Assessing biodiversity from space: An example from the diverse tropical mountain rainforests

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Platform for Biodiversity and Ecosystem Monitoring and Research in South Ecuador

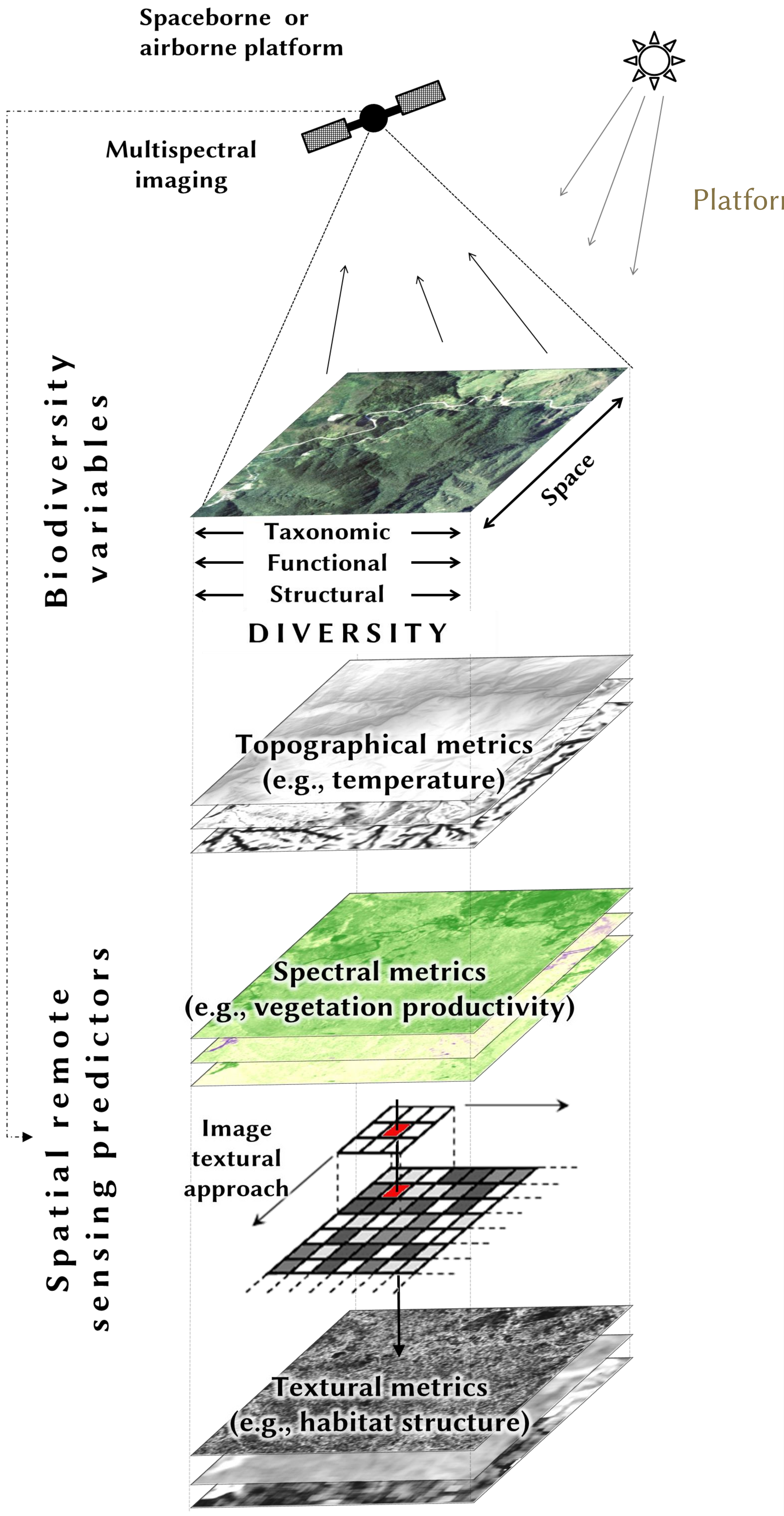

Figure 1 Sampling of in situ data of interest for biodiversity monitoring and their remotely sensed environmental drivers.

Background

The development of spatially explicit indicators is of particular interest for biodiversity monitoring. This is especially the case in remote and topographically complex regions such as tropical mountain rainforests. Spatially explicit indicators of biodiversity can be derived from spaceborne multispectral remote sensing data with an appropriate life span and repetition rate which enables long-term monitoring.

Aim

Here, we aimed to model and map tropical montane biodiversity variables considering taxonomic and functional diversity using multispectral Landsat 8 OLI data. We compared the predictability, the relative predictor contributions and spatial patterns of multiple biodiversity variables in a tropical montane rainforest in southern Ecuador.

