Sustainable Practices in the High Plains: A Study of Water Conservation Efforts and Well Ownership

By

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Abstract

Extreme demands for crop irrigation and droughts have stressed water supplies in Kansas, making the state increasingly reliant on its underground reserves of freshwater. As precipitation and the availability of surface water become less reliable, aquifers (reservoirs of groundwater) remain one of the only sources of water in the High Plains. Growing demands for water are tapping aquifers beyond their natural rates of replenishment, which has profound implications for sustaining communities in a region prone to drought. This dissertation investigates the water conservation efforts, environmental priorities, and water supply awareness of Kansas well owners, a key social group whose actual and potential water usage is pivotal to understanding and safeguarding groundwater formations. My main research goal is to learn how the reliance on different water supply infrastructures influences water usage. The central research question is: Does owning and using a well change the propensity to conserve water? This is a relevant question because previous research investigating the reproduction of conservation behaviors has not adequately explored how systems of water provision contribute to resource management decisions. To address this omission, I constructed one of the only datasets of well owners used in social scientific research by surveying well owners and non-well owners throughout Kansas (n = 864). Well owners are a key social group whose actual and potential water usage is pivotal to safeguarding groundwater formations, and researching well owners' conservation efforts will be key to aquifer preservation and wider water management policies. Previous research has outlined how some demographic predictors like political views, age, and sex are tentatively correlated with pro-environmental behaviors; however, my work finds that a household's water supply moderates several relationships associated with water conservation. This finding suggests that infrastructure contextualizes the adoption of conservation habits, and Kansans' notions of environmentalism are recalibrated by their systems of water provision. The project provides quantitative and qualitative evidence that well owners embody a form of "groundwater citizenship," an ethic of conserving and staying mindful of aquifers. Through this research, I seek to identify how infrastructure influences the decision to adopt environmentally-conscious watering practices, which will assist the development of more effective groundwater management policies, and, in turn, improve drought adaptation measures.

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I take full responsibility for the interpretation of the works cited here, and I hope that my project is accurate, well-researched, and has valuable policy implications. Any misinterpretations of the cited works are my own.

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Abbreviations

ANOVA	Analysis of Variance
CDC	Centers for Disease Control and Prevention
CEP	Climate + Energy Project
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
COR	Conservation of Resources
CPR(s)	Common Pool Resource(s)
FIML	Full Information Maximum Likelihood
GFI	Goodness-of-Fit
GMD(s)	Groundwater Management District(s)
HPA	High Plains Aquifer
IGUCA(s)	Intensive Groundwater Use Control Area(s)
KDA-DWR	Kansas Department of Agriculture's Division of Water Resources
KGS	Kansas Geological Survey
KHC	Kansas Humanities Council
KRC	Kansas Rural Center
KSU	Kansas State University
KU	Kansas University
KWA	Kansas Water Authority
KWO	Kansas Water Office
LEMA	Local Enhanced Management Area
PEB(s)	Pro-Environmental Behavior(s)
PMDD	Planned Missing Data Designs
RCPI	Resource Conservation Partnership Initiative
RMSEA	Root Mean Square Error of Approximation
SDWA	Safe Drinking Water Act
SEM	Structural Equation Modeling
SPSS	Statistical Package for the Social Sciences
SWP	State Water Plan
VBN	Values-Beliefs-Norms
WWC5	Water Well Completion Form

Preface

Due to growing demands for irrigation water, the availability of groundwater has been a diminishing in Kansas, where the future of the High Plains aquifer is in jeopardy. As precipitation and the availability of surface water become less reliable, aquifers (reservoirs of groundwater) remain one of the only sources of water in the High Plains. Growing demands for water are tapping groundwater supplies beyond their natural rates of replenishment, which has profound implications for sustaining communities in drought-prone regions. This dissertation investigates the water conservation efforts and environmental beliefs of Kansas well owners, a key social group whose actual and potential water usage is pivotal to understanding and safeguarding groundwater formations. Aquifers and well owners constitute an interconnected socio-ecological system, and researching well owners' conservation efforts will be key to aquifer preservation and wider water management decisions. My main research goal is to learn how the reliance on different water supply infrastructures influences water usage. The central research question is: Does owning and using a well change the propensity to conserve water? In addition, I ask: In the context of groundwater depletion and droughts, are Kansans conserving water domestically? To answer these questions, I constructed one of the only datasets of well owners used in social scientific research by surveying over 850 well owners and non-well owners throughout Kansas. Through this research, I seek to identify if well owners adopt environmentally-conscious watering practices, which will assist the development of more effective groundwater management policies.

I hypothesize that reliance on wells is connected to prudent water usage habits, and that the relationship between water consumption and well ownership is influenced by geography and the function of the well (for example, if it is used for agricultural, lawn and garden watering, or domestic purposes). Drawing on theories of sustainable practices, my study frames well owners as a unique community defined by conservation routines and investments in water-saving appliances to protect groundwater reserves. Reliant on diminishing groundwater supplies, well owners constitute an important subpopulation that has been understudied in sociology. Well owners are unique because they influence their own water supply through their daily routines of water usage. By conceptualizing well owners as groundwater stewards, this research contributes to the sociology of water and sustainable practices, and provides a sociological assessment of groundwater withdrawals. My findings show that well owners are more aware of the state's water supplies than the general population, express environmental motivations to conserve water, they are more likely to invest in water-saving appliances, and deliberately conserve water more frequently than non-well owners; however, well owners also react to droughts by increasing, not curtailing, their water usage. Previous research has outlined how some demographic predictors like political views, age, and urban residence are tentatively correlated with pro-environmental behaviors, but my work finds that an individual's water supply moderates several relationships associated with water conservation.

