Iberian oak decline ("seca") caused by *Phytophthora cinnamomi*: A spatiotemporal analysis incorporating the effect of host heterogeneities at landscape scale

E. Cardillo[1], E. Abad [2], and S. Meyer[3]
[1]Institute of Cork, Wood and Charcoal, Centro de Investigaciones Científicas y Tecnológicas de Extremadura, Mérida, Spain,
[2]Departamento de Física Aplicada, Instituto de Computación Científica Avanzada (ICCAEx),
Universidad de Extremadura, Mérida, Spain,
[3] Institute of Medical Informatics, Biometry, and Epidemiology,
Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany

The pathogen *Phytophthora cinnamomi* is considered a main driver of Iberian oak decline (IOD), a forest disease which decimates holm oaks (*Quercus ilex*) and cork oaks (*Quercus suber*) in a multipurpose, silvo-pastoral and semi-natural ecosystem of 3.1 million hectares in the south-west of Europe. Little is known about the spatial dynamics of *Phytophthora cinnamomi* and how forest stand characteristics affect the IOD epidemic. Here, we analyse IOD spread over several decades in one such ecosystem by means of a multilevel approach [1] based on (a) identification of diseased sites via repeated aerial imagery at landscape scale, (b) confirmation by subsampling of soil and roots, and iii) an epidemic model accounting for host population heterogeneities. We use a 'self-exciting' spatiotemporal point process with two additive risk components: a distance-dependent epidemic component represents the inoculum pressure from nearby disease foci, and a background component describes sporadic disease transmission over larger distances or from unobserved sources.

A lagged power-law spatial kernel provides the best fit for the observed disease pattern. We estimate that 49 % of the secondary infections triggered by a primary source occur within a distance of 250 m. The color code in Fig. 1 shows the strong differences in disease intensity within the area under study.

Our results also highlight the role of density and diversity of the host population; we find that the rate of sporadic infections in silvo-pastoral systems (*dehesas*) is lower than in forests, and higher in mixed stands and shrub encroached oak lands than in pure stands.

The above findings have direct implications for IOD management, for example the estimated spatial kernel may guide the definition of suitable target areas for localized control measures and help to quantify their success. Our results also suggest that silviculture treatments aimed at controlling the density and species composition of oak stands, as well as the abundance of shrubs, are crucial to the containment of IOD.

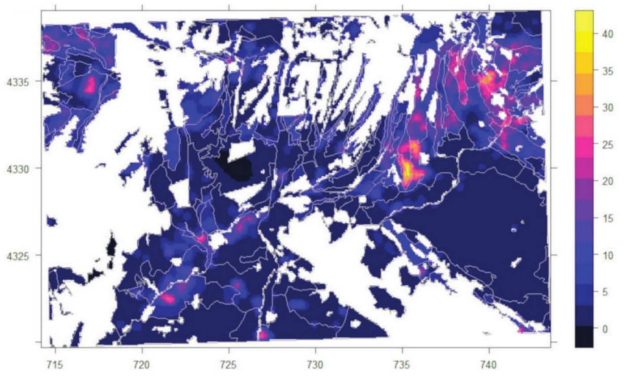

Fig. 1. Model-based estimation of the IOD disease intensity (=accumulated number of foci / km^2 during the reference period) in the area of study. UTM coordinates in km referenced to the WGS-84 system.

[1] E. Cardillo, E. Abad, and S. Meyer, Forest Pathology **51**, e12667 (2021).