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Effects of oil palm cultivation on silicon pools in soils

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Since the 1970s large parts of the tropical rainforests on Sumatra, Indonesia, have undergone a rapid transition into oil palm plantations. Nowadays, Indonesia is among the largest oil palm producer worldwide ($\sim$ 7.4 Mio ha, 127 Mio t ha-1 oil-palm fruit harvest). Several studies have shown that oil palm cultivation may lead to a decline in soil organic carbon and various nutrients. However, no studies on the influence of oil palms on silicon (Si) pools in soils exist yet. In this study, the impact of the transformation of tropical rainforest to oil palm plantations on the soil Si pools was analyzed. As an underlying hypothesis, we supposed that oil palms have a considerable impact on soil-plant Si cycling in tropical soils because they are Si-accumulating plants. This hypothesis was tested in the lowlands of Jambi province, Southeast Sumatra, which is dominated by loamy Acrisol soils. Top-soil samples (n=5) were taken in a depth of 0-10 cm in natural rainforest and oil palm plantation plots (n=4). Silicon extraction was carried out on soil samples to extract mobile Si, adsorbed Si, Si in soil organic matter, Si occluded in pedogenic oxides, amorphous Si and total Si. The Si concentrations in the extracts were measured by photospectrometry and ICP-OES. Soils taken from the oil palm plantations had lower adsorbed Si contents (4.1 ± 2.4 μg g_{soil}^{-1}; $P \leq 0.05$) and higher Si contents occluded in pedogenic oxides (0.2 ± 0.06 mg g_{soil}^{-1}; $P \leq 0.05$) compared to the rainforest. In two oil palm plantation plots decreased amorphous biogenic Si contents (0.9 ± 0.3 mg g_{soil}^{-1}; $P \leq 0.05$) were found in top-soils, when compared to natural rainforest (1.75 ± 0.6 mg g_{soil}^{-1}; $P \leq 0.05$). The obtained results suggest that oil palm management and plantation architecture have an important impact on the variability of Si contents along oil palm plantations. Increased Si contents occluded in pedogenic oxides and hydroxides under oil palm plantations let suggest that soil mineralogical properties change at different landscape positions which requires further attention in future research. For a better understanding of Si pools and fluxes within oil palm plantations, a detailed soil sampling considering oil palm management practices and Si export through oil palm fruit harvest is needed.