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European biomass demand can affect forests nutrient budgets in wood exporting regions

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Energy production from biomass is one of the adopted strategies in different European countries to limit global warming to within the 1.5-2º targets after the 2015 UN climate agreement. This will motivate enhanced forest harvest rates and whole tree harvest to supply the increasing biomass demand. The aim of this study was to investigate the geogenic nutrient budgets of U.S. timberland areas, to estimate geogenic nutrient deficiencies for intensive harvest rate scenarios, and to discuss countermeasures preventing negative nutrient budgets.

Budgets for Ca, Mg, K, and P were calculated using public data on tree species distribution, atmospheric nutrient deposition, and lithological maps, as well as data on wood density, tree chemistry, rock geochemistry, and weathering rates to quantify geogenic nutrient supply and loss through harvest. Geogenic nutrient supply is represented by weathering nutrient fluxes and atmospheric deposition rates. Nutrient losses were determined for typical harvest rates of 100-1600 m^3 km^{-2}.

For a minimum nutrient loss and supply scenario, geogenic nutrients are undersupplied in 17, 20, 16, and almost 94% of the studied areas for Ca, K, Mg, and P, respectively. For a high nutrient loss (considering intensive harvesting) and high supply assumptions, the areas affected by negative budgets would be 50, 57, 45, and 96% for Ca, K, Mg, and P, respectively. Considering a harvest rate of 3200 m^3 km^{-2}, twice higher as the maximum reported harvest rate for timberland area, and distinguishing the specific nutrient supply by twelve lithological classes, the efficiency of Mg, Ca, and K supply to meet the nutrient losses would be lithological class dependent, while P supply is insufficient for all lithological classes. Atmospheric nutrient deposition is of minor importance in areas with high nutrient fluxes.

Strategies like letting harvest remains in the field could decrease the areas affected by negative nutrient budgets for the high nutrient loss scenario by 4.2, 6.1, 3.4, and 0.7% for Ca, K, Mg, and P respectively. Increasing global woody biomass demand would probably increase the areas affected by nutrient losses. Therefore, preventive strategies to counterbalance nutrient gaps which limit growth rates might be necessary. These could be the preparation of harvested areas with suitable rock products, designed to replenish growth limiting nutrients, and/or the implementation of forest management strategies to minimize nutrient export.