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Phosphorus speciation by 31P NMR in seasonally dry tropical forests across a rainfall gradient

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The effect of precipitation regime on the P cycle of tropical forests is poorly understood, despite the existence of models that suggest a drier climate may substantially alter the biogeochemistry of these ecosystems. Along a precipitation regime gradient containing 12 mature seasonally dry tropical forests growing under otherwise similar conditions (similar annual temperature, rainfall seasonality, and geological substrate), we analyzed the influence of variation in annual rainfall (1240 to 642 mm) and duration of seasonal drought (from five to seven months) on soil P cycling. We investigated litterfall-, litter-, fine root- and soil-P, and analyzed the dependence of these processes and pools on rainfall amount. Total P concentration in both litterfall and roots decreased from stands with 1240 mm yr-1 to those with 642 mm yr-1, meanwhile increased in forest floor litter and mineral soil. The 31P NMR technique revealed that, consistently, orthophosphates and monoester-P dominated the P return from plants (i.e. in litterfall and fine roots, and litter) to soil, as well as the P organic species in mineral soil across sites. Reduced precipitation strongly affected orthophosphate abundance in roots, and monoester-P abundance in litterfall and soils that decreased with decrease in rainfall amount. Also, diester-P and pyrophosphate abundances in litterfall and soils decreased with the decrease in rainfall. We conclude that in these forest ecosystems, the long-term consequences of increase drought would be a decrease in P cycling, and an increase in P storage in organic layer and mineral soil, mainly due to lower decomposition and restricted P-uptake by plants, and likely also less soil leaching, resulting in accumulation of labile inorganic and organic P forms. This could turn these seasonally dry tropical forests into significant soil P hotpots under the predicted longer drought periods if primary productivity is maintained.