Fire in the Earth System Abstracts
Vol. 1 FES-Fire Behavior Modelling and Simulations-127
Valencia, Spain, 3-7 November, 2021
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Terrain metrics: Directional roughness for forest fire risk mapping

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Abstract

The main factors that contribute to fire ignition and propagation are topography, vegetation, weather, human activities, fire temperature and the portion of fuel consumed. Among topographic metrics, slope, aspect, elevation, distance from road, and distance from settlement are usually considered relevant when mapping fire risk. Previous studies have proved that the risk map for a non-planar topography includes areas with a reduced risk as well as with an enhanced risk as compared to the planar case. On the other hand, the accurate assessment of surface roughness with digital elevation models (DEM) has important implications for the numerical simulation of mass movements. Natural hazards have a predominant diffusion direction identified as the combination of terrain slope and curvature. We hypothesize that fire propagation simulations and fire return interval assessments can take advantage of surface roughness algorithms to improve their predictions. In this study, we analyse the outputs of five surface roughness algorithms (standard deviation of the profile curvature, SD_PC; standard deviation of the residual topography, SD_RT; standard deviation of the slope, SD_S; terrain ruggedness index, TRI; and vector ruggedness measure, VRM) that were calculated using four moving window areas (radius: 2, 4, 8 and 10 cells). The selected study area is a medium-size sub-catchment (14.5 km^2) located in the headwater of the Igrejas River, which source area is located in Spain (province of Zamora), and drain into Onor River in north-eastern Portugal; within the Natural Park of Montesinho (Duero/ Douro River Basin). Recurrent fires have affected this area in the last decades. The results analysis include the spatial pattern of the metrics with regard to the main geomorphic elements (steep slopes, internal water divides, valley bottoms, and ravines) and land uses (forest, cropland, trails, and a specific grassland named '*lameiros*'). The evaluation of the directional roughness and the selection of the most relevant approach may help to refine fire propagation models and fire risk mapping.

Keywords: Surface roughness, Fire propagation, DEM, Mass movement

Acknowledgments: European COST Action FIRElinks (CA18135) “Fire in the Earth System: Science & Society”.

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