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Some power law and scaling behaviors of forest and urban fire disasters

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Power-law distribution have been found in many actual systems, such as the earthquake, rainfall and forest fires etc, and considered as one of the characteristics of SOC(Self-Organized Critical) systems (introduced by P. Bak in 1987). It is found that there are three types of power-law relations in forest fire system, i.e. frequency-size distribution, frequency-interval distribution, and the relation between population density and fire probability. Some of these characteristics are attributed to the SOC.
The frequency-interval distribution of forest fires showes periodic change, different to that of frequency-size distribution. On the base of the traditional forest fire model proposed by Drossel and Schwabl in 1992 (DS model), the effects of influencing factors to the forest fire are studied. A Weather-Driven forest fire model (WD model) was built, in which the igniting probability is calculated with the weather parameter, i.e. relative humility, instead of a constant. The results demonstrate that the temporal distribution agrees well with that of actual forest fire data. Furthermore, it is found that the change of weather data also exhibits a power-law relation with periodic fluctuations, implying that the external driving from weather parameters is the essential reason for the power-law behavior of fire intervals.
In order to explore the temporal scaling behavior of forest and urban fires, Allan factor (AF), Fano factor (FF) and Detrended Fluctuation Analysis (DFA) are used to investigate the fire data in different countries or regions. It is found that both the forest and urban fires exhibit time-scaling behavior, and the scaling exponents of urban fires are larger than forest fires, signifying a more intense clustering. Similar power-law characterizes the relative humidity, and its AF and FF plot validate the existence of a strong link between weather and fires. By studying the forest fire area series, it is found that both the forest fire and the weather parameters, including temperature, relative humidity and rainfall, all have similar “crossover” points and behave persistent long-range power-law correlations in large timescales. The long-range correlation of urban fires seems weaker than that of forest fire, and the human behavior or uneven population density may effect the relation in some way. Similar results are obtained analyzing Chinese urban fires.
The suty may be useful to understand the scaling behaviors and their origins.