OBSERVING IRRIGATION-BASED CHANGE IN WESTERN KANSAS

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The story of the High Plains is very much the story of water. It comes as no surprise that changing perceptions express prevailing views of water availability. The evolution of perceptions is shown by the process of naming the region.

Early European explorers included western Kansas in the "Great American Desert." However, in the last quarter of the 19th century railroads and real estate promoters saw a "bountiful garden." It was widely believed that increased rainfall followed the plow. This notion lost all credibility in the 1930s. A new appellation came into currency, one that was heard across North America. The "Dustbowl". Indeed, Southwestern Kansas was at its center.

But there were more names to come. In the 1960s and 1970s western Kansas became part of the "new farming frontier". This was not to last. More recently part of western Kansas has been slated for inclusion in a huge new national park proposed by two New Jersey scholars. It would be known as the "Buffalo Commons." One wonders if we have come full circle. Native Americans lived off buffalo five generations ago.

It is the period since World War II that has concerned my colleague Steve White and me. In the 1940s a prosperous dryland agricultural economy emerged, not unlike that which flourished in the wet years prior to the Dustbowl. But dry weather in the 1950s resulted in another downturn. This time a new response occurred, and that was irrigation. Some irrigation, using surface water sources, had begun at the end of the 19th century, but western Kansas rivers lacked sufficient flow to permit irrigation on a large scale.

New pumps and pump motors and drilling equipment and an increase in natural gas extraction and rural electrification provided the technology and energy needed to lift water from the High Plains or Ogallala aquifer. A rapid expansion in irrigation resulted. As a part of the New Farming Frontier in the High Plains, western Kansas irrigation expanded from about 250,000 acres in 1954 to nearly 2,000,000 acres in 1978.

An integrated agribusiness economy based on irrigation emerged. Irrigation permitted high yields of corn, wheat, and grain sorghum. The feed grains sustained many huge confined cattle operations. The feedlots in turn supported large meat packing plants. Strong backward and forward linkages developed. An economic and population boom took place in western Kansas. As the Ogallala is a fossil aquifer comprised of sands and gravels laid down by Rocky Mountain fluvial deposition 10,000,000 years ago and receives minimal annual recharge, there was increasing concern that groundwater depletion could lead to an economic bust.

This is the western Kansas Steve White and I first entered as researchers in 1979. We have returned annually, sometimes two and three times a year, ever since. Today, I will tell you the Ogallala story through an overview of our twenty years of funded research. A record of scholarship we hope will continue for years to come.

SOUTHWEST KANSAS RESPONSE

We began our research on the response to groundwater depletion in the High Plains with a southwestern Kansas study in the late 1970s. It was funded by the Kansas Water Resources Research Institute. Southwestern Kansas has the largest land area underlain by the High Plains aquifer in Kansas and also the greatest saturated thickness. Southwest Kansas accounts for some two-thirds of the irrigated acres harvested. We believe that there are four constraints that determine the feasibility of actions that might be taken to cope with the decreasing availability and increasing cost of water for irrigation. To succeed, adjustments must be (1) technically possible, (2) financially viable, (3) legally permissible, and (4) socially acceptable. We wanted to find out what policies were acceptable in southwestern Kansas.

Through lengthy fieldwork in the 13 counties in southwest Kansas we identified thirty-one possible adjustments to groundwater depletion. We prepared a questionnaire, which identified characteristics of the respondent, knowledge of groundwater issues, attitudes about regional economic conditions and problems, and support for 31 different potential adjustments. Using the area-wide telephone directory we selected a random sample of 1,500 persons. A total of 566 usable surveys were returned, giving a usable response rate of 37.1 percent. Altogether, 133 farmers responded, of which 85 were irrigators.

Which of the adjustments to groundwater depletion were preferred? From the table it is clear that improvements in water use efficiency by irrigators had the highest preference. Five of the six most preferred adjustments fell into that category. There also was relatively strong support for enhancing water supply through recharge dams, even though the limited precipitation makes such a scheme impractical. Respondents wanted greater equity in water allocation as shown by high acceptance of equitable apportionment and water quotas.

Adjustments receiving the least support dealt with establishing financial incentives, limiting irrigation, and regulating water use. Government intervention in nearly every form was very much disliked. Continuing things as they are, however, was equally distasteful. There was an apparent willingness to change.

