

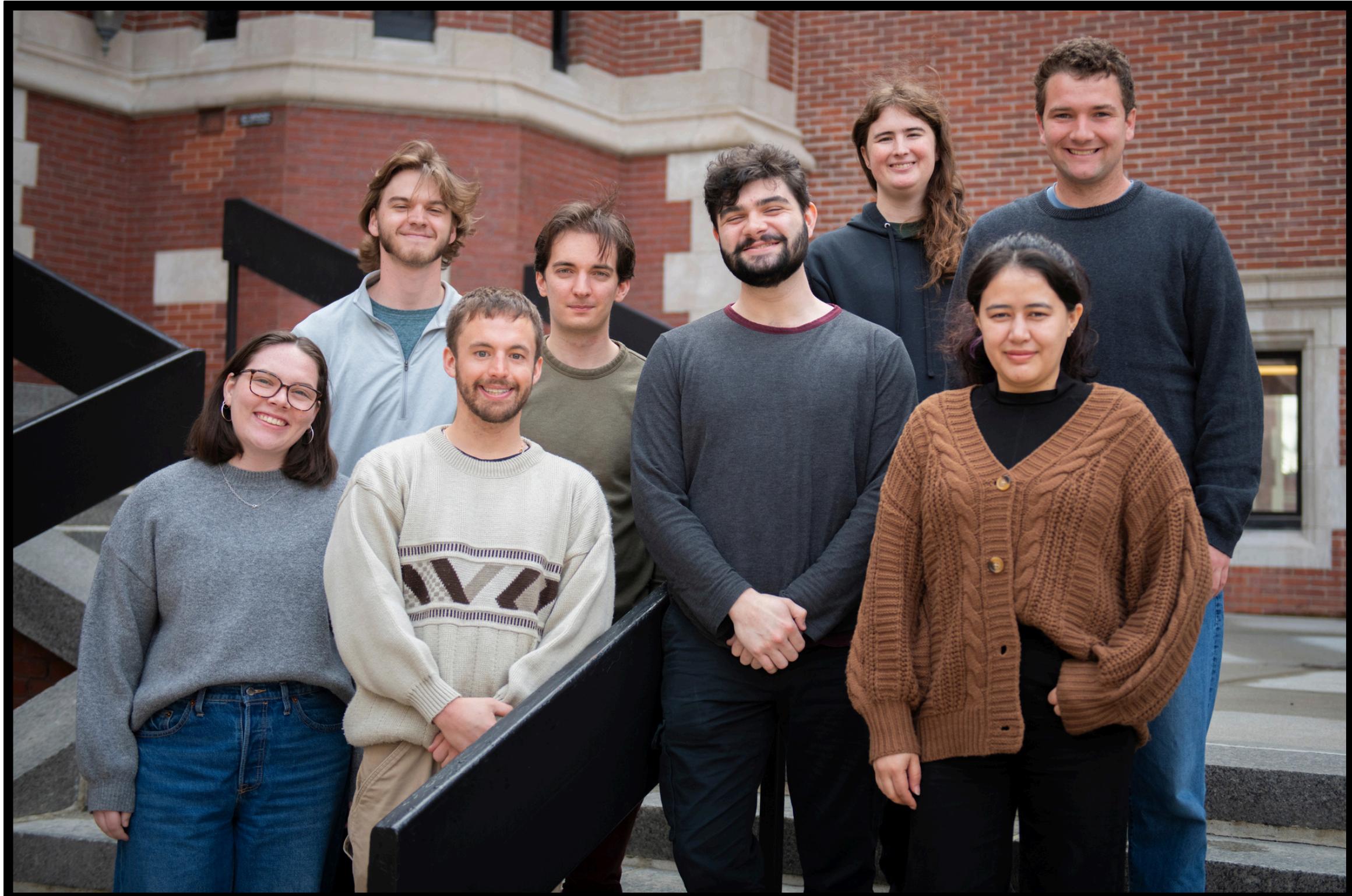


CLARK CONSULTING GROUP

TRENDS IN TERRESTRIAL WCS MANAGEMENT UNITS: CENTRAL AND SOUTH AMERICA



MEET THE TEAM



Spring 2025 WCS Team

Adlai Nelson
Andrew Niehaus
Ben Spencer
Caleb Kluchman
Rory Dickinson
Saida Mousavi
Tanner Honnef
Wynnie Gross

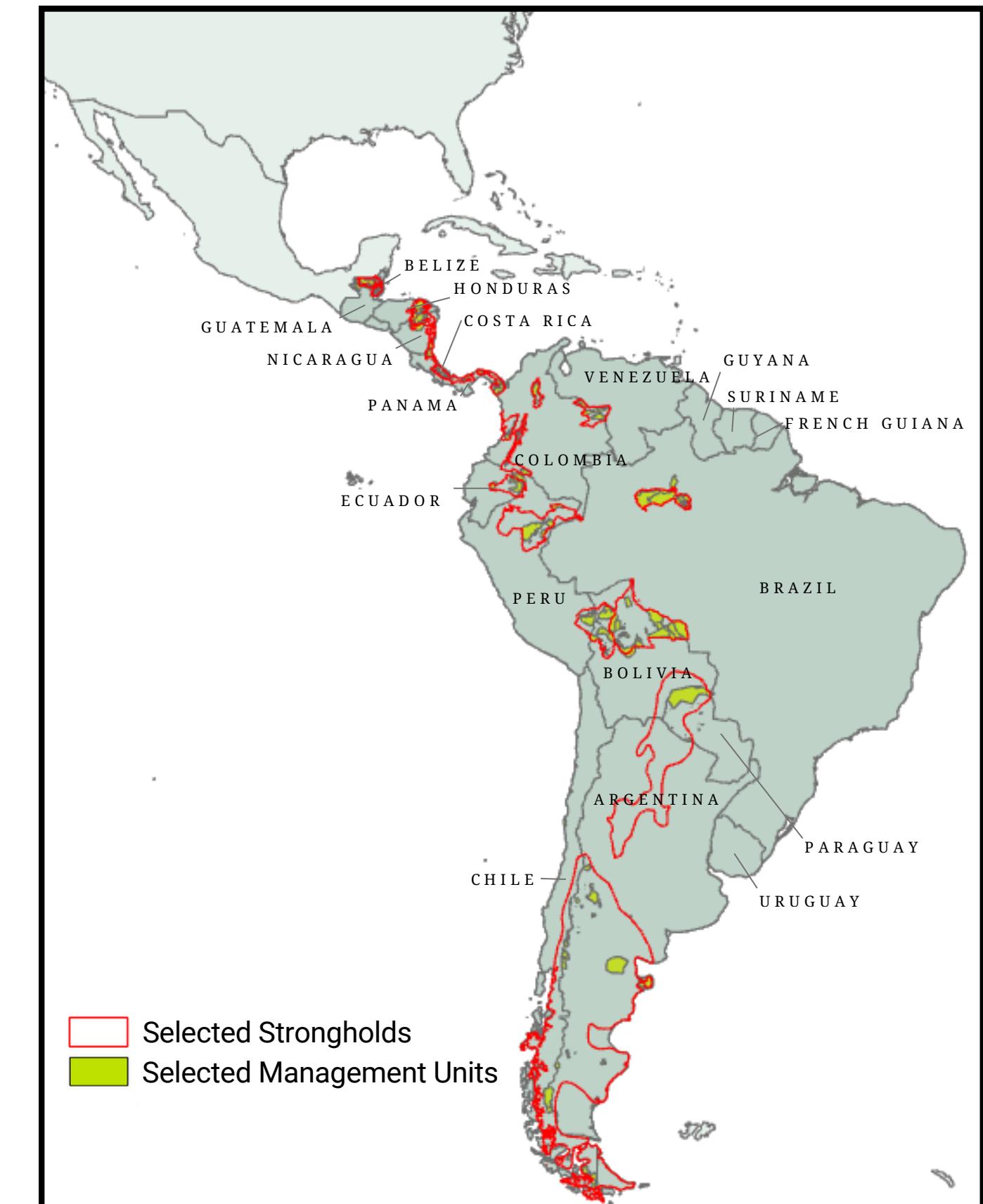
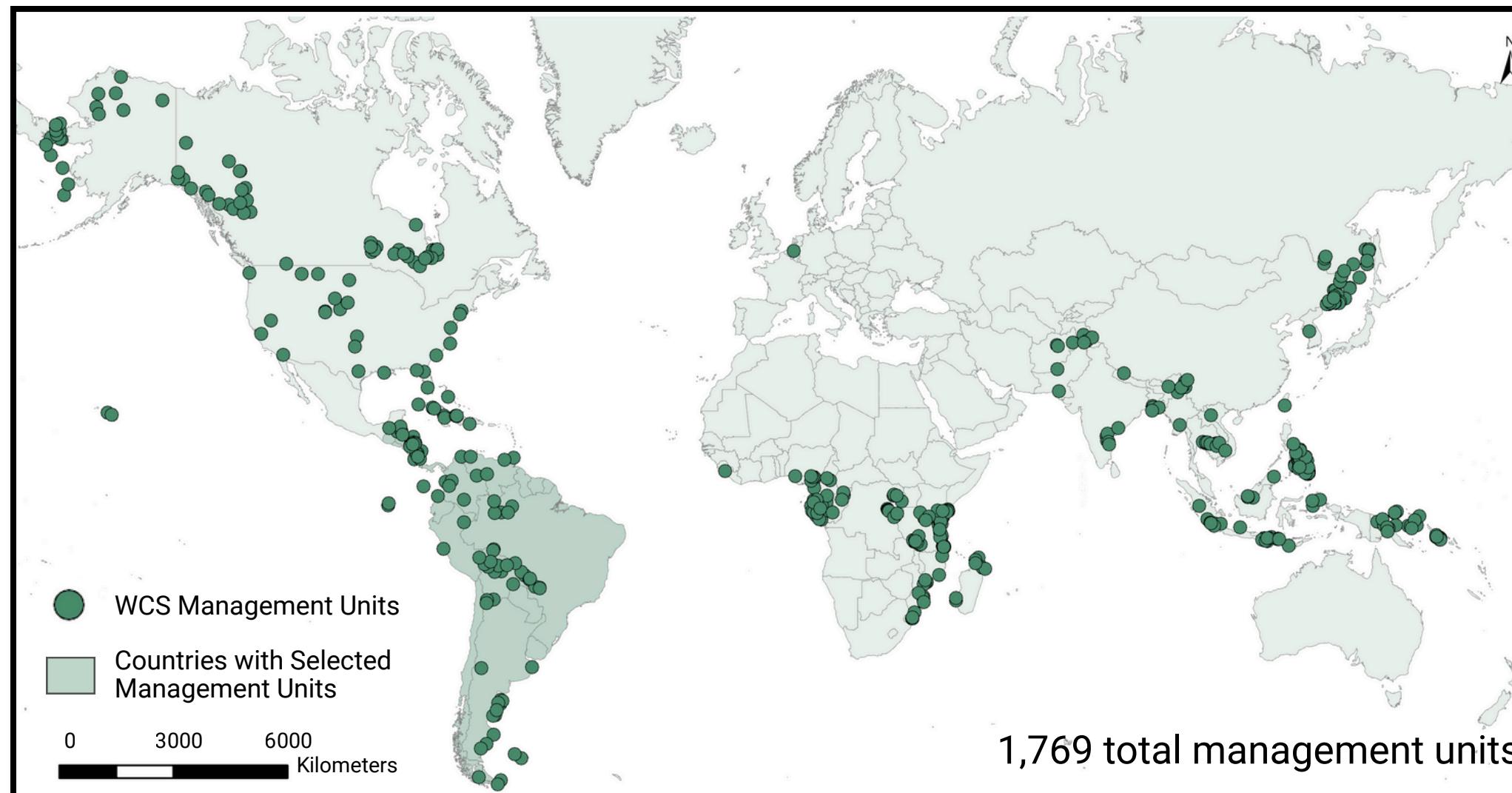
CONTENTS

- Background and Objectives
- Management Unit Characteristics
- Results
 - Landscape Characteristics
 - Land Cover
 - Human Impact Index (HII)
 - Forest Landscape Integrity Index (FLII)
 - Fire
 - Nighttime Lights (NTL)
 - Climate
 - Temperature
 - Precipitation
 - Case Studies
 - Gran Chaco
 - RNSC los Clavellinos
- Conclusion
- ArcGIS Dashboard



STUDY AREA: CENTRAL AND SOUTH AMERICA

- Varying management unit characteristics
- Ecological importance and biodiversity
- Vulnerability to anthropogenic disturbance
- Terrestrial ecosystems focus



RESEARCH QUESTIONS AND PROJECT GOALS

Guiding Questions

1. How do landscape characteristics and climate variables vary through time and across management units in the study area?
2. How do these trends differ at varying scales?
3. What do these trends imply for WCS management practices?

Examining Trends in WCS Management Units

1. Analysis for Management Units

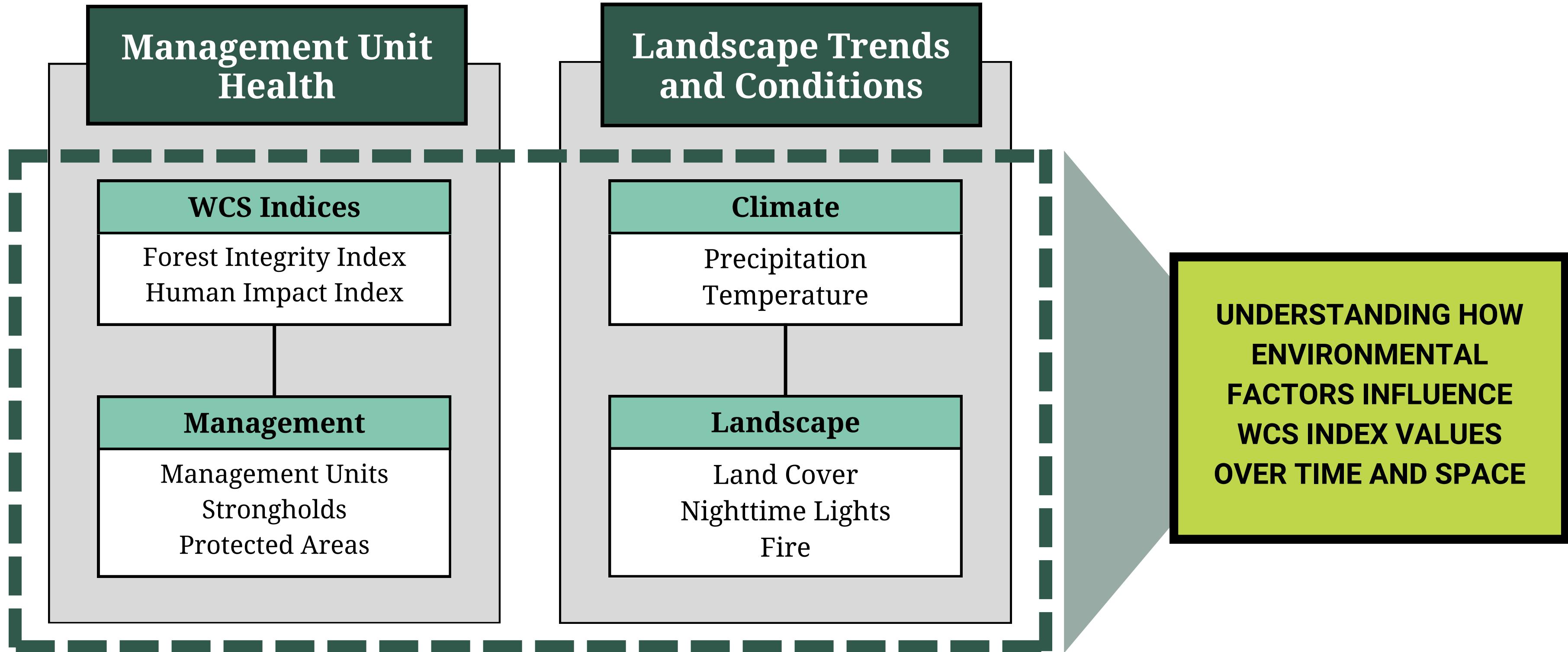
- WCS data trends
- Trends in external environmental indicators

2. Compare Across Time and Space

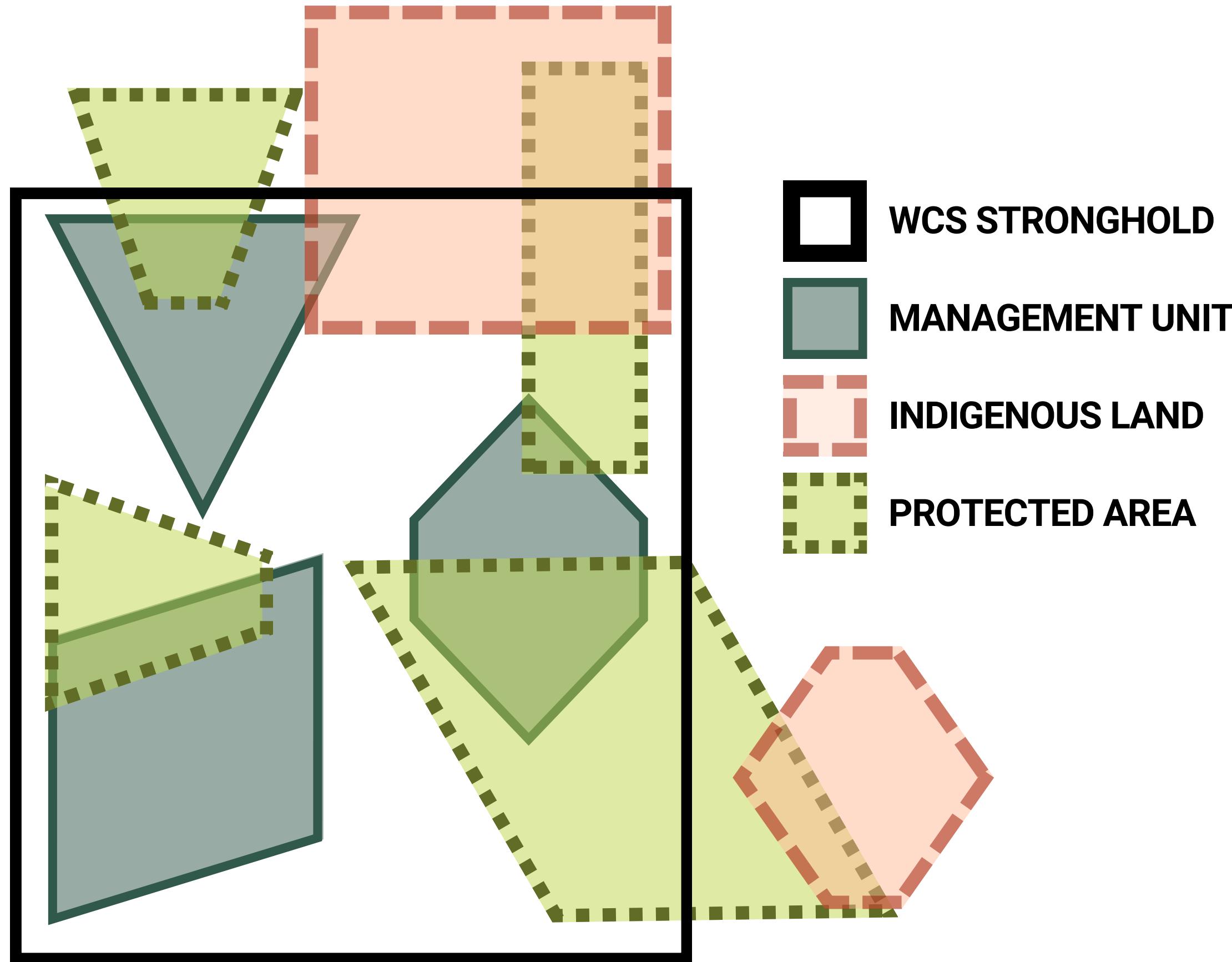
- Aggregate by both WCS stronghold and country to identify regional trends



