Where will we get the water?

An engineer with an affinity for economics envisions the possibilities

BY ANGELA SPIVEY

PHOTO BY LINDA KASTLEMAN

In the rural eastern part of North Carolina, the soil is dark and fertile, and the groundwater historically has been abundant. There, whole towns — like Kinston — get much of their water supply from ground water, pumped up from aquifers.

In the more densely-populated Research Triangle region of the state, most people use surface water from man-made reservoirs. While water occasionally has been scarce in the Triangle and other parts of central North Carolina, periods of scarcity often could be managed through relatively simple measures, such as restrictions on lawn watering. However with North Carolina's growing population, water demands everywhere are increasing. Cities and towns are starting to plan how they'll meet their needs in 20 or 30 years.

Enter Dr. Greg Characklis. An associate professor of environmental sciences and engineering, Characklis and some hardworking graduate students have been looking at all the different possibilities, the might-bes and the what-ifs. He crunches the numbers to figure out which water supply scenarios will be most efficient and cost-effective. Then he offers suggestions for rules and plans that towns can put into place when water shortages become reality.

Many of Characklis' papers feature equations that you'd need to be an economist or mathematician to understand. The equations model supply and demand as well as the cost of pumping water out of the ground or a river, treating it, and delivering it. "I fell amongst economists as a PhD student," Characklis says with a laugh.

TIP: If you're concerned about a water issue in your state, write your U.S. Senator, your Congressperson in the U.S. House of Representatives or your representative in your state's legislature. For U.S. Senate information, visit: *www.senate.gov/general/contact_information/senators_cfm.cfm*. For U.S. House of Representatives information, visit: *www.house.gov/writerep*. For state legislature contact information visit: *www.ncsl.org/public/leglinks.cfm*.

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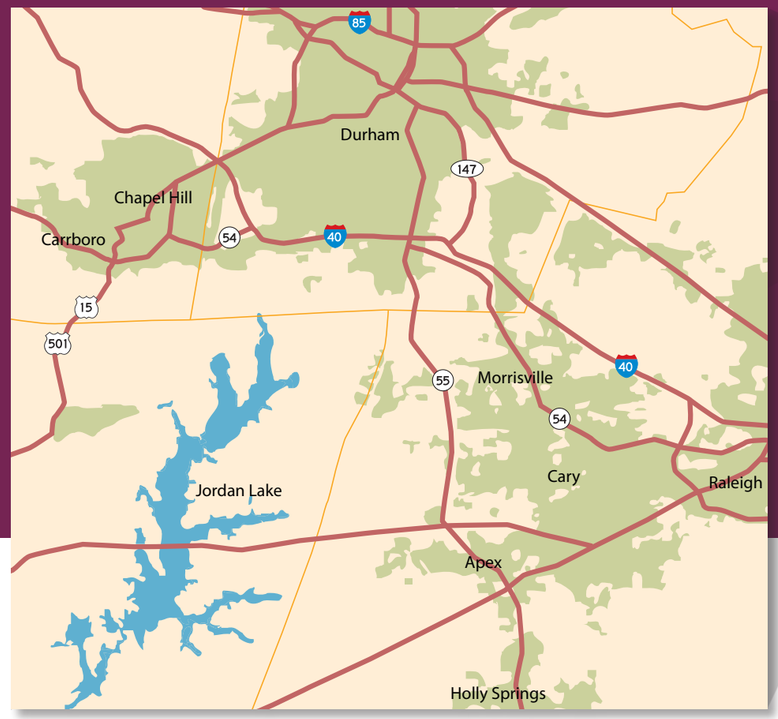

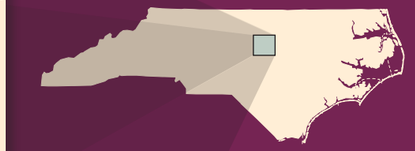

Water authorities for Chapel Hill and Durham, N.C., are working with UNC researchers to plan for water usage decades from now. Population in this area is growing while water resources are becoming increasingly scarce. One solution being discussed is to augment water supply in these communities with water from Jordan Lake, piped from the water treatment plant in Cary, N.C.

Jordan Lake (previous page) is located in North Carolina's Piedmont and contains almost 14,000 acres of water.

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Drying up down east

Groundwater is a fairly inexpensive source of water for eastern North Carolina because it's relatively clean, Characklis says. "You pump it up, perform some simple treatment, put it in the pipes, and you're done. Surface water has been exposed to all sorts of things, so it's dirtier, and the treatment required to make it potable is more involved and more expensive."

But if everyone "down east" keeps tapping the groundwater supply faster than the rainfall can replenish it, water levels in the aquifer will drop. This can lead to two problems. First, wells may go dry because they are not deep enough, and drilling deeper wells is expensive. Second, the aquifer formations that store groundwater can lose their ability to do so.