I identify wells as a unique type of water provision and compare well and non-well systems of provision with respect to several water-consuming practices. Sociologists researching water use have employed the theoretical framework of systems of provision—the notion that infrastructures which deliver resources to certain groups reinforce the behaviors and mentalities that justify the systems themselves. I contend that structures of water provision shape watering routines, and municipal supply systems and private wells represent different watering infrastructures that have important implications for how "normal" or "excessive" water usage is defined. While sociologists have studied conservation practices and infrastructures, they have yet to analyze how reliance on wells affects domestic water usage. By putting forth an analysis of well owners and the practices associated with well ownership, this project contributes to theory-building of pro-environmental behavior research. Furthermore, my dissertation supplements growth machine theory, which conceptualizes cities and towns as dependent on economic expansion. Such growth is typically created by transforming the *use values* of natural resources (their utility) into *exchange values* (prices). Groundwater is not straightforwardly commodified in Kansas, and the state's agricultural communities are dependent on non-commodified groundwater sources. This dependency complicates their survival in a neoliberal political climate that emphasizes capitalism's growth imperative.

I begin my analysis by outlining the environmental realities: Kansas, a state highly reliant on groundwater, faces a number of challenges regarding its water supplies, as contemporary groundwater losses across the High Plains aquifer leave the state susceptible to drought. Chapter 1 also discusses the political efforts by Kansas legislators and irrigators to address groundwater withdrawals, and the tension between agricultural irrigation and non-agricultural (i.e., domestic) water use in Kansas. The project's research agenda and broader impacts conclude the first chapter. Chapter 2 contains the literature review, which draws from research on groundwater measurements, pro-environmental behaviors, the sociology of water use, and water supply infrastructure. It outlines my argument that water supply infrastructure sets the stage for water usage, and recalibrates notions of environmentalism, resource management, and citizenship. Chapter 3 contains my larger theoretical framing and contextualizes groundwater losses within the political climate of Kansas. Chapter 4 presents my methods by describing the study's participants, data collection, details about survey construction, my analytical approaches associated with structural equation modeling (SEM), and the respondents' descriptive statistics.

The first data-driven chapter, Chapter 5, overviews the general effect of well ownership on water conservation. This chapter provides quantitative and qualitative evidence that well owners embody a form of "groundwater citizenship," an ethic of conserving and staying mindful of aquifers. Chapter 6 supplies a nuanced interpretation of my results by outlining the influence of geography and the moderating effect of the well's primary function by using SEM. From there, Chapter 7 discusses these results and describes the relationships between well reliance, residence above the High Plains aquifer, and water conservation. It also contains important comments about the feasibility of data collection on well owners and accessing this hard-to-reach rural population and policy recommendations for groundwater management and conservation efforts in the state. By way of conclusion, Chapter 8 summarizes the importance of the research and its contributions to related literatures. It also discusses larger themes including environmental stewardship, groundwater management, and drought adaptation in Kansas.

Chapter I: The Overworked Ogallala

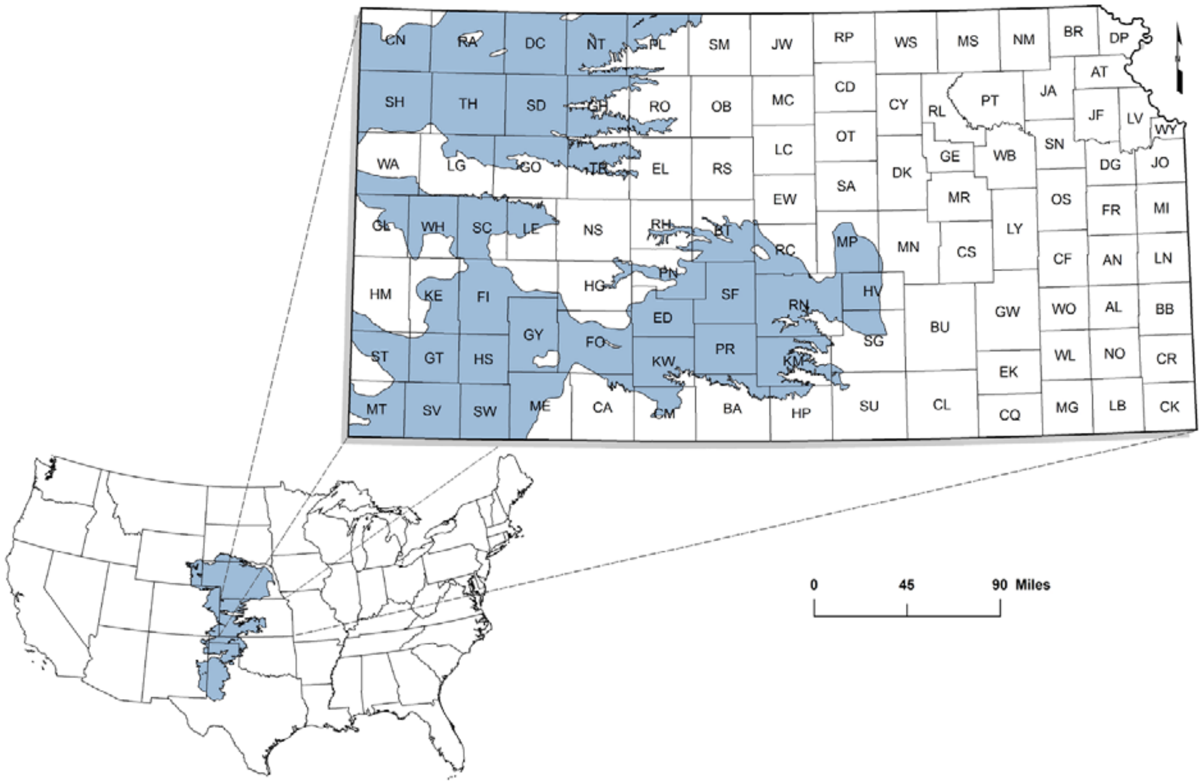
Since 2002, a pair of satellites monitoring changes in groundwater levels has recorded rapid declines in aquifers all over the world. Known as the Gravity Recovery and Climate Experiment (GRACE) satellites, they can measure water table levels within a centimeter of accuracy by detecting the slightest variations in the Earth's distribution of mass (Powell 2011). Observations from the GRACE satellites indicate that a third of the largest aquifers on the planet are overstressed (Richey et al. 2015). Scientists studying rivers, lakes, mountain runoff, precipitation, and aquifers around the planet have concluded that freshwater supplies are becoming destabilized; such findings have generated serious concern about freshwater availability (IPCC 2013; Molina et al. 2014). The depletion of aquifers—underground reservoirs of freshwater—is a leading cause for these global water shortages, and groundwater declines symbolize one of the main hydroclimatic hazards of droughts, which are exacerbated by global warming (Shah et al. 2001; McKibben 2003; Kallis 2008). The consequences of groundwater losses include inevitable food production challenges and rural depopulation. The most overused aquifers are in the world's driest areas and aquifers are a critical supply of freshwater in some of the most water-stressed areas on the planet. South Asia relies on groundwater irrigation for at least 75 percent of its food production (Shah, Singh, and Mukherji 2006). Groundwater assessments in Africa indicate that groundwater is the largest and most broadly distributed supply of freshwater on the continent and the primarily supply of drinking and irrigation water for nearly three-quarters of its population (UNEP 2010; MacDonald et al. 2012), but it is also considered the most vulnerable supply (Alavian et al. 2009). Researchers anticipate an increasing reliance on groundwater in the future (Famiglietti 2014), making it critical to explore water conservation efforts. Managing groundwater resources therefore requires researching the interface between aquifers and the communities reliant on groundwater.

