Vegetation Succession on Degraded Sites in the Pomacochas Basin (Amazonas, N Peru) - Ecological Options for Forest Restoration

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UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

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1. Location


Ecuador
Colombia
Brasil
Perú
Océano Pacífico
Bolivia
Chile
Amazonas
Florida

2. Environmental site factors

2.1 Climate

CHELSA

Climatologies at high resolution for the earth's land surface areas

Free climate data at high resolution, https://chelsa-climate.org/

forests

Article

Climate Change Impact on Peruvian Biomes

Jose Zevallos [1] and Waldo Lavado-Casimiro [2,*]

Forests 2022, *13*, 238. https://doi.org/10.3390/f13020238

2. Environmental site factors

2.1 Climate

Macroclimate (M)

C = temperate (with AMT <18°C)
f = fully humid
b = all months with MMT <22°C

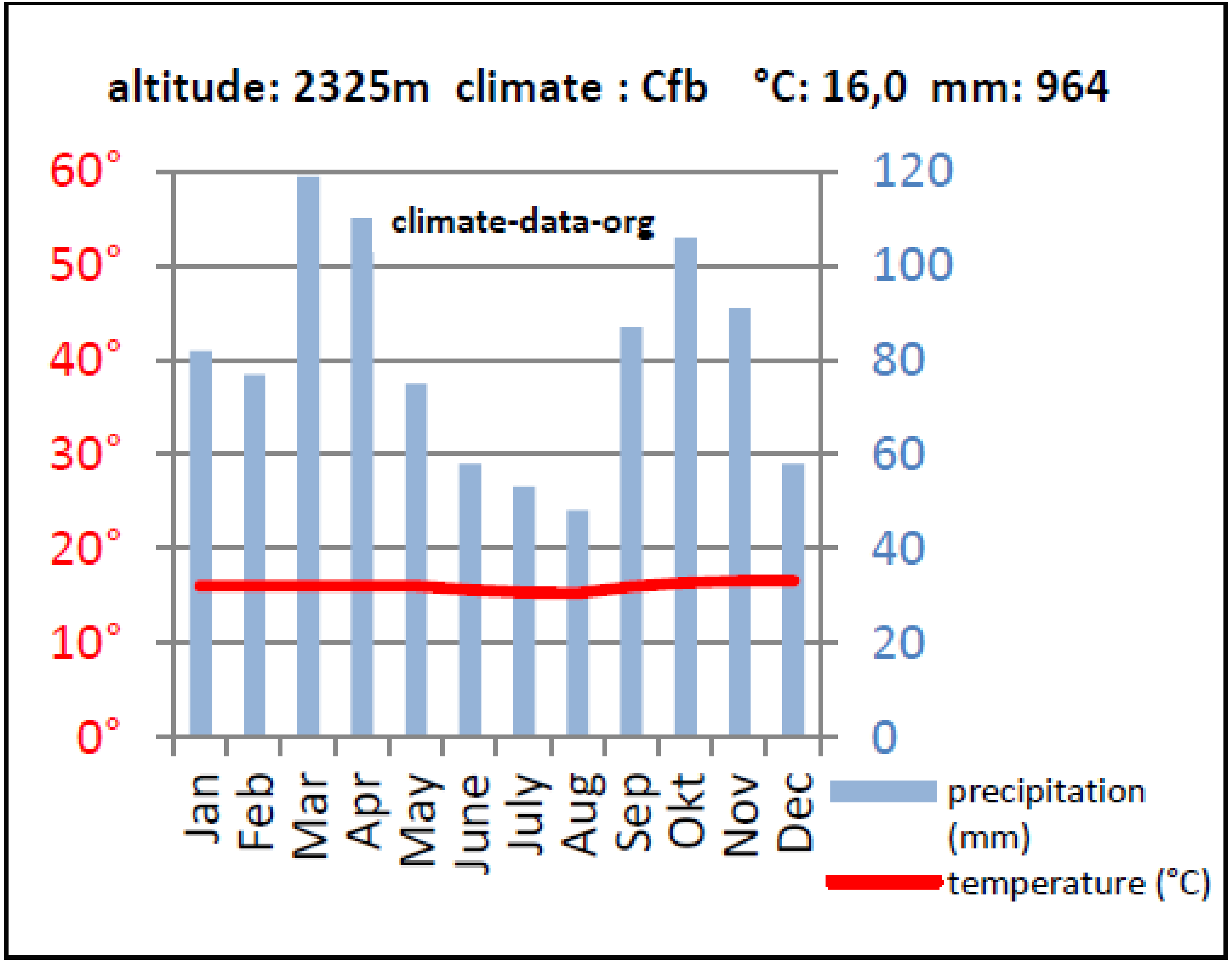
Regional climate

Humidity type:
C (o, i) B’2 H3 Werren Thornthwaite

Altitudinal belts

- **Lower tropical montane forests (LTMF) (> 15,0°C, < 2,500 m a.s.l.)**
- Upper tropical montane forests (UTMF) (≤ 15,0°C; > 2,500 m a.s.l.)

