

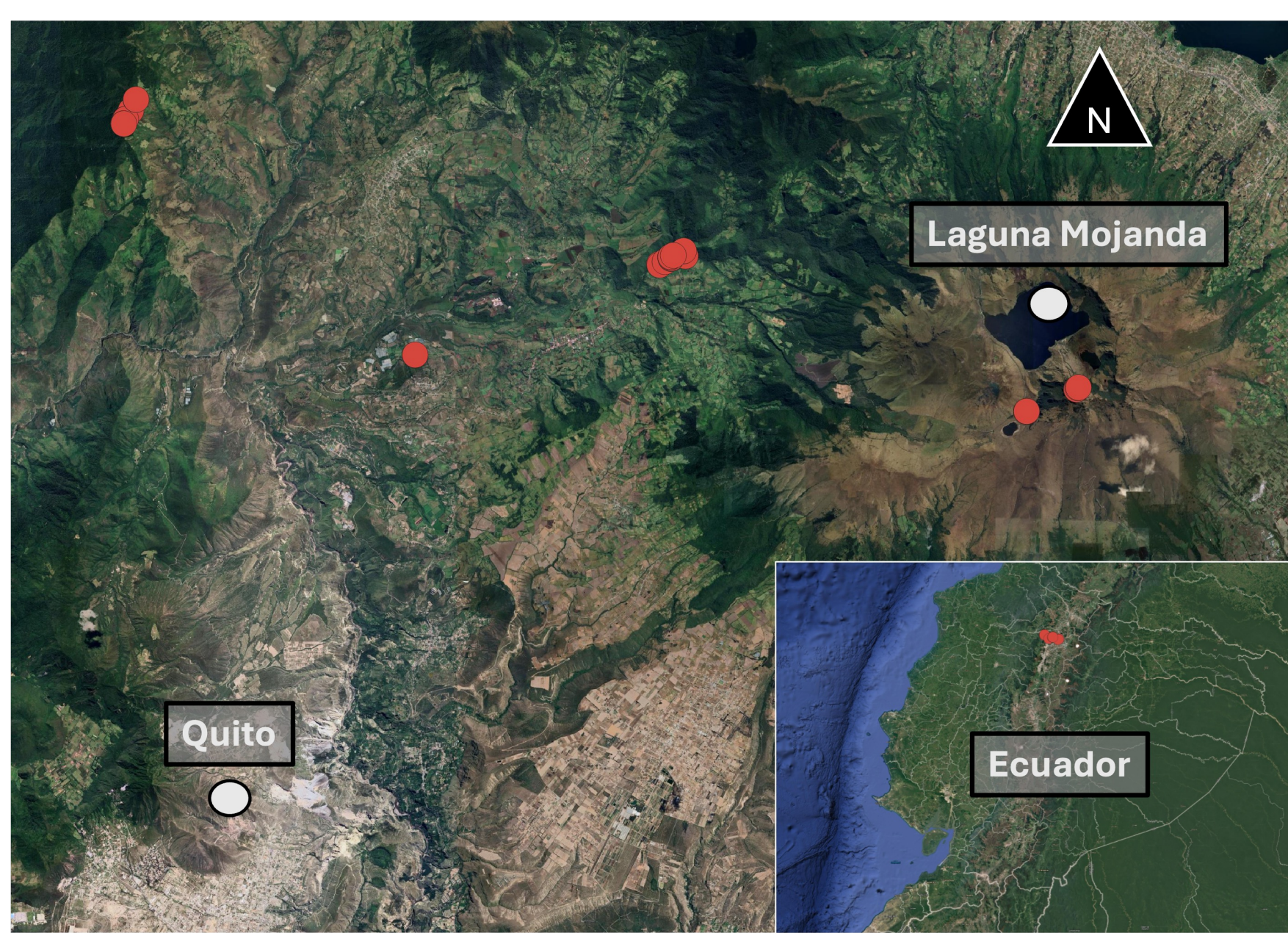
Master Thesis: Supporting community-based climate change adaptation by a low-cost microclimate observation network in the northern Ecuadorian Andes

First results from a low-cost sensor network and mobile laser scanning

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A. Background and Study Area

The **Northern Ecuadorian Andes (NEA)** is a global biodiversity hotspot facing acute socio-ecological risks from land-use change and climate extremes. To support **local climate adaptation**, communities and decisionmakers need accessible, fine-scale microclimate data. We ask: (a) How does land-use type control microclimate buffering? (b) Is vegetation structure associated with buffering capacity?