Recent climatic conditions have led to historic droughts across the United States, particularly in the Southwest. Weather Type (WT) analyses have confirmed that the Southwest received significantly less precipitation for the past three decades, and researchers believe the region has already shifted into a drier climate state that will be characterized by droughts lasting decades as the climate warms (Prein et al. 2016). Extreme surface water losses have changed the face of development in California, as new subdivisions north of Sacramento are being constructed with the assumption that they will sustain themselves by relying entirely on groundwater (Weiser and Reese 2015). To add even more uncertainty, as groundwater levels reach record lows, increased well pumping is contributing to the formation of sinkholes and land subsidence across California (Moran, Choy, and Sanchez 2014; Thomas and Buis 2015; USGS 2015). In Texas, hydrologists have forewarned that some wells drawing from declining aquifers could run dry because they will not reach the water table. The state's aquifers have been the site of intense water disputes, pitting the small rural towns overlying groundwater sources against the rapidly expanding suburbs of Austin and drilling companies from Houston seeking to drain aquifers. Small communities that are not within the boundaries of any metropolis's water conservation district are being considered as sites for large groundwater drilling operations to transfer the water to cities in Texas (Parker 2015). Since these towns lack political and economic strength, they cannot compete with huge cities and drilling corporations; rural communities face the real prospect of having their groundwater sources drained.

One of the largest aquifer systems in the world, the High Plains aquifer, has undergone particularly severe declines on account of extreme droughts, heat waves, and the extractions from tens of thousands of irrigation wells. This massive groundwater formation is located primarily in Nebraska, western Kansas, western Oklahoma, and northwest Texas, with smaller portions extending into South Dakota, Wyoming, Colorado, and New Mexico. The High Plains aquifer technically refers not to a single aquifer, but many; it contains three individual aquifers in Kansas alone: the Equus Beds and Great Bend Prairie aquifers in south-central Kansas, and the expansive Ogallala, which occupies far western Kansas and extends into the aforementioned neighboring states. The High Plains aquifer is a gigantic underground network that can be more accurately described as a system rather than a single groundwater formation. It has multiple segments that react differently to *overdrafting* (the removal of water out of an aquifer faster than it can be regained), and *recharge* (the natural percolation of surface water into groundwater sources). The enormous imbalance between recharge and withdrawal has been so severe that many portions of the High Plains aquifer are experiencing significant declines in storage, particularly in the central and southern portions of the aquifer (Haacker, Kendall, and Hyndman 2016).

While most of the water tables in Nebraska remain relatively stable (USGS 2013), the sections in New Mexico, Texas, Colorado, and Kansas have seen sizeable declines over the past thirty years (Reisner 1986; Guru and Horne 2000; Peterson and Bernardo 2003; McGuire 2007;

Map 1a. The High Plains aquifer



Source: Buchanan et al. 2009

Wilson 2012; Butler 2013; Evans 2013; Steward et al. 2013). Low amounts of recharge make parts of the High Plains aquifer essentially nonrenewable. The Ogallala aquifer only receives a quarter to a half of an inch of recharge annually in some places; other segments receive virtually no recharge whatsoever (Pumphrey 2006). Aquifers are wet piles of sand, with water located between the grains of sand; therefore, the water is somewhat locked in place, but can move about one foot a day within the formation (Buchanan 2013). Groundwater is relatively stationary, meaning that drawing water from one aquifer does not influence the amount of groundwater available in nearby aquifers. For example, overdrafts in the Equus Beds aquifer do not change the *saturated thickness*, the distance from the top of the water table to its bottom, of the Ogallala aquifer. Since withdrawing water from one area of an aquifer does not cause the entire aquifer to decline, groundwater depletion is more pronounced in some areas of the aquifer than others. The Northern High Plans aquifer, located mostly in Nebraska, has shown little change in its volume and has not experienced the same water level declines suffered in the Southern and Central High

Plains aquifers since the 1940s and 1950s (Haacker, Kendall, and Hyndman 2014). Due to these geological differences, the High Plains aquifer has tremendous variability in terms of the amount of groundwater available. An aquifer's saturated thickness can be influenced by groundwater extractions in a number of ways. The recovery of a water table depends on how quickly withdrawals are made, how much water each withdrawal removes, how the water table redistributes itself after withdrawals, and if it receives any recharge (Butler 2013). Unless drastic changes in groundwater management are implemented in the near future, the western parts of the Southern and Central High Plains aquifer are likely to become unusable for irrigation in the next few decades (Haacker, Kendall, and Hyndman 2016).

