Prospective distribution-shift of native tree species in Ecuador according to future climate projection

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Introduction

Most human populations in tropical regions rely on the forest as resource for income, food, construction, energy and medicine. In Ecuador these human activities promote land-use change, which together with the effects of climate change can pose a major threat to conservation. One counter-measurement to prevent the negative impacts is to improve current Forest Management Strategies, paying special attention to the resilience of forest species against environmental change. This study uses species distribution models to explore the potential effects of climate change on the geographical distribution of important tree species native to the region.

Methods

We selected species based on the relative importance for local livelihoods, e.g. providers of Timber or Non-timber Forest Products (NTFP) and some endemic species of the area. We obtained occurrences from herbaria and the Ecuadorian Ministry of Environment; Bioclimatic layers were downloaded from WorldClim at 30 s resolution (approx. 0.9 x 0.9 km). For environmental niche modelling we used Maxent v3.3 previous removal of highly correlated variables. Future climate scenario chosen was the most extreme projection for 2070 (RCP 8.5; GCM HadGEM2-ES; from CMIP5).

Data points quality was guaranteed by validation of metadata and removal of mismatched points, then we used ENMTools v1.4.4 to leave a single occurrence per raster pixel. Remaining predictor variables were Annual temperature, Mean diurnal range, Temperature seasonality, Temperature annual range, Annual precipitation, Precipitation seasonality, and Precipitation of wettest and driest quarter. All raster data and analysis was performed using QGIS v2.2.

Results

Raw occurrence data set had between 21 and 126 points depending of the species. Only models with high AUC outcomes are reported here (0.87-0.96). Caution should be exercised in the interpretation of results, given that projected areas strictly represent suitable climatic niche, rather than distribution of the species.

