Going with the Flow: Southwest Kansas Farmers and the Declining Ogallala Aquifer

By

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Abstract

The Ogallala Aquifer provides irrigation water for much of the agricultural industry on the Great Plains. In southwest Kansas, the Ogallala is used to produce corn and other grains, much of which are fed to beef and dairy cattle. This complementary production system is important to the economy of Kansas and the food system of the United States. The use of the aquifer for this purpose since the 1940s has severely depleted it.

Although farmers understand their activities are depleting the aquifer, they have been hesitant to commit to the conservation plans the state has proposed. I argue that farmers' reluctance in this area is the result of their cultural models of agriculture, cooperation, and of the Ogallala aquifer itself—all of which are influenced by their interaction with the social, environmental, and technological factors that are part of industrial agriculture. The Kansas state government also plays an important role in farmers' decisions. Kansas's reliance on the concepts of private property and the individual as the basis for water law have created a situation in which they cannot compel farmers to use less water, despite expressing the desire for them to do so.

I conclude that conservation of the Ogallala (defined as reduced usage meant to extend its agricultural use) will only be possible with changes to the cultural models that motivate farmers' decisions and Kansas's approach to governance. I present evidence that farmers already possess alternative cultural models of cooperation that may be useful in preserving the Ogallala if the state, or farmers themselves, frame the issue of aquifer depletion to be compatible with those models. The state has already signaled its willingness to try new forms of water governance but, absent a radical change in water law, must wait on the farmers to cooperate.

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Allan Hanson also made important contributions to my scholarship. His challenging classes and keen way of asking probing questions made me challenge my assumptions about the material. I have a long way to go, but I hope to be one day be as effective in the classroom as Allan.

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Introduction

A Rumbling

> The question is always asked by the curious travelers who have crossed the Plains at Interstate speeds, "How can you live here without the mountains, the ocean, the woods?" But what they are really speaking to is their desire to "get it" right away. The sublime of this place that we call the prairie is one of patience and looking. There is no quick fix….If one is to understand the beauty of this place, the old answers just won't do.
>
> —Keith Jacobshagen

One evening in late July, around 8 o'clock when the heat finally broke, I decided to take a bike ride. There was still about an hour and a half of light left and I needed some exercise. I decided to ride to the west end of town and explore some of the county farm roads I had only seen from the car. As I pedaled west and out of Ulysses, Kansas, I passed the county fairgrounds, the municipal airport, and the last of the neighborhoods. It suddenly became very quiet. The sounds of the semi-trucks on the county highway and the constant whir of the fans that kept air moving over the grain in the elevators faded. These droning sounds were replaced by the irregular and melodic chirping of birds and insects hidden in the brush along the ditch lining the road. I pedaled along and enjoyed watching and listening to evening fall in this patch of fertile plain in southwest Kansas.

Suddenly, I started to notice the sound of an engine. I checked behind me to see if a vehicle was approaching. Nothing. Puzzled, I continued until I found the source of the sound: a large V-8 engine, the size found in some of the largest pick-up trucks, mounted on a frame a few feet off the ground, and turning a shaft that disappeared into the earth. This was a pump engine for a center pivot irrigation system, the technology that creates the crop circles airline passengers see when they fly over parts of the West. I had seen these engines from afar, but had never been so close to one in operation. The engine was about 30 feet from the road, but the sound was uncomfortably loud. I could feel its rapid, rhythmic pounding in my chest as it drew water from deep underground.

This is the sound of irrigated agriculture in southwest Kansas. It is the sound of abundant crops and plentiful beef and dairy products for markets near and far. For farmers, it is the sound of financial success, of food on the table, of a college education for their children. But these pumps are yielding less and less water—some have even gone quiet—as the Ogallala Aquifer, the major source of irrigation and drinking water in southwest Kansas, is being depleted. Just as the residents of the area are accustomed to the sound of the pumps, they have become inured to the news that the aquifer is a limited and declining resource.

Without the pumps, the water, and the center pivot sprinklers, agriculture would look very different here. The region's semi-arid climate and unrelenting summer heat and wind meant that agriculture before irrigation consisted of dryland wheat and grain sorghum (known as milo in southwest Kansas and referred to as such from here onward) and a significant portion of the land was left fallow every year. Leaving a field fallow allows the soil to store the scant moisture the dry climate bestows upon it for next year's crops. Thanks to irrigation, more water-intensive crops can be grown in southwest Kansas and fallowing fields is no longer as necessary. Now, a significant portion of the United States' supply of alfalfa, corn, milo, wheat, meat, and milk are produced in southwest Kansas. The crop yields produced with irrigation are also partly responsible for the fact that many feedlots and dairies, which depend on a steady supply of grain, hay, and silage, are located in southwest Kansas.

Rumblings of change were already underway in southwest Kansas when I took my bike ride. Much of the region had been in various degrees of drought—including the exceptional categorization, which is the most severe rating according to the U.S. Drought Monitor—for the past several years, placing additional stress on the Ogallala Aquifer (Tanner 2011). The state had introduced the concept of voluntary conservation districts and was encouraging their use throughout western Kansas. Additionally, a high-profile research paper by civil engineers from Kansas State University, the state's land grant school, had suggested that the usable life of the Ogallala Aquifer could be extended by at least 60 years if farmers immediately reduced their consumption of water by 20 percent (Steward et al. 2013). The findings of this paper received wide attention, and its recommendations were beginning to appear in the state's discussions about water policy. It appeared possible that the state would mandate reductions if farmers did not agree to them voluntarily. To complicate the already tense situation in western Kansas, two brothers who farmed together were initiating legal action to protect their water right from being degraded by their neighbor's water use. All of these developments suggested that some type of change was on the horizon.

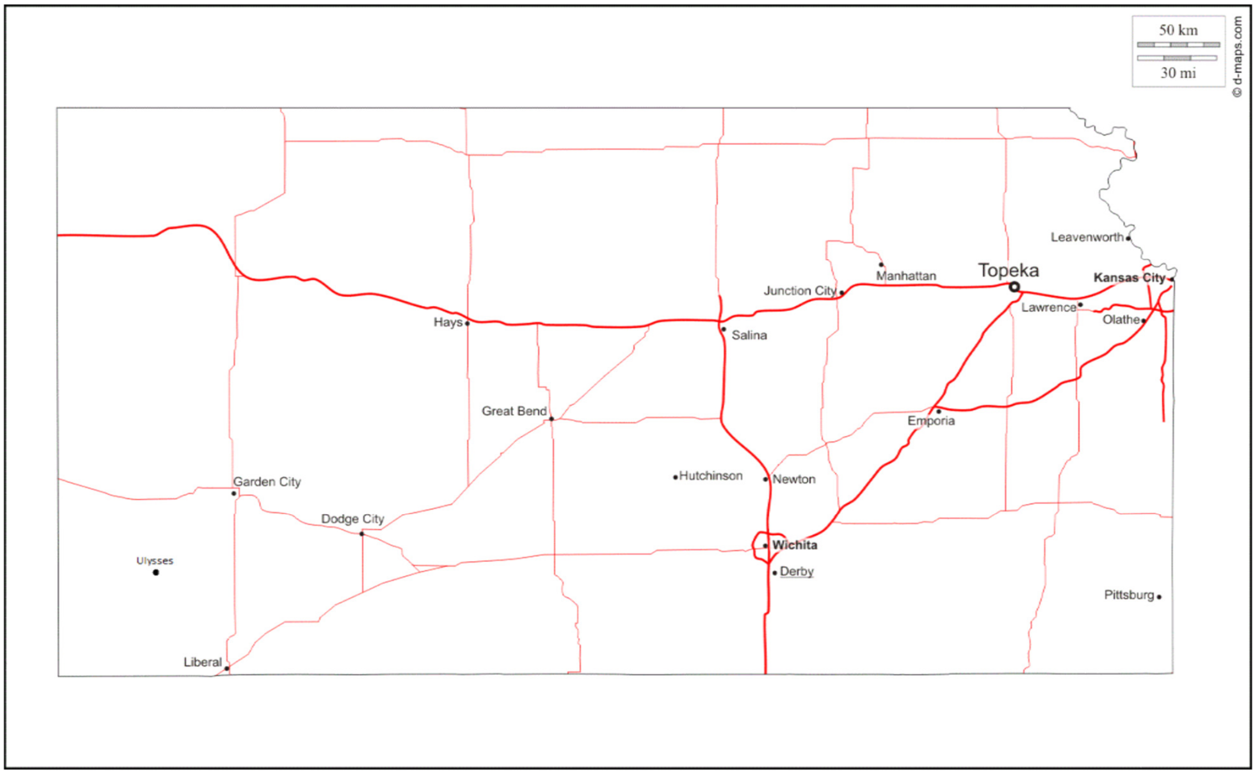

Figure 1. Kansas state map. Ulysses is located in the southwest corner of the state. Image courtesy of d-maps.com.

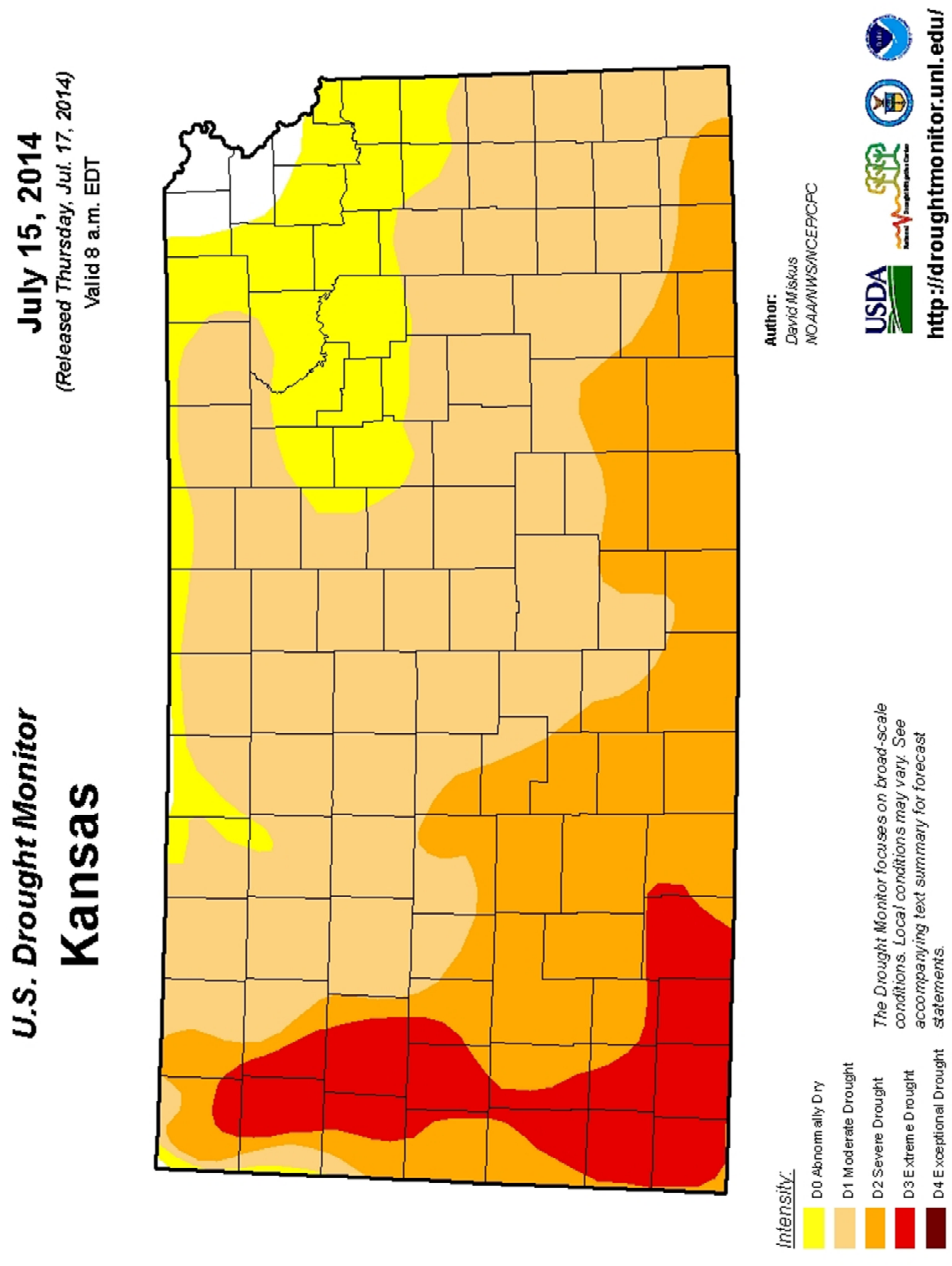

Figure 2. The drought had moderated by 2014, but was still serious.
Image courtesy of the U.S. Drought Monitor.

As I watched the sun hang for far longer than it seemed it should on the treeless western horizon, I wondered about the future of southwest Kansas and the other parts of the Great Plains. Agriculture in general already faces a host of pressing problems. Climate change (Shafer et al. 2014), soil degradation through erosion and loss of organic matter (Srinivasarao et al. 2015), the declining availability of phosphate rock used in fertilizer (Cordell and White 2011), herbicide-resistant weeds (Shaner, Lindenmeyer, and Ostlie 2012), and declining economic returns for farmers (Canning 2011) are some of the major challenges faced by agriculture. Many of these challenges can be addressed, but what will happen when the water runs out?

"If I had a crystal ball, I could tell the future," was the response one farmer gave when I asked that question. Some in southwest Kansas assume there will be a shift back to less-productive dryland farming and fewer farmers will remain in the countryside. The feedlots and dairies would probably leave for greener pastures, where they could be guaranteed an uninterrupted flow of feed and water. These are reasonable speculations; according to a crop consultant I interviewed, this process is already happening:

> Farmers are selling their ground because they know the water is running out. A guy I worked for got out three or four years ago and sold most of his stuff. He knew he wasn't going to make any money without water. He bailed on the land and put the money in the bank.

This farmer sold his land, but someone else bought it, presumably to farm. How the depletion of the Ogallala Aquifer and the transitions associated with declining water availability will affect the communities of southwest Kansas and the food they produce is uncertain.

The Financial Importance of the Ogallala Aquifer

Water from the Ogallala Aquifer is the foundation of an agricultural economy that produces abundant amounts of corn, milo, and wheat, and to a lesser extent cotton and alfalfa. Much of this produce is used in other local economic activities. Corn and milo, in particular, are used for ethanol production and cattle feed. Alfalfa is a favorite hay for dairies. Even the remnants of the ethanol production process (called dry distiller's grains) are used as cattle feed. This complementary production system has made Kansas the second leading producer of cattle and calves, first for wheat, seventh for corn, ninth for hogs and pigs (which also benefit from the close supply of grains and processing plants), and 19th for milk from cows (USDA 2014c). Although Kansas is only the 19th largest dairy state, dairy production ranks fourth in agricultural sales in the state (USDA 2014b).

Southwestern Kansas counties with access to sufficient irrigation water have a much higher total market value for agricultural products than those that do not. Grant County, which irrigates heavily and is home to several large cattle feedyards, reported over $918.1 million of agricultural sales in 2012. By contrast, its neighbor to the west, Stanton County, which has less irrigation and fewer feedyards, reported only $163.7 million in sales for the same period. Ness County, in central Kansas, lacks both irrigation and significant cattle production, and reported only $63.5 million in sales (USDA 2014a). This is despite the fact that Ness County has almost twice as much land in farms as Grant County and 200,000 more acres than Stanton County. Clearly, the integrated system of irrigated crops and cattle production is an important economic activity. Any change to the agricultural productivity of southwest Kansas due to a declining aquifer will create significant ripple effects for the state, as well as the rest of the country. The economic and social impacts from aquifer depletion, should the predicted water shortages occur, will be severe (Cruse et al. 2016; Steward et al. 2013).

Irrigation is the largest contributor to aquifer decline. About 85 percent of all withdrawals from the Ogallala are for crop irrigation. Household and municipal needs account for only 10 percent of the total water withdrawn (Kansas Department of Agriculture 2015a). Currently, the water supply for domestic use is generally secure (Buchanan, Buddemeier, and Wilson 2009). There is some concern about water requirements for hydraulic fracturing, which is used to extract natural gas and oil deposits, but water requirements for this process are relatively small compared to the needs of irrigated agriculture. Two to four million gallons of water are required to “frack” a well, whereas a 128-acre field (the typical acreage covered by a center pivot sprinkler) can use over 83 million gallons each year (Suchy and Newell 2011). This is not to say there are not legitimate questions about the wisdom of using groundwater for hydrocarbon extraction. However, as an absolute user of water, fracking pales in comparison to irrigated agriculture.

The amount of water required for agricultural production in southwest Kansas is considerable. For 2010, researchers estimated that over 1 trillion gallons of water were used to produce the 4.2 million tons of corn southwest Kansas grew that year. This is enough water to submerge an area the size of Connecticut under one foot of water. The water footprint of beef is even larger because the water required to produce the feed, as well as to keep the animal alive, is counted. To produce the estimated 745,000 tons of beef in southwest Kansas in 2007 required 2.8 trillion gallons of water, or enough water to cover an area the size of both Connecticut and New Jersey with one foot of water (Sanderson and Frey 2014b:10). The purpose of discussing the amount of water used in agricultural production is not to judge how the water is used. Many people benefit from the affordable food this system creates. Rather, the purpose is to introduce the idea that it is unreasonable to expect this rate of water extraction to be sustainable.

The fact of aquifer depletion is not a surprise—not to farmers or government managers. As early as 1901, Willard Johnson (1901:647) of the United States Geological Survey (USGS) noted that groundwater on the High Plains was deposited through a scant portion of the precipitation that soaked into the ground and was basically a bank account that could not tolerate withdrawals: “Even on the assumption that lifting from the present depths would be economically practicable, the withdrawal of an amount sufficient for irrigation would rapidly result in exhaustion of stored supply.” Even before the extensive development of the aquifer after World War II, groundwater levels were dropping in some locations (Guru and Horne 2000; Hornbeck and Keskin 2014; Opie 1993). By the 1970s, concern about the future of the aquifer was widespread (Kromm and White 1992b). Even still, the number of acres under irrigation increased yearly until 1978 when 13 million acres of crops were under irrigation and water withdrawals from the aquifer grew from less than 8.6 billion cubic meters to over 25.9 billion cubic meters (Kromm and White 1992b:20; Peterson and Bernardo 2003). The U.S. Congress and the U.S. Department of Commerce, recognizing the economic and social importance of the aquifer, commissioned a study to evaluate ways to protect water supplies and preserve agricultural productivity in the area (High Plains Associates 1982). However, no serious efforts to reduce groundwater withdrawals were ever implemented, and the eventual depletion of the aquifer remained the anticipated conclusion.

Although aquifer depletion was predicted—even before its widespread use—and the prediction and present trajectory toward it are acknowledged by both users and managers, leaving the water in the ground, or at least not using it for agriculture, is not an idea that is seriously discussed. A government hydrologist seemed to belittle this unthinkable position when he said, “There’s nothing intrinsically evil about mining groundwater, as long as everyone understands just what he’s doing. . . . The alternative is to leave it underground and simply enjoy knowing that it’s there” (Ashworth quoted in Wolfe 2013:7). Instead, discussions have focused on the rate at which water is extracted from the aquifer (Kansas Water Office 2015b; Peterson and Bernardo 2003; Steward et al. 2013). Everyone may have known what they were doing, but the clarity of the past has been replaced by an uncertain future. David Brauer, of the Agricultural Research Service of the USDA remarked, “The [aquifer] supply is going to run out and the Plains will become uneconomical to farm. That is beyond reasonable argument. Our goal now is to engineer a soft landing. That's all we can do” (Laurence 2011).

How to land softly is difficult to imagine considering how dependent the economy is on Ogallala water. Many residents of southwest Kansas believe irrigated agriculture is the most important industry, even residents of towns with large oil and gas fields like Ulysses. They say Ulysses could survive without oil and gas, but would be devastated by the loss of irrigated agriculture and its related activities. When I asked farmers about a future without irrigation, they often pointed to places like eastern Colorado.

> I think there’s still life after irrigation. It may be me or another one of my neighbors [who survives]. It could be like eastern Colorado where you drive miles and miles and miles before you find another farmstead, and that guy’s farming tons of land.

Others point to Syracuse, Kansas, a town less than an hour drive from Ulysses. Syracuse is the county seat of Hamilton County and is located about 20 miles west and 30 miles north of Ulysses, near the Colorado border. Hamilton County does not have as much irrigation as Grant County; most of the farms are dryland and there is a lot of pasture. Driving through Syracuse, it is obvious the town does not enjoy the same economic prosperity as Ulysses. There are more houses in need of repair or that are uninhabitable. Syracuse has a much smaller population—about 1,800 people. A smaller population in itself is not proof of a poor economy for the people who live there or indicative of a poorer quality of life. However, it does suggest there may be fewer opportunities and reasons for people to stay.

Although Ulysses is a small town compared to many other places in the U.S., it is one of the largest towns in a several county region. Johnson City to the west, Lakin to the north, Hugoton to the south, and Sublette to the east are all smaller and offer fewer amenities. According to Bob Dale, the current head of the Grant County Economic Development Commission, Ulysses was at one time a more prominent community, often mentioned in the same breath as the relatively large cities of Liberal, several counties to the south and east, and Garden City, to the north and east. Now, these two micropolitan centers' economies and populations are growing while Ulysses struggles to maintain its economic base—despite its economic advantages over its neighbors.

Part of the reason for Garden City and Liberal's prominence (when most of the rest of southwest Kansas has been losing population) is due to meatpacking, which is the end of the chain of production that begins with Ogallala water. The population of both of these cities has increased because meatpacking plants opened there in the 1980s to take advantage of the proximity of both grain and cattle (Stull and Broadway 2013:134). When the labor-intensive meatpacking plants opened, Garden City had an unemployment rate around 3 percent (Stull and Broadway 2013:131), which is considered full employment. This meant the packinghouses needed to recruit workers for their operations. The labor came from a variety of refugees and immigrants, but one-third of the new labor was provided by Mexican immigrants (Stull and Broadway 2013:132). These immigrants mostly settled in the towns where the plants were located. After a time, however, they began to move to nearby smaller communities in search of places to live that were similar to the small towns they had left in their home countries (Sulzberger 2011). This movement benefits places like Ulysses because the workers increase the demand for consumer services and their children fill seats in the schools.

Despite the fact that places such as Garden City and Liberal are dots of urban concrete in a rural sea of grain and grass, they are as vulnerable to the decline of irrigated agriculture as places like Ulysses. One farmer near Dodge City, where the Ogallala deposit is thin and already running out, described the vulnerability this way:

> The Ogallala is being depleted at such a tremendous rate that irrigation's going be a thing of the past, and if irrigation goes, the plentiful grain supply's going to go out here for particularly feed grain, and when that goes the feedyards go, and when the feedyards go the packing plants will go, and when the packing plants go, most of the immigrants are all going to be gone. It's going be a snowball effect.

In short, the success of the meatpacking towns is still predicated on water. These cities are just as vulnerable as the rest of southwest Kansas. Perhaps they are more vulnerable because most of their populations do not own any capital assets and can only sell their labor to make a living.

The quote above was from an interview conducted in 2012. When I talked to this farmer a year later, he had lost the ability to irrigate grain crops completely and was using his remaining water to grow a high-value specialty crop in an attempt to gain a foothold in a new industry.[1] I did not have a chance to speak with him during the fieldwork for this project. I heard from mutual acquaintances that he had established himself in his new industry, although I do not know if it he made enough money to sustain himself. This farmer is at the front edge of a wave that is threatening to wash away the familiar form of agriculture in southwest Kansas. In addition to the diminished deposits near Dodge City, parts of western-central Kansas have experienced decreased well yields, well abandonment, and conversion to less productive dryland farming (Buchanan, Buddemeier, and Wilson 2009:4-5). This pattern is beginning to repeat in parts of southwest Kansas as well.

The snowball effect the farmer described may also take another path. When the water level drops, many of my informants (including those who handle real estate) predict that property values will decrease. This drop in value will likely make banks less willing to lend money or to be less forgiving on existing loans for which land was used as collateral. As fewer farmers are able to irrigate, chemical, seed, and equipment sales will suffer as well. Although the snowball is still small, it is starting to collect more mass, as indicated by a conversation I had with a seed salesman.

I met Charles for the first time during my involvement in a different research project. He works for one of the major seed companies and lives with this wife and children in Ulysses. I ran

[1] I am not able to mention the specialty crop this farmer grows because it will identify him.

into him again at a social function during fieldwork for this project and asked him how the last few years had treated him. He said he is hanging on, but had lost about two-thirds of his income because so many farmers in the area switched to dryland farming and milo production. Milo is a more reliable dryland crop in southwest Kansas than corn. Charles's income dropped because milo seed is much less expensive than corn seed because it does not have the same genetic engineering (such as resistance to glyphosate or the ability to generate its own pesticide) as corn. This means that Charles receives less commission on his sales. Also, farmers are purchasing fewer seeds overall because they plant less per acre in dryland fields than in irrigated ones to adjust for the reduced moisture content in the soil. As a result, Charles has less disposable income and is less able to support the local economy.

Although the depletion of the Ogallala can seem like a farm problem, it has implications beyond the farm. The slow but steady depletion of the Ogallala affects many people. Some of the farmers I spoke with compared Ogallala water to oil or coal. Both are extracted for an economic activity. Both are what brought economic prosperity to their respective regions. And like the coal mining towns of Appalachia where the coal has been mined out (Flanders 2014), southwest Kansas will have to face the repercussions of the loss of water.

Groundwater Depletion—A Global Cause for Concern

> When the well is dry, we know the worth of water.
>
> —Attributed to Benjamin Franklin

Aquifer depletion is a global problem, not just in southwest Kansas and the seven other states that share the Ogallala (Famiglietti 2014). The entirety of the central and southwestern United States and parts of Mexico face groundwater shortages (Abramsky 2013; Abruzzi 1985; Guerrero and Amosson 2013; Johnson et al. 2009; Vaux et al. 1996; Wolfe 2013). California has turned to its delicate groundwater supply to counteract a historically devastating drought that has reached emergency proportions (Dimick 2014). Australia (Clark and Brake 2008), China (Wu et al. 2015), India[2] (Buechler and Mekala 2005), Spain (Esteban and Albiac 2011; Swyngedouw 1999), Morocco (Bekkar et al. 2009), and parts of the Middle East (Wada et al. 2010) are all experiencing groundwater declines as well.

The main reason for groundwater decline is irrigated agriculture. Groundwater provides at least 43 percent of the irrigation water used in agriculture (Siebert et al. 2010).[3] In the U.S overall, groundwater provides 65 percent of irrigation water (Pimentel et al. 2004:910). The Ogallala provides 30 percent of this total to water 27 percent of the irrigated land in the United States (United States Geological Survey 2000:2) and is responsible for the production of one-fifth of the national agricultural output (Little 2009).

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[2] India is the world's largest user of groundwater (Brara 2013:119).

[3] Together, China, India, and the United States conduct about 49 percent of all agricultural irrigation in the world (Howell 2001).

The worldwide depletion of groundwater is all the more dire because the world's population is growing quickly. There could be 9 billion people alive by 2043, a 2 billion increase over today's population (UN News Centre 2011), which will put even greater stress on the world's supply of groundwater. Currently, more than 2 billion around the world rely on groundwater as their primary source of water for drinking and household use (Famiglietti 2014), a number that is likely to increase with population. Further, the world will need to produce at least 50 percent more food than at present to prevent widespread hunger (The Royal Society 2009:1).[4] Although we need more food in the future in general, many of today's people, especially in Asia, want to eat more meat as their economic situation improves (Heady and Fan 2010:14, 32). Meat production, particularly in industrialized countries, relies on grain crops as feed for the animals (Manning 2004). As a result, both the burgeoning population and demand for grain crops are placing "unprecedented demands on agriculture and natural resources" (Foley et al. 2011).

The demands for water and the goods it produces are not localized, however. Due to the globalized marketplace, agricultural products are often exported from the regions in which they were produced. Researchers use the term *virtual water* (Hoekstra and Chapagain 2008:138) to recognize the water used in the production of these goods. Water may become virtual, but its use for export goods creates real shortages and water quality issues for people living in the affected regions (Zlolniski 2011). The people who depend on the grain shipped from the Ogallala region are intimately linked to the condition of the aquifer in this way. In the flows of virtual water, it is

[4] This figure assumes a consistent level of waste and meat consumption.

possible to see how the depletion of a significant amount of the world's resource of fresh water, which at first appears to be a local problem, is actually a global issue (Wilbanks and Kates 1999:603). The depletion of the Ogallala is a cumulative, local phenomenon that is a global problem.

Groundwater depletion is not just an issue of food security. Groundwater has been important to economic development and drinking water access programs in the Global South (Alley et al. 2002; Burke, Sauveplane, and Moench 1999). This importance is due to its low cost of development and on-demand availability. Unlike the seasonal cycle of some lakes and streams, groundwater is available all year. Groundwater is also easy to access at desired locations because it is literally underfoot in contrast to the fixed geography of surface water (Birkenholtz 2015). Worldwide, groundwater extraction has increased from 99.7 million acre-feet in 1960 to 229.4 million acre-feet in 2000 and shows no signs of slowing down (Wolfe 2013:4). As a point of reference, the amount of groundwater withdrawn in the year 2000 would cover an area the size of the United Kingdom, including the Republic of Ireland, with almost four feet of water.

Groundwater depletion also presents an environmental problem. The environmental cost of groundwater depletion can include the dewatering of lakes, rivers, and wetlands, land subsidence, salinization, and water quality problems due to increased concentrations of naturally occurring toxins such as arsenic and fluoride (Villholth 2006:331). Southwestern Kansas is already experiencing some of these problems associated with the depletion of the Ogallala Aquifer. Lakin, a small town in southwest Kansas, has seen the concentration of naturally occurring uranium in its wells rise above the EPA-mandated standards due to the effect of agricultural irrigation on water levels (Evans 2008). The city built a costly water treatment plant to clean the uranium out of the water. The cost of municipal water increased tenfold (AP 2013). The Arkansas River, which runs south of Garden City and through Dodge City and the Cimarron River, which lies in extreme southwest Kansas, no longer flow continuously. Some of my informants estimated that it had been 40 years since they did. Wagon Bed Springs, a historic watering hole along the Santa Fe Trail that contributed to the flow of the Cimarron River, stopped flowing sometime around 1960 because the water table was lowered by irrigation (Whitacre and De Vore 1997). The loss of a historic spring is regrettable in its own right, but the loss of stream flow also has environmental impacts for the entire watershed. A longtime resident, who had come to Kansas as a young man and witnessed the gradual changes, said,

> It sure has changed a lot since I got here. I don't begrudge anything they did to this country before I got here. But once I got here, I don't like it changing for the worse. I don't like that the river dries up and the trees all die and fall down.

Figure 3. The streambed of Wagon Bed Springs, dry since the 1960s. Image by author.

The Same Story from Different Perspectives

> Your perspective on life comes from the cage you were held captive in.
>
> —Shannon L. Alder

Although the environmental and economic problems associated with groundwater depletion are well known, the social impacts of groundwater decline are not well articulated (Burke, Sauveplane, and Moench 1999). A recent examination of groundwater scholarship found the consideration of social concerns to be relatively sparse (Mitchell et al. 2012). This is not to say that social science scholarship about water in general is lacking; there is a long history in anthropology and other social sciences of investigating water. Steward (1955), Wittfogel (1957), Geertz (1972), Hunt and Hunt (1976), Lansing (1987), Strang (2004), Whiteford (2005), Sheridan (2007), Orlove (2010), Walsh (2011, 2013), and Wagner (2012) are excellent examples of social science scholarship about various aspects of water. However, these examples do not address the social aspects of the Ogallala Aquifer specifically or groundwater generally.

Disciplines other than anthropology have studied the Ogallala Aquifer. The state of the aquifer and agricultural irrigation can be told as several different stories, depending on the point of view of the teller. Albrecht (1990) conducted a telephone survey of how farmers changed their operations to respond to declining well levels; Sophocleous (2005) examined the sustainability of the aquifer from a hydrogeological perspective; White (1994) discussed irrigation water use from a geographical perspective; Ding and Peterson (2012) and Hendricks and Peterson (2012) explored the economic effects of reducing irrigation water use through various policy tools; Johnson et al. (2009) weighed the merits of various policy alternatives to reduce irrigation withdrawals; Lamm and others (2003) have spent many years investigating new irrigation technologies that promise to increase the efficiency with which water is applied to crops; and Sanderson and Frey (2014a, 2014b) use a Marxian political ecological framework to suggest how power plays a role in the depletion of the aquifer. These studies all tell different stories and provide important insights about the condition of the aquifer, reasons for its demise, and how emerging technology and policy tools can be used to address aquifer depletion.

Many studies of environmental issues reflect the tendency of scientists to confine themselves in exclusive silos that favor empirical data over people's experiences and perceptions (West and Vásquez-León 2003). This is unfortunate because environmental problems are largely people problems (Wallace 2006:28). Yet the majority of the scholarship about the Ogallala is from the perspective of the natural sciences or economics. None of the researchers, other than Albrecht who focused on farmers' actions but not their cultural understandings, spoke with or included the voices of farmers in their analyses. It is unreasonable to reduce the human element to a variable that predictably changes in response to changes in other parts of the system. Humans are dynamic and their behavior is neither so plastic nor so inconsequential that it can be ignored in favor of assumptions about how humans should behave under certain circumstances. Formal maximization theories of resource allocation do not always describe the behavior of people even in Western industrialized economies (Barlett 1980:547), and individuals faced with the same circumstances rarely choose identical maximization strategies (Edwards-Jones 2006:784). Drawing from a historical example of Ogallala farmers, the introduction of more efficient irrigation technologies (irrigation efficiency is defined as the amount of pumped water that is applied to crops and not lost during conveyance or to evaporation and wind drift) resulted in greater water use—not reductions—because farmers used their newly efficient systems to irrigate more acres instead of saving the water (Peterson and Bernardo 2003).

One perspective, or story, is yet to be represented—that of the farmer who irrigates with water from the Ogallala. This is an important oversight, as the experience with agricultural modernization programs have demonstrated. Debates about their merits aside, they have recognized the importance of incorporating the cultural context, the voices of the farmers, into their recommendations (e.g., Behnke and Kerven 1983; Cernea 1991, 2005; den Biggelaar 1991; McCorkle 1989). Policy prescriptions and technical tools are always introduced into a cultural context; their fit with that context determines how successful they are. More to the point, the economics, technology, and institutions of southwest Kansas and the Ogallala studied by other researchers are manifestations of cultural beliefs about the proper relationships between humans and each other and humans and the environment.