Estimates suggest that segments of these aquifers would take at least 500 years to naturally recover the water lost from contemporary pumping (Steward et al. 2013). Due to advances in well pumping technology, irrigation wells have become so powerful they can easily extract groundwater much faster than it can be recharged (Buchanan and Buddemeier 1993; Sophocleous and Sawin 1997). Water table declines are caused by excessive overdrafts, and as a whole, the High Plains aquifer has been over-pumped for its valuable irrigation water. Irrigation began in western Kansas in the late 1800s for the purposes of making farmland more productive and giving homesteaders an advantage in the stubbornly semiarid environment. It was primarily achieved through redirecting surface water supplies, and Kansas's first irrigation infrastructures were ditches that were used to divert water from the Arkansas River in Southwest Kansas (Buchanan et al. 2009). With the advent of irrigation, the state Board of Agriculture predicted an irrigated utopia and a new era of guaranteed crop production; irrigation supporters claimed the practice made farming independent of weather, even during droughts (Foth 2010b). Irrigation ditches quickly took a heavy toll on surface water supplies, which were already being utilized by Colorado irrigators. Reports as early as 1895 noted that the Arkansas River "became practically dry in Kansas during the season when water was most needed for the crops" due to the construction of the canals that fed 150 irrigated farms near Garden City (Wornall 1895). It became clear that farmers in southwest Kansas would likely have to settle for rainfed operations, or wells powered by windmills that only extracted a few gallons a minute, unless irrigators could somehow access a large and reliable supply of water.

In response to the Dust Bowl drought, and due to breakthroughs in diesel-powered well pumping technology, agricultural groundwater reliance greatly increased in the twentieth century. High capacity well pumps invented during the 1940s and 1950s allowed groundwater to become the major source of irrigation water, as surface water is relatively scarce in most of the High Plains. By the 1940s, the historical change in how water was used in Kansas (and where it was supplied) became clear: surface water used for navigation and hydropower had been replaced by groundwater used for irrigation and municipal uses (Governor's Report 1944). Extension engineers in the 1950s claimed that rainfall would supplement irrigation, and irrigation, not precipitation, would produce crops (Foth 2010b). "For decades, farmers tried to drill their way out of the problem. When water tables sank and wells failed, they simply dug deeper or dug elsewhere" (Genoways 2016). Western Kansas was experiencing a "boon in water" (Evans 1955) unlike any time before the emergence of high powered wells, and the newly-empowered irrigators changed farming in the semiarid region. While low-capacity wells only yield about 10 gallons per minute, modern irrigation wells can extract anywhere from 400 to over 1,000 gallons per minute, depending on the amount of groundwater available in the aquifer. Some of the first-ever wells that tapped the Ogallala aquifer in southwest Kansas started with an astonishing yield of 2,500 gallons per minute (Garetson, Townsend, and Rude 2014). While irrigation has since declined, it does not mean that groundwater is now more abundant—it means that groundwater is getting harder to pump because the water tables are dropping.

Powerful well pumps enabled larger irrigation operations to install center-pivot systems, large rolling sprinklers used to water giant areas of cropland. Their popularity led to the cultivation of crops that could not previously be grown on dryland operations in the High Plains, particularly corn. Groundwater, referred to as "underground rain" by irrigators, also boosted crop yields because it enabled the application of fertilizers that typically stressed rainfed crops (Foth 2010b). This giant increase in grain production attracted massive feedlots and meatpacking plants, therefore creating a wave of economic growth in southwestern Kansas in the second half of the twentieth century. The economies of these communities—which I refer to as "groundwater economies"—are largely dependent on tremendous groundwater withdrawals. By 1980, there were over 18,000 center pivots installed in Nebraska alone, and nearly 50,000 center pivots operating in the Great Plains overall, enabling farmers to plant water-intensive crops on marginal land (Genoways 2016). The agriculture industry in the region has been sustained by vast, but dwindling, groundwater reserves that have offset surface water shortages.

The region over the aquifer comprises the largest irrigation-sustained cropland on the planet (Peterson and Bernardo 2003). It contributes more than $20 billion worth of crops to the global economy each year, making groundwater in the High Plains essential for food production and a tremendous revenue source (Ashworth 2006). In 2013, the irrigated corn and wheat grown in southwest Kansas was valued at just under $1 billion (Buchanan et al. 2015). Nearly one-third of all of the groundwater used for irrigation in the United States is extracted from these aquifers, and over one-quarter of the irrigated land in the nation overlies the High Plains system (USGS 2000; 2013). A fifth of all the corn, cotton, wheat, and beef produced in the US depend on irrigation from the High Plains aquifer, but in the coming decades it will be more severely depleted and receive less recharge due to harsher droughts. If irrigation were to suddenly end in the High Plains, its crop yields would drop by at least one-third (Postel 1992).

The expansion of irrigation agriculture in Kansas has come at the expense of its groundwater sources. Geologists have established, "The major driver of water level changes in many heavily stressed aquifers, such as the High Plains aquifer, is irrigation pumping…" (Butler, Whittemore, and Wilson 2014). The overdrafts caused by irrigation represent losses of millions of acre-feet of groundwater. An acre-foot is the amount of water it would take to cover an acre of land in a foot of water, or approximately 325,851 gallons. The average family of four using 150 gallons per person per day (which is nearly twice than the national average of 81 [Kenny et al. 2009]) would amount to 211,200 gallons annually, or about two-thirds of an acre-foot. This is actually a modest amount compared to the water required for heavy irrigation. In western Kansas, corn irrigators apply around 1.3 acre-feet per acre—which is to say that they place about 16 inches of moisture in addition to natural rainfall. The amount of water needed to irrigate 160 acres of corn would be around 200 acre-feet, an amount that could supply 1,200 people with their domestic needs for the year (Kenny et al. 2009). Heavy irrigation is the primary culprit for groundwater decline in the High Plains; it accounts for over 80 percent of the water consumed in much of this region, specifically in Nebraska, Kansas, Oklahoma, and Texas.[1]

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[1] In the year 2000, irrigation withdrawals from the aquifer totaled 17 billion gallons per day (USGS 2013). This constitutes a vast majority of the water extracted from the entire system, as 18.75 billion gallons were extracted daily in the same year (Buchanan, Buddemeier, and Wilson 2009). Most of the water consumed in the United States is used for irrigation; agricultural irrigation accounts for 62 percent of the nation's freshwater consumption, and a fifth of the freshwater used in the United States is drawn from aquifers (Prud'Homme 2011).
Some groundwater researchers also measure water in terms of cubic kilometers; one km^3 is approximately 810,713 acre-feet of water. This metric is obviously only used to describe extremely high volumes of water, for instance the entire storage of the High Plains aquifer (Haacker, Kendall, and Hyndman 2016).