"They've been pumping water out of those (underground) formations faster than water's been percolating down into them as a result of rainfall," Characklis says. "Over time, as you remove the water, some of these strata that hold the water can become weaker and compact, leading to a permanent loss of storage capacity."

In 2001, in response to such problems, North Carolina mandated a plan to wean many communities off ground water over a 16-year period. The state issued permits that, roughly every five years, reduced the amount of ground water each community was allowed to pump. "Some communities are looking at a 75 percent reduction in their pumping capacity," Characklis says.

The logical solution may be to make up the difference with surface water from the Neuse and Tar rivers. But, little surface water treatment capacity exists in the region, and it is expensive to build. Also, many of the towns are located far from a river and would need to build costly pipelines to access surface water. As a solution, Characklis and Brian Kirsch, a doctoral student in environmental sciences and engineering, have proposed a two-pronged approach. This involves building several large regional surface-water treatment plants to serve communities close to the rivers and having those served by these plants transfer their groundwater pumping permits to communities located farther from the rivers.

Dr. Greg Characklis

"We tried to strike this balance between how big to build these surface-water treatment plants, what communities are joining them, and what communities acquire the existing pumping permits to continue using groundwater. The trick is figuring out how to do this for the lowest cost," he says.

Tapping backup water for the Triangle

The Triangle area has its own water worries as more people flock to its combination of universities, high-tech industry and available land. "We get a fair amount of rain (in the Triangle), but we've got a population density that's increasing to the point that water is becoming more scarce," Characklis says. "If growth continues, we're going to have to develop more and more expensive water resources."

When local water authorities for Chapel Hill (Orange County) and Durham plan for water usage 20 to 30 years from now, they foresee having enough water to meet demand most days, but not at times of peak demand, such as hot days when everyone wants to wash their cars and water their lawns.

One solution is drawing water from Jordan Lake, from which the nearby town of Cary gets its water. When the reservoir was built, both the Orange Water and Sewer Authority (OWASA) and Durham were allotted a bit of that capacity for water supply.

In the next 30 years, as water demand continues to grow, OWASA and Durham may need to cash in on their rights to Jordan, if only to put off building new reservoirs as long as possible. "Every year that you delay spending 20 to 30 million dollars results in significant savings," Characklis says.

Another concern is that no pipeline runs from Jordan Lake to OWASA's treatment plants. One possible fix: Cary already draws water from Jordan Lake into its treatment plant and has a pipeline for pumping treated water to Durham's system, which then connects to OWASA's.

But Cary officials are not likely to treat and send water away without ensuring they have enough to meet the demand of their own residents. As for OWASA and Durham, they want to be reasonably sure that Cary will have the capacity to treat and send water to them when they really need it.

PHOTO BY JEANINE DENITTO

In 2001, North Carolina mandated a plan to wean many communities off ground water over a 16-year period in an effort to prevent ground water resources from drying up. Water from North Carolina's Tar River (above) may become a water source for some North Carolina communities that traditionally have relied on ground water sources.

Characklis' job is to offer these towns the information they need to develop rules for negotiating water transfers in a fair and cost-effective way. "The idea is to try to help these communities develop more sophisticated contracts so that everybody knows when water is available and when it isn't. There need to be rules in place so everybody's clear on what they get out of these agreements," he says.

The calculations get as detailed as the size of water pipes between the towns. "If this pipeline is really big, such that Durham can get a lot of water from Cary very quickly, then it may be willing to let its reservoir levels drop fairly low before it requests water," Characklis says. "But then, Durham has paid for this big pipe that may sit idle a lot of the time. There are always trade-offs."

Characklis' team (which includes Reed Palmer, a 2006 master's degree graduate from the Department of Environmental Sciences and Engineering, and Casey Caldwell, a master's degree student in the same department), will complete their analysis next year, at which point they will make recommendations to stakeholders. Characklis notes that Durham and OWASA appear to be seriously exploring the water-transfer idea. "In the long run, our results suggest that having Durham and OWASA access Jordan Lake—a supply that's already been built—has the potential, depending on how the contracts are written, to be significantly less expensive than having either of them build additional reservoirs themselves."

For many areas of North Carolina, with all the uncertainties involved—development, climate change—exploring different options for supplying water is becoming a necessity. "A flexible approach—relying not on just one big reservoir, but on a mix of reservoirs, ground water and transfer contracts—may be best," Characklis says.

The Eastern North Carolina project was funded by the North Carolina Water Resources Research Institute. The OWASA/Durham project was supported by the N.C. Urban Water Consortium as well as the city of Durham, the town of Cary, and OWASA. ■

UNC researchers are helping create water-sharing agreements between North Carolina municipalities to help communities weather periods of drought.