Farmers are the primary stakeholders of the Ogallala. They use the majority of its water and are the people who are most affected by changes in the resource and the policies that govern it. Although farmers are the most visible components of aquifer depletion, and the people the public most often blames for its demise (e.g., Dillon 2014), they are not the only components. When farmers talk about the Ogallala, they draw economic, environmental, technical, and policy factors into the conversation. Farmers say that these influences shape their behavior in important ways. The depletion of the Ogallala is the result of the interaction of farmer's activities, the technology they use to realize their goals, the institutions established to control their extraction and use of the resource, the environment in which their activity takes place, and the nature of the resource itself. To understand the future of the Ogallala we must understand the interaction between all these elements.

One reason so many stories have been written about the Ogallala is that the influences farmers cite for their behavior are numerous: they are local, distant, natural, and cultural. Yet the one thing all these influences have in common is the Ogallala Aquifer itself. In combination with other influences, the presence and characteristics of the Ogallala made southwest Kansas into an agricultural powerhouse, motivated the Kansas government to create laws and agencies to control it, compelled researchers to study it, made some technologies obsolete and others relevant, and attracted people from other parts of the country to settle in southwest Kansas. The Ogallala, and water in general, is not only a thing on which people act and about which they argue. It is an entity that acts on and connects people (Orlove and Caton 2010). Although the farmers of southwest Kansas live several hundred feet above the aquifer, they are connected to it. They draw their livelihood from it. Further, the way its water is unevenly distributed throughout the formation, the way it reacts to withdrawals, the fact that it does not quickly recharge, all have a significant influence on farmers' attitudes and decisions. The Ogallala connects farmers to itself, but also farmers to each other, and then to other agricultural industries, state policy makers, and even to the people who consume the products it helps create. The Ogallala acts on them as much as they act on it.

In recognition of this fact, this work is situated in the tradition of water scholarship that draws on the concept of the *hydrosocial cycle* that can be found in anthropology, geography, and political ecology (e.g., Boelens 2014; Strang 2004; Swyngedouw 2004, 2009). The hydrosocial cycle incorporates the nature and dynamics of water as a natural resource with the effects of engineered environments and infrastructure as well as human values. It recognizes that the relationship between water and society is dialectical and "directs our attention towards the social relations, power structures and technological interventions that produce, and reproduce 'water', in any given context" (Linton and Budds 2014:179). It is an attempt to wrest the study of water from the realm of hydrology that concentrates only on water's physical properties and the environment, and refocus the inquiry on the ways water, environment, and society shape each other. The hydrosocial perspective has the ability to organize the many different stories about the Ogallala, including the social context of its use and farmers' voices, into a coherent narrative.

Contribution

I hope this project will contribute to the conservation of the Ogallala Aquifer and raise awareness of its condition within Kansas and beyond. Unfortunately, many people, including Kansans from the eastern part of the state, are unaware of the uncertainty facing agriculture in southwest Kansas. There has been some national coverage of the declining aquifer (e.g., Plumer 2013), but few lay people or politicians outside the region recognize the seriousness of the issue. Perhaps this is because their supply of meat and dairy products has not yet been interrupted, or the fact many people still think Kansas, and the rest of the Great Plains, is "fly-over" country—a cultural and economic backwater (White 1994). Whatever the cause for the public's lack of attention to this looming disaster, it is important to address the condition of the Ogallala before disruptions to the food supply and other economic and social consequences become too dire.

This project highlights anthropology's ability to use cultural knowledge and values to address environmental and natural resource problems. Southwest Kansas, and rural America in general, is fertile ground for social scientific inquiry because, while ethnographic work has been ongoing, these spaces have been underserved and relinquished to natural sciences and economics (Adams 2007). Irrigation, too, has been inconsistently addressed by anthropology. Although there is a literature on various irrigation systems (e.g., Bacdayan 1974; Enge and Whiteford 1989; Fleuret 1985; Geertz 1972; Guillet 2006; Hunt 1988; Hunt and Hunt 1976; Lansing 1991; Leaf 1992; Lees 1986; Mitchell 1976; Rodríguez 2006; Roth 2011; Sheridan 2002; Steward 1955; Trawick 2001b; Wittfogel 1957) most of this work deals with aspects of the social regulation and management of shared water sources, which are often gravity-operated canal systems fed by surface water. These systems describe the majority of irrigation arrangements around the world (Guillet 1997). However, with the exception of a limited network of canals to distribute a small bit of water from the Arkansas River, there is no such shared physical infrastructure for groundwater irrigation in southwest Kansas. Farmers tap the aquifer through private wells on private land and then distribute the water using their own sprinklers. Therefore, the anthropological literature on irrigation does not provide much information about the context of southwest Kansas. This project will provide a unique case study of irrigation using individually accessed groundwater. I hope this will be a useful contribution as governments around the world try to preserve this precious but largely nonrenewable resource.

Chapter Outline

In Chapter 1, I introduced the issue of the depletion of the Ogallala Aquifer and discussed the financial importance of the aquifer to southwest Kansas. I related this particular case to the larger issue of groundwater depletion worldwide and argued why anthropology should have a voice in a realm dominated by economics and the natural sciences. I also introduced the concept of the hydrosocial cycle as a way to understand the many different stories being told about the Ogallala. In Chapter 2, I discuss why and how I approached this research project and begin to sketch my theoretical approach. This chapter includes descriptions of Ulysses, Kansas, and the southwest portion of the state. Chapter 3 opens with a more detailed discussion of the hydrosocial cycle and then moves to a discussion of the theoretical ideas contained in it. The goal of the chapter is to build the argument that the Ogallala is both a natural and a constructed object that acts on society as much as society acts on it. Chapter 4 situates southwest Kansas farmers in their environment, first by providing the ecological history of the formation of the Great Plains and how the characteristics of this grand expanse influenced settlement. It concludes with a discussion of the evolution of water law in the West in general and in Kansas in particular. Chapter 5 explores farmers' cultural models of irrigation and water and the reasons farmers cite for declining to participate in a state-sponsored water conservation program. In Chapter 6, I explain the hydrological and technical aspects of farmers' resistance to reduced water usage as proposed by the state. Chapter 7 summarizes arguments in the previous two chapters and considers a case where farmers did agree to cooperate on a joint problem. The chapter also considers the implications of the formulation of access to water as a private property right and the individualism enshrined in Kansas water law, and reflected in and reinforced by, the Ogallala and the irrigation infrastructure.

Chapter 2
Research Approach, Methods and Analysis, and Location

Research Approach

The seeds for this project were planted while I worked on a research project from 2011 to 2014. The project was funded by the National Science Foundation's Experimental Program to Stimulate Competitive Research (EPSCoR) and was called "Biofuels and Climate Change: Farmers' Land Use Decisions." It was an interdisciplinary examination of how farmers made land use decisions in an operational environment characterized by climate change and an increasing emphasis on ethanol production. I was a member of the ethnographic team and conducted wide-ranging interviews with farmers across Kansas. It was during this time that I became familiar with the issues and practices of Kansas agriculture. I had the opportunity to interview farmers in southwest Kansas and immediately became interested in the people, the agriculture, the landscape, and the Ogallala.

Two observations I made while conducting and analyzing these interviews motivated my dissertation research. The first observation was that many farmers who irrigated with the Ogallala Aquifer acknowledged the declining water level but were largely opposed to government intervention or voluntary restrictions on water use. Nevertheless, they viewed the economic and social viability of western Kansas as dependent on the continuation of irrigated agriculture and its related industries.

At the time, the state had implemented a new voluntary water reduction program. It was unpopular with many farmers (Bickel 2014), even though recent research argued that immediate reductions in water use, although resulting in somewhat reduced yields, would preserve productive irrigated agriculture until 2070 (Steward et al. 2013). I was curious why these farmers were not clamoring for immediate solutions to the declining aquifer, which had already caused production problems for some and threatened the agricultural future of them all. What could explain their reluctance to reduce their water consumption if doing so would allow them to irrigate longer? How did they define water conservation? What did water mean to them? Farmers sometimes said water management was an economic issue. Was it the case that farmers' primary conception of water was as an economic good and that its management should be determined by profit and loss? What other ways did farmers think about water?

The second observation was that farmers often referenced the characteristics of a crop, their equipment, or the environment as a way to explain their decisions. When asked how they determined how much water to use, they indicated their decision was based on how much water the crop needed at the time (which is based on the weather, the soil, and where the crop was in its growing cycle) or how much water their wells would provide. How did the material elements of farmers' practices affect their decisions and understanding of water? What did the influence of these elements imply about their agency?

In thinking about how to explore these questions, I felt an approach that emphasized only the cultural aspects of farming in southwest Kansas would be incomplete. The environment and the technology farmers use to harness it play important roles. Another farming crisis in southwest Kansas—the Dust Bowl—illustrates my point.

Donald Worster (1979), the eminent environmental historian, places the blame for the Dust Bowl on Americans' cultural desire to harness nature for economic gain. In his analysis, the devastating drought of the 1930s was a contributing factor, but the Dust Bowl would not have occurred without farmers' rapid expansion of wheat cultivation during a period of high market prices. Worster does not give the same causal importance to the agricultural technology farmers used in the 1920s and 1930s, although he does discuss it. He wrote that farmers abandoned the moldboard plow, which turned the soil but left it mostly intact, for the one-way plow. This plow was easier to pull across fields but pulverized the surface of the soil into a fine dust (Worster 1979:91). Compare the resulting soil textures in Figures 3 and 4. When the drought hit and wheat crops failed, the dry, fine dust was easily carried away by the wind. Clearly, technology must also be considered as a contributing factor to the Dust Bowl.

The practices that began to lift the High Plains out of the Dust Bowl must also be considered. New farming techniques—contour plowing, emergency cover crops, strip cropping, fallowing, keeping stubble on the fields, and windbreaks—were introduced by the Soil Conservation Service in the latter half of 1930s to protect the soil from further erosion (Helms 1990:61). Worster (1979:210-226) credits these techniques with the restoration of the land after the Dust Bowl, but he does not ponder what might have been, had they been in place in the decades leading up to the crisis. This is an important point because the Dust Bowl was made more severe by human mismanagement (Cook, Miller, and Seager 2009), suggesting that the absence of these practices should not be overlooked.

Figure 4. A moldboard plow turns the soil but leave it intact.
Image courtesy of the Tiny Farm Blog.

Figure 5. A one way plow being used in Finney County, Kansas in the 1920s. Notice the difference in soil texture compared to the results of the moldboard plow in Figure 3. Image courtesy of the Kansas State Historical Society.

From this perspective, I argue that, for the causes and severity of the Dust Bowl to be fully understood, Worster's emphasis on farmers' culture must be combined with an account of the environment of the Great Plains and the role of technology. The same factors exist in groundwater depletion today. In addition to cultural values that commodify natural resources, groundwater depletion is caused by "the combination of advancing knowledge of hydrogeology, the technology to access the resource in the form of electric- and motor-powered pumps, and rapid economic and demographic growth worldwide that fueled the demand for the resource" (Wolfe 2013:5).

As a guide for understanding the interaction between the cultural, environmental, and technical factors in the highly technical industrial agriculture of southwest Kansas, I drew from actor-network theory (ANT), expressed as the hydrosocial cycle, supplemented with insights from cultural model literature. On the surface, it may seem these are incompatible literatures, but they are complementary and address different aspects of the Ogallala problem. I will discuss these literatures in detail in Chapter 3, but a few aspects bear mentioning now because they relate to how I approached fieldwork. Both ANT and the hydrosocial cycle concentrate on the interaction of human and nonhuman actors (such as technology and the environment) in the creation and maintenance of social forms, including water regimes. I chose to work with ANT concepts based on famers' reliance on the explanatory and determining ability of nonhuman influences (e.g., their crops, the characteristics of the aquifer, their irrigation equipment, and their interactions with the state). ANT is not a method. Rather, it provides propositions about the nature of the social world and has little to say about how actors understand these interactions and the meanings they hold for them.

To understand actors' internal worlds, I turned to cultural models. Cultural models are the interpretive framework informants use to make sense of their worlds (Holland and Quinn 1987). They have a significant influence on how people interpret the world around them. Meanings arise from the interaction of cultural models with events in the world (Strauss and Quinn 1997:54). There is an established methodology for eliciting cultural models, which I followed in my fieldwork and will explain below.

Although the influence of the environment and technology is important to consider in relation to water issues, I am not suggesting that human actions are determined by material conditions. Cultural beliefs strongly influence how natural resources are used and managed (Ponette-González 2007:290); however, they also exist in a dialectical relationship with the material world. Further, the direction of the interactions between human desires, technology, and the environment is sometimes counterintuitive and not dictated by the capabilities of technology. For example, although the capabilities of water management technologies have increased over time, water users in the West have not used the available technology to reduce their water consumption. In fact, they have increased their water usage—even in the face of pleas to reduce it. Strang (2004:2) argues water consumption is conditioned by users' concerns for "social agency and inclusion" and their relationship to the power structures that control water. In western Kansas, enhanced irrigation efficiency offered by new water application technologies lead to increased acres under irrigation, which has done little to slow aquifer depletion (Peterson and Bernardo 2003:189). Farmers are able to do more with less water and still keep poor wells (i.e., those with low flow rates) in service. In the past, farmers considered a well that produced 400 gallons of water per minute to be marginal for use in irrigation. Today, I know of several farmers who keep wells that produce less than 200 gallons per minute in production.

Based on the observations that motivated this project, I followed an abductive research approach (Agar 2010). Abductive research begins, not with a hypothesis, but by identifying a surprising observation (such as farmers not wanting to reduce their water use today to preserve their ability to irrigate tomorrow) and then developing an explanation for that observation using a continuously iterative and recursive process. The process is iterative in that what is explored today is based on what was learned yesterday and recursive because new facts will demand a return to earlier data or a formulation of different questions (Agar 2010:289-291). This was an asset to my project because my investigation moved between interior and exterior realms of farmers' experience. For example, new questions about farmers' interpretations of the world arose as I learned more about the technology and practices of farming. I often bounced back and forth between farmers' realms of experience and my previous understandings.

Location Choice and Description of the Area

The main research area for this project was Grant, Haskell, Seward, and Stevens counties in southwest Kansas. These counties are part of the Southwest Kansas Groundwater Management District (GMD3), which is a local management organization that represents groundwater users in southwest Kansas and determines water policy within the bounds of regulations established by the state. GMD3 includes Finney, Ford, Grant, Gray, Haskell, Hamilton (a small portion), Kearney, Meade, Morton, Seward, Stanton, and Stevens counties. I chose this region because of the prevalence and importance of irrigated agriculture and because I already had established contacts in this region.

Southwest Kansas is the region of the state that uses the most irrigation water. The state's irrigation reports show that southwest Kansas (represented by GMD3) uses over 2 million acre feet of water each year (Kansas Department of Agriculture 2010, 2011, 2012). This is just over 3.5 times more water than the amount used by the next largest consuming GMD. There are several reasons for this. The first is that GMD3 is much larger than the other GMDs; there are over three times as many acres irrigated in GMD3 as in the next geographically largest GMD.

The large area is not the only reason. GMD3 also uses more water per acre than other GMDs because of the heat of southwest Kansas and the composition of the soil, which is often sandier and does not retain water as well.

Kansas is thought by outsiders to be exceptionally flat, but only part of the southwestern portion of the state lives up to this reputation. Part of the reason southwest Kansas seems so flat is that, outside of the towns, there are very few trees. The treeless landscape provides an uninterrupted view of the horizon, which stretches off into an interminable distance. This, combined with the often cloudless sky and the uniformity of grain crops, contributes to the impression of a flat and never-ending landscape. However, the land rolls in broad swells in many places. From the top of one of these swells, the land unfolds endlessly in every direction, making a beautiful panorama.

On the way home from an interview I stopped at one of these spots to take a few pictures. There were no houses within one mile of where I was in any direction and no traffic on the well-maintained country road. I could see houses in the distance though. They were easy to spot by looking for the lines of trees, often eastern red cedar, planted as windbreaks. These windbreaks generally protect the western face of the home, the direction from which the wind blows most often, and sometimes the northern and southern exposures as well. These windbreaks are meaningful; they indicate civilization—a place where you could find people in an otherwise empty countryside. Sometimes, these stands of trees just mark the place where a house once stood. Locals use these windbreaks as landmarks, calling them by the name of the people who once lived there. One windbreak, with only a concrete slab as testament to prior occupation, was introduced to me as “the old Robinson place.”

One place to both find people and "get out of the wind" is in the towns that dot the countryside. In many of the counties in southwest Kansas, there is only one town or city per county. Although there are sometimes more than one named place in a county, there is generally only one incorporated town with a municipal government. The city that formed the base of my operations was Ulysses, Kansas. It is the only incorporated community and the county seat of Grant County. Ulysses had a population of 6,161 in 2010, and the county as a whole had a population of 7,829 (United States Census Bureau 2010).

According to its motto, Ulysses is a town on the move. The motto is clever—referring to the town's history while promoting itself as dynamic in the present day. Ulysses no longer stands on the spot where it was founded in 1885. In 1909, the town could not make payments on its bonds and the land was repossessed. The town simply pulled up stakes and moved—bank, hotel, and all—a few miles west and down a gentle slope to its current location. The event is commemorated in a large iron cutout statue at the location of the old town site and a mural on a wall downtown that depicts a team of horses pulling the bank.

These inauspicious beginnings did not stop the new town from thriving. Oil and natural gas have been a source of wealth for the area. Ulysses sits in the middle of the Hugoton Gas Field, one of the largest deposits of natural gas in the world. Linn Energy, an oil and gas company, is one of the largest employers in Ulysses. Its employees drive company pick-up trucks and live in town. In the evening or on the weekend, some streets have as many as five company trucks parked in front of houses, giving Ulysses the appearance of a company town. The outskirts of town are dominated by light industry and manufacturing dedicated to agriculture and its related industries. Irrigation motor repair and manufacturing shops, irrigation sprinkler dealers, pipe and sheet metal fabricators, a John Deere dealer, and diesel engine and truck repair shops can be found here.

Downtown Ulysses consists of one main street and several side streets. Downtown is home to restaurants, boutiques, hair salons, a cable company, and the post office. The hospital, county courthouse, Ulysses Police Department, Grant County Sheriff's Office, and jail are also in the area. All the downtown restaurants, with the exception of the doughnut shop, are Mexican. There are two Mexican sweet shops and three Mexican restaurants. In fact, the only "American" restaurants in Ulysses are chains such as McDonald's, Pizza Hut, Subway, and Sonic, which are located on the east-west highway that runs past town. The oldest parts of town are those immediately surrounding the downtown district. The homes in Ulysses are modest. Most are in good shape and tidy, but some are in need of clean-up or repair. One noticeable thing about Ulysses is how wide the streets are. It is possible to park two cars across from each other on the street and still comfortably drive two cars between them. Only a few streets are narrower than this. No one I asked could think of a reason the streets were so wide.

During my stay in Ulysses, I rented a modest studio apartment on the north side of town, across the street from the Catholic church and close to other apartments and neighborhoods. It was furnished with a bed, dresser, end table and light, and had a separate bathroom. It also had a small kitchen that allowed me to prepare most of my meals. Ulysses is large enough to offer a variety of services, yet small enough that I quickly grew to know many people around town. I participated in the community life of Ulysses and several other nearby towns during my fieldwork. Although it is nearly impossible for an anthropologist to be "off the clock" in the field, I made social contacts with community members that did not revolve around my research. I attended the Methodist church, went to county fairs and community dinners, joined the gym in Ulysses, and developed friendships. These social contacts undoubtedly helped people become familiar with me as a person and ultimately helped me in my research.

Methods and Analysis

The data for this project come from five months of fieldwork conducted between July and December 2014. For the month of October, I returned home to spend time with my family and reflect on what I had learned to that point. Also, harvest season begins in October and farmers were busy preparing their equipment and planning their work. Harvesting, as with many other agricultural activities, is a time-sensitive operation and I felt it best to stay out of their way during this period.

I divided the fieldwork in two stages. First, I conducted informational interviews with farmers (both irrigators and dryland farmers), employees and board members of the Southwest Kansas Groundwater Management District (also known as GMD3), agricultural extension agents, agricultural lenders, members of economic development commissions, state hydrologists, irrigation researchers, and irrigation dealers. The purpose of these informational interviews was to approach the topic of aquifer depletion from the perspectives of people with a variety of interests in the aquifer and agriculture. The relationships I formed during my previous fieldwork on the EPSCoR project facilitated the process of finding people willing to speak with me. As I renewed my previous contacts and made new ones in southwest Kansas, I asked if they could refer me to people who held positions related to agriculture and other aspects of the community. I selected the people I spoke with based on the types of jobs they held. For example, although I knew of several real estate brokers who handle agricultural land transactions I only interviewed the agent to whom I had been referred. I did, however, ensure that the people I spoke with were actively engaged in their fields. I conducted 17 such interviews and had informal conversations with many more people.

I did not record these interviews. I provided the people I spoke with informed consent statements and discussed with them how I would use the information they provided. I used the information from these informational interviews to create a semi-structured interview guide. I wanted to be sure I could ask salient questions and be conversant in the jargon of agriculture and irrigation. These interviews allowed me to understand current developments in, and community sentiment about, aquifer decline. I conducted this first phase of fieldwork from July through the end of September.

When I returned to the field at the end of October, I began the second stage of research and recorded semi-structured interviews. I chose this method because interviews are an effective way to elicit cultural models (Paolisso 2002). People use their cultural models to make sense of the world and communicate the way they interpret the world to others. Therefore, cultural models appear in speech about the topics to which they are related (Holland and Quinn 1987). For example, I found that questions about Frank and Debora Poppers' controversial proposal of the Buffalo Commons (1987) elicited farmers' cultural models of appropriate land use.

As in the first stage, I used a chain-referral method, otherwise known as snowball sampling, to find potential participants for the semi-structured interviews. Probability sampling is unrealistic with this population for several reasons. There is a commercial database that contains demographic and farm information for farmers, but it does not have information about which farmers irrigate, and therefore cannot be used as a sampling frame. Additionally, farmers generally live and work in a sparsely populated countryside.

Don Stull, my advisor and researcher of southwest Kansas, recommended to me that I should frequent the local diners and cafés to make more contacts with the farming community. Unfortunately, I found the café gatherings that characterized an earlier generation of farmers are not as prominent in the current generation. One farmer, with whom I had an extended discussion about this topic, connected the decline of the café to the trend toward social isolation in American culture in general and to changes in the nature of farm work. When he was growing up his family used furrow irrigation, which required him to move aluminum pipes and siphon tubes by hand several times each day. Center pivot irrigation, the most common type of irrigation in present-day southwest Kansas, no longer requires such heavy, manual labor. As he put it:

> Farming isn't such hard work anymore. The hours are still long but it's nowhere near as physical. It used to be that they [farmers] needed a break [and would go to the café], but now you just sit on your butt and push buttons.

Farmers do stop by the café or doughnut shop, to be sure, but they just as often go through the drive-through as come in. In Ulysses, the town in southwest Kansas where I stayed during my fieldwork, the only people in the café in the morning were retired persons. Although I met and talked with several retired farmers and valued their insights and did gain a few referrals from them, the group I was most interested in was farmers who were currently making decisions about water. Unfortunately, I could not locate any local hang-outs specific to farmers or where a sufficient number of active farmers gathered on a regular basis. The best and most efficient way of finding farmers to talk with was by asking other farmers for referrals.

Probability sampling was not a requirement for this project because the methods do not rely on making statistical inferences. Also, because many farmers in a given area know each other, or at least know about each other, it is easier to locate potential participants who fit specific criteria, making the chain-referral method far more likely to generate a representative sample than other methods (Wright and Stein 2005). A final point of validation for using this method is that farmers in southwest Kansas are protective of their time and privacy. This is not different from people in other professions or in other places. However, the issue of aquifer depletion is a sensitive topic locally, and farmers are often suspicious of outsiders who want to ask questions about water. Many of the people I spoke with wanted to know who I was, where I came from, whether I grew up on a farm, whether I was a reporter or an employee of the state (a "water cop"), what organization I represented, and the basis for my particular interest in the Ogallala. Their suspicion was understandable—their livelihood is directly connected to the water. That an investigative reporter from Lawrence, Kansas, had recently worked in the area and wrote a piece many farmers felt to be unfair (Dillon 2014) only added to their cautiousness. I quickly realized I was jumping into water that had already been disturbed.

Political issues surrounding water in southwest Kansas are sensitive. Questions of who controls the resource (the farmers or the state), who is allowed to have a voice in decisions about water (eastern Kansans, for example), whether to use the water now or save it for the future, and what the best use of the water is, are hotly contested. In recognition of this charged environment, I positioned myself as a researcher who was trying to understand farmers' views on this debate. In the field, I refrained from taking sides in any of the debates to which I was a witness. Likewise, in this dissertation I do not offer criticisms about farmers' choices or the state's role in managing water. I examine the cultural beliefs that influence farmers' decisions, and explore the interaction of these beliefs with state regulation and the characteristics of the Ogallala. I hope my observations and analysis will inspire critical examination of this pressing problem both by farmers and the state.

As my fieldwork progressed and I made new contacts, I learned I had passed several tests related to my trustworthiness. Before agreeing to meet with me, several farmers called the groundwater management district offices or consulted with friends to learn more about me. Fortunately, I contacted Mark Rude, the executive director of GMD3, early in my fieldwork and had earned enough trust that, to my knowledge, neither he nor other office staff dissuaded anyone from speaking with me. Some farmers asked me to send them the interview questions before we met. I preferred not to do this because I feared it would lead to canned interview responses, but I did send my questions when asked. I explained that the questions were starting points only—to "prime the pump" so to speak—and they were free to steer the conversation to topics and issues important to them. Despite my fears, the few times I provided questions in advance did not harm the interview. On the contrary, some of the best and deepest interviews were with those farmers who had asked for the questions.

I had planned to conduct 40 semi-structured interviews to ensure theoretical saturation and adequate coverage of variation in farmers' responses. Theoretical saturation is defined as the point when "new information produces little or no change to the codebook" (Guest, Bunce, and Johnson 2006). I was able to collect 19 recorded semi-structured interviews. (These are in addition to the informational interviews I performed in the first stage, which were not recorded.) There are no established rules for how many interviews are required to document cultural models. D'Andrade (2005:99) suggests that 20-30 interviews are sufficient, but this is only an estimation. Given the consistency of the interviews I collected, I am confident I have sufficient data from which to draw conclusions. According to D'Andrade, it is not surprising that a small sample would demonstrate high agreement about cultural models because this is exactly what the concept of culture suggests should be the case.

Two informants who had agreed to be interviewed decided at the last minute they did not want the interviews recorded. Although I had described the interview process and my wish to record it when they agreed to meet with me, these informants felt uncomfortable when the time came for the interview. I probed gently for their objections to recording the interview in the hope I could allay their concerns, but both informants gave rather vague statements along the lines of "I would just rather not." I respected their wishes and used these interviews as opportunities to clarify information I had learned from previous conversations. All of the other interviews in the second stage were recorded and informed consent was given.

The size of the farms my informants managed varied widely: the smallest was about 640 acres; the largest was near 20,000 acres. Seven of the operations were larger than 5,000 acres. With few exceptions, the farmers were close to the average age for Kanas farmers: 58 (Kansas Department of Agriculture 2015b). The farmers represented in the interviews are male, although their wives may also be involved in the operation in various capacities. These men primarily define themselves as farmers, although a few of them also run cattle or other livestock or have other professional occupations or prominent community roles. These details are generally not mentioned or are obscured in the project because they are highly identifying in a sparsely populated region such as southwest Kansas. To further protect my informants' confidentiality, I have used pseudonyms for all farmers. I have used the real names of informants who hold a high profile office, such as Mark Rude, the executive director of the southwestern groundwater management district.

As my network of contacts and research participants expanded, I occasionally found myself venturing outside of the four core counties—Grant, Haskell, Seward, and Stevens—where I spent most of my time. This was of small consequence because the main research area was chosen as a matter of convenience and practicality rather than because of special characteristics of the farmers in these counties. Agriculture is generally the same throughout southwest Kansas. By and large, farmers grow the same crops, use the same technologies and inputs, and, if they irrigate, use groundwater from the Ogallala.

In hindsight, I wish I had recorded some of the informational interviews from the first stage. Many of the people I spoke with for that part of the project were farmers in addition to holding positions in related agricultural industries or community functions. I was concerned about not having enough knowledge to start the project and subsequently may have spent too much time on the first stage. Further, by the time I left the field, I had largely exhausted the vein of connections and referrals I was pursuing. I have contact information for about 30 farmers who never returned my calls and who I never met at water meetings or other venues. I might have prevented that if I had begun the second stage earlier.

As part of my fieldwork, I spent a day on a farm, at a field test site for a new irrigation technology, and on many occasions at several types of meetings about the control of water and the condition of the Ogallala. These experiences gave me a different perspective about how farmers relate to and manage water in southwest Kansas than an interview around a kitchen table did. They yielded rich information that provided more context to what farmers told me during interviews.

For the day I spent on the farm, I followed around one contact's sons, Jim, to learn what a typical day is like for an irrigator in southwest Kansas. The farm was quite large—well over 10,000 acres—and used hired hands to help with much of the work. Jim's responsibilities that day were to change the oil on the farm's several irrigation engines, ensure they were producing the proper water pressure, check that the pumps were not sucking air (a common concern in low-yielding wells), examine the nozzles on the center pivot sprinklers for clogs (a common problem in sandy soil), and to fix an irrigation engine with a slight misfire. It was a relatively short list, but it took all day to accomplish. Although farming is less labor intensive than it used to be, this was still dirty (and wet) work. I gained a different perspective on the work of irrigators, some of the challenges they face, and how the crops, equipment, and aquifer shape their lives. Although I only shadowed one farmer for one day, several other farmers did show me around their operations. Still others produced aerial maps or land plots to discuss specific features of their farms. Occasionally, I showed farmers pictures of land features, fields, crops, or equipment I had collected in my travels to ask questions about them. These types of interactive experiences were valuable and allowed casual conversation to develop outside the interview context.

I transcribed the interviews I collected myself. By "living" these interviews again, I reconnected with my field experience and became more intimate with the interview data. I examined the transcripts for propositions that asserted the respondent's view of reality. These propositions often appear in the form of slogans, clichés, maxims, and other formulaic statements (Paolisso, Weeks, and Packard 2013:16). I also looked for the implicit structures of cultural models that organize participants' discourse by searching for patterns in farmers' speech that indicated themes (such as repetitions, indigenous typologies, metaphors, and analogies) and lacunae that can indicate cultural assumptions (Ryan and Bernard 2003). These speech characteristics suggest ideas that are linked together by the speaker and indicate the presence of underlying cultural models (Paolisso 2007). I also coded the interviews for technological interactions and evidence of their influence on farmers' actions.

Research Dissemination

The results of this project will be disseminated beyond the academy. The farmers in my preliminary fieldwork have all expressed an interest in my results as has the leadership of Groundwater Management District 3 and the Kansas Water Office, as well as several elected officials. I will make the dissertation, and any articles that come from it, available to them. Also, I will offer to present my work in various fora, such as the board meetings for the groundwater management district and local co-ops, at the Kansas Water Office, and other locations as might be appropriate.

Chapter 3
Actor-Network Theory and Cultural Models

> Believing, with Max Weber, that man is an animal suspended in webs of significance he himself has spun…
>
> — Clifford Geertz

> He becomes, now, not just the producer of culture but, in a specifically biological sense, its product"
>
> — Clifford Geertz

The Hydrosocial Cycle as an Expression of Actor-Network Theory

Today, water managers generally think of water as H_20—a chemical compound identical the world over, albeit with different levels of minerals or pollutants. This is a relatively new way of thinking about water. Before the 19th century, when advances in science decoded water's molecular composition and identified it as a disease vector, people considered water to exist in infinite varieties and have different qualities beyond merely being potable or not (Hamlin 2000). This transformation from many "waters" to "water" abstracted water from its many social, historical, and local understandings and made it subject to technoscientific management. It was the birth of "modern water" (Linton 2014).

The modern water paradigm arose in Britain between 1800 and 1850 (Hamlin 2000) and arrived in the U.S. in the 1930s. It is characterized by:

> an emphasis on the development of water supplies by the agencies of the state, the view of water as a 'resource' to be 'developed' and 'managed', the concentration of expertise in government agencies responsible for quantifying, engineering and controlling water supplies, and large-scale infrastructure symbolized by large dams (Linton 2014:113).

The rules, regulations, and infrastructure of water control are involved in the production of state power (Meehan 2014) and make the state indispensable, even as it may be unwelcome, in water affairs (Carroll 2012). Modern water carries with it the power and knowledge relations used to create it (Linton 2014; Linton and Budds 2014). This view of water, and the state's involvement in it, entangle water in the cost-benefit analyses of neoliberal discourses and governance that characterize many aspects of U.S. domestic policy (Finewood and Stroup 2012; Perreault 2014).

Increasingly, however, water scholars have challenged this view. Although science often treats the hydrological cycle—the familiar process of precipitation, surface deposition, evaporation, and atmospheric circulation—as a natural event, researchers are becoming sensitized to the fact that when water changes, society changes also (Swyngedouw 1999:444). When the United States Army Corps of Engineers dammed the Big Blue River and created Tuttle Creek Lake, near Manhattan, Kansas, for example, several towns and their populations were displaced (Johnson 1973). Instead of considering it as a natural resource to be measured and managed, or even as an "object of social and cultural production" (Krause and Strang 2016), scholars are putting forth a view of water as a generative and agentive force.

This emerging paradigm conceives of water as a socionatural material, a hybrid material subject to both the laws of nature and of society (Boelens 2014). The hydrological cycle is being replaced with the *hydrosocial* cycle, which incorporates the hydrological cycle with the engineered environment and society (Barnes and Alatout 2012; Budds, Linton, and McDonnell 2014; Schmidt 2014; Swyngedouw 2004, 2009). The hydrosocial cycle offers a way to bridge the spaces between the often independent silos of the natural and social sciences in water studies and forces an engagement with the power relations embedded in people's encounters with water.

Although this view of water is finding a new articulation, its roots are not entirely novel. Observations about the relationship and feedbacks between nature, things, and people have been circulating for some time (e.g., Bateson 1972; Geertz 1972; Marx 1867; Wittfogel 1957). Much hydrosocial literature critiques the nature-culture divide implicit in the modern water concept (Schmidt 2014). Although not all who make this critique draw from actor-network theory, many do (Schmidt 2014). The language of the hydrosocial concept suggests that it at least shares the same ideological genealogy, if not owes an outright debt to actor-network theory. Referring to water as an agent, as a socionatural material, and as something that flows and circulates (which are obvious puns about the subject matter), demonstrate this connection.

In this project, I use the language of actor-network theory, which is an analytic approach that concentrates on relational dialectics and hybridity, to talk about the hydrosocial cycle and to draw attention to the important interplay between the social, the environmental, and the technical factors involved in governing water. The benefit of discussing actor-network theory at length is that it explains the basis for the relational claims made in hydrosocial literature and relates them to anthropological concerns.