B. Methodology

Network established in 2025 across 11 plots equipped with 22 TOMST TMS sensors recording soil moisture and temperature across 1,900–3,000 m a.s.l. north and east of Quito. The network spans six land-use types and is supported by one reference weather station (Vaisala) in the upper Río Piganta catchment. **Vegetation structure** was characterized using mobile laser scanning (MLS; one scan per plot), deriving metrics such as box dimension (Db; structural complexity) and Plant Area Index (PAI).



Foto 1: Workshop with the local community and Fundación Cambugán (© Felix Ganter).

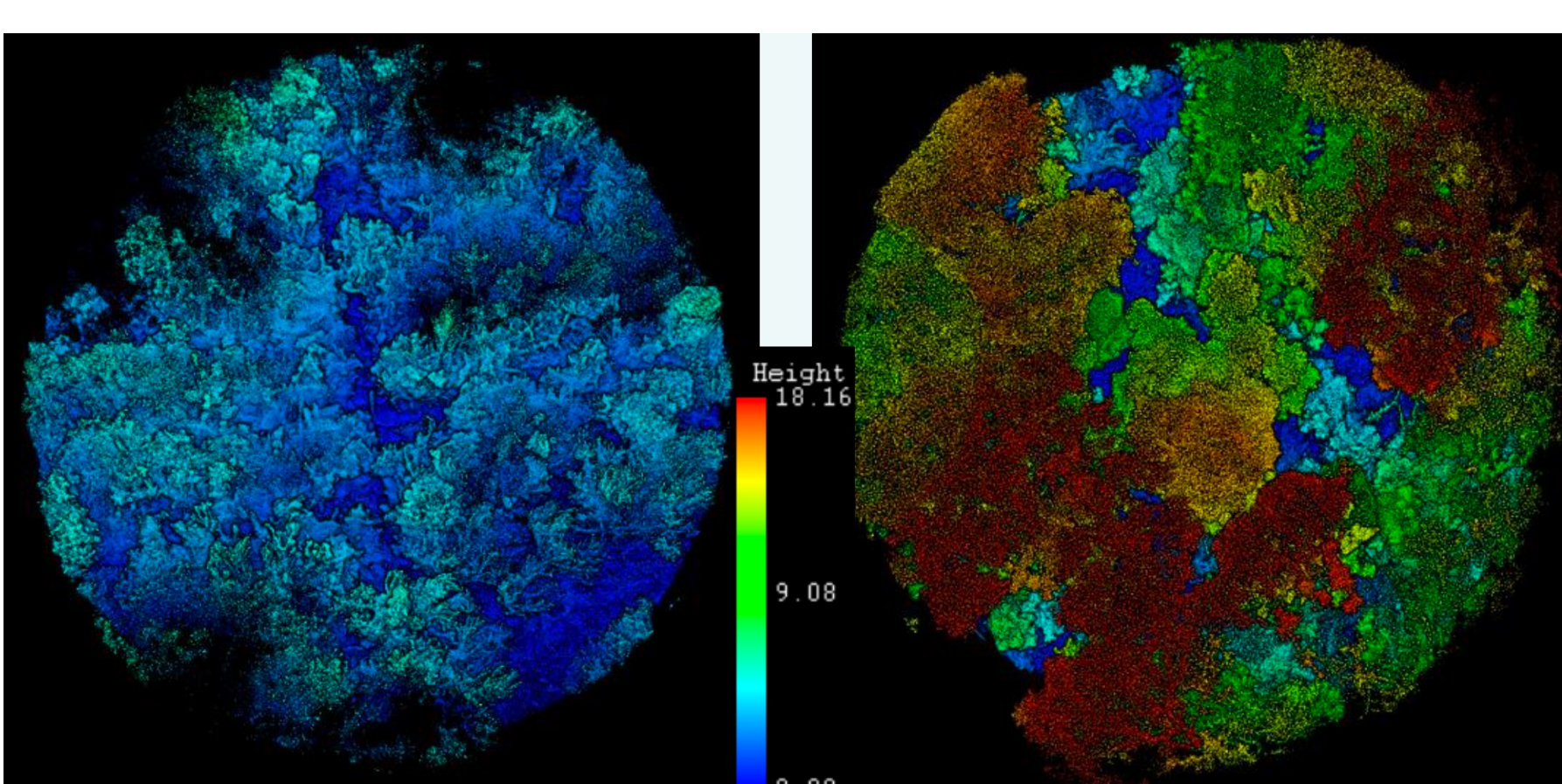


Fig. 1: Top-down view of MLS point cloud data for shrubland plot in Atahualpa (left) and forest plot in Cambugán (right). (© Alejandra Valdés-Urbe)



