Title: **Extrapolating Ecosystem Processes of Seasonally Dry Tropical Forests Across Geographic Scales and into Future Climates**

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Seasonally dry tropical forests (SDTFs) experience a pronounced dry season, are understudied compared to tropical rain forests, and are poorly represented in earth system models. Important knowledge gaps include: i) whether STDF are vulnerable or resistant to changing rainfall regimes, ii) how plant hydraulic traits and soil biogeochemistry vary across the dry forest biome, and iii) how nutrients and water interact to shape forest structure and function. We addressed these questions using multiple approaches including long-term observations, ecosystem-scale experiments, vegetation modeling, and surveys of plant hydraulic traits. Our results are transforming our understanding of this biome.

Long-term records of forest mortality show that a SDTF in Costa Rica is extremely sensitive to extreme drought, and that hydraulic safety margin explains interspecific variation in tree mortality. We expanded trait measurements to three other dry forests in Colombia, Mexico, and Puerto Rico that differ in rainfall regimes and soil parent material. Hydraulic traits, but not morphological traits, varied in relation to annual precipitation, rainfall seasonality and dry season length, especially when expressed as community weighted mean values. Traits conferring drought tolerance were associated with a less seasonal rainfall regime and a higher proportion of evergreen plant species, irrespective of mean annual rainfall.

We also analyzed soil samples collected during the wet and dry season from these four forests for particle size distribution, elemental composition, microbial biomass and stoichiometry, extracellular enzyme activity, net nitrogen mineralization, and phosphorus fractions. Soil biogeochemistry exhibited marked heterogeneity across the four forests: organic C, N, and P pools varied up to four-fold among sites, and inorganic nutrient pools varied over an order of magnitude. Most soil characteristics changed much more across space (i.e., among sites and plots) than over time (between dry and wet season samplings). Moreover, nutrient pools also exhibited substantial variability within forests, in some cases exhibiting as nearly much heterogeneity within a 0.25 ha plot as observed across the Neotropical dry forest biome. We observed stoichiometric decoupling among C, N, and P cycles, which may reflect their divergent biogeochemical drivers. Organic C and N pool sizes were influenced by the species composition of forest stands, particularly the relative abundance of ectomycorrhizal trees and legumes; by contrast, the distribution of soil P pools was driven by soil weathering status.