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Afforestation, subsequent forest fires and provision of hydrological services: a model-based analysis for a Mediterranean mountainous catchment

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Mediterranean landscapes have experienced extensive abandonment and reforestation in recent decades, which should have improved the provision of hydrological services, such as flood mitigation, soil erosion protection and water quality regulation. However, these forests are fire-prone, and the post-fire increase in runoff, erosion and sediment exports could negatively affect service provision. This issue was assessed using the SWAT model for a small mountain agroforestry catchment, which was monitored between 2010 and 2014 and where some eucalypt stands burned in 2011 and were subsequently plowed for replanting. The model was calibrated and validated for streamflow, sediment yield and erosion in agricultural fields and the burnt hillslopes, showing that it can be adapted for post-fire simulation. It was then used to perform a decadal assessment of surface runoff, erosion, and sediment exports between 2004 and 2014. Results show that the fire did not noticeably affect flood mitigation but that it increased erosion by 3 orders of magnitude, which subsequently increased sediment yield. Erosion in the burnt forest during this decade was one order of magnitude above that in agricultural fields. SWAT was also used to assess different fire and land-use scenarios during the same period. Results indicate that the impacts of fire were lower without post-fire soil management, and when the fire occurred in pine forests (i.e. before the 1990s) or in shrublands (i.e. before afforestation in the 1930s). These impacts were robust to changes in post-fire weather conditions and to a lower fire frequency (20-year intervals). The results suggest that, in the long term, fire-prone forests might not provide the anticipated soil protection and water quality regulation services in wet Mediterranean regions.