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Evaluation of post fire changes in soil properties and influence on the hydrological and erosive dynamics in a Mediterranean watershed

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In the last fifty years, forest fires and changes in land use and management practices have had a significant influenceon the evolution of soil loss processes in the Mediterranean area. Forest fires have immediate effects in hydrological processes mainly due to sudden changes in soil properties and vegetation cover. After a fire there is an increase in runoff processes and peak flows and thus in the amount and composition of the sediments produced. Silting in dams downstream is often reported so the description of the post-fire hydrological processes is crucial in order to optimize decision making.

This study analyzes a micro-watershed of 25 ha in the south of Spain that suffered a fire in October 2010 burning around a 2 km2 area. As the erosive processes in this area are directly related to concentrated overland flow, an indirect assessment of soil loss is presented in this work based on evaluating changes in runoff in Mediterranean post-fire situations. For this, the study is divided into two main parts. Firstly, changes in soil properties and vegetation cover are evaluated. Secondly, the effects of these changes in the hydrological and erosive dynamics are assessed.The watershed had been monitored in previous studies so soil properties and the vegetation cover before the fire took place were already characterized. Besides, the hydrological response was also available through an already calibrated and validated physically-based distributed hydrological model.

For the evaluation of soil properties, field measurement campaigns were designed. Philip Dunne's tests for the determination of saturated hydraulic conductivity, as well as moisture content and bulk density measurements were carried out in both unaltered and burned soil samples. Changes in the vegetation cover fraction were assessed through desktop analysis of Landsat-TM5 platform satellite images as well as through visual inspection in the field campaigns.

The analysis of the hydraulic conductivity revealed a reduction in post-fire values of near 90 % over those previous to the fire. Regarding the vegetation cover, the recovery of the burned covers, mainly herbaceous with some bushes, turned out to quick due to the wet character of the year. Nevertheless, an apparent decrease in the cover fraction and thus in the vegetation storage capacity was reported. These changes were incorporated into a new hydrological model configuration and compared to the response previous to the fire. The results point out the rainfall pattern to be a determinant factor in post-fire situation with an increase in modeled runoff of up to 350% and even more in dry years. These results have direct implications in soil erodibility changes in hillslopes as well as a considerable increase in bedload processes in Mediterranean alluvial rivers.