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Suspended sediment dynamics in a peri-urban Mediterranean catchment

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Peri-urban areas are subject to complex land-use changes that alter water and sediment fluxes within catchments, but the magnitudes of impacts vary greatly with urban pattern, associated with the extent of impervious surfaces and type of urban features. In peri-urban Mediterranean environments, relatively little is known about the relationship between sediments and urbanization style. This paper explores the spatiotemporal suspended sediment dynamics in a peri-urban catchment containing contrasting urban patterns. The study was carried out in the Ribeira dos Covões (615ha) catchment on the outskirts of the city of Coimbra in central Portugal. The catchment is 40% urban, 56% woodland and 4% agricultural. Measurements were made of total solids (TS), suspended sediment concentration (SSC) and turbidity (T) at the catchment outlet (ESAC) and in three upstream tributaries, draining contrasting sub-catchments: (i) 49% urban, sandstone Espírito Santo (ES) (54ha); (ii) 39% urban, limestone Porto Bordalo (PB) (52ha); and (iii) 22% urban, sandstone Quinta (Q) (141ha), most of which (18% out of the 22%) comprises an enterprise park, under construction since 2009. Water sampling was carried out manually (a) in 10 storm hydrographs between October 2011 and March 2013, when the enterprise park was under active construction, and (b) in several storms in 2017. Storm-median TS values were recorded in Q and ESAC (up to 4320mg/l and 1656mg/l, respectively) than in the ES and PB (up to 852mg/l and598 mg/l), despite their greater impervious cover. In Q, containing the enterprise park, a recorded decrease in storm sediment concentration from 2011-2013 to 2017 is considered to be associated with a reduction in construction activity and vegetation recovery on bare soil areas of 2011-13. SSC and turbidity reached higher values in PB, with an ephemeral regime, possibly due to the piping of urban runoff to the stream and the loamy soil, than in ES, despite its larger urban cover. This is attributed to runoff from the mainly upslope distributed impervious surfaces of ES being dispersed in surrounding pervious sandy-loam soil, thus accounting for the lowest turbidity and SSC responses. Greatest TS, SSC and turbidity values in PB were always reached at the beginning of storm responses and declined prior to peak flow (clockwise hysteresis) and are considered to reflect partial exhaustion of available sediment sources on the slopes and urban surfaces as slopewash proceeds during storm events. In the other sub-catchments, however, greatest sediment concentrations were recorded at peak flows and suggest greater availability of sediment. Storms greater rainfall intensity and storms recorded after the long dry summer period make a greater contribution to sediment transport. For similar storms, TS in Q, ESAC and ES were 1.9, 1.6 and 1.4 orders of magnitude greater in the first storms after the summer than in storms of late winter. In contrast, PB showed a distinct temporal pattern, with TS 1.7 times higher in late winter than after summer. Understanding spatiotemporal sediment dynamics and how they are influenced by urban style are useful in urban planning to mitigate land degradation and the impacts on aquatic ecosystems.