Foto 2-4 in order: Meteostation, ZEB Horizon MLS, Old-growth Forest, TOMST TMS Sensor (© Felix Ganter, FARO Knowledge Base)

C. Preliminary Results

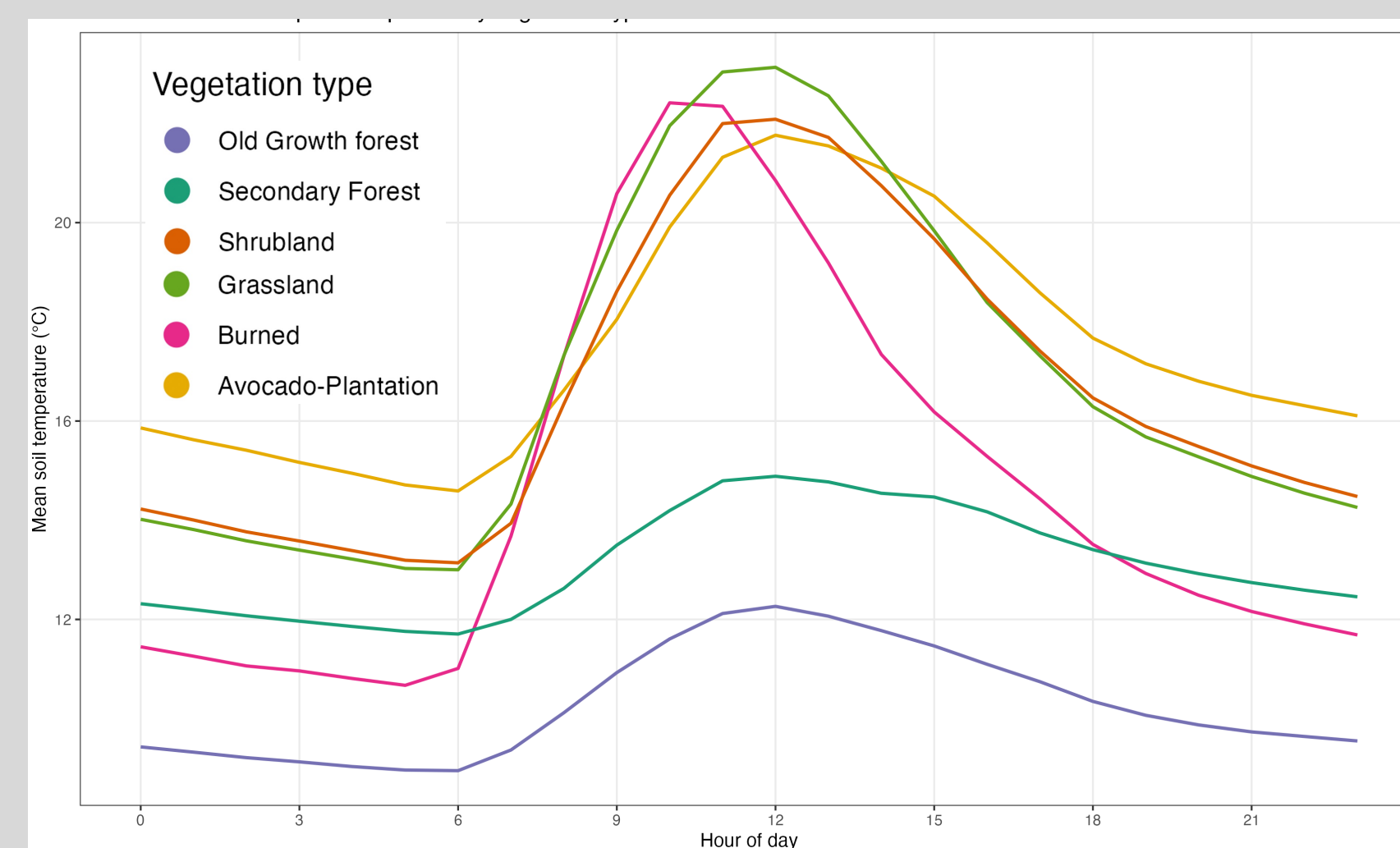


Fig. 2: Mean diurnal soil temperature pattern by vegetation type. Old-growth forest remains cooler and stable (~10°C) throughout the day. Burned forest peaks at ~25°C at midday - a 12°C difference from old-growth at the same hour.

