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Forest tree defoliation and mortality in Tuscany (central Italy) connected to extreme drought and heat waves in summer 2017: a preliminary report

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Introduction

Extreme climatic events threaten the health of the forests in the world. Summer drought and high temperature are among the main causes of extensive crown defoliation and tree mortality. Mediterranean forest species are considered resistant to drought. However cases of forest dieback following extremely dry and hot summers have been observed extensively in the Iberian peninsula (Lloret et al. 2004). From experimental studies carried out to assess the effects of such events on tree growth, resilience and mortality (Barbeta et al. 2015, Liu et al. 2015, Peñuelas et al. 2017), come out the need to investigate the vulnerability of Mediterranean forests under climate change.
In this presentation we describe a first extensive case of forest dieback and mortality in Tuscany (central Italy), as consequence of the extremely dry and hot summer 2017.

Study area and tree species

Where: In Tuscany (central Italy) during the summer 2017 an intense drought and heat waves, with mean daily temperatures higher than 35°C for several weeks (Table 1).

Tree species: Beech (*Fagus sylvatica* L.) (Fig. 1 A-B), downy oak (*Quercus pubescens* Will.), Turkey oak (*Quercus cerris* L.) (Fig. 1 C-D) and holm oak (*Quercus ilex* L.) (Fig. 1 E-F) in Appennine, hilly and Mediterranean forest stands, respectively.

Survey: Crown defoliation, leaves and branches desiccation and tree mortality were assessed in selected observational plots (Fig. 2).

		Prec. (mm) Apr.-Aug.	T max (°C) June	Tmax (°C) July	Tmax (°C) August
Beech forest	**2016**	377	19.3	24	23
Vallombrosa (UTM N 43°44'42.69" E 11°34'32.01")	**2017**	194.2	23.3	25.3	27.3
1190 m a.s.l.	**Average**	318	18.4	22.2	21.9
Downy oak forest	**2016**	371.4	25.6	30.9	29.8
Radda in Chianti (UTM N 43°29'43.18" E 11°23'22.54")	**2017**	97	30.9	32.4	34.4
441 m a.s.l.	**Average**	271	24.3	27.9	27.6
Holm oak forest					
Scarlino	**2016**	154.6	28	32.2	31.8
(UTM N 42°52'07.35" E 10°46'20.43")	**2017**	62	30.4	32.5	34
57 m a.s.l.	**Average**	178	25.9	29.1	29.1

Table 1. Meteorological data at three study sites representative of the forest types studied. The data of 2017 (precipitation and the average of the maximum temperature for the vegetative season April-August) are showed in comparison with those in 2016 and with the average for a period of 30 years.

