Geophysical Research Abstracts
Vol. 19, EGU2017-17194-1, 2017
EGU General Assembly 2017

Conversion of tropical forests to smallholder rubber and oil palm plantations impacts nutrient leaching losses and nutrient retention efficiency in highly weathered soils

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We examined the impact of forest conversion to rubber and oil palm plantations on nutrient leaching and nutrient retention efficiency in the soil. In Jambi province, Indonesia, we selected two landscapes with highly weathered Acrisol soils, which differed in texture: loam and clay. Within each landscape, we compared two reference land uses (lowland forest and jungle rubber, defined as rubber trees interspersed in secondary forest) with two converted land uses (smallholder rubber and oil palm plantations). The first three land uses were represented by four replicate sites and the oil palm by three sites within each landscape. We measured leaching losses using suction cup lysimeters, sampled biweekly to monthly from February to December 2013. In these highly weathered soils, texture controlled nutrient- and water-holding capacity and leaching losses. The clay Acrisol reference land uses had larger soil cation exchange capacity, base saturation and soil organic C than those in the loam Acrisol; this resulted in lower leaching of dissolved N and base cations (P=0.01-0.06) and in higher retention efficiency of N and base cations in the clay soils (P<0.01-0.07). The fertilized area in smallholder oil palm plantations resulted in increased leaching of dissolved N, organic C and base cation (P<0.01-0.08) and in reduced N and base cation retention efficiencies compared to the reference land uses and/or the rubber plantations (P<0.01), particularly in the loam Acrisol. Additionally, N fertilization in the loam Acrisol oil palm plantations had decreased soil solution pH and increased dissolved Al. The unfertilized rubber plantations had low nutrient leaching fluxes brought about by its reduced soil fertility. Our results highlight the importance of developing soil management practices to maintain soil fertility in unfertilized rubber plantations and to increase nutrient retention efficiency in fertilized oil palm plantations in order to minimize the reductions of ecosystem provisioning services (e.g., soil fertility and water quality) in these converted landscapes.