Further, Holifield (2009) suggests that actor-network theory can be fruitfully used alongside other critical approaches to environmental study, not to simply challenge constructions of power, but to put a tracing dye in the small conduits of power that enable the large social structures of capitalism and neoliberalism. Indeed, this is precisely the vision that one of the main architects of actor-network theory had. He wrote, “if you have to fight against a force that is invisible, untraceable, ubiquitous, and total [like the social, or culture], you will be powerless and roundly defeated. It’s only if forces are made of smaller ties, whose resistance can be tested one by one, that you might have a chance to modify a given state of affairs" (Latour 2005:250). The hydrosocial perspective provides these ties and actor-network theory suggests how they are made.

Introduction to Actor-Network Theory

Actor-network theory (ANT) developed in the 1980s as a branch of sociology and science, technology, and society studies. Although many scholars contributed to the development of ANT, Michael Callon, Bruno Latour, and John Law were its most prominent architects (Fox 2000). These authors were inspired by the realization that many of the natural and technological entities that play a role in the formation of facts and society are unrecognized. For example, when Bruno Latour was studying the Salk Institute in the 1970s, he noticed that scientists omitted the test tubes and other equipment of the lab whose characteristics shaped their observations and decisions from their final account (Law 2009:144). Yet, discoveries at the Salk Institute required more than the scientists' hands. It was a combination of

> a lot of hard work in which heterogeneous bits and pieces—test tubes, reagents, organisms, skilled hands, scanning electron microscopes, radiation monitors, other scientists, articles, computer terminals, and all the rest—that would like to make off on their own are juxtaposed into a patterned network which overcomes their resistance (Law 1992:381).

The test tubes, microorganisms, computers, and an array of other materials and equipment were as necessary to the work as the scientists themselves were. This now-invisible network became integrated in every scientific construction based on the Salk Institute's results, and the later projects built on those results. ANT researchers soon realized that the same pattern of omission applies to claims about the social world. Eventually, statements are repeated as fact and social forms are accepted as natural and their origins and validity are no longer interrogated.

These omissions are not nefarious; they are necessary. Otherwise, the amount of information that would need to be included with every statement about the world would be crippling. Latour (1987:3) calls this phenomenon of omissions the “black box.” A black box is a metaphor for what happens when facts and technology are taken for granted and people no longer question the inner workings of a machine or theory, just as most people no longer question whether the Earth is round or orbits the sun. A black box can also be said to form when there is “knowledge which is accepted and used on a regular basis as a matter of fact” (Yonay 1994:41). This is how most of us relate to computers and cars. All we need to know is how to give them inputs and harness the results. We do not need to know how microprocessors or internal combustion engines work. Black boxes are “technical artifacts” because they are bundles of knowledge that can be separated from their context and transported anywhere (Smith and Tatarewicz 1994). As artifacts, black boxes can be passed on to others and the nature of their contents is assumed static as long as they are unopened.

Are the contents of a black box truly static? What happens when we want to understand how a fact or a social claim is assembled? How can we know which factors are important? How do we know if the machinery inside the black box is outdated? When change is a given, how is permanence explained? ANT asks these questions and seeks to open black boxes and learn how it is that certain social relationships stabilize and reproduce themselves, growing to the point where they become generalized (Law 1992:380). ANT also pays special attention to the role power plays in this process, where power is understood as an effect of relations between a heterogeneous mix of entities (humans and society, nonhumans and nature, and technology).

ANThropology

Given its pedigree and emphasis on materiality, ANT may seem at first glance an odd choice to carry the theoretical load for an anthropological project. In fact, anthropology's core concept, culture, rarely appears in ANT texts. However, the orientations to research laid out in ANT literature are consonant with anthropological approaches and reflect concerns found in a wide range of anthropological research.

Although ANT makes statements about the nature of the social world, it is not a theory that explains or predicts phenomena like the theory of gravity explains the attraction between two bodies (Latour 1999). Rather, ANT, is a "toolkit" (Law 2004:157), or a set of ideas, for "invoking a set of trajectories, linkages and discussions" (Saldanha 2003:421) and "something that could help to sensitise researchers to complex and multiple realities which might otherwise have remained obscure" (Nimmo 2011:109). This effort to make the links and multiple realities of the social visible once again corresponds with the effort to bring back the "many waters" that the modern water paradigm submerged in technoscientific governance (Linton 2014).

ANT seeks to provide an understanding of social phenomena by examining and reincorporating the many elements that have been sequestered in black boxes. ANT wants to bring the test tubes, microscopes, and other materials back into the story. In quotidian conversations about stable relationships, it is okay to omit these things. However, when relationships begin to change or when a question is asked, an account is incomplete without them. It is because of this proposition that ANT can also be referred to as the "semiotics of materiality" (Law 1999:4). A canonical definition is:

> … a disparate family of material-semiotic tools, sensibilities, and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterize the webs and the practices that carry them. Like other material-semiotic approaches, the actor network approach thus describes the enactment of materially and discursively heterogeneous relations that produce and reshuffle all kinds of actors including objects, subjects, human beings, machines, animals, "nature," ideas, organizations, inequalities, scale and sizes, and geographical arrangements (Law 2009:141).

This definition of actor-network theory is complete, although it does presuppose knowledge of several of ANT's core concepts. I will spend the balance of this chapter discussing those concepts and demonstrating how they relate to anthropological concerns. This chapter lays the groundwork for a discussion about the southwest Kansas environment, water and irrigation, and the farmers of southwest Kansas.

You Should Follow the Actors, but What Is an Actor Anyway?

Actor-network theory struggles to free researchers from preconceived notions—largely by questioning assumptions about knowledge and explanations (i.e., by opening black boxes). I say struggles, because researchers, as instruments, have their own characteristics and interpretation is inescapable. As John Law (2002:11) wrote to illustrate this point, "The hands of the storyteller are never clean." Engaging in this struggle, however, increases the ability to follow Agar's surprising observations to whatever conclusions they may lead.

One of the struggles that marked this work was also what motivated it in the first place. From previous fieldwork, I knew farmers were not interested in the government's proposed water reductions. I already knew that at least some farmers viewed Ogallala water as an economic resource, like oil or coal. In this view, dry irrigation wells are not different or any more disappointing than played out oil fields. This conception of water challenged my own cultural model of water. I was hoping that, in the end, this solely economic view of water was not as common as I feared. I was interested, indeed, convinced there was more to farmers' views of water. I was willing to get my hands dirty sifting through the obvious and utilitarian responses that had characterized much of the discourse around water, both at the individual and the state level, to find the intricate meanings and non-economic values I hypothesized lay below the surface.

It was not always easy work. I had to toe the line between prompting my informants toward a conversation about the non-economic dimensions of water and leading them there. Whether I was successful was not always apparent during the interview. However, it was very clear when I failed. On one such occasion, for example, an informant responded, "Well, water is life." He was giving me a response he thought would make me happy, but it was the same rote response many people can repeat. "Water is life" is a widely shared metaphor for water, and it is true. Water is a requirement for the metabolic processes of all life as we know it. However, it is a metaphor that does not have much motivating force. The pollution in our lakes and rivers and the potable water flowing unused down the gutter is testimony to this fact. Either that, or the value of life is not what I assumed it was. Regardless, I had made a mistake and pushed my informant instead of prompting him. Returning to Law's metaphor, my hands became dirty when I refused to relinquish water to the reductionism of economics and guided my informants into a deeper consideration of the topic. Although my hands are dirty, it is from work rather than chicanery.

Interviews are co-constructed events and creating the correct setting and frame can be arduous work.

Once this task was complete, informants were free to explore and talk about water and related issues as they desired. The economic aspects of water were still present in the conversations, but they were also accompanied by talk about other dimensions of water. In this way, I was able to follow Latour's (2005:12) edict "to follow the actors themselves." By this he means that researchers should withhold their own interpretations and instead listen to how their informants theorize the world. Once the non-economic values of water were engaged, the farmers showed me how they cognized agriculture and their place in it.

In contrast to the top-down determinism of structuralism, actor-network theory offers an analysis from the ground up. On this point, Latour (1999:19) wrote:

> Actors know what they do and we have to learn from them not only what they do, but how and why they do it. It is us, the social scientists, who lack knowledge of what they do, and not they who are missing the explanation of why they are unwittingly manipulated by forces exterior to themselves and known to the social scientist's powerful gaze and methods.

This approach is common sense in modern anthropology, but was a departure from what Latour and other ANT writers observed in sociology. In their opinion, sociologists relied too much on preformed theories they tried to apply to every situation. When researchers summon "social forces" for explanations—be they economics or power—they are treating social assemblages as ready-made facts and failing to "inspect their contents, … check their expiration dates, to verify if they really possess the vehicles and energy to be transported all the way to what they claim to explain" (Latour 2005:248). It is, he says, "like trying to make a mayonnaise with neither eggs nor oil – that is, out of hot air alone" (Latour 1986:277). Latour and other ANT writers felt this "have-theory-will-travel" approach to social science obscured important insights, not only because it limited the questions that could be asked by starting with so many prepackaged assumptions. This is why statements of economic optimization do not accurately describe people's behavior (Barlett 1980:547; Edwards-Jones 2006), or why the classification of water as a natural resource fails to describe the personal and social meanings of water (Perreault 2014).

The advice to follow the actors is straightforward, but what ANT considers an actor is not. The traditional understanding of the word "actor" is that of a human being who makes decisions and behaves according to its desires. In ANT, however, an actor "can literally be anything provided it is granted to be the source of an action" (Latour 1990:5). Actors can be the environment, technology, or anything else as long as it makes a difference in the state of another actor. Elsewhere, Callon and Latour (1981:286) define an actor as "any element which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own."

Defining nonhuman entities as actors is difficult for some to accept (Alberti 2014; Scarborough 2014). For some scholars, being an actor and having agency implies intentionality. However, for ANT scholars, agency only implies the presence of an effect that one entity has on the state of another. If this sounds like a flight of fancy, consider the familiar chemistry term re*agent* [emphasis added to highlight the applicable part of the word]. A reagent is a chemical that causes a reaction in another substance. It has an effect. From anthropology, Clifford Geertz (1972:26), in his comparison of Balinese and Moroccan irrigation systems, suggested that the environment is more than a limiting force on decisions: "It [the environment] is and has been an active, central, and creative one." Or, as other researchers have said, the environment behaves as "an active, lively, constitutive and relational presence, rather than only as metabolism" (Schneider et al. 2012:244).

Like the environment, technology can also be an actor if it makes a difference in the state of another entity. Again, anthropology offers examples of technology making a difference in human affairs. Clifford Geertz (1977) remarked on the importance of technology to human biological development, which suggests that overlooking the influence of technology is in some ways akin to ignoring biology. Russell Bernard and Pertti Pelto (1987:5) encouraged anthropologists to engage with technology because they observed that: "Many potentially important insights can be passed over by researchers who are unaware of the complex knowledge, skills, and the physical requirements of machines and other equipment." More recently, Allan Hanson (2008, 2009, 2014) explored the moral implications of human-machine hybrids.

The concept of attributing agency, when understood as the ability to effect a change on another entity, is not foreign. Attributing agency to inanimate objects allows researchers to explore two-way connections and effects between the material and semiotic. One place where the material and semiotic meet is water. Often thought of as a natural resource, water is simultaneously a cultural material (Boelens 2014). Veronica Strang (2004:4-5), described water's dual nature:

> As the substance that is literally essential to all living organisms, water is experienced and embodied both physically and culturally. The meanings encoded in it are not imposed from a distance, but emerge from an intimate interaction involving ingestion and expulsion, contact and immersion. Engagement with water is the perfect example of a recursive relationship in which nature and culture literally flow into each other.

Water is a natural material because it exists in the “real” world and it is not dependent on whether we have social concepts or words for it (D’Andrade 1987). It is cultural because the natural aspects of water are both shaped by and shape cultural practices. Or as Trawick (2001b:374) elegantly put it while addressing the subject of the equitable distribution of water through an irrigation system:

> The moral economy of water is a product of the unfolding of nature and culture together, of their mutual transformation. It is the outcome of a process whereby the human mind and spirit have expressed themselves within a material reality that is itself partly, but only partly, a social construction.

In Strang’s and Trawick’s statements about water can be found another characteristic of ANT thought—the dual status of actors as naturally occurring and socially constructed.

John Law’s definition of ANT earlier in this chapter asserts that nothing has a definite form and that everything and every actor is an effect of the web of relations in which it is embedded. Actors are outcomes, or network effects, determined by their relationship with other actors (Law 1999:3). Admittedly, Law’s statement that nothing has reality or form outside of its relationships may sound hyper-relativist. However, what at first seems a theoretical conceit is one of the hallmarks of the ANT approach. This position should not be interpreted to mean that rocks are not hard or that water is not wet. Of course they are. Rather, the point is that ANT assumes entities do not have definite properties, but have instead potentialities that manifest when combined with other entities. For example, the color of a particular Kansas limestone deposit matters to a person who wants to build something out of it, but does not matter to the person who wants to use it for agricultural lime.

The characteristics of entities exist independently of human interpretation, but they are interpreted and made important (or not) by their relationship with human agency (Strang

2014a:167). Meanings, therefore, are not direct correlates of the properties of matter. Rather, they are the products of the recursive relationship between matter and culture (and cultural models). The nature of relationships between entities depends on the potentialities of the other. Both entities partially define the other and give shape and definition to the resulting relationship, as with the facts resulting from the scientists' work at the Salk Institute. Callon and Law (1997:168-169) put it this way:

> … there is no difference between the person and the network of entities on which it acts. Or (the real point) between the person and the network of entities which acts through the person. Network and person: they are co-extensive.

Using these criteria, the Ogallala Aquifer is an actor. It is the source of action for farmers, government, scientists, and engineers, all engaged in the use of or questions about how to manage this essential resource. When farmers refer to the Ogallala and other factors, or (f)*actors*, they focus attention on the real differences these entities make in their lives. It is not just the Ogallala that is an actor, however. The same can be said of a corn crop. Corn makes its need for water, as determined by other (f)*actors*, such as the soil and the weather, known to the farmer via the condition of its leaves. The farmer strives to meet this need, but at times is constrained by how much water his well will produce. In this scenario, the corn crop is affected both by the farmer's willingness to pump and the well's ability to release water; the Ogallala is affected by the farmer's pumping; and the farmer is affected by the characteristics of both the Ogallala and the corn. None of the entities in this scenario can be completely understood without the others.

Farmers are dependent upon the Ogallala; and, as I will demonstrate in the following chapters, they, government agencies, scientists, and others in southwest Kansas are both compelled and constrained by it. The changing potentialities of the Ogallala, based on its recursive interaction with human systems constantly acts on those who live above it. For example, I met two farmers who had moved from Texas to southwestern Kansas in the 1970s. They described themselves as "water refugees" because their move from Texas was precipitated by the depletion of the thinly saturated deposits there.[5] I also met two crop consultants who had stopped working for farmers who did not have sufficient water to irrigate their crops. The services of a crop consultant are expensive and these consultants did not like taking money from farmers who were starting to run dry. They began to concentrate their efforts in areas of southwest Kansas that still had water. They were chasing it. Although these people were free to pick their dance partners, the Ogallala was calling the tune.

A recent monograph about the Nile River by the anthropologist Jessica Barnes (2014) draws from much of the same literature on which I am building my argument, but arrives at a different conclusion. Where I argue that the Ogallala Aquifer is an actor that makes a difference in the states of other actors, Barnes argued there are multiple Niles that are variously created by the specialist understandings the Egyptian government, NGOs, engineers, and farmers each hold. The existence of the Nile is not guaranteed, but is contingent on these other actors and their roles in managing it. Although it can be said that the unique understandings of farmers and hydrologists create different "Ogallalas," the existence of the Ogallala is not dependent upon engineering management, locks, and dams, as is the modern Nile. The difference between the two cases is the nature of the resources in question—the Nile is a surface water body and the Ogallala is a groundwater deposit. This is a case where the potentialities of an entity make a

[5] Between 1978 and 1982, the irrigated area in Texas decreased by over 1 million acres (Albrecht 1990:48).

difference, not only in the states of other entities, but in how they can be understood. Yes, the Ogallala, like all other actors is a network effect in the way that we understand it; but it is not dependent on human intervention as is the dammed and locked Nile. One particular trait of the Ogallala, the variable distribution of water throughout the formation, cannot be influenced in the same way it influences farmers.

Technology is also Society

Actor-network theory is not only interested in technology (broadly conceived) as an actor, but views it as an extension of society because its existence is the product of social relations and desires (Law 2009).[6] Technology is a moment of society, and is best understood as a phase in the quest to create order (Latour 1991). As soon as a particular technical arrangement has been selected by a system's builders, organizational arrangements are already partially prefabricated (Coward 1980:16). Neither is technology value-free; it often reproduces power relations, such as the dams and dikes that hold back the sea in New Orleans and the Netherlands (Bijker 2007) or the pipes and valves that bring potable water to your home from the municipal pumping facility. Technology is not simply a reflection of the social, however. Once implemented, the effects of technology feed back into the social and can undermine power relations. Changes in either society or technology often encourage or result in changes in the other (Coward and Schutjer 1970:473). One of the most vibrant examples of this principle

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[6] A similar idea can also be found in Marx's writings (Roseberry 1997).

occurred when contact with Europeans caused the Yir Yoront, an aboriginal group in Australia, to discard their polished stone axes in favor of steel ones (Sharp 1952). The stone axe was not simply a technological artifact of Yir Yoront culture. Axe ownership represented masculinity and status. When European missionaries indiscriminately distributed steel axes to all Yir Yoront, regardless of age or gender, men's status was undermined and a process of social change was begun with a new power arrangement.

The natural world is drawn into technological developments. Technology engages with, and acts on, the natural world, and acts a mediator between us and it: "although technical development portrayed the world as passive, as nature to be overcome or material resources to be developed, the relations of science and development came into being only by working with such forces" (Mitchell 2002:51). However, the negotiations of technology with nature are never final or unidirectional:

> Man opposes himself to Nature as one of her own forces, setting in motion arms and legs, head and hands, the natural forces of his body, in order to appropriate Nature's productions in a form adapted to his own wants. By thus acting on the external world and changing it, he at the same time changes his own nature (Marx 1867:124).

Or later, as Wittfogel (1957:11) observed:

> Contrary to the popular belief that nature always remains the same—a belief that has led to static theories of environmentalism and to their equally static rejections—nature changes profoundly whenever man, in response to simple or complex historical causes, profoundly changes his technical equipment, his social organization, and his world outlook. Man never stops affecting his natural environment. He constantly transforms it; and he actualizes new forces whenever his efforts carry him to a new level of operation.

Building on this same line of thinking, Geertz addressed the fallacy that technology freed humans from environmental constraints, which was demonstrated by the emerging ecological awareness of the 1960s and 1970s: "Indeed, it may be that advanced technology ties us in even more closely with the habitat we both make and inhabit, that having more impact upon it we in turn cause it to have more impact upon us," (Geertz 1972:38). Or as the Marxist scholar Neil Smith (1987:135) worried: When "…the production of nature be made a means of control over nature, the greater too is the loss of control and the consequent reverberations in the form of the revolt of nature." As a case in point, in southwest Kansas, the technological intervention of irrigation, and the subsequent choice to grow corn, has made farmers more susceptible to drought in the long-term in addition to leading to aquifer depletion (Hornbeck and Keskin 2014).

The tying up of society, technology, and nature means that even technical questions about irrigation infrastructure have an inescapable social dimension (Walsh 2013). This is because an irrigation system is "simultaneously a hydrologic, engineering, farming, and organizational system" (Coward 1980:16). The form of an irrigation system is not only determined by the physical environment but by culture. Every irrigation system requires construction and maintenance, the social organization of relationships among its users, water allocation, and conflict resolution (Hunt and Hunt 1976:390). Changes in management regimes can be slow to occur because the physical infrastructure of an irrigation system is also a social system and ossifies the social relations that led to its development in the first place. Therefore, the environment, regulations, or social desires may change, but the physical infrastructure can impede changes or even shape what people think is possible (Orlove and Caton 2010:407). This network of relationships, which at one time bound the system together and made it work, can at a later a time inhibit change—even to the detriment of all concerned. To irrigate is to bring many (f)*actors* into relation with each other, forming a dense point of interaction between humans and their environment. This is perhaps why, more than 30 years after the crisis of the Ogallala was widely recognized, the Ogallala's managers and users have realized little success in protecting it for the future.

Running Away from Dualisms on a Flat World toward Generalized Symmetry

Actors are chimeric, multifarious, and composed of elements from the social and natural worlds. This has implications for not only how the social and natural worlds are conceived, but other dualisms as well. Although ANT researchers try to follow the actors, be they humans or not, there is an inherent tension in this approach because of the relational nature of actors. Latour (1999:16) writes that this tension creates a "dual dissatisfaction" when researchers concentrate on the microlevel and "quickly realize that many of [the] elements necessary to make sense of the situation are already in place or are coming from far way." Therefore, researchers move on to something else, often what is termed the "social," where they pay attention to "notions such as society, norms, values, culture, structure, social context, all terms that aim at designating what gives shape to micro interaction" (Latour 1999:17). Another dissatisfaction arises when they do this, however, because "the abstraction of [these] terms is too great, and… one needs to reconnect, through an opposite move, back to the flesh-and-blood local situations from which they had started" (Latour 1999:17). The dual dissatisfactions embody the classic agency-structure debate that periodically wracks the social sciences. The "social" is predetermined and the local, although accessible, does not contain all of the answers. ANT theorists found no satisfying answers at either pole and felt that strict adherence to either viewpoint obscured important processes.

Examples from western Kansas illustrate the tension between agency and structure. The farmers' cooperatives and other agricultural buyers only deal in grains. Even if a farmer grew a different crop, getting that crop to market would be difficult and expensive. In the early years of the cotton industry in southwest Kansas, for example, cotton growers had to ship their cotton to Texas for ginning. Likewise, if southwestern Kansas farmers decided to grow perishable salad vegetables instead of durable grains, there is currently no distribution mechanism that could move the volume of vegetables that could be produced in this vast stretch of agricultural land.

The influences on farmers' decisions come from the national level, too. Earl Butz, President Nixon's secretary of agriculture, is best remembered for pushing for maximum agricultural production and reducing agricultural income-stabilizing measures. This encouraged farmers to seek the maximum yields their land would allow (Bradshaw 2013). Butz's *laissez-faire* market prescriptions should also be viewed in the context of the radical changes in productive ability, advances in farm equipment, and pattern of rural depopulation that had taken place since the late 1800s. These are changes that coincided with America's industrialization (Beale 1964) and urbanization (Vias, Mulligan, and Molin 2002). The foundations, assumptions, and operation of industrial agriculture, what Bell (2004) calls the "structure of agriculture," provide few options outside of its precepts. The built environment of the western Kansas agricultural industry is a practical limit on farmers' choices.

Given these factors, does the structure of the agricultural economy or local conditions play the largest role in farmers' decisions? The concept of agency explains the decision by cotton farmers to "buck the system" and grow the crop without a ready way to process it, at least initially. At the same time, the way farmers grow cotton, driving for maximum production using intensive methods, can be explained by structural influences.

The agency-structure debate is but one dilemma introduced when dualisms are entertained. Another dualism, the nature-culture divide, is equally difficult to pull apart. Is a genetically engineered corn seed, altered with genes from different species, a natural or a cultural object? Similarly, Donna Haraway (1991) suggests that we are all cyborgs, the technological aspects being indivisible from the human aspects, which troubles the seemingly obvious categories of human and nonhuman, breaking down their distinctions and making them ambiguous (Haraway 1991). David Harvey (1974) questions whether natural resources are natural at all:

> A 'thing' cannot be understood or even talked about independently of the relations it has with other things. For example, 'resources' can be defined only in relationship to the mode of production which seeks to make use of them and which simultaneously 'produces' them through both the physical and mental activity of the users. There is, therefore, no such thing as a resource in the abstract or a resource which exists as a 'thing in itself'.

Actor-network theory researchers do not try to solve the riddles of these dualisms directly. Instead, they prefer an approach based on the concept of circulation (Latour 1999:16). As in the example where technology is both a result of and an influence on social forms, local social forms and individuals are both the result of and influence macrolevel forms and actors. Therefore, every action is a "summing up" of the various circulating influences and is simultaneously local and general, conditioned by other actors, objects, and institutions (Latour 1999:16). When things circulate, be they water or influences, they complete a circuit, touching each aspect of the system, connecting everything to everything else at once, just as blood flowing through the body simultaneously connects all points at once.

Circulation was based on an earlier concept of the rhizome, an idea introduced by philosopher Gilles Deleuze and the psychiatrist Félix Guattari. They developed a framework to conceptualize relationships between social elements that avoided causal and hierarchical explanations. Their rhizome connects any point or social element to any and all other points or social elements and “ceaselessly establishes connections between semiotic chains, organizations of power, and circumstances relative to the arts, sciences, and social struggles” (Deleuze and Guattari 1987:7). The purpose of the rhizome is to explore the connections between social elements without any *a priori* assumptions about causality.

The rhizome also has implications for subjectivity. These heterogeneous connections made by a rhizome form a multiplicity, a unity of unrelated things. A multiplicity “has neither subject or object, only determinations, magnitudes, and dimensions that cannot increase in number without the multiplicity changing in nature” (Deleuze and Guattari 1987:8). If any other component is added to the multiplicity, its nature necessarily changes. Further, these multiplicities are not permanent. They exist only so long as they are carrying out a performance or a transaction. The transaction is the defining moment that brings the rhizomatic network and its multiplicities into being. Rhizomes are “always detachable, connectable, reversible, modifiable, and have multiple entranceways and exits (Deleuze and Guattari 1987:21).

The concept of the rhizome is what the word “network” in actor-network theory was meant to convey (Latour 1990:2). Network does not refer to the current common meaning of a network such as the World Wide Web. Whereas the rhizomatic network is flexible, impermanent, and only exists during transactions, technical networks are not. The relationships between the transformers, wires, and poles of an electrical grid remain in place even if there is no electricity, for example. A more faithful example of a rhyzomatic network is water and its courses. It flows over, across, and through boundaries and connects many points at once (Strang 2014b). The water in the Mississippi River system connects the smallest drainage ditch in the upper Midwest to the oceans of the world, but only so long as it is flowing at every point. Similarly, the Ogallala simultaneously quenches thirst, makes corn grow, makes the economy grow, is subject to governance, and is the subject of science.

It is possible to conceive of culture in rhyzomatic terms. Imagine Marvin Harris's hierarchical arrangement of infrastructure, structure, and superstructure as a three-layer cake. Deleuze and Guatarri and ANT writers would unceremoniously flatten it with a rhyzomatic rolling pin. The mess on the table would be flat and shapeless. The rough center of the resulting mass could be located, but certainty about its origin and importance could not be determined. The edges would be irregular and difficult to define. In this mess, however, each putative realm of existence would be mixed in and connected with each other. Trying to separate the frosting from the cake or to reconstruct the layers would be pointless. This flattened world allows for unimpeded circulation and connection.

The flattened world of actor-network theory also recasts the issue of scales and boundaries, a concern shared with the anthropological study of the environment and climate change. Concentrating only on local people and phenomenon, although conceptually clear, is nonetheless difficult because the boundaries of local populations are often fuzzy and they engage in many relationships with entities both near and far (Orlove 1980:244). Ignoring the linkages to distant influences invites some of the same frustrations as choosing one side in the agency/structure debate. The clarity of which influences are local and which are distant are lost in the frosting. This is why some anthropologists call for the discipline to bridge the gap between individuals and small groups and transnational corporations and institutions to understand climate processes (Henning 2005). This is a worthy goal, although ANT scholars would likely prefer Kottak's (1999:26) suggestion to follow the links between local, national, and regional scales as the research problem dictates, since, in their view, there never was a gap to be bridged.

The need to recognize and cross scales is particularly relevant in climate and water issues because they both flow across boundaries and connect local and distant influences. Therefore, understanding scale is a key to sustainable water management (Perreault 2014; Wells, Davis-Salazar, and Moreno-Cortes 2014). In water as in climate issues, changes are expressed as both differences in global or regional patterns (macroscale) and in local settings (microscale). However, what occurs in local settings also influences the global or larger pattern, as Wilbanks and Kates (1999:601) noted: "Global changes in climate, environment, economies, populations, governments, institutions, and cultures converge in localities. Changes at a local scale, in turn, contribute to global changes as well as being affected by them." This is true for the Ogallala as well. Although changes in one part of the aquifer are not immediately felt elsewhere from a hydrological perspective, local conditions do have the potential to result in regulatory changes that can affect the entire area of the aquifer under a given regulatory regime. Southwest Kansas is but one point overlying the Ogallala, but it is a nexus, both sending and receiving signals that can lead to change.

A major theme that runs through ANT scholarship is the withholding of assumptions about the nature of actors and the worlds they inhabit. Explanations, which might have served admirably in a different case, may no longer be valid and should be investigated. When this theme is combined with Deleuze and Guattari's flat world the concept of generalized symmetry is born. Generalized symmetry asks that no special status be ascribed to an entity at the outset of an investigation, including humans (Latour 2005:76). For example, although the state and multinational corporations are powerful actors in agriculture, it is incorrect to assume at the outset that they have any influence at all on a given situation. Doing so necessarily shapes the resulting inquiry in ways that may distort the conclusions. This principle also applies to classes of the same types of elements (e.g., the rich and poor or powerful and weak humans).

***

Although my point of departure is different, ANT provides a roadmap to the same destination as other approaches. Some of what ANT recommends is simply good research practice and it is possible to say some of the same things in other ways. However, ANT also makes it possible to say different things. I chose to draw from ANT because it provides a coherent vocabulary that can be used to articulate the principles behind hydrosocial thought, and it opens up possibilities that some other approaches do not allow.

Cultural Models

> Realities are negotiated in close relationships (Berger & Kellner, 1964). They involve selective perception and interpretation and a good deal of effort to maintain them in the face of the inevitable evidence that things are more complicated and may even be quite different from the socially negotiated reality. To maintain that negotiated reality, much that is threatening and much that is inconsistent with it must be pushed into the shadows, out of sight, and perhaps out of awareness (Rosenblatt & Wright, 1984). Any crisis, any major change may illuminate what is in the shadows (Wright and Rosenblatt 1987:394).

When social arrangements are stable, when the associations one has built remain intact, when the things one has always done return the expected results, there is little need to trace the forgotten contours of the system, examine dusty details, or open black boxes. However, questions arise when stable arrangements change. Such is the case with the Ogallala Aquifer. Concern about the Ogallala has waxed and waned since the 1980s, but the recent drought and the realization that more farmers are converting to dryland agriculture has brought the issue to the forefront again. Today, farmers in southwest Kansas are beginning to open the black boxes they have been relying on, dragging their assumptions about the Ogallala and each other into the light.

One of the goals of this project is to understand the interaction between the materiality and the semiotics of irrigated agriculture in southwest Kansas. However, neither the hydrosocial cycle nor actor-network theory offer suggestions about how to explore people's understandings of these interactions or the meanings they create. Although ANT is willing to follow the actors where they lead, it does not explore the meaning these journeys have for the human actors because the study of meaning is not empirical. It is not equipped to dive into the sea of meaning that exists only in the human mind (D'Andrade 1995; Strauss and Quinn 1997) and can only be reconstructed rather than observed. It is for this reason that I turn to cultural models and a method of exploring these connections.

Cultural models may be described as the "presupposed, taken-for-granted models of the world that are widely shared (although not to the exclusion of other, alternative models) by the members of a society and that play an enormous role in their understanding of that world and their behavior in it" (Holland and Quinn 1987:4). Or to paraphrase Holland and Quinn (1987:14), a cultural model is not what one sees, but what one sees with. Although people may harbor individual models, they become cultural when they are shared among people who have the same experience with the world (Strauss and Quinn 1997:122). In this view, culture is described as "a very large pool of information passed along from generation to generation, composed of learned 'programs' for action and understanding" (D'Andrade 1981:179).

Cultural models are developed through shared interactions with the social world and are used to frame and interpret behavior (Blount 2007:115; Strauss and Quinn 1997). They have a powerful influence on cognition because they are the filters through which new experiences and information are processed (D'Andrade 1992). Cultural models do not translate directly into behavior (Holland and Quinn 1987:7), although they are implicated in the creation of meaning (Strauss and Quinn 1997:54).

Cultural models, sometimes referred to as schemas (Bernard 2011; D'Andrade 1990b:108), are not mental reproductions of events or things. Rather, they are processing mechanisms by which to interpret events and things (D'Andrade 1990a:156). Cultural models are relationally organized. The information contained in one schema often contains schemas relating to different concepts. As D'Andrade wrote: "a representation [schema] of the event in which somebody 'buys' something from someone else contains subschemata by which 'money,' 'price,' 'exchange,' and so forth are represented" (D'Andrade 1990a:155).

In studies about environmental issues, the cultural model approach has been successfully used to understand a variety of environmental and economic issues (e.g., Atran, Medin, and Ross 2005; Blount 2007; Cooley 1999; Kempton and Falk 2000; Paolisso 2002; Paolisso, Weeks, and Packard 2013). In the context of this project, they are what "enable individuals to make sense of or understand today's complex environmental problems" (Paolisso 2002:229). Therefore, they contain information about people's experiences with the hydrosocial cycle in general or the Ogallala specifically, for example.

People's efforts to impose order and meaning on these everyday experiences can be described as "folk theories," which are a class of cultural model (Kempton 1987). As a form of cultural model, folk theories may guide behavior and may differ from institutionalized theories of the same experiences that arise from specialist knowledge. Kempton's (1987) study of home thermostat understanding and use demonstrates both the folk model of home users and the specialist model of thermostat engineers. Home users often think of thermostats as valves that supply more or less heated or cooled air based on the difference between the thermostat setting and the temperature in the house. In this model, setting the thermostat control to 75 degrees when the house is 65 degrees would open the heat "valve" more than setting the control to 70 degrees. Engineers, however, consider the thermostat as a switch that turns on the heating or cooling mechanism until the temperature of the house matches the thermostat setting. This discussion demonstrates how home users developed models of thermostat use based on their experiences and observations with cold and heat, but that were not based on the scientific functioning of the device itself. I will present a similar case of a folk model in Chapter 5.

The knowledge contained within cultural models is implicit knowledge and not typically consciously referenced (Holland and Quinn 1987; Paolisso, Weeks, and Packard 2013) and people rarely talk about cultural models in explicit terms (D'Andrade 1987:114). Therefore, the effort to uncover cultural models is the "reconstruction, from what people said explicitly, of the implicit assumptions they must have in mind to say it" (Quinn 2005:45). As such, it is an interpretive approach to understanding and explaining informants' worlds. These underlying assumptions are identified through speech acts such as analogies, indigenous typologies, metaphors, repetitions, and lacunae that can indicate cultural assumptions (Ryan and Bernard 2003). They also assert themselves in propositions about the nature of the world (D'Andrade 1995). In this project, metaphors, propositions, and typologies were the model indicators that emerged most strikingly.

