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The Significance of Water to Nebraska

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Speakers

The Significance of Water to Nebraska

James Goeke
Professor, School of Natural Resources
University of Nebraska–Lincoln

James Goeke has been a hydrogeologist in the School of Natural Resources at the University of Nebraska–Lincoln since 1970. His research focuses on the groundwater resources of central and southwestern Nebraska, groundwater management under conditions of scarcity, and the age of the Nebraska Sand Hills, research that has contributed to models of the unconfined aquifers in the central Platte region and stream-aquifer studies in the Republican River Valley. Goeke has worked closely with the Natural Resources Districts in west-central Nebraska to develop and implement state-mandated groundwater management plans.

James Goeke

James Goeke introduced his talk by reminding the audience that everyone is connected by a dependency on water. "The good life in Nebraska has its roots in our water supply. Author and scientist Loren Eiseley once said that if there's magic on this planet, it's contained in water," Goeke said. "I assure you, there's a lot of magic in Nebraska."

Groundwater in Nebraska

Goeke described the groundwater "magic" in Nebraska. Groundwater resources comprise less than 1 percent of the world's total water supply, and more people are competing for that resource. The High Plains aquifer is one of the primary aquifer systems in the U.S., covering more than 174,000 square miles in parts of eight states. Seventy-seven percent of this aquifer is contained in the Ogallala geological formation and is referred to as the Ogallala aquifer. In 1980 the High Plains aquifer stored 3.25 billion acre-feet of water. Sixty-six percent of that was in Nebraska, which covers the thickest portion of the aquifer, 12 percent was in Texas and 10 percent in Kansas.

In 1980 the total amount of depletion of groundwater since predevelopment in the High Plains aquifer was 166 million acre-feet. By 2007 depletion was 267 million acre-feet and 52 percent of these depletions were in Texas, where substantial groundwater pumping has occurred since the 1940s. Twenty-three percent of depletions were in Kansas. In Nebraska, areas of decline were offset by areas where groundwater levels rose, so Nebraska accounted for almost none of the total High Plains aquifer depletions. However, from predevelopment to 2007, Nebraska's groundwater storage capacity has declined 21.4 million acre-feet, a total of 1 percent of the predevelopment water in storage. That means 99 percent of Nebraska's original water supply is still available, which represents a tremendous opportunity, Goeke said.

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Groundwater is one component of the total water supply budget that "is on a massive conveyor belt that is inexorably moving the groundwater to a point where it connects with the streams," Goeke said. It is important to consider the entire water budget: how much water flows into an aquifer from precipitation, how much water flows out as evapotranspiration and how much stays in storage. Balancing these components of the water budget is how water must be dealt with in the future.

Precipitation and surface water. Goeke described Nebraska as a transition state between the moist midcontinent and the semi-arid West. Rainfall in Nebraska varies from 32 inches in the sub-humid southeast corner to 16 inches in the semi-arid western region, with an average across the state of 22.74 inches. Eighty percent of that rainfall occurs during the growing season. "Many places aren't that lucky," Goeke said.

Nebraska has numerous streams and rivers, many originating in the Sand Hills and fed by groundwater. "Those are the arteries coming from the heart, the water heart of Nebraska," Goeke said. These rivers feed the Platte River, which supplies water for irrigation and for the well fields that provide water for Nebraska's population centers, Omaha and Lincoln.

A history of drought. Nebraska is the home of the Great American Desert. The drought of the 1930s was a significant event in Nebraska. Goeke showed a photo of a 1930s dust storm, with a farm family watching the dust cloud approach. "This was a significant hydrologic event," he said. "In this area we take these for granted, but these scar us socially, and they have impacted our future." The decade-long drought in the 1930s was nothing new. In reconstructions of droughts on the Great Plains dating back to the 1200s, there were 21 droughts that lasted on average 12.8 years. The longest drought lasted 38 years; the shortest lasted five years. The average period between droughts was 23.9 years.

> *"Loren Eiseley once said that if there's magic on this planet, it's contained in water. I assure you, there's a lot of magic in Nebraska."*

The Nebraska Sand Hills, the largest grass-stabilized sand dune area in the world, has experienced a number of periods during the last 18,000 years when unprecedented drought killed the grass cover on the dunes, and the dunes began to blow and move. The most recent, according to research by UNL geoscientist David Loope, was only 800 years ago. "I think we kid ourselves if we think it won't happen again," Goeke said.

"Nebraska can also be a water machine," Goeke said. Since the 1950s an average of 1.7 million acre-feet of surface water has flowed into Nebraska and an average of 8.9 million acre-feet of water flowed out of the state. Most of Nebraska's streams and rivers are fed by both groundwater and surface water. Ninety-seven percent of the flow of streams and rivers emanating from the Sand Hills – such as the Niobrara, Dismal, Calamus, Loup and Snake rivers – comes from groundwater. In other Nebraska streams, particularly in the eastern part of the state, surface water runoff contributes a bigger proportion of the streamflow.