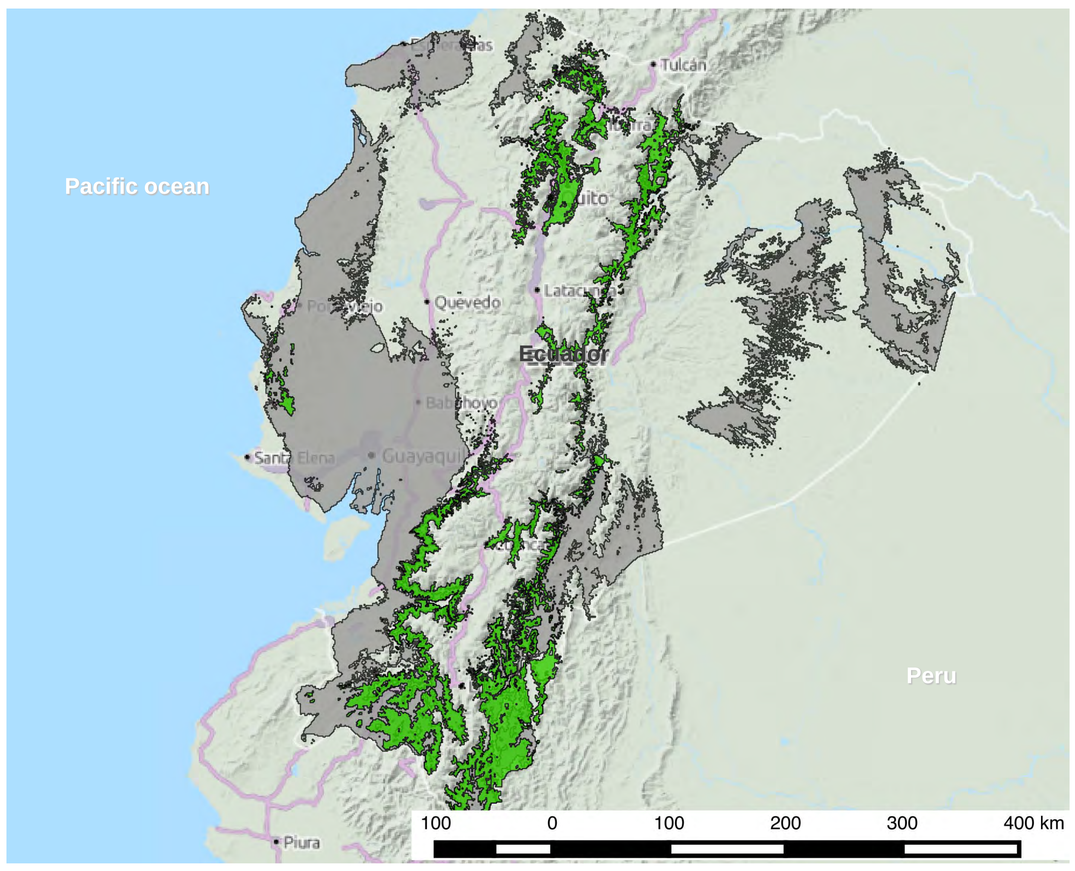

Fig. 1: Example of Environmental niche modeling for *Tabebuia chrysantha*. Grey shadow shows current projection and bright-green color shows future projection (2070)

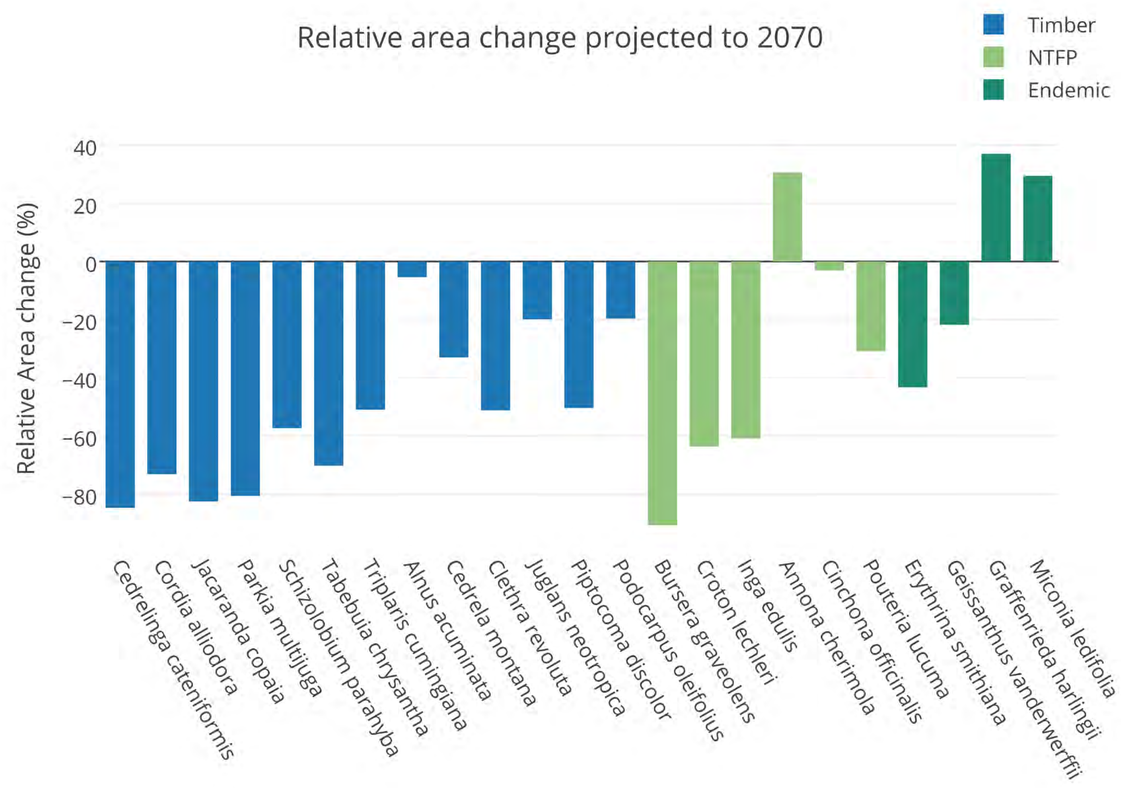

Fig. 2: Based on present and future climate, we measured projected areas for each species. This graph shows relative change (positive values = increase area; negative values = decrease area).

