CEST 2019

Sustainable landscapes: restoration and land use planning in an adaptive approach to climate change and desertification. Case study of Inter-Andean Valley of Cauca River in Colombia.

Alvarado-Solano D. P.[1,2,*]**, Otero J.T.**[2]**, Šarapatka B.**[1]

[1] Department of Ecology and Environmental Sciences, Faculty of Science, Palacký University Olomouc, Czech Republic.

[2] Grupo de Investigación en Orquídeas, Ecología y Sistemática Vegetal, Universidad Nacional de Colombia, Sede Palmira.

*corresponding author: e-mail: dianapatricia.alvaradosolano01@upol.cz

Abstract

The inter-Andean valley of Cauca River (IVCR) is one of the most industrialized regions in Colombia leading its seasonally dry tropical forest (SDTF) to a fragmented and degraded state. Changes in land cover may alter the climatic and hydrological patterns. In the period 1984 – 2014, 26% of natural areas detected remotely at IVCR have persisted in a sugarcane matrix. However, IVCR species composition and its ecological status are unknown. After reviewing several datasets, 1725 plant species were compiled. Using a modelling approach, habitat suitability was predicted with a maximum entropy algorithm implemented in Biomod2 R-Package for 14 prioritized plant species. Models were produced using as predictors, the variables selected with their Variance Inflation Factor (VIF) and for those selected with a Principal Component Analysis (PCA). Although the selected variables differed between VIF and PCA, the geographic space predicted to be suitable for the species were similar. VIF and PCA variables strongly reflect the temperature and precipitation under warm and wet periods and their seasonality. These models will help to estimate the potential restoration of SDTF at the ICVR and its vulnerability to climate change. This information will contribute to planning effectively the IVCR landscape for the future.

Keywords: Anthropogenic landscape, Land degradation, Species distribution modelling.

1. Introduction

Land cover change (LCC) is one of the major drivers of biodiversity loss worldwide. Due to its moisture deficit and extensive agriculture, seasonally dry tropical forests (SDTF) are among the most susceptible ecosystems to land degradation (Pulla et al. 2015). 54% of SDTF global remnants are found in South America (Portillo-Quintero & Sánchez-Azofeifa, 2010), in Colombia less than 8% still persists and, ICVR is where SDTF is more degraded (Alvarado-Solano & Otero 2017). Climate change will influence, among others, species distribution ranges, and therefore, is a priority to know the species composition in the landscape and to understand the influence of the climate on their distribution. According to the previous, species distribution modelling approach is being used to identify areas with potentially suitable habitat conditions for STDF plant species. The results will be used as input to evaluate different restoration scenarios and to be considered as potential areas for restoration.

2. Material and Methods

Study Area. The IVCR, with 7313 ha, is in the southwestern portion of the Colombian Andes mountains (7°17' 41.49" N - 76°39'25.85" W, 3°0'4.083"N - 75°21'32.762" E). The ecoregion is characterized by a bimodal precipitation regime (annual average = 160 mm.y-1), with two peaks in the months of May (215 mm.y-1) and October (251 mm.y-1); and an average temperature of 23°C (min: 18 °C, max = 28 °C) (WorldClim V2, Fick and Hijmans 2017) The IVCR includes six administrative Departments, Antioquia (29.16%), Caldas (10.26%), Cauca (8.13%), Quindío (0.19%), Risaralda (4.11%) and Valle del Cauca (48.15%).

Prioritization of species. A total of 36 data sets (SIB Colombia, https://sibcolombia.net/servicios/herramienta-de-publicacion/) were reviewed, filtered and cleaned for all the plant species records included in the IVCR. Then, species were prioritized based on a set of criteria: threat level, endemism and priority category (Pizano and García 2014).

Habitat suitability approach: A maximum entropy algorithm (Maxent) implemented in the Biomod2 R-Package was used. Bioclimatic variables (BCV) (http://worldclim.org/) and species occurrence records (https://www.gbif.org/) were used as inputs. Model complexity was reduced filtering BCV with their Variance Inflation Factor (VIF) and Principal Component Analysis (PCA). Models were built using VIF and PCA selected variables (10 runs, 1000 iterations). Binary maps (presence/absence) were created using the performance statistics, True Skill Statistic (TSS) and an arbitrary threshold of 70% of habitat suitability (HS).

3. Results

Prioritized species. 1725 plant species distributed in 7 classes, 58 orders, 167 families and 823 genera, have been recorded in the IVCR. From those, 112 species were prioritized and from this group, 14 species were chosen to identify potentially suitable habitats.

