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How do large wildfires impact sediment redistribution over multiple decades? A landscape evolution modelling assessment in a Mediterranean watershed.

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Wildfires have become an increasing threat for Mediterranean ecosystems, due to increasing climate change induced wildfire activity and changing land management practises. In addition to the initial risk, wildfires can alter the soil in various ways depending on fire severity and cause enhanced post-fire erosion. Usually, post-fire erosion studies focus on a short time window and lack the attention for sediment dynamics at larger spatial scales. Yet, these large spatial and temporal scales are fundamental for a better understanding of long-term destructive effects of multiple recurring wildfires on post-fire erosion processes and catchment sediment dynamics. In this study the landscape evolution model LAPSUS was used to simulate erosion and deposition in the 404 km^2 Águeda catchment in northern-central Portugal over a 41 year (1979-2020) timespan, including eight wildfires each burning more than 1000 ha. To include variation in fire severity and its impact on the soil four burnt severity classes, represented by the difference Normalized Burn Ratio (dNBR), were parameterized. Although model calibration was difficult due to lack of spatial and temporal measured data, the results show that long-term post-fire net-erosion rates were significantly higher in the wildfire scenarios (5.95 ton ha^{-1} yr^{-1}) compared to those of a non-wildfire scenario (0.58 ton ha^{-1} yr^{-1}). Furthermore, erosion values increased with burnt severity and multiple wildfires increased the overall catchment sediment build-up. Simulated erosion patterns showed great spatial variability with large deposition and erosion rates inside streams. This variability made it difficult to identify land uses that were most sensitive for post-fire erosion, because some land-uses were located in more erosion-sensitive areas (e.g. streams, gullies) or were more affected by high burnt severity levels than others. Despite these limitations, LAPSUS performed well on addressing spatial sediment processes and can contribute to pre-fire management strategies, by identifying locations at risk for post-fire erosion.