



Time fluctuation analysis of forest fire sequences

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Forest fires are complex events involving both space and time fluctuations. Understanding of their dynamics and pattern distribution is of great importance in order to improve the resource allocation and support fire management actions at local and global levels.

This study aims at characterizing the temporal fluctuations of forest fire sequences observed in Portugal, which is the country that holds the largest wildfire land dataset in Europe. This research applies several exploratory data analysis measures to 302,000 forest fires occurred from 1980 to 2007. The applied clustering measures are: Morisita clustering index, fractal and multifractal dimensions (box-counting), Ripley's K-function, Allan Factor, and variography. These algorithms enable a global time structural analysis describing the degree of clustering of a point pattern and defining whether the observed events occur randomly, in clusters or in a regular pattern. The considered methods are of general importance and can be used for other spatio-temporal events (i.e. crime, epidemiology, biodiversity, geomarketing, etc.). An important contribution of this research deals with the analysis and estimation of local measures of clustering that helps understanding their temporal structure.

Each measure is described and executed for the raw data (forest fires geo-database) and results are compared to reference patterns generated under the null hypothesis of randomness (Poisson processes) embedded in the same time period of the raw data. This comparison enables estimating the degree of the deviation of the real data from a Poisson process.

Generalizations to functional measures of these clustering methods, taking into account the phenomena, were also applied and adapted to detect time dependences in a measured variable (i.e. burned area). The time clustering of the raw data is compared several times with the Poisson processes at different thresholds of the measured function. Then, the clustering measure value depends on the threshold which helps to understand the time pattern of the studied events.

Our findings detected the presence of overdensity of events in particular time periods and showed that the forest fire sequences in Portugal can be considered as a multifractal process with a degree of time-clustering of the events.

Key words: time sequences, Morisita index, fractals, multifractals, box-counting, Ripley's K-function, Allan Factor, variography, forest fires, point process.

Acknowledgements

This work was partly supported by the SNFS Project No. 200021-140658, "Analysis and Modelling of Space-Time Patterns in Complex Regions".

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