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Response of soil microbial activity and community structure to land use changes in a mountain rainforest region of Southern Ecuador

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Over the past several decades the mountain rainforest region of Southern Ecuador, a hotspot of biodiversity, is undergoing a rapid conversion to pastureland through slash and burn practice. Frequently this pastureland is invaded by the tropical bracken fern. When the bracken becomes dominant on the pasture sites the productivity decreases and the sites are abandoned. To assess the effect of these land use changes on nutrient turnover and on ecosystem functioning, a study was conducted in the area of the German research station Estación Científica San Francisco (ECSF) in Southern Ecuador. At 2000 m above sea level three adjacent sites were selected: a mountain rainforest site, an active pasture site dominated by the grass species Setaria sphacelata and an abandoned pasture site overgrown by bracken. Mineral soil samples of all three sites (0-5, 5-10 and 10-20 cm) as well as samples from the organic layer (Oi and Oa) of the natural forest site were taken to analyze biogeochemical properties. Besides pH-value, total organic C and N contents, the amounts of microbial biomass (CFE-method), microbial activity (basal respiration, net N mineralization (KCl-extraction); gross N mineralization (15N dilution technique) rates) and microbial community structure (PLFA-analysis) were determined.
17 years after pasture establishment, twofold higher stocks of soil microbial biomass carbon (Cmic) and nitrogen (Nmic) as well as significant lower C:N ratios were determined compared to the natural forest including the 11 cm thick organic layer. 10 years after bracken invasion and pasture abandonment the microbial biomass (Cmic) decreased and the C:N ratio increased again to forest levels. Generally, land use change from forest to pasture and from pasture to abandoned pasture induced shifts in the soil microbial community structure. The relative abundance of the fast growing copiotrophic Gram(-) bacteria was positively correlated with the amounts of readily available organic carbon (DOC_KCl) and nitrogen (TDN_KCl). Thereby, the highest amounts of DOC_KCl and TDN_KCl were associated with high carbon and nitrogen mineralization rates which resulted from the supply of fresh organic substrate from the litter in the forest as well as from easily degradable organic substrate from root exudates of the dense fine-root system of the Setaria grass.
Comparing 0 to 5 cm depth, the active pasture showed the highest carbon mineralization, gross N mineralization and ammonium consumption rates which corresponded to the lowest net N mineralization rates indicating an active microbial immobilization of inorganic N. Furthermore, this was associated with the lowest Cmic:Nmic ratio compared to the other land uses. The metabolic quotient of 0 to 5 cm depth increased from 1.1 (forest) to 1.8 (pasture) to 2.7 mg CO2-C g-1 Cmic h-1 (abandoned pasture) indicating the lowest substrate use efficiency after the invasion of bracken due to a higher C:N ratio and lignin content of the bracken residues (Potthast et al., 2010). Mineralization rates of all three land use types were affected by the amount of organic matter susceptible to decomposition. Thereby, the land use change from an active to an abandoned pasture showed an impact on nutrient transfer and on the amount of soil N supplied to plants.

Potthast, K., Hamer, U., Makeschin, F., 2010. Impact of litter quality on mineralization processes in managed and abandoned pasture soils in Southern Ecuador. Soil Biology and Biochemistry 42, 56-64.