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Design and Performance Evaluation of Internet of Things (IoT) Based Multifunctional Device for Plant Ecophysiology & Hydrology: Toward Stem Water Content & Sap Flow

Shahla Asgharina¹, Luca Belelli Marchesini², Damiano Gianelle³, and Riccardo Valentini⁴

¹Department for Innovation in Biological, Agro-food and Forest Systems (DIBAF), Tuscia University, Viterbo (VT), Italy (asgharina@unitus.it)

²Department of Sustainable Ecosystems & Bioresources (DASB), Fondazione Edmund Mach, San Michele All' Adige (TN), Italy (luca.belellimarchesini@fmach.it)

³Department of Sustainable Ecosystems & Bioresources (DASB), Fondazione Edmund Mach, San Michele All' Adige (TN), Italy (damiano.gianelle@fmach.it)

⁴Department for Innovation in Biological, Agro-food and Forest Systems (DIBAF), Tuscia University, Viterbo (VT), Italy (rik@unitus.it)

Using IoT technologies represents a novel low cost and efficient tool for studies in many disciplines (plant ecophysiology and hydrology) to unravel the vulnerability of an ecosystem to climatic stress. Taking advantage of IoT, a new multifunctional device, the “TreeTalker”, was developed to monitor in real time physical and biological parameters of single trees as well as some additional ecosystem-related variables. Here, we present performance of the TreeTalker to illustrate mainly the role of stem water content and water transport in tree behavior and function with respect to internal and external forces. TreeTalker is designed based on Granier-type thermal dissipation probe (TDP) and a capacitance sensor to measure stem water content.

In this study, two main experiments are analyzed. In the first experiment, procedures for calibration and use of capacitance sensors are presented. Considering the effect of wood density on frequency data, calibration is performed on different species and diameter harvested stems to convert the sensor-reported values to stem volumetric water content. In the second experiment, application of 20 TreeTalkers with particular emphasis placed on measuring hourly, daily and monthly sap flow and stem water content fluctuations under well-irrigated and deficit-irrigated treatments of *Juglans regia* L. was conducted on a study site in northeast of Italy.

The results show that the range of stem water content is highly influenced by environmental factors. Stem water content has a significant portion of the daily tree water uptake. Low water storage occurs in response to drought and less soil water availability, which clarifies the high dependency of trees on stem water content under deficit-irrigated treatments. The diurnal-nocturnal pattern of stem water content and sap flow revealed an inverse relation. Such finding, still under investigation is explained by the important water recharge during the night, likely due to stem volume changes and lateral water distribution rather than by vertical flow rate.