Climate Data



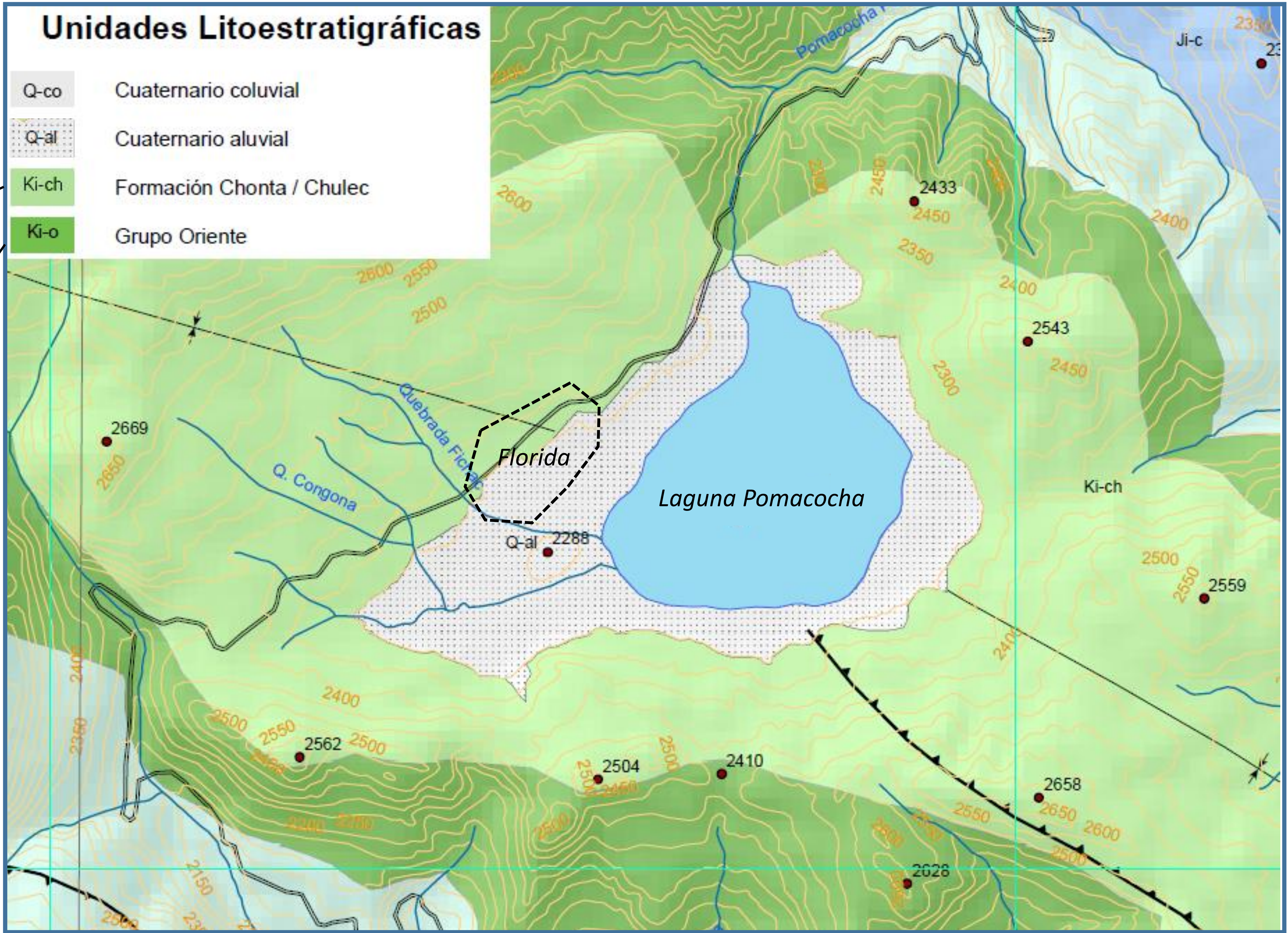
2. Environmental site factors

2.2 Geological substrate and relief

Lithology (L)

limestone-marl alternations (LMA)

sandstone and siltstone alternations (SMA)



Alluvial-lacustrine basin, deposited on calcareous sequences of the Chulec Formation. View NW of the Pomacocha Lagoon, towards Florida (Fig. 2.4 / p. 20)

INGEMMET, Boletín Serie L: Actualización Carta Geológica Nacional (Escala 1: 50 000) N° 45

Geología del cuadrángulo de Jumbilla (hojas 12h1, 12h2, 12h3, 12h4)

https://repositorio.ingemmet.gob.pe/bitstream/20.500.12544/3886/3/L045-Geologia-cuadrangulo-Jumbilla.pdf

