Mapping tree species vulnerability to multiple threats as a guide to restoration and conservation of tropical dry forests

Tobias Fremout[a,b], Evert Thomas[b], Hannes Gaisberger[c], Koenraad Van Meerbeek[a], Jannes Muenchow[d], Siebe Briers[a], Claudia Elena Gutierrez-Miranda[e], José Luis Marcelo-Peña[f], Roeland Kindt[g], Rachel Atkinson[b], Carlos Iván Espinosa[h], Zhofre Aguirre-Mendoza[i], Bart Muys[a,*]

[a] Division of Forest, Nature and Landscape, KU Leuven, Leuven, Belgium; [b] Alliance Bioversity International - CIAT, Lima, Peru; [c] Alliance Bioversity International – CIAT, Maccarese, Italy; [d] Institute of Geography, Friedrich Schiller University, Jena, Germany; [e] Facultad de Ciencias Forestales, Universidad Nacional Agraria La Molina, Lima), Peru; [f] Universidad Nacional de Jaén, Jaén, Peru; [g] World Agroforestry, Nairobi, Kenya; [h] Departamento de Ciencias Naturales, Universidad Técnica Particular de Loja, Loja, Ecuador; [i] Herbario LOJA, Universidad Nacional de Loja, Loja, Ecuador

Context

Most vulnerability assessments:
- Are not spatially explicit
- And/or focus only on climate change and/or land use change
- Assume that different species are equally sensitive to threats

Research questions

1. How to design a transparent but robust **spatially explicit vulnerability mapping** method to estimate the impact of **different current and future threats** to **different tree species**?

2. How to translate these patterns of vulnerability into concrete recommendations for **restoration and conservation actions**?

Methodology

Study species: 50 most frequent species of the tropical dry forests of northwestern Peru and southern Ecuador

Ensemble **habitat suitability modelling** to estimate distribution ranges and **climate change exposure**
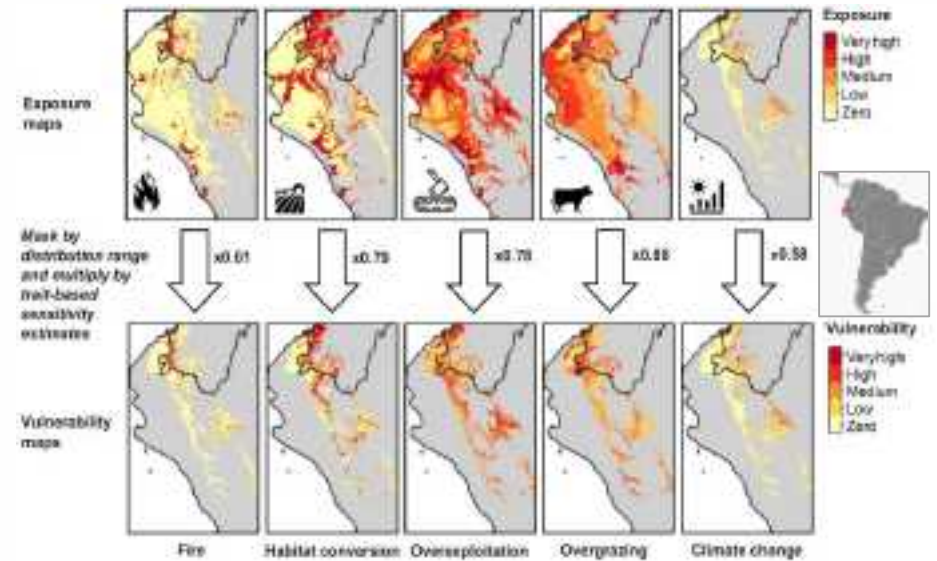
Freely available spatial datasets to estimate **exposure to fire, habitat conversion, overexploitation, and overgrazing**

Sensitivity scoring of tree species using **functional traits**:

Vulnerability maps = exposure maps x sensitivity:

Sensitivity analysis to assess robustness of the results against
- Thresholds used to construct exposure maps (nominal, best-case, worst-case)
- Chosen trait weights to estimate sensiti
- Missing traits

Results

Main findings:

1. Average of 46% of species distribution range under high to very high vulnerability to at least one of the five threats

2. Habitat conversion, overgrazing and overexploitation more important threats than climate change

3. Results relatively robust against chosen trait weights and missing traits, but sensitive to thresholds used to construct exposure maps

Species-specific priority maps for restoration and conservation actions:

In-situ conservation and seed collection in areas with low vulnerability to climate change and current threats

Ex-situ conservation or translocation of populations in areas with high climate change vulnerability

Active planting or assisted regeneration in areas under high current threat vulnerability but low climate change vulnerability

General priority maps for restoration and conservation actions: