Combining multiple fallout radionuclides (^{137}Cs, ^{7}Be, ^{210}Pb_xs) improves our understanding of sediment source dynamics in tropical rivers

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Soil erosion has accelerated as a result of land use change, increasing the sediment supply to rivers worldwide. A thorough knowledge of sediment dynamics is required to design efficient management measures to control erosion and reduce sediment delivery from catchments. Fallout radionuclides are often used separately to provide spatial (^{137}Cs) or temporal (^{7}Be, $^{210}Pb_{xs}$) information on sediment sources. In this study, we examine their combined application to simultaneously model spatial and temporal sediment source dynamics. To this end, potential sediment sources (n=84) and suspended sediment (n=16) were collected at two stations in a 12 km² catchment in Northern Laos during the first flood of the 2014 wet season. Part of the source material was directly sampled in ephemeral flow occurring on hillslopes to avoid the grain size selectivity problems that may occur during erosion and river transport processes. A distribution modelling approach quantified the relative contributions of recently eroded surface (labelled with both ^{7}Be and ^{137}Cs), recently eroded subsurface (depleted in both ^{7}Be and ^{137}Cs), re-suspended surface (depleted in ^{7}Be and labelled with ^{137}Cs) and re-suspended subsurface sources (enriched in ^{7}Be and depleted in ^{137}Cs). At an upstream sampling location, surface sources contributed the majority of sediment (55%) whereas subsurface sources dominated the supply of sediment downstream (74%). Importantly, re-suspended subsurface sources, labelled with ^{7}Be, were a significant sediment source at the catchment outlet (60%). This approach demonstrates the utility of combining multiple radionuclides when investigating spatial and temporal sediment source dynamics in tropical catchments. In the future, sampling of source material in ephemeral flows occurring on hillslopes should be encouraged. Furthermore, the proposed approach should be tested in larger catchments to guide the implementation of efficient erosion control measures.