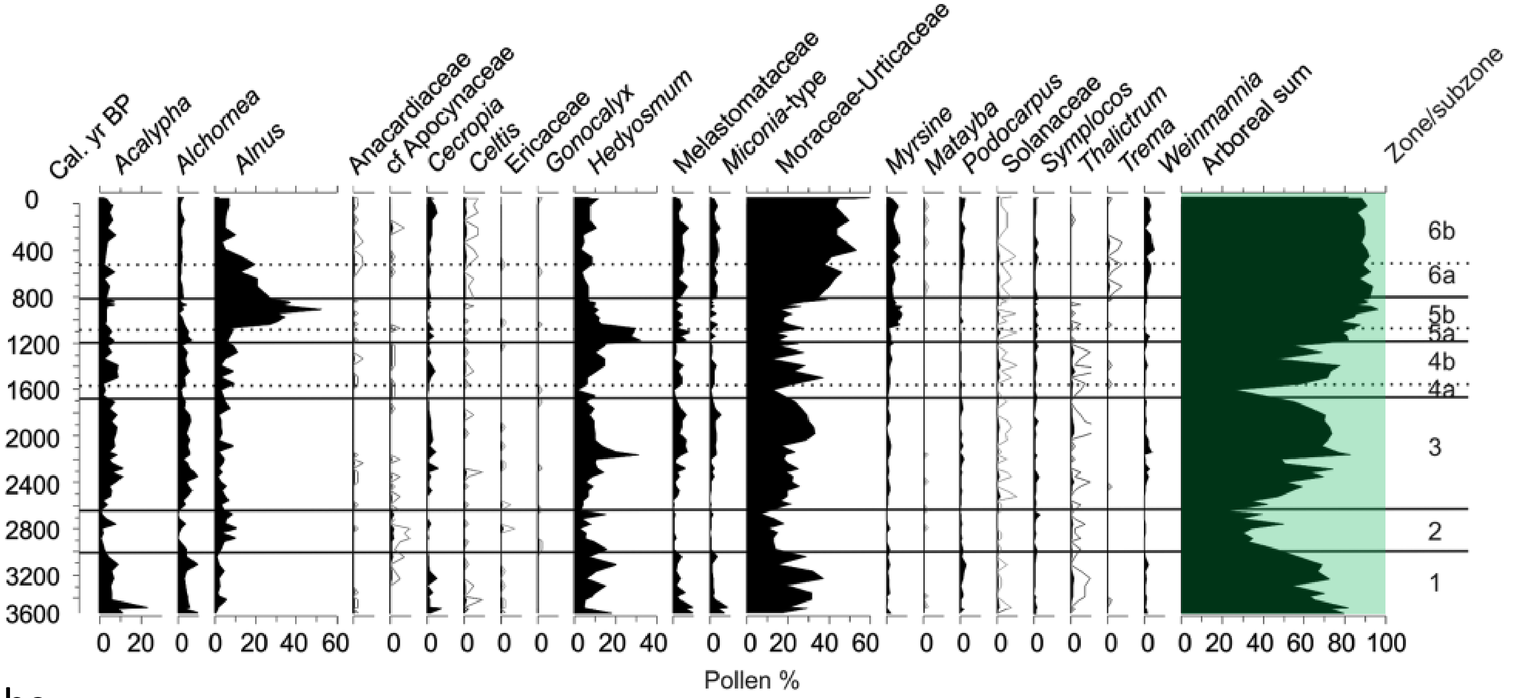
Hills in sedimentary rock, formed in calcareous sequences of the ***Chulec Formation***. View NW of the Pomacocha lagoon, towards the locality of Florida (fig. 2.2 / p. 17)

2. Environmental site factors

2.3 Human impacts – history of Human occupancy

>3.500 years (BUSH et al. 2015)

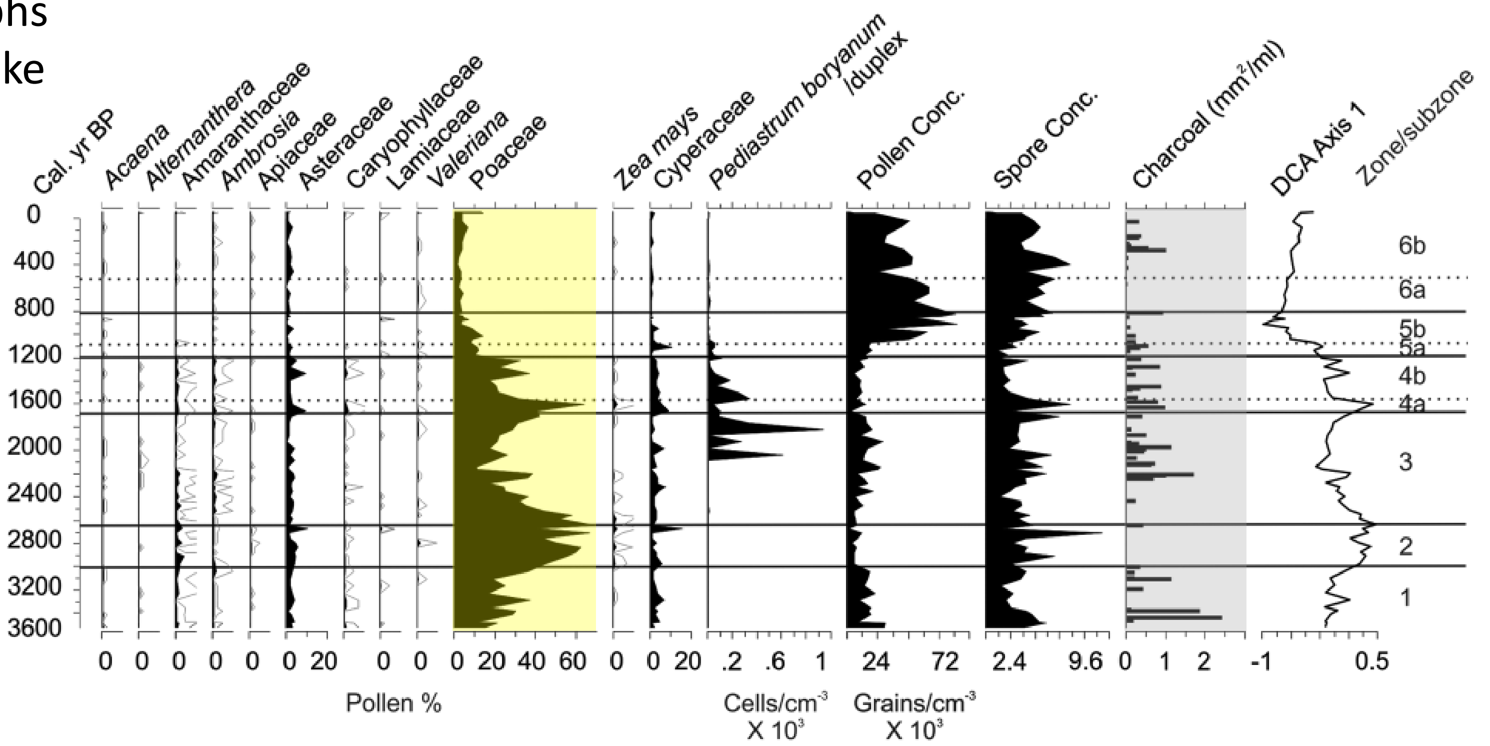
Arboreal sum indicating forests



Percentage plot of the most abundant palynomorphs and total pollen concentration for samples from Lake Pomacochas (BUSH et al. 2015).