Habitat suitability modelling: Variables selected using VIF and PCA differed for each species. With VIF, bio2, bio3, bio8, bio13, bio14, bio15, bio18 and bio19 were almost uniformly selected (>11 sp.). For PCA, bio1, bio4, bio5, bio9, bio10, bio11, bio12 and bio17 were chosen (>8 sp.). After running Maxent and ensemble models were obtained with Biomod2, an initial restoration scenario for the SDTF in the IVCR was prepared by joining each species' mean model according to the method used to reduce the number of environmental predictors (Fig. 1).

Discussion

Identifying potential areas for restoration requires exploring new approaches. Habitat suitability modelling (HSM) provides a spatially explicit representation of potentially suitable areas for a species. For the IVCR, models produced with a different set of variables influenced the extent of suitable areas for each species. PCA models were less constrained when compared with VIF models. However, models exhibit favourable habitats for 85% of the species in the central part of the ecoregion. This area corresponds to the north sector of Valle del Cauca, in which LCC was less intense than in the southern sector (sugarcane-dominated landscape) and where more persistent natural areas were detected with multitemporal analysis (Alvarado-Solano and Otero, 2017).
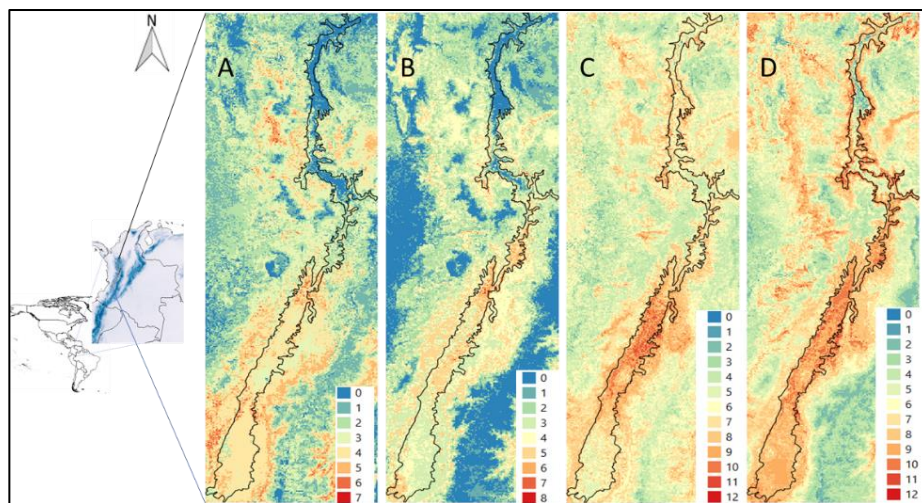
Figure 1. Restoration scenarios produced with TSS and HS >70% with variables selected by VIF and PCA. A: VIF-70; B: PCA-70; C: VIF-TSS; D: PCA-TSS. Colours show combined binary maps for 14 species modelled

4. Conclusions

Landscapes will be influenced by climate change, and those that are under degradation, as the highly fragmented IVCR region, are vulnerable to novel climate conditions. To be able to face those conditions, stakeholders must know the species distributed on the landscape and their ecological requirements. The best information should be available for stakeholders and for the decision-making process. HSM can contribute to identifying preliminary restoration localities as part of the task of planning landscapes more effectively for the future.

References

Alvarado-Solano, D. P. and Otero J.T. (2017), Áreas naturales de bosque seco tropical en el Valle del Cauca, Colombia: una oportunidad para la restauración, *Biota Colombiana,* 18, 9-34.

Fick, S.E. and Hijmans R.J. (2017), Worldclim 2: New 1-km spatial resolution climate surfaces for global land areas, *International Journal of Climatology*, 37, 4302-4315.

Pizano, C. and García H. (2014), El Bosque Seco Tropical en Colombia, Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH), Bogotá, D.C., Colombia.

Portillo-Quintero, C.A. and Sánchez-Azofeifa. G. A. (2010), Extent and conservation of tropical dry forests in the Americas, *Biological Conservation*, 143, 144-155.

Pulla, S., Ramaswami, G., Mondal, N., Chitra-Tarak, R., Suresh, H.S., Dattaraja, H.S., Vivek, P., Parthasarathy, N., Ramesh, B.R. and Sukumar, R. (2015), Assessing the resilience of global seasonally dry tropical forests, *International Forestry Review*, 17, 91–113.