

Use of remote sensing data and GEE (Google Earth Engine) for detection and monitoring of cork oak decline caused by *Phytophthora cinnamomi*

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Abstract

Over the last decades the role of pathogens in natural forests has gained increasing attention due to an exponential increase in the number of emergent diseases in worldwide forests. Exotic pathogens are now threatening forests where pathogens have not traditionally been considered as major ecological drivers of tree demography, such as water-limited Mediterranean forests. The oomycete *Phytophthora cinnamomi* is one of the most aggressive plant pathogens on earth, which has been identified as the main biotic driver of the severe decline and mortality of evergreen oaks in southern Europe. In the Mediterranean Basin, *P. cinnamomi* is decimating populations of cork oak (*Quercus suber*) stands representing a problem of paramount ecological and socio-economic importance, since cork oak is a major structural element in Mediterranean forests providing economic and cultural services. Identifying and mapping declining forests is highly relevant for management, however, this is often difficult and costly. The trend of the vegetational index, other environmental conditions being equal, can represent a valid proxy for deriving the state of health and evaluating how external disturbances affect productivity. In this context, the analysis of the time series of the vegetation indices represents a valid tool for evaluating the vegetation dynamics and deriving various phenological parameters. Nowadays the progress achieved by AI (Artificial Intelligence) and the availability of cloud computing platforms (e.g. Google Earth Engine), allows the processing of long time series of geographic data at low cost.

The objective of the work was to advance in the use of machine learning approaches to the processing of remote sensing data for the detection and monitoring of cork oak forests impacted by *P. cinnamomi*. Using harmonic analysis of time-series vegetation indices data, it is possible to better understand the evolution of symptoms in time and severity of the disease. Two sites, one *P. cinnamomi* infested and one disease-free, were selected in the area around Tempio P. (Sardinia, Italy). Fifteen circular plots (five for the disease-free site and ten for the infested site (Fig.1) with a diameter of 12m, were randomly selected and the geographical coordinates acquired with a GNSS receiver. The time series of three vegetation indices (NDVI, SAVI, EVI) were derived from multispectral satellite images with high spatial resolution (10m), acquired by the Sentinel2 satellite in the period January 2016 - December 2020. Whereas the canopy transparency was monitored in two consecutive years using a spherical densiometer.

For each plot and for each vegetation index a single continuous trajectory was derived. This novel approach of combining harmonic analysis with cloud computing of massive data with GEE allowed deriving and analysing the most significant phenological parameters, among which the date of onset and end of the vegetative period, annual peaks and troughs of the vegetation indices (Fig. 2-3).

The analysis of differences in the vegetation intra-annual seasonal cycles, in the various sites affected in different ways by the infection, has shown that the phenological phases appear profoundly different, both in terms of temporal shifting and in amplitude.