Poaceae indicating more open landscapes

Charcoal indicating slash-and-burn (or swidden) agriculture



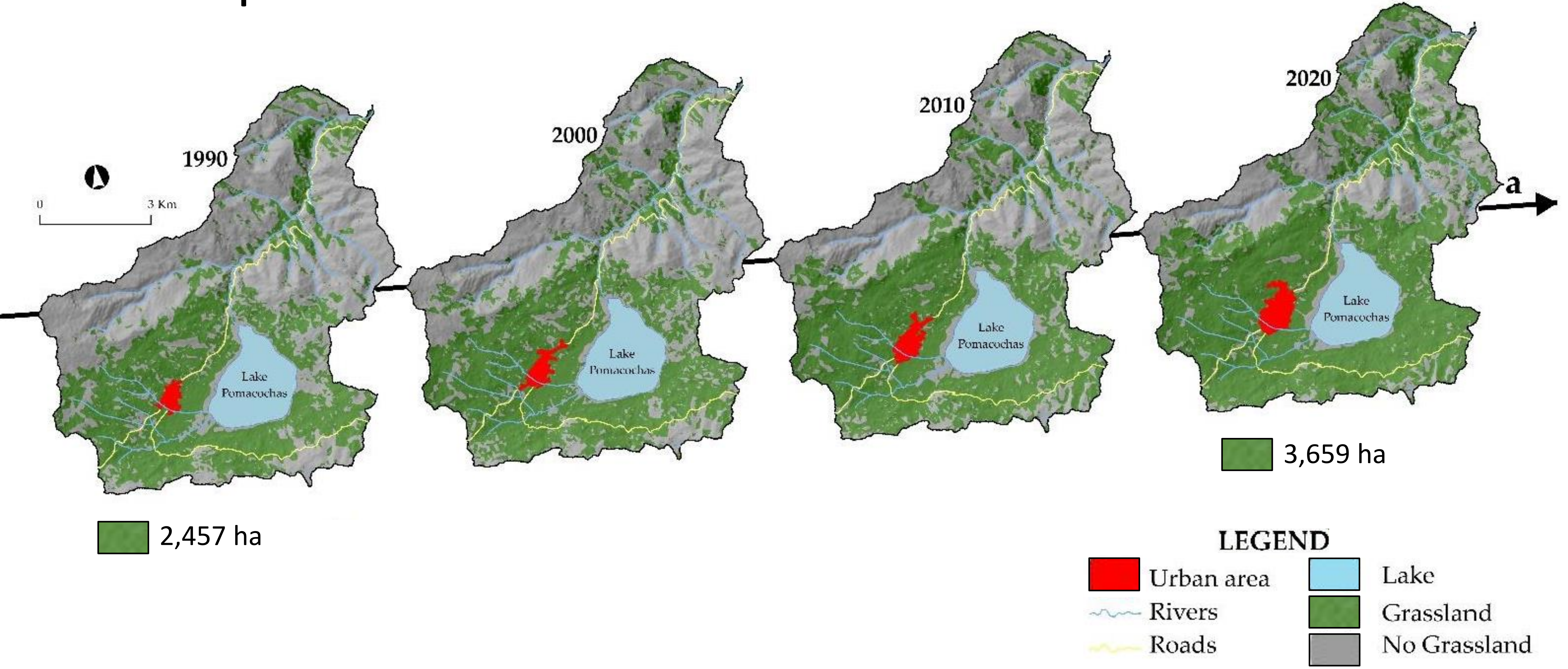
2. Environmental site factors

2.3 Human impacts - the modern landscape

Lake Pomacochas view (A). Patches of forest adjacent to Pomacochas Lake (B). Source: Rascón et al. (2021)