Although cultural models are not consciously accessed or talked about, they make the world easier to comprehend. Benjamin Blount (cited in Rinne 2008:22) writes, "By focusing on a small set or subset of complexity, the world is reduced to perceptually and cognitively manageable portions, i.e., it is simplified," and these experientially formed structures allow people to interact with the world in "relatively straightforward, predictable, and meaningful ways." If these cultural models did not exist, then all social interactions would need to be negotiated each time they occur (Holland and Cole 1995:479). This characteristic of cultural models, of simplifying social interactions and interpretation, is the complement to actor-network theory's black box I mentioned in Chapter 2.

Actor-network theory uses the metaphor of a black box to indicate when knowledge is "accepted and used on a regular basis as a matter of fact" (Yonay 1994:41). When this happens, the separate elements in the box become invisible and seem to act as a single block (Law 1992). ANT's black box hints at mental processes within the human components of the network that are satisfied to accept the box as it is, but ventures no further. On the cultural model side, if the proposition is accepted that society is composed of material and ideological properties, and that cultural models simplify and organize the complexity of the interaction of these entities (Strauss and Quinn 1997), then it follows that cultural models contain information about the material as well as ideological aspects of people's worlds (Holland and Cole 1995:480). However, cultural models do not necessarily speak to how or if the material elements they organize are connected. A cultural model does not necessarily say anything about the ontology of the elements it organizes.

Another complementary trait cultural models share with actor-network theory is that they are both dialectic and iterative. Strauss and Quinn (1997:6), writing specifically of the meanings encapsulated in cultural models, write: "Our definition…highlights the fact that meanings are the product of current events in the public world interacting with mental structures, which are in turn the product of previous such interactions with the public world." Meanings and models exist independently, but can be dynamic depending on the interaction—much like actors are dynamic and change according to their relationships.

Chapter 4
The Formation and Settlement of the Great Plains and Kansas

> The prairie, in all its expressions, is a massive, subtle place, with a long history of contradiction and misunderstanding. But it is worth the effort at comprehension.
>
> —Wayne Fields

> I must describe it. Its physical characteristics are somehow close to the heart of the matter.
>
> —Mark Helprin

The Formation of the Great Plains

The Great Plains stretch from southern Canada to southern Texas and from Indiana to the Rocky Mountains (Licht 1997:2). This area lay under shallow inland seas for about 500 million years. Then, 70 million years ago, portions of the North American continent slowly lifted to form the Rocky Mountains and the inland seas ran off. Glacial activity eroded the new mountains even while the Earth's tectonic plates continued to distort and crumble the crust. Streams formed by glacier melt deposited rocks and silt that fell from the face of the mountains, along with debris from an era of volcanism, on the now exposed surface of the inland sea. Grazing animals, the first of several waves, took advantage of this new environment, which was punctuated with further episodes of fluvial deposition. Between 5 and 10 million years ago, the land surface rose again. This caused rivers and streams to cut into the Great Plains instead of running over them and carved the rough shape of the geology we see today.

The area known today as the High Plains, which includes southwest Kansas, is the central part of this region that was untouched by fluvial erosion. It is a plateau with a gentle downward slope to the east. The boundaries of the High Plains are defined by escarpments: the Pine Ridge Escarpment in the north near the Nebraska and South Dakota border; the Caprock Escarpment in the east near the Texas Panhandle; the Mescalero Escarpment on the west in eastern New Mexico; and the Edwards Plateau to the south in south-central Texas. The Great Plains landscape is relatively new, geologically speaking, and is the product of geologic changes and the action of water (Little 2009; Opie 1993:15-23; Trimble 1980).

The soils of the Great Plains range from aridisols (very dry soils with little organic matter) in the western part to entisols (a newly formed soil that still has similarities to its parent material) near rivers to scattered alfisols (a clay-rich soil that forms in humid areas) in the south (Kromm and White 1992b:5). In the High Plains, the most common soils are mollisols, which are some of the most fertile soils in the world. Mollisols are the products of grassland biomes that experience frequent water deficiency and have a high degree of organic matter because of the periodic decomposition of the grasses and their roots (Kromm and White 1992b:5). In Grant County, Kansas, where I was based, most of the soils are mollisols. The most common subtype is Ulysses silt loam (USDA 1969:46), which farmers told me is excellent for farming, although the carbon content has probably been lowered in many places by long-term conventional farming (Baum et al. 2009:228).

The Formation and Characteristics of the High Plains Aquifer

> Aquifer: a mysterious, magical and poorly defined area beneath the surface of the earth that either yields or withholds vast or lesser quantities of standing/flowing water, the quantity and/or quality of which is dependent on who is describing it or how much money may be at stake.
>
> —Russell Radden

The High Plains Aquifer (HPA) is one of the world's largest aquifers and is sequestered underneath 174,000 square miles across Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. The U.S. Geological Survey estimates the aquifer contains about 2.9 billion acre feet of water (McGuire 2011:9). An acre-foot is the amount of water required to cover uniformly an acre of surface area with one foot of water and is equivalent to about 325,853 gallons.

The Ogallala formation is the most important component of the HPA, covering about 134,000 square miles. It is the portion of the aquifer that extends into western Kansas, and it is from the Ogallala that farmers draw water. There are also other aquifer formations in Kansas called the Great Bend Prairie and Equus Bed formations (Figure 5), but they were formed during different geologic periods (Figure 6) and differ from the Ogallala formation in both physical characteristics and agricultural importance. For these reasons, they will not be considered here. Aside from this chapter, which addresses the formation of the entire aquifer system, generic references to "the aquifer" refer to the Ogallala formation only.

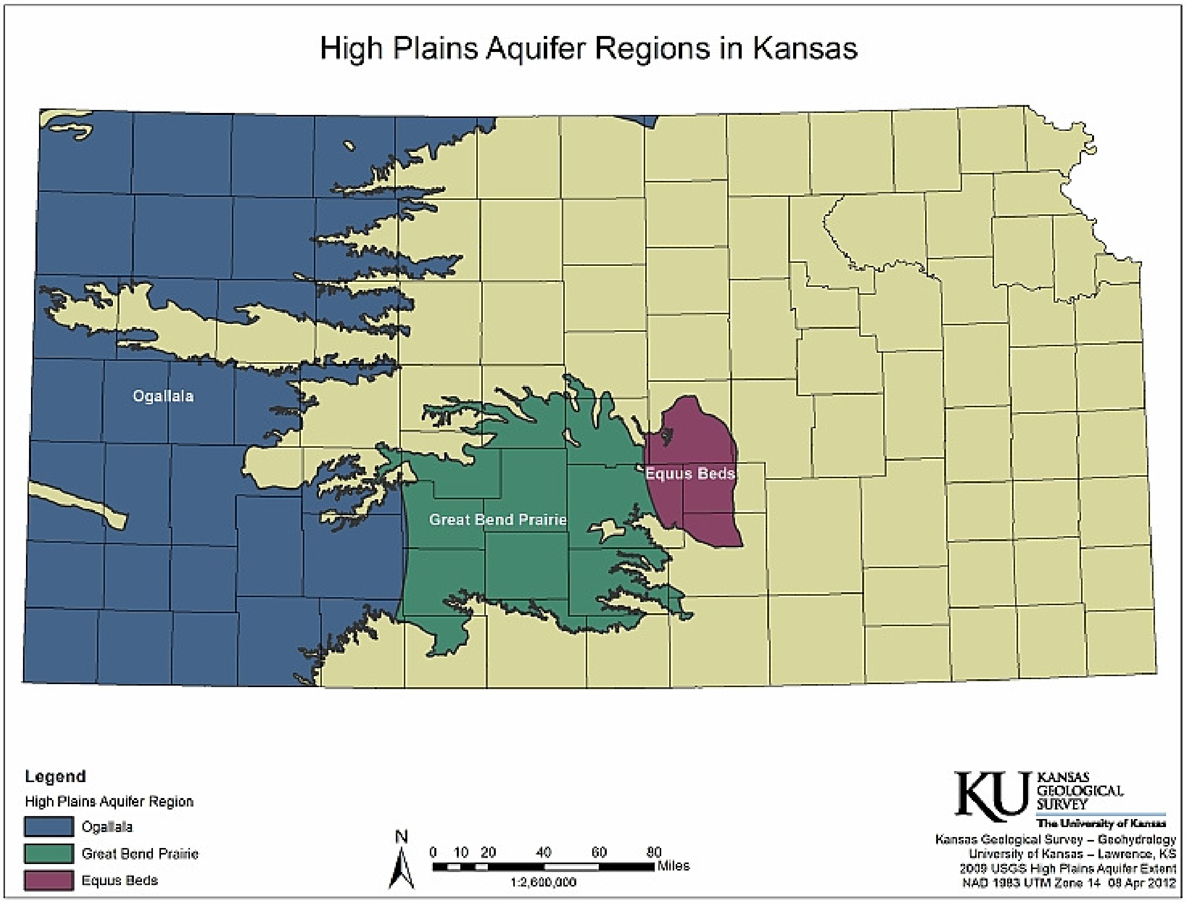

Figure 6. The three components of the High Plains Aquifer in Kansas. Image courtesy of the Kansas Geological Survey.

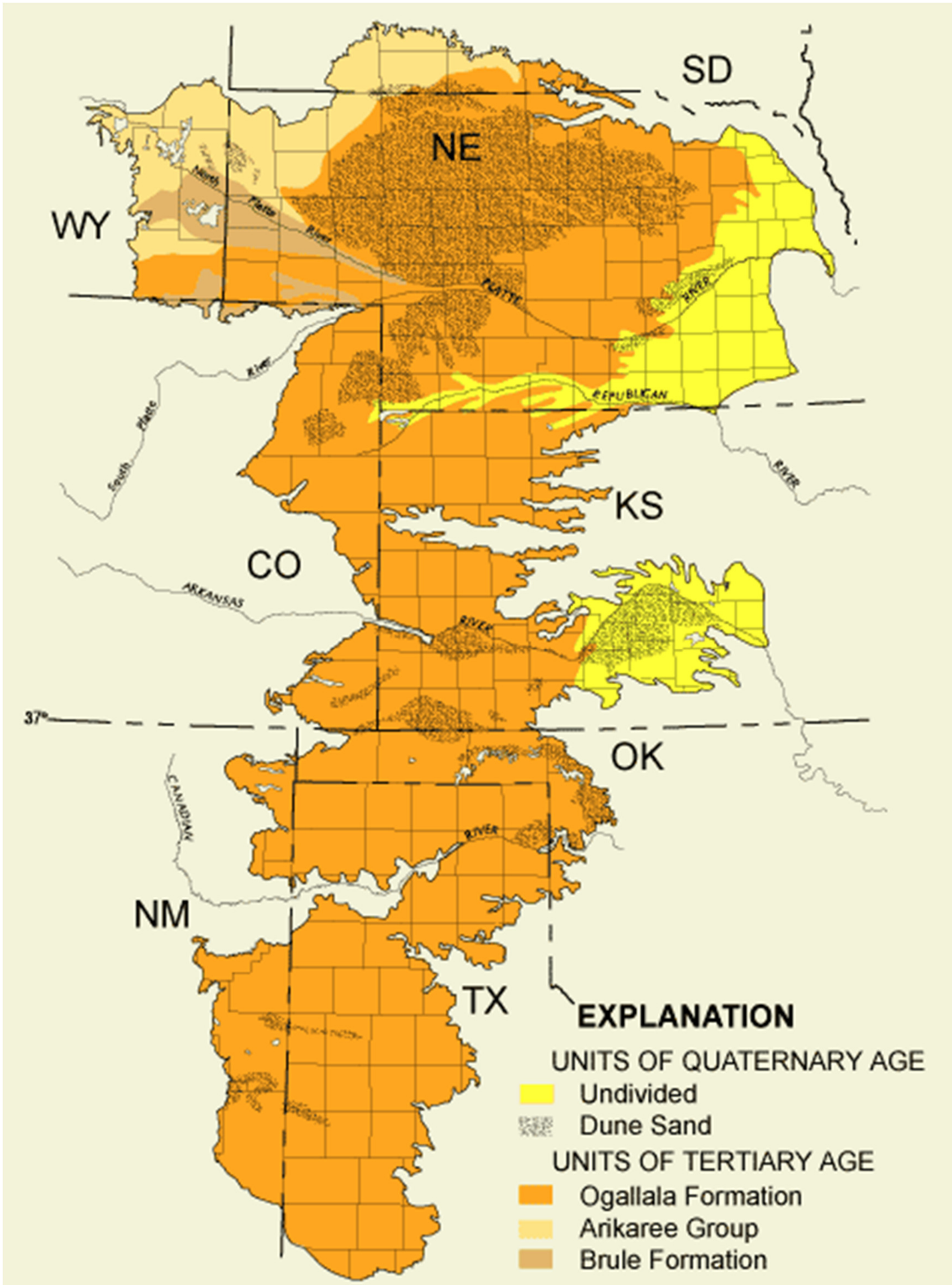

Figure 7. The extent of the High Plains Aquifer and its principle geologic components. Image courtesy of the United States Geological Survey.

The HPA is a layer of saturated silt, sand, gravel, and clay that has become trapped between geological layers over the course of several million years (Wilson 2007). People sometimes refer to the HPA as a vast underground lake or river, but it is actually more akin to a porous sponge than a lake. About 10 million years ago, rocks and dirt eroded off the face of the Rocky Mountains and were carried away by glacier water, to be deposited as a rocky slush on the face of the Great Plains (Kromm and White 1992b:15). This porous deposit was eventually covered by loess blown in from the still dusty Rocky Mountains (Opie 1993:25). Rain, snow, and river flow trickled through this surface and became trapped in the mountain debris, creating what we know today as the High Plains Aquifer (Guru and Horne 2000:5). Until about 10,000 years ago, water from Rocky Mountain streams continued to fill the aquifer. But a geological shift created the Rio Grande and Pecos rivers, cutting the water off from the HPA (Opie 1993:22). The water found in the aquifer today is “fossil water” that was deposited long ago.

Because of this change, the aquifer no longer receives the same type of recharge it once did. The HPA only receives about an inch of recharge per year from precipitation that manages to escape the searching roots of crops and grass and trickle through the overburden (Buchanan, Buddemeier, and Wilson 2009; Opie 1993:22). The part of the aquifer that underlies the Sandhills region of Nebraska can have a recharge rate as high as six inches per year, but that region, ironically, is not heavily involved in irrigated agriculture due to the unsuitability of the landscape and soil (Kromm and White 1992b:16).

When the geologic shift cut off the water supply, the clock began ticking on the HPA. Aquifers are open systems; they do not hold water in perpetuity. Aquifers connect to surface water bodies and provide base flows to rivers (Balleau 2013). The declining levels of water in the HPA have resulted in reduced mean annual streamflow since 1960 (White 1994:31). Further, the Great Plains tilted slightly to the east when geological activity uplifted them. This tilt encourages water to move downhill through the aquifer and discharge into various streams and rivers, albeit very slowly. Estimates range from one to three feet per day (Opie 1993:22) to tens of feet per year (Buchanan, Buddemeier, and Wilson 2009).

The saturated thickness of the aquifer, the vertical measurement between the top and bottom of the water table, varies considerably from state to state. Nebraska has most of the HPA deposit (65 percent), with the rest of the states sitting on top of 12 percent or less each (Kromm and White 1992b:15-16). Kansas has only about 10 percent of the aquifer water, although about 23 percent of the area of the HPA (30,500 square miles) is in Kansas. By contrast, Nebraska has about 65 percent of the total water but only 32 percent of the aquifer area, and Texas has only 12 percent of the water but over 20 percent of the aquifer's area (Kromm and White 1992b:15-16).

Even in Kansas, the saturated thickness varies considerably. Some parts of southwest Kansas have over 300 feet of saturated thickness, while parts of northwest Kansas have about 50 feet (Buchanan, Buddemeier, and Wilson 2009:2). The saturated thickness and depth to water can vary considerably within a few miles (White 1994:31). Farmers I have spoken with tell me that saturated thickness can even vary within one farm, where one well produces sufficient water and another is drying up. These characteristics, and the fact that the water level does not quickly equalize throughout the formation (as water does in a tub), causes farmers to have widely different experiences with the aquifer. Even in areas, such as Stevens County, that are purported to have many years of water remaining, farmers all know of or have wells that are no longer sufficient for irrigation.

Researchers estimated that only about 30 percent of the available water has been pumped out of the aquifer (Steward et al. 2013:ES3477). Granted, it is technically impossible to deplete the aquifer, but this is only because a relatively small amount of water can be extracted from it with current technology. The remaining water is unavailable using the gravity drainage method on which irrigation wells and pumps rely. This is referred to as the specific yield and is generally accepted to be about 15 percent of the water for most of the aquifer area (High Plains Underground Water Conservation District Number 1 2010).

This may seem like heartening news at first. But, in the mere 60 or so years that irrigation has been a major method of production, we have changed our optimistic perspective of the HPA region. We no longer consider it an inexhaustible source, the land of the underground rain (Green 1973). There will likely always be drinking water available from the Ogallala, but the days of wells producing enough water for irrigation are numbered everywhere and already over in some places (Wilson 2007). We have begun forecasting the date of its demise.

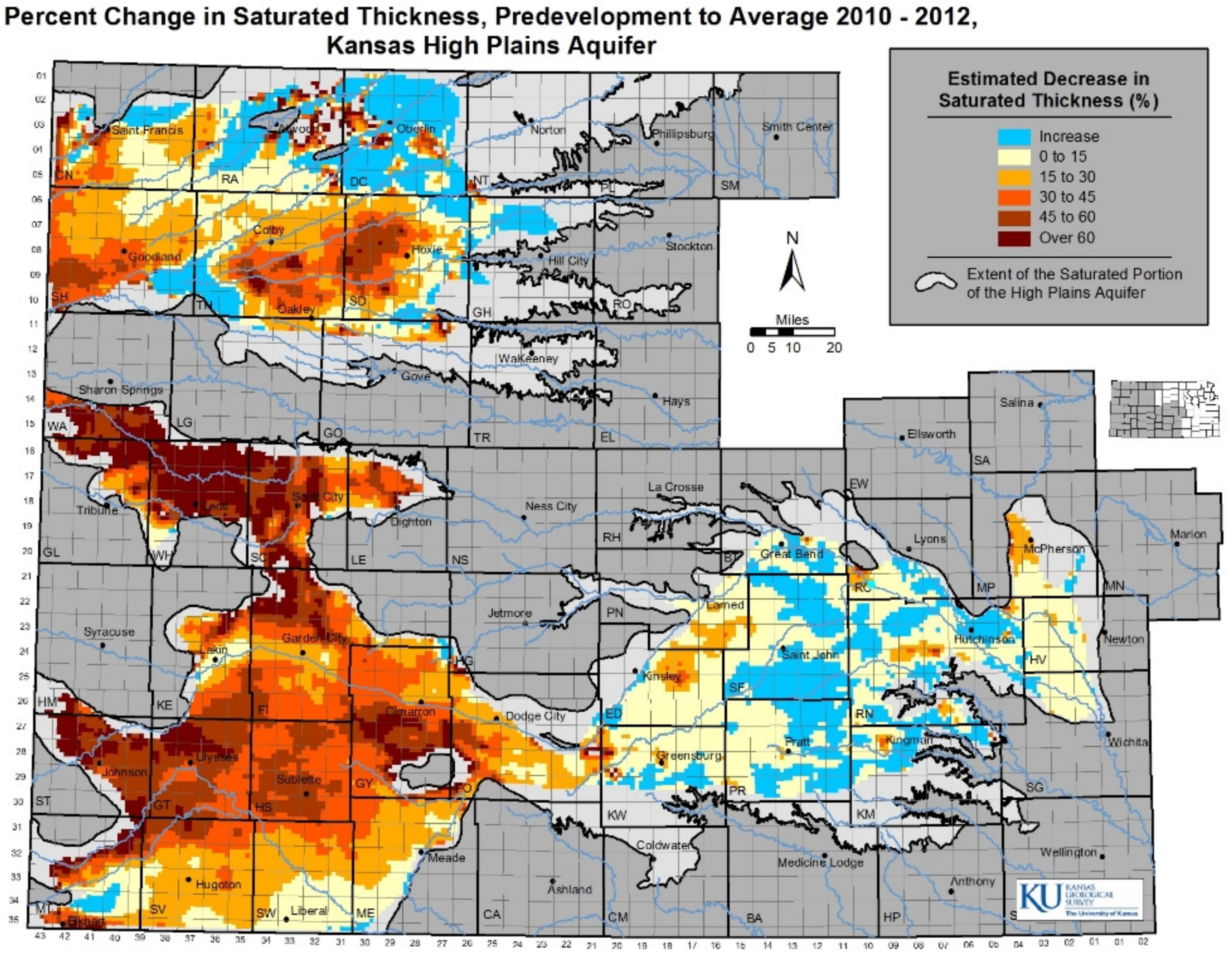

Figure 8. Extent of depletion in the Ogallala Aquifer.
Image courtesy of the Kansas Geological Survey.

The Settlement of the Great Plains

> I cannot understand why you should wish to leave this beautiful country and go back to the dry, gray place you call Kansas.
>
> —L. Frank Baum

> If I went west, I think I would go to Kansas.
>
> —Abraham Lincoln

The boundaries of the Great Plains are not quite clear and people sometimes quibble about how to draw the map (Mather 1972:239). Licht (1997:2), for example, writes that the Great Plains is three biomes, consisting of tallgrass, mixed-grass, and shortgrass prairie and that no distinct boundaries may be drawn between where the biomes contact each other or other areas. The zones are reflective of differing amounts of rainfall between the eastern and western regions of the area (Kromm and White 1992b; Licht 1997:2).

The plains are called subhumid, or semiarid (Kromm and White 1992b:1), depending on the observer, perhaps reflecting whether the observer sees the glass as half-full or half-empty. Kraenzel says they are neither, or both, writing that "some years they are dry and even arid; other years they are very wet; and still other years they are wet or dry at the wrong times from the standpoint of agricultural production" (Kraenzel 1955, quoted in Kromm and White 1992b:2). One reason weather on the Great Plains is uncertain and potentially extreme is because the region is distant from the moderating effects of the oceans. Land masses cool and heat more quickly than water, which can lead to dramatic temperature changes. Amarillo's low temperature can be the same as Detroit's, 500 miles to the northeast. The high temperature can vary just as greatly (Kromm and White 1992b:2).

One approach to defining the Great Plains, and the one most pertinent to this project, was offered by Walter Prescott Webb. In his classic treatise, *The Great Plains,* Webb (1931:3-4) defined the Plains as an area consisting of three environmental traits: a large, flat land area; lack of trees; and insufficient rainfall levels to support agriculture as practiced in the humid environments of the eastern United States. The High Plains section, that area bounded by escarpments, has all three characteristics. Webb notes that these characteristics are not coextensive or coterminous, but that the presence of two of these traits are enough to designate a plains environment. The relevance of this argument is that his definition of the Great Plains is based on how the environment affected Euroamerican settlers rather than specific definitions of landscape, climate, or vegetation.

The importance of water for the inhabitants of the plains is not new. A farmer I interviewed showed me a *metate* he said eroded out of a stream bank on his land. He talked with great enthusiasm about the many other artifacts he finds near that stream. He remarked that he is just as concerned with water as the earliest inhabitants in the land that is now Kansas must have been. Indeed, it seems so.

Water scarcity and climatic extremes led early European visitors to consider the Great Plains as hostile and uninviting. In 1541, the conquistador Coronado stomped through the plains for months looking for cities of gold, eventually reaching somewhere near modern-day Lyons, Kansas, before giving up. He and his men grew sick and weary from lack of water and were reduced to drinking from buffalo wallows when they could find them (Ashworth 2006; Little 2009). Ironically, the Ogallala Aquifer lay just a few feet below them. Despite this experience, Coronado had a favorable impression of the fertility of the plains, although he made no recommendation that Spain should establish an agricultural venture there (Bader 1988; Webb 1931:106). On another expedition, led by the conquistador Zaldivar, five soldiers panicked and deserted when they encountered the featureless plains (Opie 1993:49).

During the period of U.S. western expansion, later travelers came away from their encounters with the Great Plains with similar impressions. In 1787, James Monroe told Thomas Jefferson that all of the land past the Appalachians was essentially worthless and would probably never sustain enough people to be admitted to the union (Opie 1993:49). Zebulon Pike likened the area to the African deserts in 1806, and in 1819 Thomas Nuttall referred to the region as a pathless desert. Then, in 1820, Major Stephen H. Long's expedition marched from the Missouri River to the Rocky Mountains and, somewhat carelessly, labeled the area in between as the Great American Desert (Dillon 1967:93). This appellation sealed the public's perception of the plains as inhospitable and created a natural barrier to widespread western expansion. Later, the traveler and artist, George Catlin, declared the plains of "no available use to the cultivating man" (Licht 1997:11). In 1850, Jefferson Davis, hearing the reports of the vast, dry expanse, had two loads of camels sent to Indianola, Texas, to be used for the exploration of this desert (Mather 1972:237).

For about 50 years, the Great American Desert stood as the *de facto* western barrier of the United States. Many adventurers and settlers who entered the territory were never heard from again. Later visitors would find piles of their sun-whitened bones resting atop the prairie as testimony to a failed adventure (Miller 1906:5). When gold was discovered in California in 1849, would-be miners and soldiers began crossing the unwelcoming expanse in great numbers. Forts and outposts sprang up, territorial governments were formed (Miller 1906:5), and settlers began to come to the plains in earnest. These settlers were, despite the experience of those before them, optimistic. They held a firm belief that “rain follows the plow”— that somehow the turned earth, or perhaps the planting of trees or fires from burning prairie brush would attract rain (Licht 1997:14).

Carving a Euroamerican civilization out of the Great Plains was arduous and uncertain work. Even the advance of soldiers, merchants, and other bearers of Euroamerican culture into the territory could only do so much to blunt the hard edge of life on the plains. Droughts, heat, and cold beat back many who sought to make a home there. Optimistic settlers arrived by the droves, only to leave later as discouraged refugees.

Settlers found many frustrations and failures as they expanded into the plains. The hardiness of the people was never in question. The difficulties arose because the practices, institutions, and technologies settlers brought with them were adapted to the humid climes of the east and were not well suited to the task of living in such a demanding environment (Webb 1931). Webb’s central thesis about settlement on the plains is that the experience of the treeless, arid expanses of the Great Plains was so different from the arborous, humid geography to which Euroamericans were accustomed, that the institutions, techniques, and technologies they brought to the plains had to be modified. This environment challenged and remade the institutions with which the settlers thought to tame it. Webb (1931:Preface, unnumbered pages) wrote:

> It was that the Great Plains environment…constitutes a geographic unity whose influences have been so powerful as to put a characteristic mark upon everything that survives within its borders. Particularly did it alter the American institutions and cultural complexes that came from a humid and timbered region….The failure to recognize the fact that the Plains destroyed the old formula of living and demanded a new one led the settlers into disaster, the lawmakers into error, and leads all who will not see into confusion.

Webb's thesis that the Great Plains represented a new experience for American settlers is supported by the fact that they did not even have a word to describe the landscape they encountered (Licht 1997:11). About this, Theodore Roosevelt (2007:34) wrote:

> We have taken into our language the word prairie, because when our backwoodsmen first reached the land [in the Midwest] and saw the great natural meadows of long grass—sights unknown to the gloomy forests wherein they had always dwelt—they knew not what to call them, and borrowed the term already in use among the French inhabitants.

"Prairie" is the French word for meadow and did not accurately describe the plains. However, it was a word Anglophones already knew and could apply to the new environment.

The Settlement of Kansas

The early days of Kansas saw it used as Indian Territory, a place to relocate the tribes of the Northeast (Ronda 1999). People and goods flowed through Kansas, by way of the Santa Fe, Oregon, and California trails, long before it was a destination itself (Miner 2002:33; Prentis and Race 1909:42-49). Vanguards of Euroamerican settlement—missions, military forts, and trading posts—soon appeared along these routes (Prentis and Race 1909:59-65). The trails and military roads, which connected the forts, influenced settlement along their routes, particularly in western Kansas (Miner 2002:112). Eventually, the Kansas-Nebraska Act of 1854 opened Kansas to Euroamerican settlement and the Homestead Act of 1862 brought further waves of settlers to the new state (Bader 1988:8; Miner 2002:35; Prentis and Race 1909:67-78 ,168). The settlement of Kansas was fitful, influenced by both political and natural events and the state's mercurial weather.

Life in Kansas was not easy in the beginning. The area west of the 100th meridian, which runs through Dodge City, Kansas, and is considered to be the beginning of the West, receives an average 17” of rain per year (Powell 1879).[7] There is very little moisture to spare. In 1860, a severe drought hit Kansas and as many as 30,000 immigrants left the state (Prentis and Race 1909:130). Another drought and a financial depression in the 1880s curdled the enthusiasm for Kansas development (Miner 2002:148, 171). In 1889, the Oklahoma territory was opened to Euroamerican settlement and an estimated 50,000 Kansans left for greener pastures (Prentis and Race 1909:229-230). “In God we trusted, in Kansas we busted” became a favorite motto of immigrants worn out with the struggle against the plains, who were leaving for more hospitable climes. For many years it expressed the popular opinion of the state (Carl Becker 1960 quoted in De Bres 2003:111).

In addition to homesteaders, the government granted large swathes of land to railroad companies to subsidize rail development. New tracks sometimes preceded town development (Prentis and Race 1909:169-170). To increase their business, rail companies promoted Kansas communities, sold land for settlement, and played an important role in the selection of some town sites (Kansas Historical Society 2015). They even operated experimental farms in conjunction with the government to demonstrate the types of plants and trees that could be grown in the dry Kansas environment (Miner 2002:148). The cattle trade took advantage of the new railroads and Texas cows and cowboys became common sights in Kansas. The populations of cowtowns grew to take advantage of the new trade (Prentis and Race 1909:184). The legacy

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[7] Webb labeled the 98th meridian as the beginning of the West, which runs just to the west of Salina, Kansas.

of the Texas cattle industry can still be felt in southwestern Kansas towns, where Dodge City, Garden City, and Liberal form beefpacking's Golden Triangle (Stull and Broadway 2013).

In the 1910s and early 1920s, the Kansas weather moderated and agricultural endeavors met with more success. By the turn of the century, Kansas was a leader in the production of corn and wheat and had established significant industries in coal mining, natural gas, salt mines, and food production (Miner 2002:140; Prentis and Race 1909:235-236). New people from the East arrived to take advantage of the rejuvenated land, newly generous with its bounty. Some of those who came were called "suitcase farmers" (Baltensperger 1987; Mather 1972:246; Riney-Kehrberg 1989:191) because they only set foot in Kansas long enough to plant a wheat crop and then returned to harvest it later.

Unfortunately, this bonanza was short-lived and the dual disasters of the Dust Bowl and the Great Depression mercilessly crushed Kansas agriculture under their heels. The angry winds filled the emptiness of people's pockets and bellies with the very dirt that once sustained them. These disasters pushed people out of Kansas in droves. Bader (1988:72) estimated that Kansas lost about 80,000 people to outmigration during this time, more than any other state.

Eventually, southwest Kansas, and the rest of the Ogallala region, became highly productive agricultural areas due to the motor-driven irrigation that developed after World War II. Ogallala water reversed the fortunes of some parts of the state that had been written off as being unsuitable for agriculture. As one writer opined in the early 1900s: "The country watered by the Cimarron [river] is wild, arid, and sandy. Cultivation of the land is nearly futile. The people of the Cimarron region support themselves by gypsum mining, stock raising, and a very uncertain agriculture" (Miller 1906:11). The scarcity of water led Miller (1906:11) to declare there was only a "most slender economic basis for society" to be found there and that widespread use of the Ogallala for irrigation was required to support a permanent, dense population. Fifty years later the technology to take advantage of the Ogallala on a large scale was available. Today, the Cimarron region and elsewhere in southwestern Kansas is a highly productive agricultural area. The use of the Ogallala is credited with preventing a repetition of the misery of the 1930s during subsequent droughts in the 1950s, 1970s, and 1990s (Guru and Horne 2000).

The Development of Land and Water Law in the West and Kansas

> One will never ride nature like one can ride a horse.
>
> —Karl August Wittfogel

The problem of settlement was exacerbated by how the U.S. government handled land and water issues in the West. The land on the frontier belonged to the federal government. The question of how to transfer federal land to settlers was unsettled. Several programs were instituted, but proved too costly for the settlers or were poorly structured (Webb 1931:401). In 1862, Abraham Lincoln signed the Homestead Act, which granted free land to settlers if they lived on it for five years (Webb 1931:406). The amount of land bestowed to settlers by the act was an apparently generous 160 acres, a quarter section. In the East, this would have been more than enough land to support one family. In the subhumid and arid West, it was not, given the agricultural practices and technology available at that time. The succession of failed farmers seemed to prove that the Great American Desert was the inhospitable place early travelers had claimed it was.

Later government acts included the Timber Culture Act of 1873 (Webb 1931:412). This act promised settlers land if they planted trees on a portion of it. This mandate proved to be impossible to meet because of the variability of precipitation and lack of available moisture in all areas except those near river streams. Then, the Desert Land Act of 1877 allowed settlers to purchase up to 640 acres (an entire section, or one square mile) of land if they irrigated a portion of it within three years (Webb 1931:414). Irrigation at this time was generally accomplished using surface water, of which there is very little on the Great Plains. Later, the Grazing Homestead Act of 1916 bestowed up to 640 acres to cattle herders, one of the first agricultural pursuits that managed to gain a secure toe hold on the plains.

Webb noted that these requirements, to plant trees or to irrigate, or make do on a large, but poorly producing acreage, reflected the poor understanding eastern lawmakers had of the plains environment. Despite agitation from ranchers, who tended to expand their holdings by skirting the law, eastern legislators could not understand why one person or family would need so much land. As a result, land laws developed in Washington, D.C., could not keep pace with the development of the economy and practices in the West, and federal policies impeded the development of the western territories.

Direct experience with the Great Plains was generally sufficient to change a person's perception of them. In 1878, Major John Wesley Powell, the geologist charged with surveying the Rocky Mountains and the lands of the arid region,[8] noted that much of this land was only fit

[8] Major Powell, in the *Report on the Lands of the Arid Region of the United States,* determined the 100th meridian as the beginning of the arid areas (Webb 1931:353). The 100th meridian runs through Dodge City, Kansas, which was the eastern extent of my research area.

for irrigated agriculture, not the dryland agriculture practiced in the East. He recommended that the government grant settlers farmsteads of 2,560 acres, instead of the 640 maximum acres allowed by the law then in effect. Further, he saw that the government's handling of land grants and the English common law used to administer access to water meant that the first settlers of a particular region would essentially have a monopoly on the resource. Powell suggested that settlers' plots be drawn so that all homesteaders had access to some river frontage for the irrigation of a small amount of cropland, and that the bulk of their holding be away from the river. He found there to be an "inconsistency" in a policy that would grant a settler free land, but deny access to water (Webb 1931:451).

