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Spatio-temporal dynamics of sediment sources in a peri-urban Mediterranean catchment

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Sediment fluxes driven by hydrological processes lead to natural soil losses, but human activities, such as urbanization, influence hydrology and promote erosion, altering the landscape and sediment fluxes. In peri-urban areas, comprising a mixture of semi-natural and man-made land-uses, understanding sediment fluxes is still a research challenge. This study investigates spatial and temporal dynamics of fluvial sediments in a rapidly urbanizing catchment. Specific objectives are to understand the main sources of sediments relating to different types of urban land disturbance, and their variability driven by (i) weather, season and land-use changes through time, and (ii) sediment particle size.

The study was carried out *Ribeira dos Covões*, a peri-urban catchment (6.2km^2) in central Portugal. The climate is humid Mediterranean, with mean annual temperature and rainfall of 15˚C and 892 mm, respectively. The geology comprises sandstone (56%), limestone (41%) and alluvial deposits (3%). The catchment has an average slope of 9˚, but includes steep slopes of up to 46˚. The land-use is a complex mosaic of woodland (56%), urban (40%) and agricultural (4%) land parcels, resulting from urbanization occurring progressively since 1973. Urbanization since 2010 has mainly comprised the building of a major road, covering 1% of the catchment area, and the ongoing construction of an enterprise park, occupying 5% of the catchment.

This study uses a multi-proxy sediment fingerprinting approach, based on X-Ray Fluorescence (XRF) analyses to characterize the elemental geochemistry of sediments collected within the stream network after three storm events in 2012 and 2015. A range of statistical techniques, including hierarchical cluster analysis, was used to identify discriminant sediment properties and similarities between fine bed-sediment samples of tributaries and downstream sites. Quantification of sediment supply from upstream sub-catchments was undertaken using a Bayesian unmixing model.

Geochemical signatures of sub-catchment sediment varied significantly with lithology and type of urban influence, but a tendency for limestone sub-catchments to be more urbanized made it difficult to isolate the influence of each factor. Nevertheless, differences in sub-catchment geochemistry between the survey dates indicate significant changes through time in both the relative importance and character of urban impacts. In 2012 the sandstone sub-catchment provided 88%, 92% and 93% of the $<63\mu$m, 63μm–125μm and 125μm-2000μm sediment, respectively, with most sediment deriving from the enterprise park site undergoing deforestation and construction. Most of the remaining sediment derived from the construction of the major road in the limestone sub-catchment. In 2015, however, sediment losses within the catchment appear to have been significantly reduced by planned and accidental retention basins below the enterprise park and major road construction sites, respectively. Nevertheless, the landscape disturbance provided by these constructional sites was of much greater importance than sediment mobilization in urban areas with paved roads and other impervious surfaces. The greatest heavy metal concentrations, however, were recorded in sediments deriving from road runoff.

Despite the positive impact of retention basins in reducing sediment delivery from human disturbed areas, sediment connectivity could be reduced further by dispersing and filtering upslope runoff from urban surfaces more systematically into woodland sink areas.