2. Environmental site factors

2.3 Human impacts

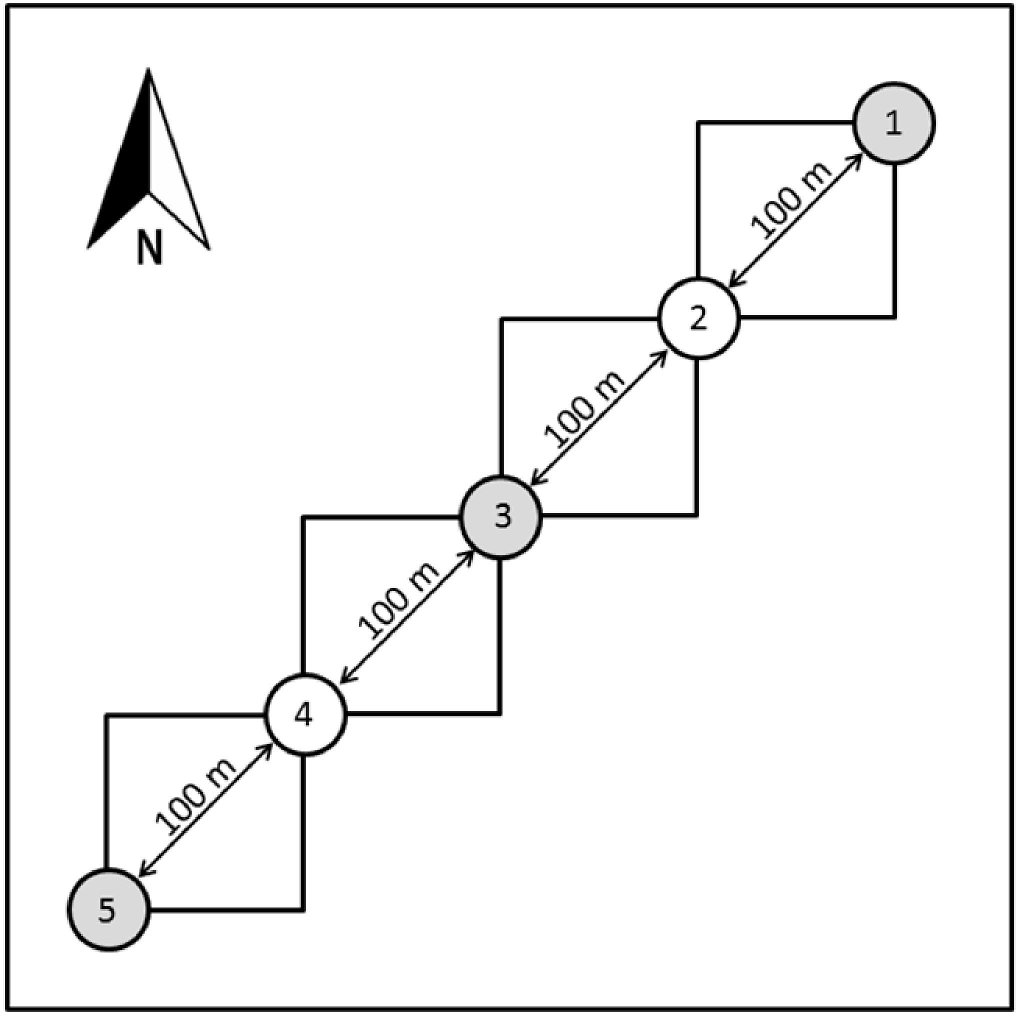


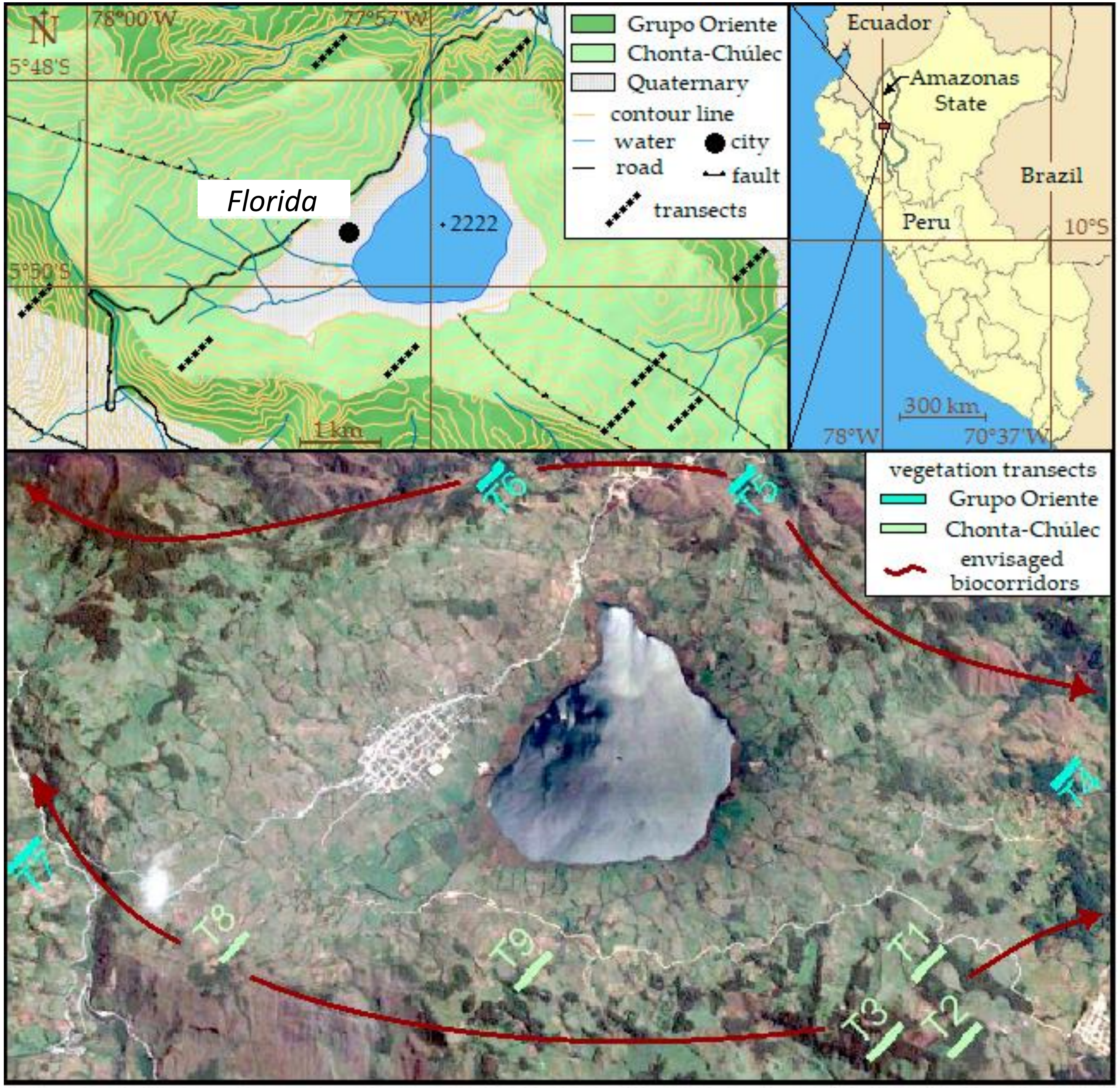
Maps of grassland dynamics from 1990 to 2020 in the Pomacochas micro-watershed (MARIN et al. 2022)

3. Methods

3.2 Study design

In total, we sampled 40 soil plots (out of 9x5 = 45) and 24 vegetation plots (out of 9x3 = 27), i.e. nearly 90% of the potential plots.