Powell also suggested that property rights should be bundled with water rights, a major departure from the English common law used in the East. Powell perceived that water, not the amount of land a settler received, was the limiting factor of western development, but the control and allocation of water was a secondary consideration in the humid East (Webb 1931:419-422). The government rejected Powell's proposals, however, and settlement continued to meet with difficulty. Twenty years later, a geologist for the USGS made a similar finding:

> In like manner the relative term "subhumid" has come practically to signify a climate in which the natural moisture supply, from rain and snow, falls a little short of what is necessary for agriculture without irrigation. Hence, in a subhumid region provision must be made for at least supplemental irrigation; and the necessity for resort to such artificial aid will be imperative most of the time and advantageous always (Johnson 1901:675).

As it became clear that Powell and Johnson were correct in their assessments that Euroamerican style agriculture would not be possible on the plains without irrigation, particularly in the areas west of the 98th meridian,[9] the government made allowances for irrigation to develop and for the plains to blossom. However, there were still hurdles to overcome. As with homesteading laws, water law was based on conditions in the humid, eastern United States. The preferred means of administering water was English common law and its associated riparian doctrine. The riparian doctrine states that the owners of stream banks on non-navigable rivers, which describes most rivers in the West, had use, but not ownership, of the water that passed by their land (Webb 1931:431-432). Each riparian owner along the river was entitled to the full and undiminished flow of the water.

The riparian doctrine would not permit irrigation to develop in the West because it stated that only limited amounts of water, what was considered "reasonable use" for purposes such as hygiene, the household, or the watering of animals, was allowed to be diverted from the flow of the river (Webb 1931:434-435). Irrigation was not considered reasonable because it was a consumptive use of large quantities of water and because English common law did not have a framework for regulating it. In England, and in the eastern U.S., irrigation was generally unnecessary because these regions received abundant rainfall.

Over time, however, western judges shifted the definition of "reasonable use" to include irrigation. Judges found that the necessity for irrigation flowed naturally from the conditions of the environment, and irrigation was therefore a permissible use. Reasonable use came to mean the consumptive use of water for a beneficial purpose (such as agriculture) as long as such use

[9] This was the opinion during the time about which Webb was writing. However, advances in land management, planting techniques, and seed varieties have made dryland farming of many crops possible in most years.

did not interfere with other users' rights to the water (Webb 1931:435-436). This change allowed people to use the water while diminishing the stream, and to use it away from the stream itself, as long as they left enough for those downstream to do the same. This made widespread farming a possibility in the arid West. Eventually, the concept of "reasonable use" was changed to "beneficial use," which allowed for a wider variety of activities, such as mining and manufacturing, to be performed with the water (Webb 1931:435-436).

Another innovation in western water law was the concept of prior appropriation: a term which means that the first claimants of water have priority over later claimants. California (in 1855) and Colorado (in 1872, in a modified form) were among the first states to implement this idea (Webb 1931:436). Although prior appropriation allowed western farmers to make use of the scarce water resources available to them, it was not without pitfalls. This prior appropriation and the new permission to diminish the water supply meant trouble for downriver states and users. The farmers near Garden City, Kansas, for example, used the Arkansas River for irrigation until Coloradoans took all the water (Sherow 1990 quoted in White 1994:31).

The prior appropriation doctrine replicated the same problems with groundwater as the riparian doctrine had with surface water. In the riparian situation, those lucky enough to own land bordering water had a monopoly. In the prior-appropriation doctrine, the people to have first claim to water are in a superior position to later claimants. Webb compared water in the West to crowds following Jesus out into the desert. There was only a bit of bread and fish to feed the people. The first ones to get in line would eat, but the rest would have been out of luck absent a miracle. So it was with prior appropriation (Webb 1931:323).

Even with the changes to the governance of water use, there were not enough sources of water to make irrigation on the Great Plains widely practicable (Webb 1931:325). The scarcity of rivers and the absence of pronounced valleys and lakes in the Great Plains made large-scale water storage impossible as well. The search for water eventually moved underground (Webb 1931:320). The existence of the High Plains Aquifer was known to Euroamericans since at least 1854 (Kromm and White 1992a:xiii), but drawing the water up by hand was arduous and limited the use of the water to domestic purposes.

The advent of the windmill on the plains made groundwater accessible. Cattlemen were the first to introduce windmills to water their livestock in the 1860s. These early windmills drove crude irrigation rigs that could pump the relatively shallow water deposits for thirsty livestock and small garden plots (Reisner 1993:108). They worked better than the poorly performing mechanical pumps of the time. During the 1870s, windmill manufacturing increased (Stull and Broadway 2013:38) and technological innovations, such as the ability to automatically turn into the wind and govern their speed during periods of high wind, made them more efficient. By the 1880s, farmers brought these new windmills with them to the plains. Although they were not powerful enough to irrigate much land, they did allow farmers to water small gardens and orchards—things that both beautified their existence on the lonely plains and provided extra security in case of crop failure (summarized from Webb 1931:336-340). Windmills came to dot the horizon everywhere in the plains and were commonly regarded as the vanguard of civilization. Windmills for stock watering can still be seen in the plains today.

After World War II, improvements in lubrication, bearings, pumps, and drilling technologies allowed farmers to use internal combustion engines efficiently for pumping

(Hornbeck and Keskin 2014; Opie 1993:133-134). The technologies increased farmers' ability to withdraw water and, combined with the fertile but dry soil, helped transform the Great Plains into one of the world's most fertile agricultural areas. Between 1940 and 1978, the number of acres irrigated in the Great Plains tripled (Baltensperger 1987).

Current Kansas Water Governance

> Government has no other end, but the preservation of property.
>
> — John Locke

> When a man assumes a public trust he should consider himself a public property.
>
> — Thomas Jefferson

The Ogallala Aquifer has been a boon to Kansas and the rest of the Great Plains. It played a part in lifting the area out of the economic devastation of the Dust Bowl and making Kansas an attractive place to live. However, in developing an extensive irrigation practice, Kansans traded one problem for another. Instead of rigid land and water policies that would not allow agriculture to flourish, state policy makers developed a water management regime that ceded water management decisions to individuals. Within the framework of prior appropriation, farmers can use as much of the water allocated to them by the state as they need or can coax out of the ground. The Kansas state government, meanwhile, is charged with protecting the resource and overseeing its development for the beneficial use and economic good of the state. So far, these goals are contradictory and incompatible when it comes to groundwater (Wolfe 2013:12). The poor fit between agricultural practices, social institutions, and the environment that characterized early settlement has been replicated in a different form.

The following discussion traces the evolution of water law in Kansas. Kansas changed its laws from the traditional, but modified English common law to “modern water” and in so doing implemented a framework for its governance that focuses on private property rights, individual liberty, and entrepreneurial freedom. In this framework, the state has given a great deal of responsibility to local groundwater users but has retained ultimate control over the water. This effectively makes the local users assume the risk of decision making, common in an era of neoliberal governance (Evans and Reid 2013; Reid 2012), but at the same time makes the state indispensable through its own regulations and enforcement (Carroll 2012). This approach to water management is reaching its limits in the Kansas system, however. There are significant shortcomings to this design given the nature and condition of the Ogallala.

In the early years of groundwater use, Kansas followed the modified English common law discussed earlier in this chapter. However, state regulators soon realized that the law did not provide sufficient security to water users. Until this point, the state had not quantified the amount of water each person was allowed and was therefore not able to effectively intervene in disputes between users. Some of the disputes were serious, with several men and one horse[10] losing their lives (Peck 1995). The state’s response to the concern of water rights users was a series of legislative actions that included the creation of the Water Commission in 1917, and the Irrigation Commissioner in 1919, the Division of Water Resources (DWR) in 1927, the appointment of a

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[10] The horse was killed during a dispute about water.

Chief Engineer for the DWR in 1933. These actions culminated in the Water Appropriation Act of 1945 (Peck 1995:738).

The purpose of the Water Appropriation Act was “to conserve, protect, control and regulate the use, development, diversion and appropriation of water for beneficial public purposes, and to prevent waste and unreasonable use of water” (Peck 1995:741). The Water Appropriation Act instituted both the prior appropriation rights scheme (first in time, first in right) and declared the legal basis for the state’s control of water. The responsibility of groundwater management was placed in the hands of the Kansas Department of Agriculture and the chief engineer. Importantly, the Water Appropriations Act granted the state the power to establish how much water a rights holder may use. A typical water right for agriculture is two acre-feet, or about 615,702 gallons of water per irrigated acre. Wells for domestic use or to water lawns and gardens are exempt from state control as long as they are not used on an area larger than two acres.

Although the state controls the allocation and regulation of the water, access to groundwater is considered a private property right that belongs to the owner of the land under which it is found (Ashley and Smith 1999:143; Peck 2003). The holders of water rights do not own the water, but may benefit from the use of the water. Peck (2014) refers to this situation as a hybrid right. Although water rights holders do not actually own the water, their use right is reflected in land values. In western Kansas, acreages with water rights often sell for twice as much as acreages without rights (fieldnotes, August 2014). Because these rights are granted in perpetuity, many water rights still belong to the original owners’ descendants. It is not uncommon for farmers to talk about wells their parents or grandparents developed. Neither is it unusual for farmers to make statements about "my water." As one farmer put it: "I own the water that is under the ground that I farm. Now, don't tell me that because you are two miles away that I can't take mine." Despite this feeling of ownership and the benefits related to its use, the state still claims control over water within its borders.

Eventually, the state decentralized a portion of water control to local users. In 1972, the Kansas Groundwater Management District Act allowed more local control of water resources. Groundwater management districts were formed that corresponded to the underlying formation of the aquifer (Figure 8). The groundwater management district for southwest Kansas is the Southwest Ground Water Management District (GMD3). There are five districts in total. Groundwater management districts are controlled by elected boards of directors, with one commissioner per county within the district boundaries. Each GMD can determine what its goals are for managing the water in its area as long as those goals are compatible with state law (Ashley and Smith 1999).

The Groundwater Management District Act is an example of a type of governance that is common in the neoliberal era and offers ostensible benefits to citizens:

> In addition to the bold promise that increased democracy and participation will result from the dismantling of restrictive state structures and practices, advocates of neoliberal conservation suggest that such models protect the land rights of rural communities and aid local communities in the development of conservation-associated business ventures such as ecotourism (Brondo and Bown 2011:92).

Although the issue of ecotourism, perhaps with the exception of hunting, is not a major consideration for southwest Kansas farmers, the other issues outlined by Brondo and Brown are. Private property rights and local control of water figure heavily in how farmers talk about the Ogallala (next chapter). Local control is beneficial to the farmers, but they assume much of the risk for developing and managing the resource while the state benefits from their economic activity without the same degree of risk exposure.

Another important agency involved in water governance is the Kansas Water Office (KWO). In 1963, the state legislature passed the State Water Plan Act, which directed the Kansas Water Resources Board (KWRB), an entity charged with planning the development of water resources in the state, to “formulate and adopt, and . . . from time to time amend, extend or add to a comprehensive state water plan for the development of the water resources of the state, hereinafter referred to as the ‘state water plan.’” (Peck and Nagel 1988:208). The KWO, which was established in 1981, replaced the KWRB and largely assumed the responsibility of developing the Kansas Water Plan (Peck and Nagel 1988:210). The KWO is now the water planning, policy, and coordination agency for the state and is responsible for developing and implementing the Kansas Water Plan. The plan assesses water resources and challenges every five years.

In 2012, Governor Sam Brownback directed the KWO to concentrate on developing a plan, not just for the next five years, but for 50 years, to secure the supply and quality of water in Kansas for the next two generations. The plan recognizes the various sources of water for the state and the threats they face, but the water itself is treated monolithically as a thing to be managed to create “a long term statewide water supply while balancing conservation with economic growth” (Kansas Water Office 2015a:10). Further, the state proposes to accomplish this goal by encouraging every citizen to be aware of and responsible for the condition and quantity of the water in the state.

The modern water regime in Kansas has served the interests of the both state and its farmers well for many years. However, as the depletion of the Ogallala has become more serious, the management scheme is hampering efforts to conserve, or save for the future, what is left of the resource. This section will discuss the tools that are currently available to the state to manage the Ogallala. The state, having made itself both indispensable (by declaring control of the water with the Water Appropriation Act) and impotent (by devolving control of the Ogallala to local users) has left itself in an ideological conundrum.

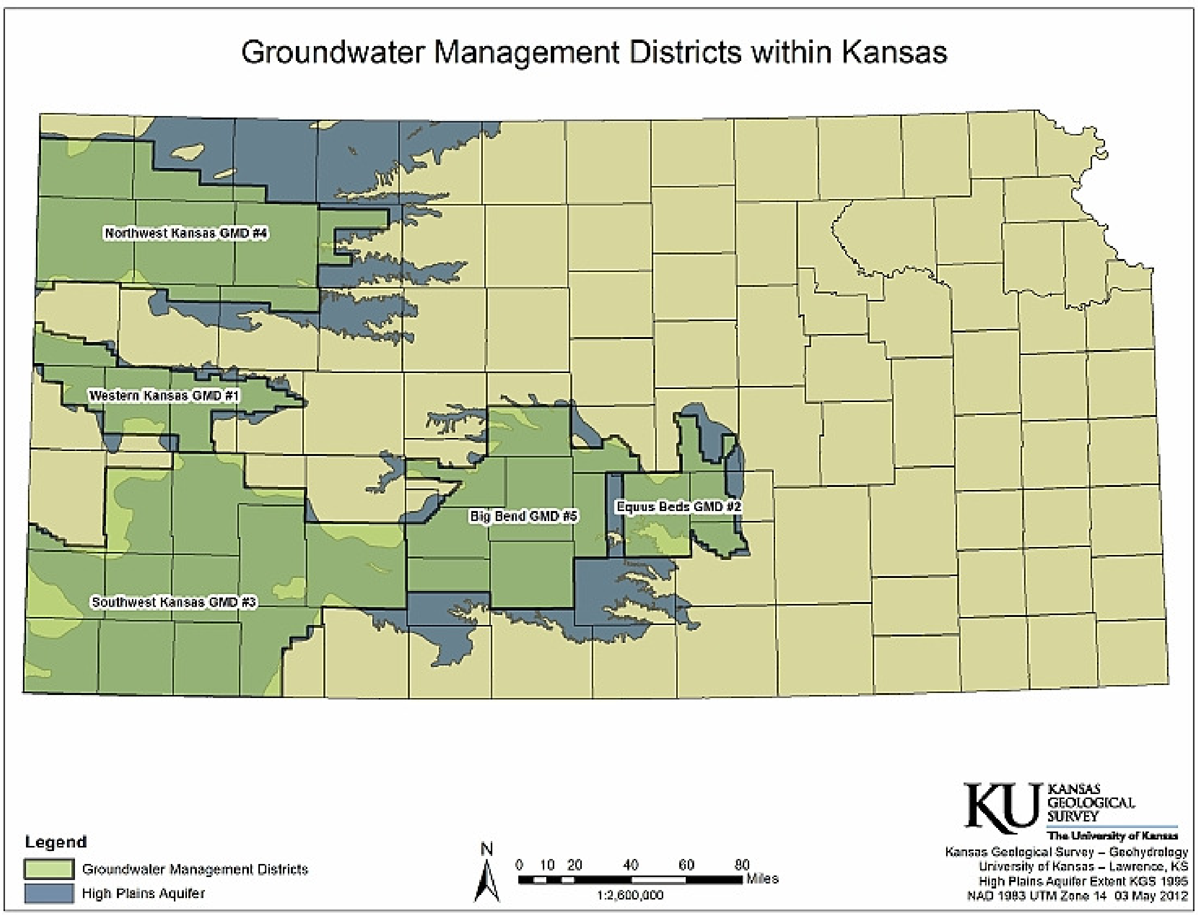

Figure 9. The boundaries of the groundwater management districts as they relate to the aquifer components in Kansas. Image courtesy of the Kansas Geological Survey.

Once a water right has been granted, daily decisions about its use are left to individual rights holders (Ashley and Smith 1999:145). The state has relatively few tools to mandate reduced extractions and has thus far favored voluntary reductions. Two existing mechanisms are the Conservation Reserve Enhancement Program and the Water Right Transition Program (Kansas Department of Agriculture 2016a). Known colloquially as "buy and dry" programs, both pay farmers to relinquish their water rights. However, they target limited areas in the aquifer and the payments are not tantalizing enough for farmers with good wells to enroll in them.

One tool at the chief engineer's disposal is the imposition of an Intensive Groundwater Use Control Area (IGUCA). The authority to create IGUCAs was granted to the chief engineer in 1978 as an amendment to the Groundwater Management District Act of 1972 (Peck 2014). The chief engineer can reduce water allocations over a wide area with limited regard to seniority. There are currently eight IGUCAs throughout Kansas. However, they only address relatively small areas, such as the ribbon of the Arkansas River corridor that runs through GMD3. None of the IGUCAs address wide areas the size of a GMD (Kansas Department of Agriculture 2009).

The constitutionality of IGUCAs has not been tested in the courts (Peck 2014). Although the statute gives the chief engineer wide latitude in deciding which water users must reduce their consumption and by how much, this authority has not been reconciled with the prior appropriation doctrine, which is the bedrock of Kansas water law. For example, when the chief engineer declared an IGUCA in the Walnut Creek area in western-central Kansas, he made two classes of water rights—those granted before 1965 and those granted after. The post-1965 water rights were required to reduce their pumping more than the pre-1965 rights. However, the oldest right holders in the post-1965 group felt they were not being treated fairly in light of the concept of prior appropriation. In their opinion, rights holders that were junior to them should have been required to reduce their pumping more than they were (Peck 2014). One farmer, whose farm is in the Arkansas IGUCA, and who is also subject to these restrictions, shared these thoughts when we talked about the uniform volume reductions the state was considering at the time:

> Sure, I could get by on 20 percent less, but I think the way Kansas water law is, and I have the good fortune to get an early well, my idea would be that they shouldn't cut mine by 20 percent, because the very fact that they're going to cut everybody 20 percent means that them other guys are impairing me. That's practically inherent in the statement. Because we are overappropriated, which they weren't when my well was drilled in 1933. We weren't overappropriated. And so it's obvious it's these later guys that are impairing me.

Although we were talking about the state's proposal to curtail the volume of aquifer extraction by 20 percent and not about IGUCAs in general, his statement reflects the argument made by rights holders in Walnut Creek. They filed a court challenge over the IGUCA and the way the chief engineer declared two classes of water rights and ignored the history of prior appropriation. However, they withdrew it before the case was decided. It is still unknown if the current IGUCA program would survive a legal challenge from a small number of users, much less the tumultuous reaction that would surely ensue if the chief engineer were to impose a similarly structured IGUCA on an entire GMD. The political costs to elected state government and the appointed bureaucracies could be extraordinary.

Kansas law favors stability of access for water rights. Recently, the chief engineer issued a water permit to Mary Clawson and the Clawson Land Partnership, but tried to retain jurisdiction over the allocation in case the new permit had a negative effect on local groundwater levels. Mary Clawson and the partnership sued the chief engineer and the court found he had no legal authority to retain jurisdiction over the right.[11] The result is that a water right cannot be amended once issued. This decision did not test the IGUCA law and its effects on the state's ability to mandate wide-scale reductions is unclear. At this time, it does not appear that the state has any options to the constitutionally questionable IGUCAs other than invoking the Public Trust Doctrine. This is the idea that the state can hold the water in trust for public use, but this seems highly unlikely (personal correspondence with John Peck, scholar of Kansas water law). However, it is likely that any new powers the legislature gives to the state would be challenged by rights holders, just as the Water Appropriation Act of 1945 was originally challenged (Peck 2014).

There is a mechanism where water rights holders can agree to reduce their consumption and have the agreement enforced by the state. Termed local enhanced management areas (LEMAs), the water users in a specified area can agree to reduce their withdrawals by a certain percentage and make themselves accountable to the Division of Water Resources through financial penalties and the threat of suspension of their water right. Only one LEMA has been established. It is for a term of five years and is in one small section (99 square miles) of Sheridan County in northwest Kansas, which is in the GMD4 area (Kansas Farm Bureau 2012; Sheridan 6 Advisory Committee 2014). The farmers and board members of GMD3 were not interested in establishing a LEMA until they had explored the possibility of building an aqueduct to bring

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[11] *Mary Clawson and Clawson Land Partnership v. State of Kansas, Department of Agriculture, Division of Water Resources*, 49 Kan. App. 2d 789; 315 P.3d 896; 2013 Kan. App. LEXIS 105

water to southwest Kansas from the Missouri River on the eastern side of the state. (I will discuss this proposal in Chapter 5.)

A few farmers commented that the only people who really wanted a LEMA in southwest Kansas were the farmers running out of water. I asked several of my contacts about this claim. Although I did not conduct a thorough inquiry, the farmers' observation seems valid. The farmers who were most vocal about not wanting a LEMA were often those who still had a secure water supply. On the other hand, the farmers who were often in favor of implementing a LEMA were those who had already lost their water or were watching their supply dwindle. I interviewed a farmer who wanted the LEMA because his small farm was running out of water. He said of other farmers, who he thought had more water:

> They don't want it because they don't want change. They want to grow corn. They want all the water they can. If you keep going that way, the decision is that they are going to keep growing corn until it's all gone.

This pattern makes sense. The people who benefit most from controlling resources usually have the greatest resistance to change and perhaps more ability to protect the status quo (Swidler 1986). Further, when situations become "messy," as with depleting the Ogallala, being able to adhere to models of previous action depends on an individual's personal characteristics, financial resources, and persuasive ability (Guillet 2000:714). These characteristics and competencies are in some part determined by individuals' relationship with other elements in their world.

The efforts to create a LEMA in western-central Kansas in the Western Kansas Groundwater Management District (GMD1) has failed (Bickel 2014). According to Greg Graff, the president of the board of directors for GMD1, the LEMA failed, not because of the concept, but because of issues of representation. The board and manager of GMD1 wanted to institute a LEMA throughout the entire GMD, rather than a small section as GMD4 had done. He wanted to avoid arguments about boundaries where farmers on one side commit to reducing their consumption but farmers on the other side of the line still get to enjoy their full allocation and possibly even benefit from the others' sacrifice. Farmers argued over whether vested water rights (those granted before the 1945 Water Appropriation Act) should be included in the LEMA (they are not required to be) and whether the reduced ability to water would cause difficulties with crop insurance claims. Ultimately, a slim majority of farmers voted for the LEMA, but not enough to meet the two-thirds supermajority required to implement it.

The GMD1 LEMA failed because the board decided to hold a vote among rights holders. They did this although the LEMA legislation does not require a vote of affected water rights holders, only the vote of GMD board members (Kansas Senate Bill No. 310). This decision was made with neighborliness in mind. As Greg Graff was quoted in a newspaper article, "When you are doing this, you want to do this right, and you want to have a good taste in your mouth" (Dillon 2014). This scenario, however, illustrates a problem with the LEMA framework.

The Water Appropriation Act of 1945 gave the state responsibility to regulate and control water use for the benefit of the public (Peck 1995:743). Yet, the state has consistently cleansed its hands of this responsibility by abdicating responsibility to private individuals (to be fair, some would say empowering), originally through the GMD act and now through the LEMA framework. Further, the prior appropriation doctrine treats each water user individually, rather than as a class, and arranges individuals by order of application rather than by consideration of need. Now, however, the state is asking for voluntary cooperation, both with it and among farmers, although its laws have enshrined individual use as the basis for water administration.

Another interpretation of this problem is that the institutions in place are not necessarily wrong, but are ill-suited for the scale of the job (Sanderson and Frey 2014b:14). The Ogallala formation not only stretches across farm, city, and county boundaries, it straddles state lines as well. It is subject to different use patterns and regulatory regimes with every boundary it crosses. Further, through the concept of virtual water, the water required to produce an agricultural product (Hoekstra and Chapagain 2008:138), the rhizomatic influence of the Ogallala stretches to and connects users and beneficiaries across the world. Yet, the institutions that manage the Ogallala in Kansas—the GMDs—are local and may not sufficiently bridge the gulf between the local ecosystem and larger economic processes.

In the case of the Ogallala in southwest Kansas, GMD3 carefully administers its portion of the Ogallala in compliance with the state's and its own regulations. The board is concerned with consistently and equally applying the laws and regulations to all water users under its jurisdiction. A conversation during a board meeting about how to respond to the application of federal groundwater regulations to federal land in GMD3's borders reveals the board also guards its borders against encroachment from other authorities. Despite the faithful execution of its duties, GMD 3 (and all other GMDs or their equivalents in other states) is isolated in that it represents only small portion of the total aquifer and has no formal input into the actions of any other region. Yet, the ripples of its local actions, those GMD3 is permitted to take, spread beyond its borders.

Local control dedicated to meeting local needs means that the coordinated action that will be needed to address the aquifer-wide issue of depletion is unlikely to be forthcoming. GMD boards are faced with a choice of saving as much water as they can for the future or meeting the needs of their members today as they ride the fickle currents of the global agricultural economy. As a result, some farmers suggest the GMD framework should not be thought of a preservation body. As one farmer put it:

> Other than the acre footage allotment, the groundwater management district and the Division of Water Resources have not done one thing to save one gallon of water in the last 40 years.

He had previously served on the board of GMD3 and could not think of one action that he took or was aware of that saved water. Another farmer observed, “The GMD has a lot of meetings. Lots of talking but it doesn’t do much.”

Ultimately, the institutions that manage water in Kansas could be adjusted, but lower crop yields and economic pain would likely be the result—something not many people want to agree to. A farmer in the Arkansas IGUCA offered a damning assessment of the issue:

> We could do this if we had a will to do it. If everybody worked for it, everybody wanted it. I mean, we put men on the moon. But we don’t really want to save the prairie chickens [an endangered species in Kansas]. We don’t really want to save this aquifer.

He gave a big, deep sigh at this point.

> We want to save it if it is painless and we want to save it if it doesn’t cost us anything. We want to save it if it doesn’t cost *me* anything.

It appears Mary Douglas (1986) is correct—there can be no solidarity without sacrifice. Yet, the reasons farmers resist the state’s call to use less water go beyond economic loss. The next chapter explores these reasons in detail.

Chapter 5
Cultural Barriers to Reduced Water Use and Cooperation

> Water links us to our neighbor in a way more profound and complex than any other.
>
> —John Thorson

It is no secret that farmers and other agricultural interests often resist government regulation (e.g., Bell and Lowe 2000; Maloney and Paolisso 2006; Moore, Parker, and Weaver 2008; Paolisso and Maloney 2000). This chapter addresses why farmers in southwest Kansas have so far resisted implementing a LEMA in their GMD, which would require coordinated action. There are many reasons why southwest Kansas farmers have resisted the LEMA concept. Some are based on the cultural values of agricultural communities in southwest Kansas and farmers' understanding of the aquifer. Other reasons can be understood as acts of resistance to the state's desire for them to assume more risk in the modern water framework. There are also agronomic, hydrological, and technical issues that work against farmers' cooperation.

The data in this chapter are drawn from my observations at water meetings of various types and interviews and conversations with farmers. I present aspects of farmers' cultural models about agriculture and irrigation and have chosen representative quotes to illustrate farmers' perspectives. Although cultural models may be organized hierarchically, I choose to present them here as parallel. I prefer to think of cultural models as processing units that may be called, as a function is called in a computer language, to interpret a situation.[12] The cultural data

[12] Cultural models differ from computer programs in important ways because they also have affective dimensions and can accept a wide range of inputs (D'Andrade 1981).

that emerged from my fieldwork tended to center around particular issues. I feel that leaving the models as discrete processing units is more faithful to the data. The models, however, are often related in various ways. Leaving them as separate units allow them to come into and out of the analysis as needed.

I should be clear that the discussion presented below is not intended to represent all farmers in southwest Kansas. Nor is it the fact that the multiple reasons for not cooperating in a LEMA are found in every farmer who objects to the program. However, these interpretations and models are distributed widely and may be found, in various mixtures, among many of the farmers of southwest Kansas. There were outliers, of course. I have included data from those farmers as points of contrast where appropriate.

One of my contacts, Mason, spoke frankly about the Ogallala, irrigated agriculture, and his neighbors. He felt free to do so because, as a dryland farmer, he "did not have any skin in the game," as he put it. Mason was a valuable informant; he was both an "insider" because he was a native, local farmer, and an "outsider" because he had never irrigated. When I asked him about the prospect of irrigators in southwest Kansas forming a LEMA, he said he did not think they would do so voluntarily.

Mason based this assessment on his experiences travelling to other Western countries as part of a best-practices exchange program. Farmers in other countries, Mason said, would periodically sit down with each other to talk about their farming practices and even share their financial books to discuss cash flows and strategies. This is a level of sharing and solidarity he had never witnessed in southwest Kansas. He hypothesized that southwest Kansas farmers' sense if individualism and the intense competition for land had made farmers too wary of each other to make cooperation in this matter possible.

In the following discussion, farmers' sense of independence is explored as the lens through which they interpret farming decisions, their relationship with their neighbors, and their place in the world. Other elements of farmers' cultural models emerged as well. They are models of risk, competition, and the inevitability of change. Taken together, their model of agriculture can be interpreted as "Individuals Searching for Control in a Risky Competition."

Economic gain is one reason farmers compete in this risky game. However, as one informant noted, money is often not the most important consideration for deciding on an agricultural career. One motivation for farmers, which also colors their attitudes about water, is the production and reproduction of society. This suggests a model of agriculture as being "Necessary for Life", not in the sense that humans require food, but in the sense that agriculture makes humans. This chapter includes a discussion of this aspect of farming and then concludes with a consideration of the consequences of these models for water conservation. Resignation that the aquifer is being depleted and distrust of the government emerge as hindrances to farmers' support of state-sponsored water-use reduction plans.

Independence

Mason's observations are correct. Interviews with farmers reveal a strong orientation to independence and awareness of competition. When you ask farmers what they like about agriculture, one of the foremost responses is "Being my own boss." Farmers enjoy making their own decisions and setting their own schedules. These are experiences of work only those at the highest levels of other professions enjoy. This sense of independence is reflective of the discourse of private property and individual freedom (Dudley 1996), and perhaps even the often solitary nature of modern agricultural work.

One informant said independence was both farmers' greatest strength and weakness. He continued by saying, "I am not willing to sacrifice my independence for the good of us all. And boy that's a detriment to us." This is an internal conflict with which other farmers also struggle, suggesting the presence of more than one cultural model farmers use to define their relationships to each other. Independence, however, seems to be the motivating model.

A farmer once told me, "If you get three farmers in a room you will have four opinions." I heard variations of this phrase from other farmers as well. This phrase is a nod to the strong sense of individualism many farmers have and the fact that farmers advocate for outcomes favoring their own individual needs, based on their financial situation, farm operation, stage in life, goals, and innumerable other factors. It is also a humorous self-criticism of their inability to coordinate on issues that affect them.

Competition

Emery (2015) argues that British farmers often conflate independence and individualism, where the latter is defined as placing the highest value on the individual, rejecting arguments about the collective good, tying individual freedom to market freedom, and embracing self-interest as the best guide for action. This leads them to see their neighbors as natural competitors. Southwest Kansas farmers also conflate these concepts, although perhaps not as totally. When farmers talk about independence, the concept of individualism is certainly present.

Farmers often mentioned competing with each other during the interviews. Competition between farmers can be classified three ways: noneconomic, non-zero-sum economic, and zero-sum economic. The term “zero sum” refers to situations in which one party’s gain results in another party’s loss. Noneconomic ways of competition that farmers talked about were “straight rows” and fields that looked good from the highway. These ways of “winning” increased farmers’ social status but did not put them in economic competition with each other. A non-zero sum, but economic way for farmers to compete is by growing “good crops,” which means crops of high quality and yields. Because the market farmers sell into is a monopsony which sets its buying price based on global demand, when farmers “won” in these contests they did not diminish the welfare of their neighbors.

The third category of winning, the zero-sum economic, involves the quest for productive capacity through land acquisition. Buying more land is how farmers compete in the sense of making real winners and losers. This is because farmland is scarce and more acreage is required to compensate for the declining financial returns farmers have been experiencing (Canning 2011). “They don’t make it anymore,” as a real estate agent told me. The amount of agricultural land in Kansas has been stable, but has been concentrated into fewer farms. There has only been a 1.5 percent increase in farmland since 1920, while the average size of farms has increased 174 percent (Institute for Policy & Social Research 2015:35). Land auctions and sales draw many farmers who are trying to increase their holdings. This is why a few farmers talked about competition as being in a better position to make higher bids on attractive parcels when they become available. Farmers can increase their ability to bid by consistently growing high yielding crops while controlling their costs. Irrigation leads to higher yields and is therefore a potent competitive tool.

The competition for land also extends to the land rental market. Renting farm ground is the easiest way for most farmers to increase their productive capacity. In some respects, renting is even more competitive than the outright purchase of land. I heard several stories about how cutthroat the rental market could be, like this one:

> If you are a couple days late getting your wheat cut, your landlord is going to get a stack of letters from other farmers saying that they can do better. We've even heard of farmers dying and his widow getting a knock on the door a few days later from a farmer asking to rent the ground.

Farmers also tell about other farmers offering their property owners more money per acre for a chance to rent their land. It is no wonder farmers would be hesitant to share their books if they would risk revealing how much they pay to rent farm ground.

The competition for land is both an outgrowth of and reinforces farmers' sense of individualism. It inhibits cooperation and sharing, even on quotidian issues. Farmers attempt to secure their competitive advantage by keeping some of their techniques secret. One farmer told me about a crop and grazing rotation he accidentally discovered that increased his returns. I asked if he had shared his observations with anyone else. "Only a few friends," he replied. "I don't share everything I learned the hard way," said one. "Maybe I should, but I don't," he mused after a pause. Another informant recognized the sometimes caustic nature of this competition and how it was a wedge that prevented them from unifying. "We compete mighty hard with each other for land," he said, "but somewhere in there you have to work as a team. Competition is good, but not all the time." Competition, as a result and expression of individualism, is subject to the same internal conflict as farmers' sense of independence. Nonetheless, farmers are hesitant to commit to water reductions, which would weaken their financial position and increase their risk, if they are not sure their neighbor has made the same commitment.

Risk and Control

Over time, I began to interpret the saying about three farmers have four opinions another way. The fourth "extra" opinion in this saying is also a testament to the unpredictability of agriculture that can leave farmers unwilling to commit too strongly to any course of action. A few bad years in a row, caused by bad weather or bad breaks, can buck farmers off their land. Water conservation programs, such as a LEMA, with binding enforcement provisions, seem unappealing because they remove the ability to change course should a new problem or opportunity arise. Nature and markets can scrap even carefully laid plans. "How do you set your goals each year?" I asked Paulen. "Well, that's a good question," he began. "We plan, but it seems like our plans are constantly being hammered down. This drought killed us, but in the past it has been price declines and other issues as well." Paulen went on to talk about the time he was trying to break into a specialty meat market and reduce his grain agriculture:

> We were pasture-raising beef. But we had to water the pasture because the weather was so dry. [Natural gas] went from two dollars per MCF [metric cubic foot] to 13 dollars per MCF. All of a sudden what was working was no longer working. So we looked around and said, "We need to grow some corn to make some money!"

