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Effects of fires on silicon availability in topsoils under lowland rainforests and oil palm cultivation

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Over the past decades, Indonesia has experienced an increase in the extent, intensity and frequency of fires, mainly due to national land development policies such as the establishment of rubber and oil palm plantations and extremely dry years. Fires may have considerable effects on ecosystem functions by the release of ash that changes the biogeochemistry of soils, e.g. soil nutrient content, cation exchange capacity and water repellency. However, the biogeochemical effects of fire on silicon (Si) pools in soils were seldom investigated, especially in soils that have undergone land-use change. In this study, we investigated the effect of fire, including different fire temperatures, on Si solubility in topsoils of lowland rainforests and oil palm plantations in Sumatra, Indonesia. Our hypothesis is that forest soils show enhanced Si dissolution compared to oil palm plantations due to higher content of Si-containing soil organic matter (SOM). This hypothesis was tested in the lowlands of Jambi Province, Southeast Sumatra, an area dominated by loamy Acrisols. Topsoil samples (n=3) were taken at a depth of 0-1 cm in three lowland rainforest plots and in three managed inter-rows of oil palm plantation plots. Dried (45°C, 24 h) and sieved ($\leq$ 2 mm) soil aliquots were burned for 15 min in a muffle furnace at 300°C and 500°C to simulate a fire event. Both, treated samples and an untreated sample, were then shaken for 28 h with simulated rainwater containing cation and anion concentrations typical for rainwater of Jambi Province. The Si content was measured in subsamples taken after 5 min, 30 min, 1 h, 2 h, 5 h, 10 h, 21 h, 24 h and 28 h. In the untreated forest soils Si release was considerably higher compared to the untreated soils of the oil palm plantations. After 28 h, Si release from the untreated forest soil samples was 20.4 $\pm$ 6.9 μg g-1 compared to 8.1 $\pm$ 3.0 μg g-1 from the soils of the oil palm plantations. Si release from burned samples was up to 36.4 $\pm$ 18.4 μg g-1 (300°C) and 46.8 $\pm$ 17.6 μg g-1 (500°C) in oil palm plantations and 73.0 $\pm$ 11.9 μg g-1 (300°C) and 77.1 $\pm$ 9.8 μg g-1 (500°C) in forest plantations and showed a higher variability compared to the untreated samples. No significant difference in Si release was found between samples subjected to different temperatures, although the samples treated at 500°C tended to show higher Si release. The lower Si release in oil-palm plantations was due to severe topsoil erosion, resulting in SOM loss in the inter-rows. Further studies on Si biogeochemistry are necessary to understand the effects of [U+FB01]re on terrestrial Si [U+FB02]uxes and the total Si exported from soils that have undergone land-use changes.