HIGH PLAINS RESPONSE

In the mid-1980s we extended our study of the response to groundwater depletion to the entire High Plains underlain by the aquifer and used for irrigation. It was funded by the General Service Foundation. We designed a questionnaire similar to the one prepared for southwest Kansas. We selected fourteen major irrigation counties in six states from which to draw our sample. The Kansas counties were Thomas, Wichita, and Finney. A sample of 3,560 potential respondents was drawn systematically from telephone directories. A total of 956 questionnaires were returned in a complete and usable fashion, with 264 of those being from western Kansas. Four hundred and five farmers responded, of which 239 were irrigators. Agribusiness as a general category for all agriculturally related activities employed 478 respondents.

This questionnaire included a list of 48 potential adjustments to groundwater depletion. The very strong preference for irrigator water conservation practices stands out. Eight of the most preferred adjustments fell into that category. All practices already in relatively wide use garnered very high preference scores. Building reservoirs to store water and encouraging water conservation laws rounded out the most preferred list. The list of least supported adjustments was similar to the one that emerged in the southwest Kansas study. Financial incentives and disincentives and management policies that in any way restricted water use in irrigation were strongly disliked. Again, a common thread among the unpopular choices was governmental intervention in most forms.

IRRIGATOR RESPONSE

In the two studies I have discussed so far, no special attempt was made to include irrigators in the sample. By chance Steve and I had 85 in southwest Kansas and 239 in the 14 counties of six states. We noted that there were differences among irrigators in what techniques they preferred, but we had little insight into why this was true beyond size of operation and only a partial understanding of what practices they were actually using to conserve water. In 1988 we initiated a study of water-saving practices adopted by irrigators in the High Plains. It was funded by the Ford Foundation. We chose ten of the counties from the previous project as our study area. Those in Colorado and New Mexico were not used. The Kansas counties were again Thomas, Wichita, and Finney. One hundred and seventy-five questionnaires were mailed to irrigators in each county. A total of 709 returned completed questionnaires, giving a response rate slightly above 40 percent. For Kansas the response rate was about 44 percent, as 229 sent back a completed survey.

At the heart of the questionnaire was a listing of 39 possible strategies to conserve water. These adjustments to groundwater depletion and energy costs to pump water were determined by extensive fieldwork in each of the ten counties and consultation with numerous water researchers and managers. The practices that we identified represent the practical range of choices available to irrigators in the High Plains in 1988. The table lists the ten water-saving practices most reported as being used by irrigators.

Chiseling compacted soil is the most common practice. It may be popular because it not only helps reduce water use by slowing runoff but also reduces soil erosion and is a residue management measure. Importantly, it is a relatively inexpensive field practice that requires little investment in new equipment. None of the top ten water-saving practices involves irrigation system modification or replacement. The results reveal that the most common water-saving techniques are management and field practices that rely more on know-how than capital. System practices tend to be riskier in that they generally require substantial investments in hope that future profits from yield increases will more than offset their initial costs. Nonetheless, conversion from furrow to center pivot irrigation has been widespread.

Although the percentage adoption for many practices was low, most irrigation farmers had individually adopted a combination of several. Irrigators have actively responded to conserve ground water. Based on the survey results, the mean number of water-saving practices adopted by irrigators was 9.7, about one quarter of those listed. Several alternatives can only be used with either sprinkler or furrow irrigation, and the majority (78 percent) of irrigators responding used only one type of irrigation system. Nonetheless, we were still surprised that several relatively low cost and effective management practices such as monitoring soil moisture and metering water use were not adopted by at least one-half of the irrigators. Since 1989 both practices have become commonplace.

INSTITUTIONAL STUDY

In 1992, Steve and I began an institutional study that was funded by the Ford Foundation. We compared the effectiveness of groundwater management districts in Kansas and Colorado. In each state groundwater is largely under local control, but both the autonomy and level of activity are higher in Kansas districts.

As part of the study, we sent a mail questionnaire to irrigators from both states, and 330 responded. The survey solicited irrigator's responses to two categories of questions; (1) irrigator and farm characteristics, and (2) strengths, weaknesses, objectives, priorities, and administration of their respective groundwater management districts. Five questions dealt with preferences for specific management options. They considered districts limiting irrigation to protect stream flow, wetlands, and the water rights of other users. The results of these questions are shown on the table.

There were significant differences between Colorado and Kansas irrigators. Because metering and water use reports are required only in Kansas, and Kansas districts have a weather modification program, preference for these actions were far higher in that state. Colorado irrigators were significantly more likely to support limiting irrigation to protect streamflow.

These varied results question the often assumed homogeneous "irrigation culture" in the High Plains.

GLOBAL CHANGE IN LOCAL PLACES

Global Change in Local Places (GCLP; 1996-1999) assessed the links between local areas and global change processes. It established the local greenhouse gas emissions, social and economic driving forces behind the sources, and mitigation and adaptation capacities. Under the sponsorship of the Association of American Geographers and funded by NASA, there were sites in North Carolina, Ohio, Pennsylvania, and Kansas. Each site was approximately one equatorial degree in area, a spatial dimension chosen to coincide with an individual grid cell in many global climate and integrated assessment models.