Farmers' desire to maintain the ability to take several courses of action is an indication of their view of agriculture as an inherently unpredictable and risky venture. Farmers use metaphors of gambling to describe the risks of agriculture. Said one:

> I go to Vegas and I like the shows and the dining, people watching and stuff like that. People say that's surprising because look at what you do for a living. Well, I think ours is a gamble that we try to mitigate risk on.

This statement about indicates a widely shared model of risk in agriculture. This farmer's unnamed interlocutors, aware of how risky agriculture can be, are surprised he is seeking more risk as entertainment. The unspoken assumption is that agriculture is risky enough. Or as another farmer, who was slightly exasperated at this point in our interview, said:

> This is one of those years where I should have told my banker to give me my operating note and I'll go over to Vegas and put it all on red. Then we will know real quick whether we are going to go around again. Why wait and work all summer to know?

He equates Vegas, one of the world's most famous centers for risk, with agriculture. He estimates that putting it all on red is more advantageous than farming, at least that year, because he will know the results immediately. It also indicates he feels he has no ability to control the financial outcome of efforts. It is the same as if he spun the roulette wheel.

Another farmer said this about the scale of risk involved in agriculture:

> If I ever farmed trying to not lose money I would never make it. You've got to have that optimism that next year will be better. It's a huge gamble in proportions that people don't really understand. My operating note, I'll probably have a million to a million and a half dollars tied up in crops this year. But I'm hoping I'll make two million. I'm hoping to make 3 or 4 hundred thousand dollars on the crop this year [after costs]. People say, "Gosh, that's a lot of money." And I will say that doesn't even make the down payment on the next piece of ground I am buying. And tractors are a quarter million. When I go to Las Vegas, and I am playing with a 100 dollar bet, I'm sweating it. But when I am running my irrigation pumps, 14 or 15 of them depending on the year, they each cost me about 250 dollars a day to run. My electric bill will run per month, about half my wells on electricity, my electric bill will run over 70,000 per month. One year it was 150,000 dollars per month. The amount of money you are spending is huge.

As with the other farmers, he compares farming to visiting Las Vegas. He also equates the money he spends on powering his irrigation pumps to a gamble.

Irrigation is a high-stakes gamble as the cost of running the pumps indicates. However, the odds are good that the gamble will pay off. A few of the farmers I spoke with explicitly equated irrigation water with money. This is certainly true in the sense that water increases their yields, which increases their profit. However, another meaning of water emerged. Water also equals control—control over the weather and the outcome of the growing season. When irrigation is viewed through the model of agriculture as risk, the importance of the control that irrigation provides farmers is apparent.[13] Irrigation represents a rare aspect of control, although not absolute, over a process they feel is largely governed by chance rather than skill.

From this viewpoint, farmers find the state's suggestion to reduce their water use and cooperate with each other in a LEMA to be an undesirable proposition. Doing so would increase their exposure to risk and contradict the strong cultural value of individualism—of standing on their own two feet and assuming the responsibility for success or failure, even if the results are beyond personal control.

One way farmers attempted to exercise control was to bring more water to southwest Kansas. During the summer and winter of 2014, the board members and the executive director of GMD3, Mark Rude, were exploring a proposal to build an aqueduct to draw water from the Missouri River on Kansas's eastern border and deliver it to a reservoir near Utica, Kansas. The

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[13] Crop insurance and crop subsidies are both government programs that help farmers manage risk.

farmers in southwest Kansas were split about the feasibility of the project. Those that thought the project would work were opposed to considering a LEMA until the final determination had been made. They viewed the aqueduct project as a last card to be played.

The project reexamined an idea, originally explored in 1982, during the original assessment of the condition of the aquifer (United States Army Corps of Engineers 1982). As with the original assessment, this version proved to have insurmountable problems. Missouri Governor Jay Nixon has already publically opposed the plan, citing concern for how it would affect the water supply and quality in his state (Carpenter 2016). Beyond the interstate politics was an engineering issue about how to transfer water across the state. Mark Rude and his staff presented a comprehensive engineering plan that included possible routes and beneficial uses of the water as it crossed Kansas (fieldnotes, July 2014). However, there were signals that securing rights of way for such an ambitious project was going to be problematic. The chief of the Iowa Tribe of Kansas and Nebraska, in the northeast corner of Kansas near where the aqueduct would begin, opposed the proposed route on the basis that it would remove around 19,000 acres of prime farmland in the area to be used as a collecting reservoir. The chief also made the claim that the water in the river belonged to his tribe (fieldnotes, September 2014). However, the largest hurdle for the aqueduct was the cost. The proposed infrastructure would have cost $18 billion to build, $1 billion annually to maintain, and the water would have cost farmers about $450 per acre foot (Helling 2016). The cost of the project, and the water, were unfeasible.

In early 2015, the KWO announced that the state would not pursue the project (AP 2016a). The leaders of GMD3 have not given up on the project, however. In January of 2016, they testified in favor of a bill that would reduce the filing fees for water rights (Marso 2016).

Under current law, the GMD would have to pay $200,000 just to file a claim to water from the Missouri. They are still looking for ways to get the project approved. The aqueduct effort is evocative of Smythe's (1969 [1905]:xvii) description of the man called to the frontier, "He wants to…turn rivers out of their courses, drive the desert back inch by inch...." in search of control.

Inevitability of Change

When I asked Marlon, a third generation farmer, to describe his farm, he did so through a series of what he termed "evolutions." When his grandparents first arrived in southwest Kansas in the early 1900s they used horses to pull the plow through the fields. By the 1930s they replaced the horsed with tractors. They drilled their first irrigation well in the 1960s. The same well is still producing water today, albeit no longer at the rate his grandparents enjoyed. These descriptions of changes as "evolution" are indicative of how he feels about the nature of the changes as well as how he feels about his current situation.

In the biological sense, evolution is not a directed process. Evolution is the result of changes in the distribution of alleles in a population over time due to natural selection, gene flow, mutation, or genetic drift. Life does not evolve in a purposeful sense. This sense of evolution is different, of course, than the way changes occur on the farm or the social world in general. Each of the three generations in this example all made conscious changes to the farm operation in pursuit of specific goals. Retiring the horses in favor of tractor power and replacing the reliance on rain with groundwater were all decisions meant to increase the productivity and stability of the farm operation. However, these changes, no matter how long ago they occurred, have implications for the farm today. In this sense, the metaphor of evolution is accurate. Just as a modern whale can no more go back to the ways of its land-dwelling ancestor, the *Pakicetus*, Marlon does not see a way to go back to the dryland ways of his grandparents—at least not without massive changes. Other research has reached similar conclusions:

> Farmers frequently specialize in the production of specific agricultural products and have little flexibility in terms of making significant changes in existing farming systems, at least in the short-run. Land owner-operators also develop specialized management skills that are often not easily transferred to alternative farming systems. Costs associated with making changes in existing farming systems under such conditions often cannot be justified (Sommers and Napier 1993:135).

This is not simply because the structure of agriculture has changed since the early 1900s. Rather, it is commitments both inherited and made that complicate a change to different ways. The time-lagged effects created by past decisions and actions can determine the available course of action for future decisions and actions. This is the concept of path-dependency (Arthur 1989; David 1985) that is characteristic of communities and economies built on resource extraction (Aistrup et al. 2013).

Other farmers also view the depletion of the aquifer as a natural process based on the evolution of farming. One maintains nothing can be done about it and the fact the water levels are declining is the same as him getting older every year:

> It's kinda like I'm getting older every year and it really sucks. But I'm pretty good at it. So I deal with that. I deal with maturity. I deal with aging and I adapt. Well, the Ogallala is the same way. It's getting older, it's depleted, it's going to happen and we'll do the best we can.

The comparison of aquifer depletion with aging equates aquifer depletion with an inevitable and natural process. Farmers feel they have little control over the aging of their bodies or the depletion of the aquifer and can only adapt to the challenges each brings.

Many farmers feel they have no choice but to compete in the risky game. Farmers consider the behaviors and choices required to succeed in agriculture and the arm's distance relationships with their neighbors to be the natural order of the world. This is not to say that innovation and deviance do not exist; they do. Rather, it is that the model of agriculture which includes the elements of individualism, risk, competition, and inevitable change has the most sway.

Resignation and Regret

> I don't have much time left on this Earth. When I get to Heaven, Saint Peter's going to ask me what I've done. I'll say, "Well, I pumped all the water out of southwest Kansas."
>
> —a farmer near Montezuma, Kansas

One of the consequences of this cultural model of agriculture is that farmers are largely resigned to the fact that southwestern Kansas will eventually return to dryland farming. They view efforts to save the Ogallala as ineffective meddling or wishful thinking.

> The state hasn't really articulated its position. What do they want? Do we use a lot of water? You bet. Do I wish it came from up above? You bet. But what the state wants to do is just kick the can down the road 50 years. But it doesn't solve the problem. It just makes it more difficult for the people who are doing it now.

Despite feelings of regret about the depletion of the Ogallala, farmers are now left with a situation from which they cannot return. Like the concept of evolution, the way the Ogallala water was used seemed natural at the time.

Most farmers put on a brave face when we talked about water. I think this is for several reasons. The first is that people have been concerned about water in southwest Kansas since at least the 1980s and the completion of the *Six-State High Plains-Ogallala Aquifer Regional Resources Study* commissioned by the U.S. Department of Commerce (United States Department of Commerce, High Plains Study Council, and High Plains Associates 1982). They are accustomed to the news that the aquifer is being depleted. Farmers also have little choice but to soldier on in the current environment. It is impossible to undo what has been done in the past. Unresolved regret (grief is too strong a word, I think) about how Ogallala water was used in the past and the attitudes surrounding that use are apparent if you scratch the surface of the brave mask many farmers wear. This resignation and regret about aquifer depletion are tied to farmers' sense that it is unavoidable.

Matthew farms over a thin area of the aquifer. He fears he will run out of water sooner than most farmers and bemoans the loss of the resource. When he talked about the way the Ogallala used to produce water, he would hang his head a little and look down to the ground. His voice would trail off in unfinished sentences, leaving a heavy silence. In some ways, this mannerism reminded me of the way people speak of the tragic loss of a loved one.

Farmers may not have lost a loved one, but they certainly have lost the exuberance that was tied to the seemingly unlimited possibilities and ease of operation that plentiful water provided. According to one farmer:

> Back in 1963, when the water level was at 90 feet, you didn't have to drill particularly deep to get to good water. It took a small engine to pump it. Natural gas was 3 cents an MCF. So you didn't even try to pump the well's capacity. We were pumping into an open ditch and throwing tubes over the side of the ditch to irrigate. You had so much water that if you ran it up to max the ditch would break out. The soil banks of the ditch couldn't hold the water. So water was available, it was easy to pump, and the energy was totally available. So you didn't have to be a genius to make it work. You had water that was shallow, *big* water, and you had energy that was practically free. Now pause for a minute and say, "Well, that was really wasteful." But back then we had so much water and almost free energy. You would have been out of your mind to go buy a sprinkler—well, they weren't even that available back then.

Imagine the exhilaration a southwestern Kansas farmer must have felt the first time he turned on his new irrigation well. The water that was flowing out of the ground, seemingly free, and faster than he could use it, promised to end crop failures and bring security, if not prosperity, to him and his family. Now that the aquifer is depleted, and hindsight is fully realized, some farmers wish they had taken a different path. Said an older farmer: "Should have been started 50 years ago, this conserving deal. I wish we would have had sprinklers 50 years ago when I started farming." As with Matthew, this statement was also offered with more than a tinge of regret.

Other farmers were more sanguine about the development of irrigation in southwest Kansas:

> Back in the day when water was cheap, and fertilizer was cheap, everything got ripped every year out here. Back in the '70s, there was tail water running down every road. Water was cheap, we thought it was going to last forever and we just pumped. They wasted 100 years of water through the decade of the '70s alone. Which, you know, that's where you see people back east that see that and think "Well, you are just a bunch of dumb farmers out there raping the land and everything." But there is a learning curve on everything, you just don't know. So...

Ripping is a deep tillage method than can penetrate the soil by 15 inches or more. It is not commonly used in western Kansas any longer because opening the soil to that degree can lead to the evaporation of stored moisture. Tail water is the water that runs past the end of the rows in flood irrigation systems. These practices were reflective of a time of plenty. Now the sense of freedom is lost and farmers are worrying about the resource base. The bounty has been reduced to scarcity. "Coulda, woulda, shoulda, but it didn't make sense back then. Who knew? My grandad told me that we used to waste more water than we used."

Water is in the Blood

I was talking with Ben, who had experience with livestock, about the possible imposition of water restrictions when he suddenly offered the following metaphor:

> Now let me tell you about predation [by wolves]. Predation is like rape. You know it happens and that it is a terrible shame. But it doesn't really matter to you until it happens to your sister or wife. Then predation is a big deal.

I did not realize it at first, but this was an admonishment to tread lightly on the subject of water and a statement about how an intellectual issue can quickly become a personal and emotional one. I realized this later when the same type of metaphor appeared in the same context during other interviews as well. As another farmer noted when he compared water restrictions to losing a child: "It doesn't matter how many people get killed in the war until your child dies. That's when it hits home." These are more than reflection of the impact of when abstract debates become specific. These metaphors equate water restrictions with the harm or loss of a family member. They are offer a glimpse onto farmers' conceptions of the connections between farm and family.

I had scheduled an interview with Nick for a morning in late September. He asked me to meet him at his farm, which was located on a paved county road outside of Ulysses. The morning was still and grey, the air thick with mist. The tractors and work trucks motoring around the yard outside his workshop had their headlights on to combat the early morning dreariness. A man in coveralls, a mechanic judging by the dark grease stains, pointed to the house next to the workshop and told me I would find Nick there. I hesitantly walked past a barking, but ultimately only curious black dog and saw Nick waiting by the garage, completing some business on the phone. Nick showed me into his home. It was a large ranch-style house, popular in these parts, with a finished basement. His wife, Brenda, who was busy doing chores around the home, stopped to say a friendly hello and asked me a few of the questions I had come to expect as a stranger in southwest Kansas.

We sat down in Nick's office. It was in a room that was probably the formal dining room at one time. His office had all the equipment you would expect to find in any business. Two desks were pushed to face each other in the center of the room. Nick, a bear of a man, sat behind the big desk which faced in the traditional manner toward the room's entryway. I sat at the smaller desk. As I looked around the office, in the dining room of his home, I was struck by how intimately related the farm enterprise is to the family that runs it. Although I had met with a few other farmers who had offices separate from their homes, as I think Nick could have had if he had wanted to, the majority of my conversations with farmers happened around kitchen tables or in home offices like this one.

As Nick was giving me an overview of his farm, he spoke at length about his children, where they attended college, what they studied, and who they married. They had each become successful professionals in different aspects of medicine and seemed to be living happy lives, albeit away from the farm. Nick said that their education was the best investment he had ever made and it would not have been possible for him without irrigation. As we talked, I learned that Nick was firmly against any restrictions, voluntary or mandated, on pumping. However, in a comment that was revealing of the importance of family to him, he added, "Though I might feel differently if I had any children coming back to farm."

Nick is not alone in not having any children come back to the farm. Most of the farmers I interviewed had grown children who were engaged in other professions. This is reflective of the age of the average Kansas farmer. These farmers were largely against water restrictions. Only six of the farmers I interviewed or spoke with had offspring on the farm, either as children or adults who returned after college. Four farmers out of this group were in favor of some type of water conservation program. This pattern suggests that the consideration of children's futures has an effect on attitudes about water conservation. This is a topic that would benefit from further research.

Although more research is needed, Nick's and other farmers' attitudes do suggest that their view of water conservation is tied to their reproductive state. Since Nick's children are grown and independent with established careers, Nick and his wife have entered their postreproductive years. Obviously, his children still want his companionship and benefit from his wisdom, but his job of raising them is essentially complete. Other farmers who still have children on the farm generally favor some type of water conservation. Although this finding is tentative, it is clear that farm (including water) and family are intimately related.

One of the questions I asked farmers, usually at the beginning of an interview as a way to ease into the conversation, was what agriculture meant to them. One of the most typical answers was that "farming is in my blood." I usually asked informants to expand on that phrase, which would seem to indicate a cultural model. Ben, who was also a hunter, offered these insights about what it means for farming to be in the blood:

> I hunt and I kill way more stuff than I need to eat. And I give it to people. We give away way more meat than I eat. But the point is, farming and hunting are basically the same thing. I don't think we farm just to make money. And now we don't hunt just to eat. But we hunt because people have always hunted and it's kind of built into us. And people have farmed for a long time. This is kind of an instinctive thing to want to do. There is a continuity of human experience. I know lots of women (I hesitate to say I know a lot of women…) But when I was divorced, I dated women that thought killing things was foreign to them. It wasn't anything in their behavior, but they were attracted to men who hunted. I think a lot more people would farm if they could. We don't need as many people to farm, but maybe people still need to farm for themselves. It's a way of making something out of nothing. It's the most basic thing that we can do is make food. It's one of those good things to do.

Agriculture is more than a profession, it is something farmers are compelled to do because it is an innate part of their beings. It is a worthy pursuit that does not just produce food, but prestige for its practitioners. Agriculture also connects farmers to the people who came before them and what they see as the essential nature of humanity. One farmer said it was akin to "participating in a divine cycle." Another farmer indicated that the land and water resources associated with his farm are akin to a sacred trust that connects present day farmers to the past and the future:

> Well, I think it's [the meaning of farming] the threefold aspects of making a living, personal fulfillment, and passing on the land to our next generation. We are third generation, we would like to pass on the land in better condition, so we can't let it fail with us.

Another common category of response stated that "farming is a business and a lifestyle." This combination of "business and lifestyle" linguistically reflected the physical reality of many farm homes, such a Nick's. As we talked, members of his crew would come freely in and out of the house, sometimes stopping by the office to ask a question or say hello. Although the phrase seems to present a balanced equation, the two categorizations of farming do not appear to have equal weight in farmers' minds. The business aspect of farming is important, but not totalizing. As one farmer said:

> Income is not the reason why most people get into what they do. It's on the list, but it could be the fourth or fifth reason, not the first. I go to church on Sunday, and they talk about how money shouldn't be the focus of this world, of what's driving us. But it's still important when we're here. And my wife is saying, "You buy all these combines and tractors and stuff, and I want to buy a new car occasionally and I want some new clothes. Upgrade *my* way of living." And that's part of the thing. The goal of business is to provide those things for your wife and kids.

When I probed on what farmers meant by lifestyle, they offered responses that fit neatly in the positive discourses about rural life with which most people would be familiar. In the country: you do business on a handshake, if you forget your wallet when you go to the diner they will just send you a bill in the mail, you know everybody, there is plenty of space and wildlife, the pace of life is slower than in the cities, and it's a good place to raise a family. None of these answers is particularly surprising, but this last answer, “it’s a good place to raise a family,” points to farmers’ views of agriculture, and water by extension, as generative of the vital function of social reproduction—as sowing the seeds for the next generation.

One of the most vibrant examples of this came from John, who related this poignant example:

> I’ll tell you, this is how much irrigation means to me. We started farming when I was 12. We came out here and bought a dryland section of ground and drilled that first well. And my dad rigged a little light on that well and we had pivot points on 4 quarters on that section and we had one sprinkler and we pulled that sprinkler all the way around to all 4 of those pivots. Because we were short on resources. We had nothing but lots of labor. And cheap labor at that. But anyway, we had a little light on that well back then. And the last thing we did every night, no matter what time we went to bed, we looked at that light to make sure that that light was on. That meant that that engine was running. It didn't matter what time at night it was. If it was 10:30 at night and that light was off, we went down there and we worked on that thing until we got it going. Cause that was our lifeblood, the irrigation. And my mom and dad never graduated from college. All of us kids did. I’m thinking here…

At this point, John had removed his glasses and was wiping at his eyes. I sat silently and averted my gaze. I was trying not to disrupt the moment and to give him space to collect himself. He continued:

> Every one of my nieces and nephews did, but one. And I have one son that is a senior at Kansas State University right now and a daughter at another school. And I think they're both going to graduate this year. And my folks set up a fund to help the education of their grandkids. So it’s not all been wasted. And my sisters have done well in other areas of the country. One of my sisters was a school teacher, and quit recently. Another was a plant manager and had 500 employees beneath her. Another one has her own, she was a computer engineer, and quit doing that so she could become her own real estate person. I guess what I am saying is that the aquifer has given a lot more than a lot of people realize. And it’s gone into every aspect of society. It hasn't just provided cheap corn and cheap food. Although it has done that too.

The aquifer is intimately connected with John’s personal story, as it is with many others. Another farmer, bragging about his daughter, told me about how she was interviewing for an internship with a large company and the recruiter asked if she had grown up on a farm. The recruiter could tell she had by her work ethic, he said. I encountered several cases where farmers' children became doctors, lawyers, or engineers—something that many farmers attributed to the strong work ethic developed on the farm and the financial security afforded by irrigation. As John said, the gifts of the aquifer are widely distributed when people leave the farm and apply their education and work ethic to other walks of life. In this way, water is a material linkage to past and present (Barnes and Alatout 2012) because it connects farmers with the dreams of their parents and the dreams for their children.

One debate about water conservation is whether it is better to use the aquifer now or save it for future generations. Is it a better use of water to produce higher economic returns in the short term or reduced economic returns over a longer period? How will decisions made today affect the distribution of the aquifer's gifts tomorrow? What is the best way to care for future generations? This tension emerged in many interviews. One farmer remarked:

> Sometimes the tension is between leaving water for your son or taking all the economic value you can today and leaving the money for your son.
>
> Another spoke about this goals for farming and water management:
>
> I want to pass this on to my son. Don't want to burn up my resources in my generation. For longevity's sake, I want to use water properly and not waste anything to the best of my capability.

This passage was offered by a younger farmer who had a son who was planning to stay on the farm. He continued with a criticism of older farmers (and presumably ones with grown children who do not farm):

> I have a sense that the older farmers don't care about the water situation. They're almost finished with their careers now. They have to get their mentality changed from "that's mine I can do what I want," to maybe considering the next guy.

One farmer, who seemed to be more interested in conserving the aquifer than most, related a conversation he had with his father:

> I asked my dad, “How long will this water last?” “It will never run out,” he said. Well, it didn’t take 20 years. It’s a real shame that we are using such a valuable resource for quick money that only benefitted a small amount of people.

At the risk of discounting the regret he feels for the loss of the water, he can likely find solace that his children are cared for and will have good opportunities because of the Ogallala. Nonetheless, the tension between the needs of the present and future is unavoidable.

Some farmers negotiate this tension by equating water with oil. This comparison renders water as a productive resource with no value unless it is used. Many farmers, however, are not able to remove the non-economic concepts of water (such as stewardship of an entrusted resource) from the equation completely. They struggle to balance today’s needs with a felt responsibility to tomorrow. One farmer justifies his water use by referencing what he calls the “parable of the talents mentality.” In this parable (Matthew 25:14-30), a rich man leaves on a long journey and entrusts three of his servants with his money. He gave five talents to the first servant, two to the second servant, and only one talent to the last servant. A talent was a monetary unit worth about 20 years of wages. The first two servants took the rich man’s talents and doubled them. The last servant simply buried the talent. When the rich man returned from his journey he was very happy with the servants who had increased the value of the trust he had given them. However, he dealt harshly with the servant who had done nothing with his trust. What good can come from burying talents under the ground? This view of water as an entrusted resource that has no value unless it is used sits uncomfortably alongside the felt need to save it for future generations. He continued:

> But I struggle from the standpoint of future generations who say, "How come you guys didn't do a better job in managing this resource? From 1945 until today, how did you use it all up?" But at the same time, if you don't put it to use, what benefit does it have?

This is the only time over the course of my fieldwork where a farmer referenced a religious text or concept to explain his viewpoint. This absence of religious-based reasoning is surprising given that many of the farmers, in other parts of their conversations, indicated they were Protestant Christians. I sometimes probed for how their religious beliefs informed their attitudes and decisions about water, but the responses to these probes felt stilted and rote. I was not confident that these responses, which could have clustered around a "God" schema, had motivating force. That a person can vocally reproduce a cultural model does not indicate that the model motivates his or her actions (Strauss 1992). It may be that the beneficent and transcendent characteristics Western Christians generally attribute to God are reflected in farmers' views of nature and the inevitability of change. This, however, is speculative and more research is needed to explore whether such a model would necessarily require religion to explain.

Distrust of Government

> As soon as the legislature wants to save our bacon we need to put the hogs in the shed.
>
> —A farmer near Ulysses, Kansas

Another consequence of the farmers' model of agriculture manifests in distrust of the government. Private property rights and individual determination are sacrosanct. The interference of the state government in their water use threatens these values. This distrust has a long history. Recall that the early settlement period was characterized by the creation of legislation and programs that were ill-suited to the environment. The federal politicians in the eastern half of the U.S. were not familiar with the conditions of the West and were slow to adjust their policies to meet settlers' needs. More recently, the Sagebrush Rebellion of the 1970s and 1980s sought to wrest public lands from the federal government and cede them to state and local control (Olson 1980). As in the settlement period, many Westerners still feel disconnected from the federal government and that their voices are not heard.

In the 1990s, a different type of discontent with government control emerged in Kansas. Governor Joan Finney implemented a new school finance formula that channeled tax dollars from southwest Kansas to urban areas of the state. The law left the people of southwest Kansas with fewer resources and the feeling that politicians in Topeka did not appreciate their contributions or right to self-determination. This touched off a short-lived movement for southwest Kansas to secede from the rest of the state (McCormick 1995).

What these events have in common is a mistrust of distant governments. The people of the western states, as in the settlement period of the plains, distrusted a distant federal government they felt did not understand their needs. Ulysses is closer to Denver, Colorado, than it is to Topeka and about the same distance to Santa Fe, New Mexico, as to Topeka. Many of the farmers I spoke with feel disconnected from Topeka and the decisions made there: "Sometimes the politicians don't have common sense. And a lot of this stuff is run by politicians back east." Yet farmers in southwest Kansas are subject to the decisions of faraway legislators and administrators.

Sometimes even government officials from the local area are unaware of farming issues. At a water meeting in Liberal, a state representative from a nearby district in southwest Kansas asked a farmer for more information surrounding the herbicide 2,4-D. The representative called the chemical "4,2-D" instead of its correct name and did not know why it was used. To his credit, the representative made the effort to attend a meeting to learn about issues that could affect his constituents. The farmer he was speaking with answered his questions patiently and referred him to other sources of information. I was surprised that a local government official was unaware of these issues and wondered if this was an example of the gulf that farmers feel between themselves and the state government.

Farmers resent rules and regulations that do not make sense to them or that frustrate their efforts to be more productive. During my fieldwork, the Environmental Protection Agency and the U.S. Army Corp of Engineers introduced new rules outlining the types of water bodies that would be regulated under the Clean Water Act (Environmental Protection Agency 2016). Local radio airwaves we filled with spots denouncing the proposed rules as an example of government overreach and a radical environmental agenda. Farmers and their organizations were concerned the rules were going to claim jurisdiction over groundwater and even drainage ditches (Kansas Farm Bureau 2015). The rules did not say what some of the most ardent objectors maintained they did, but they nonetheless represented "more government interference."

Farmers were also frustrated with rules about where water from a particular well could be used. Over lunch at Macia's restaurant in Sublette, Kansas, Ross told me about the difficulty he had with water allocation rules. The original water allotments for the wells on Ross's farm no longer made any sense to him. His father had drilled five wells in the late 1950s. Two of these wells had large water allocations that were more than sufficient to irrigate six quarter sections. His father later drilled three more wells to irrigate four other sections. These last three wells, however, did not have enough water allotted to them to adequately water the crops. Ross's father tried, but failed, to persuade the Division of Water Resources (located in the Department of Agriculture) to administratively move some of the water allotment of their older wells to their newer wells. The state government would not permit change in the place of use.

Ross's father was left with a water shortage—one caused not just by the aquifer, but by government regulations. Ross could use all of his allotment in places where it was authorized, but could not spread that amount to fields served by wells with less output. I heard this same complaint from others. They could see no logical reason why they could not balance their allocations as needed among different wells. If they were approved to use a particular quantity of water, what did it matter where it was used? As I later learned, concerns about the spacing between wells and whether moving water allocations from one well to another would impact other people's wells were often at the root of such refusals. Nonetheless, farmers often perceived the state as being "nonsensical" when it came to administering water law.

Farmers became even more critical when I asked about the potential wisdom in the state's push for water usage reductions. The value of taking such steps was not clear to them because it would only delay the inevitable. A farmer at one of the water meetings asked, "So we get 25 years of extended life of the aquifer and then what? My grandkids will be farming by then. What's the plan?"

Farmers generally responded to my questions on this subject with refrains of "They don't care about us! They just want our taxes!" One farmer even showed me a printout of the taxes his irrigated county in southwest Kansas contributed to the state coffers compared to other rural counties without irrigation. The amount was ten times as large for the irrigated county. "Water and money flow east," was an aphorism one farmer offered. This pattern of extraction has been well documented. As Sanderson and Frey (2014b:11) noted in their political economic study of the management of the Ogallala:

> To support development, higher-income places therefore often import biocapacity through trade with lower-income, more peripheral places (Rice 2007b). Thus, in a stratified world economy structured by large and persistent income differentials between places, there is a 'vertical flow' (Bunker 1984) of ecological capital from less-developed, peripheral places to more-developed, core places. This vertical flow is the 'social metabolism' of the world economy (Fischer-Kowalski 1998), as the material throughput necessary to support living standards in higher-income places flows upward from lower-income places.

This pattern of economic and resource extraction is why Greg Graff, the president of the board of directors for GMD1, wants to implement what he calls "vertical integration" of the agricultural industries in western Kansas. He does not want any grain to leave the area without being used in some type of manufacturing process or fed to livestock. This, he hoped, would bring more money to the area, give young people more jobs to do, and make it more difficult for the eastern part of the state to justify interfering with their water decisions. Although southwest Kansas already imports grain to support the feedyards, Greg's idea reflects his desire to gain more local control and autonomy.

Farmers like the idea of local control and determination because they feel they know their needs better than others. They are not dissimilar to the original Euroamerican settlers of the West. Although the LEMA idea is being pitched to them as a way to maintain local control, farmers sense that the state is extending a carrot but the stick is not far behind:

> The DWR says that the LEMAs are local control, but we all feel like that they are saying that if you don't do something for yourself then we will come out and do something for you. This is the heavy hand that we feel like we are under. And the people who have made the investment feel differently about it. As I understand it, water rights are private property rights and the government cannot take them away without compensation.

To this farmer's point, at one of the water meetings I attended, a staff member mentioned the possibility of some mandatory conservation plans such as Intensive Groundwater Use Control Areas. Predictably, this put attendees ill at ease and the presenter hurriedly moved on. Farmers are unsettled by the prospects of action by Topeka. One farmer observed how farmers were preparing for any actions the state government might take:

> They are trying to hedge against Topeka and the uncertainty about what's coming down. I saw it this year. As soon as the combine left the field they were watering again. They are trying to make sure that their yearly amounts [of water use] are up because they are afraid of what Topeka is going to do.

Southwest Kansas farmers resent the sudden concern from outsiders about what they view as a private problem: "So when people come knocking to ask about how they can help us manage the water, I say, 'Well, you never helped me buy that $350,000 combine.'" This farmer continued, "The state of Kansas wants to save the state economy. Well, that's good. I'm trying to save my farm. The state of Kansas can kiss my ass." The last three words of his sentence declined in pitch and were slightly separated and evenly emphasized, giving his statement a quietly emphatic quality.

Farmers' concerns extend beyond the unasked-for meddling of distant authorities or that they feel their taxes are sucked east and they receive little benefit in return. They also fear the outcome of well-intentioned policies that are made by people ignorant of their challenges and the southwest Kansas environment. The following example illustrates this concern.

We were relaxing in Ben’s living room, preparing to continue our conversation after having lunch at the Mexican restaurant down the road. Ben seemed thankful for an excuse to escape the unrelenting heat of an August afternoon. He is an avid hunter, in addition to being a farmer and rancher, and the evidence of his prowess hung everywhere on the rafters. The deer and ducks adorning the exposed wood beams and the mix of western and southwestern décor made his home feel like a hunting lodge. Fat, black flies circled our heads, not as an indictment of Ben’s housekeeping, but as a testament to the time of year. They were everywhere. Ben had a background in environmental science, but also over 40 years of experience in agriculture and related fields. Yet his plain and direct way of speaking belied this experience and made him all the more genuine.

Ben and I explored many issues that afternoon, from species conservation (such as the longleaf pine in the southeastern U.S. and the lesser prairie-chicken in Kansas) to general morality, farm and home economics. Ben used many examples from his life and knowledge to illustrate his points. Although these examples ranged over many topics, they all had one theme. It is known popularly as the “law of unintended consequences,” or more accurately as Robert Merton’s (1936) Unanticipated Consequences of Purposive Social Action. In Merton’s discussion, social planning (e.g., government programs) can trigger unintended consequences, in part because planners have only partial or imperfect knowledge and the dynamics of the social realm are too numerous to know fully. Although the unintended consequences of a particular action may be beneficial, they may just as easily be ludicrous or even disastrous.

One of the unintended consequences Ben talked about was the state of Kansas’s Conservation Reserve Enhancement Program (CREP), which tries to entice farmers in heavily depleted areas of the aquifer to retire their water rights (Kansas Department of Agriculture 2016b). In exchange for a payment over the course of 15 years, the farmer agrees to cease farming the ground, establish some type of native land cover, and then retire the water right. After 15 years, the farmer will still own the ground and will be able to graze cattle on it. One of the targeted areas for this project is the sandhills that lie to the south of and run parallel to the Arkansas River in southwestern Kansas, where Ben has land.

These sandhills were some of the last farm ground to be developed in southwest Kansas. As the name implies, the soil is very sandy and the topography hilly. Because sandy soil will not hold much moisture, any crop grown in the sandhills requires a great deal of moisture from other sources. However, the hilliness of the area meant that it was not a candidate for the flood technique common in the early days of irrigation. It was not until Clarence Gigot and his four sons installed center pivots in the sandhills in the 1960s that this ground could be used for anything other than grazing cattle (Opie 1989:261). Other farmers followed the Gigots' lead and eventually much of the sandhills turned into productive farmland.

Productive until the water runs out, that is. As Ben said, "If you just quit farming the sandhills, they will just blow way." I saw this problem firsthand. I had driven through the sandhills a few times and marveled at the contrast of the lush green of the crops against the pale yellow sand dotted with sagebrush and yucca, and the way the center pivot seemed to bend impossibly as it contorted itself to the shape of the hills. On one of my visits, I left my car to get a better view of the scenery. I was walking along the side of the road and almost tripped on what looked like a remnant of a fence post. I quickly realized that this was actually the top of the fence post and that the entire fence line had been covered with the shifting sand. Ben told me about how his neighbor's dry field kept blowing and burying his fence. It would cost him several thousand dollars to dig it out. This is the outcome CREP was trying to avoid.

