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Multifractal Analysis of MODIS Terra Satellite Time Series of Italian Urban Forests

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Extended Abstract

Urban forests can improve the environmental quality of urban areas increasing their sustainability and contributing to reduce the effects of natural and anthropogenic hazards, like climate change, hydrogeological hazards, heat waves, acoustic and atmospheric pollution. Therefore, identifying any disturbance, which could affect vegetation, represents an important task within the framework of urban forest monitoring.

Among the causes of plant diseases and loss of biodiversity, pathogenic bacteria have been documented as severely impacting vegetation status, as in the case of Toumeyella parvicornis, an alien species prevalent from southern Canada to northern Mexico, that has been detected for the first time in Europe at the end of 2014, in Campania (Italy) on Pinus pinea, in the urban area of Naples [1], and now spreading in Southern Italy, where it could have devastating effects.

It is well known that remote sensing is an effective means for monitoring the status of forests, thanks to the availability of advanced sensors that make possible to capture in advance trends of vegetation degradation [2]. In particular, remote sensing could be used to detect pre-visual stages of the plant infection, thus preventing the epidemic spread by infected but asymptomatic trees.

In this work we study six urban forests located in different sites of Italy (Roma, Torino, Castel Volturno, Castel Porziano, Appia and Milano) by using the time series of four MODIS Terra satellite indices: Evatranspiration (ET), Enhanced Vegetation Index (EVI), Leaf Area Index (LAI) and Land Surface Temperature (LST), spanning from 2000 to 2021.

The satellite time series were analysed by means of the Periodogram to filter out the seasonalities. Then, the residual time series were analysed by using the Multifractal Detrended Fluctuation Analysis (MFDFA) [3, 4] that allows the characterization of time series by multifractality, a useful tool for describing the complexity of a nonstationary time series at different timescales.

Our findings point out that the urban forest of Castel Volturno has an anomalous behavior in terms of multifractality. This site is also well known to be strongly affected by the Toumeyella parvicornis, and the anomalous pattern displayed in terms of multifractal behavior could be due to the presence of this parasite that might suggest the multifractality as a good indicator of parasite-affected status of vegetation.

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