GROUNDWATER AVAILABILITY ACROSS KANSAS

The director of the Kansas Geological Survey (KGS), Rex Buchanan (2013), has stated that it is not possible to understand Kansas without understanding its water. By this, he means that Kansas contains two hydrologically separate geographies: the eastern half of the state has little groundwater and adequate levels of precipitation, while the western half of the state has much less precipitation but contains enormous aquifers. Precipitation is usually scarce in the semiarid western half of the state, making groundwater "the only reliable source of large volumes of water" (Buchanan and Buddemeier 1993:2). Given the low levels of rain in western Kansas, aquifers have been vital water sources for over a century. The "liquid dynamics" (Mehta and Movik 2015)—the interactions between the social, technological, and hydrological dimensions of water systems—vary across Kansas due to the reliance on surface or groundwater supplies. This environmental reality reveals the crucial connection between groundwater dependence and vulnerability to drought. Droughts, generally defined as "a temporary lack of water… caused by abnormal climate conditions and… is damaging to an activity, group, or the environment" (Kallis 2008:86), reduce the amount of surface water that can be recharged into aquifers, but more importantly, communities dependent on aquifers must resort to extracting more groundwater to offset the low levels of precipitation. If those communities do not have access to recharging aquifers, they might face challenges acquiring sufficient water to meet their needs.

The Kansas portion of the Ogallala contains roughly 260 million acre-feet of available water (McGuire, Lund, and Densmore 2012); overall, the High Plains aquifer contains 3 billion acre-feet, or a quadrillion gallons, "enough to cover the entire continental United States to a depth of nearly two feet" (Prud'Homme 2011:258). In 2013, 2.5 million acre-feet of water were withdrawn from the Ogallala in Kansas, but as a system it only receives an annual recharge of 0.75 million acre-feet (Buchanan et al. 2015). This annual deficit of nearly 1.8 million acre-feet is equivalent to about one-fifth of the Colorado River's annual flow. The aquifer's saturated thickness declined twelve feet altogether in the 1990s alone, a loss driven primarily by irrigation pumping (Pumphrey 2006). Research now estimates that the aquifer is now 30 percent depleted overall, and another 39 percent will be taken out over the next 50 years (Steward et al. 2013). Some southern portions of the aquifer have already been totally exhausted for many years (Williams and Satterwhite 1998). As a result of such massive groundwater withdrawals, Kansas lost nearly $1.1 billion of its farmland's productivity from 1996-2005 (Fenichel et al. 2016).

Research suggests that groundwater withdrawals would have to be reduced by 80 percent in order to prevent overdrafting in some areas (Steward et al. 2013). Due to the exploitation of groundwater sources, geologists estimate that water levels will decline 0.6-2.0 feet a year even in normal, non-drought conditions if the current level of extraction continues (Butler et al. 2014).[2] Experts have called this unsustainable pumping in the High Plains "a one-time experiment, unrepeatable and irreversible" (Guru and Horne 2000). Suffice it to say, the groundwater economy of the High Plains, in its current structure, is temporary.

Kansas's portion of the High Plains aquifer contains some of the worst rainfall-to-pumping ratios in the entire system (Padget 2013), particularly in the southwest corner of the state, where depletion has been extremely rapid. Grant and Haskell counties contain some of the system's fastest declines (Stover 2013b). During the drought years of 2011 and 2012, the region's water table dropped over 40 inches and 50 inches, respectively (KGS 2013a). For a frame of reference on how extreme the depletion is in southwest Kansas, consider the following: while Kansas's portion of the Ogallala aquifer declined almost 15 feet from 1996 to 2012 (a tremendous loss in its own right), the southwestern counties lost over *twice* that, or 32.5 feet, in the same period (Layzell and Evans 2013). These declines can represent anywhere from a 10 to 30 percent loss over that period (depending on the original depth of the saturated thickness). This degree of depletion has accelerated through the second half of the twentieth century and over-pumping in Kansas finally reached its peak in 2010 (Steward and Allen 2015). Since the introduction of high-capacity wells, depletion of the aquifer across Kansas ranges from 10 percent to 70 percent in many areas, making depletion a more serious threat for some communities than others (Butler 2013). Within the past thirty years, the yields of irrigation wells in western Kansas have fallen as the water table continued its descent, and several hundreds of additional wells may have a limited capacity to pump water as early as the 2020s (Steward et al. 2013). Research suggests that the Ogallala aquifer will no longer support irrigation wells in southwestern Kansas within 25 years (KWO 2014); wells are down to 25 percent of the water that existed when the aquifer was first tapped 70 years ago (Genoways 2016). This implies that

[2] Converting the depth of a portion of a water table (in inches, feet, or meters) to acre-feet (a volume) is challenging. It depends on how porous the formation's water-containing portions are. In some places, wells have to suck out a lot more than an inch of water off the water table to get an inch of irrigation water. This makes it challenging to measure the volume of an aquifer's content, but it is easier to assess their losses in terms of lowering the water table.

agricultural practices and water usage in the state will need to be seriously rethought in the coming decades.