The unintended consequence, according to Ben, was that many farmers who participated in the program continued to grow crops for the first two years when they should have been using their water to establish the native groundcover. They were counting on enough rain to be able to establish the grass. When the rains failed to appear in sufficient quantities, the young grass with shallow roots failed to establish. It simply withered and blew away with the sand. Once a field in the sandhills starts blowing, it can be impossible to stop. Another farmer, who also has land there, told me: "There are a lot of big blowouts out there. It is just a horrific situation. And then if you try to get equipment out there to stop the sand blowing, then it just makes it worse."

In some situations, the government program actually created the problem it was designed at avert. It is possible to see the results of this policy using the satellite view on publically available Internet mapping applications. The outlines of old center pivot fields can be found everywhere in the sandhills. The blowing sandhills are not only an ecological problem, they are an economic problem for those nearby. The consequences of the program leave locals with the uneasy feeling that the state government simply does not know how to manage southwest Kansas.

Figure 10. A barbed wire fence swallowed by a dune in the sandhills south of Lakin, Kansas. Image by author.

For these farmers, the perceived failure of the CREP program in the sandhills is an unambiguous and specific example that reinforces their doubt the government is properly equipped to make and administer policy for southwest Kansas. However, Ben offered an extended metaphor that points to a more general model of state ineptitude. We were talking about the possibility of the state reducing everyone's water allocation by 20 percent through a mandate, which was being discussed at the time, when Ben suddenly veered into the passage below:

> Now let me tell you about wolves. I have a friend, he was a senator for New Mexico, he bought himself a home in Montana and was fascinated by all the wolves around his property. Well, one day he was in town and mentioned them to some people and they were all aghast. Apparently, he did not know anything about wolves, they said. Wolves threatened people and sometimes could put ranchers out of business. Well, my friend got curious and decided to learn everything he could about wolves. Eventually, he wrote a book about them. I have it over here on my shelf. Did you know that wolves kill 6 or 7 thousand people in Russia every year? Why don't we hear about that? They can kill so many people because the government don't trust its population with guns. When the peasants rush out to scare the wolves away, they have to do it with pitchforks. They don't even have metal pitchforks, they are wooden. Now, there was this deal in New Mexico with the red wolves. I guess they [the federal government] had reintroduced some red wolves back into the area. Well, wolves were watching kids at the bus stops. And they started getting more numerous. Eventually, the fish and wildlife commission wanted to build cages for the kids at the bus stops because you can't mess with the wolves because they are endangered.

This story offers another example of how well-intentioned government actions can create policies that burden local residents and lead to rather preposterous results. As I researched the claims in this statement it became interesting for other reasons as well. I found conflicting information about the impact of increased populations of red wolves—some say they pose a tremendous threat and others say wolves are essentially harmless to humans (Berlin 2013). Records of wolf attacks are difficult to come by and misidentification of other canine species as wolves is a source of error in the data. One group of researchers suggests that the number of wolf attacks in Russia in the 20th century is probably less than 100 (Linnell et al. 2002). Regarding the wolves in New Mexico, the cages for children at the bus stops were not recommended or built by any government department. Reporting on the incident suggests that they were being used as a publicity stunt by anti-federal activists (Berlin 2013). Additionally, Russian citizens have been allowed to own and use long guns. Hand guns are generally prohibited and, until recently, so was the public display of permitted weapons (Sterbenz and Holodny 2014). Russia's strict gun control laws were likely the source of this conflicting information. Finally, although I could not find a scholarly source to verify, it is doubtful that modern Russians do not have access to metal hand tools. Despite these contradictions, the importance of the story is that it casts Russia as the prototypical oppressive government villain. It is an account consistent with discourse about the Cold War-era Soviet Union, which Ben was old enough to remember. The Soviet Union, and its successor state Russia, are the archetypes for repressive and inept governance, which Ben compares to the U.S. with the wolf metaphor. Regardless of the conflicts in this story, Ben believes this example, and the meaning encapsulated by it, to be true.

Another vivid example of farmers' conception of the government as capricious and inept emerged in the tale of the time when the DWR shut off a farmer's well 20 days before the end of the growing season. The shut-off came with no warning when the DWR concluded a six-year evaluation of the effect the farmer's well on neighboring wells. The farmer who related the story about the DWR estimates that this move reduced the affected farmer's yield by 30 percent, which was especially damaging to the young farmer involved. "How could you do that?" he asked.

The Rules of the Game

Farmers' distrust of the government and resistance to its interference was particularly visible during a special meeting GMD3 convened with the Kanas Water Office and the Department of Agriculture. The meeting was called to reiterate the farmers' resistance to a flat 20 percent reduction in water extractions and to present data on GMD3's proposal to build an aqueduct to deliver water from the Missouri River to southwest Kansas (more on this later).

Unlike the previous feedback meetings[14] I had attended, the farmers at this meeting were unabashedly vocal about their displeasure with the direction they perceived the state to be headed. Mark Rude, executive director of GMD3, periodically interjected himself in the conversation in an effort to reduce the simmering tensions between farmers and state officials.

James, a prominent farmer who was heavily involved in water management issues, declared that whatever steps the state decided to take should not penalize farmers who already had been conserving:

> If a farmer has already figured out how to grow corn with only 16 inches of water, but his neighbor still uses 22 inches, then a 20 percent across the board reduction would hurt the conserving farmer more than the one who did not conserve.

This statement was another iteration of the common concern that farmers are affected differently by the same event. It also gives an interesting look at how farmers view their relationship to the Ogallala and the state.

When lay people talk of conserving water, they mean taking shorter showers or turning off the faucet when they brush their teeth. This sense of the word implies that more water is available, but someone has decided to save it for later use. This common definition is not what James means by "conserving." Rather, conserving in this case means that farmers are making do or getting by with what water their wells can produce. It is very common in southwest Kansas that a well will not produce enough water during the growing season to use the total amount allocated by the state. A typical water allocation for a well is two acre feet, or 651,702 gallons

[14] On July 7, 2014, the Kansas Water Office and the Department of Agriculture held three meetings in southwestern Kansas to gather feedback about an early draft of the 50-year vision plan they had been directed by the governor to produce. The meetings were held in Liberal, Garden City, and Dighton. I attended all three.

per acre. A well that produces 400 gallons per minute[15] would need about 145 days of continuous pumping to apply its total allotment to a 128-acre crop circle. This is longer than the crop will likely need water. Some farmers are running wells that produce much less than 400 gallons per minute. In cases like these, the farmers are not conserving; they are scraping by. When James says some farmers have "figured out," how to grow corn with only 16 inches of water, it is not that these farmers did this for altruistic purposes, but to survive the changes in their water supply. Depending on how the state structures mandated reductions, James was worried that some farmers would have so little available water that they would not be able to profitably irrigate at all. It was a worry shared by many.

Other farmers felt reductions were unnecessary in the first place because "the wells were taking their own reductions" or "the aquifer is taking care of itself," or "the Ogallala is already cutting itself back." These phrases are acknowledgments of the agency of the aquifer. Although it is unlikely that farmers share my theoretical viewpoint, they are making explicit the fact that they are reacting to the Ogallala, rather than only bending it to their will. The concept of the Ogallala reducing itself was the best type of argument. It was rhetorically effective and something they believed to be true. The Ogallala was the reason less water was coming out of the ground and causing both farmers and state agents to stare warily at each other across a room in the Grant County Convention Center on a hot August day.

James' and the other farmers' arguments were appeals to maintain the status quo. To put it another way, farmers were trying to hold the relationships between all the actors constant. The

[15] Many farmers consider the rate of 400 gallons per minute the minimum rate necessary to fully irrigate a corn crop.

Ogallala was already giving them enough trouble, and a change in the relationship with the state would only introduce a new factor to which they would have to adjust.

Farmers also appeal to the status quo when they say "economics will take care of the aquifer," by which they mean that farmers will stop pumping wells when the benefit of the water extracted is exceeded by the cost of the energy. This happened in the 1980s because energy prices were high and crop prices were low. Although an imbalance between the cost of fuel and the price of crops may have almost brought an end to irrigation in the 1980s, it is difficult to think that farmers, who recognize agriculture as a risky endeavor and who use water to control the uncertain process as much as they can, would be content to relinquish water management to economic determinations. Farmers, perhaps more than most people, are aware of how intertwined their lives are with the global and unpredictable economy. After talking with some farmers, it is tempting to see their commitment to economics as a reflection of their ideology. Although free market ideology undoubtedly informs their worldview, as evidenced by their individualism and "do the best with what you have" work ethic, farmers' appeals to economics may best be understood in this instance as appeals to maintaining the rules of the game as they understand them and to keeping their relationship with the state the same.

Chapter 6
How the Materiality and Regulation of Farming Affects Farmers

Farmers' resistance to the LEMA program cannot be understood solely as a function of their cultural models expressed as ideology. There are also material conditions that play an important role in their resistance. The combination of material and semiotic influences can be found in the way farmers understand the Ogallala. This chapter presents a folk model of the Ogallala that helps explain another aspect of farmers' resistance to the LEMA program. I use this discussion to transition to a discussion of other material factors that affect farmers' views of water conservation and which limit their choices, at least within the agricultural system as it currently exists in southwestern Kansas.

A Folk Model of the Ogallala

As discussed at the end of the previous chapter, farmers are afraid to relinquish part of their security and productive capacity, particularly if other people are unwilling to do so. Expressions of this fear emerged many times over the course of my research, with one of the more notable instances occurring during my first full day in the field at a water meeting.

At the meeting in Garden City, a woman dressed in a green blouse, one of the few women to attend the mostly male meetings, feared that the Kansas City and Wichita metro areas would eventually try to take water from southwest Kansas. She mentioned that this had been done in places like California and Nevada and she was worried it would happen in Kansas as the metro areas grew in population. Kansas Secretary of Agriculture Jackie McClaskey responded that her agency was attempting to "get in front of" an east-west water battle and prevent it from happening. Far from allaying the woman's fears, Secretary McClaskey's statement seemed to validate them. The woman in green's concern about other people taking her water extended to Kansas's neighboring states as well. She asked why western Kansas should be punished by reducing its pumping when Oklahoma and Texas did not have similar restrictions. Said one farmer, "Well, that's one of the things that came up with the water plan. Everybody thinks that if you don't use it someone else will."

Although I have not heard of any plans to transfer water from western Kansas to Kansas City or Wichita, long-distance water transfers have happened in other states (see for example Cousins and Newell 2015) and could potentially happen in Kansas if the legal framework were developed. In Texas, which manages its groundwater by the rule of capture (if you can pump it, it is yours) rather than prior appropriation, the billionaire T. Boone Pickens is planning such transfers from the Texas Panhandle to Dallas and El Paso (Little 2009).

However, the woman's concerns about neighboring states benefitting from Kansas's pumping reductions does not have to do with a legal framework but a mental model of the Ogallala as a flowing body of water, akin to a river, rather than a relatively static aquifer. The woman's objection stems from having a conception of the Ogallala as a contiguous body of surface water. This is a common folk model (Kempton 1987) of the aquifer in southwest Kansas. Several times over the course of the interviews, farmers talked about the Ogallala "flowing" as if it were a river, or indicated in some other way that it had characteristics of surface water. A farmer expressed a concern based on this conception of the aquifer in the following way:

> You know, that was one of the things that came up with the water plan. Everybody thinks that if you don't use it then somebody else will. And so we've got an Ogallala Aquifer that spans several states and they're saying, "Well, fine, if we have a 50-year water plan, but what about Nebraska? We can conserve our water, but they're going to suck it out from under us then and use it. So it's kind of like we got to hurry up and use it before they do. Or why should we be regulated because they're not going to be regulated. And so, instead of saying, you know, if we regulate ourselves a little, then maybe they would regulate themselves a little.

The same worry about users from other states, this time Nebraska, benefitting from the sacrifice of Kansas farmers appeared here as well. There is also an implied reference to the nature of the Ogallala. The phrase "suck it out from under us" indicates a conception that water in the Ogallala can be relocated in the same way water may be siphoned from a river. When I encountered statements such as these, I would gently probe to verify my informant's understanding of the aquifer. In this case, I offered alternative information about the aquifer in a way that cast doubt on my own knowledge and invited him to clarify his statement and correct my understanding:

> Does the Ogallala water move that quickly? I think I heard about a foot a year, or something like that?

The farmer responded to my probe with:

> But I mean, if we sucked the water out from under Kansas, or say we don't suck the water out from under Kansas…, you know, if it's theoretically an underground lake, it's not so immobile that it wouldn't flow over to where it was being sucked out.

He clarified his statement and introduced the concept of the Ogallala as an underground lake and reinforced the idea that the water could move through the formation quickly. Later, he would correct himself and talk about the Ogallala in ways more closely related to the standard hydrological understanding of the formation. Yet, these instances where farmers reveal their underlying notion of the aquifer as having surface water characteristics are significant.

The cultural model of the aquifer as having the dynamics of surface water are connected to farmers' resistance to enter into conservation programs because they fear the aquifer will react as a lake or river does to irrigation. In a lake, any withdrawal, no matter where it occurs on the lake, immediately depletes the available water for all users. If the Ogallala reacted to pumping this way, their reduced consumption would benefit others more than themselves.

But the Ogallala does not behave this way. The aquifer is composed of saturated silt, sand, gravel, and clay (Kansas Geological Survey 2007); it more resembles a sponge than a lake or river. This means water moves slowly and unevenly through the formation. Further, the water deposits are shaped more like an egg carton than a basin (Alley, Reilly, and Franke 1999), meaning there are areas where the saturated thickness in the aquifer is deeper than in others. Therefore, the water level does not drop evenly across the aquifer and the water level in one part is not clearly and immediately connected to the water levels in other parts. Although the total amount of water available to withdraw from the aquifer is reduced, the distribution of that water stays relatively the same because of the slow movement of the water.

The woman in green was correct in her statement that both Oklahoma and Texas have fewer restrictions on groundwater extraction than Kansas (Allison 2011; Johnson et al. 2009). However, since her farm was about 80 miles or so from Oklahoma, she had little worry about her southern neighbors taking her water—although it is true that Kansas farmers on the border of Oklahoma would have more to worry about. Wells in the Ogallala that are 50 miles apart are in effectively different formations due to the slow movement rate of water, but wells that are two miles apart will affect each other (Gisser 1983). Her neighbors posed a larger threat to her water than farmers in other states.

I can only speculate why farmers hold this particular model of the Ogallala. Media accounts that portray the Ogallala as a "lake" (Dillon 2013) or as a "reservoir" (Little 2009), are conceptually easier to think about than a large mass of saturated clay, rock, and silt buried underground. Another reason farmers might apply surface water characteristics to the Ogallala is that groundwater cannot be observed directly and they lack other conceptual models for how the aquifer works. As one farmer observed, "Nobody really knows what the hell is going on down there."

A more satisfying explanation is that farmers developed this cultural model of the Ogallala based on their interactions with it and the effects they can witness. Pumping a well can affect the water level in other nearby wells. Hydrologists use the term "cone of depression" to describe the effect of a pumped well on the local water level. A cone of depression is:

> the name given to describe the shape of the water table surface around an actively pumped well. The cone shape—actually an inverted cone with the point down—is created as the aquifer around the well is dewatered, and the surface of the original water table, or static level, declines (National Driller 2008).

The cone of depression can extend from a pumped well for several miles and alter the movement of groundwater (Theis 1938). These effects can explain why farmers apply models of surface water dynamics to the Ogallala. Another farmer told me about how a neighbor's wells affected his own:

> People living out here have known for years that all of this water pretty much is connected to a certain degree. In 1967, when we drilled the well on the section where I live, we had one well right in the middle of the section that pumped 1,200 gallons per minute. And our neighbor drilled a well on the section north, right in the middle of the section. At that time we were ditch irrigating and we used siphon tubes. When we would be running full bore and our neighbor a mile away started his well, we would pull 20 tubes off because of the production drop. That was in 1967. Well, he drilled one more well on that section. We drilled three more wells on that section where we lived. And we drilled a couple of more wells across the road. I mean, there were just more straws in the milkshake is what I always say. So now that well that produced 1,200 gallons back then [in 1967] is not even viable now.

Again, there is the conception of the aquifer as a contiguous or "connected" body, in this case a milkshake. Connected to this idea is the farmer's observation that his neighbor's pumping affected his wells. He was experiencing the effects of the cone of depression. Yet this phenomenon, which is local, does not translate to a regional scale immediately. Although cones of depression move out from the wells that created them, their movement is measured in hundreds of feet per year rather than miles (personal communication, Brownie Wilson, hydrologist with the Kansas Geological Survey; Theis 1938).

Cultural models have various degrees of motivational force (D'Andrade 1992). The models that have the most force are the ones related to "experience-near" concepts and associated with speech acts indicating informants feel compelled to act in certain ways (Strauss 1992:217). Such is the case with the model of the Ogallala. The dynamics of surface water, with which farmers have experience and have seen, helps explain the effects of the cones of depression, the effects of which they have experienced but have not seen. This leads them to feel the need to protect, or if that is not possible, use their fair share of, the water while it is still there. Although farmers are aware of the scientific understanding of the aquifer, this seems to be a secondary model that has little motivating force on their actions. The default notion of the aquifer as a basin is the basis for how many of them react, at least initially, to suggestions to use less water.

Holland and Quinn (1987:11) note that folk models of material things, such as thermostats, are generally more flexible than cultural models about things like gender and marriage, which can be almost impervious to change. Models about material things are more amenable to revision with expert knowledge than models which address normative behaviors. These models about behavior encapsulate a huge amount of information and can therefore be resistant to change with sufficient reason (Holland and Skinner 1987:106). Holland and Quinn also suggest that part of the reason a cultural model of marriage may be extremely durable is that it relates to constructs of meaning that seem natural. Models of material things, on the other hand, are more practical and not necessarily connected to deep meanings.

The cultural model of the aquifer in this case seems more flexible than a cultural model of marriage, but less so than one for thermostats (Kempton 1987). The amount of risk farmers would face in adjusting their model may account for this difference. The risk associated with the acceptance of a different cultural model of how a thermostat controls the heating and cooling of a home is relatively low. It may change the consumer's heating bill on the order of tens of dollars per month. The acceptance of a new model of the aquifer, however, could result in a change of hundreds of thousands of dollars per year for a farmer. It is perhaps for this reason that the assurances by state officials, who maintain that local water savings remain local due to the slow movement of water through the formation (Foley 2016), often find a skeptical audience among farmers.

Irrigation Infrastructure and Water Deposits

The irrigation infrastructure of southwest Kansas also plays a role in the way farmers view water issues. Farmers' reluctance to enter reduction agreements is not only an expression of competition, reluctance to commit to a path of action, or relinquish control. It is also an effect of their irrigation system itself, which in turn is an effect of the nature of the water resource, and also an expression of their individualism.

Southwest Kansas looks very different from many other areas where anthropologists have studied irrigation. The nature of groundwater means that water resides under each farmer's land and does not come from a nearby stream or lake. To access this water, the farmer hires someone to drill a well, installs a pump and an engine, lays underground pipe to move the water from the well to his fields, and then installs some sort of distribution system to apply the water to his crops. All of this infrastructure is privately owned and financed; none is shared with a neighboring farmer. There are advantages and drawbacks to this system compared to the shared-canal irrigation systems that are found in much of the rest of the world. One of the advantages is that this private system of water access and distribution is not as subject to conveyance loss as open canals—the loss of water due to seepage, spillage, and evaporation (Price 1995). Further, because of their linear nature, canals have a beginning and an end. If the canal is not managed fairly, the farmers at the top can take more than their fair share of water (Pfaffenberger 1988). The farmers of southwest Kansas have no such concerns. Their water comes straight from the ground and heads directly to their fields.

Being protected from these problems means, however, that farmers in southwest Kansas are also insulated from the advantages of shared canal systems. Many canal systems distribute the available water proportionally to all eligible users (see, for example, Eastman, King, and Meadows 1997; Geertz 1972; Lansing 1987; Leaf 1992; Rodríguez 2006; Trawick 2001a). For example, if a farmer has 10 percent of the land served by a canal, then he is allotted 10 percent of the available water. The farmers on a canal system share in the cost of the canal maintenance with donations of either cash or labor in exchange for access to the water (see Mitchell 1976:36; Rodríguez 2006; Trawick 2001b). In southwest Kansas, however, it is entirely possible a farmer's well can fail and he will be without water while his neighbors' wells are still productive. There is no social obligation to share water; nor is there a realistic way to move a useful volume of water from one farm to another because of the private, self-contained systems. Southwest Kansas farmers are solely responsible for the maintenance of their systems. If a pump engine fails, there is no hope of collective action to repair it. The perspectives on risk and responsibility enshrined in the modern water paradigm militate against this sort of rescue.

Although the wells and sprinklers of southwest Kansas are private, they are nonetheless a social system. Whereas canal systems require cooperation, the southwest Kansas system and the variable distribution of the water in the Ogallala encourage individualism. The regulations that tie the water to the land above it as a private property right, the prior appropriation framework that favors some users over others, and the technology used to harness it are reflections of and contribute to the sense of individualism among the Ogallala's users.

Different Wells, Different Farmers

The characteristics of the Ogallala, and how they interact with the economics of farming, also contribute to individualism. Water is not evenly distributed throughout the formation. This means that the amount of water available at any given area can vary within a relatively short distance. Despite the fact that the Ogallala as a whole is being depleted, there are areas, such as Stevens County, that still have massive deposits of water (Buchanan, Buddemeier, and Wilson 2009). Although aquifer depletion is a regional problem that will eventually manifest in changes to the economic and population base of southwest Kansas and affect everyone who lives there, the depletion of the Ogallala is currently experienced individually.

This point was driven home by an extended description of how well characteristics vary from farm to farm, and sometimes vary within the same farm. I heard versions of these scenarios from several farmers, suggesting that this argument had circulated around the community. This example was both a good rhetorical strategy farmers could use to shape the discussion of possible water restrictions as well as something they believed to be true.

> I am going to give you five scenarios that are occurring within ten miles of me. The first is a young farmer that's out of water. He's got three wells that together will pump maybe 1,200 gallons per minute between all of them. He's got five sprinklers and only 1,200 gallons of water. Any time that it's not way below freezing he's running those wells. His choice, his economic decision, what he thinks makes sense today, is he has two circles of fully irrigated corn. He's got two circles of limited-irrigation corn and he's got one circle that he tries to get a full moisture profile in the soil and he plants milo on it and has no plans to go back and irrigate it again. He runs his pumps about 300 days out of the year. When he starts the growing season, he prays for rain. When you get a droughty year, like 2011, his decision sucks. It's just a mess. But in 2013, when we received about 20" of water, he's doing great. So in a good year, when you look at the bushels of grain raised to the amount of water used, he's doing great. But in a bad year, it's a bust and he's got nothing to show for it.
>
> Now on my farm, I've got another situation. I've got 1,200 gallons of water, but I don't have a lot of land—just two circles. I am going to pump that 1,200 gallons for about 120 days on two circles and I am going to raise great corn every time. Now if I get rain on a good year like my neighbor did, then my bushels of grain to water used is not that impressive. But if it's a droughty year, I'm still going to get a good crop. So what is the efficiency? Is it the first guy or is it me? So who's to say who's right? It's just choices.

This first scenario, where the farmer's efforts were successful depending on the rain he received, is what would likely occur with many farmers if the state reduced their water rights. Whereas they could grow a good crop in most years with their current irrigation ability, the crop failure rate would most certainly increase under limited irrigation conditions. The second scenario, where the farmer concentrates his water to fewer acres means he will almost always grow a crop, but he must find another use for his nonirrigated land. This vignette also illustrates how the unpredictable nature of weather unsettles irrigation decisions, affecting each farmer differently based on his farm's characteristics. One of my crop consultant contacts told me the amount of water that you need to grow corn varies by year. In 2011, 600-gallon-per-minute wells could not keep up with the water needs of a corn crop. However, 400-gallon-per-minute wells were sufficient in 2013. The farmer continued:

> So for another situation, on one side of the road, a guy's got three quarters of ground. It's old irrigation there. He's re-drilled those wells. He thought he had an 800-gallon-per-minute well, but four years down the road he's back to 300 gallons per minute. So he's frustrated, he's dealing with not having any water. But just across the highway, there's five quarters of ground. This ground was so mismanaged, so underserved, so poorly farmed that the guy hardly ran the wells at all. They were old, shallow wells, but that guy choose not to be intensive about production. So a guy from Goodland comes down and buys those quarters of ground for $2,000 per acre. He redrills four of those shallow wells and makes them deeper. He puts five new pivots on those circles and this year he has beautiful fields of corn. It looks like a fricking oasis. Now, what I know from my redrilling experience is that I hope he enjoys this year because those wells won't hold that volume. But does that make any sense?

My informants told me that drilling new wells could cost $100,000 or more, and finding adequate water that will last long enough to repay the cost of drilling a well and installing an engine, pump, and pivot is not guaranteed. Also, when farmers purchase land with water rights, they pay a premium for that land—often twice what dryland sells for. This type of investment and reinvestment occurs regularly. Farmers feel the state must take into account these types of scenarios to prevent financial hardship. In the last scenario, the farmer talked about his operation again:

> Now the fifth scenario I am going to tell you about, is a family, us, that put in eight quarters of drip tape. We put in over 2 million dollars in eight quarters of ground to deal with our water situation. We have been conservative and compliant for the past 20 years. And we have been trying to save. Now how do we go to a meeting, like we did the other day, but how do you make a regulation to save the Ogallala that is going to be fair to all of the scenarios I described above? Where do we start the reductions and start the consideration? I cannot even make one decision for all of the wells on this farm.

This core message of these examples is that the aquifer does not treat farmers equally. Some have very productive wells, others do not, and still others have a mix of wells. Some farmers have their land paid for while others recently financed theirs. What type of program could be implemented to treat all of these different farmers fairly? Or as another farmer put it, "One size fits all is destined to not fit too many people very well." This is an example of the variability and complication farmers see in the world. Yet, despite the compelling reasoning offered by this farmer and the others who repeated these scenarios to reject LEMAs or mandated reductions, other farmers are not so sure:

> Sure, a LEMA would hurt the old boy who went out and gave $5,000 for ground with good water. Because everyone has to cooperate in a LEMA. Does that put him out of business? Probably. Because land prices aren't going to be where they are anyway. There are lots of things to look at. But at the same time if it gives a community 25 or 50 years more of water then it might be a good idea.

The problem the state and farmers face is how to pick the winners and losers. This also raises the question of when should a private concern become a public one.

Technological Limits

The private ownership of the irrigation infrastructure and the distribution of the water in the Ogallala make a difference in what is possible for farmers to do and the way they view water conservation programs. There are also technological limits to saving water in southwest Kansas. The current generation of irrigation technology is nearing maximum efficiency. Water efficiency is the percent of pumped water that is applied to the crops and not lost in conveyance, evaporation, seepage, or wind drift (Howell 2003).

The first method of irrigation farmers used in southwest Kansas was flood, also known as furrow, irrigation and was only able to achieve about 65 percent efficiency (Howell 2003:468). The next step in the development of irrigation technology was the center pivot system that is found in about 90 percent of fields in southwest Kansas today (Rogers, Alam, and Shaw 2008). The early iterations of the center pivot only achieved 80 percent efficiency, but new designs that eliminate end guns[16] and use hoses to drop the water at or below the crop canopy level have increased the water efficiency rate to 90 percent and above (Peterson and Bernardo 2003:189). Any improvements in the center pivot system from this point forward are likely to be marginal.

One type of irrigation system promises even greater efficiencies still. Subsurface drip irrigation (SDI) installs plastic tubes, referred to as drip tape, about 15 inches deep in the soil. These tubes apply water directly to the root zone of the crops and avoid the problems of evaporation and wind drift inherent in above-ground systems. Some estimates put the water efficiency rate of SDI at 95 to 99 percent (Lamm and Trooien 2003) and say the net irrigation requirement (the total volume pumped) can be reduced by as much as 25 percent (O'Brien et al. 1998).

One farmer, who changed from flood irrigation to drip, had a fantastic experience with it. He and his family used to flood his corn fields for about 240 days per year but SDI allowed them to reduce their irrigation to about 150 days per year. SDI offers significant improvement over current systems, but there are roadblocks to its implementation.

The first problem farmers have with SDI is the cost. Farmers who have considered SDI say it costs at least $1,200 per acre to install. This is about twice as much as purchasing a pivot for the same number of acres. Then there are problems with the drip tape becoming clogged with sand. Elizabeth, an employee with the Division of Water Resources, told me SDI is becoming more prevalent in central Kansas but that in very sandy soils of the type found in southwest

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[16] End guns are attached to the end of the center pivot system and shoot water high into the air to water the corners of fields outside of the circle drawn by the center pivot. This water is often carried away by the wind before it can land on the crops. Most farmers today think end guns are an inefficient use of water. One of my informants even wanted to officially ban them in GMD3.

Kansas, clogging is problematic. Additionally, Elizabeth and several of the farmers I talked with noted that SDI cannot "water up." This means that water emitted by the system trickles down through the soil with the direction of gravity. This is a problem because seeds are planted above the installation of the drip tape and will not have access to water from the system until the roots reach the same depth. Farmers feel SDI leaves the early crop vulnerable to withering if they are not lucky enough to "catch a natural rain."

Some farmers also reported problems with pests eating the drip tape. One farmer, recounted his experience:

> We used the sprinkler to get the crop germinated. Because in our previous drip experience we put the drip in at 7 inches and used all different sorts of watering protocols, like 2 hours on 2 hours off – 12 hours on, 12 hours off. We did everything we could do but you only planted the seeds about an inch deep and the water would come to within a quarter inch of where the seed was at and stop. And we could not get it to soak up. And then it never rained. It didn't rain a quarter of an inch all spring. So we had a big problem as far as utilizing the drip to get the crop up. The other thing was, we used the sprinkler to get the crop up and then we turned the drip on the first time. We couldn't get the water to the end because the bugs had eaten the tape. It has only been in the ground for 47 days. So I called the vendor, a guy from California, and I told him, "Man, we have a problem. There are so many leaks out here that the water won't even get to the end of the tape." He said, "You need to take some toothpicks and break them in half and put toothpicks in all those holes." I told him that I am standing out here in the field and within 40 yards of me I can see 100 plus holes in the tape. It would take me the rest of the summer to plug these holes up. So he flew out here and he said, "I have never seen anything like this. Ever." And so they pulled the tape up and couldn't even see the holes. They took it back and put it under a microscope and you could see where some kind of bug had eaten into the tape.

This farmer still had to use a center pivot to water his crop until its roots could reach the water zone. Although this experience occurred about 15 years ago, and the farmer thinks SDI companies may have improved drip tape to be more resistant to pests, he still counts this as a failed experiment and said he will not go back to it.

Although “watering up” and pest damage are significant problems, the largest hurdle is still the cost of the system. One SDI user thinks the cost not only discourages farmers from investing in the system for their own farms, but also discourages them from investing in the system on land they rent. Most landlords, he thinks, are not going to be interested in putting that large of an investment into their property and then trusting another person to operate it correctly. He thinks tenants would not be interested in installing SDI because the rental arrangement with the landlord could change. This would mean the renter would have to take the system out of the ground, which is much more difficult than disassembling a pivot system. Long-term rental contracts could alleviate some of these concerns, but I do not know whether landlords would be willing to enter into them because it would reduce their flexibility in changing land markets.

Finally, in addition to the differential costs, farmers’ age also appears to play a factor in making these decisions. A farmer who had considered SDI told me:

> I keep thinking that drip irrigation is the next likely step. But I don’t know about doing drip irrigation the way they do it now—digging the shit out of the ground and putting in manifolds. And there’s all the problems with the insects and rodents. But anyway, I am thinking about retiring soon, but if I put it in, it would make the farm more valuable. But anyhow, I am not excited about building value in the farm. My kids already can’t afford to buy it.

For many farmers, SDI is also a farm economy decision.

If water application is already nearing top-end efficiency, and newer technologies like SDI seem problematic, then perhaps the amount of excess water farmers apply to crops can be adjusted. Jonathan Aguilar, a water research engineer with the Kansas State Research and Extension office in Garden City, is working on one such improvement. He is developing soil probe technology that would help farmers understand how much water is in the soil under their crops. This knowledge would help farmers know when they could safely turn off their pivots without risking crop damage. Such information could help farmers save money and reduce water use. Jonathan estimated that widespread adoption of these probes could result in water savings in the range of single percentage points of total current use.

The soil probes, however, have not found a wide appreciation. I attended a GMD3 board meeting where Jonathan presented information about his work. Farmers at the board meeting had concerns about the placement of the probes in the fields and worried they would have to remember to take them out before performing a farming operation. They were concerned about the cost of the equipment and telemetry. They also doubted the soil measured by the probe would be representative of the field as a whole.

Other farmers appreciate the potential of soil probes, but are limited in their irrigation management decisions by the condition of their wells. If a farmer has a 300-gallon-per-minute well to use on a quarter section, it will take six to seven days to apply an inch of water. In this type of situation, farmers cannot shut down the well, even if the soil profile has sufficient moisture, because the crop already shows water stress by the time the pivot makes a full rotation. When I spent the day with Jim working on irrigation engines, he said this slow rotation and rate of application was the reason farmers continued to irrigate during a rainstorm. Unless they received a “frog strangling” amount of rain and could expect cool temperatures, they would keep pumping.

What is leading to the depletion of the Ogallala is not careless or inefficient use of water. The general rule of thumb is that farmers try to put as little water as they can on their crops, or as much as their wells will allow them. Although total water consumption could be reduced if farmers transitioned to SDI systems, operational and financial hurdles prevent consideration of

SDI as a realistic option for many. The high efficiency of current irrigation systems, the problems with alternative systems, and the marginal efficiencies gained by closer water monitoring mean that many farmers see the curve of water conservation through technical means as flattening out.

Farmers' concern about the unmanageable variability in soil as a reason to reject probe technology is similar to how their concern about the variability of their farm operations is used to reject water management plans. This concern about unmanageable variability is also related to how farmers perceive risk in agriculture and fear they will not be able to recover from bad decisions.

Corn, Milo, and Another Four-Letter Word

If farmers are "locked in" with irrigation technology, so too are they on crop choices. There are crops available to southwest Kansas farmers that would use less water than corn. These crops, however, have characteristics that limit farmers' choices. These characteristics not only lead farmers to favor some crops over others, but can also be sources of social conflict.

The first meeting KWO held to collect feedback about its proposed plan was in Liberal, Kansas, the southernmost of the three cities KWO visited that day. The meeting started at 7:00 a.m. and was held in the Seward County Exhibition Hall. As the attendees filed in—older men wearing short-sleeved, button up, checked shirts; younger men wearing knit golf shirts—they grabbed donuts and coffee and made themselves comfortable, talking with friends and acquaintances while we all waited for the meeting to begin.

Tracy Streeter, director of the Kansas Water Office, opened the meeting with a few pleasantries and general remarks and turned the floor over to his team to present key aspects of the water vision plan. Several provisions garnered disapproval from the audience. When the presenter talked about a plan to reduce water usage by 20 percent, as had recently been suggested in a research paper (Steward et al. 2013), attendees sat with their arms crossed, but were, I thought, surprisingly quiet. The state was evaluating less water-intensive crops, such as milo, that it would recommend farmers grow instead of corn. Conversations with several crop consultants and seed salesmen in the area suggested farmers were growing more milo already because their wells were no longer sufficient for the needs of a corn crop.