3. Methods

3.3 Statistical Analysis Process

Variables	Statistical analyses
soil and vegetation (comparison of variables among land-use types and between geological substrates)	**Linear Mixed-Effects Models (LMMs)** with transect as random factor
compositional differences in the vegetation between land-use types and geological substrates	**Nonmetric Multidimensional Scaling** (**NMDS**)
plant indicators for forest sites, succession sites and geological substrates	**Indicator Species Analysis (ISA**; Dufrêne and Legendre 1997)
effects of altitude on soil and vegetation	**Regression Analysis (RA)** with transect as random factor; goodness-of-fit by marginal R^2

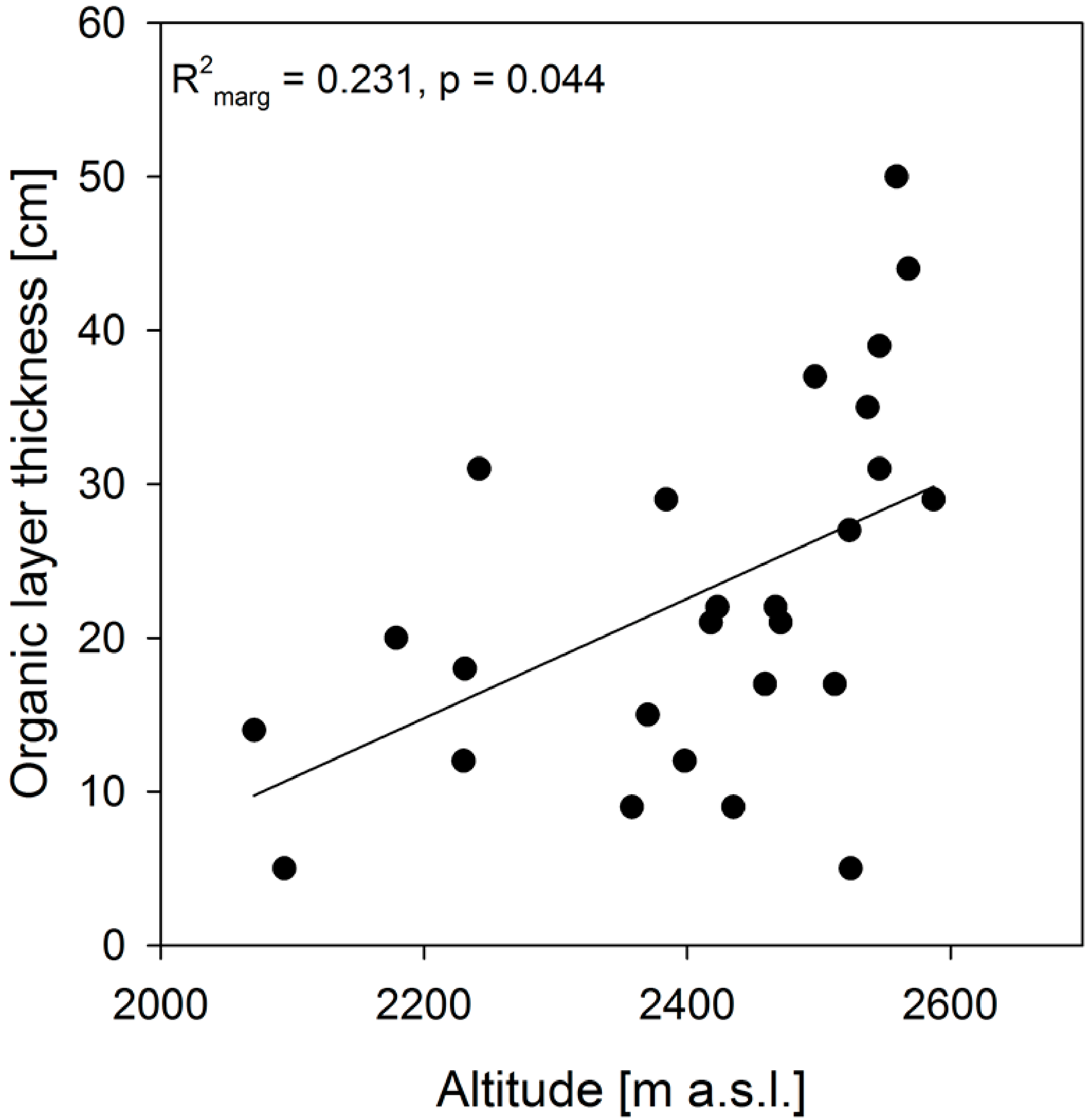
4. Results

- **Forest sites** (LTMF; covered with trees and underbrush)

Soil organic layers (and functions) were particularly impacted by human-induced disturbance

- **Succession sites** (abandoned; open to semi-open)