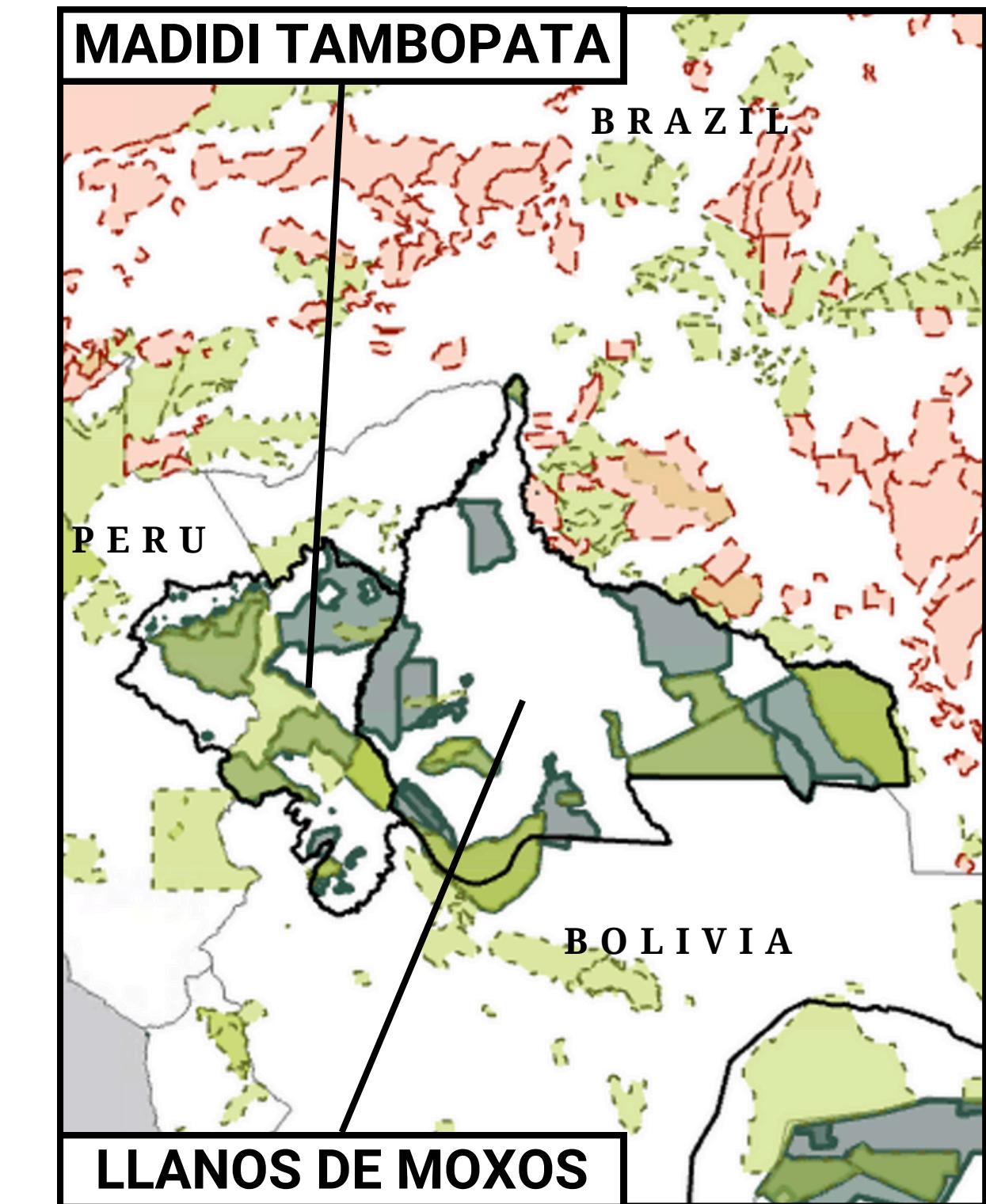
FRAMEWORK FOR ANALYSIS



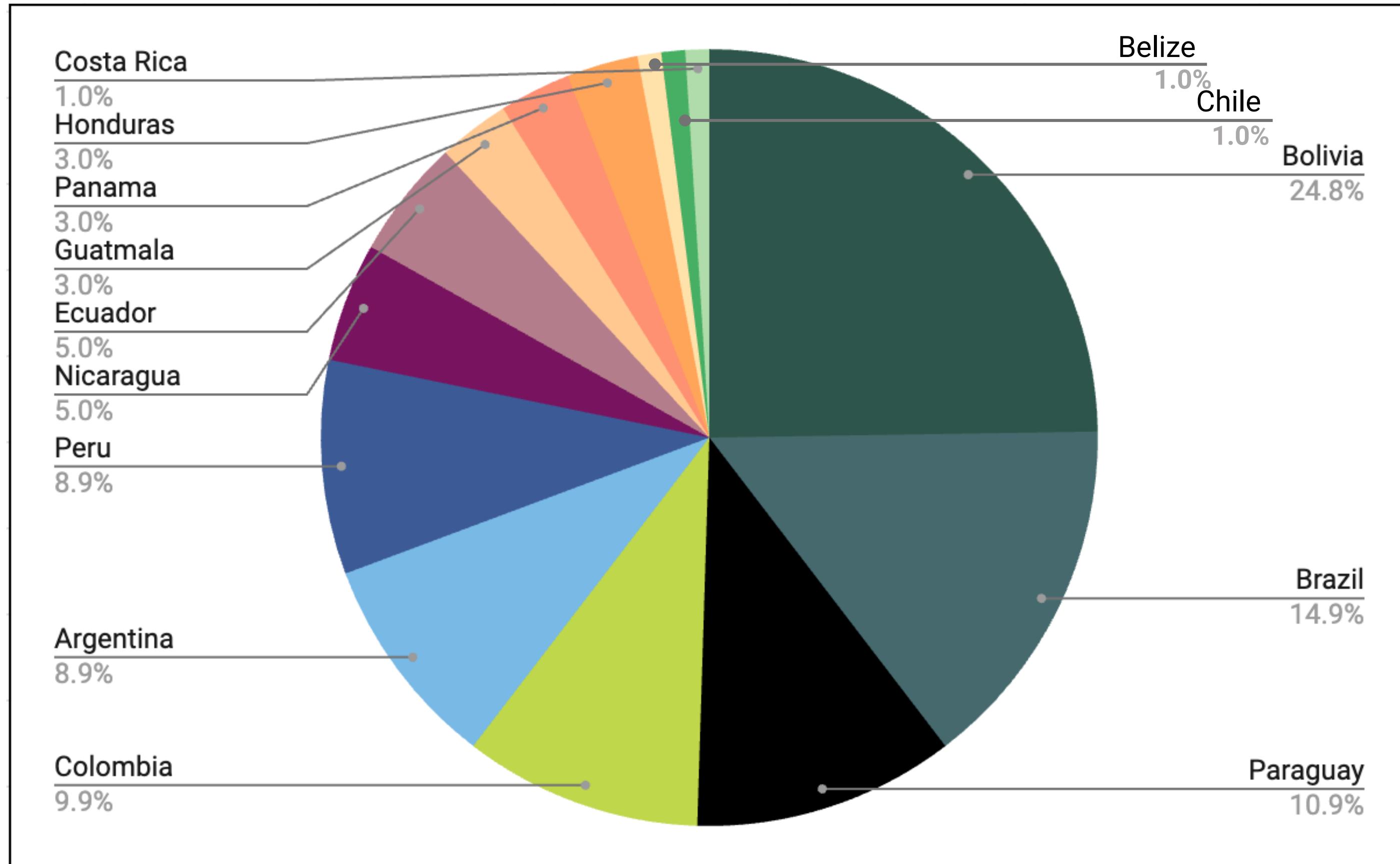
CONCEPTUAL MODEL



EXAMPLE

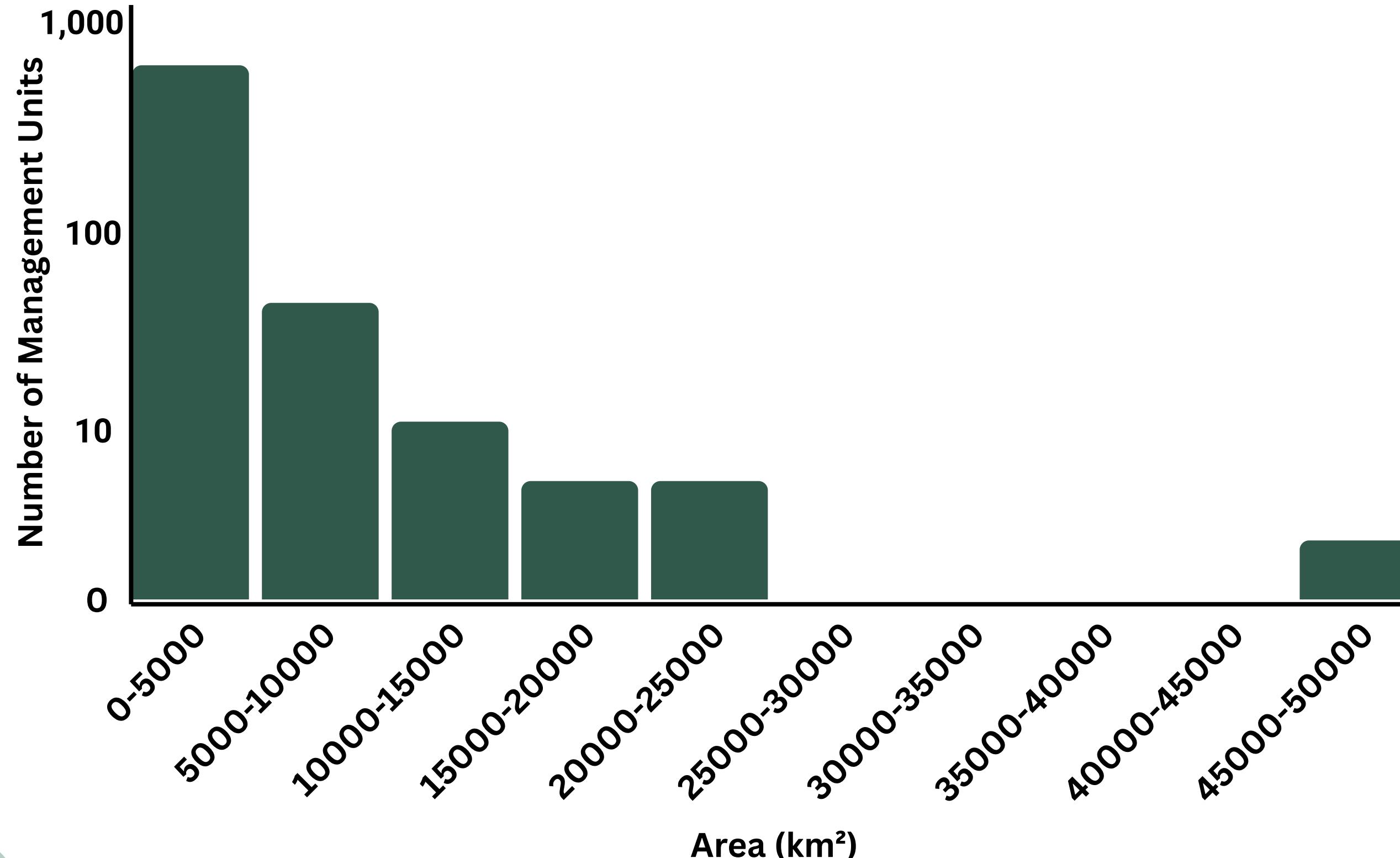


MANAGEMENT UNIT AREA BY COUNTRY



MANAGEMENT UNIT DISTRIBUTION

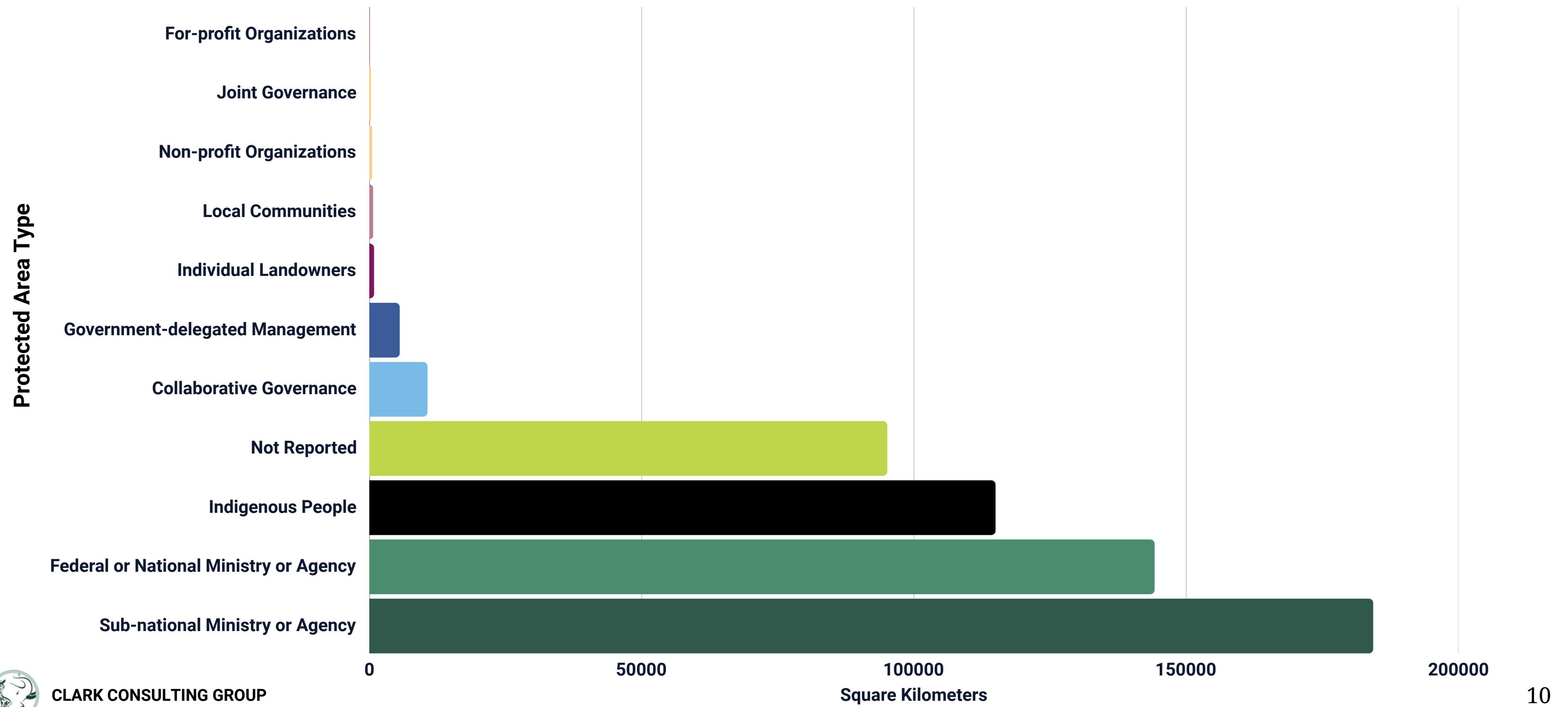
● Distribution of Management Unit Areas



Statistic	Area (km ²)
Mean	863.29
Median	12.02
Minimum	0.002
Maximum	45,901.16
Sum	556,822.05



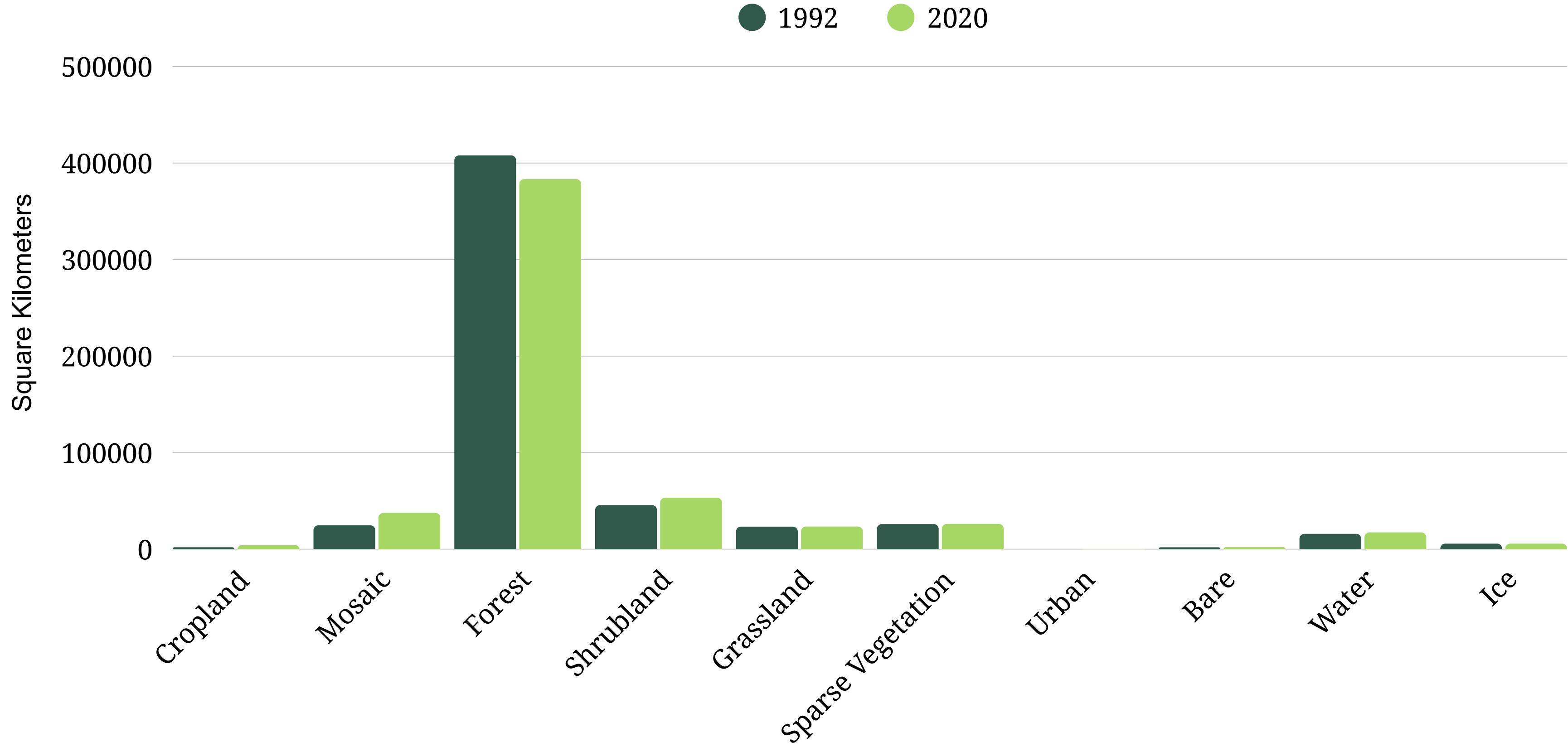
OVERLAP OF MANAGEMENT UNITS AND PROTECTED AREAS



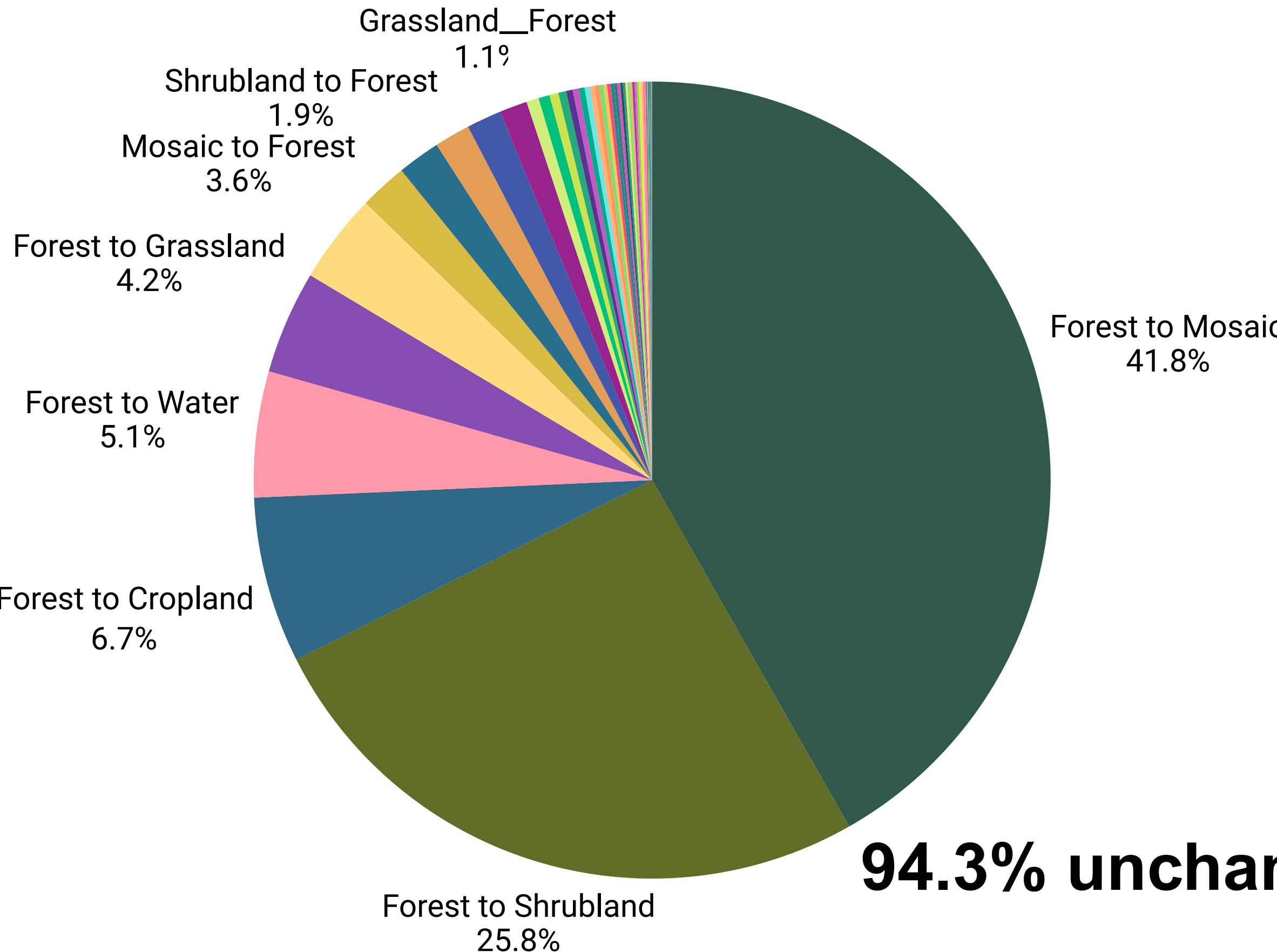
LAND COVER COMPARISON ESA (1992 - 2020)