When Tracy opened the floor for discussion, one farmer angrily charged that the state was poised to tell farmers how to run their farms. “Why does the government need to be involved in crop decisions? Isn’t that a private matter?” he asked. This farmer’s objection was more than disquietude that the state would insert itself into what had always been a private enterprise. To be sure, most farmers would rather the government “stay out of my way,” but this objection was also about the crops themselves.

The farmers of southwest Kansas generally grow as much corn as their wells will allow. Corn is the most widely irrigated crop in the area; in 2012, farmers in GMD3 used 140 percent more water for it than they did for alfalfa, milo, soybeans, and wheat combined (Kansas Department of Agriculture 2012: Table 4). This absolute number is in part due to the sheer number of acres farmers devoted to corn compared to other crops. However, it is also due to the water requirement of corn to reach its full yield potential. Farmers applied about 20 inches of water to their corn crops that year, compared to only 12 inches to their milo and wheat crops.[17]

Although corn requires more water than milo, it is not the entire story. Corn also has agronomic and financial advantages over milo that make it an attractive choice for farmers in southwest Kansas. Irrigated corn has a higher yield potential than milo (Perry 2006). A rule of thumb one farmer uses is that corn yields 12 or more bushels per inch of water, while milo only yields about eight. The yield difference is also important because the price of corn has been higher than milo in recent years, although this is not guaranteed.

The characteristics of corn are also appreciated on feedlots where it has about 10 percent more feed value than milo (Klopfenstein, Erickson, and Bremer 2008). This means that animals will gain weight quicker on corn than on milo. Further, some operators feel they cannot rely on a steady supply of milo as they can with corn because farmers have not grown much of it recently. This creates a self-fulfilling prophesy. The feedlot operators are not willing to risk feeding milo, because if they run out in the middle of a feeding cycle they would need to switch to corn rations and this would be difficult for the cattle to tolerate.

Milo is also subject to “lodging,” when a maturing milo crop falls to the ground from a weakness in its stalk caused by soil pathogens and water stress (Grains Research Development Corporation 2016). Lodging can also occur after a strong wind. Milo is more prone than corn to being blown over because all of its grain is produced at the top of the stalk, making it top-heavy. Corn, on the other hand, grows its grain on ears distributed over the length of the stalk and is

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[17] Alfalfa has slightly higher yearly water requirements that corn, but is harvested several times throughout the year.

therefore more stable. Lodging causes problems for farmers because it leads to yield loss. Additionally, farmers must slow down their combines to harvest lodged milo. Harvesting milo is often a dusty, itchy affair (one farmer called milo "itch berries") and slowing the combine down makes it even more so.

Aside from the agronomic problems associated with milo, farmers in southwest Kansas are not sure it is the answer the state says it is. One farmer's experience at a recent Governor's Water Conferences illustrates this point.

> The conferences focused on milo. I went and listened to that session and I stood up and said, "I am a little frustrated that all you are talking about is milo, but it is a little more complicated than that in our part of the world. It isn't worth as much, it is a little cheaper to raise but doesn't have the yield potential. And they say it is water sipping, and that reads well, but it really isn't that much of a savings. Also, we have high pH soils out here which means that iron is tied up in the chemicals. Sorghum also shows iron deficiencies out here. Can't grow continuous sorghum because we can't get the iron out of the soil. You can't add enough amendments to make up the deficit. I don't think it's physically possible and it would be too costly.

His list of reasons why milo is not the solution to aquifer depletion are important to acknowledge. So, too, are his statements that "our part of the world" and "out here" are places the people advocating milo are unfamiliar with. The agronomic reasons are important, as are the themes of government distrust and ineptitude and separation from the rest of the state.

Farmers talk about corn as the crop that "pays the bills" and keeps their farms profitable. Gesturing with his hand around his living room, a farmer said:

> Corn is the major crop. It's our major money crop and it pays for all this stuff, you know. You would never pay for it with wheat and milo. It just doesn't generate enough dollars to do it. I can't pay for the ground, or pay for the equipment with a 40 or 50 bushel [irrigated] wheat crop. But I can raise 220 bushel corn underneath that sprinkler.

Another farmer said, "I can ship out 20 to 30 thousand bushels of corn off that circle. Or if it was put to grass, it would support four cows. Big difference."

I asked farmers if they could survive without corn. Most said no. A few farmers, however, thought that this was not strictly the case. A farmer, whose views on conservation probably aligned more closely with groups like the Sierra Club than with other farmers, thought that when "farmers talk about only being able to make it by growing corn, they are talking about maintaining their lifestyle rather than making ends meet." Another attributed farmers' insistence that corn was the only viable option to an unwillingness to change rather than economic necessity.

> I think it's the mentality that they are afraid. None of them want change. They have been doing it for so long. I ran some cash flows last week. I can make more money by planting wheat and then coming back behind it with sorghum silage. I will probably be using a third less water and making more dollars per acre profit than planting corn and putting all those inputs into it and water, water, water, water. Corn is easy to grow and you can control the weeds better.

Whether an unwillingness to change or economic necessity, many farmers believe they could not survive without growing corn. I only encountered one active farmer who grew corn although he felt it was a bad decision. There were other farmers I spoke with, mostly retired ones, who did not believe growing corn was a good decision for western Kansas. Even they were exceptions to the rule. The only time most farmers decided to grow something other than corn was when their wells declined to the point it was no longer economically beneficial, or physically possible, to grow corn.

Besides the ecnomic advantages, farmers do have other reasons for preferring corn. It is easy to grow due to genetic modifications that have given it resistance to the herbicide glyphosate (known commercially as Roundup). Farmers are able to spray their fields with glyphosate and combat the moisture and nutrient stealing weeds that would rob their corn of its vitality. Milo, on the other hand, has not been engineered to be resistant to glyphosate because it is too similar genetically to other field weeds. Milo (*sorghum bicolor*) is in the same genus as the invasive species Johnson grass (*sorghum halepense*) and shattercane (a wild version of the domestic cultivar). The fact that both Johnson grass and shattercane hybridize readily with milo means that any genetic modification to resist glyphosate would spread rapidly, defeating the purpose (University of California Agriculture and Natural Resources 2016). To control weeds in milo, farmers use a variety of other herbicides, including 2,4-Dichlorophenoxyacetic acid (commonly known simply as 2, 4-D). Although 2, 4-D is an effective choice for milo, it can drift or vaporize from the field it was sprayed on and severely damage nearby crops (Clemson Cooperative Extension 2016).

One crop that is particularly vulnerable to damage from 2,4-D drift is cotton. Although Kansas it not known as a cotton state, some farmers in southwest Kansas have begun to grow it.[18] They view cotton as a water saving alternative to corn that does not have some of the disadvantages of milo. Cotton's sensitivity to 2,4,-D has kept it from becoming more popular.[19] Every cotton farmer I met had a story about his nice looking crop withering the day after his neighbor sprayed 2,4-D. Some of the original cotton farmers, tired of losing yield to factors outside of their control, have given up on the crop. There were about 40 cotton farmers at one time, but the number has dwindled to a dozen or so.

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[18] Generally, cotton is grown south of Highway 160 in western Kansas, an east-west road that forms the southern border of Ulysses.

[19] Dow AgroSciences (2016) recently released a 2,4-D-resistant strain of cotton for the 2016 crop year. This is likely to ease tensions over competing land uses.

Cotton cropping has led to some uncomfortable interactions between farmers. At the water meeting in Liberal, a small contingent of active cotton farmers gathered in seats near the front of the room. A mildly heated discussion about the 2,4-D broke out after the state agricultural staff had talked about increasing the acres planted to milo. As displeasure at the thought of increased milo cropping withered their spirits like a cloud of 2,4-D withers cotton, one cotton farmer stood up and called for unity. He said the water issue was something they would have to come together on and they should not be bickering among themselves. This farmer's call for unity did not seem well-fated because feelings ran high on both sides of the debate. During one interview, a farmer told me of an incident where his cotton crop was damaged by 2,4-D that drifted from his neighbor's field. During the confrontation that followed, his neighbor said, "Fuck your cotton! My milo was here first."

This incident is an intense example of how farmers' relationships with nature and technology not only place limits on what decisions they can make, but on how they relate to their neighbors. Once again, individualism comes to the fore, demonstrating potential fault lines between cotton and milo farmers as there are between junior and senior water rights users.

The Garetson Case and Fairness

> When one man drinks while another can only watch, Doomsday follows.
>
> —Turkish Proverb

A court case currently working through the state court system sits at the intersection of state regulation, the characteristics of the aquifer, competition between farmers, the unintended consequences of state action, the limits of crop choices, the fault lines of the agricultural community, and the role water plays in social replication. One farm family, the brothers Jay and Jarvis Garetson,[20] is using Kansas water law to petition the state to restrict their neighbor's pumping because the cone of depression from that well is lowering the water level in their well and impairing use of their water right. The case has a long history, the highlights of which I am summarizing from an AP (2016b) article that appeared in the *Washington Times*.

In 2005, the Garetson brothers, fifth-generation farmers in Haskell County, Kansas, filed suit against their neighbor, claiming his well's cone of depression was impairing their water right. The Garetsons claimed they had to redrill their well to 450 feet (a very deep well) to preserve their output. The Garetsons eventually dropped the suit because community members condemned their actions as distasteful and unneighborly. They refiled their suit in 2012 and recently won an injunction against the well's owner, preventing him from extracting water while the suit is litigated (Bickel 2016).

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[20] These are their real names. I have chosen to use them because they are involved in a unique high-profile legal battle that would be impossible to discuss and still maintain their anonymity. They have given many press interviews and have participated in public forums about the issue.

The legal basis of their claim rests on Kansas's water law principle of prior appropriation, colloquially known as "first in time, first in right." The Garetsons' well at the center of the suit is known as a "vested" right, a water right that was granted before the 1945 Water Appropriation Act. In fact, it is one of the oldest rights in Haskell County. Their neighbor's well was drilled later and was therefore considered "junior" to the Garetsons' water right. The question in this case is not whether Kansas water law is clear—it is. Junior rights cannot interfere with rights senior to them. Rather, the question is whether the Garetsons can prove their well was being impaired by their neighbor's well, a difficult case to make when the aquifer is recognized as a declining resource.

When the Garetsons' originally withdrew their suit, they wrote that they did so because: "Rather than being a positive catalyst for change in the effort to extend the useful life of the aquifer as a whole, we have been perceived as selfishly damaging our neighbors for our own gain" (AP 2016b). Now, it seems that the community's perception of them is secondary to their water concerns. However, community sentiments about the impropriety of the Garetsons' actions are still strong. One water official told me he would not be surprised if someone killed one of the brothers—they had already received death threats (Dillon 2014). Although I think this statement was hyperbolic, I did hear from other sources that many people in the community had largely shunned the Garetsons.

During my fieldwork, the Garetson case was the most sensitive subject I broached with farmers. The Garetsons are long-time residents of southwest Kansas and many of the farmers I interviewed know them; some even consider them as friends. I pursued this potentially delicate topic because I felt it would provide insight into how farmers believed the declining resource should be handled, much like discussion of the Poppers' Buffalo Commons concept illuminated farmers' cultural models of appropriate land use. The legal mechanism is present, so the question was not *could* they pursue their lawsuit, but *should* they pursue it. Exploring this situation with farmers helped uncover their feelings about fair play and the social fabric of southwest Kansas. As with other irrigation issues, the nature of the Ogallala itself and the regulatory infrastructure of the state hid around every corner.

I asked Nick what he thought about the Garetson case and the legal tactic to address aquifer depletion. He did not pull any punches when he responded:

> People talk about that tactic, but if they have any common sense that's all they ever do. There is no guarantee that you would have the most senior water rights in every situation. How could you know that you aren't opening a huge can of worms? It isn't a winning strategy. They would be stupid to pursue it.

Nick's farm has both very senior water rights (what farmers call a low number—the lower the number the earlier the water right was granted) and junior water rights (high numbers). If Nick pursued an impairment claim against a neighbor, it would be likely that the same neighbor, or another one, could claim impairment from one of Nick's junior wells. It would likely be a no-win situation.

The Garetsons' efforts were roundly criticized. One farmer suggested a hypothetical response if the Garetsons' case was successful: "The first thing I would do is look up all my wells and see how old they are." The purpose of examining the age of his well permits would be to assess his potential vulnerabilities. A different farmer gave the following assessment about what the Garetsons were pursuing:

> We all have water rights that are senior and junior to each other. But this thing will cause a turf war, a range war. I think he [Jay Garetson, the brother who usually addresses the media] has done a real disservice to the area when he's talking about trying to get the state to test the water right. He misrepresents his neighbors. I think he's made things worse for them. You know, most of us have those same issues and we haven't taken those tactics.

Still another farmer referred to the Garetsons' pursuit of the lawsuit as a "dangerous game."

Yet, the Garetsons did have some defenders. A farmer who counts Jay Garetson as a friend offered a more charitable interpretation. He believed Jay's statement that he was taking this course of action so his children would have water to farm with and that Jay was trying to force the state's hand. However, he was not quite sure what card the Jay was seeking to force the state to play.

It remains to be seen whether the Garetsons' efforts will be worthwhile. One farmer I interviewed observed, "It doesn't seem to, if people quit irrigating in an area, it doesn't seem like the water comes back." A farmer who lived near the Garetsons in Haskell County made a similar assessment, "I think you could shut off every well in Haskell County and it wouldn't help them. It wouldn't bring that water level back up to where they can pump, I don't think."

It is quite possible the Garetsons have toppled the first domino in a regional water struggle that may only marginally benefit their situation, but could potentially ruin them socially. As the dominoes fall, they may even be harmed if they have a well that is challenged by a farmer with a more senior right. As one farmer observed, the only ones likely to emerge unscathed from this struggle will be the lawyers.

Farmers' disdain for the tactic the Garetsons are pursuing comes not just from fear the Garetsons are lobbing the first volley of an ugly internecine warfare, but that their actions fly in the face of fair play. Many farmers feel they have similar situations to the Garetsons, where a nearby well is reducing their access to water. Although they recognize they probably could leverage the law to protect their water rights, they do not think it would be the proper thing to do. Farmers often drew on metaphors from gaming to express their feelings about fairness in dealing with the declining resource. As a water right holder, you should "play the hand you've been dealt" instead of appealing to the house (the state) for a new hand to improve your lot. You should "do your best with the cards in your hand" rather than complain that someone else is better off than you. Whether the water level in your well is holding steady or dropping precipitously is a matter of "the luck of the draw," and there is nothing that can or should be done about it.

Ben, who had a very old water right developed in the 1930s, expressed his sense of fairness this way:

> Everybody around me sure as hell is impairing my right! But I would feel really bad if me and just 22 other guys [referring to the number of rights in his county granted before his] had water.

Other farmers wondered if the owners of vested wells had already withdrawn their fair share of water and that it was time to let other users have the same type of access. Still other farmers thought the prior appropriation framework should be modified or eradicated because it was designed for the dynamics of surface water in lakes and streams and ill-suited for the glacial and mysterious flows of groundwater. In any case, the Garetsons' lawsuit is unlikely to enhance farmers' willingness to cooperate in a LEMA.

I have met both Jay and Jarvis Garetson. I met Jarvis at an aerial drone demonstration at the Satanta John Deere dealership. We did not talk about water, but chatted pleasantly while watching the drone's acrobatics. I met Jay at the Kansas Governor's Water Conference in 2013.

During the question and answer session after a presentation about the problems of the Ogallala, he stood up and made an impassioned speech for the government to do something, *anything*, that would preserve the water for his sons and future generations.

Jay is a polished public speaker, but his emotion was evident in the slight tremble of his voice. He begged the administrators in the room to help save the farmers from themselves. He wanted the state to step in with a program that would make it possible for farmers to grow less water-intensive, but less lucrative crops. Jay talked about having nine circles planted to corn that year, a crop that uses a lot of water but that offers a good return, when he would rather grow a crop that used less water. He did not feel like he could lose financial ground to his neighbors because of the competition for land. Voluntary reduction programs, such as the LEMAs, were not going to be sufficient.

Jay is a passionate and dedicated person who seemed to be genuinely concerned for his family's future. I learned that Jay's concern about the Ogallala stretched back to at least 15 years ago. At a public water meeting, Jay had expressed his concern about the condition of the aquifer and volunteered to cut back his water use by 25 percent if everyone else would. With this in mind, I wonder if it is possible that by threatening to start a water war, Jay hopes the government will create programs that save the farmers from themselves. Perhaps the Garetsons are doing in their own way what other farmers have advised them to do—the best they can with the cards they have been dealt.

The Garetson case reveals how the Ogallala and state regulation can affect farmers and reshuffle them into competing camps. A farmer, who lives near and knows the whole Garetson family, shook his head when discussing them: “Their mother is the sweetest lady in the world. How did they end up like this?” he wondered. Water has been used as a metaphor for healing social conflict (Smith 1952:29) and bringing communities together (Sikkink 1997:171). The reality of its management, however, can also tear them apart.

Chapter 7
Conclusion

Letting the days go by
Let the water hold me down
Letting the days go by
Water flowing underground
Into the blue again
After the money's gone
Once in a lifetime
Water flowing underground

— The Talking Heads

The depletion of the Ogallala Aquifer is a multifaceted problem. Agronomists, economists, engineers, hydrologists, and other professionals have made contributions toward understanding the problem and conserving the Ogallala's water for the future. However, none of the previous work on the Ogallala has engaged farmers directly. As the daily users of the resource who have a great amount of latitude in their decision making, understanding farmers' actions is important to understanding the future of the aquifer.

In this project, I used cultural models to understand southwest Kansas farmers' decisions. Cultural models are tools to uncover the interpretive frameworks farmers use to understand their world. Although they include information about the environment, technology, and outside influences, they reside in farmers' minds and are therefore local. Cultural models do not provide a direct way of understanding other aspects of actors' characteristics. They cannot explore farmers' operational capabilities and limitations or extra-local influences. For this reason, I also used the lens of actor-network theory to emphasize the influence that the materiality of agriculture, the Ogallala, water extraction, and state water law, have on farmers.

I have presented information about the internal worlds of the farmers and the external world which they both react to and are shaped by, as separate chapters. I will now bring these lines of inquiry together. I am not suggesting the influences in these chapters are causal, only that they reflect and reinforce patterns of thought and behavior. The theme common to these observations is the concept of the farmer as an individual competing for scarce resources. Farmers' cultural model of agriculture supports this interpretation as does their distrust of collective action, no matter if the suggestion originates among themselves or from the state. Factors, which at first seem external to farmers' selves, such as state water law, the agricultural economy, water infrastructure, and the Ogallala formation, actually influence farmers as actors and reinforce the competitive individualism in their cultural models. In turn, the state and the agricultural economy are also affected by farmers' actions. The state is influenced through farmers' political participation and the agricultural economy (characterized by diminishing financial returns and competition for limited land resources) through farmers' continued participation as competitive individuals. In a flat world made up of many connections, such as that proposed by actor-network theory, it can be difficult to choose a place to begin "tying up" the loose ends. I have chosen to begin with the state.

Integration

The Water Appropriations Act of 1945 declared the state's authority over groundwater and implemented the prior appropriation framework for the assignment of water rights. The concept of prior appropriation explicitly creates water users as individuals.[21] Priority for water use is given to those who file water claims first. There is no cooperative mechanism in Kansas water law that allows for proportional or otherwise cooperative water sharing in times of scarcity. It is not just that Kansas water law treats water users as individuals, it treats them as individuals competing for a limited resource. This is the legal basis on which the Garetson brothers' claim of impairment against the neighboring water right holder rests.

The individual water user is also reflected and reinforced in the way water is accessed and used. The wells, engines, pumps, and sprinklers are all privately owned. Water rights are tied to the land above them and have a designated place of use. There is no physical infrastructure that would enable farmers to share their water with their neighbors. The scale of agricultural enterprises in southwest Kansas cannot be discounted as a factor in the development of private water infrastructure. However, the influence of the 1945 water law cannot be ignored either. The water right framework was in place well before the majority of irrigation development occurred in the 1960s.

Geertz (1972:24) cautions that any adaptive regime, such as irrigation in southwest Kansas, "tends to take on the look of not only inevitability but also optimality" but that "things

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[21] Partnerships may also file for water rights, but this is generally a small group of people whose interests are still set in potential conflict against others.

could quite easily be otherwise than they are." There is no engineering or physical reason why the shape of irrigation in southwest Kansas could not have taken a different form. In the early days of irrigation, wells produced so much water (I have heard reports of around 1,600 gallons per minute) that farmers could not use as much water as they produced at a time in their furrows (the irrigation method used at that time). Reports of water flowing down the road were common. It would have been possible for a well to serve more than one farm. I am not suggesting that Kansas water law is solely responsible for the shape of the southwest Kansas irrigation system. It is likely that the development of the water law reflected prevailing social values. However, it and the private water infrastructure, reinforce the concept of individual water users who are competing for a limited resource.

The Ogallala also contributes to farmers' individuality because of the way its water is variably distributed throughout the formation. Some farmers have more water than others. Some farmers are out of water and others have no concerns about water security. Access to this water, now and in the future, is a private property right that farmers have absorbed the personal risk of developing and maintaining. State law already creates water users as individuals, but the characteristics of the Ogallala and the technology used to harness it reinforce this individuality. Farmers fear the state's LEMA proposal will mean that farmers with more water available to them would need to make larger reductions than farmers with less water. The farmers with plentiful water worry their productive capacity would be curtailed more than their water-challenged neighbors and that these same neighbors would reap the most benefits from any water saved. If this situation came to pass, it would be inconsistent with the individualism enshrined in state water law and the cultural belief that farmers should “play the hand they have been dealt” with regard to the variability of water deposits.

As I noted earlier, influences travel in both directions between farmers and the state and farmers and the agricultural economy. The same is true for the Ogallala with the exception of one of its potentialities. Although the aquifer is changed by farmers’ actions, the variable distribution of water and its effects are not acted on by farmers in a managerial sense nor on a relevant timescale due to the slow movement of water through the formation. How much water farmers’ have under their land and the management and production decisions this water enables is an influence of the Ogallala that moves in one direction, at least as the situation exists now.

State law, irrigation technology, and the Ogallala cannot be said to cause farmers’ cultural models. However, farmers’ cultural models react to and classify these elements of experience. Turning now to the farmers of southwest Kansas, the foundation for their cultural models is the competitive individual. As individuals, they participate in the risky industry of agriculture and compete for the finite amounts of available farmland in order to increase their productive capacity. They often conceptualize the risk as a game. As such, there are rules about the proper way to compete with each other in the game. Those who deviate from these rules, such as the Garetsons, experience social sanctions—even if their deviations are legal. Further, the rules of the game also mean that farmers expect the relationship between the game’s elements to be constant. Any changes introduced by the state would fundamentally change the rules of the game.

Farmers see themselves as shouldering the burden of the risk for operating the farm and developing water resources. In return, they expect to enjoy the fruits of their labor without interference. Further, they feel they are using the best tools and technologies to harness the resource and are being responsible in its use. They point to progress in water efficiency, not just of application but of use as expressed by crop yield. It has been argued in climate change studies that agriculture is unfairly expected to shoulder the costs of conservation (Glenk and Colombo 2011). Famers feel that conservation programs, such as the LEMA, replicate this inequity. This sentiment was expressed by a farmer contemplating the possibility of mandatory water restrictions:

> Should we be expected to absorb that economic burden of losing it, of giving up that income if that is for the betterment of the whole state? If the whole state, if they benefit, do they have any responsibility in sharing part of that burden?

The risky game of agriculture is unlike other speculative industries. Agriculture is not simply an economic activity, but a "good thing to do" that is essential to replication of family and society. The data I collected do not directly support the assertion that farmers view the individual as the root of family and society, but this may be surmised by their connection with the individual to agriculture and of agriculture to the family. Agriculture connects past, present, and future individuals and families, creating a transcendent order. The deep meanings agriculture has for farmers means that the prospect of government interference or changes to the rules of the game are not only economic threats. They are threats to the family and to themselves as individuals. Farmers seek to defend themselves and their family through political participation and by consolidating their competitive position in the agricultural market – once again connecting their local decisions and use of resources to distant influences.

Moving the Hydrosocial System Forward

The continuing depletion of the Ogallala, which has been recognized as a serious problem for over three decades, suggests that the current water management framework in Kansas, the hydrosocial system, is at an impasse. Kansas's reliance on the concept of private property makes it unable to protect the state's water for the benefit of all of its citizens. Although the state set the parameters for water use, it has left many of the daily water decisions to regional groundwater management districts. This has left the state unable to coax farmers into its conservation programs. The state has made itself both indispensable to farmers—because it controls water rights—and impotent—because it cannot compel farmers to adopt its programs. The state could impose an IGUCA over the entirety of GMD3, but the constitutionality of the IGUCA program with regard to Kansas water law is not clear and would surely be tested. The Kansas legislature could create or amend legislation that would give the state the authority to dictate reduced use, but this possibility has not been publically discussed. The resulting backlash from farmers would most likely make the outrage over the Garetsons' actions pale in comparison. Farmers who already resent government intrusion would likely be incensed. The GMD boards have the ability to mandate a LEMA within their boundaries (Foley 2016). This would be one way of forcing farmers to use less water, but there is no way for GMD board members to take this action without community approval. The personal backlash against board members likely would be met with the same backlash as a state-mandated IGUCA.

The state has also done a poor job of articulating why it wants to conserve water. It leans on the language of economic growth, but conservation achieved through reduced withdrawals will clearly harm farmers who believe the state is more interested in keeping their tax dollars flowing than the water. Further, the water is not currently needed in other places in the state; there is no place for it to be shipped and no competing uses have been identified. The costs to farmers are clear; the costs and benefits to the rest of the state are not.

The state lacks the resources to protect farmers from the worst financial effects of water restrictions. It cannot pay creditors or widely supplement farmers' incomes to offset reduction in yields that would accompany reduced water use. Nonetheless, the state is most likely in a better position to implement conservation measures than GMDs. However, it has so far proven unwilling to confront either its farmers or its own regulations. The Ogallala Aquifer and the water supply for the future are caught in the middle.

Failure to protect water is an institutional failure; there must be a fit between the resource and the governance structure designed to manage it (Acheson 2006). This is clearly the case with the Ogallala Aquifer, and water in the West, as Webb (1931) pointed out so long ago. The water scarcity facing Kansas is largely the result of a style of agriculture operating in an environment that is not conducive to the long-term sustainability of its practices. As with the settlement period, the institutions and expectations are not well adapted to the environmental conditions in which they operate.

Adger et al. (2009:338) suggest that cultural preference might impose limits to the possible range of adaptive behaviors. Southwest Kansas farmers' cultural models, which cognitively organize the conditions created by the state, environment, and technology, equate the depletion of the Ogallala with other natural processes, such as getting old. Farmers are resigned to the fact that their world will change and they will need to change (or be changed) along with it. Southwest Kansas farmers predict a return to dryland agriculture in the future and recognize that their communities will be very different as a result, with fewer farmers operating larger farms. The overall population of the region would likely decline as well due to reduced economic opportunities for non-farmers. Resignation to this future does not mean that farmers see it in a positive light, however.

To avoid this future, or at least some of its worst effects, the hydrosocial system in Kansas requires an evolution or revolution in water administration, law, and agricultural production systems, instead of an involution (the internal elaboration of an established form) that current options represent. There is little flexibility and few options in the production system as it exists today. This type of paradigm shift, although radical, would be necessary. The current approach, illustrated by the Kansas Water Office's (2015b) 50-year vision for the Ogallala and other water sources, calls for every person in the state to assume responsibility for water conservation. Although the KWO's proposal seems to be an anodyne approach to water management, its insistence that each Kansas citizen assume responsibility for the future of water changes nothing about the institutions that manage water.

How do we move forward from today? Kottak (1999:25) believes ecological anthropology must "devise culturally informed and appropriate solutions" to environmental degradation. What culturally informed and appropriate solution might exist in this case? One answer involves encouraging farmers to draw from different cultural models than they do now. As I suggested in Chapter 5, farmers are conflicted about the extent to which they should share their knowledge with their neighbors or cooperate to save the aquifer. The conflict suggests they are aware of, and even consider, other behaviors than the ones they have traditionally taken. Although it may be difficult to encourage farmers to adopt new modes of behavior, albeit consonant with models they already know, there is an example where farmers have cooperated to achieve a shared goal.

In addition to the Ogallala Aquifer, southwest Kansas was bestowed with the Hugoton Gas Field, a rich deposit of oil and natural gas. In some ways, the history of the Hugoton field parallels the history of the Ogallala. When the field was first developed, oil and natural gas burst from the ground. Farmers leased their mineral rights to petroleum companies who drilled wells and installed the pumps and infrastructure to collect the oil and gas. For a long time, farmers were able to tap into the gas transmission lines from the well head and use unprocessed natural gas to power their pump engines. According to my informants, the gas was "clean," meaning it contained very little water or other chemicals. For many years it was the preferred energy source for pump engines. Like groundwater, it was literally underfoot and extremely cheap. After years of extraction, the pressure of the field fell to the point where the gas company no longer wanted farmers to tap the wells directly. The gas company needed to account for the extra expenses of recovering gas from the declining wells.

After being shut off by the gas company, farmers were faced with the choice of converting their pump engines to either diesel or electric power, both of which are more expensive than natural gas (Martin et al. 2011). Further, farmers told me that electric pump engines are not adjustable and only run at one speed.[22] This is an undesirable trait because farmers in areas of declining water worry about pumping air when the engine turns faster than

[22] There seems to be after-market variable speed controls that farmers can install, but none of the farmers I worked with mentioned these to me.

water comes into the well. Farmers with natural gas or diesel engines can combat this problem by reducing the speed at which the engine turns the pump.

The gas company offered to sell farmers processed gas if they built their own distribution infrastructure to deliver the gas to their engines. The gas company, however, would not assist with the costs of laying the pipe or the right-of-way issues to build the distribution system. The gas company's terms were analogous to an electric company offering to sell customers electricity, but only if the customers built their own transmission lines. Rather than use the undesirable and expensive electric motors, or switch to diesel, the affected farmers decided to build their own gas infrastructure. These farmers organized their neighbors, raised money to support the project, negotiated right-of-way-access to land where the pipelines were to cross, and managed the construction of the system. This same scenario was repeated in several areas throughout southwest Kansas.

When I asked farmers how this situation differed from the possibility of joining a LEMA, their answer was ready and simple: everyone was affected equally by the gas shut-offs. No matter how much water a farmer had, how long ago he purchased the land, or his financial situation, every farmer faced the same problem, was affected by it in the same way, faced the same costs to contribute to the solution, and would similarly benefit. This homogenous cost and benefit were different from the LEMA proposal in which the sacrifice and benefit would be different for each farmer.

This example suggests that the requirement for cooperation among farmers is a perceived sense of equality in the problem, the costs, and the solution. Yet, farmers do not see aquifer depletion as a shared problem. The private water infrastructure, Kansas water law, the cultural expectation of providing for one's own water needs, and the intra- and interfarm well variability in southwest Kansas all work against viewing aquifer depletion as a shared problem. Changing this paradigm appears to be imperative for the survival of the Ogallala, irrigated farming, and the communities of western Kansas. The current one simply is not effective. As Bateson (1972:326) argued:

> Your survival unit will be you and your folks or conspecifics against the environment of other social units, other races and the brutes and vegetables. If this is your estimate of your relation to nature and you have an advanced technology, your likelihood of survival will be that of a snowball in hell.

A Final Word

The depletion of the Ogallala is a complex problem that demands a sophisticated solution, one that will require passages from many stories, including those of farmers, to implement. There is no single solution, no magic bullet, to staunch the loss of water but leave unchanged the farming practices and economy of southwestern Kansas. Such a solution would have likely been applied by now had it existed. Rather, the future of the Ogallala and irrigated farming in southwest Kansas will depend on an interdisciplinary collection of interventions that take into account the dynamics of the aquifer, the environment of southwest Kansas, policies and technological interventions that can reduce water consumption, and the lives of the people that use it. It will require a new story to be written. It may be a story that challenges the structure of the economy and the things we say constitute a good life.

If the depletion of the aquifer is not staunched, then farmers will continue to pump water until they can do so no more. David Brauer, of the USDA, is pessimistic the aquifer can be saved and is hoping to find a soft landing. The softest landing may be to do nothing and let the aquifer "take care of itself." Farmers will stop pumping one by one and the economy will have a chance to adjust to decreased yield and revenues over time rather than experience a shock. This is not necessarily a successful future, however.

The way groundwater is managed in Kansas has not changed appreciably since in the Water Appropriations Act of 1945. It is tempting to observe a social system, such as the irrigation system in southwest Kansas, and get the feeling that the relations that keep it together are ossified and permanent. In his conclusion to *Reassembling the Social*, however, Latour (2005:250) reminds us that there is reason to hope when facing a situation such as this:

> if you have to fight against a force that is invisible, untraceable, ubiquitous, and total [like the social, or culture], you will be powerless and roundly defeated. It's only if forces are made of smaller ties, whose resistance can be tested one by one, that you might have a chance to modify a given state of affairs.

By opening the lids of black boxes, recognizing that the current order of the world is not natural but is simply the result of the plaited-together interactions of society, environment, and technology, it becomes possible to imagine a way forward. Failure is still possible, but at least there is also the possibility of success. The examples of irrigation from around the world in the anthropological literature demonstrate that the southwest Kansas irrigation system could have a different form if the farmers and the state so desired. Indeed, the state has expressed its desire for new water management structures through the LEMA program, but cannot pursue new ideas unilaterally—the state is waiting for farmers to signal they are amenable to new forms of governance.

What a successful future for southwest Kansas looks like is a determination that will need to be made by the farmers and the state. The future they design, with whatever metrics they use to define success, will likely not be applicable to other areas of the aquifer. The seven other states that overlie the Ogallala all have different water laws, environments, and are not identical in the composition of their agricultural industries. Even within Kansas, a successful future for the southwest part of the state may look different from the one envisioned in the northwest. However, the examination I have provided of farmers' resistance to reduced water usage and cooperation, a major stumbling block in conserving the aquifer, may provide a useful tool to policy makers. Identifying farmers' cultural models is an important step that policy makers can take to understand the perspectives of water users. Examining how those cultural models are influenced by policy, infrastructure, and the environment provides an account of how distant, diffuse, and sometimes taken for granted factors influence those models. Additionally, the behavior directed by cultural models influences the external world. Understanding these bidirectional relationships can provide policy makers with insight into how their actions influence decision making.

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Southwest Kansas farmers may be resigned to a future without water, but they are nonetheless unsure of what the future holds. At the end of our interview, Nick assured me that, "It's going to be okay." He closed his eyes, tilted his head down and said it again softly. "It's going to be okay." I was not sure who he was trying to reassure.

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