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A simple analytic model for the intersection of wildfire-burnt areas and erosion-producing convective thunderstorms in space and time

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Post fire debris flows and other extreme erosion events result from the spatial and temporal intersection of burnt areas and rainfall events of sufficient magnitude to initiate these erosion processes. Both the size and frequency of fires and storms can be considered as random variables. The spatial and temporal properties of burnt areas and storms affect the probability of an intersection occurring in space and time. In many parts of the world climate change is predicted to alter the temporal and spatial patterns of both rainfall and of fire. We need suitable models to predict the long term effects of such complex changes on landscape properties such as soil erosion, water quality, and site productivity. In this presentation we propose a simple analytic probabilistic model (based on coverage processes) that can be used to identify changes in the mean annual area of extreme erosion events as a function of fire and rainfall distributions. The new equations reveal interesting relationships between fire, convective storms and extreme erosion events. For example, the effect of increases in fire frequency and size on the average rate of extreme erosion events is shown to be non linear. Finally, we use the model to explore the probable impacts of projected shifts in patterns of fire and rainfall on extreme erosion events.