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Analysis of determinants of forest - savanna transition in the northern South America

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Forest - savanna transition is the most widespread and perhaps more dynamic ecotone in the tropics, and extremely sensitive to climate and environmental change. Both kinds of tropical ecosystems are globally strategic and their presence and dynamics have important ecological, climatic and biogeochemical implications, even at the global scale. However, the processes and mechanisms that control this transition vary among regions and remain not fully understood. In general, this transition is influenced by multiple interactions between vegetation and environmental factors such as climate, soil properties, fire, and herbivory. However, the magnitude of these effects can vary substantially across continents, which can result in different responses to environmental change. For this reason, more regional studies are needed to describe and understand the factors and interactions that control forest - savanna transition, particularly in Northern South America, where climate alone has failed to explain this transition. Based on a combination of LiDAR and satellite-derived data, we developed a statistical analysis on the interactive effects of rainfall, soil properties, and fire on the forest - savanna transition in Northern South America, in the savanna region between Colombia and Venezuela, using tree cover as an indicator variable that differentiates forest from savanna. Specifically, we analyze the relationships of tree cover (from GEDI) with soil sand content (from SoilGrids), fire frequency (from Fire_CCI v5.1) as well as three rainfall variability components (from CHIRPS): mean dry-season rainfall, length of the dry season, and frequency of rainy days within the dry season. Our results show that tree cover increased with mean dry-season rainfall and frequency of rainy days within the dry season, whereas it decreased with increased fire frequency. In particular, mean dry-season rainfall followed by fire frequency are the most important predictors of tree cover gradient in the transition. Importantly, our results also suggest that areas with high annual rainfall (2000 to 2800 mm) have low tree cover (i.e. savanna) if the local rainfall climatology consists of infrequent (< 0.35) and low total rainfall (< 650 mm) in the dry season. This highlights the role of water availability and fire disturbance in determining the limits between forest and the second largest area of savanna in South America. Further, our results support that future projections for forest - savanna transition should include not only changes in mean annual rainfall but also changes in rainfall variability, which is expected to be more impacted by climate change.