MONITORING SOIL EROSION RISK IN BURNED SOILS UNDER DIFFERENT RESTORATION TREATMENTS

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INTRODUCTION AND OBJECTIVES

Wildfires cause different impacts on soil chemical and physical properties. Among the latter, some of the most important are a loss of structural stability of aggregates (because of reduction in organic matter content) and water repellency. Also, combustion contributes to a decrease in plant cover. These direct and indirect processes lead to increased runoff flow rates and soil erosion risk. Due to on-site and off-site impacts of soil erosion, the management of burned areas must focus, at least in the first stages, on soil erosion control. Among different soil erosion control measures, mulching has been considered by different authors as one of the most effective. Usually, materials used for mulch are locally available or are transported for short distances.

This experiment aims to compare the efficiency of different mulch materials for erosion control in moderately burned soils under Mediterranean type of climate in south-western Spain. These materials are agricultural subproducts available near the burned area (straw) or are produced from the burned area, as pine bark and pruned pine branches. Results are compared with an adjacent unburned area and an ash-covered burned area, not treated.

STUDY AREA

In July 6th 2011, a wildfire caused by negligence affected a forested area near Calañas (province of Huelva, southwestern Spain). About 9,000 m^2 were burned, affecting shrubland and woodlands (mainly *Pinus pinea* and *Eucalyptus globulus*), approximately at coordinates 37º 39' N/ 6º 51' W (285 m a.s.l.). The climate is Mediterranean, with cool, humid winters and warm, dry summers. According to the nearby weather station "Alosno Tharsis-Minas" (Alosno, located at coordinates 37º 35' N/ 7º 7' W; 286 m a.s.l.), the average annual precipitation is 616.4 mm, with a maximum monthly value of 104.8 mm (December) and a minimum of 2.6 mm (August). The mean annual temperature is mild, 6.9 °C, with a maximum monthly mean temperature of 25.4 °C (August) and a minimum monthly mean of 9.9 °C (January).

The main vegetation types in unburned areas adjacent to the studied burned plots are herbs; shrubs are dominated by heaths (*Erica australis*), rockrose (*Cistus ladanifer* and *C. monspeliensis*) and brooms (*Genista hirsuta*, *G. triacanthos*, *Ulex parviflorus* and *Calicotome villosa*). Where present, tree species were *Pinus pinea* and *Eucalyptus globulus*.

Soils were shallow, showing an A-R profile, limited in depth by continuous rock within 10 cm from the soil surface. Unburned adjacent soils were slightly acid (pH 5.7 ± 0.5, on average), poor in organic matter (3.2 ± 1.2%) and sandy loam (50.2 ± 12.9% sand, 17.3 ± 5.7% clay).

