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Using small-scale rainfall simulation to assess temporal changes in pre- and post-fire soil hydrology and erosion: the value of fixed-position plots

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In recent decades, wildfire has become both frequent and severe in southern Europe leading to widespread research into its impacts on soil erosion, soil and water quality. Rainfall simulation has become established as a popular technique to assess these impacts, as it can be conducted under controlled conditions (notably, with respect to rainfall) and is a very cost-effective and rapid way to compare overland flow and suspended sediment generation within burned and unburned sites. Particular advantages are that: (1) results can be obtained before the first post-fire rainfall events; and (2) experiments can reproduce controlled storm events, with similar characteristics to natural rain. Although plot sizes vary (0.09-30m2), most researchers have used < 1m2 plots because of logistical difficulties of setting up larger plots especially in burned areas that may lack good access and local water supplies. Disadvantages with using small plots, however, particularly on burned terrain, include: (1) the difficulty of installing the plots without disturbing the soil; (2) the strong influence of plot boundaries on overland flow and sediment production. Significant replication is generally considered necessary to take account of high variability in results that are due in part to these effects. One response to these problems is a 'fixed plot' approach in which bounded plots are left in place for re-use throughout the study. A problem here, however, would be progressive sediment exhaustion due to the 'island' effect of the plots caused by their isolation from upslope sediment transfer. This paper assesses the usefulness of a repeat-simulation plot approach in assessing temporal change in overland flow and erosion in post-fire situations that minimizes the island effect by partial removal of plot boundaries between surveys. This approach was tested over a 2.5-year period in a small (9 ha) catchment in central Portugal subjected to an experimental fire in 2009. Five rainfall simulation plots 0.25m2 in size were installed close to sediment traps (contributing areas: 498-4238m2) collecting sediment eroded by overland flow caused by natural rainfall. The plots were installed pre-fire and experiments carried out under 'dry' and 'wet' antecedent conditions on six occasions from pre-fire to two years after the fire. The lateral boundaries of each plot were left in place, but the upslope boundary and central (outlet) section of the downslope boundary were removed between surveys and re-installed and sealed each time measurements were carried out.
Having fixed positions of plots minimised soil disturbance on each monitoring occasion and meant that, for any given plot, results were directly comparable and gave a more reliable picture of change through time. Removing the upper and lower boundaries of the plots between measurements allowed the soil to undergo processes similar to those on the surrounding slope and reduced the 'island' effect associated with continuously bounded plots. Results from the adjacent sediment traps, which provided a parallel temporal record of hillslope-scale overland flow and sediment redistribution patterns under natural rainfall, are used to judge the usefulness of the in situ simulation plots approach.