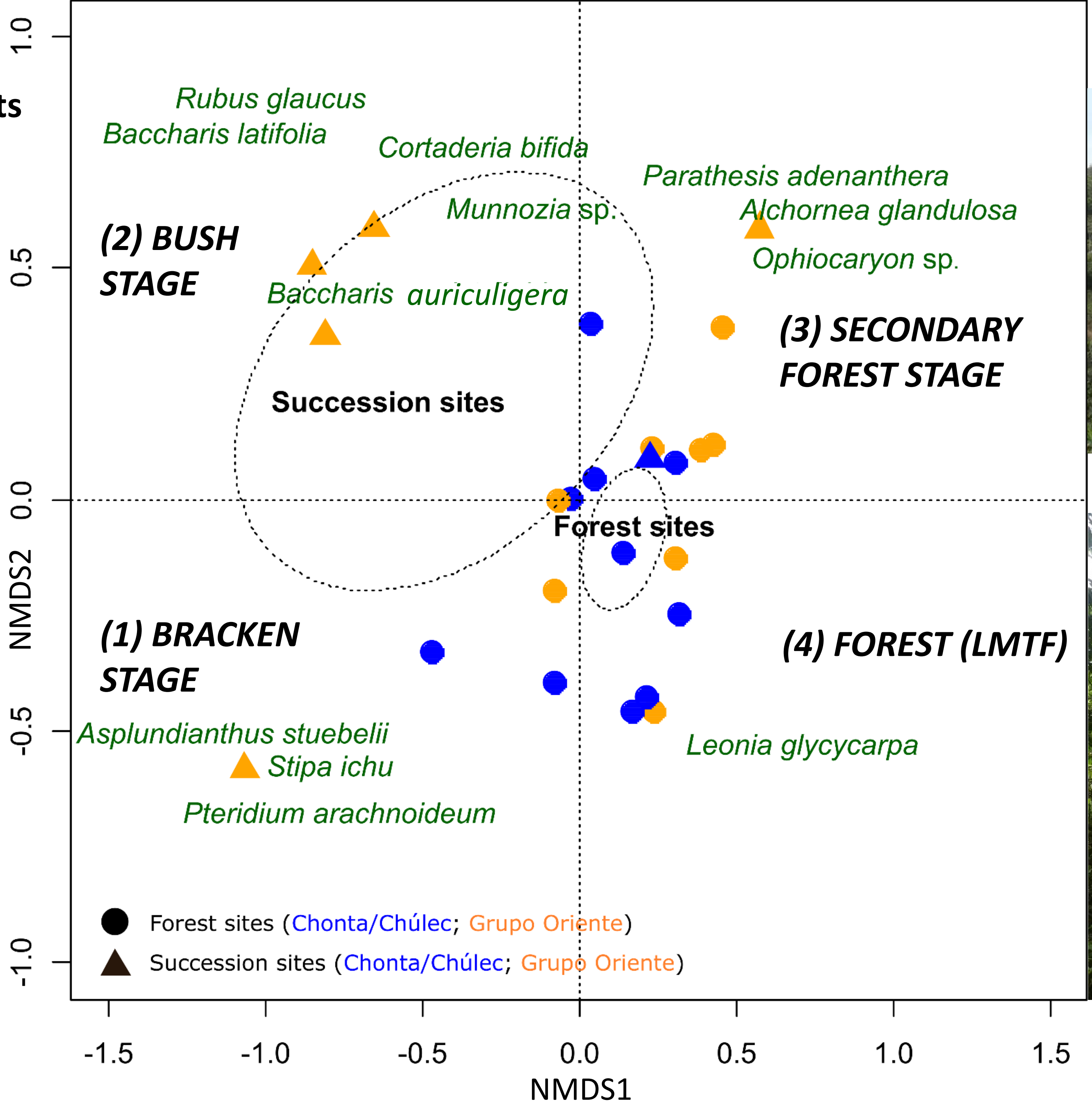
4. Results → Linear Mixed-Effects Models (LMMs)



Relationship between altitude and organic layer thickness, based on 26 soil sample plots in forests.