Overall, water availability in the much of the High Plains is projected to become more limited. Simulations projecting changes in precipitation, evapotranspiration, and recharge indicate that if current water use practices continue, they will have enormous impacts on aquifer depletion in the High Plains (Kendall and Hyndman 2014). Climate change is forecast to cause recharge to moderately decrease in the southern half of the High Plains aquifer, which will further exacerbate water shortages (Meixner et al. 2016). Furthermore, climate data reveals that the difference in rainfall between eastern and western Kansas is expected to get more pronounced (Whittemore 2015). Eastern Kansas will become wetter, but western Kansas will experience a decline in precipitation, which implies that groundwater reliance above the High Plains aquifer will grow. In addition to the substantial losses predicted to strike the High Plains aquifer, climate change research projects warmer temperatures and less precipitation in Kansas (Brunsell et al. 2010). If greenhouse gases continue to be emitted at their current rate, much of the Midwest will likely experience dangerous levels of extreme heat by the end of the century (Gordon et al. 2015), which will amplify the demand for irrigation water during growing seasons. The Goddard Institute for Space Studies has determined that anthropogenic climate change has loaded the “climate dice,” greatly increasing the frequencies of unusually warm seasons and the probability for temperature anomalies, particularly in the summer (Hansen et al. 1988; Hansen, Sato, and Ruedy 2012). The biophysical impacts of climate change are predicted to have substantial social consequences, including extreme drought and flood conditions and record high and low temperatures (Stocker and Qin 2013). The consequences of looming droughts, specifically *warmer* droughts (Wilhite 2014), imply that the state will require even more groundwater in the future to meet its agricultural, industrial, and residential needs.

Two interconnected threats loom over water supplies in Kansas: groundwater assessments now confirm that some water tables in Kansas will be exhausted within 25 years if current pumping rates continue (KWO 2014; Steward and Allen 2015), and western Kansas is expected to experience temperature increases and rainfall declines—also within 25 years (Feddema et al. 2008). Essentially, portions of Kansas will have to survive harsher summers without their supplies of groundwater. In a state that typically irrigates 3 million acres of farmland each year (KWO 2014), these projections suggest that mounting competitions will define access to water resources. Overall, these challenges will increase the likelihoods of major food production shocks by 2040, as the global food system remains vulnerable to extreme weather (Bailey et al. 2015). Furthermore, increasing groundwater extractions will not be an option for the communities overlying the most depleted portions of the High Plains aquifer, which leaves Kansas “extremely vulnerable to the occurrence of drought” (Logan et al. 2010:255).

This vulnerability is linked to well owners’ ability to continually access water. Very few large-capacity wells are “ideally-cited,” meaning that they can capture recharged groundwater indefinitely and produce consistent yields. Nevertheless, it is important to note that not all wells are powerful enough nor deep enough to extract water that can perceivably change the High Plains aquifer. Some low-capacity wells can provide enough water to sustain a household by only drawing water that is located above water tables. Domestic wells tend to be shallower and are often impacted during droughts, when the extractions of more powerful irrigation wells cause the regional water table to drop. Deeper wells that extract water from the thickest portions of the High Plains aquifer have the largest amount of water at their disposal, but in Kansas these supplies are being quickly diminished. Rapid declines in groundwater sources hurt well yields, and in some cases wells have to be reconstructed, capped, plugged, or abandoned if they no longer reach the water table. The most powerful wells have the biggest influence on groundwater levels, and the density of these high-capacity wells reduce groundwater availability to such an extent that some well owners compete for the water needed to sustain the low-capacity wells during times of heavy pumping (Garetson et al. 2014). The need for deeper, more powerful wells ushers in a cycle of rising costs that many well owners face; reconstructing current wells or finding new areas to drill new wells require a major investment in water extraction technology.

The tension between agricultural irrigation and other forms of water use is especially high in Kansas. From an irrigation standpoint, groundwater serves as a substitute for precipitation in a region too arid to dryland farm some popular crops such as corn or sustain industrial feedlots (Peterson and Bernardo 2003; Padget 2013; Stover 2013b). Irrigation uses at least 84 percent of the groundwater pumped in Kansas (Stover 2013a), but non-agricultural sectors depend on aquifers as well. In fact, roughly half the state’s population relies on groundwater for domestic use, either provided through municipal water supplies or private wells (Buchanan and Buddemeier 1993). The conflicts between groundwater’s various uses—food production or domestic consumption—is problematic for well owners whose daily activities encompass both agricultural and non-agricultural elements that are both crucial for their livelihood. Groundwater resources are important for most municipalities, industries, ranchers, and households, as the High Plains aquifer supplies 70 percent of all water used in the state (Buchanan et al. 2009).

STRATEGIES TO MANAGE GROUNDWATER IN KANSAS

The word *rivals* is rooted the Latin word *Rivalis*, meaning "taking from the same stream" (Specter 2015). In many respects, well owners drawing from the same segment of an aquifer can be seen as groundwater rivals. Aquifers are examples of "Common Pool Resources" (Ostrom 1990) because they are openly accessible to well owners, and one well owner's pumping removes groundwater that could be used by someone else. In fact, individuals who rely on CPRs might feel threatened by their neighbors' consumption, which could potentially jeopardize their ability to benefit from the resource. In turn, people might intentionally use the CPR rapidly, instead of restraining their usage, to ensure that they at least can access it in the short term (Ostrom et al. 1999). Due to its finite properties, economists would call groundwater an "exclusive good," because it essentially puts well owners in competition for the resource. Groundwater supplies are therefore threatened by free-rider behavior—withdrawals that benefit some individuals at the expense of the whole community—and the tragedy of the commons, which is the intense overexploitation of a resource for short-term productivity that is unsustainable in the long term (Hardin 1968; Hoekstra 2013). Groundwater declines represent a "utilization syndrome," environmental problems which occur as a consequence of the inappropriate utilization of natural resources (Winter 2006:5). Utilization syndromes can include the overexploitation of ecosystems, the non-sustainable industrialized management of soil and water resources, and environmental damaged caused by extracting non-renewable resources (Winter 2006). These dangers make conservation efforts and collaboration among well owners critical pieces of groundwater stewardship. It is also important to consider the permitting processes that might enable or constrain Kansans' access to groundwater, which would influence the severity of the depletion of the CPR.