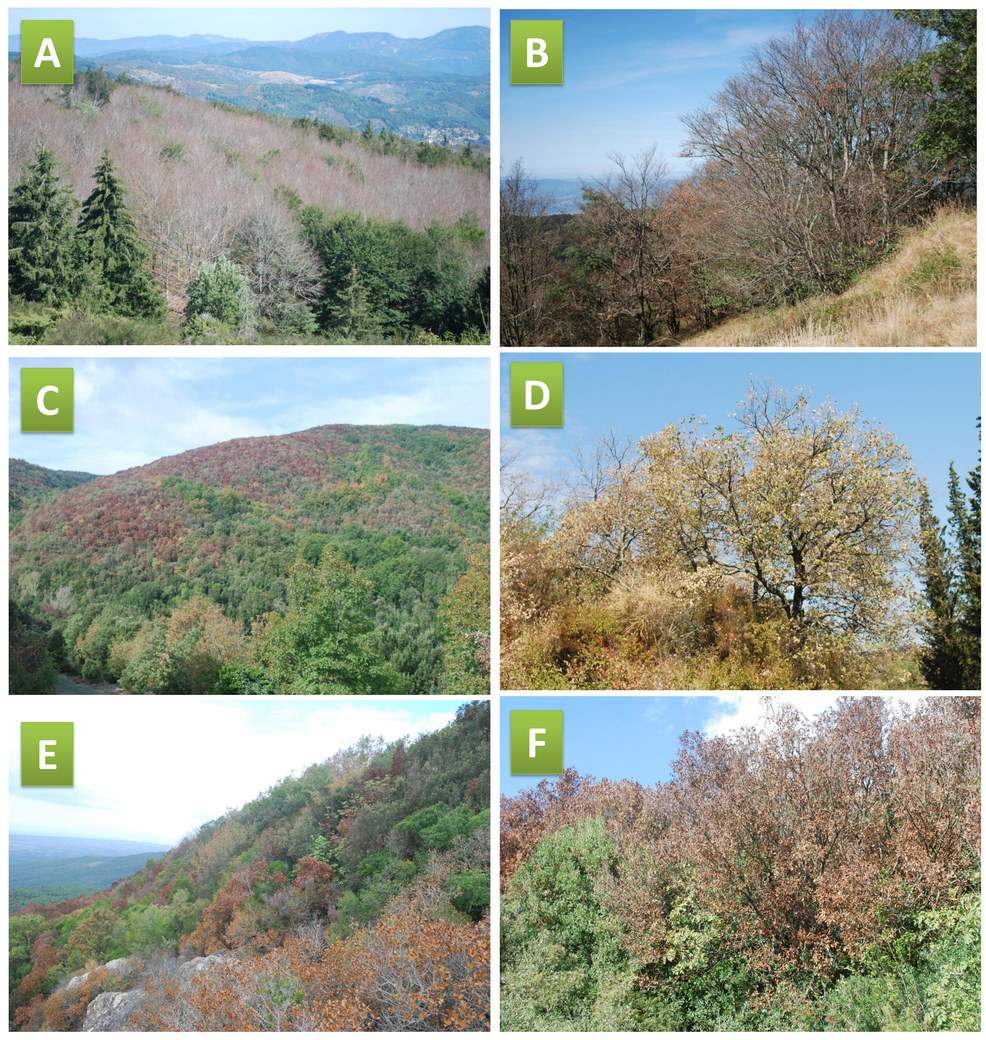

Fig. 1. Crown defoliation and desiccation induced by drought and heat waves observed in Tuscany during the summer 2017. A-B: beech forests; C-D: downy and Turkey oak mixed forest; E evergreen sclerophyllous forest; F holm oak.

A total of 87 observations combining field and remote sensing (multispectral and multitemporal Sentinel 2 imagery) surveys of healthy and unhealthy forest stands were carried out to map the extension of the damage at regional level (Figs. 3, 4).

Drought and heat waves effects in summer 2017

Crown defoliation in evergreen sclerophyllous forest ecosystems

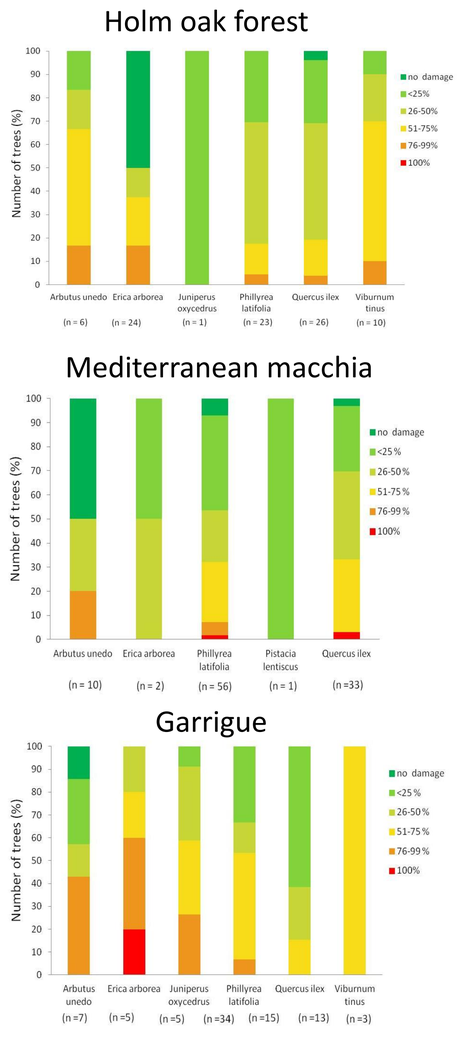

Fig. 2. Number of unhealthy trees per species in according to defoliation classes.