Data and Methods

In-situ sampling

- Species richness of trees, ants, moths and birds
- Forest biomass, productivity and four canopy traits at the community level of trees

Predictors

- Topographical, spectral and textural metrics derived from a Landsat-8 scene (Figure 1).

Approach

- Partial least squares regression models of all response variables
- The resulting prediction maps were further used to derive a biodiversity index map as well as a multi-criteria hotspot map (workflow in Figure 2).

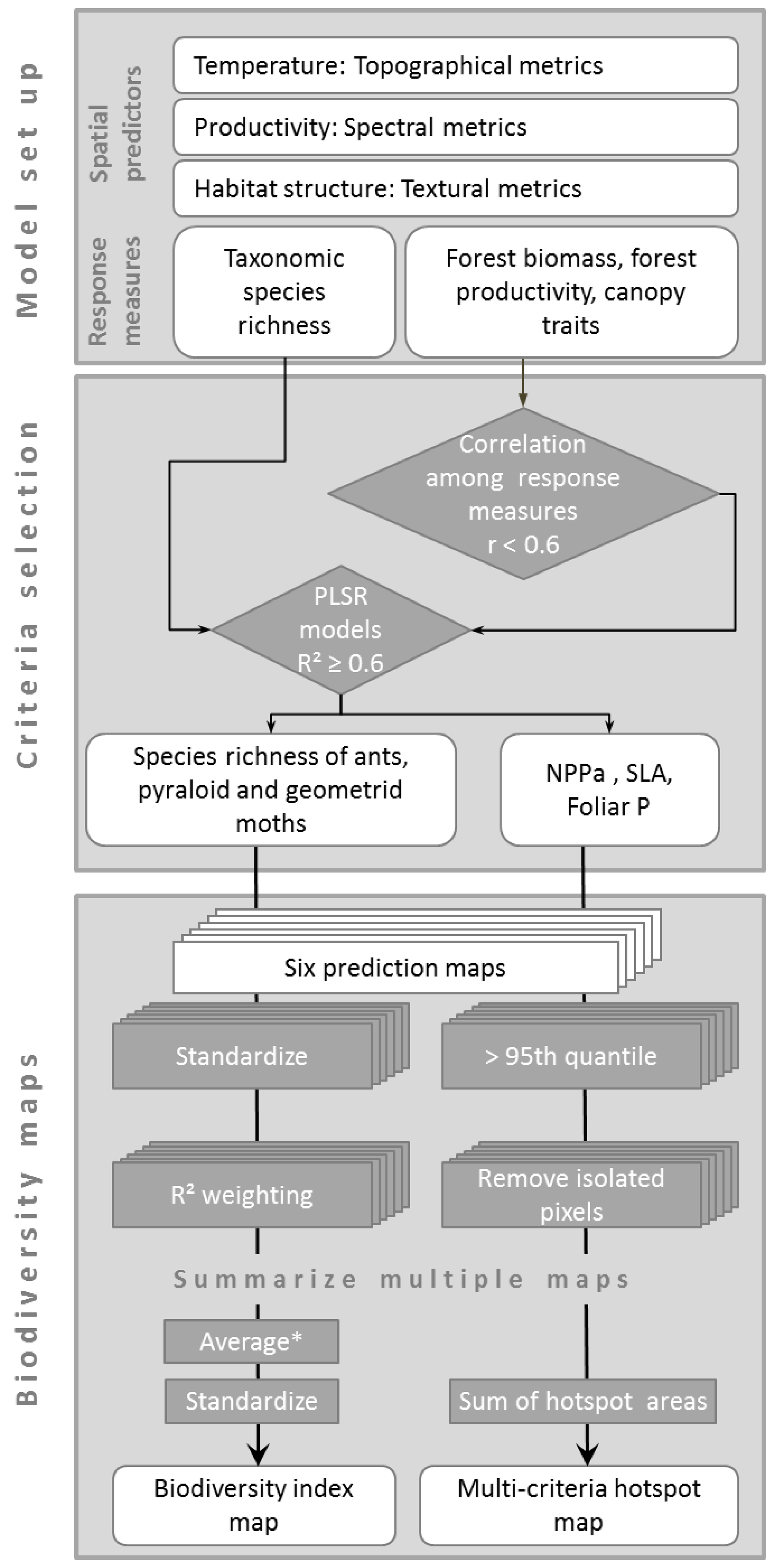

Figure 2 Work flow to summarize multiple prediction maps of biodiversity variables.

