Geophysical Research Abstracts
Vol. 14, EGU2012-12510, 2012
EGU General Assembly 2012

Testing the effectiveness of pine needlecast in reducing post-fire soil erosion using complementary experimental approaches

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Mediterranean wildfire activity has increased markedly in recent decades, leading to enhanced runoff and erosion. Limiting post-fire on-site soil degradation and off-site flooding and sedimentation, however, often has a low priority because of the high costs of materials and labour needed to implement many recognised techniques (e.g. seeding, hydromulching, installing logs along the contour). However, in pine plantations, the crowns may only be scorched so that after fire the needlecast can form a comparatively dense ground cover. Its post-fire erosion-limiting effectiveness is virtually unknown in the Mediterranean context, despite potentially protecting soil with minimal effort (requiring only a delay to existing salvage logging procedures at most). As part of the DESIRE research programme, this paper presents results from two complementary approaches testing the erosion-limiting effectiveness of needlecast.

(1) Near Moinhos, central Portugal, two 8m2 erosion plots were established immediately post-fire in September 2009 on a steep (30º) slope representative of an adjacent burnt Pinus pinaster plantation. Soil erosion was monitored during a 3-month pre-treatment phase. Needles were then applied to one plot at a density (37.7% cover) measured on a post-fire pine plantation. Soil losses from treated and untreated plots were then monitored until April 2011. By taking the percentage increase or decrease in erosion between the two monitoring phases for the untreated control plot as the 'expected' pattern, the erosion-limiting effectiveness of needles applied to the treated plot could then be determined.

(2) Six adjacent rectangular 1.23m2 lysimeters were filled with gravel and sand, and capped by 10 cm of topsoil taken from a long unburnt Pinus pinaster plantation. They were set at 15º and left open to natural rainfall. This angle was considered the steepest possible from logistical and soil stability points of view. All lysimeters underwent a phase under bare soil conditions. In a second phase, a representative amount (8.34 kg) of fermented litter and shrubs from a pine plantation was applied evenly to each of five lysimeters. In a third stage, four of the five treated lysimeters were burned to simulate a low-severity wildfire. After several more rainfall events, pine needles (37.7% cover) were applied to two of the burnt lysimeters. In the final stage, there was 1 lysimeter with bare soil, 1 unburnt with a vegetation cover, 2 burnt and untreated, and 2 burnt with needles. In all the lysimeters, runoff and percolated water were monitored during the entire study, as were the amounts of eroded sediment and organic matter contents for runoff. Calculating the erosion-limiting effect of needles was conducted in a similar fashion to (1) and based on results from stages 3 and 4.

The results from both experiments show that the needles reduced erosion by as much as c.60% compared with the corresponding control situation, indicating that a needlecast 'carpet' is likely to be able to provide a highly effective, simple, cheap means of significantly reducing post-fire soil loss in pine forests where the tree canopies have been scorched but not consumed by fire.