MANAGEMENT UNIT LAND COVER

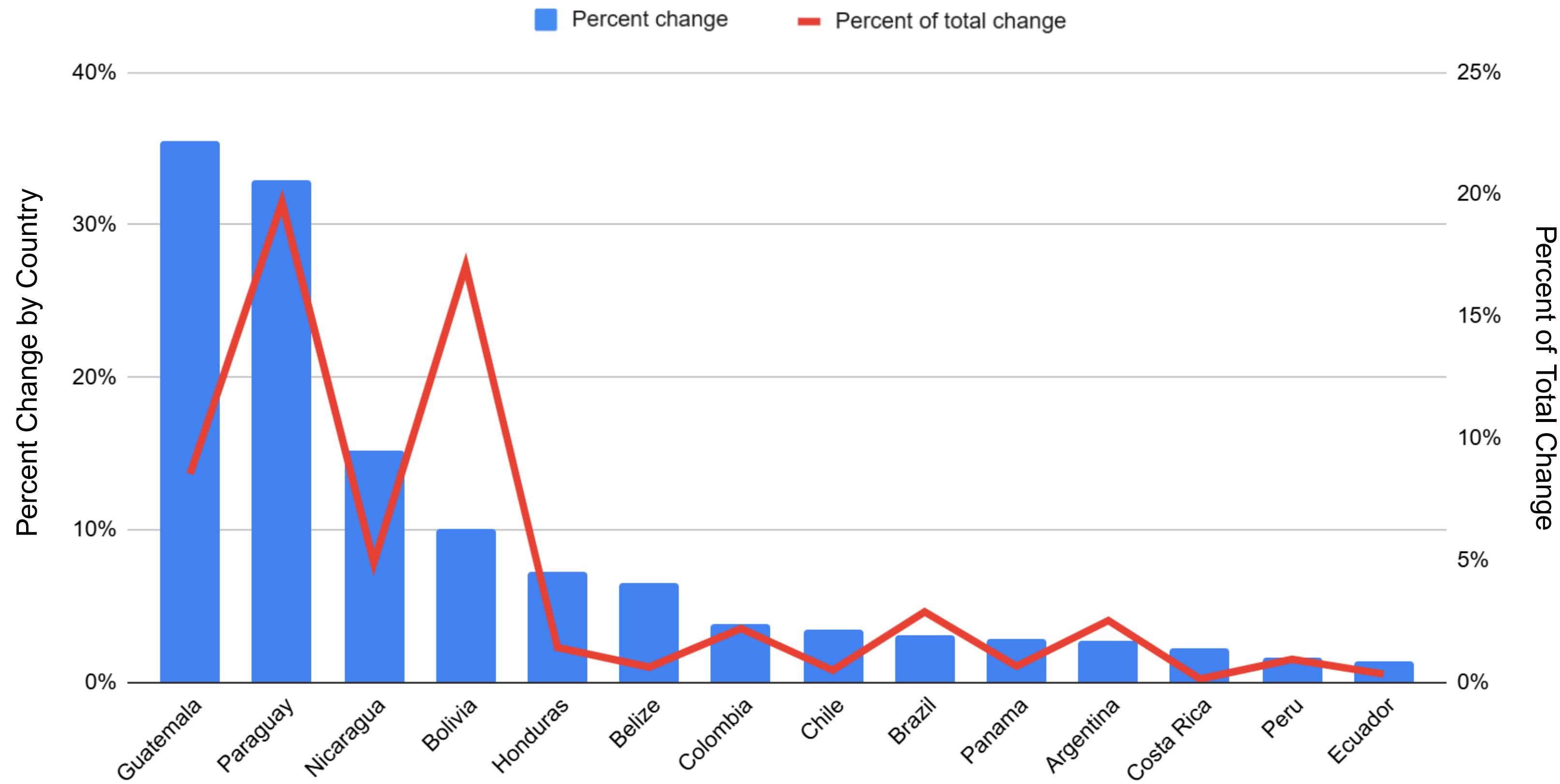


MANAGEMENT UNIT CATEGORIES OF TRANSITION

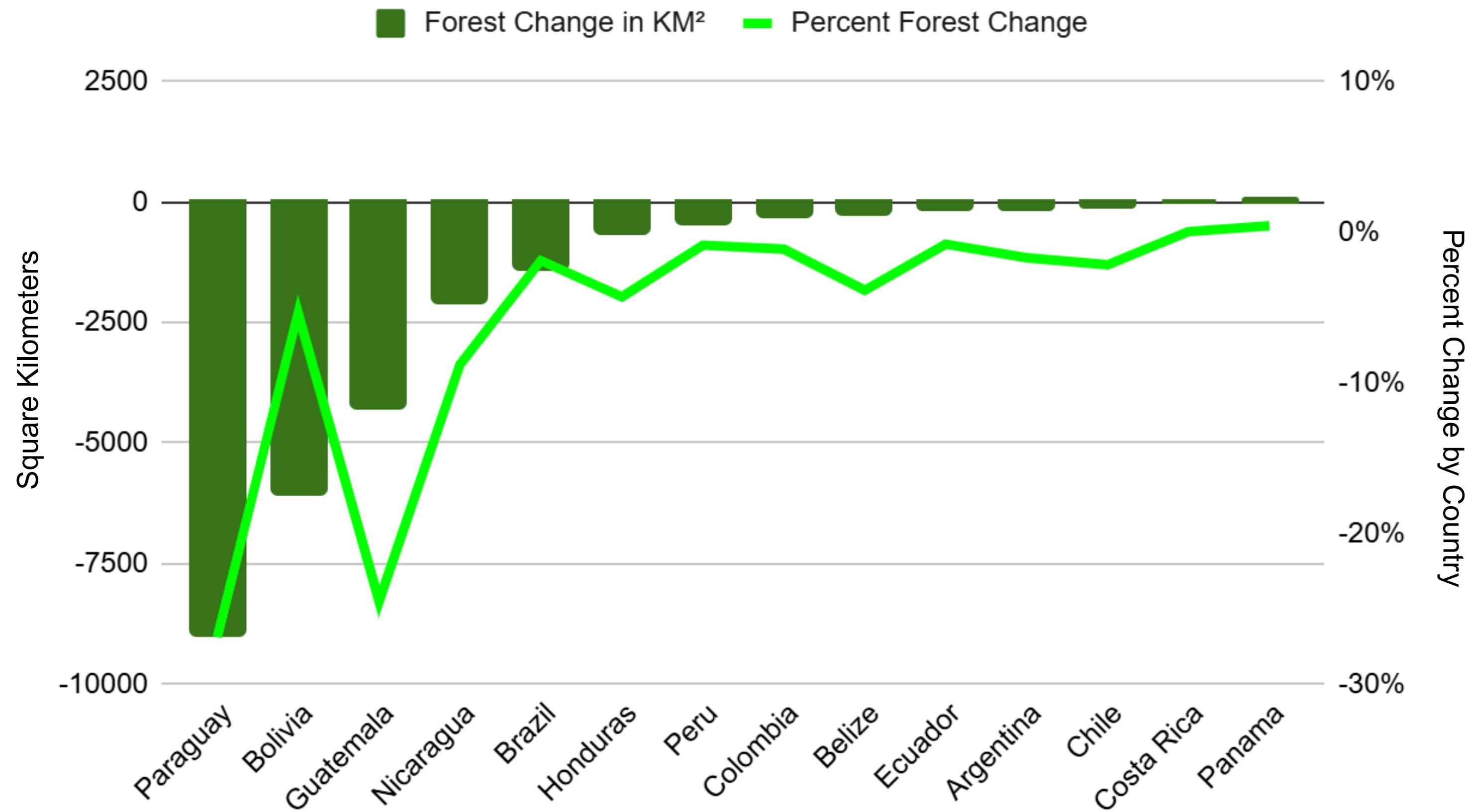


94.3% unchanged total land cover

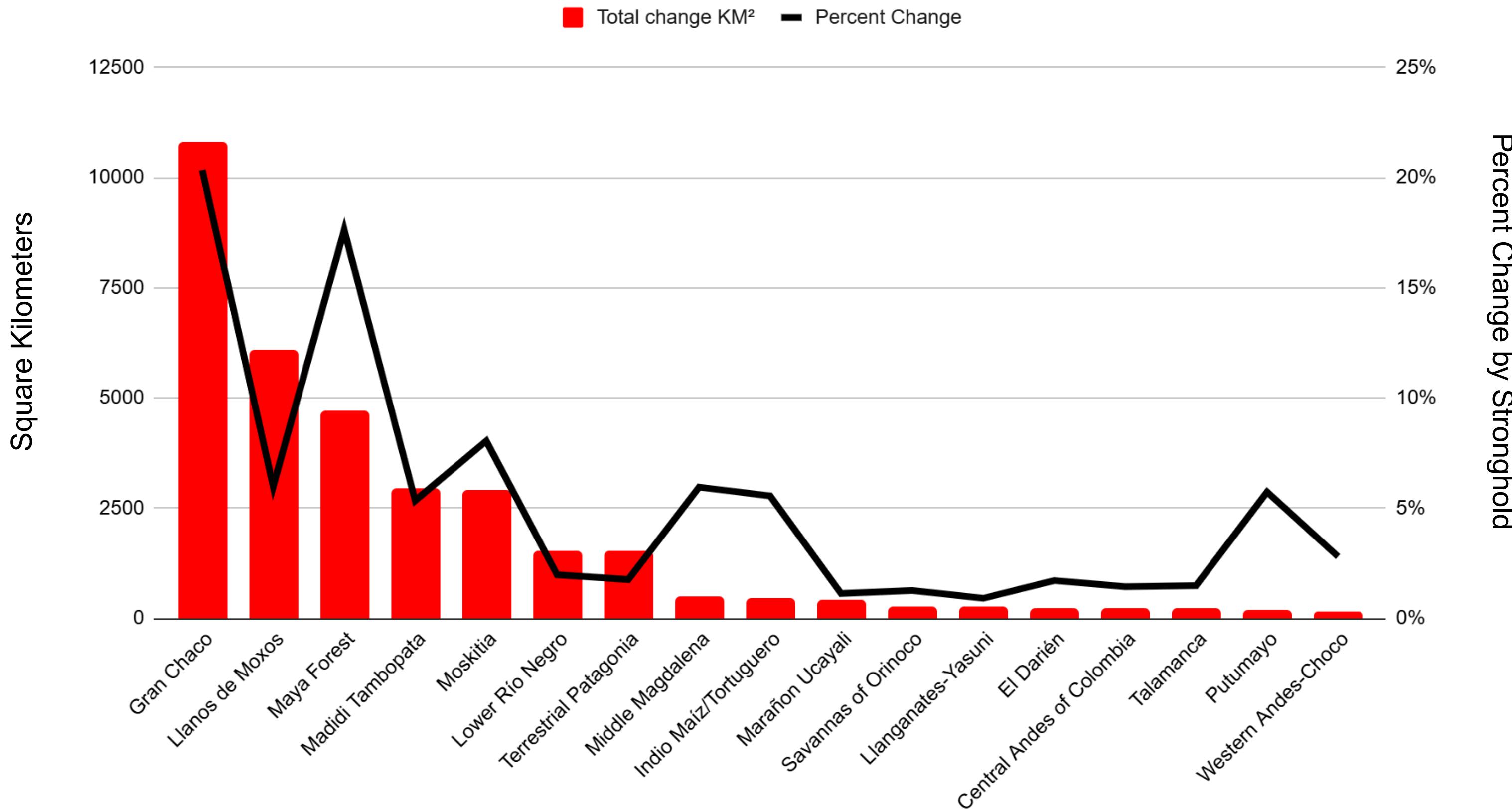
PERCENT LAND COVER CHANGE, 1992 - 2020



FOREST CHANGE BY COUNTRY, 1992 - 2020



LAND COVER CHANGE BY STRONGHOLD 1992 - 2020



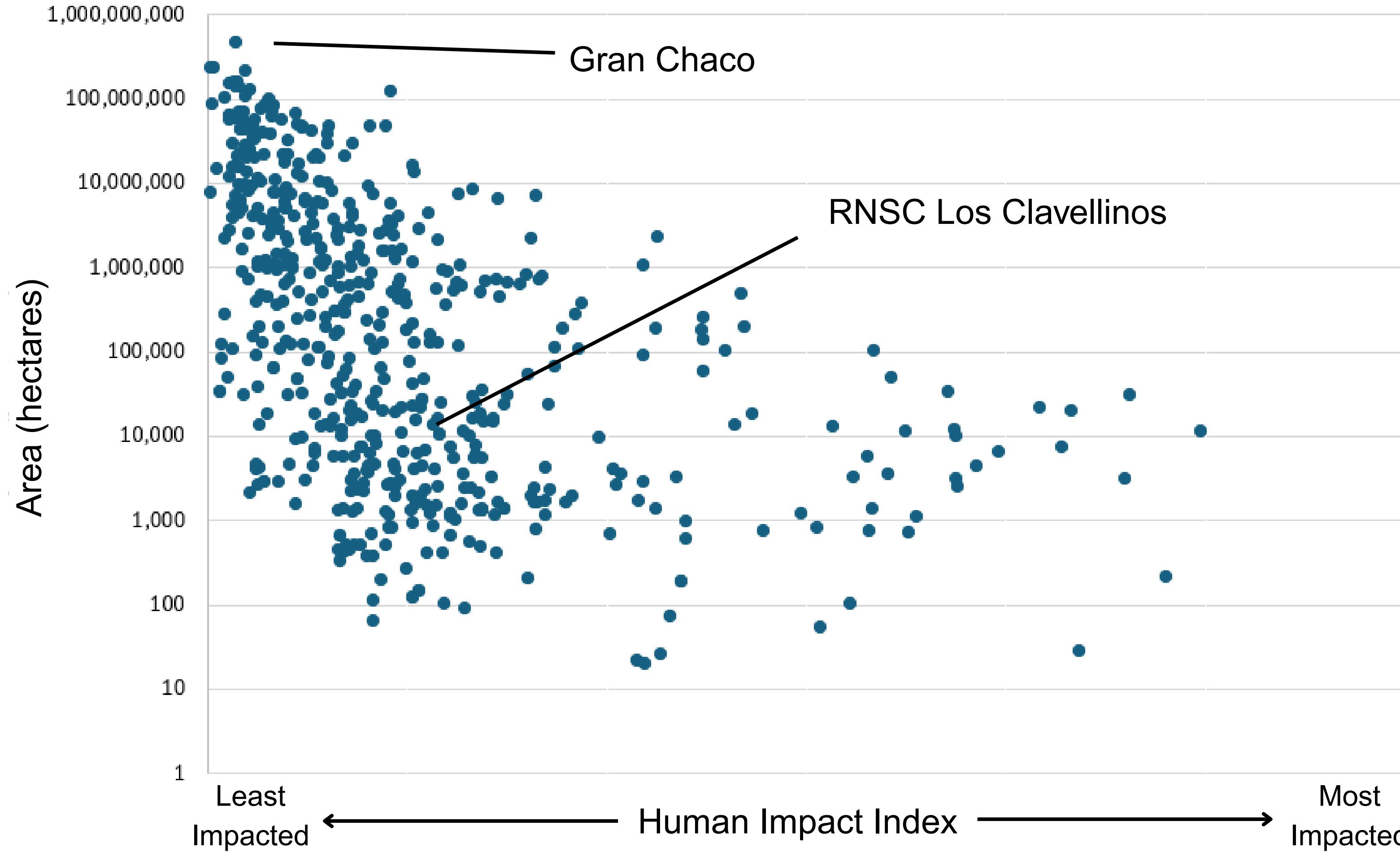
HUMAN IMPACT INDEX



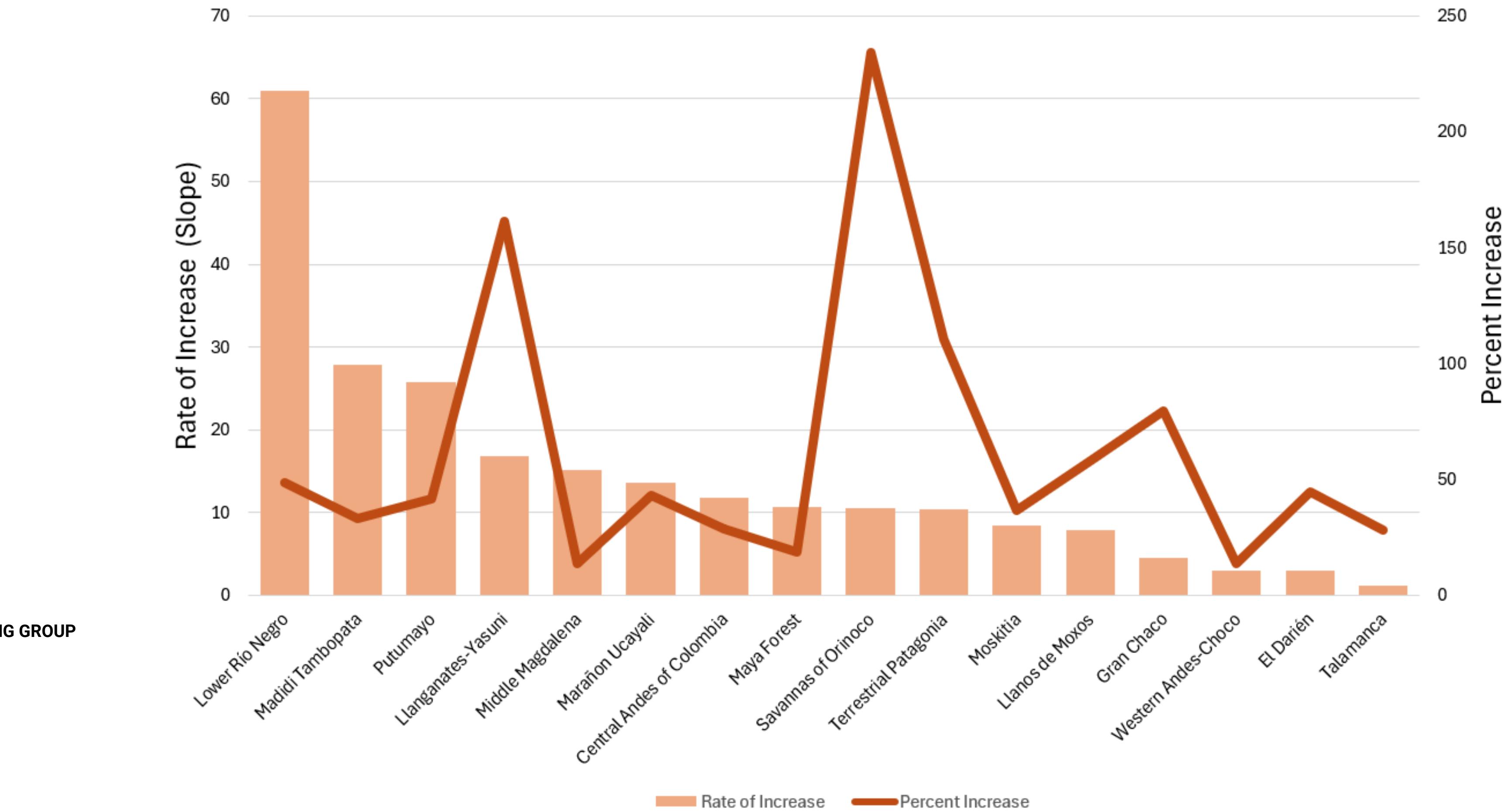
HUMAN IMPACT BY MANAGEMENT UNIT AREA, 2020



