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Land Use Change Impact on Soil Organic Carbon: Insights from Isotopic Signature in Soil Profiles

RONG LANG¹, SERGEY BLAGODATSKIY¹, JIANCHU XU², GEORG CADISCH¹

¹University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Germany

²World Agroforestry Centre (ICRAF), East and Central Asia, China

Abstract

Soil is the largest carbon pool in terrestrial ecosystems, being the natural capital necessary to maintain soil fertility and food security. Land use changes in the tropics have been a large source of anthropogenic greenhouse gas emission and a threat for soil fertility loss due to intensive agricultural usage. Rubber expansion at the expense of tropical forest and shifting agriculture in Southeast Asia is one of those cases. Comparing soils under forest, rubber plantations and agricultural fields using so called “space substitute time” approach helps to assess the land use change impact on soil carbon stock. Isotopic signature of organic carbon in the soil profiles was analyzed, aimed to assess the land use change impact and validity of applied method for comparing selected forest and land converted to rubber plantation.

We selected 3 group of sites in Xishuangbanna, Southwest China, each contained one forest plot and two (or three) rubber plots at different age, and sampled soils at 6 depths up to 90 cm with 15 cm sampling interval. The soil organic carbon content and stable isotope ratio of carbon- $\delta^{13}\text{C}$ was determined for litter and soil samples.

Forest and rubber plantation had similar $\delta^{13}\text{C}$ value in the litter, confirming that forest was dominated by C3 plants. The $\delta^{13}\text{C}$ of soil increased with depth and stabilised below 30 cm, but its profile distribution distinctly differed between land uses and between sites. On two sites of three, $\delta^{13}\text{C}$ in the forest subsoil below 30 cm were -23.3‰ -23.6‰ and -24.4‰ -24.6‰ , which were lower than corresponding values in rubber subsoil, suggesting that C4 crop, like maize or cassava preceded rubber plantation. In contrast, $\delta^{13}\text{C}$ in forest and rubber subsoil was higher at the third site ($-21.5\pm 0.1\text{‰}$), as compared to $\delta^{13}\text{C}$ in forest subsoil from two sites mentioned above, indicating the previous cultivation of C4 crop in both forest and rubber plantation on the third site.

In conclusion, “space substitute time” method should be cautiously used in assessing land use change impact, adding historical land use information derived from $\delta^{13}\text{C}$ signature in soil profiles can improve the validity of comparison.

Keywords: Delta ^{13}C , forest, land use change, rubber plantation, soil organic carbon