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Combined use of stable isotopes and fallout radionuclides as soil erosion indicators in a forested mountain site, South Korea

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The aim of this study is to assess and to validate the suitability of the stable nitrogen and carbon isotope signature as soil erosion indicators in a mountain forest site in South Korea. Our approach is based on the comparison of the isotope signature of ”stable” landscape positions (reference sites), which are neither affected by erosion nor deposition, with eroding sites. For undisturbed soils we expect that the enrichment of delta N-15 and delta C-13 with soil depth, due to fractionation during decomposition, goes in parallel with a decrease in nitrogen and carbon content. Soil erosion processes potentially weaken this correlation. The Cs-137 method and the Revised Universal Soil Loss Equation (RUSLE) were applied for the soil erosion quantification. Erosion rates obtained with the Cs-137 method range from 0.9 t ha(-1) yr(-1) to 7 t ha(-1) yr(-1). Considering the steep slopes of up to 40 degrees and the erosive monsoon events (R factor of 6600 MJ mm ha(-1) h(-1) yr(-1)), the rates are plausible and within the magnitude of the RUSLE-modeled soil erosion rates, varying from 0.02 t ha(-1) yr(-1) to 5.1 t ha(-1) yr(-1). The soil profiles of the reference sites showed significant ($p < 0.0001$) correlations between nitrogen and carbon content and its corresponding delta N-15 and delta C-13 signatures. In contrast, for the eroding sites this relationship was weaker and for the carbon not significant. These results confirm the usefulness of the stable carbon isotope signature as a qualitative indicator for soil disturbance. We could show further that the delta N-15 isotope signature can be used similarly for uncultivated sites. We thus propose that the stable delta N-15 and delta C-13 signature of soil profiles could serve as additional indicators confirming the accurate choice of the reference site in soil erosion studies using the Cs-137 method.
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