Diversity of silicon uptake by tropical forest trees and its implication for biogenic silicon flux through leaf-litter

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The role of silicon (Si), a beneficial element for many higher plants, is increasingly studied in various disciplines, including agronomy, biogeochemistry and ecology. The vast majority of studies on Si uptake and accumulation by plants, however, are from temperate ecosystems. The main objective of this thesis is to examine the diversity of Si uptake by tropical forest trees and its relation to biogenic Si flux via leaf-litter at different spatial scales (from the scale of a forest stand to the regional and global scale encompassing multiple forests). Because many plant Si extraction methods that have been proposed and used by researchers may not be totally comparable, in Chapter 2, I investigate the comparability of two extraction methods, borate fusion and 1% Na_2CO_3 extraction, the two methods most commonly used in biogeochemical and ecological studies. In Chapter 3, I focus on quantifying spatial variations of Si uptake by tropical trees and Si availability from the soil within a lowland dipterocarp forest and show that spatial variations of Si concentration and flux in leaf litter within a forest stand are modulated by distribution of tree species that differ in Si uptake. In Chapter 4, I examine Si release rates from leaf litter of tropical trees during decomposition, demonstrating that species differences in locations and solubility of phytoliths in leaves may determine Si release rates. In Chapter 5, I address the effects of species composition, elevation and parent material on Si uptake and leaf-litter Si flux in multiple plant communities and show that Si uptake and leaf-litter Si flux are greater in lower elevation forests regardless of parent material types owing to more abundance of Si accumulating species. In Chapter 6, I investigate how Si uptake by plants and leaf-litter Si flux may differ in lowland secondary tropical rainforests with differences in logging methods and post-logging vegetation structures. This study shows that pioneer trees in secondary tropical forests compensate for the loss of Si accumulating dipterocarp trees in old-growth tropical forests. Overall, the results from these five studies suggest that tree species difference in Si uptake and accumulation, rather than soil Si availability, modulates forest Si cycling both at local and regional scales.