HUMAN IMPACT BY MANAGEMENT UNIT AREA, 2020



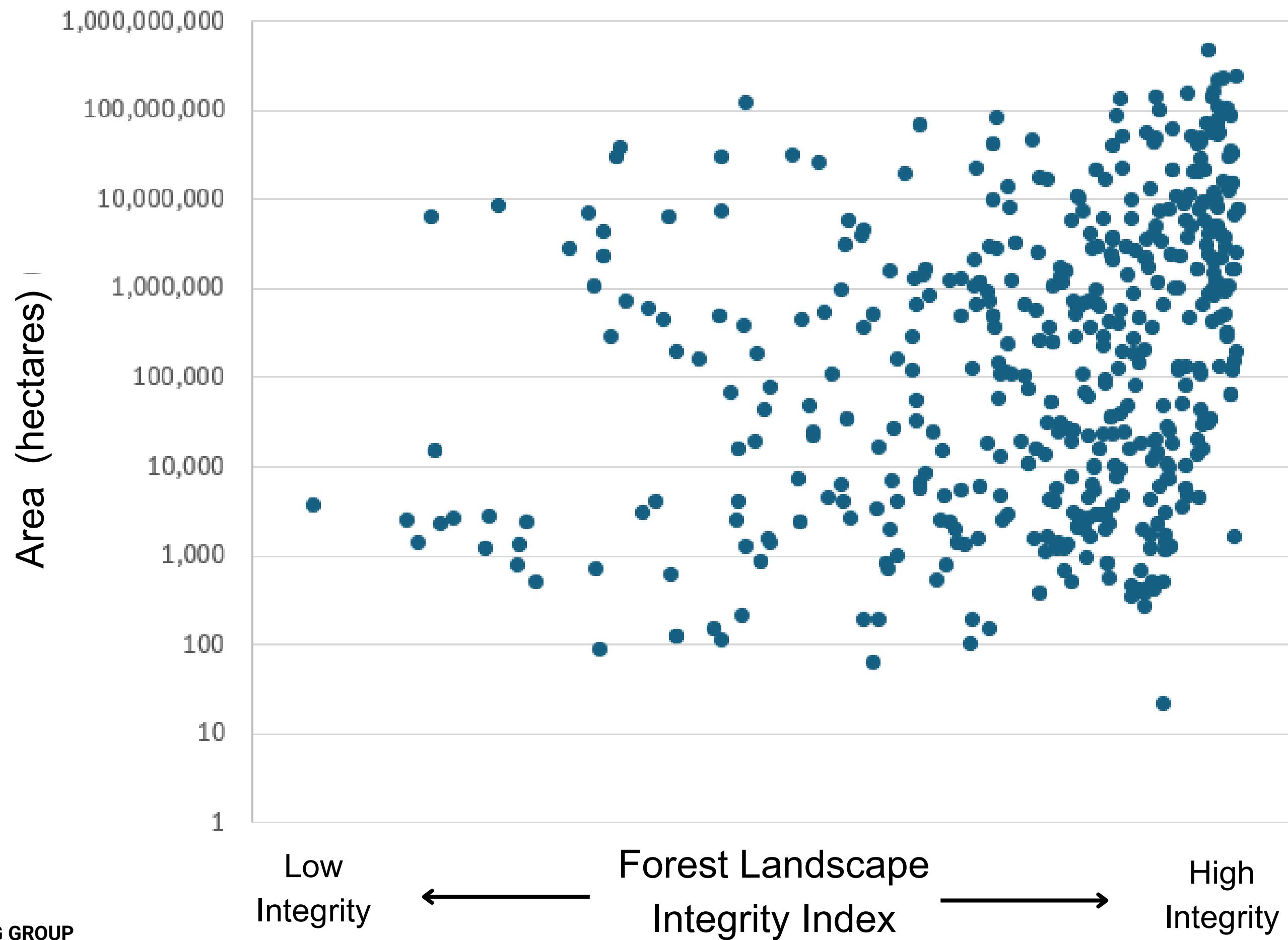
TRENDS IN HII BY STRONGHOLD, 2001-2020



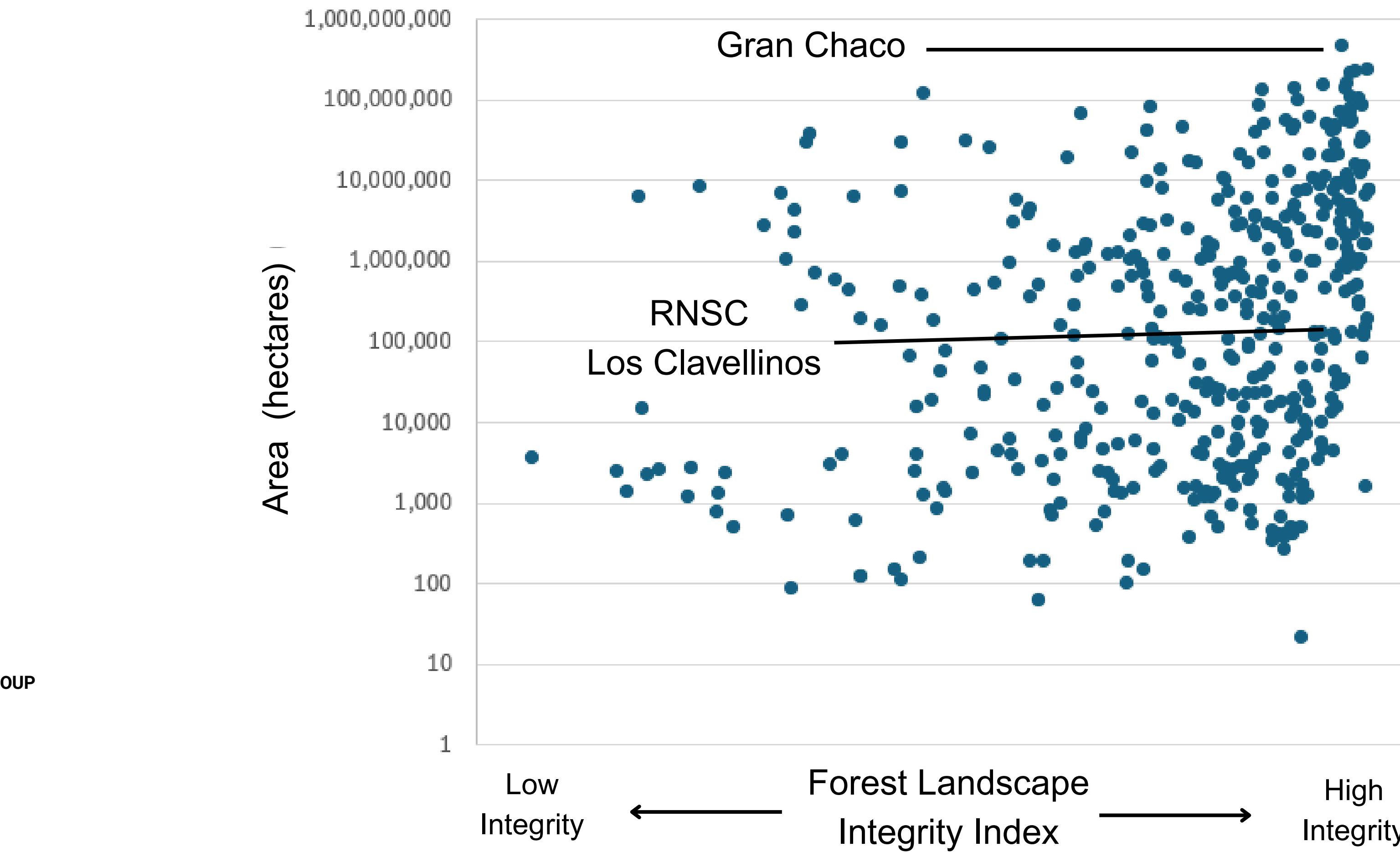
FOREST LANDSCAPE INTEGRITY INDEX



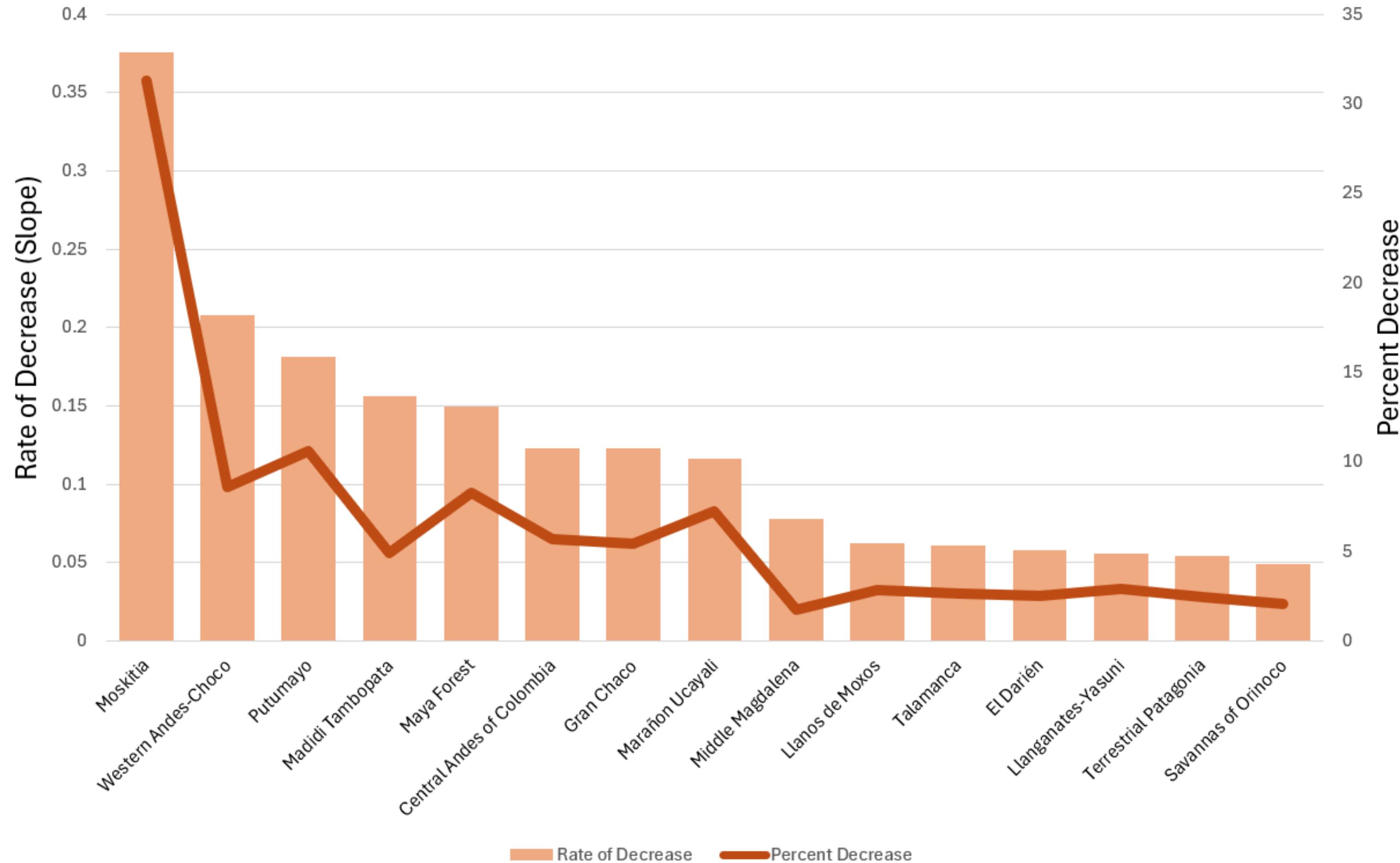
FOREST INTEGRITY BY MANAGEMENT UNIT AREA, 2021



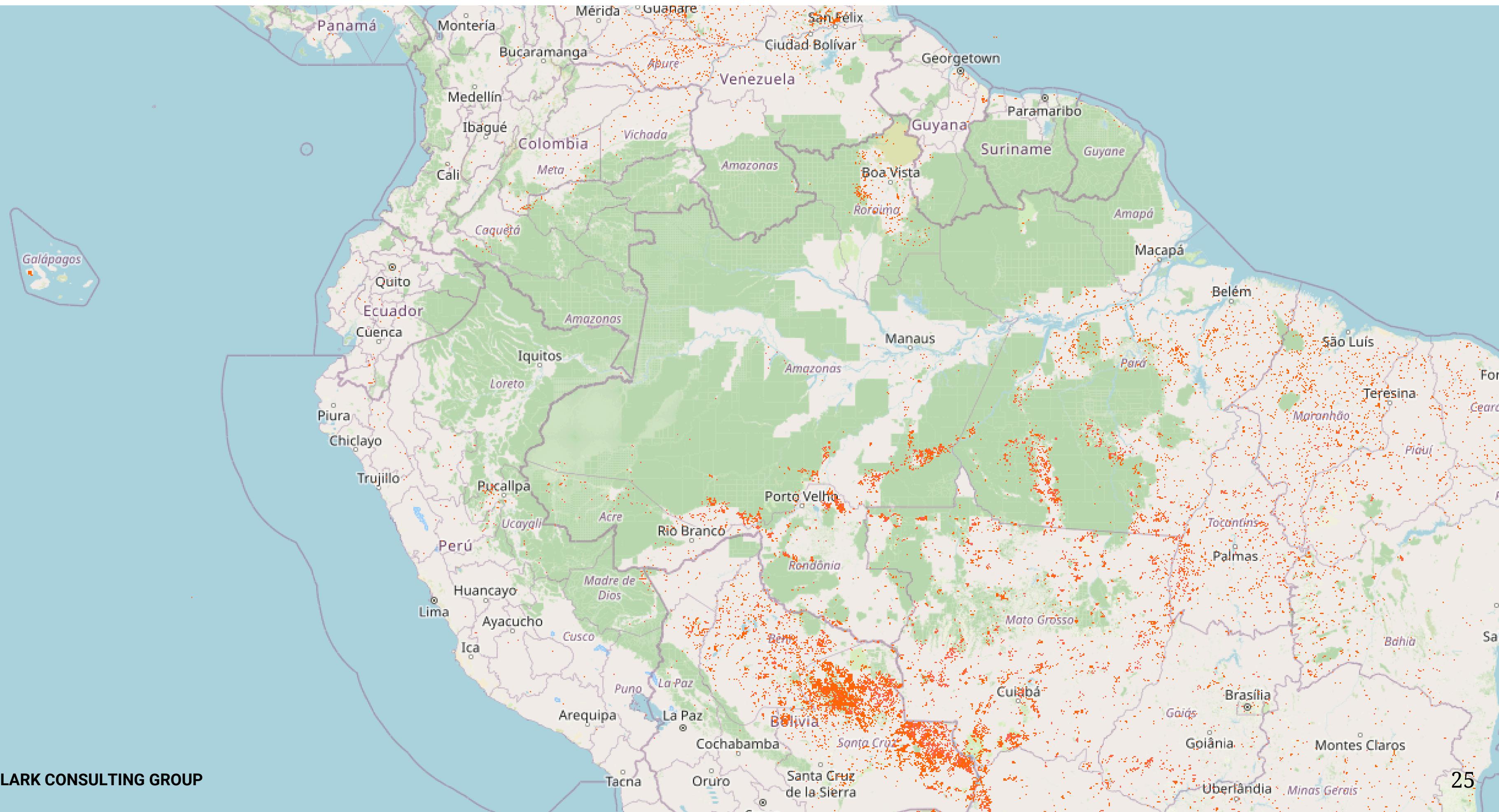
FOREST INTEGRITY BY MANAGEMENT UNIT AREA, 2021



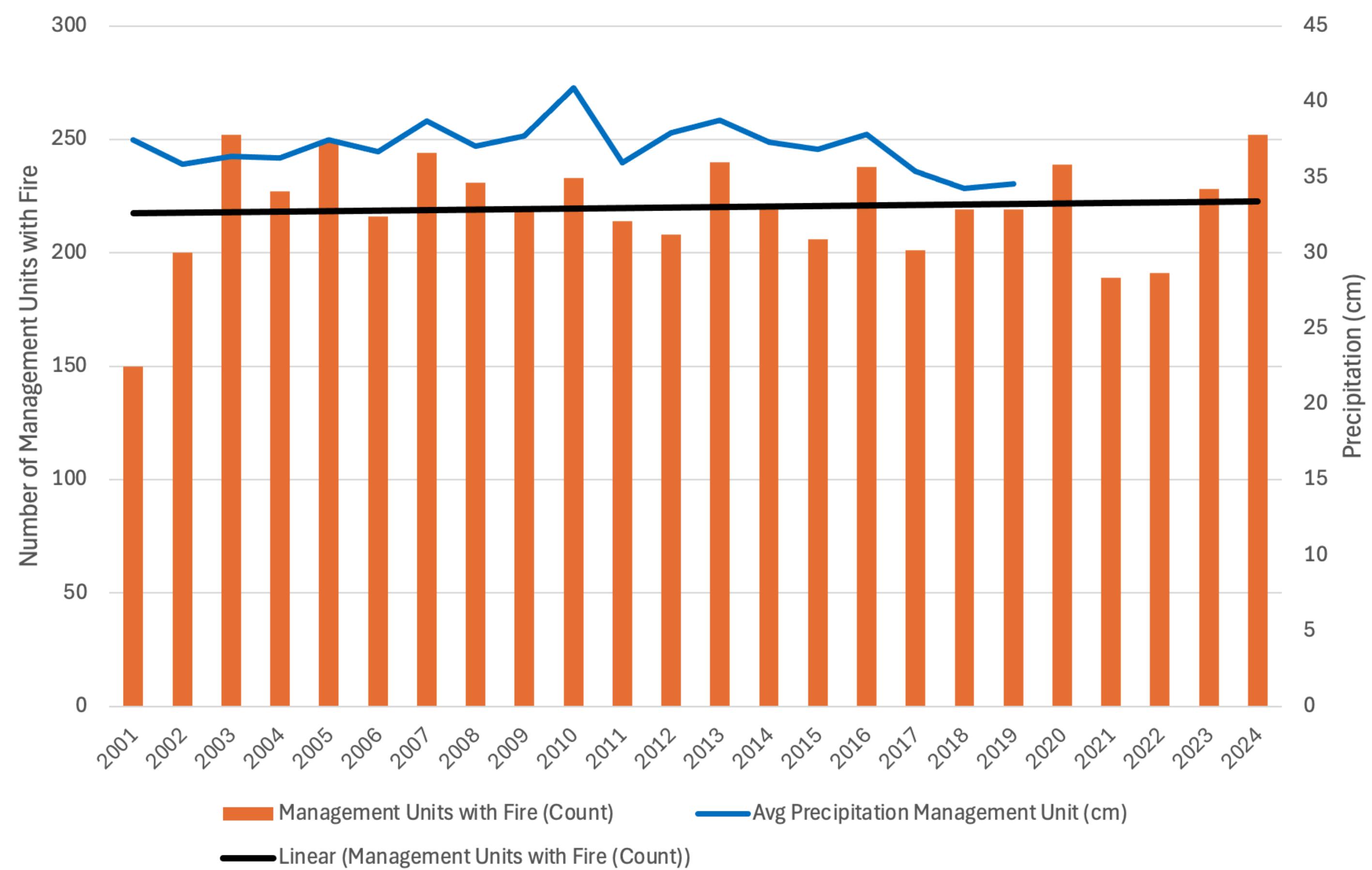
TRENDS IN FLII BY STRONGHOLD, 2017-2021



FIRE ACTIVITY | NASA ANNUAL COMPOSITE 2024

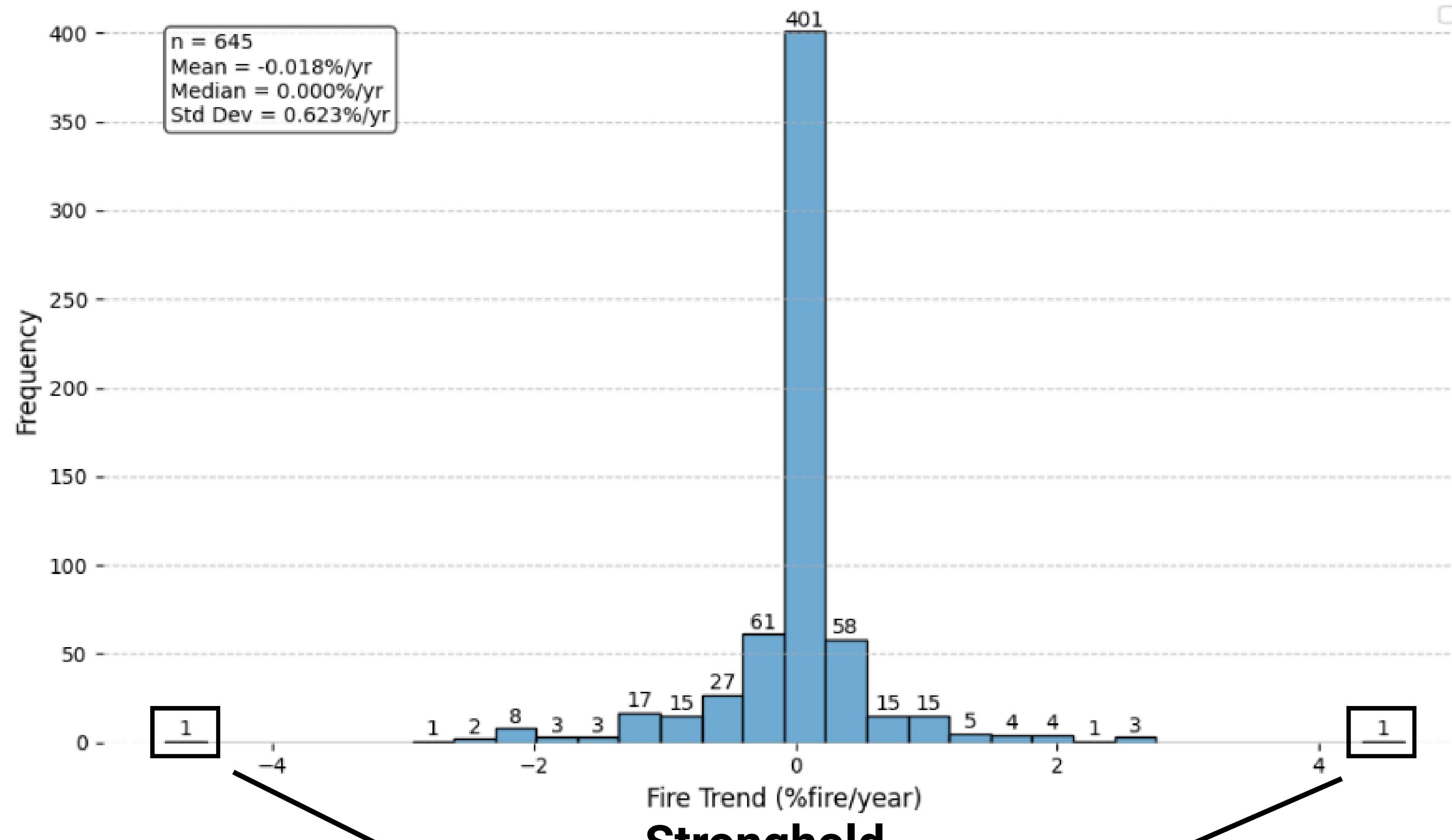


TRENDS IN FIRE BY MANAGEMENT UNIT, 2001-2024



TRENDS IN FIRE BY MANAGEMENT UNIT, 2001-2024

Distribution of Fire Trends Across Protected Areas (2001-2024)

