Oklahoma

Authors: Oklahoma State University - Saleh Taghvaeian & Kevin Wagner

Introduction

The Ogallala aquifer is a major aquifer in Oklahoma, underlying portions of nine counties of the Panhandle and northwestern region of the state. In the eastern Panhandle, the Ogallala formation often sits atop 250 million years old consolidated sediments. In the western Panhandle, a younger formation of shale and sandstone called the Dockum group overlies the redbed. Other formations including the Dakota Sandstone and Morrison Formation are also found in the Oklahoma Panhandle. The Ogallala aquifer supplies more than 98% of total water demand in the Oklahoma Panhandle. Other sources such as alluvial aquifers and streams contribute less than 2%.

Irrigation is the largest user of water in the Panhandle. Since the predevelopment period (prior to 1950s), about 3000 irrigation wells have been drilled into the Ogallala aquifer. The largest number of drilled wells (over half of them) were in Texas County, followed by Cimarron, Beaver, and Ellis counties. Based on 2007 crop mix data, there are approximately 230,000 acres of irrigated land in Cimarron, Texas, and Beaver counties alone, requiring over 290,000 acre-feet of water per year. This is about 85% of the total water demand in the region. The major irrigated crops are corn and wheat, accounting for about three quarters of total irrigated area. The expansion of irrigated agriculture in the Oklahoma Panhandle has been a major driving force for economic development and prosperity of this region. This irrigated cropland is not only critical for grain production, it also supports major livestock production enterprises in the region – i.e. cattle feedlots, dairies, and hog operations.

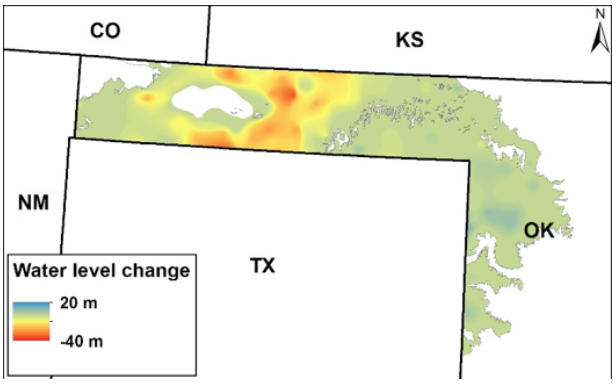

Figure 1: Water level changes pose threats to producers in the Oklahoma Panhandle because irrigation is the largest user of water in the area.

Science and Data

According to USGS analysis, from predevelopment (about 1950) to 2015 the Oklahoma portion of the Ogallala aquifer experienced a decline in water level of 12.5 feet. This estimate is an area-weighted average and thus smaller than the local declines in areas where the saturated thickness is larger. In parts of Texas County, the decline was over 50 feet. The Oklahoma Water Resources Board has also published data on Ogallala water level change over the period from 1966 to 2015, reporting declines of about 80 and 60 feet for Texas and Cimarron counties on average, respectively.

In contrast to the Panhandle, groundwater levels in Roger Mills and Beckham counties have been rising over the last 20 years. However, there are concerns that pumping in some portions of the Ogallala aquifer could induce upward movement of saline water that exists in the underlying Permian formations.

Considering the importance of irrigated agriculture in the longevity of the Ogallala aquifer in Oklahoma, researchers with the Department of Biosystems and Agricultural Engineering at Oklahoma State University (OSU) have initiated several programs to 1) evaluate the performance of commercially available

soil moisture sensors to optimize irrigation management and 2) audit water application uniformity and conveyance efficiency of irrigation systems in the Panhandle region. Most soil sensors tested to date had error rates less than 10%. Irrigation systems tested to date have averaged a coefficient of uniformity of 72.3% and a distribution uniformity of 60.5%, indicating poor uniformity and the need for full system maintenance and adjustment of nozzle packages. Water conveyance efficiency was 93%, meaning that about 7% of water was lost on average between the pumping point and the soil surface.

The OSU Plant and Soil Science Department is also working to identify production practices for corn, wheat, and grain sorghum that improve profitable irrigation management under declining well capacity scenarios, to help producers adjust input rates, or adopt alternative crops that require lower irrigation rates such as grain sorghum or forage crops.

