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Long-term changes in soil erosion due to forest fires. A rainfall simulation approach in Eastern Spain

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Soils are affected by the impacts of wildfires (Dlapa et al., 2013; Pereira et al., 2014; Tsibart et al., 2014; Dlapa et al., 2015, Hedo et al., 2015; Tessler et al., 2015). Soil erosion rates are highly affected by forest fires due to the removal of the above ground vegetation, the heat impact on the soil, the reduction of the organic matter, the ash cover, and the changes introduced by the rainfall on the soil surface (Lasanta and Cerdà, 2005; Mataix-Solera et al., 2011; Novara et al., 2011; Novara et al., 2013; Keesstra et al., 2014; Hedo et al., 2015; Pereira, 2015). Most of the research carried out on forest fire affected land paid attention to the “window of disturbance”, which is the period that the soil losses are higher than before the forest fire and that last for few years (Cerdà, 1998a; Cerdà 1998b, Pérez-Cabello et al., 2011; Bodí et al., 2011; Bodí et al., 2012; Pereira et al., 2013: Pereira et al., 2015). However, the spatial and temporal variability of soil erosion is very high as a result of the uneven temporal and spatial distribution of the rainfall (Novara et al., 2011; Bisantino et al., 2015; Gessesse et al., 2015; Ochoa et al., 2015), and the window of disturbance cannot be easily found under natural rainfall. In order to understand the evolution of soil erosion after forest fires it is necessary to monitor fire affected sites over a long period of time, which will enable the assessment of the period affected by the window of disturbance (see Cerdà and Doerr, 2005). However, it is also possible to do measurements and experiments in areas with a different fire history. This will give us information about the temporal changes in soil erosion after forest fire. To reduce the spatial variability of rainfall we can use simulated rainfall that can be applied at multiple site with the same rainfall intensity and duration. For this purpose rainfall simulation can be of great help, in the laboratory (Moreno et al., 2014; Sadegui et al., 2015; Carvalho et al., 2015; Lassu et al., 2015) or in the field (Cerdà et al., 1998c; Jordán et al., 2009; Prosdocimi et al., 2016).

In order to determine how fire and post-fire changes change soil erosion rates we selected 12 research sites at the study area of the Massís del Caroig, Eastern Spain, which suffered different fires in the last century. The parent material is limestone in all study sites and the mean annual rainfall ranges from 480 to 550 mm per year in average. The vegetation consists of scrubland (Maquia) with different species. In the years after the fire Brachypodium retusum, Thymus vulgaris, Fumana Ericoides, Cistus Albidus, Ulex parviflorus or Rosmarinus officinalis regenerated, but after some years dense shrub cover develops with typical species such as Quercus coccifera, Quercus ilex, Pistacia lentiscus and Junyperus oxycedurs. Soils are shallow (0-30 cm depth) and distributed in pockets of soil mixed with rock outcrops. All the selected plots were located on the middle tram of the slopes to avoid differences, although previous studies showed no differences in infiltration rates, overland flow and soil erosion on the different trams of the slopes on limestone (Cerdà, 1998d). Each site was selected upon the last fire registered: 0, 1, 2, 3, 5, 9, 16, 24, 33, 44, 51, and 63 years after the last fire. The measurements were carried out in August 2013 by means of a portable rainfall simulator (Cerdà et al., 2009; Iserloh et al., 2013). Ten plots of 0.25 m2 were selected at each site. Rainfall simulation at 55 mm h-1 during one hour was applied. The results show that immediately after the wildfires the soil erosion was negligible due to the ash cover, which acted as mulch, meanwhile after few months (1 year after the fire) the highest soil losses were measured. After 5 years the soil losses had reduced significantly and after 16 years were negligible.

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