Crown reflectance properties of deciduous and evergreen forests

Fig. 3. Normalized Difference Vegetation index (NDVI) and Sentinel 2 spectral bands (NIR, RedEdge 3, RedEdge 4) of healthy and unhealthy forest types in June, July and August 2017.

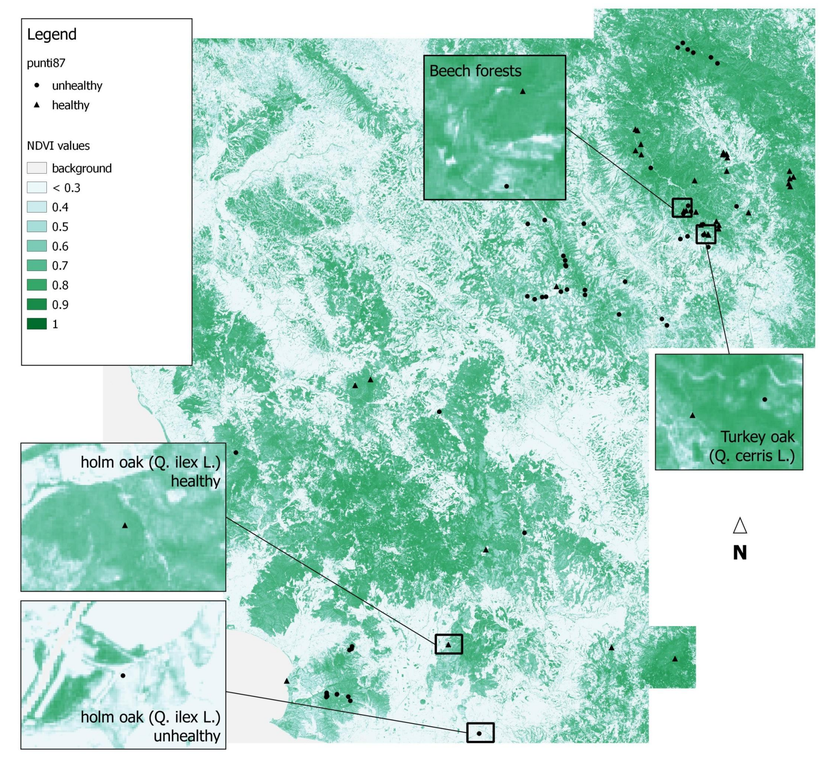

Fig. 4. Normalized Difference Vegetation index (NDVI) map of the forest types assessed in Tuscany (preliminary map).

Results and Conclusions

- Drought impact was strongest at higher altitudes, south exposition and on poor soil condition (e.g. in calcareous and serpentine soils).
- In evergreen tree species foliar desiccation and large crown dieback were observed. Deciduous species showed an early leaf loss, without apparent tree mortality.
- The drought-induced defoliation likely reduces the total amount of the photosynthates and the reserves of non-stuctural carbohydrates. Consequent reduction of tree growth, decrease in the vitality of new shoots and leaves and an increase of the plant sensitivity to pathogenic attacks and other forms of environmental stress are expected.
- The future forest structure and extension will depend on the resilience of the tree species and the recurrence of such extreme climatic events.
- Future research directions claim for a more effective monitoring system and new management concepts to improve the resilience and adaptation of Mediterranean forest ecosystems.

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