The vulnerability to drought and groundwater decline has been a major concern of Kansas policymakers. In the fall of 2013, Governor Sam Brownback called on water specialists to develop a plan for securing the state's water for the next 50 years, known as the "Long-Term Vision for the Future of Water Supply in Kansas." Brownback stated, "Without further planning and action we will no longer be able to meet our current needs." He emphasized that the economy of Kansas is directly linked to water, and that economic growth cannot occur amidst water scarcity. The Vision was developed in part by input from Kansas citizens collected by the Kansas Water Office (KWO); citizen feedback played a key role in the design of this ambitious policy. As the Vision was created over 2014, a number of critically important actions emerged as essential for the successful implementation of water security. The Governor created a Water Resources Subcabinet at the executive level in order to ensure regular collaboration with the state's primary water related agencies. Another immediate priority action item was the establishment of a Blue Ribbon Task Force that is tasked with designing an affordable method for financing water resource management across the state, including funding the State Water Plan. This Blue Ribbon Task Force utilizes partnerships among public and private sectors in the hopes of procuring sustainable funding for water security measures and hears recommendations from environmental and farm organizations from around the state (KWO 2014). Overall, the Vision is arranged around four themes: water conservation, water management, technology and crop varieties, and additional sources of supply. Each of these themes are applied at different scales: statewide, High Plains aquifer-wide, reservoirs, and other regions (ibid.). The organization of this agenda makes clear that different portions of the state face unique challenges that stand in the way of ensuring a reliable water supply. Brownback's Vision strongly encourages statewide action on the part of local entities: "A guiding principle of the Vision for the Future of Water Supply in Kansas is locally driven solutions have the highest opportunity for long term success" (KWO 2014:62).

One of the most ambitious themes within Brownback's 50-year Vision, "additional sources of supply," includes construction projects that will augment the state's surface water supplies in addition to reducing the declines of the High Plains aquifer. Chief among these surface water projects is the removal of silt in the John Redmond Reservoir nearly Burlington, an important water supply in eastern Kansas. Similar to other larger reservoirs in Kansas, Redmond is roughly 40 percent filled with sediments or suspended solids. Dredging Redmond represents a substantial investment: this project is expected to generate six million cubic yards of slurry, cost $25 million, and will take five years to complete (KWO 2014; AP 2015). All federal reservoirs in Kansas are silting, which is attributed primarily to inefficient farming practices that generate large quantities of sediments. For instance, Tuttle Creek Reservoir has lost roughly half of its capacity since the 1950s due to sedimentation; its northern branch now resembles a wetland instead of a lake (Streeter 2014). These reservoirs provide water to nearly two-thirds of Kansans (KWO 2014), making it imperative for the state to effectively manage both ground and surface water.

Other ambitious proposals beyond the 50-year Vision are being considered in order to augment the state's water resources. Some municipalities are constructing projects which can creatively make use of any excess water that flows during heavy rains. The city of Wichita built a treatment plant to clean excess water captured from the Little Arkansas River and pump it into the aquifer beneath the city for storage. This $80 million water system can treat and return 30 million gallons of runoff per day to the aquifer, where the city could draw on it later (Hart 2015). Thanks to this project, and other water conservation efforts that Wichita has implemented since the mid-1990s, the aquifer beneath the city is now gaining thickness and is nearly 96 percent full (Whisnant, Hansen, and Eslick 2015). The Vision states that expensive technological solutions and waterworks projects are seen as critical solutions for sustaining a water supply.

In response to irrigation's demand for tremendous amounts of water, the Kansas Water Office and US Army Corps of Engineers studied the feasibility of diverting water from the Missouri River to western Kansas. This project would involve the construction of an aqueduct 360 miles long that would require 15 pumping stations. Known as the Kansas Aqueduct, this proposal was first drafted in 1982 and revisited in January 2015, when it was established that the aqueduct would take 20 years to construct and cost $18 billion (KWO and US Army Corp of Engineers 2015). The annual operation, energy, and maintenance costs of the aqueduct would total $1 billion (ibid.). Approximately 3.4 million acre-feet of water would be pumped up 1,700 feet in elevation each year, which would weigh approximately 4.5 billion tons, over eight times the weight of every person on earth. Moving that volume of water uphill would require a gargantuan 8.8 million megawatt hours to operate the system. This amount of water exceeds Kansas's total extractions from the High Plains aquifer in 2013, which was 3.1 million acre-feet (Buchanan et al. 2015). Since Kansas uses about 4 million acre-feet of water annually (KWO 2014), this project could singlehandedly supply enough water for most of the entire state's water needs. If constructed, the Kansas Aqueduct would compete for the title of one of the largest hydraulic projects on earth, and would likely be the largest in the United States.[3]

Southwest Kansas is the region that could potentially benefit the most from the aqueduct if its groundwater supplies are depleted. The area uses half of the state's water, 2 million acre-feet, each year (Garetson et al. 2014). Proponents of the aqueduct insist that the state has to construct it, even if it costs nearly two decades' worth of irrigated corn (at 2013 prices). According to irrigators in western Kansas, who have suffered groundwater losses firsthand, the benefits of such a massive undertaking would far outweigh the exorbitant costs:

> The consequences of not [building] it are dire… We could take water from the Missouri and send it past Kansas. If it got to Denver and the front range of Colorado, the excess floodwater from Missouri will go to California and Phoenix. There will be work on [this proposal] from the Colorado basin states, so Kansas better be on board. (ibid.)

As a construction project, the Kansas Aqueduct proposal has few competitors in terms of its sheer magnitude, and if constructed it would be shrouded in controversy. Large removals from the Missouri River would likely raise a claim of interest in the water by Missouri—or any downstream state. Likewise, any of the Missouri River's eight upstream states may not allow the necessary flow for a future transfer of water to western Kansas. This level of removal makes it imperative to understand the interests of upstream and downstream states; both will want assurances that their water supplies will never be impeded. Taking water during the Missouri's peak flow periods might be viewed positively by Missouri and the remaining downstream states, but diverting water during non-flood periods would generate intense debates. For instance, even though Kansas and Nebraska have a water-sharing agreement for allocations from the Republican River, Kansas has sued Nebraska for damages on the grounds that it illegally removed water from the River. In August 2016, Kansas came to agreements with Colorado and Nebraska to ensure that the states comply with the Republican River Compact, which guarantees

