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Soil methane and CO_2 fluxes in rainforest and rubber plantations

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Expansion of rubber plantations in South-East Asia has been a land use transformation trend leading to losses of natural forest cover in the region. Besides impact on ecosystem carbon stocks, this conversion influences the dynamics of greenhouse gas fluxes from soil driven by microbial activity, which has been insufficiently studied. Aimed to understand how land use change affects the soil CO_2 and CH_4 fluxes, we measured surface gas fluxes, gas concentration gradient, and ^{13}C signature in CH_4 and soil organic matter in profiles in a transect in Xishuangbanna, including a rainforest site and three rubber plantation sites with age gradient. Gas fluxes were measured by static chamber method and open chamber respiration system. Soil gases were sampled from installed gas samplers at 5, 10, 30, and 75cm depth at representative time in dry and rainy season.

The soil CO_2 flux was comparable in rainforest and old rubber plantations, while young rubber plantation had the lowest rate. Total carbon content in the surface soil well explained the difference of soil CO_2 flux between sites. All sites were CH_4 sinks in dry season and uptake decreased in the order of rainforest, old rubber plantations and young rubber plantation. From dry season to rainy season, CH_4 consumption decreased with increasing CH_4 concentration in the soil profile at all depths. The enrichment of methane by $^{13}CH_4$ shifted towards to lower$\delta^{13}C$, being the evidence of enhanced CH_4 production process while net surface methane flux reflected the consumption in wet condition. Increment of CH_4 concentration in the profile from dry to rainy season was higher in old rubber plantation compared to rainforest, while the shifting of $\delta^{13}CH_4$ was larger in rainforest than rubber sites. Turnover rates of soil CO_2 and CH_4 suggested that the 0-5 cm surface soil was the most active layer for gaseous carbon exchange. $\delta^{13}C$ in soil organic matter and soil moisture increased from rainforest, young rubber plantation to old rubber plantations.

Conversion the forest into rubber plantation decreased soil respiration in young plantation and it recovered during rubber development. However, the CH_4consumption by tropical upland forest soil decreased in converted rubber plantations of all ages, with more decrement in old plantation. Change forest into rubber plantations weakened the soil function as CH_4 sink.