

Stable isotopes for characterisation of trends in soil carbon following deforestation and land use change in the highlands of Madagascar.

Tor-Gunnar Vågen^a, Markus G. Walsh^b, Keith D. Shepherd^b

^a Norwegian University of Life Sciences, Department of Plant and Environmental Research, 1432 Ås, Norway

^b World Agroforestry Centre (ICRAF), P.O. Box 30677, Nairobi 00100, Kenya

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The impacts of human land use in the highlands of Madagascar are often equated with land degradation and decreasing soil fertility. The practice most often focused on is deforestation through slash-and-burn cultivation (*tavy*), and shifting cultivators are often portrayed as being ignorant, poverty-stricken peasants felling trees for fields and food. However, there is uncertainty whether soil degradation is related to recent *tavy* or earlier forest clearance, and whether some highland areas were ever forested. In this paper we use stable isotopes ($\delta^{13}\text{C}$) and diffuse reflectance spectroscopy (DRS) to study the impacts of deforestation and various other land use changes on ecosystem properties, soil organic carbon (SOC) dynamics and soil quality (fertility) in the highlands of Madagascar. Land cover transitions (between C3 and C4 systems) are defined and quantified in the study area. Historical land use had greater effect on soil organic carbon concentrations than current land use, with cultivated areas previously under C3 and C4 systems having 37.3 and 14.8 g SOC kg⁻¹, respectively. Grasslands previously under C3 had approximately 124% more SOC than grasslands previously under C4, while SOC concentrations were 65.3 and 54.9 g C kg⁻¹ under natural forest and in mixed fallow systems, respectively. A soil fertility index developed for the study area based on diagnostic soil spectra was compared with findings related to SOC dynamics and land use change.

Keywords: Soil organic carbon; Stable isotopes; Soil fertility; Deforestation; Land use change; Diffuse reflectance spectroscopy; Madagascar
