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Assessing regional connectivity for fire propagation: a cost surface model approach

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Leaning on concepts from landscape ecology and functional landscape connectivity, we formulated and developed a cost surface modelling approach to assess fire connectivity at a regional landscape level. Once the model is calibrated to the region of interest, it allows comparing different scenarios of vegetation composition and moisture contents. The use of commonly available input data and an easy to implement method to code fire friction for a given landscape facilitates the application of this approach to other areas of interest. Functional landscape connectivity with regard to fire propagation is expressed through cost surfaces that are computed from a fire friction map and a random set of ignition points. The spatial complexity of the cost surfaces is assumed to be proportional to the landscape connectivity, and its fractal properties are used to measure and describe such spatial complexity. The fractal dimension of a cost surface serves to assess the regional connectivity in terms of the spatial structure of frictions to fire spread, while the mean value of a cost surface describes the overall resistance to fire propagation across the landscape in a lumped, non spatial form. The fire friction map is derived using objective and empirically confirmed techniques enabling to account for the major factors of general fire behaviour. Furthermore, an easy to implement and repeatable method is presented to select the optimum size of random sets of ignition points, implicitly tuning the spatial texture of the input friction surface to the size of the study area. The model was tested on a Mediterranean study area of ca. 3300 km2 located in Ayora (Eastern Iberian Peninsula), for which a NFFL fuel model map was available. An initial series of runs served to select an optimum number of ignition points and to assess the model sensitivity to fuel moisture. Then, a set of three scenarios of vegetation cover change was devised by replacing chaparral by

slower fuels (brush, dormant brush, and closed timber litter), and the existing network of fuelbreaks was also overlaid. The model performed as expected by quantifying the differential resistance to fire spread implicit to such scenarios. As an overall result, our model indicates that reducing the length scale of the landscape texture has a greater effect preventing fire connectivity than creating large, homogeneous patches of fire resistant vegetation.