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The Effects of Repeated Fires on Vegetation Communities Structure: Implications for Small Scale Soil Erosion

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Wildfires, which have been recognized to be an inherent process in Mediterranean ecosystems, rapidly change land cover, and consequently eco-geomorphic process rates. The Carmel Mountain ridge has undergone rapid afforestation and natural re-vegetation during the past century. Similarly to other Mediterranean ecosystems, wildfire frequency has increased in the region during the last several decades. In this study we took a multi-scale approach to analyze changes in vegetation community structure following repeated fires in a single site. We link those changes to observed erosion rates which were recorded following a recent fire, which occurred during April 2005.

We use satellite image analysis to monitor vegetation changes in areas repeatedly burned during the last 22 years. An extended vegetation survey of the region was conducted during 1985, and serves as a baseline for the state of the vegetation. Satellite images from 1990 (following a 1989 fire), 1995, 2000 (following 1998, 1999 fires) and 2005 were used to classify the different vegetation types present each year, based on spectral and derived vegetation indices. In addition, we monitored vegetation structure and cover at high resolutions, following a 2005 fire, in 10.5 m2 monitoring plots. Vegetation cover was estimated from plot photographs taken from a pole mounted camera. Likewise, the plots were constructed in areas burned once or twice during the last two decades. Runoff and sediment have been collected after precipitation events, during three years, following the 2005 fire.

The resulted satellite image classifications revealed changes in the spatial distribution of tree, shrub and herbaceous vegetation cover following wildfire events. Specific transition probabilities among the vegetation types, as a function of the number of times each site was burned, were being used to construct Markov based transition matrices. In addition, we also considered the interaction between slope aspect and fire occurrence on vegetation regeneration. In turn, a simulation model based on the estimated transition probabilities was used to assess the effects of different fire regimes on long term vegetation changes. Results suggest that recurring fires within short time intervals may significantly alter the long-term structure of the vegetation communities. Simulation results suggest that repeated fires may eliminate woody vegetation from the landscape (both trees and shrubs), and provide for the establishment and dominance of herbaceous vegetation communities. Similar trends have been observed in the high-resolution monitoring plots. Within plots located in areas burnt twice, vegetation regeneration rates were lower compared to areas burned once. By the end of the second growing season following the fire event vegetation cover at the area burned once was approximately 58% compared to 51% in the area twice. Sediment yield was lower, however, in the one-time burned areas, compared to plots located in areas burnt twice with a mean sediment yield per storm 0.64 g/m2 compared to 27.63 g/m2of with a mean storm yield those areas.

Thus we demonstrate that repeated fires may dramatically alter long-term trajectories of the vegetation communities at those ecosystems. This pattern, in turn, may have significant implications for the associated geo-morphological processes, particularly runoff and erosion.