Geophysical Research Abstracts
Vol. 12, EGU2010-14082, 2010
EGU General Assembly 2010

Monitoring post-fire erosion from plot- to catchment scale using a nested scale approach

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Fire-induced erosion has been observed in many regions, in both wildfire and controlled fire settings. Erosion rates have in many cases been found to be scale-dependent, with erosion rates decreasing with increasing plot size. Most studies, however, have investigated fire-induced erosion at plot and hillslope scales, leaving the catchment scale largely ignored. Moreover, many studies lack pre-fire control data.

Here, we present a unique study that combines the multi-scale approach of previous wildfire research with the experimental advantages of controlled fire studies. This study focuses on the 9-ha Valtorto catchment in north-central Portugal, monitored for 1.5 year and then burned by experimental fire in February 2009. During the fire, above- and belowground temperatures were monitored. Rainfall, interception, runoff and soil water repellency were monitored throughout the study period, and soils were characterized. In addition, vegetation regeneration and soil surface evolution were monitored using repeat-picture plots.

Runoff and erosion were monitored by various methodologies from the small plot to the catchment scale in the years before and after the fire. At the small plot scale, sediment and organic matter losses were determined from rainfall simulations performed under dry and wet antecedent conditions. At the hillslope scale, sediment losses were determined using sediment fences with known contributing areas. Sediment trapped behind these fences was collected after major rainfall events. At the catchment scale, bedload and suspended sediment sampled in a flume installed at the catchment outlet indicated the character of sediment and nutrient losses. Post-fire runoff and erosion were compared with a 1 to 10-year pre-fire record, and with values determined from a nearby comparable unburned catchment that was used as a control.

The nested-scale approach adopted in this study facilitates assessment of the effect of scale on runoff and erosion, while the use of both pre- and post-fire measurements together with a control catchment ensures reliability in the evaluation of the effect of fire on these two variables. It is hoped that this integrated approach will help understanding of the effect of fire on short- and long-term land degradation processes.