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First typology of cacao agroforests in the Colombian Amazon, based on composition, structure and light availabililty

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Background
The cultivation of cocoa in Colombia are of key social importance. Indeed cacao plays a prime role in post conflict resolution as it is the legal crop to replace illicit crops. In the current context of the need of combating climate change, cacao agroforests are also expected to be a sustainable practice, promoting forest-friendly land use. In that context, it is necessary to describe accurately these systems, and especially accounting for their potential in terms of biodiversity conservation.
Aim
In this work, we present a first a typology of cacao agroforest systems in Colombian Amazonia, systems that had yet to be described in the literature. This typology is based on tree species richness, canopy structure and light availability.
Material and Methods
We worked in 50 agroforest plots of 2000m² each, in the Bajo Caguán area of the department of Caquetá, in the Colombian Amazonia. In each plot, we measured variables of composition (diversity of plants associated with cacao trees) and variables of vertical and spatial structure (height layers, Diameter at Breast Height, basal area, shape and area of the crown, (x, y) positions of each individual plant in each plot. We also measured variables of radiation transmitted to cacao trees in the understorey: above the cacao canopy layer, we took hemispherical photographs and measured the intensity of Photosynthetically Active Radiation (PAR, in µmol m-2 s-1) using an AcuPAR LP-80 sensor. We included variables related to light availability to evaluate the amount of transmitted radiation to the cacao trees in each type, and its suitability for cacao ecophysiological development. We also use variables of spatial organization to model the distribution of light in each plot, using two models: Shademotion 4.0 to calculate the fraction of the average of shade hours and shade area in each agroforest plot and the Spatially individual-based Explicit Forest-Simulator to calculate the degree of canopy openness in each agroforest plot. We there used a cluster analysis to build a typology of cacao agroforest, based on 28 variables characterized in each plot, and related to diversity, composition, spatial structure and light availability for the cacao trees.
Major results and Conclusions
We identified 4 types of cacao agroforests. The typology was based on their differences in tree species diversity and the impact of canopy spatial structure on light availability for the cacao trees in the understorey. We also found 127 tree species in the dataset, with 3 out of the 4 types identified displayed an erosion of tree species diversity. This reduction in shade tree species may be linked to the desire to reduce shade, but we also found that all the types described were compatible with good ecophysiological development of the cacao trees. One challenging prospect will be to monitor and encourage the conservation of tree species diversity in cacao agroforest systems during the development of these cropping systems.