

# Understanding the wildfire risk landscape: Implications for forest ecosystem conservation in Tolima, Colombia



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## Introduction

Wildfires in Colombia burned over 73,000 ha in 2017 and more than 106,000 ha in 2018, with about 95% of ignitions driven by human activity and worsened by climate-induced dry spells. Despite national monitoring efforts, a critical need remains for continuous, standardized spatiotemporal protocols to evaluate regional wildfire susceptibility in **fragile ecosystems**. To address this gap, this study integrates 2016–2023 MODIS/VIIRS thermal anomalies with CHIRPS rainfall records and IDEAM guidelines to establish a robust regional baseline for Tolima, Colombia.

## Methodology

- Data Inputs:** Multi-temporal satellite thermal sensors (MODIS & VIIRS), CHIRPS precipitation grids (2016–2023), and CORTOLIMA/CLC land cover maps.
- Climate Analysis:** Annual precipitation rasters retrieved via Climate Engine to evaluate moisture patterns.
- Spatial Density:** Converted discrete active fires into continuous density surfaces using Kernel Density Estimation (KDE).
- Risk Zonation:** Applied Jenks Natural Breaks and reclassified hazard levels based on precipitation-driven susceptibility, following IDEAM national guidelines.

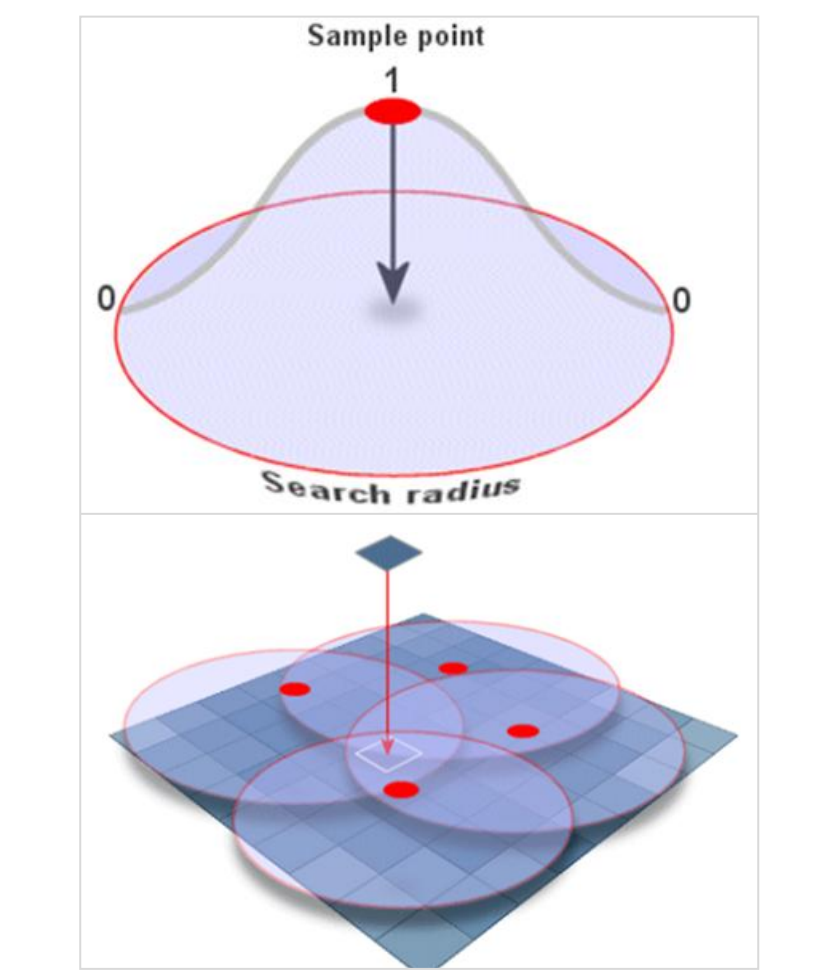


Figure 1. Kernel Density Estimation  
Source: ESRI (n.d.-b)

## Study area

- Location:** Central-Western Colombia (Andean region); 47 municipalities across 23,562 km<sup>2</sup>.
- Topography & Climate:** Elevations from 400 to 5,276 m.a.s.l.; mean temperatures ranging from <0°C to >40°C.
- Ecosystems:** Critical biomes (páramos, cloud forests, and endangered Tropical Dry Forests) protected across 69 areas, including Los Nevados, Las Hermosas, and Nevado del Huila National Parks.