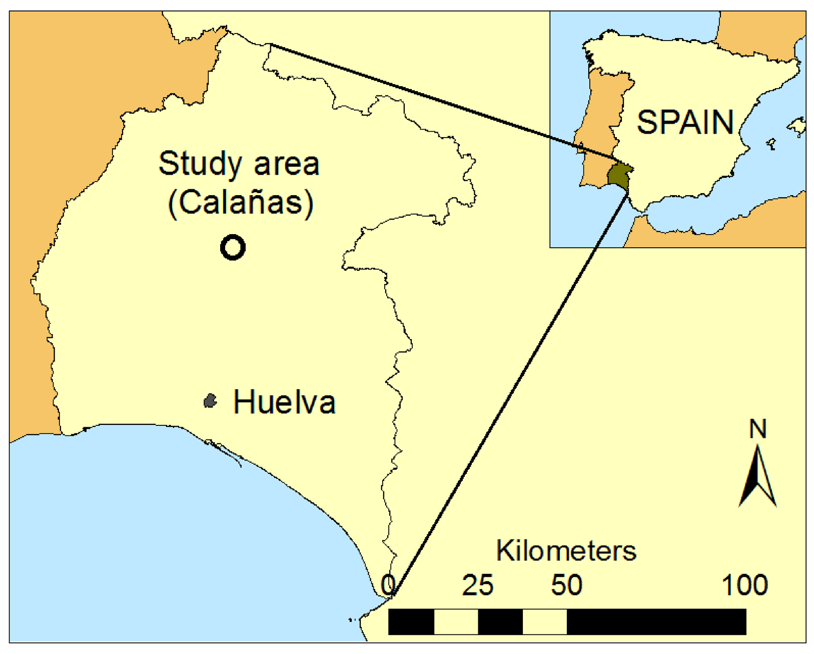


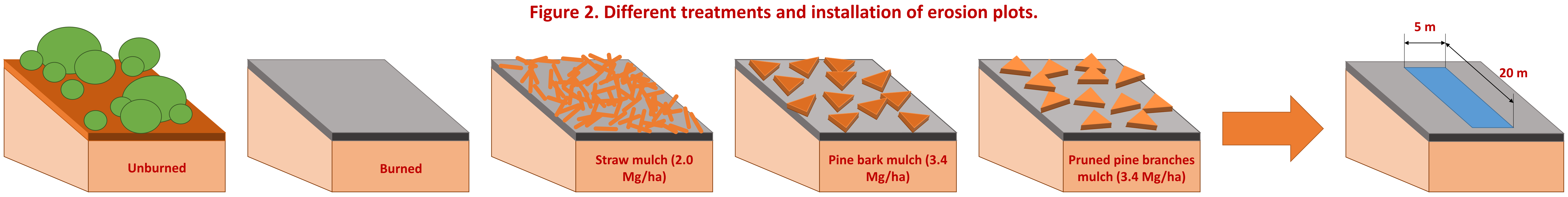
Figure 1. Study area.

EXPERIMENTAL DESIGN

In order to study the efficiency of different soil erosion control techniques, moderate-severity burned areas were selected (herbs completely consumed; stems thinner than 10 mm not completely consumed; 50-80% canopy consumed; black and white ash covering soil; organic layer deeply charred) and three treatments were considered: straw mulch (2.0 Mg ha^{-1}; SM), pine bark mulch (3.4 Mg ha^{-1}; PBM), pruned pine branches mulch (3.5 Mg ha^{-1}; PPBM), burned control (burned soil, untreated, BC) and unburned control (unburned soil, untreated, UC). All mulches were applied one month after burning (August 2011).

Five soil erosion plots (20 m × 5 m, the longest axis slope down) under each treatment were stablished and limited by geotextiles to avoid runoff or sediment inputs. For soil erosion assessment, a gutter installed on the down slope site of each plot conducted the runoff to a sample collection box. Runoff water was collected after each storm, for determination of runoff water volume and sediment yield (runoff samples were desiccated at 110 ºC and the sediment yield was quantified by weight) between August 2011 and April 2015. Plant cover was monitored in December and June between 2011 and 2015.

Figure 2. Different treatments and installation of erosion plots.



RESULTS

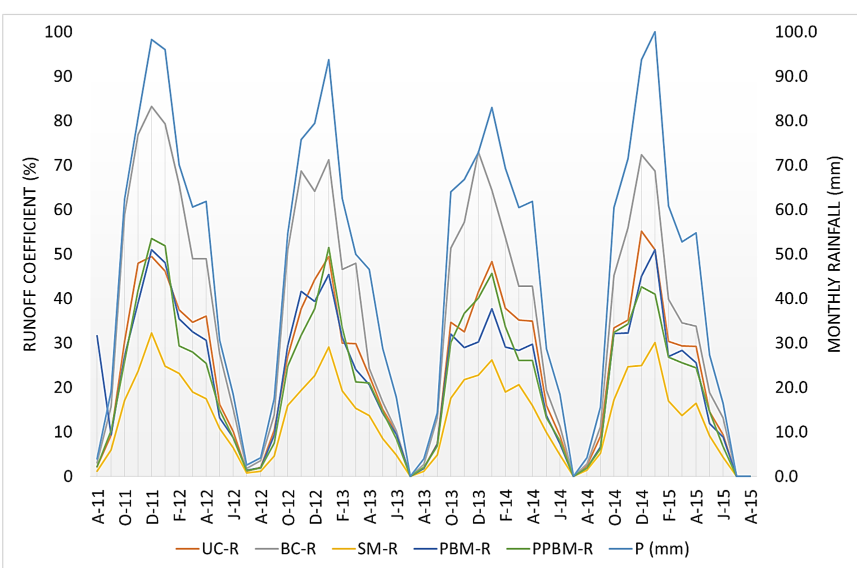


Figure 3. Monthly rainfall and runoff rate.

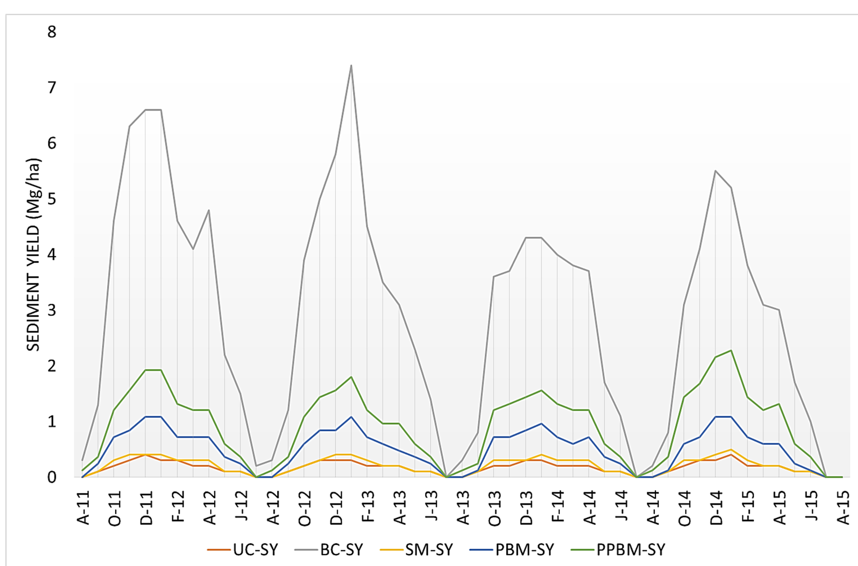


Figure 4. Sediment yield.

