# ESTIMATING SUSPENDED SEDIMENT SOURCES USING A SPECTRAL REFLECTANCE BASED FINGERPRINTING APPROACH

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Sediment source ascription using the fingerprinting approach has now been applied in numerous studies in many different areas of the world (see Walling, 2005). The technique offers a valuable indirect method for establishing contemporary sediment provenance at the catchment scale. It uses mass balance equations and tracer property values for the various potential sources to determine their relative contribution to the mixed signature in a suspended sediment sample. The methodology is founded on the assumption that the properties of suspended sediment can be compared with the equivalent information for the materials identified as potential sources. An effective tracer should be able to differentiate between potential sources, exhibit conservative behaviour during erosion and transport (cf. Foster and Walling, 1994) and the tracer property values should be linearly additive. However, the ability of a tracer to distinguish sediment sources depends on the nature of the catchment (Rowan *et al.*, 2000) and there are at present no generic guidelines for pre-selecting the most useful combinations of properties for discriminating sediment sources in different catchments (Collins and Walling, 2004). Despite the range of properties that can be successfully employed as fingerprints (e.g. geochemistry, stable isotopes, organic substances, pollen, mineralogy and mineral-magnetism), the need to use composite fingerprints and the lack of guidelines for pre-selecting tracers make the approach highly time-consuming and expensive.

As a consequence, prospects for future development should take into account the need of finding new tracers to exploit the potential of this technique when rapid and inexpensive analysis is required. This contribution reports an attempt to use a spectral reflectance-based fingerprinting approach to estimate suspended sediment sources. As an example, sediment colour measured with diffuse reflectance spectrometry was used to quantify suspended sediment sources in the Wollefsbach basin (4.4 $km^2$). Colour coefficients (CIE, 1931) were computed after preliminary results demonstrated that visible wavelength was the range of the spectra that was most suited to differentiate potential sources. Moreover, in order to obtain reliable results a quantification of the uncertainty when using the fingerprinting approach based on multivariate mixing models was performed. The methodology is based on the GLUE approach (Generalised Likelihood Uncertainty Estimation) developed by Beven and Binley (1992).

In the Wollefsbach basin, under the assumptions made, grassland topsoil was shown to be the dominant suspended sediment source in all rainfall events. Load-weighted mean contribution of grassland was 67.7% (average contributory coefficients for optimized solutions). Cropland topsoil, forest topsoil and channel banks were shown to provide a smaller contribution, with a load-weighted mean of 5.9%, 8.6% and 6.3%, respectively.

It could be due to the fact that part of the basin is drained, and the forest and cropland areas are poorly connected with the stream network, what might reduce the contribution of these sources to the overall suspended sediment yield from the basin. However, results illustrate a high temporal inter-storm variability of suspended particle in response to the changing source areas. And, nevertheless, not in all cases the results were well constrained and informative, but high uncertainy was assessed, due to the fact that different combinations of source tracer values achieved high efficiency values (equifinality). Results were validated using the classical fingerprinting approach and similar results were obtained. The estimated mean source contribution uncertainty ranges ranged between 0-33% for the cultivated topsoil, 57-98% for the grassland topsoil, 1-21% for the forest topsoil, and 0-4% for the channel banks.

Particle colour turned out to be a useful, fast and easily measurable property for examining variations in suspended sediment sources during floods and this even at very low concentrations. In fact, spectral reflectance measurements could be used not only to estimate new tracers (e.g. colour), but also to quantify sediment chemical properties using partial least-square regression models. The methodology proved to offer substantial scope for exploiting the potential of the fingerprinting approach and for extending its use to routine investigations.

## References


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