METER
ENVIRONMENT

OKLAHOMA SWITCHGRASS: HOW DEEPER ROOT SYSTEMS AFFECT THE WATER CYCLE

In the Midwest, government incentives are sometimes provided to convert marginal lands to switchgrass, a leading choice for bio-energy feedstock production. Michael Wine, a researcher at New Mexico Tech, wanted to investigate whether switchgrass's deeper root systems would affect the water cycle both during and after crop establishment. In the first stages of his investigation, he learned that many factors need to be considered when determining the optimal location for sensor installation.

AQUIFER RECHARGE

Wine used METER G3 lysimeters to determine deep drainage under natural vegetation, wheat, and switchgrass in order to improve our understanding of both the baseline water cycle and the water budget associated with a switchgrass monoculture in Woodward, Oklahoma. He put the lysimeters and some METER soil moisture sensors into the Beaver-North Canadian River Alluvial Aquifer to look at recharge, but ran into challenges with sensor installation from the start.

CLIMATE CONSIDERATIONS

One thing Wine learned was that biofuels aren't very successful in his research location– there wasn't enough water to support switchgrass. He says, "Most places here may have no precipitation recharge for a great many years. But there are sites, such as sub-humid environments, where you could get a whole lot of infiltration in a very short time." In hindsight, Wine says he "would have increased his use of preliminary data to more efficiently determine the frequency of recharge events."

G3 Drain Gauge lysimeter

USING PRELIMINARY DATA TO HELP SITE INSTRUMENTATION

Wine learned that it's important to think about the time constant of your system when siting instrumentation and that preliminary data are crucial. He says, "Before sensor installation, I did a chloride mass balance which helped me determine where I should install the lysimeters." He had been planning to put them at watersheds at the USDA-ARS Southern Plains Range Research Station, but the chloride mass balance showed there hadn't been a recharge event at that site in the past 200 years. So he chose to install the lysimeters at the USDA-ARS Southern Plains Experimental Range, located in the Beaver-North Canadian River Alluvial Aquifer, a site with coarser soil and higher permeability.

Wine also thinks numerical modeling could have been useful in determining placement. "In siting the instruments, numerical modeling would've been a big help because we could have predicted the likelihood and frequency of recharge events. So I think preliminary data, numerical modeling, and environmental tracers can all help in terms of where to place these lysimeters and soil moisture sensors."

PROXIMITY TO RESEARCH SITE

Another challenge was that the researchers were located in Stillwater, Oklahoma, far from their research site. The experiment was protected by fences, but after long absences, Wine often had to repair damage caused by cattle. "I really need to hand it to these instruments that can be trampled numerous times by cows and the battery compartment filled up with water," Wine says. "They just needed to be dusted off, dried out, new batteries inserted, and they worked great." Wine adds that researchers need to consider the distance between their office and their research site because in his case, the cows would have been less of an issue if it had been a fifteen-minute drive instead of three hours each way. He adds, "Selecting a nearby research site would have allowed us additional flexibility in our experimental methods; for example, with a nearby site we could have more easily conducted artificial rainfall simulations if a particular year turned out to be too dry for natural recharge events to occur."

PROPER SITING OF EQUIPMENT MAKES A DIFFERENCE

Once Wine determined the correct placement of his instruments, he was finally able to get some interesting data. He says, "There are large pulses of focused recharge that do occur in certain places, and we quantified one of those pulses following a storm with one of the lysimeters. We've got about a year's worth of data. Since we installed lysimeters at adjacent upland (diffuse recharge) and lowland (concentrated recharge) sites, we succeeded in observing large differences between the recharge fluxes at these nearby sites." Wine's plan is to see if he can replicate the results of the lysimeter experiment using numerical modeling, because he says, "the data look reasonable, but I'd like to confirm the measurements due to the cows playing havoc with our site." Wine is excited as these lysimeters are yielding the first direct physical measurements of diffuse and concentrated groundwater recharge in the Beaver-North Canadian River Alluvial Aquifer, and he's optimistic that his numerical modeling will match this unique time series of direct physical measurements of groundwater recharge.

Read Michael Wine's study in Forest Ecology and Management

Discover METER soil moisture sensors and the G3 lysimeter