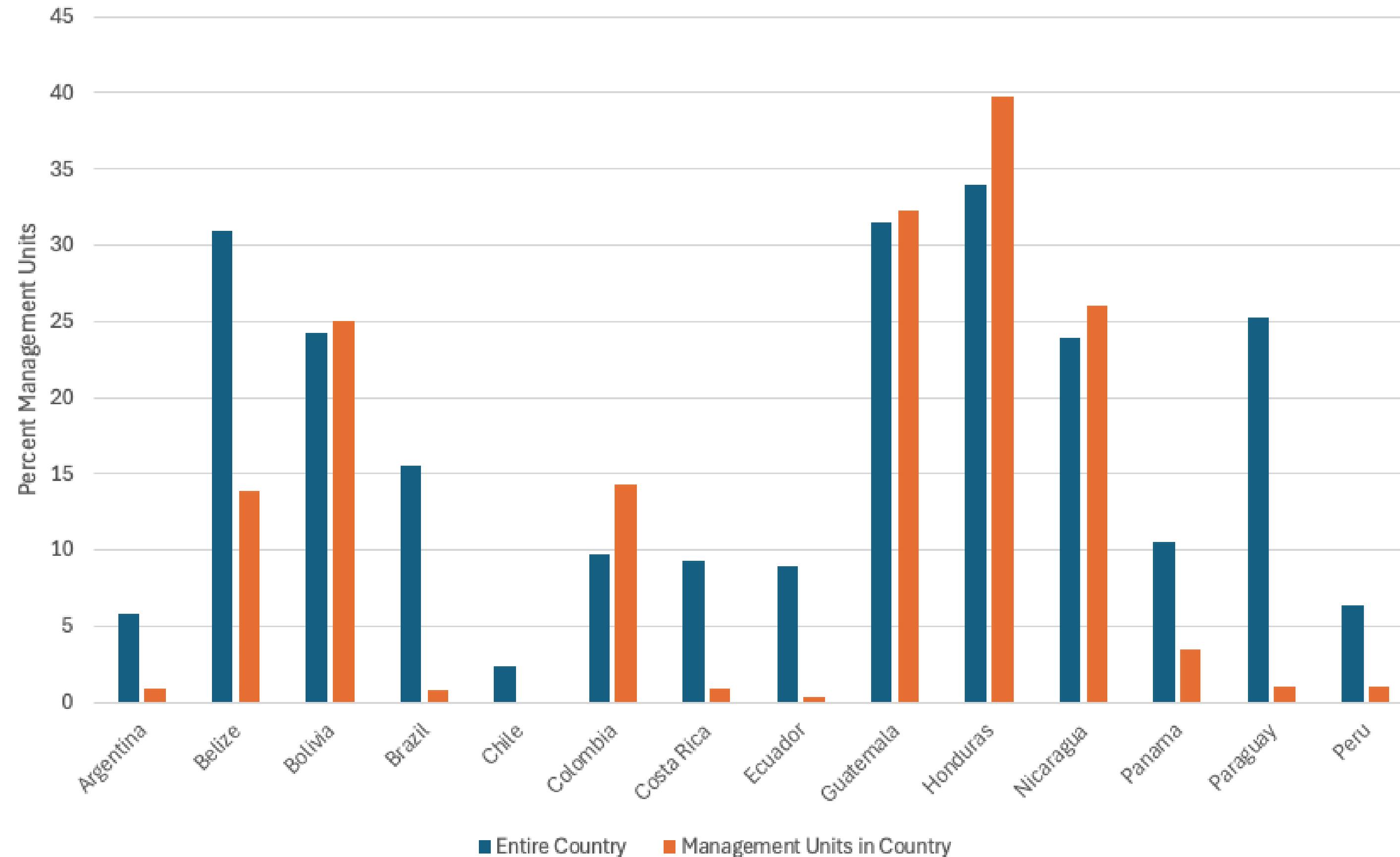


Stronghold

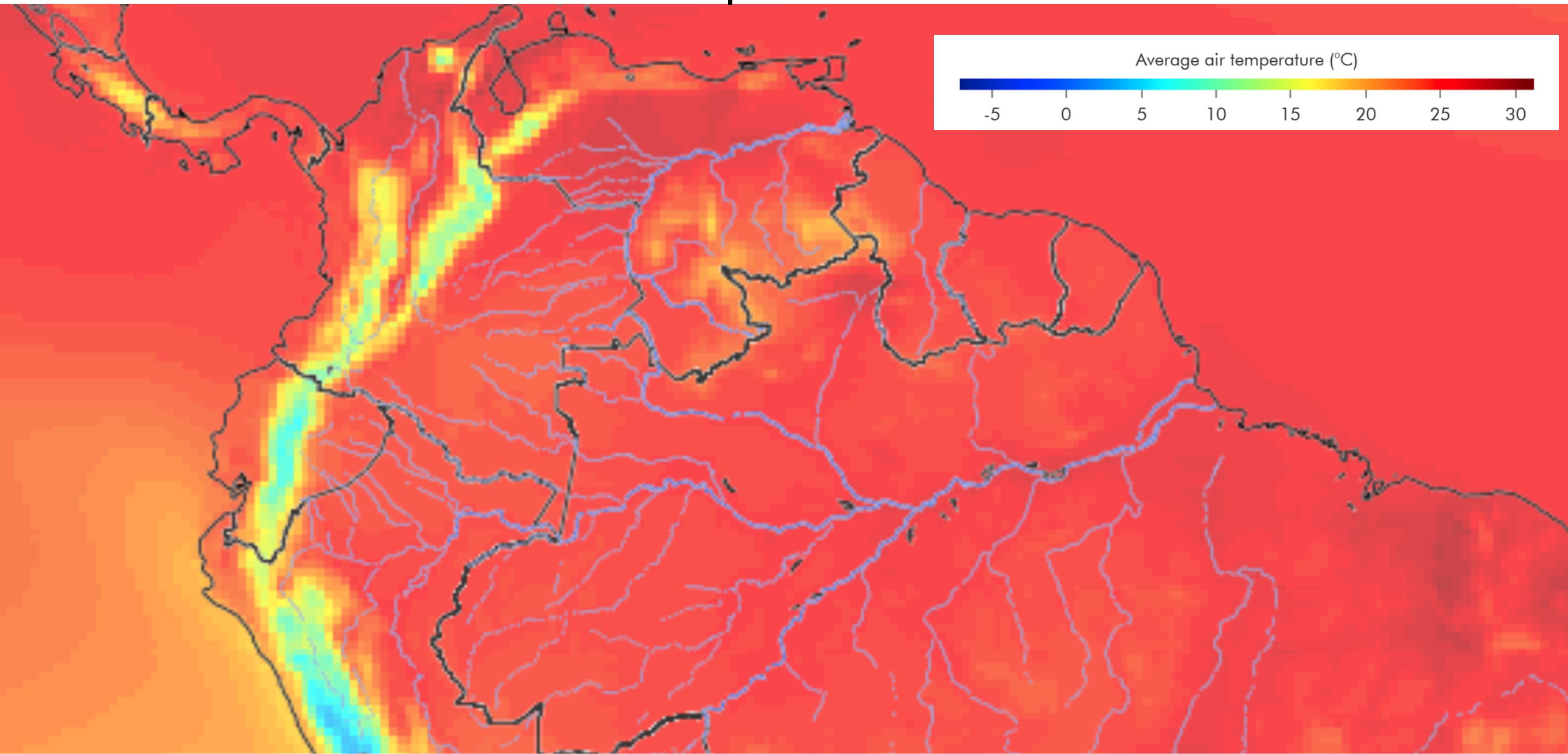
Madidi Tambopata, Peru



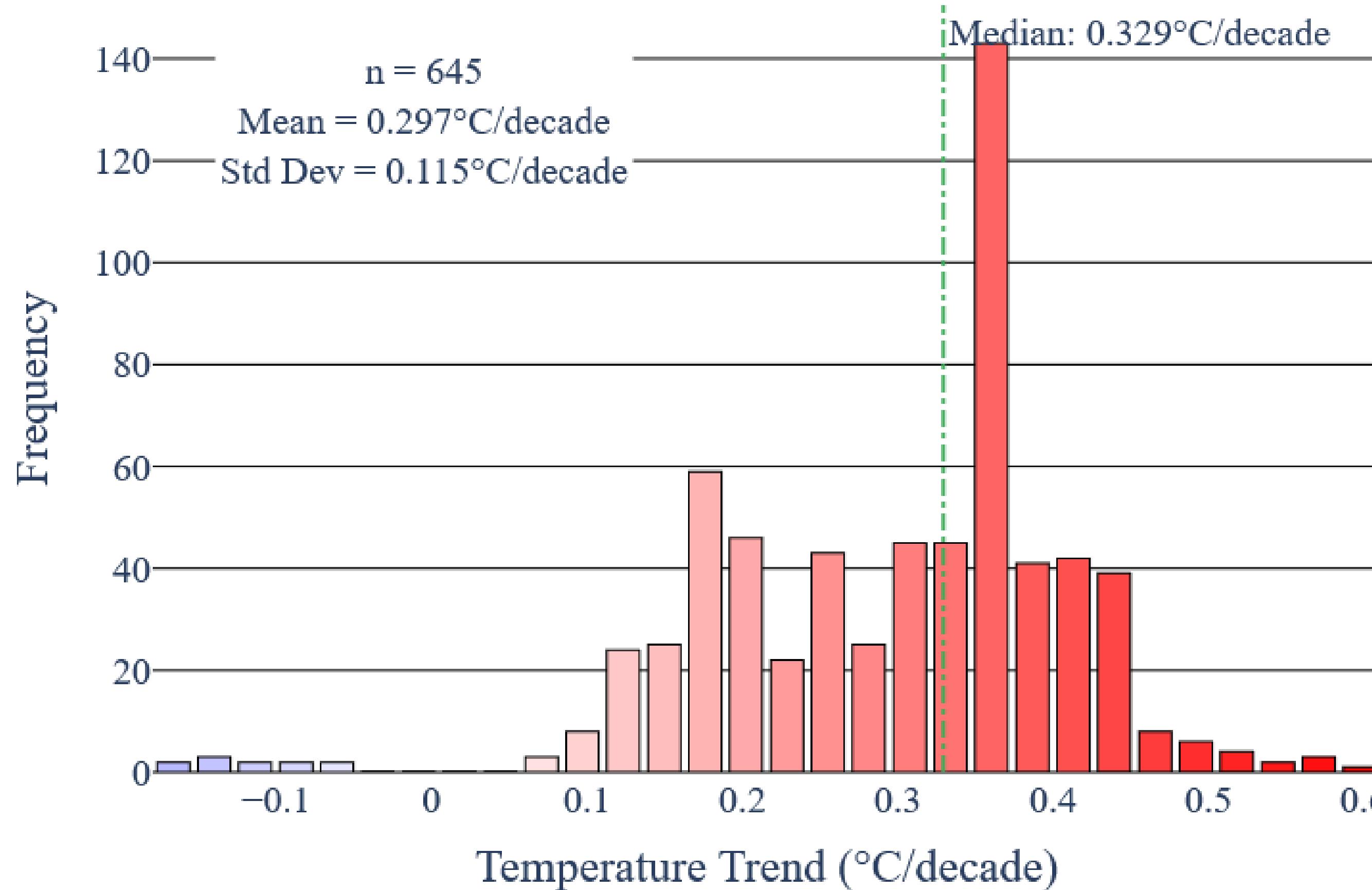
FIRE IN 2024 (MANAGEMENT UNITS AND COUNTRIES)



TEMPERATURE TRENDS | ERA5 ANNUAL COMPOSITE



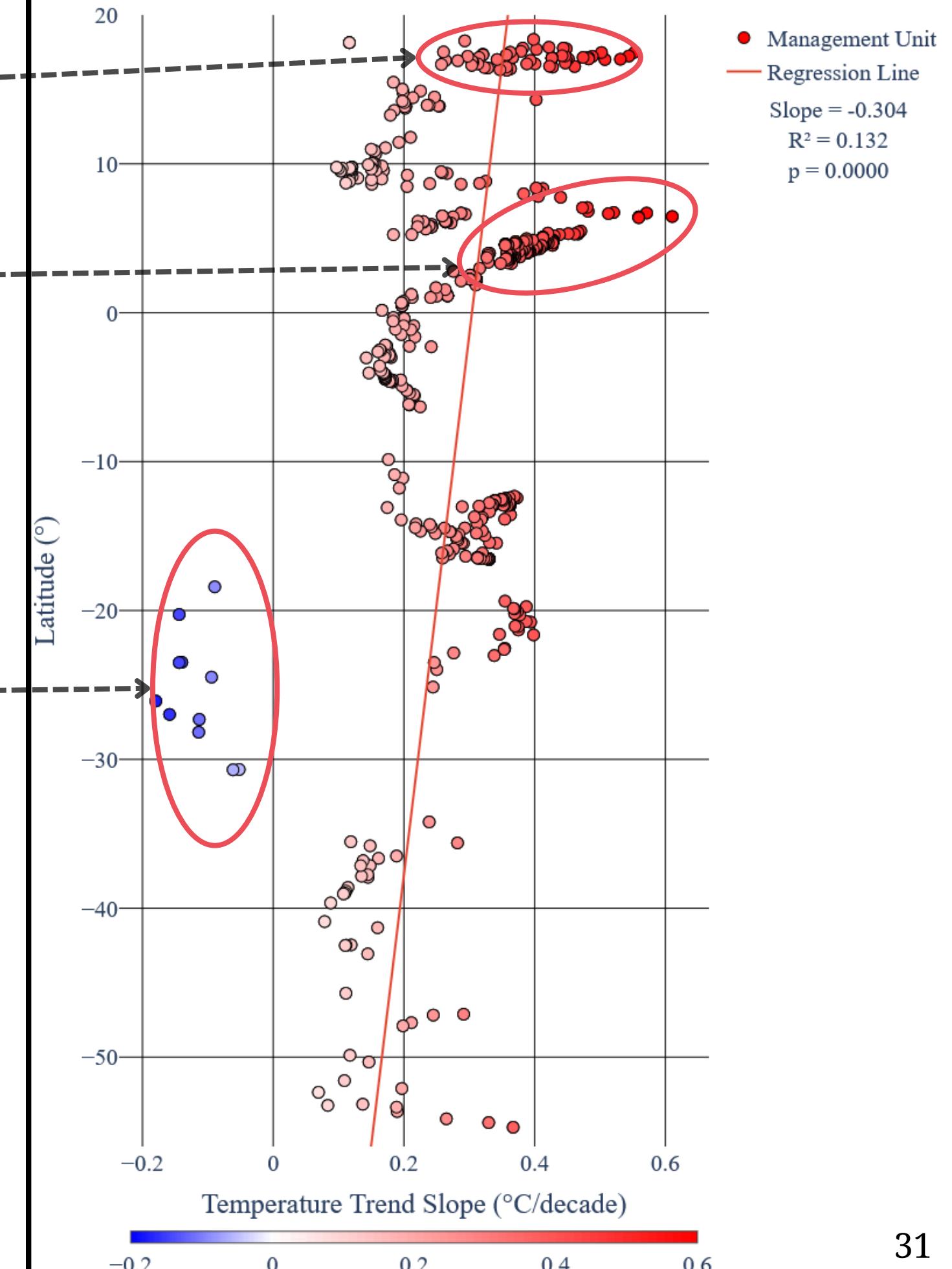
TRENDS IN TEMP BY MANAGEMENT UNIT, 1980-2020



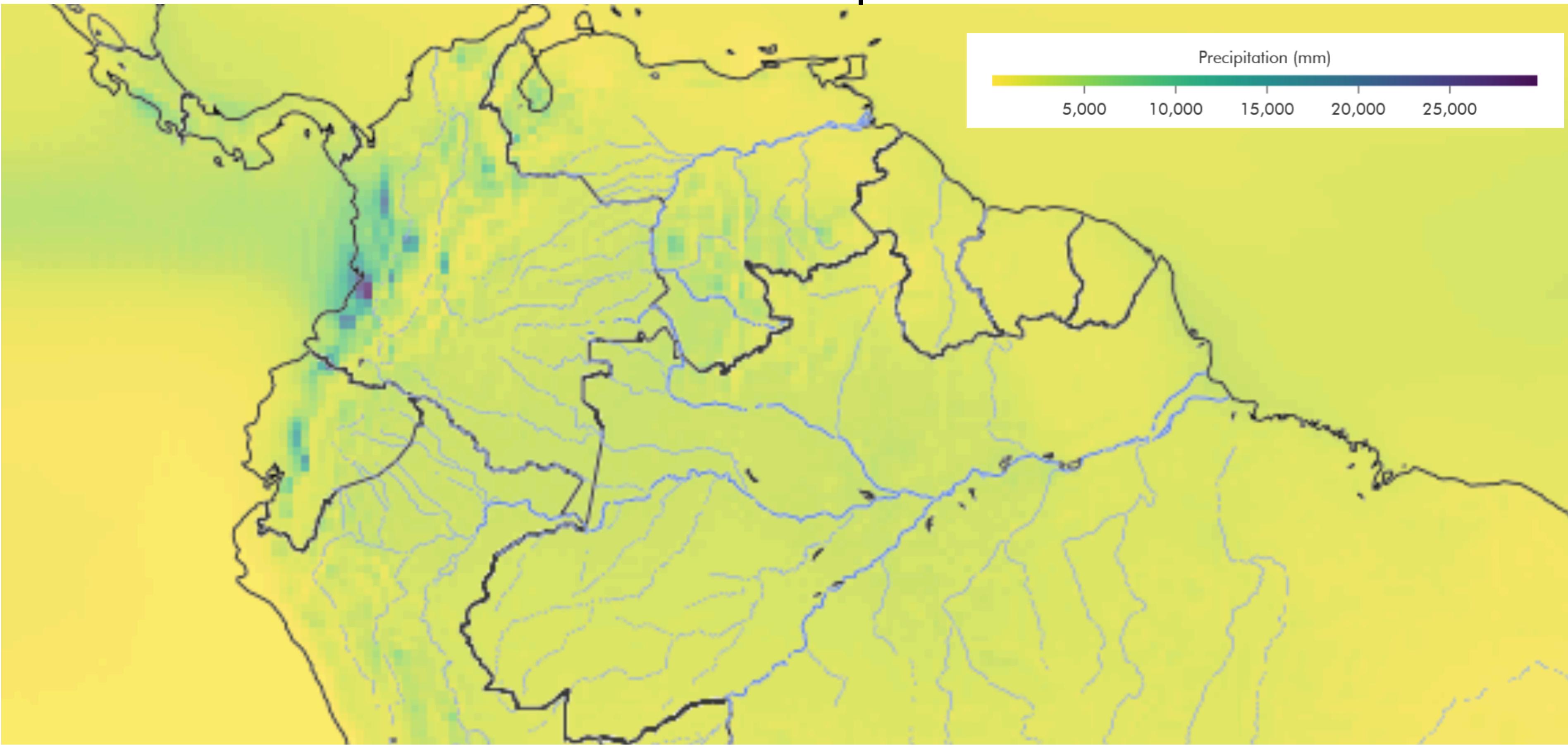
LATITUDINAL TRENDS IN TEMPERATURE



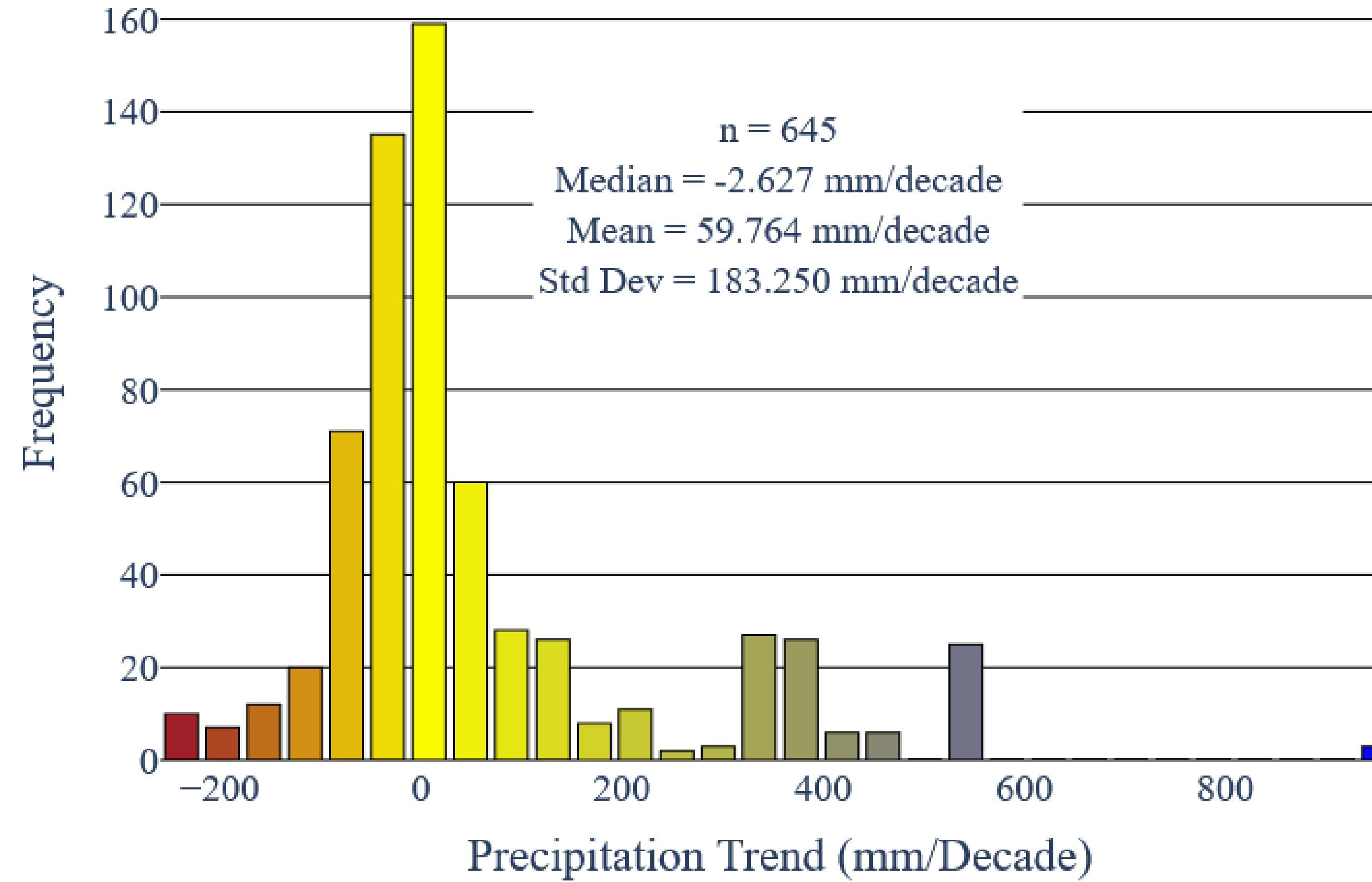
Latitudinal Variation in Warming Trends



PRECIPITATION TRENDS | ERA5 ANNUAL SUM



TRENDS IN PRECIPITATION BY MANAGEMENT UNIT, 1980-2019

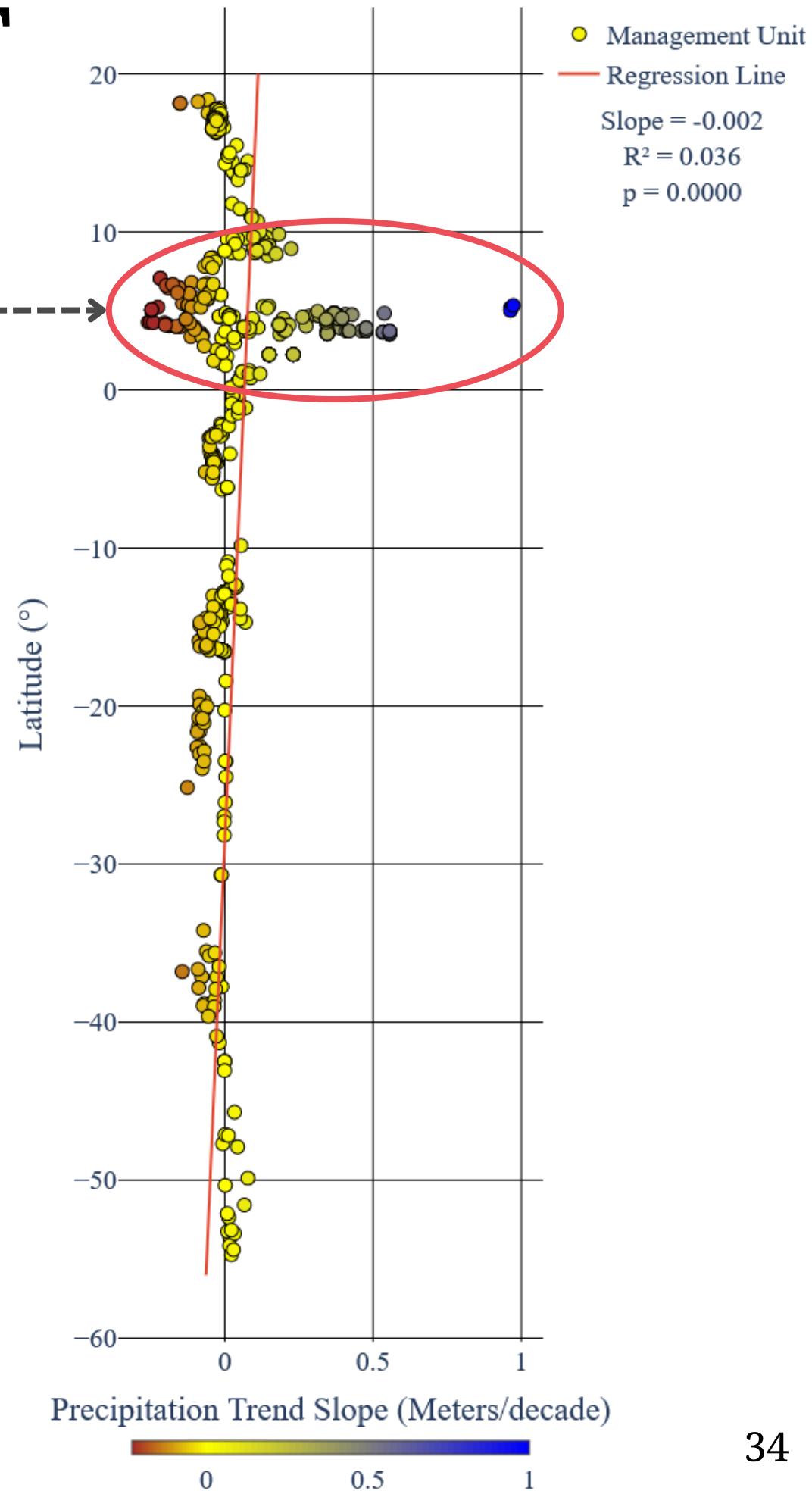


LATITUDINAL TRENDS IN PRECIPITATION BY MANAGEMENT UNIT

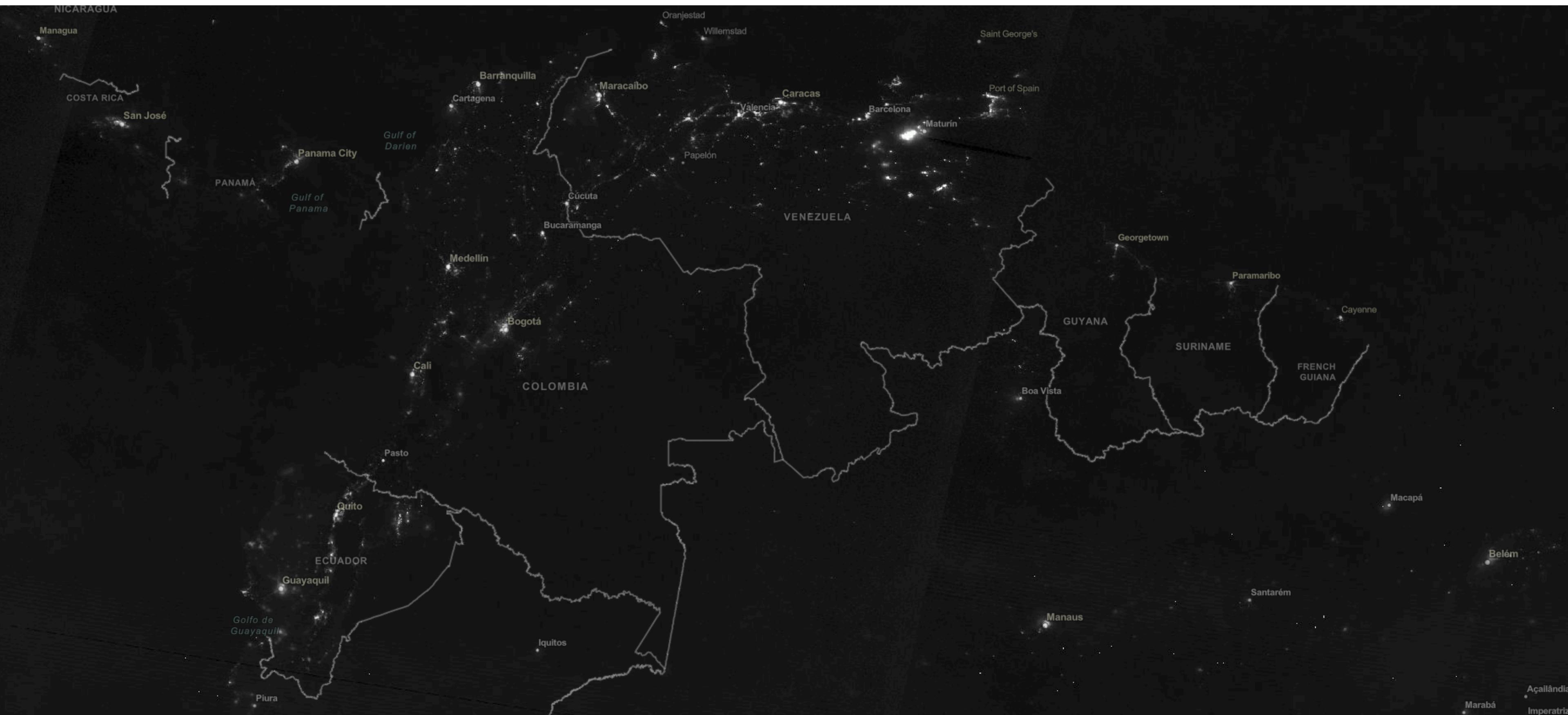


Large cluster of management units in Colombia and Central America with high climate variability