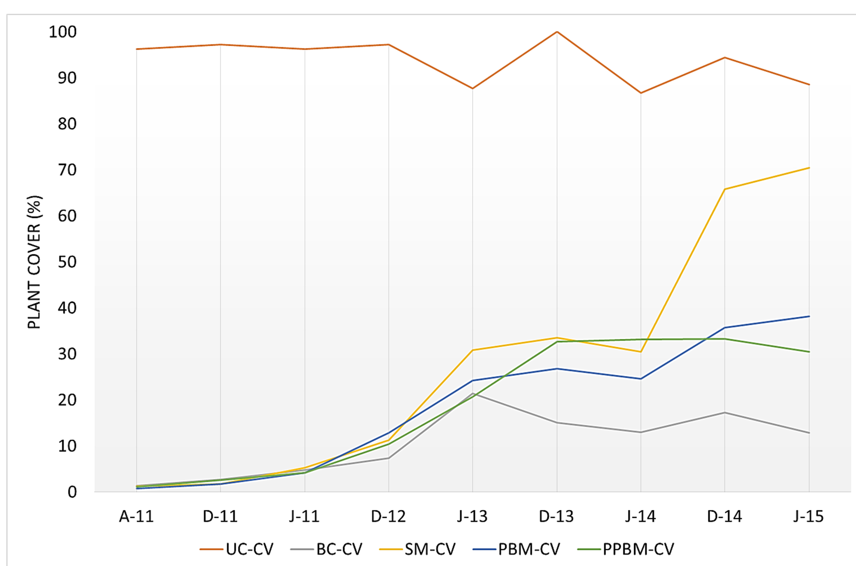


Figure 5. Evolution of plant cover (December).

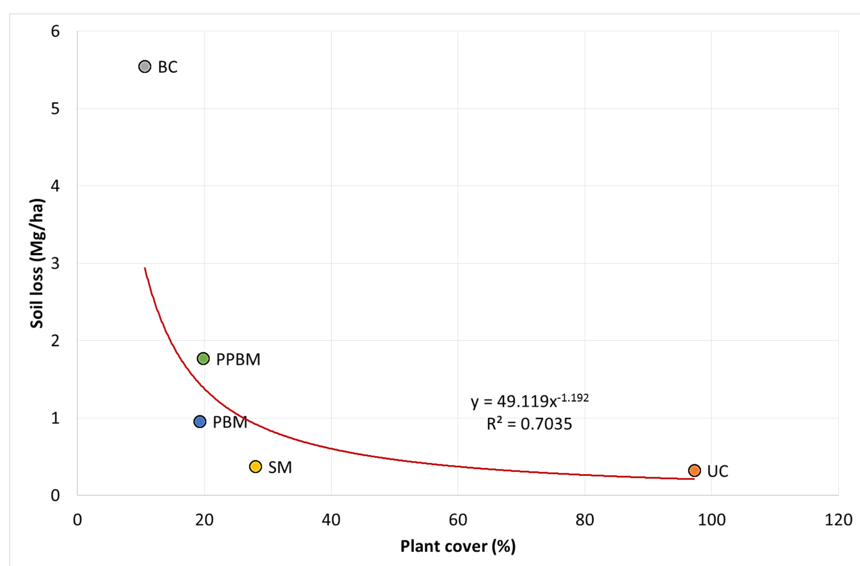


Figure 6. Relation between soil loss and plant cover.

Straw, pine bark and pruned pine branches mulches contributed to a significant reduction of runoff (fig. 3) and soil erosion (Fig. 4) during the first rainy season (September 2011-May 2012) respect to BC plots. Soil erosion in SM plots did not show significant differences with erosion in UC plots, both negligible. Soil erosion from PBM and PPBM plots showed intermediate values.

Plant cover increased in all cases with time, although it increased especially in SM plots (Fig. 5). On average, soil erosion decreased with increasing plant cover (Fig. 6), until no significant differences in runoff and sediment yield were observed between them and UC plots at the end of the experimental period. Although all mulches were effective for reduction of postfire soil erosion risk, straw mulch mostly reduced runoff and sediment yield, also favoring faster recuperation of plant cover.

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