Geophysical Research Abstracts
Vol. 19, EGU2017-1491-1, 2017
EGU General Assembly 2017

Transpiration and Groundwater Uptake Dynamics of Pinus Brutia on a Fractured Mediterranean Mountain Slope during Two Hydrologically Contrasting Years

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Semi-arid environments tend to have extreme temporal variability in rainfall, resulting in extended periods with little to no precipitation. The mountainous topography is characterized by steep slopes, often leading to shallow soil layers with limited water storage capacity. Tree species survive in these environments by developing various adaptation mechanisms to access water. The main objective of this study is to examine the differences of two hydrologically contrasting years on the transpiration and groundwater uptake dynamics of *Pinus brutia* trees.

We selected four trees for sap flow monitoring in an 8966-m^2 fenced area of *Pinus brutia* forest. The site is located at 620 m elevation, on the northern foothills of the Troodos mountains in Cyprus. The slope of the site ranges between 0 and 82%. The average daily minimum temperature is 5 ^{0}C in January and the average daily maximum temperature is 35 ^{o}C in August. The mean annual rainfall is 425 mm. Monitoring started on 1 January 2015 and is ongoing.

We measured soil depth in a 1-m grid around each of the selected trees for monitoring. We processed soil depths in ArcGIS software (ESRI) to create a soil depth map. We used a Total Station and a differential GPS for the creation of a high resolution DEM of the area covering the selected trees. We installed seventeen soil moisture sensors at 12-cm depth and two at 30-cm depth, where the soil was deeper than 24 cm. We randomly installed 28 metric manual rain gauges under the trees' canopy to measure throughfall. For stemflow we installed a plastic tube around each tree trunk and connected it to a manual rain gauge. We used sap flow heat ratio method (HRM) instruments to determine sap flow rates of the *Pinus brutia*. Hourly meteorological conditions were observed by an automatic meteorological station.

Here we present the results of the January to October periods, in order to have comparable results for the two contrasting years. During the wet year of 2015, we measured 439 mm rainfall and an average transpiration of 225 mm. During the dry year of 2016, rainfall was 188 mm while the average transpiration was 96 mm. Both during the wet and dry years, the transpiration was 51% of the total rainfall. The average soil moisture content during these two periods was 15% in 2015 and 13% in 2016; and was not enough for the transpiration needs. The water balance of the trees revealed that most of the water needed for transpiration is provided by groundwater uptake from bedrock fractures (about 80%). Reverse sap flow rates were measured during negative temperatures, indicating that *Pinus brutia* trees release water to avoid freezing. *Pinus brutia* was found to adapt to the annual and seasonal variations in climatic conditions by regulating their transpiration rates according to the water availability.

This research is supported by the European Union's H2020 BINGO project.