Results

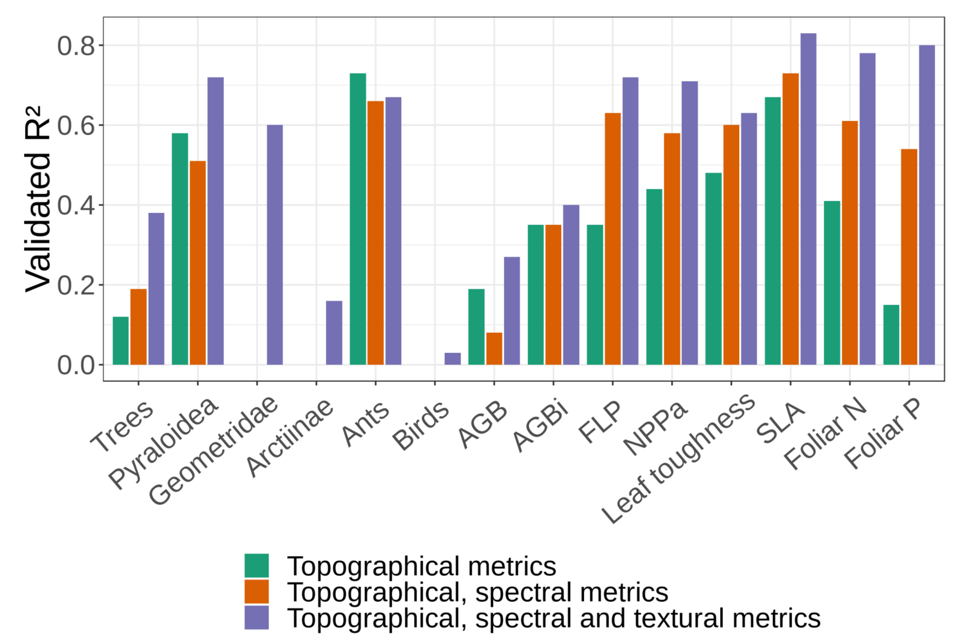

Figure 3 Leave-one-out validated R² values derived from PLSR models for taxonomic and functional diversity. AGB = aboveground biomass, AGBi = woody biomass increment, FLP = fine litter production. NPPa = aboveground net primary production, SLA = specific leaf area. Functional leaf traits (leaf toughness, SLA, foliar N and P concentration) were measured as community weighted means.

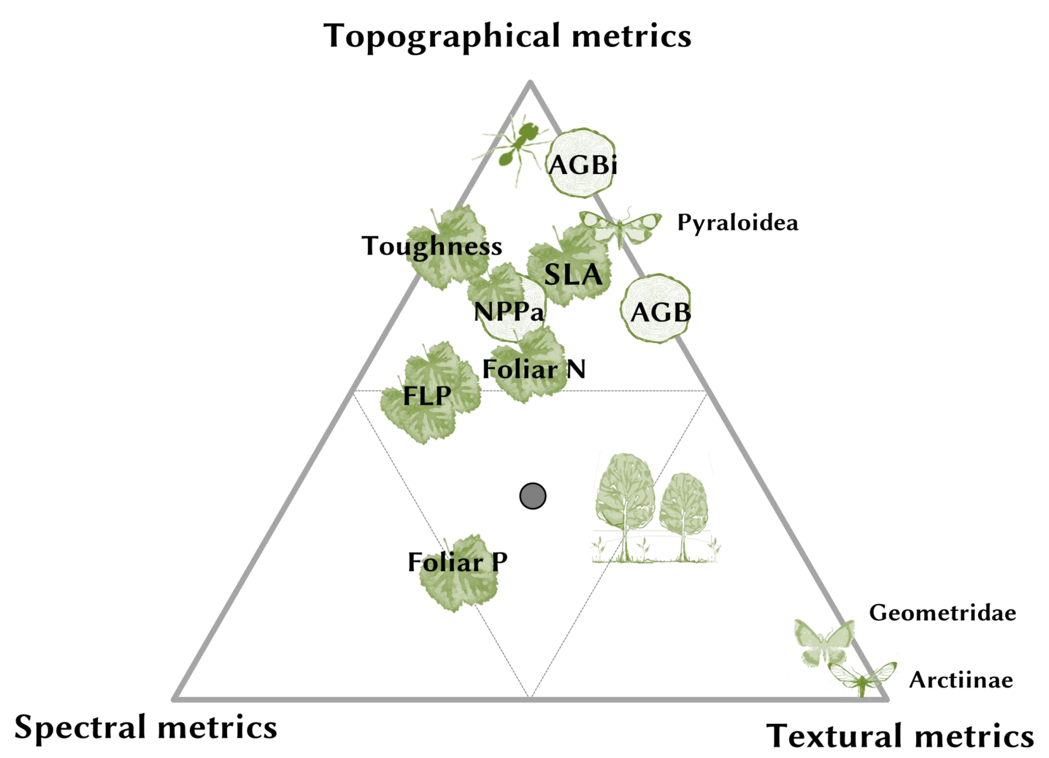

Figure 4 Relative predictor contributions of predictor sets among different biodiversity variables.