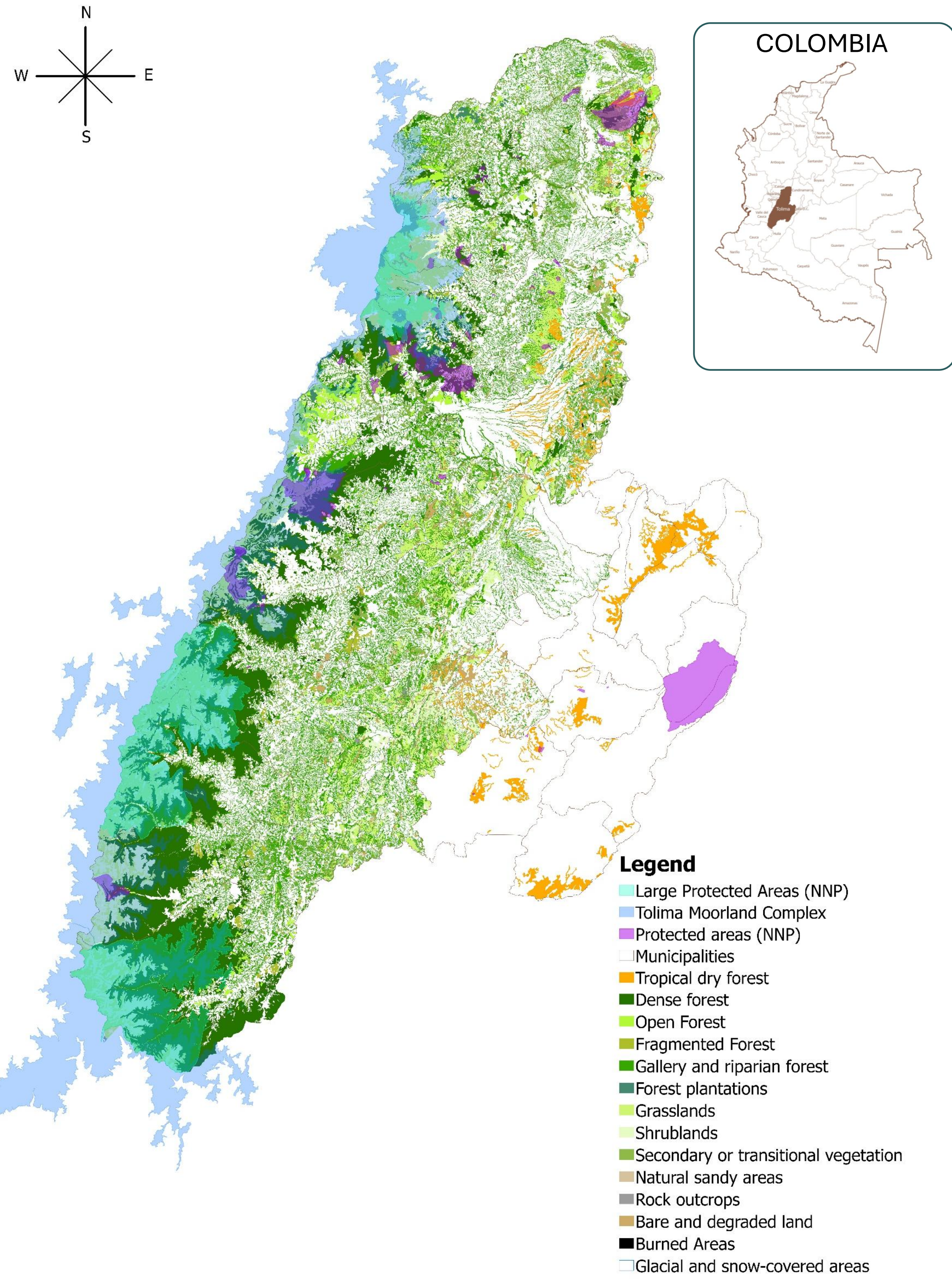


Figure 2. Environmental and Protected Areas of Tolima: Forest/Semi-natural Cover (CLC), National Parks, and Páramos. Source: Adapted from Feo-Mahecha (2024); CORTOLIMA (2023).

