



Determining tree stem water content in drought-tolerant species

Tadaomi Saito and his research team were interested in using METER dielectric soil moisture sensors to measure the tree stem volumetric water content of mesquite trees and tamarisk, two invasive species dominant in Sudan and arid parts of the United States. Mesquite is a species that can access deep groundwater sources using their taproots which is how they compete with native species. Tamarisk, on the other hand, uses shallow, saline groundwater to survive. The team wanted to see if dielectric probes were useful for real-time measurement of plant water stress in these drought-tolerant species and if these measurements could illuminate differing tree water-use patterns. These sensors could then potentially be used for precision irrigation strategies to assist in agricultural water management.

Temperature calibration was essential

After calibrating the soil moisture sensors to the wood types in a lab, the team inserted probes into the stems of both trees. They also monitored groundwater and soil moisture content to try and infer whether or not the trees were plugged into a deep source of water. Interestingly, Saito found that, unlike soil, where temperature fluctuation is buffered, tree stems are subject to large variations in temperature throughout the course of the day. This temperature fluctuation interfered with the soil moisture probes' ability to accurately measure VWC. The team came up with a simple method for accounting for temperature variability and were then able to obtain accurate VWC measurements.

Water use depended on landscape position

Saito's results were similar to Ashley Matheny's study in that they found a lot of different patterns, even in trees of the same species. Water-use depended on where the trees were on the landscape. Some of them were tapped into groundwater, and the stem water storage didn't change no matter how dry the soil became. Whereas others, depending on their position in the landscape, were very dependent on soil moisture conditions.

Implications

Saito's study illustrates that we see everything about a tree that's above ground, but we may have no sense of what's going on below ground. We can put a soil moisture sensor in the ground and decide there's plenty of moisture available. Or if conditions are dry, we may decide the tree is under drought stress, but we don't know if that tree is tapped into a more permanent source of groundwater.

Other researchers have put soil moisture sensors in orchards looking at stem water storage from a practical standpoint for irrigation management. Their data didn't work out so well because of cable sensitivity where water on the cable created false readings. However, the data they were able to obtain showed that some of the trees were plugged into water sources that were independent of the soil. Those trees were able to withstand drought and needed less irrigation, whereas other trees were much more sensitive to soil moisture.

If we had an inexpensive, easy to deploy measurement device plugged into every tree in an orchard, we could irrigate tree by tree, give them precisely what they needed, and account for their unique situation.

What does it all mean?

The interesting thing about using soil moisture sensors in a tree is that stem water content is a difficult-to-obtain piece of information that has now been made easier. Historically, we've focused on measuring sap flow, but that's just how much water is flowing past the sensor. We've measured what's in the soil: a pool of moisture that's available to the tree. But some trees are huge in size, such as ones along the coast of California. They're able to store vast amounts of water above-ground in their tissue. Understanding how a tree can use that water to buffer or get through periods of drought is a unique research topic that has had very little attention. With these kinds of sensors, we can start to investigate those questions.

Reference: Saito T., H. Yasuda, M. Sakurai, K. Acharya, S. Sueki, K. Inosako, K. Yoda, H. Fujimaki, M. Abd Elbasit, A. Eldoma and H. Nawata , Monitoring of stem water content of native/invasive trees in arid environments using GS3 soil moisture sensor , Vadose Zone Journal , vol.15 (0) (p.1 – 9) , 2016.03



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