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Landscape cultivation alters δ30Si signature in terrestrial ecosystems

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Despite increasing recognition of the importance of biological Si cycling in controlling dissolved Si (DSi) in soil and stream water, effects of human cultivation on the Si cycle remain poorly understood. Sensitive tracer techniques to identify and quantify Si in the soil-plant-water system could be highly relevant in addressing these uncertainties. Stable Si isotopes are promising tools to define Si sources and sinks along the ecosystem flow path, as intense fractionation occurs during chemical weathering and uptake of dissolved Si in plants. Yet they remain underexploited in the end product of the soil-plant system: the soil water. Here, stable Si isotope ratios (δ30Si) of dissolved Si in soil water were measured along a land use gradient (continuous forest, continuous pasture, young cropland and continuous cropland) with similar parent material (loess) and homogenous bulk mineralogical and climatological (Belgium). Soil water δ30Si signatures are clearly separated along the gradient, with highest average signatures in continuous cropland (+1.61%), intermediate in pasture (+1.05%) and young cropland (+0.89%) and lowest in forest soil water (+0.62%). Our data do not allow distinguishing biological from pedogenic/lithogenic processes, but point to a strong interaction of both. We expect that increasing export of light isotopes in disturbed land uses (i.e. through agricultural harvest), and higher recycling of 28Si and elevated weathering intensity (including clay dissolution) in forest systems will largely determine soil water δ30Si signatures of our systems. Our results imply that soil water δ30Si signature is biased through land management before it reaches rivers and coastal zones, where other fractionation processes take over (e.g. diatom uptake and reverse weathering in floodplains). In particular, a direct role of agriculture systems in lowering export Si fluxes towards rivers and coastal systems has been shown. Stable Si isotopes have a large potential to track human disturbance on the Si cycle, including subtle changes in clay evolution and biogenic sink/source functions as induced by land use conversions.