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Constraining sediment dynamics during flood events using fallout radionuclides (Be-7 and Pb-210(xs)): a pilot study in a tropical catchment of SE Asia

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Soil erosion is particularly intense in mountainous subtropical regions where heavy storms result in the production of large quantities of suspended sediment, leading to both on-site and off-site siltation problems and conveying contaminants and biological compounds along streams. To implement efficient controls on sediment transfer, it is necessary to monitor suspended matter loads and determine whether sediments are directly exported from the catchment during a given flood or re-suspended from deposits left by previous floods. Determination of sediment residence time in catchments can be performed combining fallout radionuclides (Be-7, Pb-210 and Cs-137) measurements in both rainfall and suspended sediments, but prerequisites for their use as tracers during flood events are still required.

We conducted experiments along a network of nested catchments with area increasing from 0.12 to 6.15 km^2, and sampled rainfall and suspended sediment loads during a flood that occurred at the beginning of the rainy season in May 2012. The experiment was carried out in the Houay Xon catchment, part of the MSEC (Multi-Scale Environmental Changes, http://msec3.net/portal/) project in the Northern Luang Prabang province of Laos. This catchment, under shifting cultivation since the end of the 1960s for a large part of its surface, is characterized by a steep topography (slopes ranging from 3% to 350% with a mean slope of 56%) and a land use evolution prone to gully erosion. The seasonal distribution of rainfall controls the Be-7 and Pb-210(xs) activities of soils in the catchment. With a half-life of 53 days, the fallout Be-7 activity of the previous wet season should have sufficiently decayed during the 6-months dry period to be neglected compared to new supply by early rains of the following wet season. Atmospheric deposition of Be-7 and Pb-210(xs) was measured after flocculation of rainfall samples by aluminum chloride hexahydrate and after dehydration of 75 suspended sediment samples (0.5 - 128 g/L) collected by automatic samplers during the flood. Soils, gullies and riverbanks were also sampled across the catchment to document the potential sources of sediment supply to the river. Cumulative precipitation reached 27 mm in less than 50 minutes, leading to an overall export of ca. 274 tons of sediments from the catchment during the flood. The Be-7/Pb-210(xs) ratios of suspended particles were used to monitor "newly eroded" and "older re-suspended" sediment contributions to suspended matter transport along the network. Dynamic fingerprinting of rainwater vs. groundwater and soil-detached vs. re-suspended particles supplies at the river monitoring stations was confronted to results obtained using particles- Cs-137 activity, water- delta-O-18 and particulate organic matter- delta-C-13 measurements.