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Exploring the potential for using hierarchical sediment fingerprinting as an urban management tool in monitoring changing sediment sources

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An ability to identify and quantify changes in sediment sources and erosion within catchments would be of great use for landscape managers and planners. This is particularly the case in peri-urban catchments, which are characterized by complex and dynamically changing land-use mosaics – and where today's planning decisions may be crucial as regards avoiding or exacerbating erosional, water quality and flooding problems. This study explores the potential for a sediment fingerprinting approach to provide a cost-effective way of assessing changes in sediment sources within a small peri-urban catchment. The study focuses on the Ribeira dos Covões catchment (6.2 km^2), on the outskirts of Coimbra in central Portugal. The climate is humid Mediterranean and the geology is 56% sandstone, 41% marly limestone and 3% alluvium. Current land-use is 56% woodland, 4% agricultural and 40% urban (mainly residential, but also a recently constructed enterprise park (5%) and major highway (1%)). Recent urbanization has largely occupied former agricultural land. The study adopts a multi-proxy sediment fingerprinting approach, based on geochemical (elemental) characterization of fluvial fine bed-sediment and soil samples, using a Niton x-ray fluorescence elemental analyser. Sampling of fluvial sediment was carried out at 33 sites within the stream network (including all significant tributaries, downstream sites and the catchment outlet). Samples were collected in July 2018 and November 2018 following contrasting 'late wet season' and 'end of dry season' events. In addition, in July 2018 composite samples of potential sediment sources were collected, including (i) soil surface (0-2cm) samples at 64 representative locations, (ii) 17 samples from eroding channel margin sites, and (iii) 15 samples of road sediment. All samples were sieved to obtain <63μm, 63-125μm, 125-250 μm and 250-2000μm fractions, where the <63μm fraction was taken to represent suspended sediment. The elemental geochemistry of each sample fraction was derived using the XRF analyser. Differences (and similarities) in geochemical signatures between the various tributaries and the various potential sources were assessed using a range of statistical techniques. Bayesian unmixing models were used in a hierarchical (confluence-based) fashion to assess the contributions of different sub-catchments to downstream sites including the catchment outlet. Modelling results were then compared with relative contributions for three previously analysed storm events of

2012-2015, at which time construction activities had been more active. Modelling results for the two 2018 events were also validated by comparing them with independent suspended sediment records collected at five locations on the principal tributaries and at the catchment outlet. Overall, the modelling was successful in indicating and quantifying significant changes in sediment sources through time within the catchment. Reasons as to why sediment fingerprinting was successful in this case are then examined and discussed, in part drawing comparisons with the findings from a parallel sediment fingerprinting study of changing sources in the dynamically changing partly logged rainforest, partly oil palm Brantian catchment in Sabah, Malaysian Borneo. The potential for a simple sediment fingerprinting methodology to be developed for more widespread use by urban/environmental managers and planners is then explored.