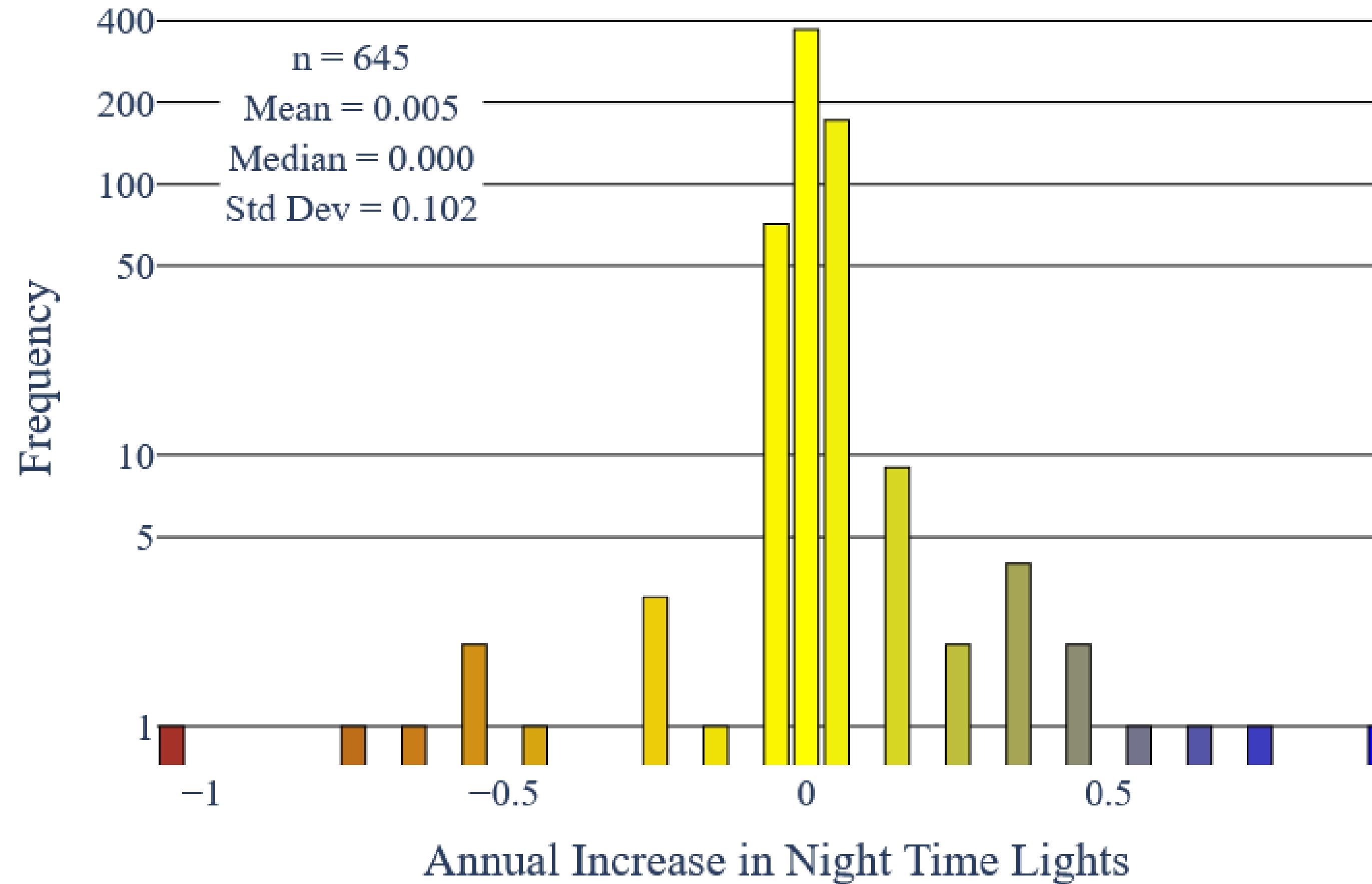
Latitudinal Variation in Precipitation Trends