Policy

Oklahoma ground water law allows landowners or lessees to obtain a permit from the Oklahoma Water Resources Board to use ground water at a rate determined based on the number of acres of the applicant's land that overlies an aquifer. According to this law, passed in 1972, those individuals who had a water right prior to 1972 would be allowed to continue to extract water at their previously permitted rate. Temporary permits are issued for aquifers where the amount of stored water has not been identified, allowing for extraction of up to two acre-feet per year (AFY) per acre of land owned or leased by the applicant. If a study has been conducted and the total water storage determined, the permittee is allowed to extract water at a different rate based on the area of land above the aquifer and a minimum basin life of 20 years. For the Ogallala aquifer, the rate of two AFY per acre has been issued for groundwater use in the three Panhandle counties and 1.4 AFY per acre for other counties in the overlying the Ogallala.

Agricultural producers in the Panhandle region have formed the Oklahoma Panhandle Agriculture and Irrigation (OPAI) Association to protect the property rights of members and to study proposed and enacted legislation, rules, and regulations. OPAI also works to initiate, sponsor, and promote research to increase profitability of agricultural operations for its members. OPAI collaborated with other local groups in developing the Panhandle Regional Water Plan, which called for more financial and technical assistance by programs such as the County Conservation Districts' cost share and the councils of government to find new ways to extend the life of the aquifer in economically viable ways.

Producer Practice

The major change in producer practices in the Oklahoma Panhandle over the past several decades has been the type of irrigation systems used. Satellite imagery reveals the majority of irrigated fields in the region were under flood irrigation in the late 1970's, with only a few center-pivot systems used. Over the next 30 years, however, most irrigated fields switched to center-pivot systems. According to the most recent Farm and Ranch Irrigation Survey (FRIS) by USDA (2013), about 95% of all irrigated acres in Oklahoma are under sprinkler irrigation.

Center pivot systems were the dominant type of sprinkler irrigation, occupying over 96% of all sprinkler-irrigated acres. Compared to flood irrigation, center-pivot systems can apply water in smaller amounts and more uniform patterns, resulting in reduced runoff and deep percolation. As a result of this increased efficiency, a significantly larger portion of pumped water is used by crops under center-pivot systems. Currently, almost all center-pivot systems are equipped with Mid-Elevation Spray Application (MESA), where nozzles are about halfway in between the main line and the ground. This setting significantly reduces wind drift and direct evaporation losses compared to traditional impact sprinklers. In addition, about 70% of all center pivot systems operate on less than 30 psi of pressure, thus having smaller energy requirements compared to

high-pressure systems. Twenty-nine percent of center pivot systems in Oklahoma run on pressures between 30 and 59 psi and only 1% require pressures larger than 60 psi.

In addition to adoption of center pivots, many growers have transitioned to minimum tillage which has a great potential to improve soil health and consequently water storage.

Moving Forward

To encourage conservation, efficiency, recycling and reuse of water, the Panhandle Regional Water Plan recommends the following:

- Actively identifying incentive programs beneficial to water users
- Promoting a culture of water efficiency by reducing unit water demands
- Supporting research, development, application, and implementation of water-efficient technologies and practices (i.e. drought - tolerant crops, alternative crops, efficient irrigation technologies)
- Supporting initiatives and seeking funding to support eradication of salt cedar and other invasives
- Encouraging water reuse programs and incentives

Significant opportunities exist to adopt irrigation systems with higher efficiency than MESA center pivots. LEPA and LESA systems have been developed and tested successfully in the Texas Panhandle, with the potential to minimize water losses to only a few percent. Drip systems (mainly subsurface or SDI) has been also used on a limited basis in the Oklahoma Panhandle. One issue that has contributed to the low adoption of drip systems is land ownership. For producers who lease the land, it is much easier to purchase center pivot systems and then move it to another location at the end of the lease than to invest in permanent SDI installation. Innovative approaches such as the Mobile Drip Irrigation (MDI) have been tested in southwest Kansas and should be considered as alternatives to existing center pivot systems to further reduce irrigation losses.

In addition to advancements in irrigation hardware, water use efficiency has tremendous potential through irrigation scheduling. Based on FRIS data, the majority of surveyed producers (88%) mentioned the condition of crop as their main method of deciding when to irrigate. Feel of soil was the second most widely used factor in irrigation scheduling, reported by 39% of growers. Use of soil moisture sensors was mentioned as a decision making factor by only 11% of growers.