Spatial Pattern Analysis of Esca Grapevine Disease

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Abstract: Esca is a major fungal wood disease of grapevine in France, whose widespread distribution in vineyards leads to vine decline and to reduced productivity. Spatial dynamics have been studied in an exploratory analysis in order to obtain better insight into the epidemiology of this complex disease. A plot of 2000 contiguous vines planted in rows was monitored visually each year, from 2004 to 2011, for esca symptom foliar expression. The ensuing data were used for join count statistical analyses, based on the symptomatic vine pair counts in the same neighbourhood, in order to measure the spatial aggregation of esca expression vines.
The neighbourhoods have been defined in terms of different distances and/or orientations with four different tests being employed: Isotropic, Row, Off test and Elliptic-Neighbourhood. The first three tests are based on distance. The Elliptic-Neighbourhood test is based exclusively on neighbour order, and has been specifically designed on the basis of an ellipse neighbourhood definition adapted to the irregular grid vineyard data.
Employing a permutation test is a simple way to extract data characteristics which do not require assumptions about the underlying distribution. The permutation tests, applied to lattice data here, were combined with specifically designed join count statistics. The p-values of the permutation tests were computed using a corrected form in order to avoid singular values. The four types of tests concerning different orders or distances (1m to 15m) were performed annually. The results have been presented as decisions (acceptance/rejection) of those tests by years according to two significance levels, to show temporal evolution. The results of the Row and Isotropic tests were compared for all distances to determine propagation direction. These two tests were further distinguished by showing the exact p-values for Isotropic, Row and Off Row tests in the same graph.

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