Geophysical Research Abstracts
Vol. 16, EGU2014-562, 2014
EGU General Assembly 2014

Downstream mixing of sediment and tracers in agricultural catchments: Evidence of changing sediment sources and fluvial processes?

Timothy Ralph (1), Adam Wethered (1), Hugh Smith (2), and Henk Heijnis (3)

(1) Department of Environment and Geography, Macquarie University, New South Wales 2109, Australia (tim.ralph@mq.edu.au), (2) School of Environmental Sciences, University of Liverpool, Liverpool L69 7ZT, United Kingdom, (3) Institute for Environmental Research, Australian Nuclear Science and Technology Organisation, Lucas Heights, New South Wales 2234, Australia

Land clearance, soil tillage and grazing in agricultural catchments have liberated sediment and altered hydrological connectivity between hillslopes and channels, leading to increased sediment availability, mobilisation and delivery to rivers. The type and amount of sediment supplied to rivers is critical for fluvial geomorphology and aquatic ecosystem health. Contemporary sediment dynamics are routinely investigated using environmental radionuclides such as caesium-137 (Cs-137) and excess lead-210 (Pb-210ex), which can provide information regarding sediment source types and fluvial processes if sediment sources can be distinguished from one another and mixing models applied to representative samples. However, downstream transport, mixing and dilution of radionuclide-labelled sediment (especially from sources with low initial concentrations) can obliterate the tracer signal; sometimes before anything of geomorphological importance happens in the catchment. Can these findings be used as evidence of sediment source variations and fluvial processes when the limits of detection (of Cs-137 in particular) are being exceeded so rapidly downstream? Sediment sources and downstream sediment dynamics were investigated in Coolbaggie Creek, a major supplier of sediment to the Macquarie River in an agricultural catchment with temperate to semi-arid climate in Australia. Radionuclides were used to discriminate between the <63 micron fraction of sediment sources including forested topsoils (Cs-137 11.28 +/- 0.75 Bq/kg; Pb-210ex 181.87 +/- 20.00 Bq/kg), agricultural topsoils (Cs-137 3.21 +/- 0.26 Bq/kg; Pb-210ex 29.59 +/- 10.94 Bq/kg) and sub-soils from channel banks and gullies (Cs-137 1.45 +/- 0.47 Bq/kg; Pb-210ex 4.67 +/- 1.93 Bq/kg). Within the trunk stream, suspended sediment, organic matter and Cs-137 and Pb-210ex concentrations declined downstream. Results from a mixing model suggest that agricultural topsoils account for 95% of fine sediment entering the channel in the upper reach (<10 km long), while sub-soils account for 90 to 100% of sediment entering and being transported in the remaining ∼50 km of the system. This shift in dominant sediment source material coincided with a large increase in channel cross sectional area (∼20 to >200 m2) downstream, with channel expansion and gullies contributing fine sediment to the system. A lack of topsoil being supplied to the channel suggests minimal lateral connectivity between the catchment and the trunk stream in all areas apart from the upper catchment. The enlargement and entrenchment of the channel downstream has also resulted in lateral disconnection between the channel and floodplain. In this case, a rapid reduction in radionuclide concentrations downstream does coincide with hydrogeomorphic changes, supporting their use for studying short-term sediment dynamics. These findings highlight the importance of understanding hydrogeomorphic processes and connectivity when interpreting sediment source and tracer data.