## Results

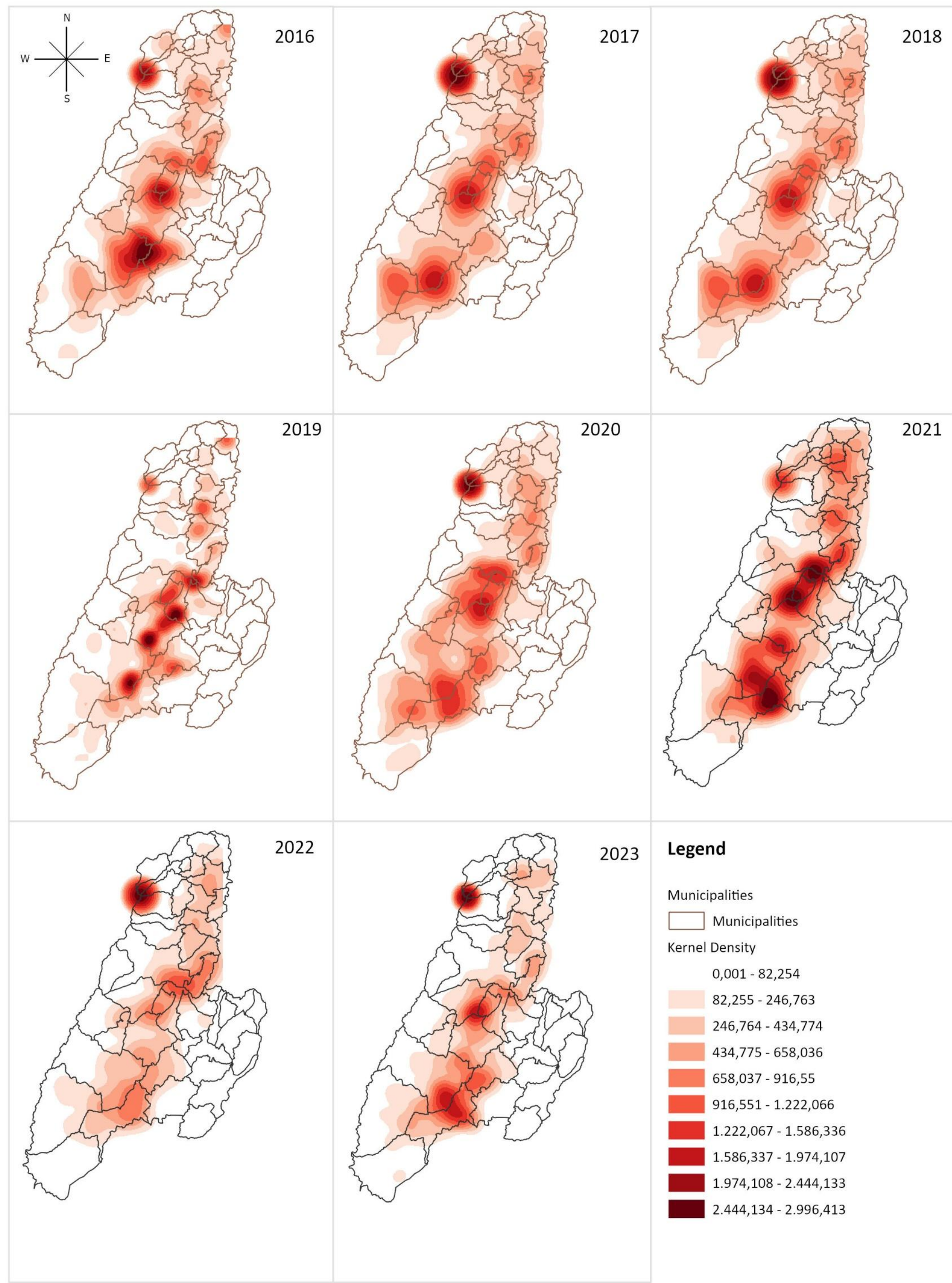


Figure 3. Kernel Density Estimation (KDE) of active fire hotspots in Tolima - Colombia. Data sources: MODIS and VIIRS thermal anomalies retrieved from the IDEAM Hotspot Monitoring Portal (Feo-Mahecha, 2024).

