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Effect of Extreme Drought on Tropical Dry Forests

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Tropical dry forests (TDFs) hold a strong economic and cultural connection to human development in the Neotropics. Historically, TDFs not only represent a source of agricultural and urban land but also an important source of goods and ecosystem services for the communities that live around them. Such is the close connection of TDFs to human activity that they are considered the most heavily utilized and disturbed ecosystem in the world. However, TDF have been largely understudied and represent only a fraction of research devoted to globally tropical ecosystems. Thus we lack the framework to properly project how predicted increases in drought events due to climate change will impact TDFs and human society which depend on its services.

Our study aims to show the effect of extreme drought on water, food security, and tropical dry forest productivity in the Guanacaste province of Costa Rica. Two pre-ENSO years (2013-2014) and an ENSO year (2015) were compared. The 2013 and 2014 pre-ENSO years were classified as a normal precipitation (1470 mm) and drought year (1027mm), respectively. The 2015 ENSO year was classified as a severe drought (654mm), with amplified effects resulting by the drought experienced during the previous (2014) growing cycle. Effects of the ENSO drought on agriculture and livestock sectors in the province included losses of US$13million and US$6.5million, respectively. Crop land losses equaled 2,118 hectares and 11,718 hectares were affected. Hydroelectricity generation decreased by 10% and potable water shortages were observed. The Agriculture and Livestock Ministry (MAG) and the National Emergency Commission (CNE) distributed animal feed and supplies to 4,000 farmers affected by the extreme droughts.

Eddy covariance flux measurements were used to identify productivity changes during the extreme drought. Changes in phenologic stages and the transitions between CO_2 sink to source during mid-growing cycle were observed. Drought significantly delayed the onset of green-up, as well as prolonged the growth season by extending senescence by approximately 30 days beyond the normal season. Comparison of total accumulated forest productivity for each growth cycle indicated significantly lower carbon sequestration during drought years, with decreasing total accumulation as drought severity increased. TDF appeared to compensate for the decreases in productivity rates during drought by lengthening the growth cycle, potentially to allow a minimum productivity threshold to survive the yearly dry season. The dynamic changes occurring in TDF carbon cycling emphasizes the importance of further studies of this ecosystem as it has a direct impact on biodiversity, ecosystem services, and water and food security.