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Spatiotemporal dynamics of suspended sediment within an actively urbanizing peri-urban catchment in Portugal

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Suspended sediment levels tend to be enhanced in urban catchments, but vary considerably with (amongst many other factors) the degree of active urban development or redevelopment within the catchment and 'urbanization style'. Relatively little, however, is known about the relationship between suspended solids and urbanization style in peri-urban Mediterranean environments. This paper focuses on spatiotemporal suspended sediment dynamics within a typical Portuguese peri-urban catchment, Ribeira dos Covoes, that is undergoing rapid urbanization. The catchment currently has a 40% urban cover, with 17% impervious surfaces, dispersed between woodland (56%) and agricultural areas (4%). The study uses suspended sediment concentration measurements made at the catchment outlet (ESAC) and in three upstream tributaries: (i) Espírito Santo, with a largest urban area (49%); (ii) Porto Bordalo, 39% urbanized; and (iii) Quinta, 22% urbanized, most of which (18%) being an enterprise park under construction. Water sampling was carried out manually during 10 storm hydrographs between October 2011 and March 2013. Suspended sediment concentrations (SSC) were derived by laboratory analysis of the filtered samples using the gravimetric method. In addition total dissolved solids concentrations (TDS) were estimated using conductivity readings. Greatest SSCs were recorded in the Quinta sub-catchment and at the catchment outlet at ESAC (113-4320 mg L-1 and 200-1656 mg L-1, respectively) than in the Espírito Santo and Porto Bordalo sub-catchments (183-852 mg L-1 and 47-598 mg L-1 respectively, despite their greater impervious cover. The greatest SSCs for Quinta result from it containing the construction site, but it showed lower TDS (56-4010 mg L-1), perhaps due to the coarse sandy nature of the construction site. Higher TDS concentrations, however, were displayed in Porto Bordalo (27-5400 mg L-1), possibly due to the loamy soil. Espírito Santo, comprising sandy-loam soils, displayed 27-5400 mg L-1 of TDS, whereas the catchment outlet showed 1-4820 mg L-1. Over the study period, the highest SSCs were recorded in the storm with greatest rainfall intensity (15.9 mm h-1) on 2nd November 2011. For similar-sized storm events, ESAC, Quinta and Espírito Santo displayed greater SSCs in the first storms after the long dry summer, 1.6, 1.9 and 1.4 orders of magnitude greater than in late winter. Porto Bordalo, however, showed a distinct temporal pattern, with SSCs. seven times higher in late winter than in similar storms after summer. These patterns can be linked to seasonal patterns of soil erodibility and soil moisture. Overland flow providing the early stream responses was able to entrain an ample supply of loose soil particles resulting in greater SSCs that peaked before peak flow. The subsequent SSC decline prior to peak flow reflected partial exhaustion of available sediment on the slopes. Although some of the differences between sub-catchment responses are linked to differences in urbanization character, notably areas of active construction and urban areas with lower impervious cover, the type of soil, storm characteristics and antecedent weather are also important influences. Measures that could be used to retard and reduce runoff in the construction area in the headwaters of the catchment are discussed.