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Using differences in particle size distributions to fingerprint suspended sediment sources

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Particle size is an important consideration for applications of sediment source fingerprinting. Here, most attention has focused on understanding the relationships between tracer property concentrations (e.g., geochemical, radionuclides and mineral magnetic properties) and particle size, since the fingerprinting approach is founded on the assumption that the properties of source material and target sediment samples are directly comparable. Beyond the careful consideration of particle size controls on tracers, there remains scope to investigate the use of particle size distributions as a tracer, building upon the limited amount of work reported to date. Accordingly, we hypothesize that particle size distributions can be informative of sediment provenance in areas where individual sources exhibit distinct particle size characteristics. To test this hypothesis, laboratory experiments were performed using artificial mixtures consisting of soil samples sieved to the same and different size fractions (<32 µm, 32-63 µm, 63-125 µm). Individual soil samples (i.e., sources) and mixtures were tested in a 40L large experimental water tank, in which a submersible particle size analyser was used to measure particle size distribution. Using the mixtures consisting of soil source samples sieved to different size fractions resulted in un-mixing modelling contributions being close to the known source inputs. Subsequently, a field experiment was conducted with samples collected using a confluence-based sediment fingerprinting approach during several storm runoff events and at low flows. Here, particle size differences between samples collected in an upstream and tributary sampling point (measured using a laboratory-based particle size analyser) were used to estimate suspended sediment contributions from these two spatial units to a downstream target sediment sampling point. The findings from the field experiments show derived estimates were good when discharge and suspended sediment concentrations were high, but less accurate during smaller runoff events and at baseflow.