Rapid, plant-induced weathering in an aggrading experimental ecosystem

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Abstract. To evaluate whether rates of weathering of primary minerals are underestimated in watershed mass-balance studies that fail to include products of weathering accumulating in plants and in developing soil, changes in the calcium and magnesium content of vegetation and soil fractions were measured in large, monitored lysimeters (sandbox ecosystems) at Hubbard Brook Experimental Forest, New Hampshire. Weathering was evaluated over 4–8 yr in sandboxes planted with red pine (Pinus resinosa Ait.) and kept mostly free of vegetation (nonvegetated). Three mass-balance equations were used that cumulatively include (a) Ca and Mg in precipitation inputs and drainage outputs, (b) accumulation of Ca and Mg in vegetation, and (c) changes in products of weathering in soils. Soil products were evaluated with an extraction process designed to avoid removing ions from primary minerals. Relative to the input-output equation, the estimated rate of weathering increased 2.4 (Ca) and 1.8 (Mg) times when accumulation of Ca and Mg in pine biomass was accounted for, and 8 (Ca) and 23 (Mg) times when changes in soil products were also included. Weathering estimates that included accumulation in vegetation and soil products were 261 (Ca) and 92 (Mg) kg ha−1 yr−1 in the pine sandbox. These rates were 10 (Ca) and 18 (Mg) times higher than the rates in the nonvegetated sandbox, which were not significantly greater than zero. This study raises the possibility that weathering can play a significant role in the release of nutrients available to plants over short periods. Faster rates like this become extremely important where managers are trying to balance nutrients available to plants from precipitation and weathering release with outputs including harvest removals.

Key words: cations, denudation, ecosystems, nutrient availability, sustainability, weathering