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Drought influence on carbon and water cycling in a Mediterranean *Quercus suber* L. woodland during the drought year 2012

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Savannah-type ecosystems account for 26-30% of the global gross primary production with water being one of the major driving factors. In Europe, savannah-type woodlands cover an area of about 2-2.5 million ha on the Iberian Peninsula. The recent past has shown there a significant decrease of precipitation in winter and spring as well as a decrease of total annual precipitation. Hence, strong effects on local water balance and carbon sink strength have been reported due to these changes in the precipitation regime.

The objective of this study is to quantify changes in the water balance, gross primary productivity and carbon sink strength of a typical Portuguese savannah-type woodland (*montado*) under the changed precipitation pattern of the drought year 2012 compared to the wet year 2011. The physiological response of the dominant tree species *Quercus suber* (L.) is evaluated, employing combined photosynthesis and stomatal conductance modelling.

Precipitation effectiveness ratio increased up to 122% in the dry year 2012 due to ground water access of the *Q. suber* trees leaving no water for ground water replenishment. By the lack of water in the upper soil and deep ground water reservoirs, the understorey and overstorey gross primary productions were reduced by 53% and 28% in 2012 compared to 2011, respectively, due to the late onset of the autumn rains in 2011 and an additional severe winter/spring drought. However, on an annual basis, the ecosystem was a carbon sink in both years, with a 61% reduced sink strength in the dry year 2012 compared to the wet 2011.

Applying a combined photosynthesis and stomatal conductance model, best model fit to gross primary productivity *and* transpiration of *Q. suber* trees could be achieved keeping apparent maximum carboxylation rate $V_{c,max}$ as well as stomatal conductivity parameter m and vapor pressure deficit sensitivity parameter D_0 of the stomatal conductance formulation variable. The *Q. suber* trees showed 20% reduced stomatal conductance g_s during the drought period 2012 compared to 2011 expressed as a reduction in stomatal conductance model parameter m. Hence, vapor pressure deficit sensitivity parameter D_0 increased under drought conditions in order to preserve the sensitivity of g_s to vapor pressure deficit *vpd*. In response to reduced leaf internal CO_2 availability and increased leaf temperatures, the trees strongly reduced apparent maximum carboxylation rate $V_{c,max}$ by 39% in 2012 compared to 2011. However, stomatal response was strongest at the drought beginning while strongest reduction of $V_{c,max}$ occurred at the end of the drought.

Our results suggest that, if the trend of decreasing annual precipitation and changed precipitation pattern on the Iberian Peninsula continues, sustained effects on local ground water reservoirs, understorey species composition and tree productivity may be expected in the long-term. To successfully model the effect of drought on the *montado* ecosystem, variable apparent maximum carboxylation rate $V_{c,max}$, stomatal conductivity parameter m and vapor pressure deficit sensitivity parameter D_0 need to be incorporated in photosynthesis and stomatal conductance modelling.