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On Ignition Modeling

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Knowledge about the spatial and temporal distribution of fire ignitions provides relevant information for assessing the potential risk of fire, offering opportunities for improving fire prevention measures. For example, the distribution of ignitions can be used to allocate resources for early fire suppression on the high risk areas [1], especially when combined with Fire Danger Rating Systems (FDRS). By combining the results of models for predicting ignition occurrence with FDRS predictions we would include those socio-economic factors behind human-caused ignitions to the weather and fuel moisture components that basically define FDRS. The number and spatial distribution of ignitions can also be integrated into fire spread models to generate spatially continuous information on probability of fire occurrence for landscape planning purposes when reducing the negative impact of fires is a goal [2,3]. Finally, by understanding the human behavior that triggers human-caused ignitions, it is possible to implement measures for reducing the number of ignitions and the subsequent fires. However, it has to be mentioned that predicting where and when they will the ignitions take place implies a high degree of uncertainty, as both natural events and human activities leading to their occurrence are often difficult to predict or even to measure.

Adding to the inherent degree of uncertainty associated to ignition occurrence, there are several other aspects that may difficult the process of analyzing ignition occurrence, and interpret the obtained results. First, it must be realized the so called ignitions are in fact fires, as the process of recording them is associated to a minimum fire size, which depends on the requirements of regional or national administrations. Despite the known fact that only a few ignitions evolve into large fires, neglecting those "non-important" fires may be a loss of important pieces for completing the fire regime puzzle. Even if any forest fire, regardless its size requires certain fuel and moisture conditions to start, its final size depends on those factors limiting its spread [4]. This implies that as the size of recorded fires increase, their distribution highly depends on factors such as: amount, type, and spatial arrangement of fuel types; previous and prevailing weather conditions; topography; and in some cases the difficulty to implement an early detection and suppression due to the remoteness of the fire initiation point. Meaning that on a study based on "important" fires, the distribution of ignitions and the source of heat causing the emergence of those fires (e.g. human activities or lighting strikes) is partially neglected. This aspect is of great importance if our objective is to identify those socio-economic factors behind the occurrence of human caused fire ignitions, as it is assumed that this knowledge can be used to define prevention measures for reducing the number of ignitions, and subsequently of fires.

Identifying the influence of socio-economic factors by modeling requires from taking decisions that may vary the potential results. For example, the choice of the statistical method and the spatial scale at which the data is aggregated should have an impact not only on the results but especially on their interpretation. This influence on the potential results becomes obvious when selecting the spatial scale to aggregate ignition data (e.g. based on the specific ignition locations as in Romero-Calcerrada et al. [5]; on the location of ignitions versus a set of random non-ignited points as in Martell et al. 1987; on an spatially continuous grid were the occurrence or the frequency of ignitions is accounted as in Cardille et al. [6]; on administrative or ecological borders as in Chou and De la Riva et al. [7,8]; or on the combination of multiple scales as in Gonzalez-Olabarria et al. [9], as the selected aggregation scale will define the type and availability of variables to be used as ignition precursors. Finally, another important aspect that should be taken into consideration when modelling the occurrence of ignitions of human origin is that these ignitions can hardly be considered as a uniform group as their etiology can be quite different. Traditionally, modelling the occurrence of ignitions has relied on broad causality groups, as for example natural versus human caused ignitions, or on the segregation of human cases into pooled groups (e.g. intentional, accident, negligence, restarted...). Nevertheless, it is known that causal groups as negligence's or accidents are the result of merging ignitions from more specific causes such as pasture burning or other escaped agricultural burning, forest works, smokers, electric lines, railroads, campfires etc, each one of them deriving from specific human behaviour and related activities. Subsequently the spatio-temporal aggregation of the ignitions is expected to vary depending the specific ignition cause [10,11] and those socio-economic and environmental factors behind their occurrence will vary accordingly [12]. Therefore, by combining ignitions from pooled causes we will obtain results that depend on the ignitions that came from the more frequent cause or are more aggregated spatially, diluting the influence of the not so common ignition causes, limiting the possibility of discern accurate relations between the occurrence of ignitions and human behaviour, and hampering future studies about the influence that the cause of ignitions may have on defining the fire characteristics other than temporal and spatial distribution [13].

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