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Soil water availability and tree water stress in a deciduous oak forest

under a Mediterranean subhumid climate

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In forthcoming decades the ecosystems of certain regions of the planet will be seriously affected by the changes brought about by climate change. One of the most sensitive aspects regarding such changes is water availability. Countries in the south of Europe have been identified as an area in which the predictive models developed so far foresee the greatest incidence of increases in temperature and decreases in precipitation. Under current conditions regions with a Mediterranean climate are characterised by high evapotranspiration, a scarcity and irregularity of precipitation, and the presence of a dry, hot season that coincides with the period of maximum biological activity. The possibility of a bioclimatic scenario that might increase water scarcity and its availability for ecosystems could generate processes of environmental degradation and noteworthy changes in the ecological dynamics of such regions.

In the present work, we performed an analysis of the evolution of plant available water in the soil and the appearance of water stress in the trees of a deciduous oak forest (*Quercus pyrenaica* Willd.) under subhumid Mediterranean climatic conditions. The work was carried out in the mountains of the Central System (Spain). To monitor soil moisture, we used a TDR (Time Domain Reflectometry) stations network. Thus, within the forest, 18 TDR stations were set up on three transects, measuring the soil water content from 0-100 cm with 5 horizontally placed two-wire probes (at 5, 15, 25, 50 and 100 cm depth). We also chose four plots representative of the different states of the forest to perform a specific monitoring of the water status of the soil and of the trees. On each plot, we placed a grid of 25 vertically-placed 20-cm TDR probes and under four trees we measured the soil moisture of the root zone down to a depth of 50 cm. On each plot, we selected four trees and installed 2 TDR probes on their trunks (at

20 and 120 cm above the ground) to follow the content in wood tissues as an indicator of the water stress of the trees.

Over a study period of the soil moisture content of more than 6 years we observed that the soil was suffering from a water deficit over 4 or 5 consecutive months, coinciding with the vegetative cycle of the forest. Over at least one or two months the water deficit was 100%; i.e., the plant available water was completely depleted. At the same time it was found that when the soil entered a period of water deficit and a certain threshold was surpassed the trees began to suffer water stress. This water stress was identified by observing the decrease in the water content in the trunks of the trees by TDR. In the present study we observed that even though subhumid conditions prevailed (more than 1000 mm rainfall/year), the current intensity of the summer drought means that the forest is subjected to water stress every year. Under environmental conditions that increase water restrictions, similar ecosystems will be similarly affected, especially bearing in mind that currently the degree of soil moisture deficit and the subsequent water stress for trees are already pronounced.