Drought Effect on Carbon Sequestration of a Costa Rican Tropical Dry Forest

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Tropical dry forests (TDFs) constitute over 40% of all tropical forests (Van Bloem et al., 2004) and have been shown to be the most threatened and disturbed ecosystems in the tropics (Janzen, 1998). Still, these biomes remain understudied and represent only a fraction of research devoted to tropical forest globally. TDFs contain large stores of biomass, which lead to rapid cycling of carbon pools through photosynthesis and respiration. The projected increase in drought due to climate change (IPPC, 2007) is expected to affect the mechanisms and total amount of carbon sequestered by TDFs.

Using eddy covariance flux measurements in Santa Rosa National Park, Costa Rica, we investigated the relationship between phenology and productivity during pre-ENSO years (2013-2014) and an ENSO year (2015). 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) and was compounded by the drought experienced during the previous (2014) growing cycle. Flux measurements were used to identify the onset of phenologic stages (green-up, maturity, and senescence) as well as the ecosystem transition between CO_2 source and sink. Drought was observed to significantly delay the onset of green-up, as well as prolog the growth season by extending senescence by approximately 30 days beyond the normal season. Comparison of compound accumulated GPP 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 highly dynamic changes occurring in TDF carbon cycling emphasizes the importance of these ecosystems as we try to better understand and model global changes in a climate change world.

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