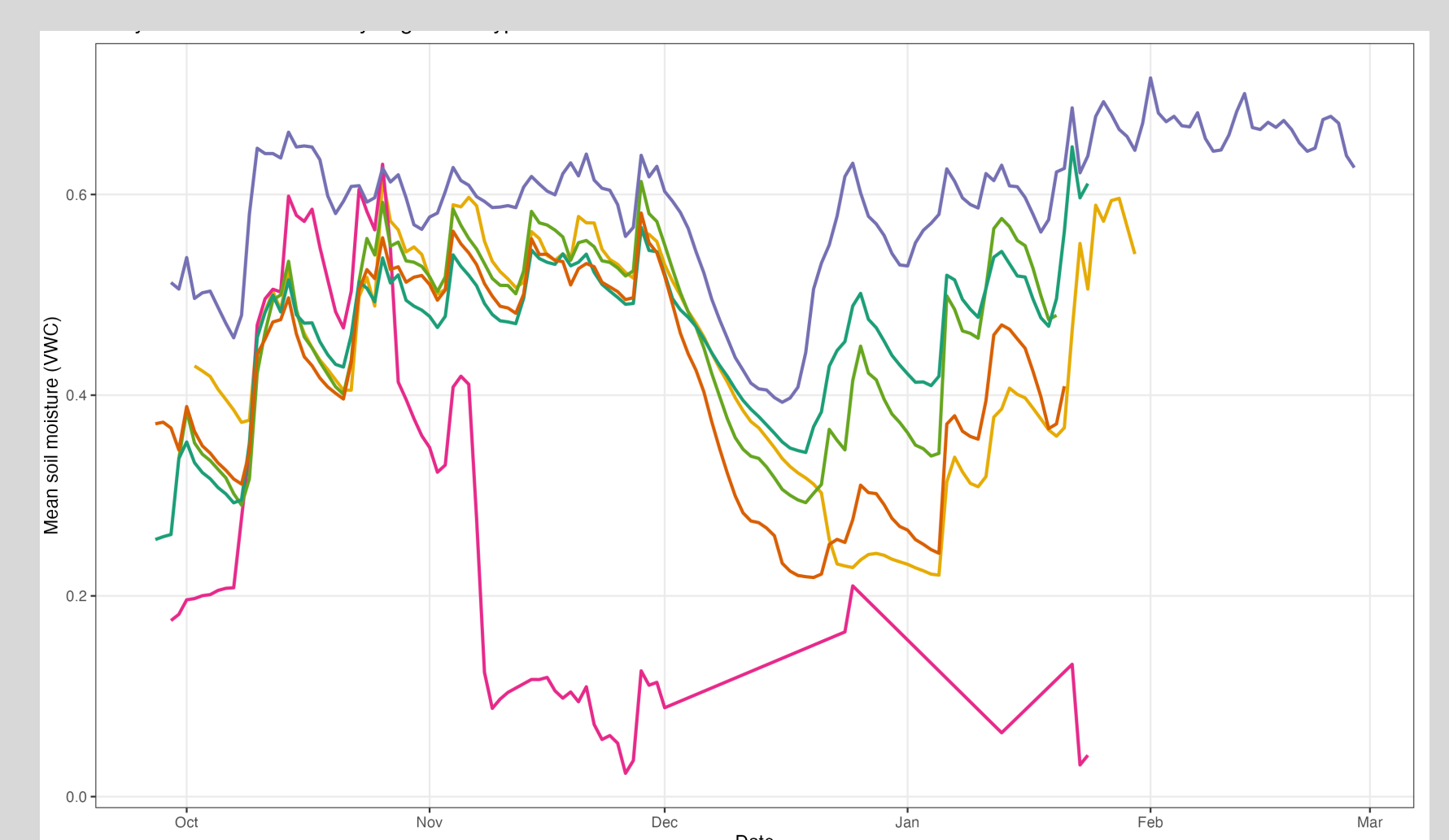


Fig. 3: Daily mean soil moisture by vegetation type. The Old-growth forest remained consistently highest, whereas the pink line showed substantially lower and more discontinuous values.

