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An appraisal of sediment tracing tools to improve knowledge of soil and sediment redistribution following wildfire

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Recent work in the water supply catchments of Sydney, Australia, has explored the potential for using a range of sediment tracing approaches in post-fire landscapes. Sediment tracing techniques offer the potential to elucidate sources and pathways of sediment which can assist with mitigation and remediation of post-fire erosion events. Furthermore, their preservation in downstream sedimentary sequences can provide important information on recent fire frequency and erosional response. Whilst the theory behind tracing approaches is relatively straightforward, complications can arise in their application, especially in post-fire landscapes where impacts tend to be heterogeneous. In this contribution we appraise mineral magnetic and geochemical techniques for discriminating sediment sources and delivery dynamics, identify strengths and limitations of each approach and problems encountered in their application.

In level terrain, clear responses were seen in measured tracing parameters with respect to fire severity. For example, low-frequency magnetic susceptibility values (χ_{lf}) of sediment sourced from burnt areas ($c.$ 8.0 10^{-6} m^3 kg^{-1}) were an order of magnitude greater than those of sediment derived from long-unburnt areas ($c.$ 0.8 10^{-6} m^3 kg^{-1}) in response to transformation of amorphous Fe-minerals at high temperature. Similarly, severely burnt soil showed enrichment in nutrient and trace element properties relative to moderate and unburnt soil, most likely in association with mineralization of organic matter. For example, PbO concentrations increase from $c.$30 mg kg^{-1} in unburnt soil to c. 80 mg kg^{-1} in severely burnt soil. However, signatures are less clearly defined in slope-derived soil samples, specifically footslope areas where material burnt and mobilised in previous wildfire events has accumulated. Ambiguous signatures from these zones will increase uncertainty in the output of sediment unmixing models. The role of footslope storage zones can be quantified through construction of fallout radioisotope-based sediment budgets which permit exclusion of ambiguous storage zones from unmixing models. We conclude that fire-related sediment source data must be interpreted in the context of slope or catchment scale sediment budgets.