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Comparing erosion rates in burnt forests and agricultural fields for a mountain catchment in NW Iberia

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A large part of northwestern Iberia is nowadays covered by commercial forest plantations of eucalypts and maritime pines, which have partly replaced traditional agricultural land-uses. The humid Mediterranean climate, with mild wet winters and warm dry summers, creates favorable conditions for the occurrence of frequent and recurrent forest fires. Erosion rates in recently burnt areas have been the subject of numerous studies; however, there is still a lack of information on their relevance when compared with agricultural erosion rates, impairing a comprehensive assessment of the role of forests for soil protection.

This study focuses on Macieira de Alcoba, head-water catchment in the Caramulo Mountain Range, north-central Portugal, with a mixture of agricultural fields (mostly a rotation between winter pastures and summer cereals) on the lower slopes and forest plantations (mostly eucalypts) on the upper slopes. Agricultural erosion in this catchment has been monitored since 2010; a forest fire in 2011 presented an opportunity to compare post-fire and agricultural erosion rates at nearby sites with comparable soil and climatic conditions. Erosion rates were monitored between 2010 and 2013 by repeated surveys of visible erosion features and, in particular, by mapping and measuring rills and gullies after important rainfall events.

During the 2011/2012 hydrological year, erosion rates in the burnt forest were two orders of magnitude above those in agricultural fields, amounting to 17.6 and. 0.1 Mg ha-1, respectively. Rills were widespread in the burnt area, while in the agricultural area they were limited to a small number of fields with higher slope; these particular fields experienced an erosion rate of 2.3 Mg ha-1, still one order of magnitude lower than at the burnt forest site.

The timing of the erosion features was also quite distinct for the burnt area and the agricultural fields. During the first nine months after the fire, rill formation was not observed in the burnt area; in agricultural fields, rill formation occurred during the post-harvest period and before the full development of winter pasture. After this period, post-fire management operations (clear-cutting, deep plowing and replanting) disturbed the soil profiles and left little protective vegetation and litter cover. Relatively mild rainstorms provoked most of the erosion features in the burnt area, but none were observed in the agricultural fields which were fully covered by pasture at this time.

The present results indicate that forest fires and especially post-fire management operations can lead to much higher erosion rates than agricultural practices. Different timings of soil losses throughout a year would be linked with different periods when soils are exposed: typically 2-3 years following fire and plowing/terracing as opposed to 2- 3 months following the harvest of annual crops (October-December). Assuming a recurrence period of forest fires of c. 25 years, burnt forests in the region would suffer similar long-term erosion rates as agricultural fields under comparable conditions, casting doubt on the role of forest plantations for soil protection in this region.