Control Over Drought

Chinese research project will extract water insights from evapotranspiration measurement

Interview compiled by Elisabeth Lisican

Dave Johnson is senior project manager for LI-COR Biosciences, responsible for the eddy covariance product line. Johnson helps take environmental hardware and software products from concept through development to the market. Prior to LI-COR, Johnson worked with the Smithsonian Institution on a climate change research project in Florida as a project environmental engineer. He has organized and participated in more than 60 workshops around the world, training more than 1,500 researchers and scientists. Johnson received his B.S.E. from Arizona State University and his M.S. in Engineering Management from the University of Central Florida. Johnson can be reached at dave.johnson@licor.com.

Projections show that China anticipates a shortage of water over the next 15 years, and many other countries—including the U.S., as the news has been widely reporting—also are facing major drought and other water management crises. The measurement of evapotranspiration, a portion of the water cycle that combines evaporation and transpiration from plants, in China has implications in water management, drought, flood and other natural disasters worldwide. The Chinese Ecosystem Research Network (CERN) has selected LI-COR Bioscience's eddy covariance system to measure evapotranspiration. Here, W&WD Managing Editor Elisabeth Lisican discusses the project with Dave Johnson, senior product manager for LIO-COR Biosciences.

Elisabeth Lisican: Please explain evapotranspiration and the work that is being done to research it. How is it measured?

Dave Johnson: Evapotranspiration describes the release or transport of water vapor from the earth's surface into the atmosphere, and is the sum total of two components: Evaporation is the transfer of H_2O from liquid to vapor phase, and transpiration is plant-mediated evaporation. Transpiration is controlled through leaf stomata and depends on factors such as plant species, vapor pressure deficit, temperature and available soil water, among others. Evapotranspiration is expressed as the amount of water lost from a surface area, in units of water depth. The time unit can be an hour, day, month, year, decade or even an entire growing period.

The eddy covariance method allows direct measurement of actual evapotranspiration over a large-scale area, using a set of instruments to measure water vapor concentrations in the atmosphere, along with wind speed and direction. Eddy covariance measures the exchange of gases (including H_2O) between terrestrial ecosystems and the atmosphere.

Lisican: How will this research help provide insights into critical water use efficiency, drought and water management issues? Please cite examples of projects that have taken evapotranspiration research to heart.

Johnson: Evapotranspiration can be used for forecasting or allocating irrigation for crops. The primary objective of irrigation is to apply water at the right period and in the right amount. Thus, without accurate evapotranspiration values, we could either irrigate too much or too little. This will result in unnecessary water loss and/or a reduction in crop yield. Similarly, when to fertilize, how much and what type can influence the vegetation's water use efficiency. Measurements of evapotranspiration can help determine which fertilizer plan and schedule are best for the plants' water use.

Another evapotranspiration research goal is to examine watersheds for water management issues. The U.S. Geological Survey and state of Texas investigated several methods for examining water availability in watersheds in Texas, where water is limited. A similar project at another location physically removed junipers that require high water uptake, which now saves more than 58 billion liters of water per year.

Lisican: There are many pressing water issues, but which do you consider to be the most critical and why?

Johnson: Understanding the water cycle is essential for researchers and scientists as demands increase due to climate change. How water resources are managed in the future is critical for humans. Understanding the evapotranspiration process can help us develop contingencies for water management issues, mitigating drought, crop production and water use efficiency.

Lisican: Please explain the timeline of the CERN project. How will it pave the way for future projects of its kind?

Johnson: The CERN, a division of the Chinese Academy of Sciences, has taken on the challenge of understanding the water cycle by directly measuring evapotranspiration using the eddy covariance technique. CERN selected 27 different locations across China to better understand the water cycle and measure evapotranspiration over a period of at least five years, and probably longer. Because China's water supply is well below the world average, the Chinese government has a significant interest in measuring and managing water resources. To support its large population, about 62% of the water in China is dedicated to food production. In China alone, many other flux networks already are planned and are looking to CERN to provide a working model for future installations. The outcomes from the CERN project can help other countries and world leaders begin thinking about water and how to best understand the water cycle. w&wd

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Stressed-Out Trees

Climate change may have an unexpected effect on large majestic forests, which ultimately can affect water supplies. A new study is applying a principle of fluid flow to show how the forests of the future could be "shorter and scrubbier," according to an article in the Christian Science Monitor. The study uses a principle known as Darcy's Law, which describes fluid flow through a permeable medium, to determine the types of vegetation most and least likely to survive rising temperatures and extreme drought.

The study was based on findings that the amount of water trees release through evapotranspiration is "at least as influential in stressing trees as the amount of rain or snow that the forests receive in winter," the article said. As temperatures rise, the atmosphere is able to hold more water vapor. The atmosphere then is driven to draw moisture from plants and soil. The hotter and drier it gets, the more water it draws, and trees get stressed when the atmosphere draws water faster than they can replace it. A 2012 study showed that slowed tree growth was highly correlated to this increase in evaporative demand from the environment. The study found that tall trees with relatively few leaves were the most vulnerable. This could change the scope of CO_2 sequestration that forests provide—thus, ultimately affecting water supplies.