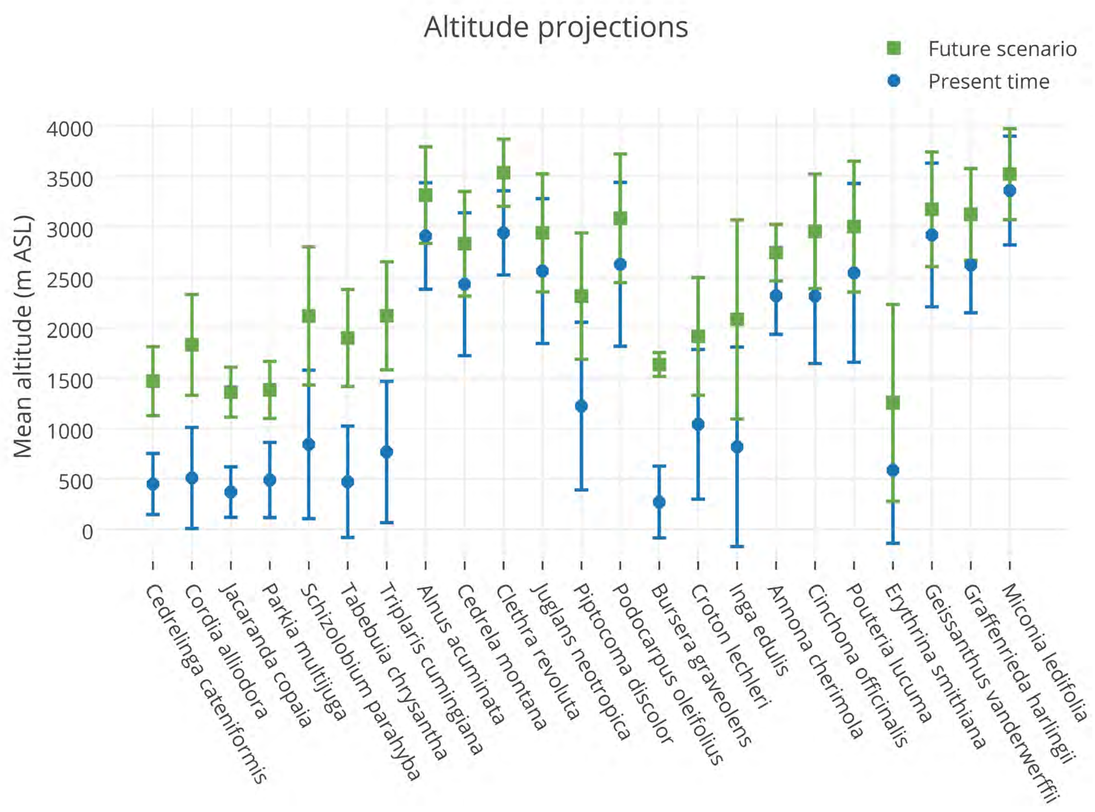

Fig. 3: Mean altitude of each species for present and future (2070) projections. Same order as previous figure to identify Timber, NTFP and Endemics species. Error bars represent SD.

Most commercially-valuable species presented in this study show a decrease in area based on RCP 8.5 future scenario. This effect, appears to be higher for predominantly lowland species, such as *B. graveolens*, *C. cateniformis, C. alliodora*, *J. copaia*, *P. multijuga* and *T. chrysantha*. Consistently, mountain tree species such as *Alnus acuminata*, *Cinchona officinalis*, *Juglans neotropica* and *Podocarpus oleifolius* show the least effect in projected area reduction.

Conclusions

Country-wide forest management strategies should consider the potential distribution-shift of suitable climatic variables for individual species, particularly before promotion of selected species for timber and NTFP production like the Ecuadorian Economic Incentives Program for reforestation with commercial purposes, currently-implemented since 2013.

Future steps

Currently resilience indicators are being assessed by comparison of genetic diversity among selected populations, as well as tree rings core extractions to find out population responses to common environmental stressors. Future steps also consider germination experiments under different climatic conditions.

Relevant literature:

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Phillips, S. J., R. P. Anderson, and R. E. Schapire. 2006. Maximum entropy modelling of species geographic distributions. Ecological Modelling 190:231-259

Acknowledgements

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