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Post-fire suspended sediment dynamics in a Mediterranean terraced catchment using a nested approach

Julián Garcia-Comendador (1), Josep Fortesa (1), Aleix Calsamiglia (1), Adolfo Calvo-Cases (2), and Joan Estrany (1)

(1) Mediterranean Ecogeomorphological and Hydrological Connectivity Research Team, University of the Balearic Islands, Department of Geography, Palma de Mallorca, Spain, (2) University of Valencia, Department of Geography, Valencia, Spain

Wildfires promote serious disturbances in the hydrological and sediment dynamics at catchment scale modifying the runoff generation response and the sediment delivery. The hysteretic loops analyses can help to clarify some landscape changes induced by fire. Accordingly, these spatio-temporal relationships between discharge and sediment transport at event scale enable the location of sediment sources, the availability or depletion of sediment and the precipitation threshold necessary to generate functional hillslope-channel connectivity. In addition, a nested catchment approach allows the characterization of the hydro-sedimentological dynamics in different landscape compartments, observing the incidence of the changes generated in the landscape and its evolution to control soil erosion and to implement useful mitigation practices after fire.
In July 2013 a large wildfire (2,450 ha) severely affected the western part of Mallorca (Balearic Islands, Spain). The hydrological and sediment delivery processes were assessed in the first three post-fire hydrological years in a representative catchment when the window of disturbance is typically more open. A nested approach was applied in which two gauging stations (i.e. US 1.2 km2 and DS 4.8 km2) were established in September 2013 with continuous measurement of rainfall, water and sediment yield. At DS, a minimal runoff (i.e. 11 mm with 2% of coefficient) and low sediment yield (i.e. 6.3 t km2 yr-1) were generated on average in the study period in which rainfall averaged amount (i.e. 468 mm $\pm$ 141) and intensities were representative of long-term records.
The hysteretic analysis allowed a better understanding of the effects of wildfires and terraces in sediment yields. For the whole study period, the percentage distribution was 43% (US; two monitored years) and 40% (DS; three monitored years) for clockwise loops in front of 57% (US) and 60% (DS) for counter clockwise loops. This percentage of counter clockwise loops was high if compared with other studies on non-burned Mediterranean catchments probably related with the increased sensitivity of the landscape after wildfire perturbation. During the following years, this percentage –as well as the sediment yield– showed a significant decrease related to the vegetation recovery. The findings also illustrated a differenced behaviour between nested catchments. For the coincident floods between US and DS, only 40% recorded the same hysteresis behaviour. Counter clock loops were predominant in US because of the higher hillslope-channel connectivity of upstream parts of the catchment, whilst the predominance of clockwise loops in DS were indicative of the mobilization of sediment deposited along the river channel and its adjacent areas. These differenced patterns can be attributed to the sediment conveyance losses and storage along the stream channel between stations as well as the size characteristics and the buffering effect of the nested catchments.