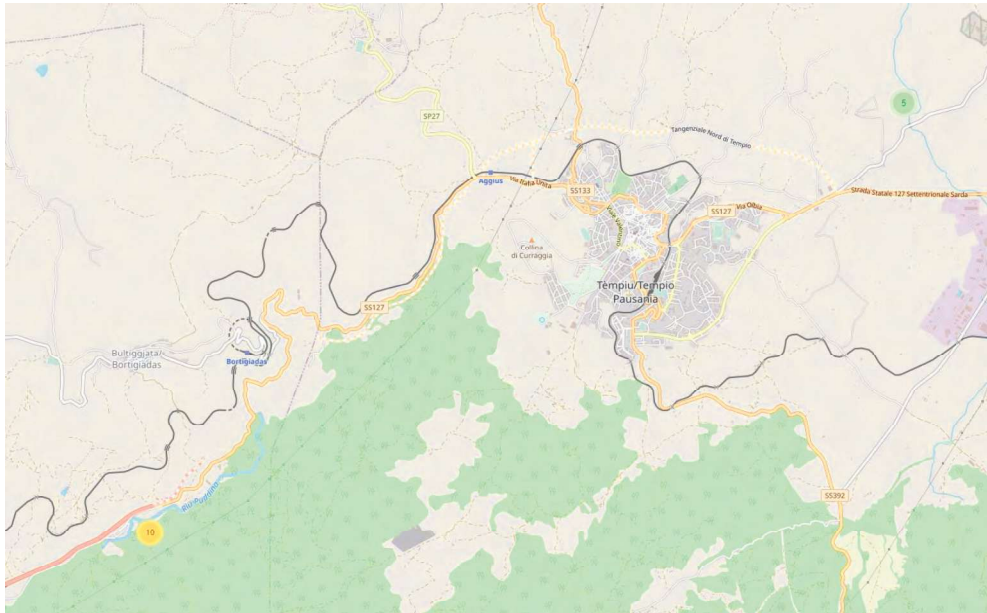


Figure. 1 - Area of Interest

Fig. 2 - NDVI-Seasonal variation

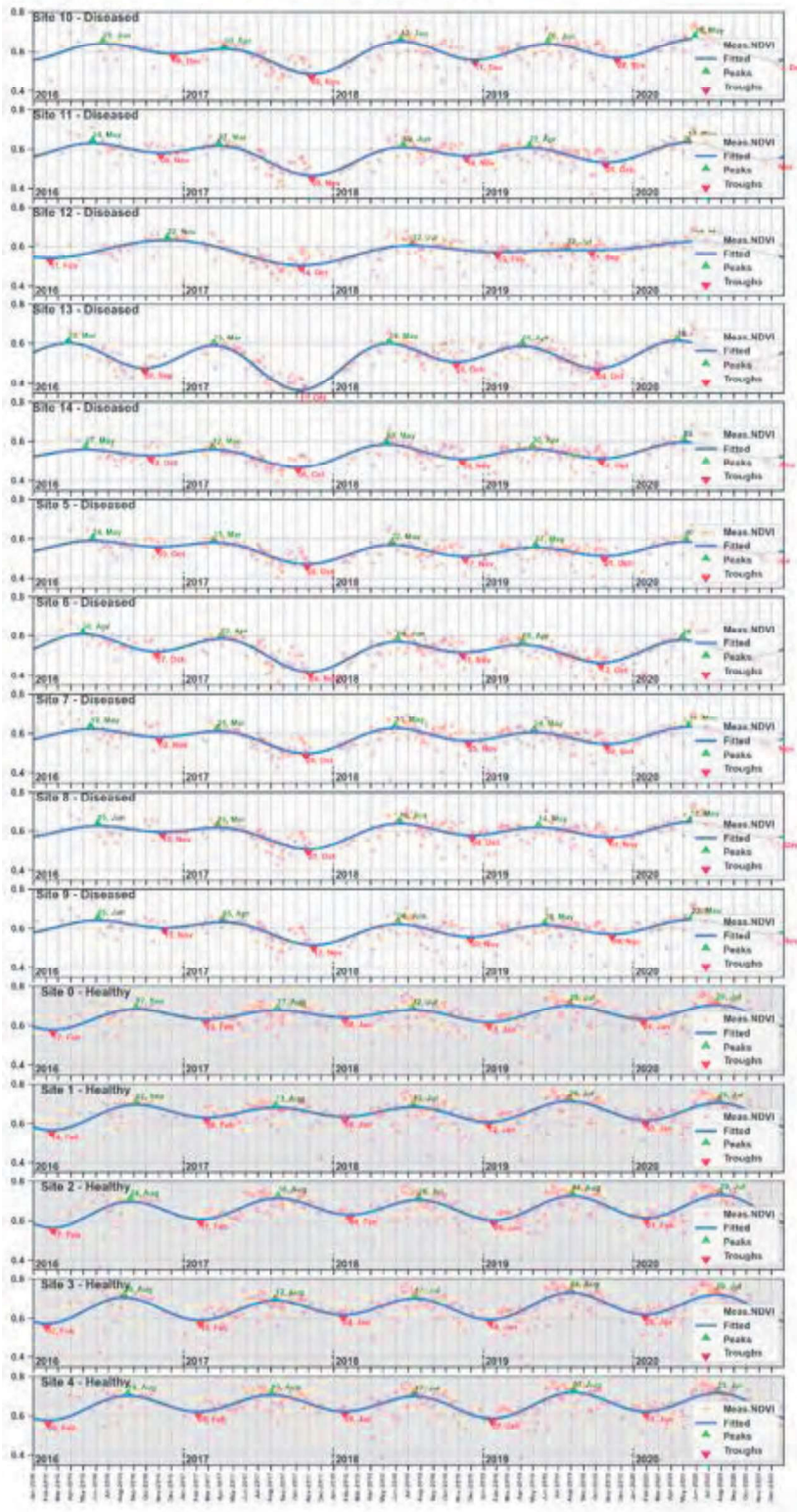


Fig. 3 - EVI values distribution

