zones into polygons and calculated the Topographic Roughness Index (TRI), slope, and aspect from the DEM. Additionally, NDVI values were assigned to each polygon. Polygons with NDVI values < 0.5, indicating minimal vegetation, were excluded from further analysis.

The Mann-Whitney Wilconxon test was applied to determine whether there were significant differences between the burned and unburned regions. The analysis revealed significant differences between the two zones for the variables examined. Fire perimeters were typically found in areas with:

- Elevation: 2800-3300 meters
- TRI: 17-44
- Slope: 20-55 degrees
- Aspect: East-West

According to the Ecuadorian Ministry of Environment, Water and Ecological Transition, the unburned areas would be woody forests reaching 10-25 m in height in areas of rugged topography and steep slopes.

3. Conclusion

In Ecuador, forest fires have been increasingly frequent and intense in recent decades (Carrión-Paladines et al. 2022), so understanding the mechanisms that determine the growth and suppression of fires is crucial both to develop a theoretical understanding of their dynamics and to guide practices that identify opportunities for forest restoration and suppression activities not only in Ecuador but in the Tropics.

4. Figures

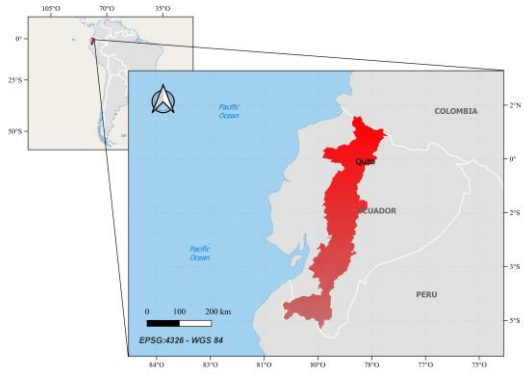

Figure 1. Map of the Ecuadorian inter-Andean region, corresponding to study area analyzed.

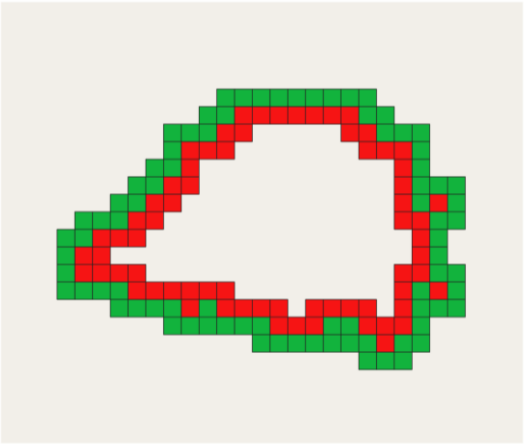

Figure 2. Patch of burned area (red), surrounding unburned area (green).

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