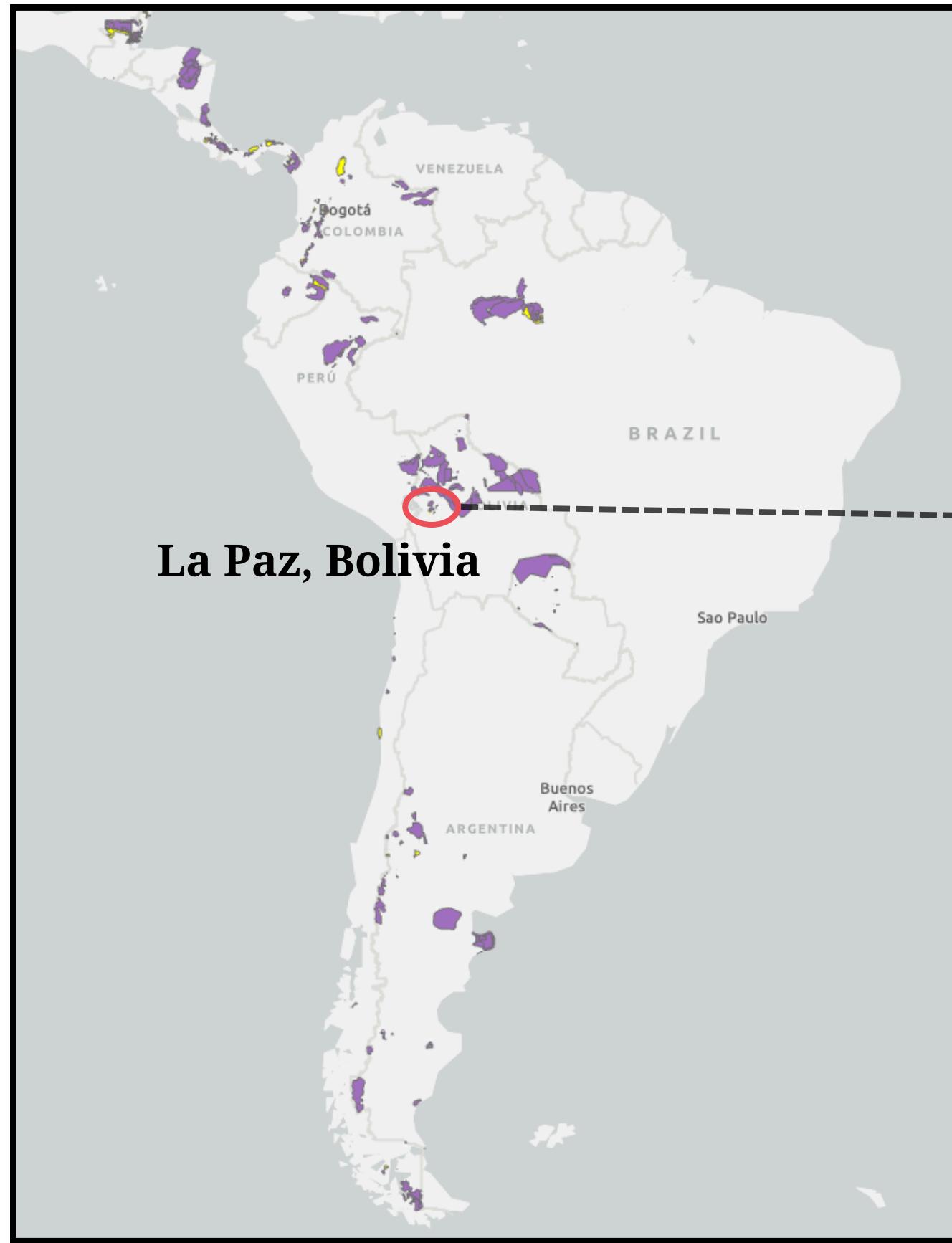
NIGHTTIME LIGHT TRENDS | VIIRS ANNUAL COMPOSITE



TRENDS IN NTL BY MANAGEMENT UNIT, 2014-2020

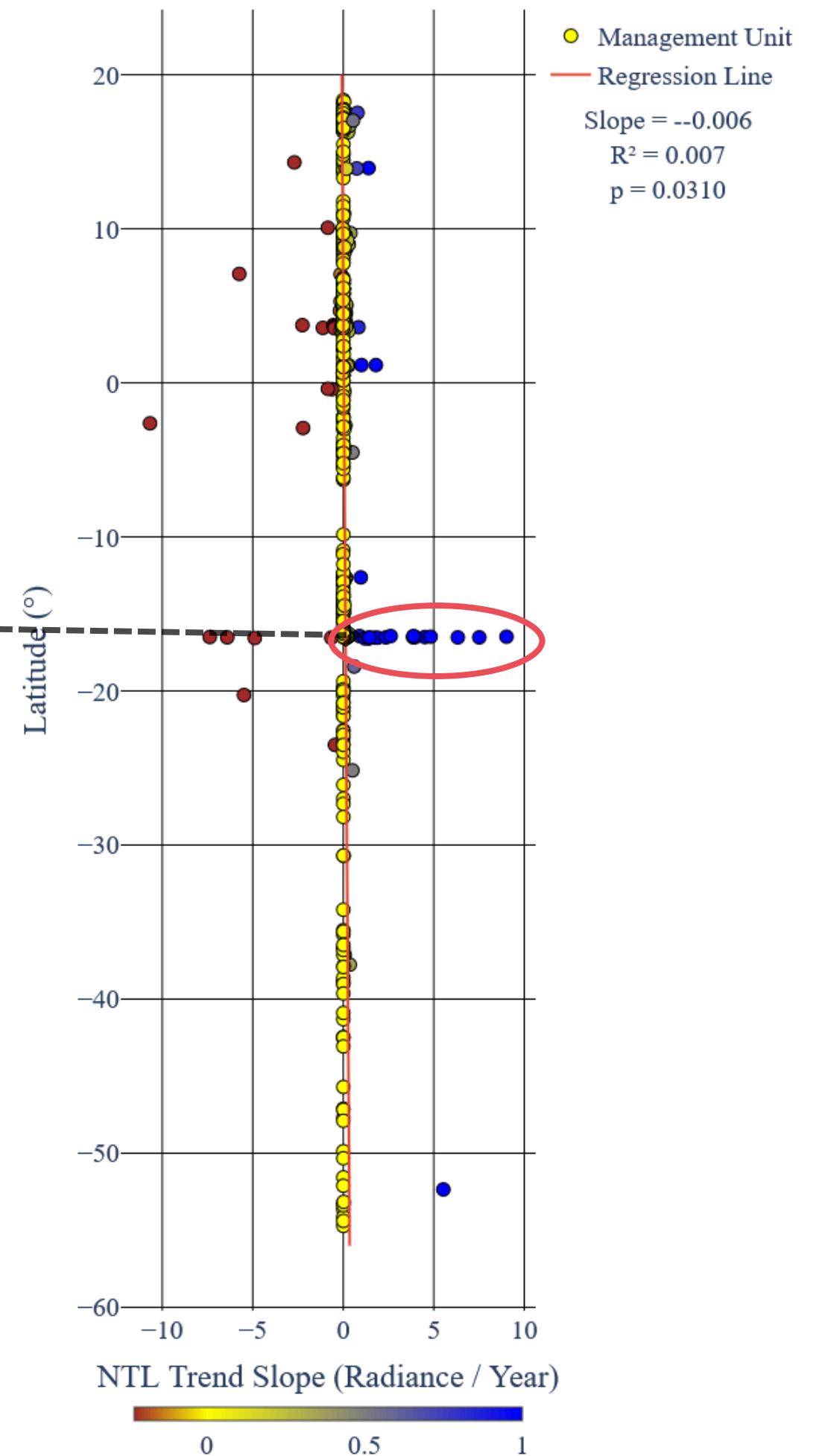


LATITUDINAL TRENDS IN NTL

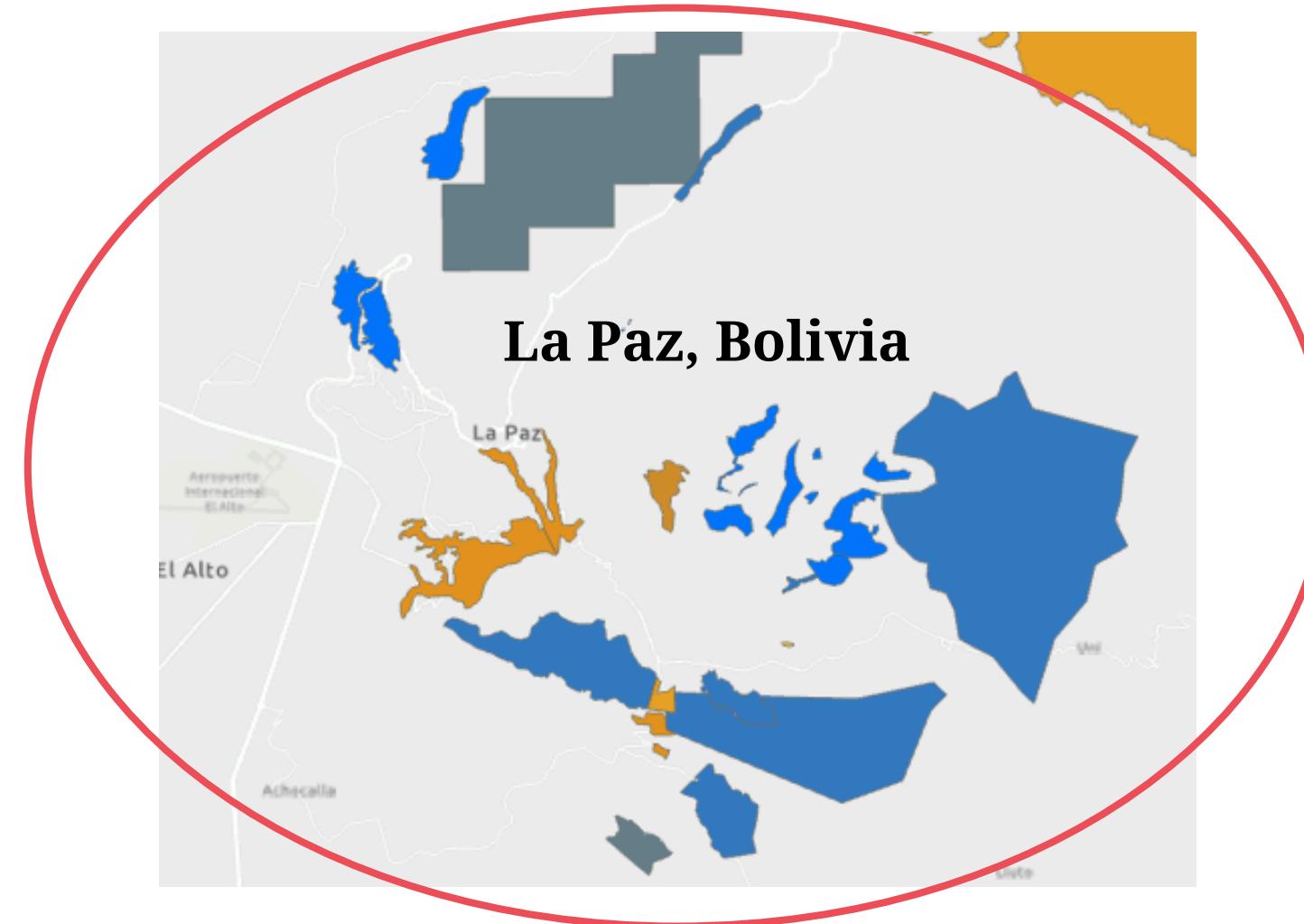


CLARK CONSULTING GROUP

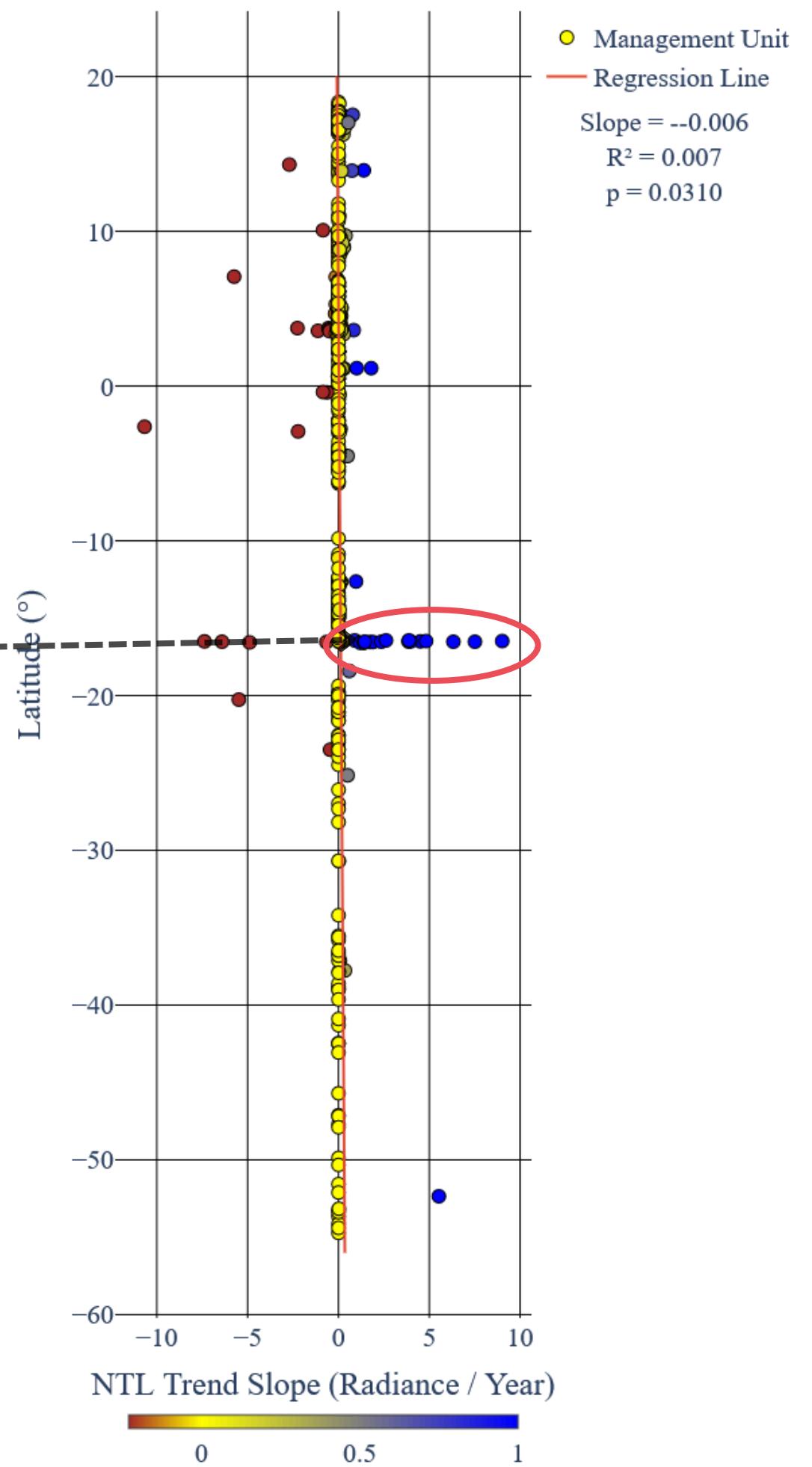
Latitudinal Variation in NTL Trends



LATITUDINAL TRENDS IN NTL



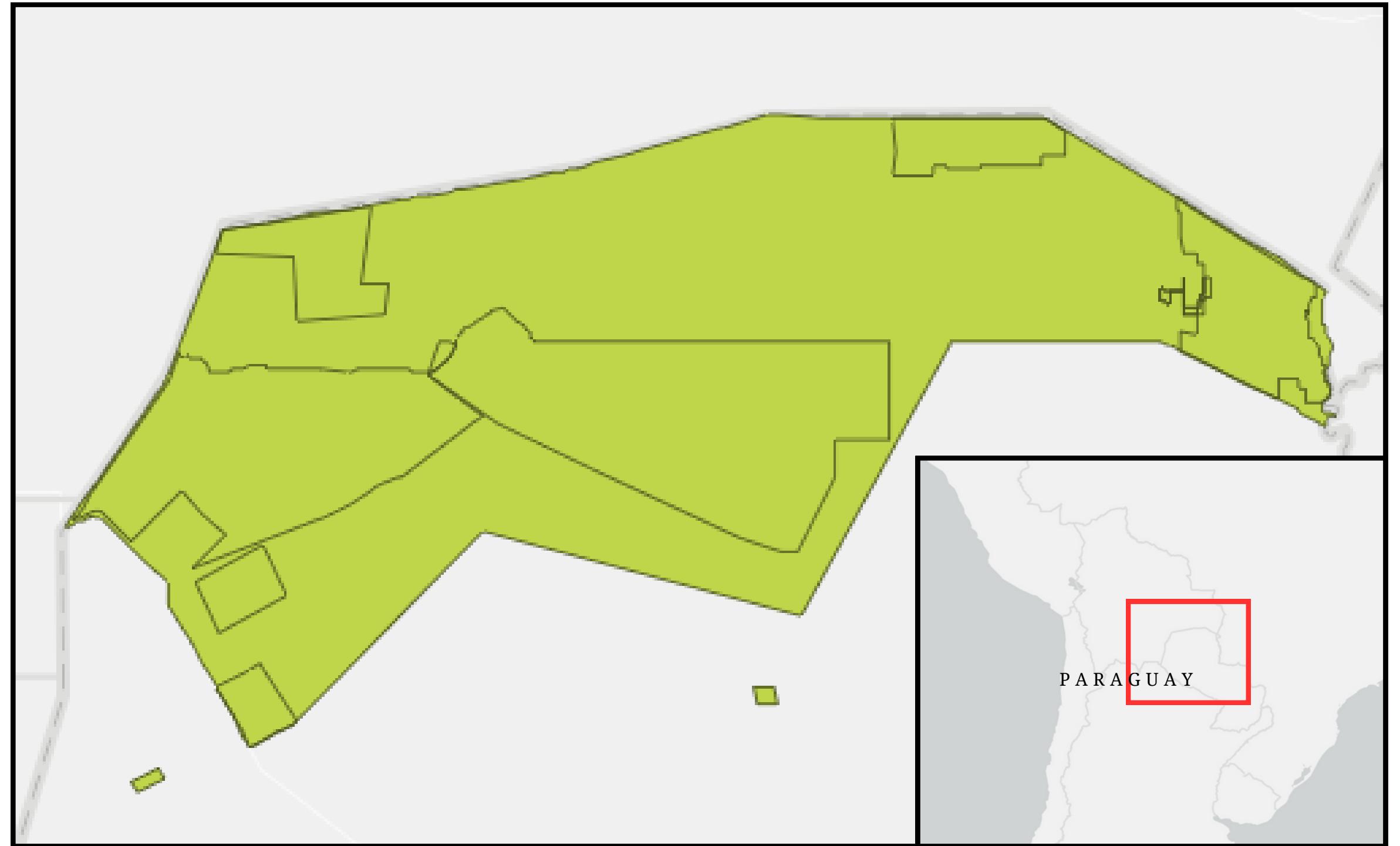
Latitudinal Variation in NTL Trends



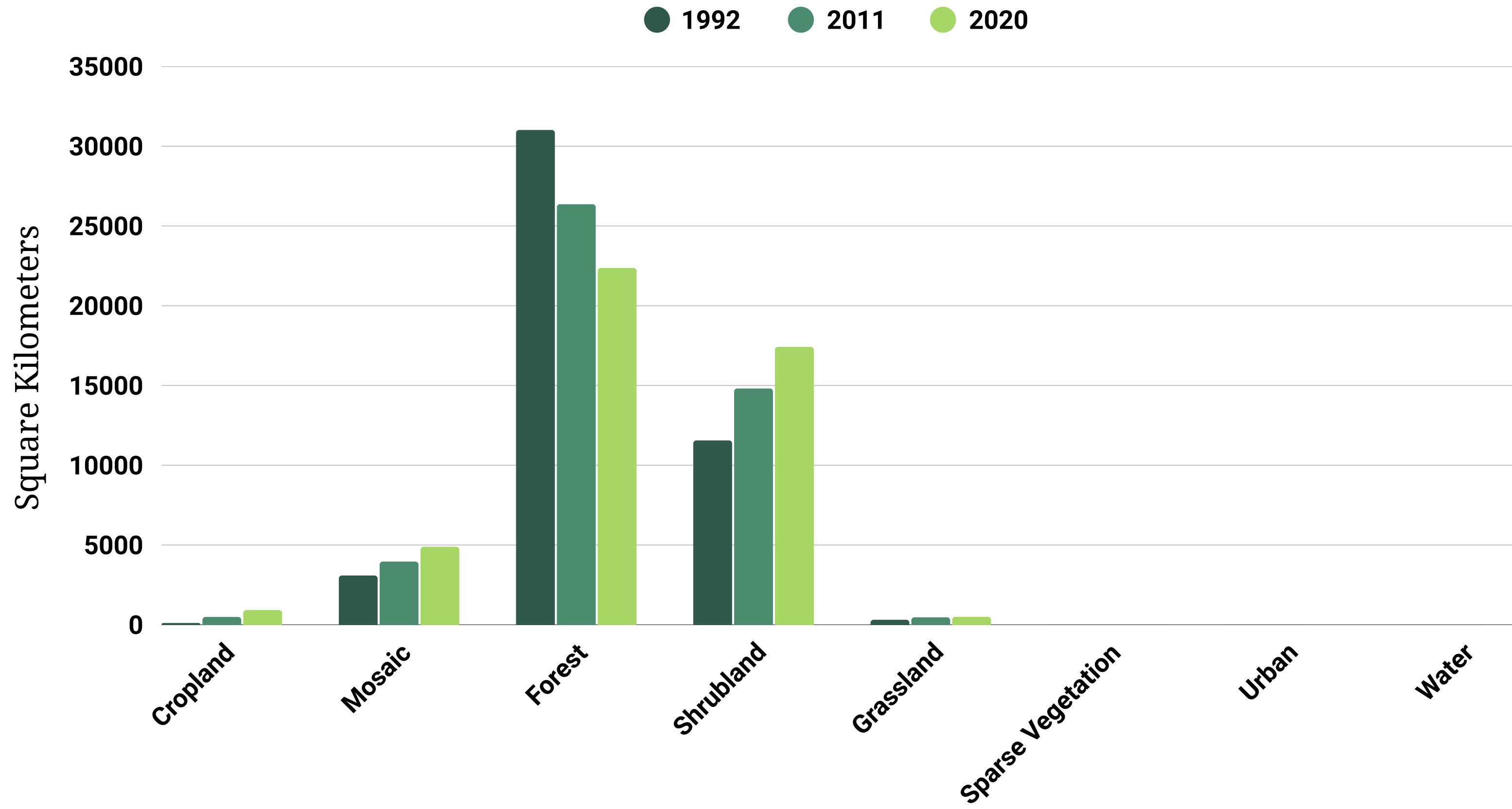
MANAGEMENT UNIT CASE STUDY - GRAN CHACO

Characteristics:

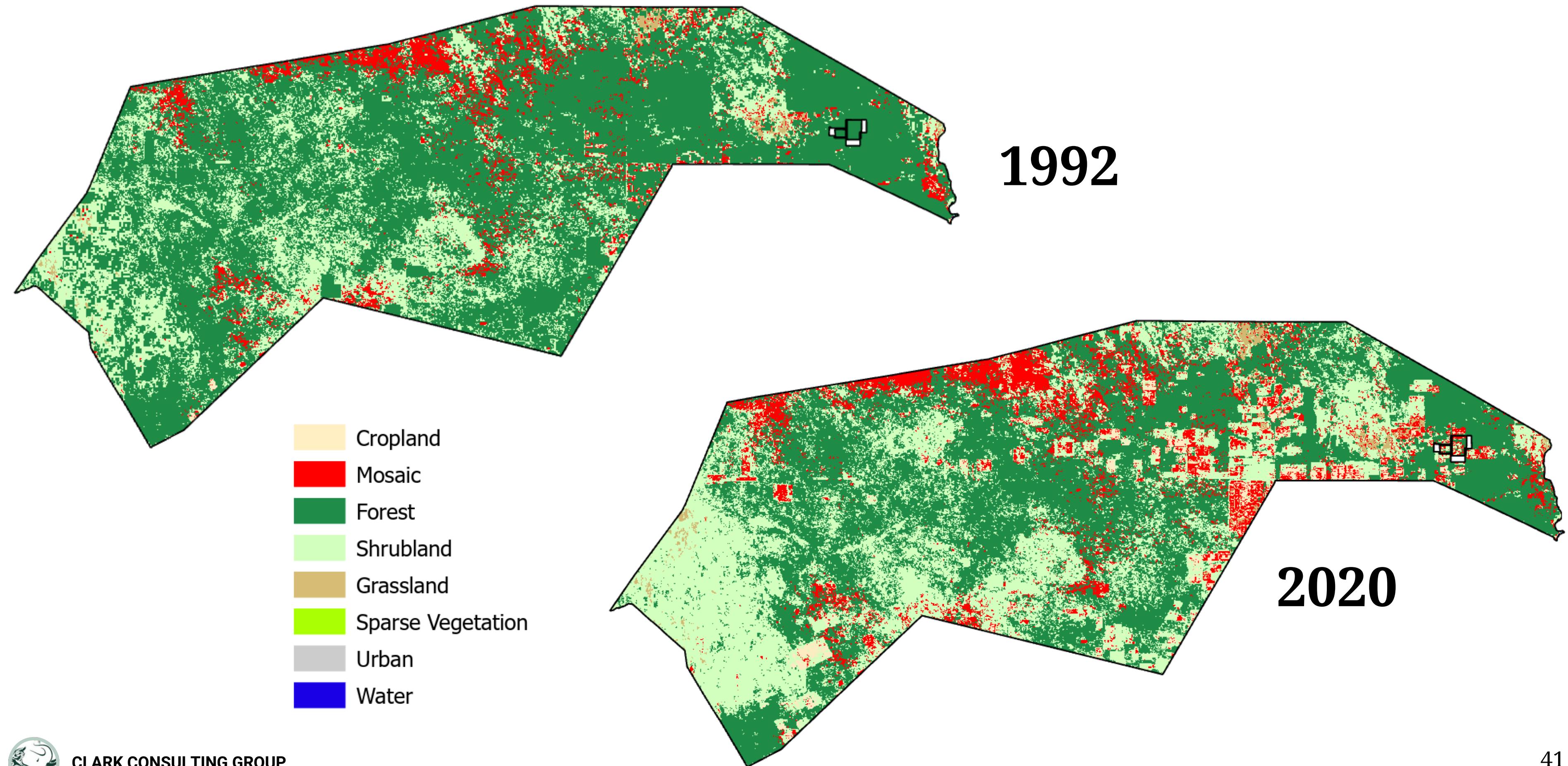
- Complexity: containing many overlapping management units.
- Size: large ($45,782 \text{ km}^2$)
- Extensive land change: decrease in forest, increase in shrub and mosaic land cover.
- Relatively stable human impact and forest landscape index values.
- Represents 28% of all land cover change across management units.



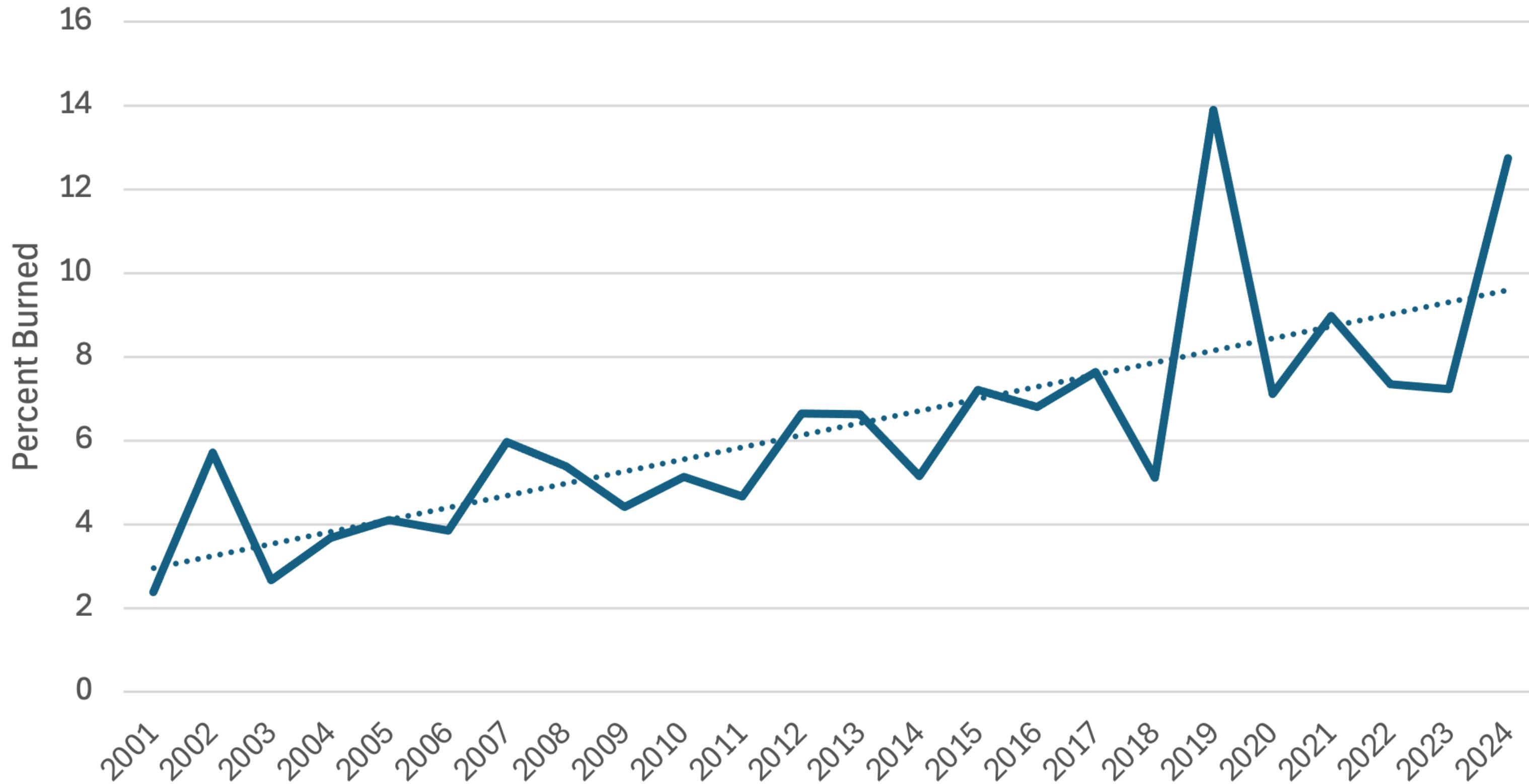
CASE STUDY - GRAN CHACO



CHANGE IN LAND COVER VISUALIZED



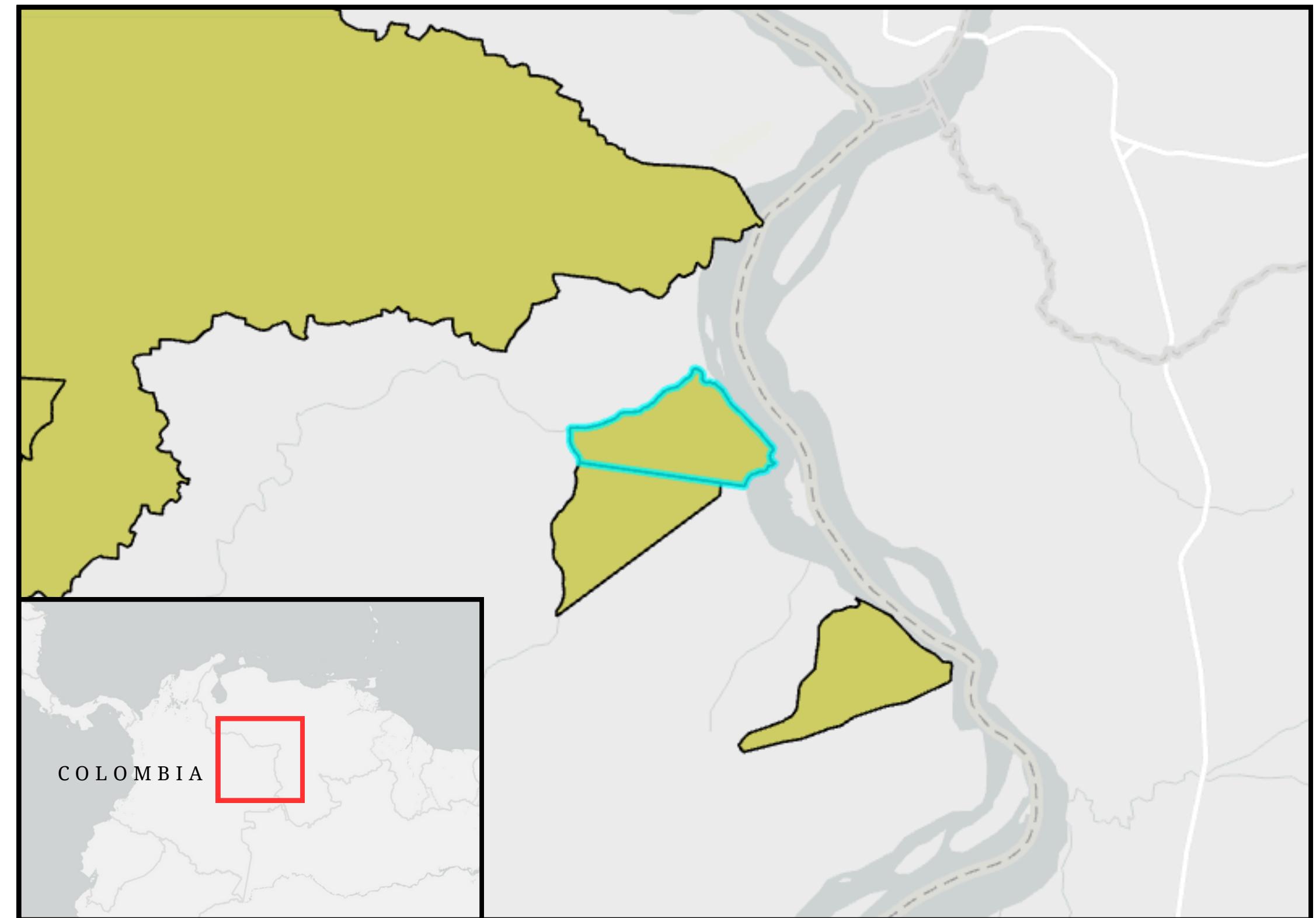
GRAN CHACHO FIRE, 2001-2024



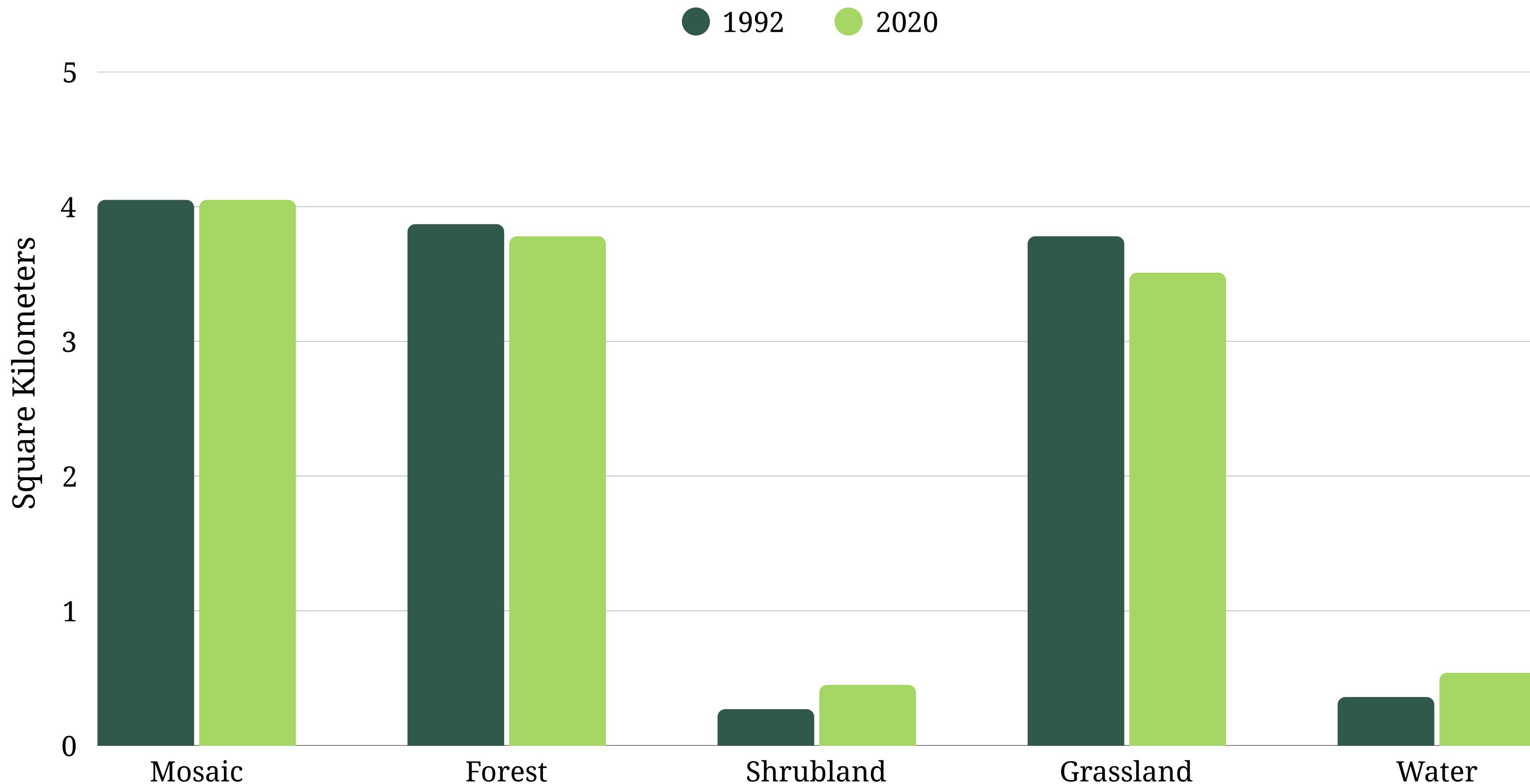
CASE STUDY - RNSC LOS CLAVELLINOS

Characteristics:

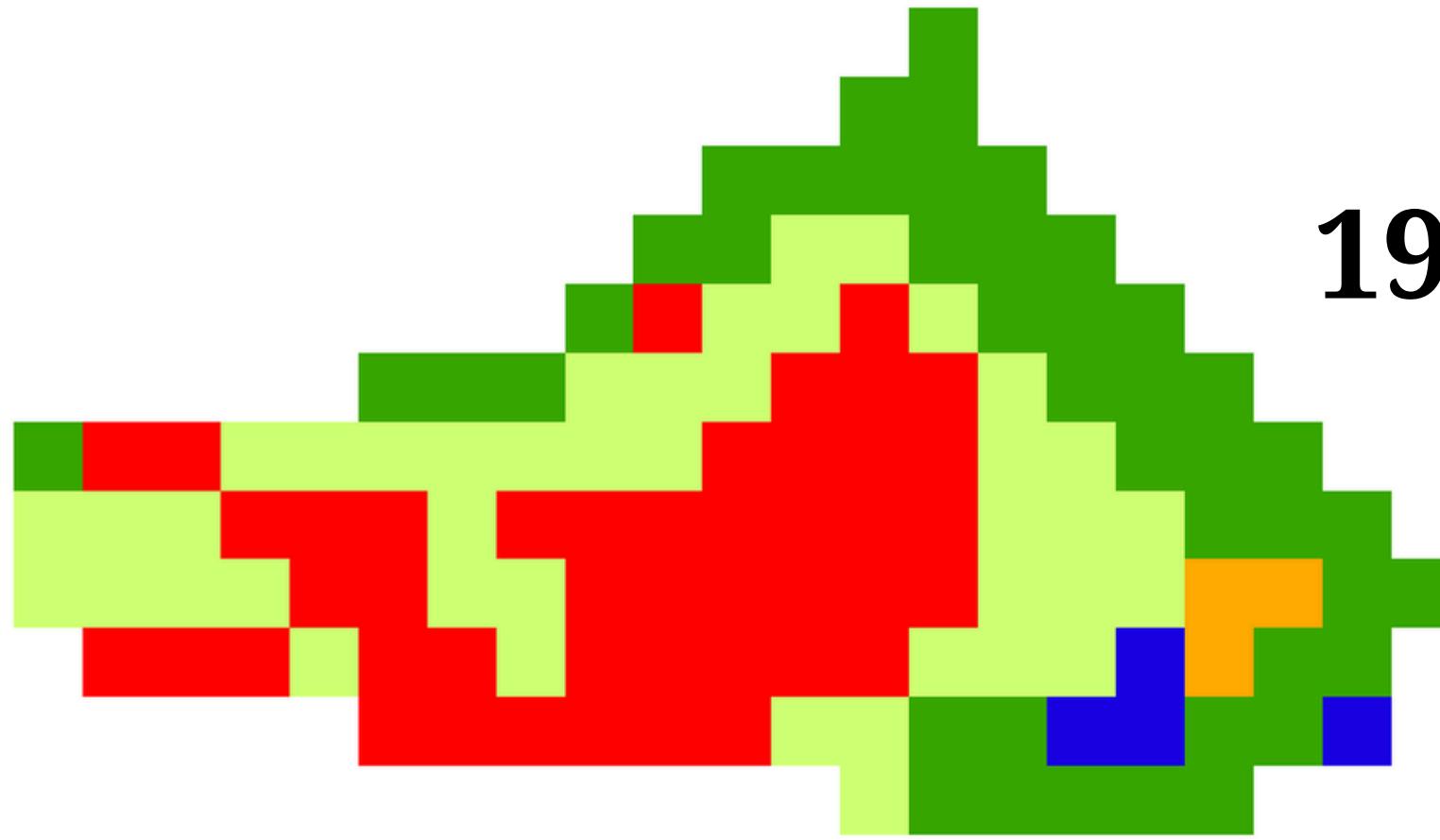
- Size: small (13 km^2)
- Human Impact index: Increasing
- Even mixture of Mosaic, Forest and Grassland
- Stable land cover



CASE STUDY - RNSC LOS CLAVELLINOS

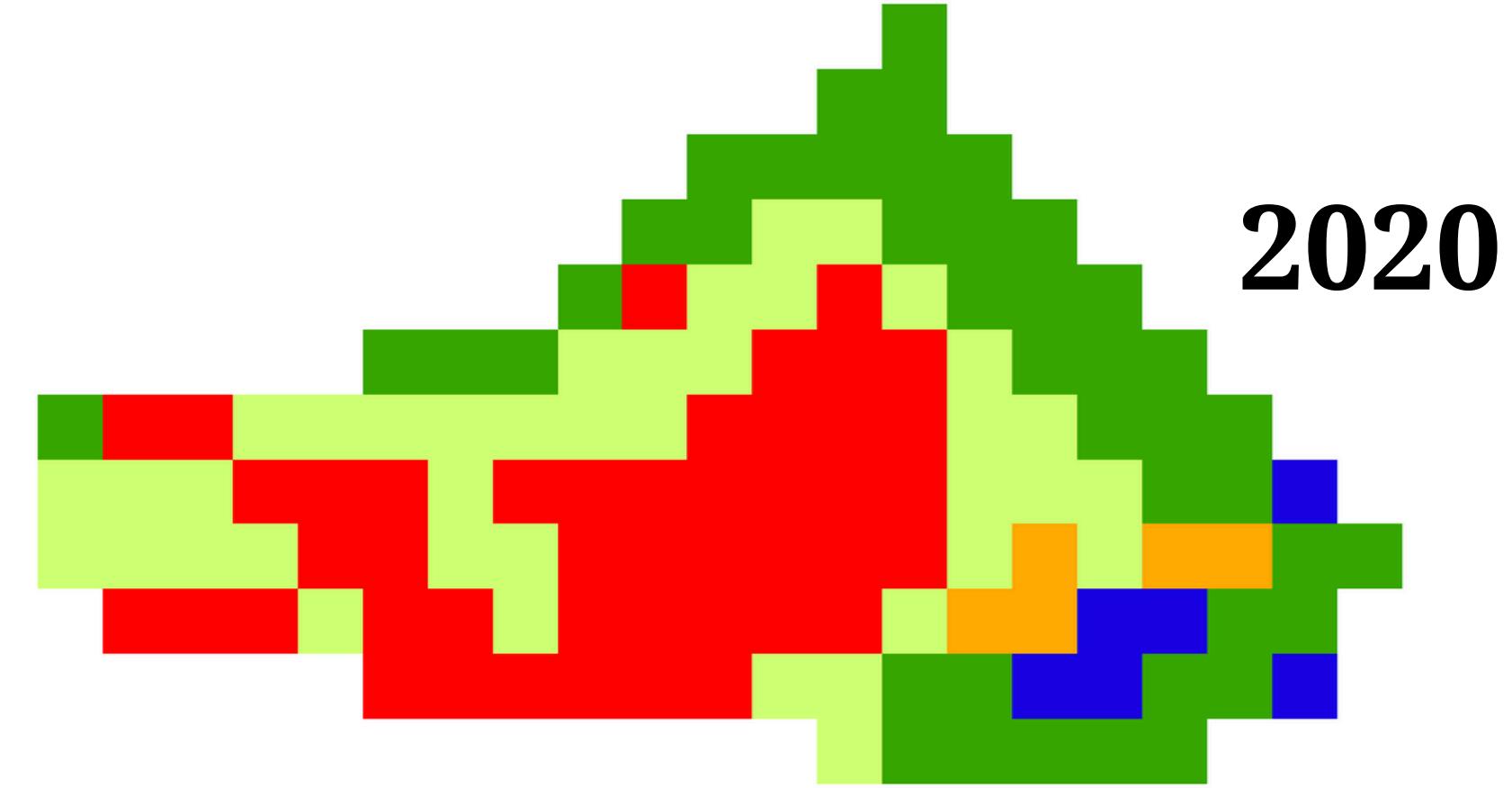


CHANGE IN LAND COVER VISUALIZED



1992

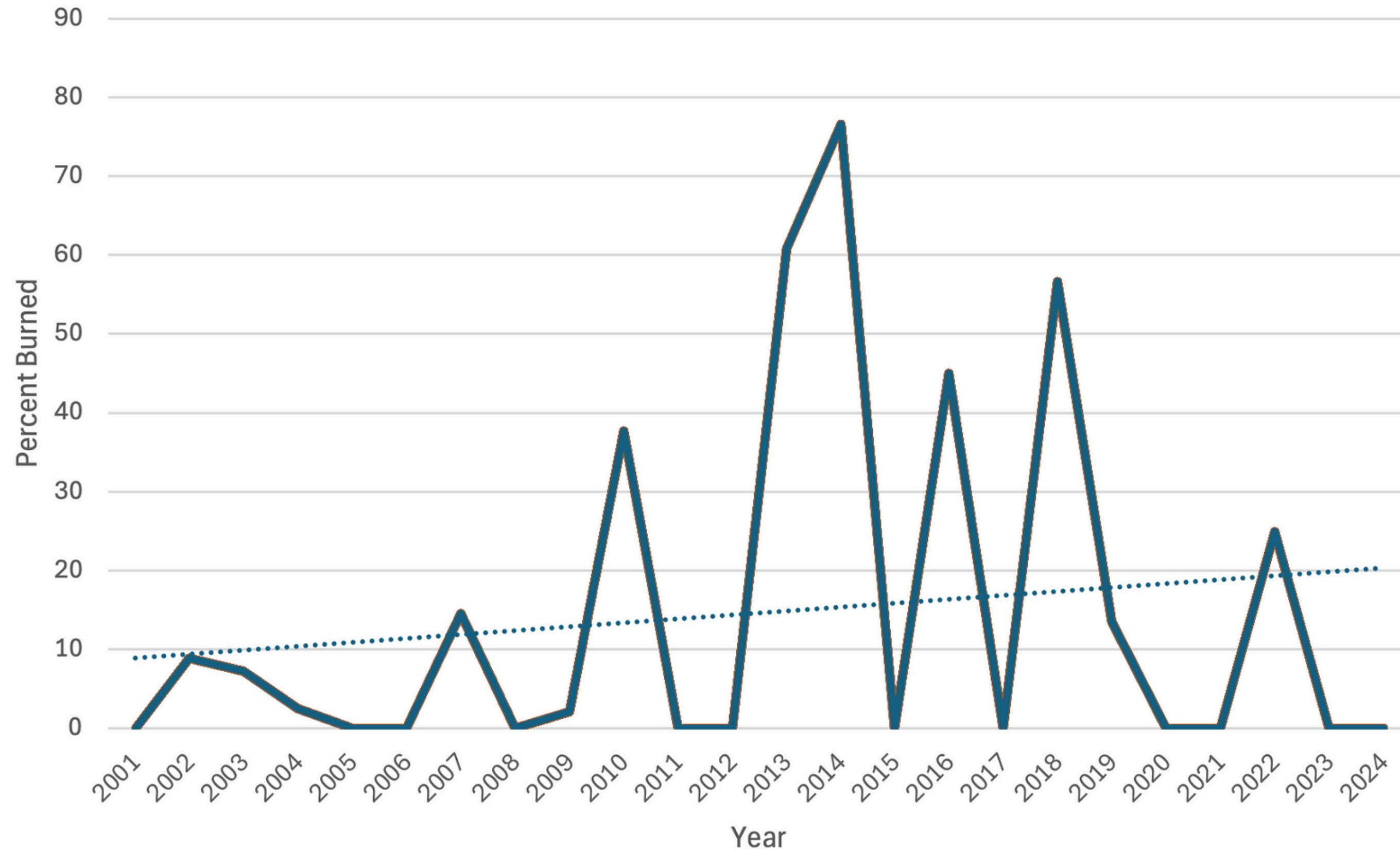
- █ Mosaic
- █ Forest
- █ Shrubland
- █ Grassland
- █ Water



2020



RNSC LOS CLAVELLINOS FIRE, 2001-2024



CONCLUSIONS

- Larger management units experience less degradation.
 - Particular attention needs to be paid towards smaller MUs.
- Over 90% of land cover does not experience change.
 - Change occurs mostly within mosaic, forest, and shrubland classes.
 - The Gran Chaco management unit and areas in Guatemala experience the most forest loss.
 - There is a gain in forest in both Panama and Costa Rica.
- Fewer than 50% of management units experience fire.
- Temperatures are increasing across the whole study area.
- Precipitation is stable, except for increases in Colombia.
- Dashboard will be available to WCS and maintained by Clark Consulting Group.



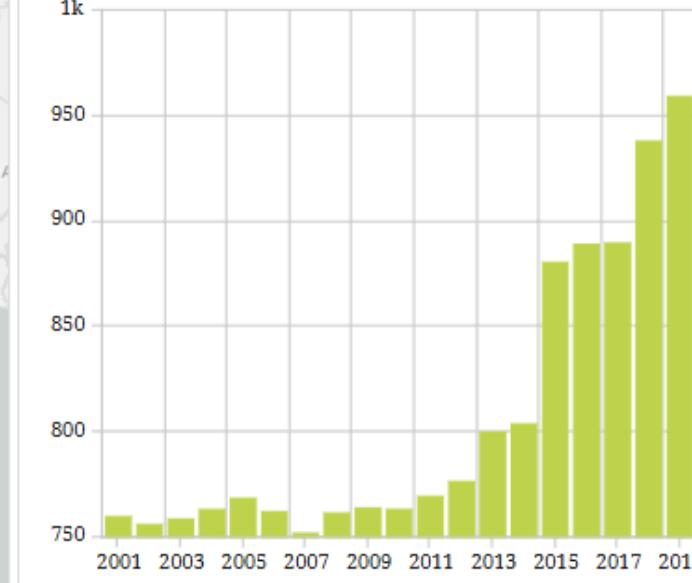
ARCGIS ONLINE DASHBOARD DEMONSTRATION

 Trends in Terrestrial WCS Management Units: Central and South America
Wildlife Conservation Society | Clark Consulting Group

Click on a Management Unit to View Trends



Human Impact Index (2001-2020)



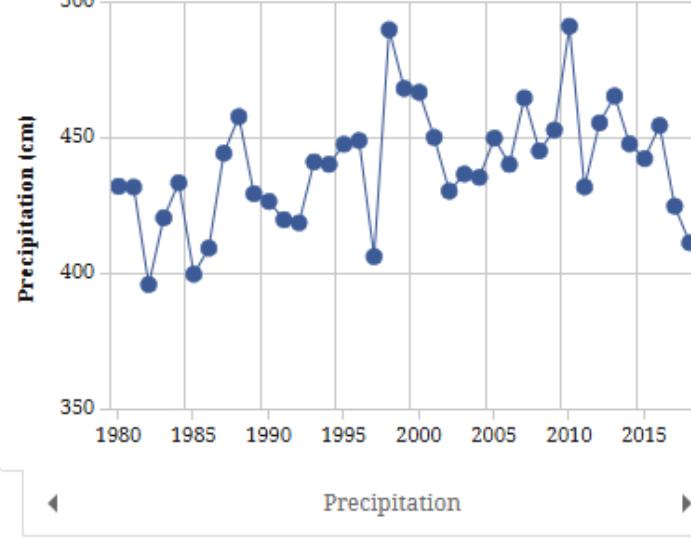
Precipitation
0.5986 cm
Average Annual Change

Temperature
0.0297°C
Average Annual Change

Landscape Characteristics

Management Unit Area
583.2k Sq Km

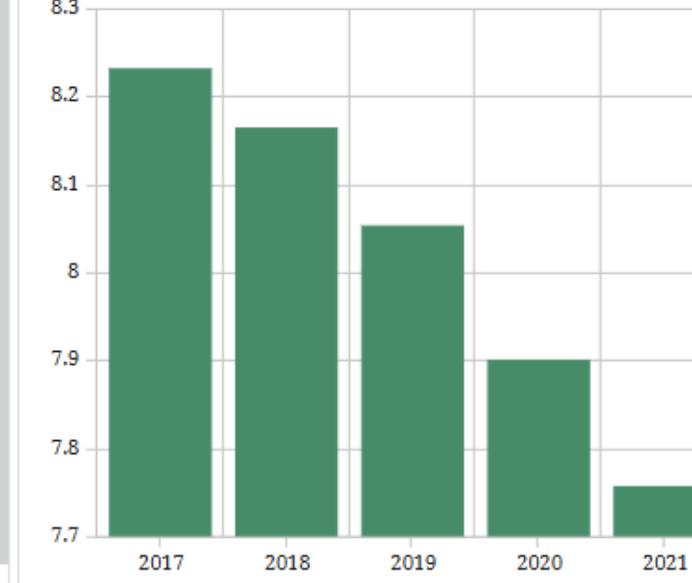
Precipitation (1980-2019)



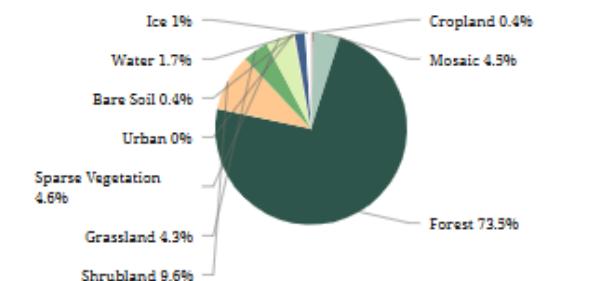
Burned Area
0.0025%
Average Annual Change

Nighttime Lights
0.0045 nW/sr/cm²
Average Annual Change

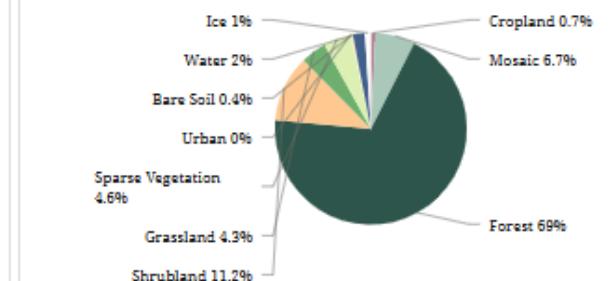
Forest Integrity Index (2017-2021)



1992 Land Cover in Management Units



2020 Land Cover in Management Units



Powered by Esri

Dashboard Produced by Clark Consulting Group

Management Units Strongholds Countries



CLARK CONSULTING GROUP

[Link to Dashboard](#)

ACKNOWLEDGEMENTS

Wildlife Conservation Society

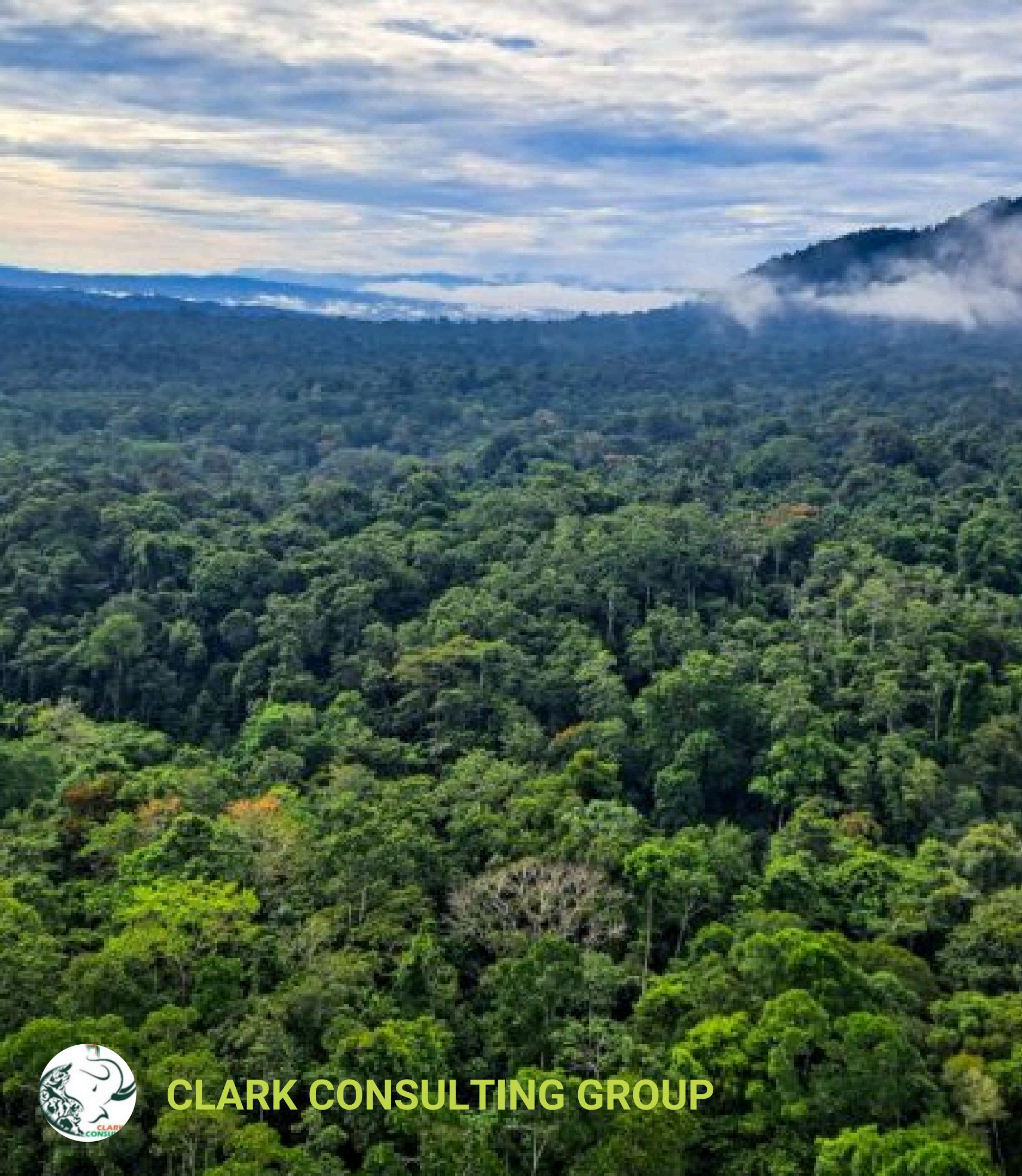
- Wenddy Acahuana
- Omar Torrico
- Jonathan Palmer

Clark University Geography

- Kas Green
- Florencia Sangermano
- John Rogan
- Abby Frazier
- Mikayla Schappert
- Antonio Fonseca

Bagel Time Worcester





CLARK CONSULTING GROUP

**THANK
YOU**