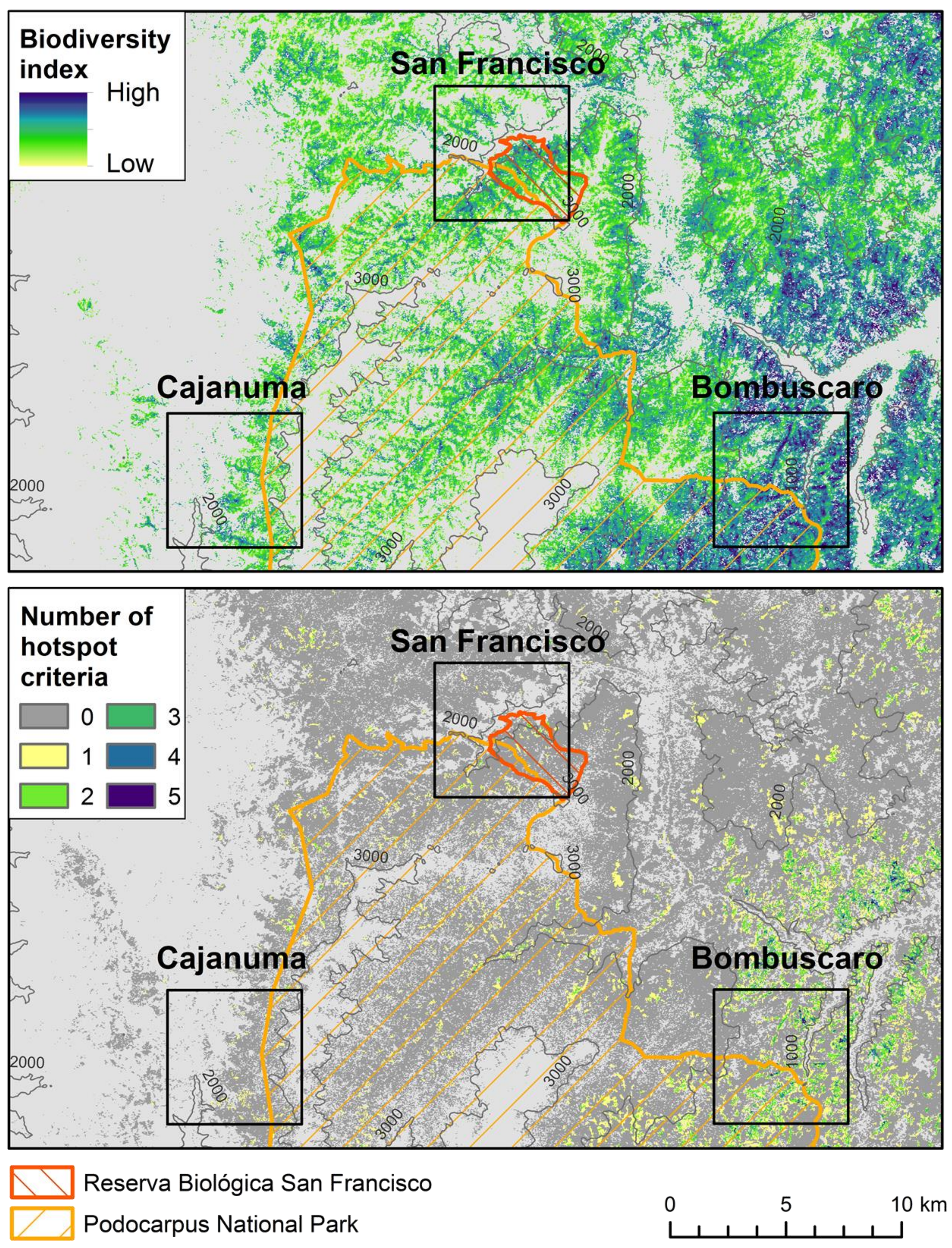

Figure 5 Prediction maps for the tropical mountain rainforests in southern Ecuador.Top: Biodiversity index map. Bottom: Multi-criteria hotspot map. See also Figure 2 for details.

Conclusion

- We found varying predictability of taxonomic richness as well as among productivity measures and canopy traits.
- The models indicated differences in their predictor importance unveiling that certain taxa could be modeled using topographical metrics only, while others benefit from the inclusion of spectral and textural metrics.
- The derived biodiversity maps identified a peak of biodiversity north of Bombuscaro which should become a focus for future field work and conservation efforts
- There is no need that different biodiversity variables are spatially congruent.

Perspectives

To enhance the quality of biodiversity maps and their applicability in conservation management, following questions need to be addressed:

- How to combine biodiversity variables to measure ‘biodiversity as a whole’?
- Which biodiversity variables are necessary, which are less important?

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