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The manifold ways to use isotopic signatures as soil degradation and sediment transport indicators

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This contribution summarizes our experiences gained during several studies that explored the potential of using isotopic signatures as indicators for soil degradation and lateral soil fluxes.
Firstly, the potential use of stable isotopes to indicate soil degradation will be presented. Long-term disturbance of oxic soils can be identified through decreasing correlations between δ13C and soil organic carbon (SOC) content, δ15N and C:N ratio. For this purpose, stable landscape positions (i.e. reference sites), which are neither affected by erosion nor deposition are compared with disturbed agricultural sites. For undisturbed soils, we demonstrate that the enrichment of 15N and 13C with soil depth, due to fractionation during decomposition, goes in parallel with a decrease in N and SOC content. In contrast, for the eroding sites this relationship is not significant. Further, δ15N is functionally related to the C:N ratio. In undisturbed sites, δ15N values cover a relatively narrow range at any particular C:N ratio while substantial loss, or gain of N, mostly results in larger or smaller δ15N values than usual at the observed C:N ratio, which is qualitatively indicating soil disturbance.
Secondly, the applicability of the fallout radionuclides (FRNs) Caesium-137, excess Lead-210 and Plutonium-239+240 as quantitative soil redistribution tracers will be discussed. Pros and cons as well as potential pitfalls of the different FRNs will be highlighted based on our studies conducted in South Korea and in the Alps. To date, the comparison among the different FRNs highlights Pu-239+240 as the most promising tracer, because of its less preferential transport compared to Cs-137 and the possibility to gain information regarding the origin of the fallout. Still, the Pu-239+240 application is limited to a few studies and since its behaviour i.e. vertical migration in the soil and lateral transport during water erosion differs from that of Cs-137, there is a clear need for a wider agro-environmental testing of this radiotracer.
Finally, the potential of compound specific stable isotope signatures as tool to identify land use specific sediment sources will be reported. This novel technique involves many open questions and testing of underlying assumptions that we aims to address through three case studies with reduced land use complexity.