Stable isotope profiles of soil organic carbon in forested and grassland landscapes in the Lake Alaotra catchment (Madagascar): insights in past vegetation changes.

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Madagascar is an island characterized by a sharp vegetation gradients in landscape and the extent to which the central highlands were once covered by forest is still under debate. Stable carbon isotope ratios have been an important tracer to understand vegetation shifts in a landscape over time because forest plants (following the C3 photosynthetic pathway) and grasses (following the C4 pathway for the majority of tropical and subtropical species) show a different degree of isotope fractionation. The main aim of this study is to provide insight into the past vegetation history of the grasslands in the Lake Alaotra region (central Madagascar). This region is under high anthropogenic pressure as it is the most important rice-producing region in Madagascar. While much of the Lake Alaotra catchment consists of grassland-covered hills, with a high density of lavaka (large erosional features), pristine forests are located just east of the lake and these form the most western part of a larger rainforest-covered region extending up to the east coast of the island. Soil profiles were sampled along the hillslope gradient at both forested and grassland sites, whereby carbon stocks were quantified and δ¹³C values of soil organic carbon (OC) were measured to find evidence for past forest vegetation in the grassland sites. The soil organic carbon content of grassland soil profile was extremely low, from 0.4 to 1.8% in the top layer and rapidly decreasing to 0.2 % below 100 cm depth. The current vegetation predominantly consists of C4 grasses (δ¹³C ~ -13 ‰), yet soil δ¹³C-OC ranges between -25.9 and -16.6‰, and most profiles show a decrease in δ¹³C-OC with depth, in contrast to observations in the (C3-dominated) forest profiles, which show a typical enrichment in ¹³C with depth. δ¹³C values in grassland and forest profiles converge to similar values (within 2.1 ±1.8 ‰) at depths below ~80cm, suggesting that the grasslands in the Lake Alaotra region have developed on formerly forested soils. Moreover, the soil OC stock of grasslands was ~55.6% lower than along the forested hillslopes for the upper 30 cm layer. Our results are consistent with the hypothesis that a vegetation change has occurred in the lake Alaotra region, and offer a promising avenue to expand this approach on a wider scale to help understand the vegetation cover change in the central highland of Madagascar.