Effect of summer drought in the natural regeneration of valonia oak

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Abstract
This paper presents an initial attempt to investigate the effect of drought in the mortality of valonia oak (Quercus ithaburensis subsp. macrolepis) seedlings and young saplings in a silvopastoral system in western Greece. The experiment was conducted in fenced experimental plots where the number of seedlings and young samplings was measured in May and October before and after the dry summer period for the years 2015, 2016, 2017 and 2018. The results show that the number of seedlings and young saplings decreased on average by 24.7% in October attributed mainly to the effect of summer drought.
Keywords: silvopastoral systems, regeneration, *Quercus ithaburensis* subsp. *macrolepis*, climate change

1. Introduction

The valonia oak silvopastoral systems are traditional agroforestry systems of high natural and cultural value (Der Herder et al. 2015) with important economic, social and cultural value (Pantera et al. 2018). Natural regeneration in these systems is affected, besides grazing which is a major factor in limiting valonia oak natural regeneration, by a number of factors that influence these systems with climate change being an important one (Pantera et al. 2008, 2011; Papadopoulos et al. 2017).
The impact of climate change on valonia oak silvopastoral systems has not being thoroughly studied with the exception of one report on climate change that incorporates this species. Based on climate change scenarions, it is estimated that valonia oak is the thrird species that may face significant dectrease to its populations area, scaling up to a loss of 56% (Bank of Greece 2011). Based on the same scenarios, in Greece and in the study area in particular, the expected temperature increase and precipitaion decrease (Bank of Greece 2011) represents a crucial factor affectinf the establishment of saplings and yound seedlings or even the survival or young and older valonia oak trees. Under the framework of the present study we attemped an initial investigation of the effect of drought on valonia oak seedlings and young saplings.

2. Materials and Method

The experimental area is located in the Xeromero valonia oak silvopastoral system in W. Greece composed of open to relatively open stands with 25-50 trees/ha^{-1}. In this area, 12 rectangular plots covering an area of 40 m^2 were established and fenced again hrazing from livestock and wild animals. In each plot we measured the number of seedlings and young sapling in May before the summer period and in October after the dry period for the years 2015, 2016, 2017 and 2018. At the same time and for the same years, the drought period was calculated based on the Bangouls and Gaussen (1953) ombrothermic diagram (data from the meteorological station of the University in Agrinio, network of the National Observatory of Athens, 38^o 36′, 21^o 24′, 75 m), as well as the Self-calibrating Palmer Drought Severity Index (scPDSI) for the years 2015-2017 using gridded monthly data, for the KNMI Climate Explorer (http://climexp.knmi.nl; van der Schrier et al., 2013; Osborn et al., 2017). This index is a diversion of the original PDSI index of Palmer, which was invented by Wells et al. (2004), so results from different climate types can be comparable. According to Wells et al. (2004), the scPDSI index is calculated from precipitation and temperature data, as well as the local available water content of the soil, and varies from -4 (extreme drought) to +4 (extremely wet).

3. Results - Discussion

The comparison of the number of seedlings and young sapling between May and October for the years 2015-2018 (Fig. 1) shows that there is a reduction of 24.7% in the number of young seedlings in October compared to May, on average, which can be attributed to a large extent to climatic factors and drought. From the ombrothermic diagram of the years 2015-2018 (Figure 2), it appears that the climatic drought period occurs early in April and lasts even in October in some years. On the other side, on the basis of the drought monthly indexes scPDSI (Figure 3) it appears that the influence of the soil drought in recent years is observed even in the winter months.

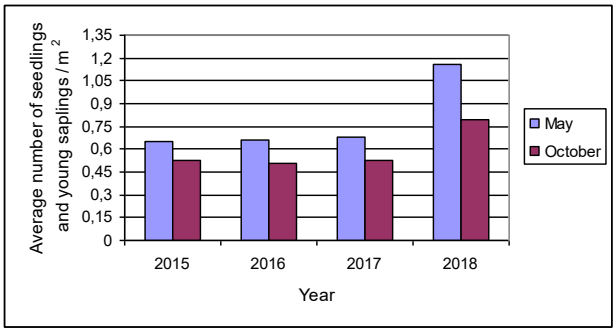

Figure 1. Average number of seedlings and young saplings in fenced plots in May and October of the years 2015-2018.

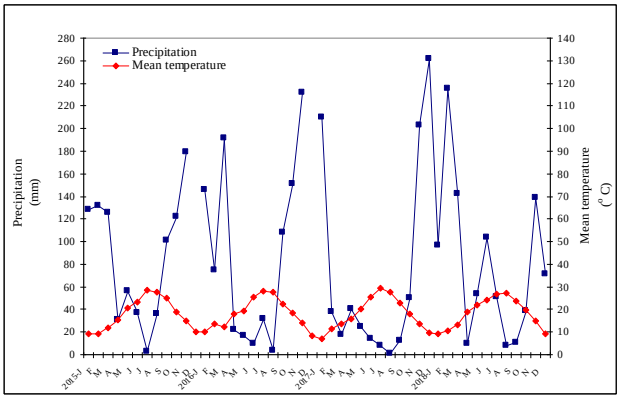

Figure 2. Ombrothermic diagram for the years 2015-2018

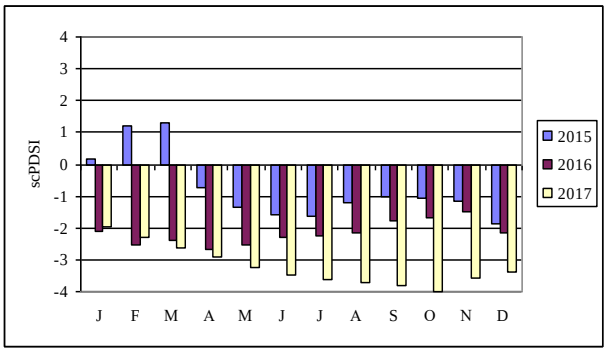

Figure 3. Diagram of the 12 drought monthly indexes (scPDSI) for the years 2015, 2016 and 2017.

4. Conclusions

Summer droughts greatly affect the survival of valonia oak seedlings. The estimated increase in the duration and intensity of the drought due to climate change in the area, combined with other factors such as grazing, fires, soil erosion and degradation, is expected to exacerbate the natural regeneration status of valonia oak in silvopastoral systems of western Greece indicating the need for immediate management measures to be taken.

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