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Changes in soil organic carbon and nutrient stocks in conventional selective logging versus reduced-impact logging in a Congo Basin rainforest of Cameroon on Ferralsol soils

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Selective logging of marketable large trees results in a spatial pattern of logging impact disturbances (felling gaps, skidding trails, logging decks and roads). In Cameroon, huge areas of natural forests are used for timber production by selective logging practices: conventional (repeated logging entries depending on timber demand), and reduced-impact (which requires a management plan with 30-year logging cycle). Compared to South-East Asia and Latin America, the logging intensity in Cameroon is very low (< 0.3 tree ha-1). We assessed the impact of conventional (CL) and reduced-impact (RIL) selective logging on soil physical and biochemical characteristics. We mapped the entire forest sites that had just been logged under CL and RIL, and selected four replicate plots at each site; each plot encompassed the disturbed strata (felling gaps, skidding trails, logging decks and roads) and an undisturbed reference area. The study sites were located in Campo-Ma'an, Southern Cameroon on a highly weathered, Ferralsol soil in Congo Basin rainforest. Soil characteristics were analysed for three depth intervals down to 50 cm. The amount of nutrients removed by harvested timber was also quantified.
With a very low logging intensity at both sites, disturbed ground area (felling gaps + skidding trails + logging decks + roads) only accounted 5.2% and 4.0% in CL and RIL, respectively, of which the roads and logging decks accounted 1.2 – 1.7%. The amounts of nutrients removed from the timber export were only < 3% of the soil nutrient stocks prior to logging. In both the CL and RIL, effective cation exchange capacity, soil organic carbon (SOC), total N, Bray-extractable P and exchangeable Al within 50-cm depth were lower in roads and logging decks compared to the undisturbed reference areas ($P < 0.01 – 0.07$). Moreover, those strata had higher extractable Mn than the reference in CL only ($P = 0.02$). Area-weighted average of the disturbed strata showed 20 – 30% reduction in SOC, total N and Bray-extractable P stocks ($P < 0.01 – 0.03$) compared to the undisturbed reference area. These reductions in SOC, N and P stocks were similar for the two logging systems following one logging entry. However, inherent to CL is repeated logging entries of commonly 5-year logging interval, which is equivalent to 6 logging events in terms of the 30-year logging rotation in RIL.
Our results suggest that CL can lead to strong nutrient depletion in forest soils, which may affect recovery of the succeeding vegetation and replenishment of nutrient supply in highly weathered soils. Selective logging practices that emphasize a sufficient rotation time (RIL) can be a sustainable way to manage forest.