Our site was in southwestern Kansas, and the Kansas State University team included Doug Goodin, John Harrington, Lisa Harrington, Steve White, and me. Our study area was six counties that cover approximately 10,000 square kilometers and are populated by 93,000 people and about 920,000 cows, three fourths of which reside in confined feedlots.

The table shows the leading sources of greenhouse gas emissions in terms of CO_2 equivalent. As with the other three sites, electrical power generation is the leading source. But the other high emitters, especially the natural gas industry and feedlots, are distinct. Residential accounts for a mere 2.2 percent of greenhouse gas emissions in southwest Kansas.

WHAT NEXT?

Geographers at Kansas State University have a proposal to NSF. We wish to prepare the infrastructure to develop a Human Environment Regional Observatory (HERO) in approximately 15 counties in western Kansas. It would be part of a network with other observatories being formed by the University of Arizona, Clark University, and Pennsylvania State University. The K-State team is the same as for the GCLP project with Max Lu being added.

Steve White and I continue to build on our twenty years in western Kansas.

Selected Ogallala High Plains Publications by Kromm and White

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"Local Groundwater Management Effectiveness in the Colorado and Kansas Ogallala Region." NATURAL RESOURCES JOURNAL, Vol. 35, Spring 1995, pp. 275-307.

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Southwest Kansas Adjustment Preferences (1980)

Most Preferred

Improve Irrigation Efficiency	92%
Require Tailwater Reuse	88%
Grow Hybrid Plants Using Less Water	83%
Encourage Water Conservation Laws	82%
Employ Minimal Tillage	72%
Measure Soil Moisture	72%
Build Small Recharge Dams	70%
Apportion Available Water Equitably	56%
Fund Water Law and Use Education	56%
Establish Water Quotas	55%

Least Preferred

Government Subsidize Energy Cost	9%
Charge for Irrigation Water Used	25%
Continue Existing Methods	13%
Permit Sale & Transfer of Water Rights	15%
Withhold More Recent Water Rights	16%
Tax Water Use by Volume	30%
Give Priority to Industrial Water Use	18%
Tax Irrigated Acreage	30%
Import Water from Other States	27%
Prohibit Sandy Soil Irrigation	25%

High Plains Adjustment Preferences
(1984)

Most Preferred

Improve Irrigation Efficiency	93%
Employ Conservation Tillage	91%
Check Well Efficiency	86%
Require Tailwater Reuse	83%
Encourage Secondary Recovery	80%
Encourage Water Conserving Laws	78%
Grow Hybrid Plants Using Less Water	78%
Plant Shelterbelts to Reduce Winds	76%
Build Reserves to Store Water	75%
Measure Soil Moisture	73%

Least Preferred

Offer Government Depletion Insurance	13%
Government Subsidize Energy Cost	14%
Impose Severance Tax on Groundwater	15%
Give Priority to Industrial Water Use	16%
Withhold More Recent Water Rights	18%
Permit Sale & Transfer of Water Rights	25%
Limit Kinds of Crops Irrigated	27%
Tax Irrigated Acreage	27%
Tax Water Use by Volume	27%
Charge for Irrigation Water Used	28%

Ten Most Common Practices Adopted by High Plains' Irrigators (1989)

Practice	
Chisel Compacted Soils	66.8%
Schedule Irrigation Based on Moisture Needed	53.2%
Reduce Evaporation with Stubble Mulch	50.7%
Employ Minimum Tillage	46.3%
Monitor Soil Moisture	45.8%
Practice Preplant Irrigation	44.4%
Measure Rainfall	44.0%
Check Pumping Plant Efficiency	44.0%
Plant Drought Tolerant Crops	43.5%
Level Land	42.2%

GMD Favored Management Preferences (1992)

Action	
Require Irrigator Water Use Report	79.4%
Limit Irrigation to Protect Rights	76.7%
Support Weather Modification	60.2%
Require Meters on Wells	42.9%
Limit Irrigation to Protect Stream Flow	32.9%
Limit Irrigation to Protect Wetlands	25.3%
Tax Water Right as a Property	9.4%

Emission Source by % CO_2 Equivalent (1998)

Electrical Power Generation	29.2%
Industrial (Natural Gas, Meat Packing)	27.6%
Feedlots (Animals and Manure)	21.3%
Transportation	14.4%
Fertilizer Use	2.5%
Residential	2.2%
Other (Waste Disposal, Human Emissions)	2.8%