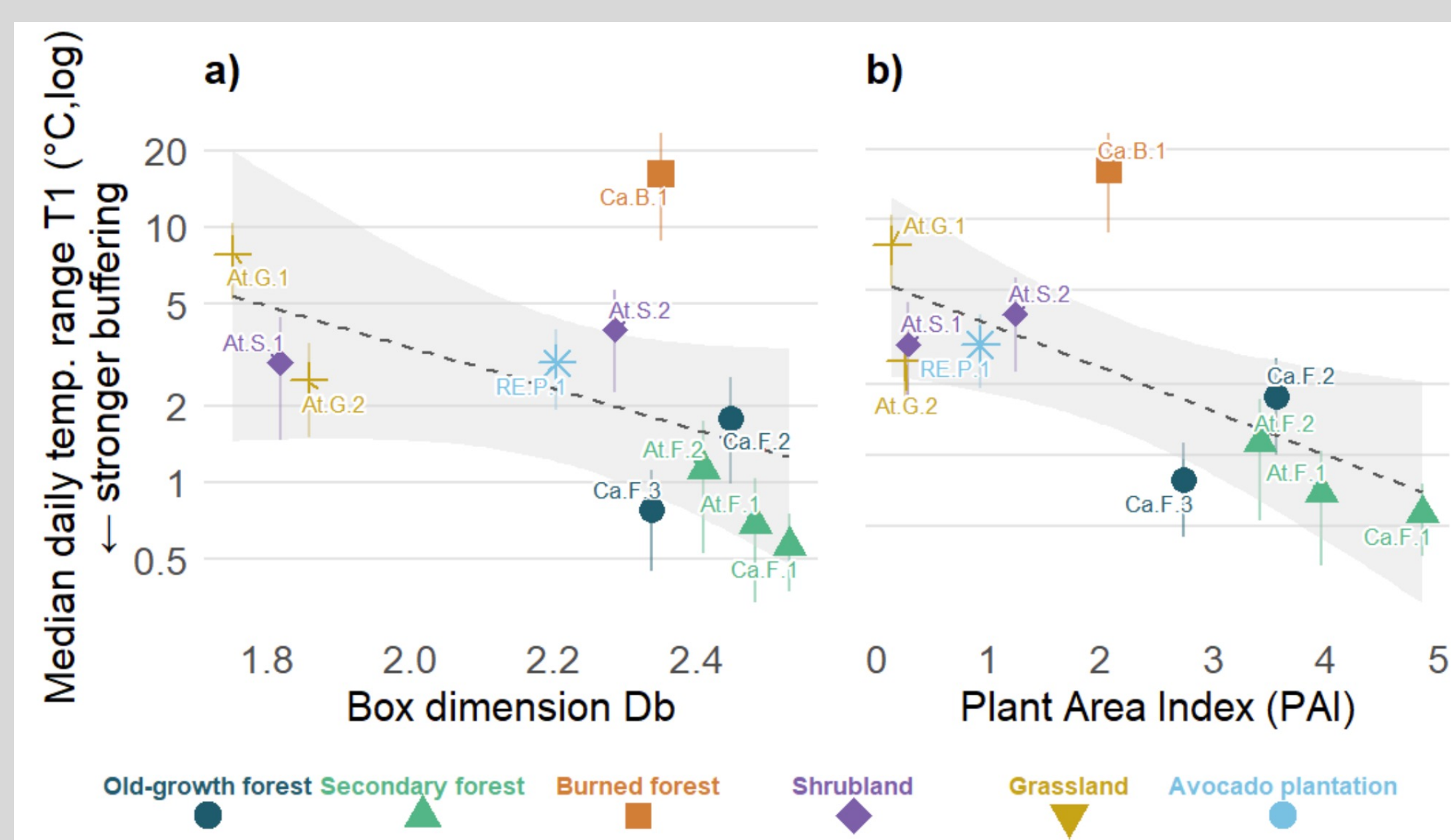


Fig. 4: Median daily T1 range vs. (a) box dimension Db and (b) PAI per plot. Both metrics show a negative relationship with temperature range — structurally complex vegetation buffers more effectively. Burned forest loses buffering capacity almost entirely, despite retaining structural complexity.

D. Discussion

- Land-use type controls microclimate buffering, reflecting canopy-driven attenuation of external conditions.
- Both Db and PAI show a preliminary negative association with temperature range.
- Burned plot retains high structural complexity from standing dead biomass yet shows near-zero buffering.

E. Conclusion and Outlook

Low-cost TMS networks provide microclimate data at the community scale — a feasible baseline for land-use adaptation planning in tropical mountain landscapes.

F. Outlook

- Analysing soil-moisture and temperature dynamics at plot level, including moisture variability, temperature amplitude, and compare them to the local climate data.
- Relating microclimatic variables to interpretable LiDAR-derived vegetation metrics, including upper vegetation height, vertical heterogeneity, layering, and fractal complexity.
- **How can we integrate these data into local decisionmaking?** Already implementation of local capacity building with the data. Further Ideas are welcome - **please get in touch.**

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