4. Results → NMDS

ordination of the 24 vegetation plots



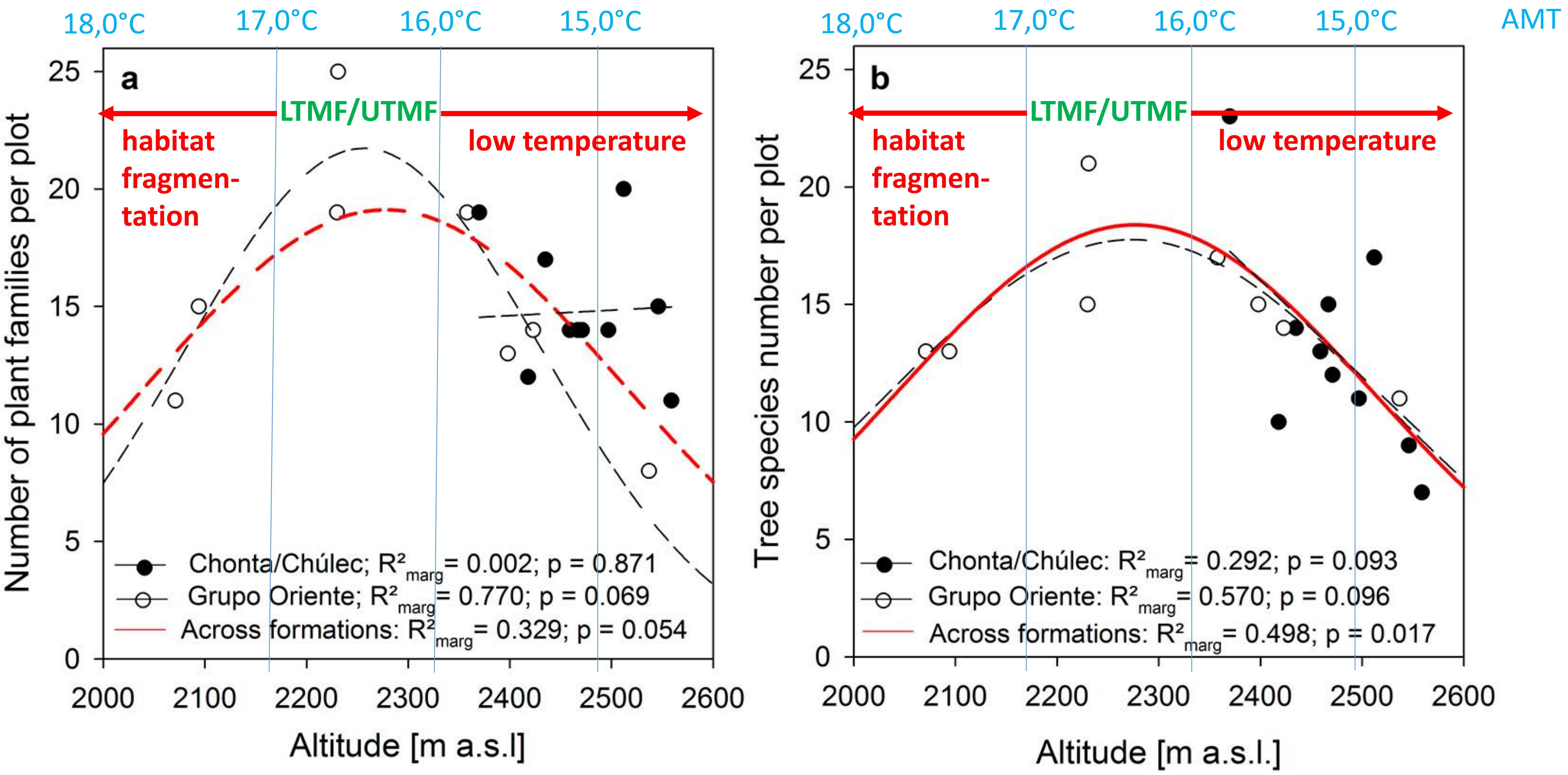
4. Results

→ **Indicator Species Analysis (ISA)**

Table 2. Results of indicator species analyses for geological substrate and land-use types.

		Geology			Land-use type		
	Live Form		**IV**	***p***		**IV**	***p***
Hedyosmum scabrum	Tree	Grupo Oriente	0.61	0.036			
Piper aduncum	shrub/tree	Grupo Oriente	0.57	0.037			
Leonia glycycarpa	Tree				forest	0.76	0.018
Ocotea albopunctulata	Tree				forest	0.72	0.005
Cyathea meridensis	tree fern				forest	0.71	0.013
Asplundianthus stuebelii	Shrub				succession	0.50	0.014
Baccharis latifolia	Shrub				succession	0.50	0.011
Rubus glaucus	Shrub				succession	0.50	0.019
Munnozia sp.	Herb				succession	0.50	0.012
Oxalis medicaginea	Herb				succession	0.49	0.035

4. Results → Regression Analysis (RA)



Effect of altitude on (**a**) the number of plant families and (**b**) the number of tree species per plot on forest sites.

5. Discussion

To answer our research questions

(1) Are anthropogenic disturbance levels crucial input variables for an effective restoration of biocorridors? YES!

EVIDENCE: (1) distinctive successional stages (NMDS); (2) habitat fragmentation caused species decline on a local scale (RA)

(2) Does the geological substrate have any significance for relationships between plants and sites? YES!

EVIDENCE: local acidity indicators (ISA)

(3) Are intact tropical montane forests determined by intrinsic soil properties? YES!

EVIDENCE: humus accumulation in forests (LMM)

6. Conclusions

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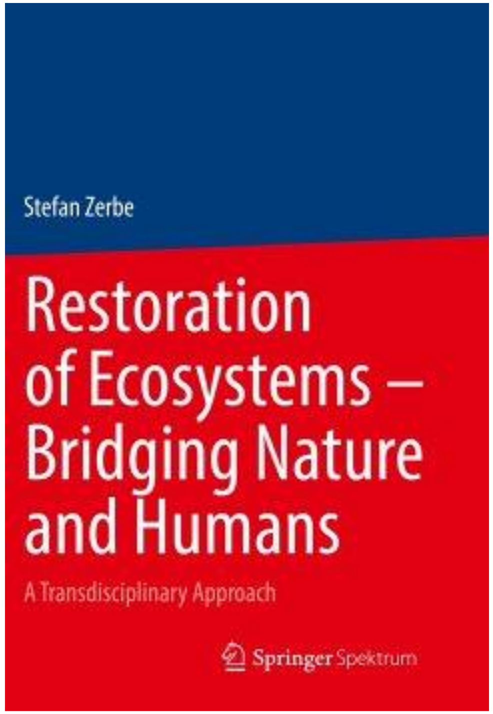
research-driven management strategies for the restoration of ecosystems in fragmented landscapes

1. **Native tree species** should be given priority (our study + BUSH et al. 2015)

2. The most species-rich biocoenoses of **TMF core habitats** at altitudes of about 2,250 m a.s.l. deliver species pools for vulnerable late-successional species

3. Secondary forest patches can function as **facilitating habitats** to support forest regrowth processes

4. Discuss all results of our study + BUSH et al. (2015) with local inhabitants of the ecoregion about possible options for a sustainable, heterogeneous and resilient cultural landscape



The Pomacochas basin can act as an important arena *for sustainable development* as *transformations* at the local level can support broader change

we are looking forward to cooperations - Muchas Gracias !

Bush MB, et al. (2015) Climate change and the agricultural history of a mid-elevation Andean montane forest. The Holocene 25(9): 1522-1532. DOI: https://doi.org/10.1177/09596836155858

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