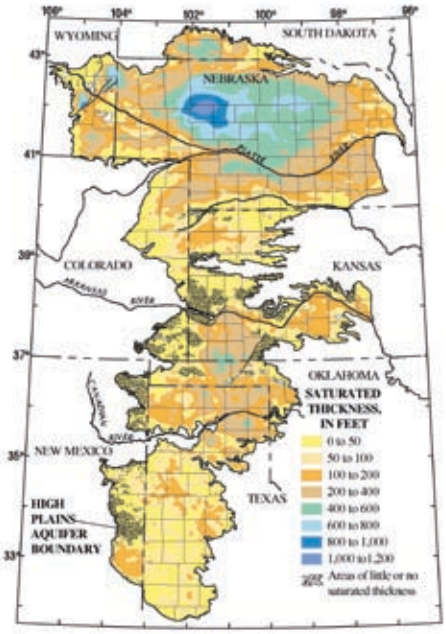
The surface water-groundwater connection. Nebraskans had a great debate in the 1990s about whether surface water and groundwater were connected. Given the difficulties of thinking about how much water in a river like the Platte River is groundwater flow and how much is surface water flow, Goeke said he can understand why people might think that surface water and groundwater aren't connected. He believes they are connected and

described many places in Nebraska where groundwater visibly spills onto the land surface to create streams. Many of these Sand Hills springs are under artesian pressure and are referred to as boiling springs, not because they are hot – they usually have a constant temperature of 56 to 57 degrees – but because the changes in barometric pressure make them appear to be boiling. The Blue Hole on the Dismal River is 24 feet across, Goeke said. A weight dropped into the Blue Hole sank to 120 feet, which is essentially the top of the Ogallala aquifer. This is the groundwater-surface water connection.

Nebraska's groundwater survey program. Nebraska has a long history of water research. *Irrigation in Nebraska* was the first bulletin produced by the Nebraska Agricultural Experiment Station in 1887, "and we have been working on water in Nebraska for well over a century," Goeke said. Since 1930 the University of Nebraska's Conservation and Survey Division has drilled more than 5,500 test holes in Nebraska. "When you drill back into Nebraska, it's like reading a book from the current day and reading back 35 to 65 million years. Every foot or so represents thousands and thousands of years of Nebraska history," Goeke said.

Groundwater irrigation in Nebraska. In 1960, Nebraska had 23,000 irrigation wells. The number of wells jumped to 36,000 in 1970 and to 68,000 in 1980. By 2007, Nebraska had more than 100,000 registered irrigation wells. "And when we look at what happened from 1972 to 1984, you can see the development of center pivots originated here in Nebraska and put to work in Nebraska," Goeke said. "When you think in terms of geologic time and you look at what we did in 12 years, it's absolutely amazing." However, well development came at a price. Water tables have declined as much as 45 to 55 feet in southwestern Nebraska. Yet water tables have risen in other areas of the state.

U.S. Geological Survey measurements of the Middle Loup River indicate that its discharge has actually increased, Goeke said. He encouraged the audience to visit http://groundwaterwatch.USGS.gov. Clicking on points in the map provides information about specific wells, including water levels, construction, saturated thickness and other data. "If water truly is the lifeblood of Nebraska, here is a good place to go. It empowers every citizen to actually see our resources and what's going on," Goeke said.



Graphic courtesy of U.S. Geological Survey

Groundwater laws in Nebraska. The Nebraska Department of Natural Resources regulates surface water use under the prior appropriation system. Groundwater is regulated by locally elected natural resources district boards under a correlative rights system. The Integrated Management Act, passed in 2004, formally recognized the need to integrate the management of surface water and groundwater. Under this law, if the state Department of Natural Resources determines that a river basin is fully or over appropriated, DNR and the local Natural Resources District must work together to develop a plan to integrate the management of surface water and groundwater. A temporary moratorium on issuing new surface water permits or groundwater well permits is imposed until the integrated management plan is implemented. As a result of these determinations, the western two-thirds of the state no longer has easy access to water.

Water budgets. People in Nebraska have been talking about water budgets since the 1960s. It is obvious, Goeke explained, that managing irrigation water use is the source of the problem and the source of the solution, but it is important to consider the total water budget, not just the water pumped for irrigation. Nebraska has 94.9 million acre-feet of water in the water budget. Since only 7 to 8 percent of this water is used by irrigation, simply placing limitations on irrigation cannot be the solution for the future. Many other things can be done; for example, practicing minimum tillage and better cropping practices, or using individual water budgets. Groundwater quality also must be addressed. The presence of nitrates and the herbicide Atrazine in Nebraska's groundwater poses potential health risks.

Water research in Nebraska. There is a tremendous future for applying the research that is being done in Nebraska to develop solutions to water challenges. "We have a tremendous amount of data in Nebraska, and with data come information, knowledge, intelligence and finally wisdom. And without data, I don't know that we individually or collectively can make wise decisions," Goeke said.

Research is being conducted across Nebraska. Water research facilities include the Gudmundsen Sandhills Research Lab, on 12,000 acres in the heart of the Sand Hills that overlays the greatest saturated thickness of the High Plains aquifer, and the 5,500-acre Barta Brothers Ranch. A new water science lab is being established on about 1,200 acres in the South Platte Valley in Lincoln County. Research and experiment stations also are located across the state. Nebraska has a tremendous opportunity to contact and educate people through research and extension around the state and has a long heritage in such education.

"In the end we conserve only what we love, we love only what we understand and we understand only what we are taught. The complex water systems, these intricate water systems, none of us know full well. We need to understand more about them if we're going to have a safe and sound, profitable, environmentally correct future."