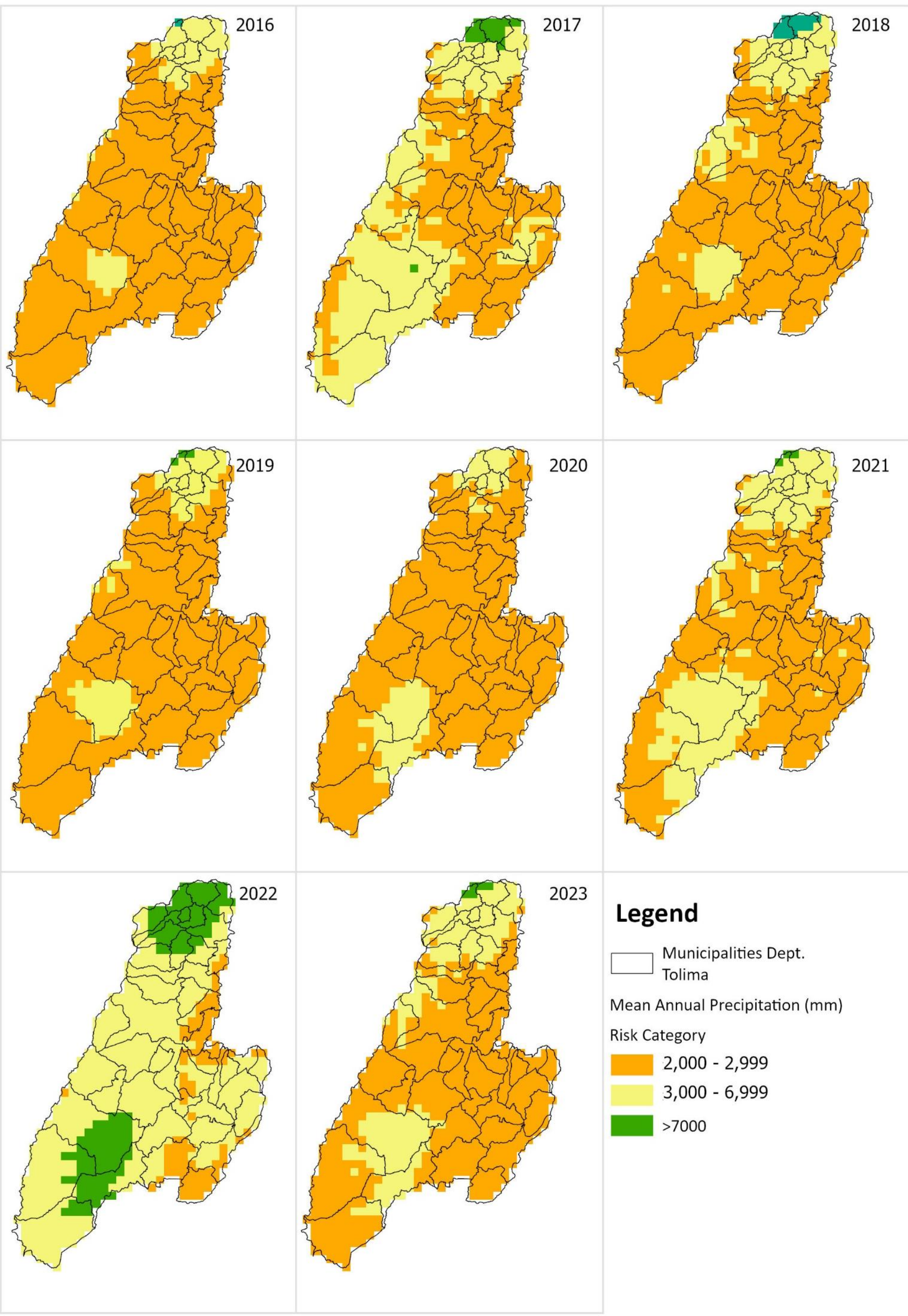


Figure 4. Wildfire Hazard Assessment Based on CHIRPS Annual Precipitation Patterns (Feo-Mahecha, 2024).

## Conclusions

- Climate & Hotspots:** High temperatures and rainfall deficits drive hotspots. Peak years (2016, 2019, 2021) coincided with severe droughts, while record CHIRPS rainfall in 2022 suppressed active fires.
- Temp. vs. Rainfall:** High temperatures override rainfall mitigation (e.g., 2017 dry spells), fueling recurring hotspots in chronic zones like Ataco–Chaparral.
- Hotspot Clustering (KDE):** Identified two persistent thermal hubs (2016–2023):
  - Central-Southern Valley: High temperatures, low rainfall, and open cover.
  - Northern High-Altitude Cluster: Thermal anomalies bordering PNN Los Nevados.
- Geospatial Framework:** Combining MODIS/VIIRS and CHIRPS data provides a robust baseline for early detection and fire hazard forecasting in Andean ecosystems.



## References

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