A multi-radionuclide approach to evaluate the suitability of Pu239+240 as soil erosion tracer

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Fallout radionuclides have been used successfully worldwide as tracers for soil erosion, but relatively few studies exploit the full potential of plutonium (Pu) isotopes. Hence, this study aims to explore the suitability of the plutoniumisotopes Pu-239 and Pu-240 as a method to assess soil erosion magnitude by comparison to more established fallout radionuclides such as Cs-137 and Pb-210(ex). As test area an erosion affected headwater catchment of the Lake Soyang (South Korea) was selected. All three fallout radionuclides confirmed high erosion rates for agricultural sites (>25 t ha(-1) yr(-1)). Pu isotopes further allowed determining the origin of the fallout. Both Pu-240/Pu-239 atomic ratios and Pu239+240/Cs-137 activity ratios were close to the global fallout ratio. However, the depth profile of the Pu239+240/Cs-137 activity ratios in undisturbed sites showed lower ratios in the top soil increments, which might be due to higher migration rates of Pu239+240. The activity ratios further indicated preferential transport of Cs-137 from eroded sites (higher ratio compared to the global fallout) to the depositional sites (smaller ratio). As such the Pu239+240/Cs-137 activity ratio offered a new approach to parameterize a particle size correction factor that can be applied when both Cs-137 and Pu239+240 have the same fallout source. Implementing this particle size correction factor in the conversion of Cs-137 inventories resulted in comparable estimates of soil loss for Cs-137 and Pu239+240. The comparison among the different fallout radionuclides highlights the suitability of Pu239+240 through less preferential transport compared to Cs-137 and the possibility to gain information regarding the origin of the fallout. In conclusion, Pu239+240 is a promising soil erosion tracer, however, since the behaviour i.e. vertical migration in the soil and lateral transport during water erosion was shown to differ from that of Cs-137, there is a clear need for a wider agro-environmental testing. (C) 2016 The Authors. Published by Elsevier B.V.
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