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[3] California's water supply issues have forced policymakers and the state and federal level to consider massive construction projects. In the summer of 2016, state and federal officials proposed building a pair of tunnels nearly 35 miles long near Sacramento to deliver water from the Sacramento River south to residents and farmers in one of the most drought-ravaged parts of the state. These tunnels are expected to cost $15.7 billion (Smith 2016). Abroad, China's Great South-North Water Transfer Project, or the South-North Water Diversion Project (SNWD), which aims to steer Tibet's rivers towards the North China Plain, has been estimated to cost more than $62 billion (The Economist 2014). This diversion will take close to 35 to 40 years of non-stop construction and creates channels that redirect 39 million acre-feet of river water as far as 65 miles over very steep terrain (Pearce 2006; Chellaney 2011; Gall 2015). It is estimated that one of the northward legs will supply a third of Beijing's annual demand (The Economist 2014).

that an additional 40,000 acre-feet will flow into Kansas (Hancock 2016). Irrigators in Nebraska and Colorado were accused of pumping too much water for irrigation, which reduced the streamflow of the basin before the rivers reached about 350 landowners in north-central Kansas.

Surface water supplies, and rivers in particular, are often the sites of bitter disagreements because upstream users influence the allocations of downstream users.[4] In the spring of 2016, the Kansas Senate narrowly passed House Bill 2059, with sets up a regulatory process for the appropriation of surface waters that would leave the state. This is the first step to prepare for the massive water transfer of Missouri River water to western Kansas (even though the bill does not refer to the aqueduct directly). Residents of southwestern Kansas proposed the bill, which "could start a water war with Missouri and other downstream states…" (Johnson and Fund 2016:12). Even though lakes and rivers remain hotly-contested water supplies around the world, it is important to remember that surface water supplies contain just 0.3 percent of all freshwater, compared to the 30 percent held by aquifers (Montaigne 2002). How is the institutionalization of groundwater extraction in Kansas legitimized, and how are permits and allocation rights obtained? I will now review the laws and state agencies manage freshwater in Kansas, which is important for understanding how groundwater has been allocated or over-allocated across the state.

Kansas Water Law and Water Management

The exploitation of water resources has long motivated Kansans to establish legal restrictions for groundwater extractions. Groundwater policy in Kansas is a complicated web of state and local policies relating to groundwater's appropriation, use, and management. Since Kansas adopted the Water Appropriation Act in 1945, Kansas groundwater law has followed western water law, or the law of prior appropriation ("first in time, first in right"). While Kansas uses the doctrine of prior appropriation to organize its water rights, other states follow different ownership doctrines, and water laws in the United States are extremely fractionalized. In Texas, the approach of *absolute ownership* states that groundwater is essentially part of the land, so a landowner may use the water beneath their land regardless of its influence on their neighbors' ability to access

[4] As of this writing, October 2016, Florida is suing Georgia for extracting more than legally allowed from the Chattahoochee and Flint rivers for the purposes of growing cotton and peanuts in southwest Georgia. Florida claims Georgia is violating their agreement of "equitable apportionment" of the rivers which jeopardizes Florida's oyster industry; both state's respective industries of interest are worth several billion dollars (Chapman 2016).

the water; anyone can take as much groundwater as they can from below their land. The *reasonable use* doctrine states that if the landowner utilizes the groundwater for a reasonable beneficial purpose, they can do so even at the expense of their neighbor. California uses the *correlative rights* doctrine, which stipulates that each owner must respect the rights of their neighbors when considering their groundwater extractions (Peck 1982). As it happens, groundwater use in Minnesota must be sustainable, defined loosely as not allowing any "negative impacts" on the environment (Whitney 2015). There, the state's Department of Natural Resources oversees the appropriation of groundwater permits, and agricultural irrigation does not outweigh the protection of ecosystems over any sustainability standard. This permitting process has the same tone of "safe yield" permitting, but the standard of "no negative impact" have been challenging to set. In the truest sense of the word, "sustainable" withdrawals would not exceed recharge.

Before the approach of prior appropriation stipulated by the Water Appropriation Act, Kansas applied ownership doctrine to groundwater and surface water, which allowed landowners to withdraw water from aquifers or nearby streams regardless of the effects on their neighbors (Peck 1995). The act asserts that water in Kansas is reserved for the use of Kansans, and that the state is required to manage the system of water rights: "All water in the state to the use of the people of the state, is subject to the control and regulation of the state." It also declared that the water could be appropriated for beneficial use. The act established a permitting procedure for appropriating water and guidelines for the protection of Western Water Law, and established the date of priority for making allocation decisions. A water right is any appropriation right under which a person may lawfully divert and use water. It is a property right that can be bought, sold, or inherited like land or other property.

Managing groundwater use is also the responsibility of the Kansas Department of Agriculture's Division of Water Resources (KDA-DWR). The DWR sets regulations on the quantity of water used by administering water rights. State water laws are carried out by the Chief Engineer and the DWR; the Chief Engineer has the administrative power of the DWR and they enforce and administer the laws of the state regarding beneficial use and aid in the distribution of water across the state. They can approve, deny, or modify water rights, and enforce actions on unpermitted water use, require metering, and conservation plans (Fund 1993). In deciding whether a proposed use will unreasonably affect the public interest, the Chief

Engineer has to consider the area's minimum streamflow recommendations and recharge rates in addition to the priority of existing rights. The Chief Engineer determines if the proposed use will unreasonably influence water quality, streamflows, and the water table. Amendments to the Water Appropriation Act (which include a provision that makes it a misdemeanor to appropriate water without a permit) primarily focused on enforcing limitations on development. They have "no real impact on reducing water use under existing water rights… [and] no impact on reducing depletion" (Fund 1993:15).

Kansas law states that water is a public resource. Individuals, companies, and municipalities can be permitted to use the water after they obtain a water right. Surface and groundwater can be appropriated for beneficial use as long as the use does not impair a senior water right and does not unreasonably affect the public interest. Water rights are distributed sequentially, and water rights holders of more recent permits are instructed to not infringe on the allotment of those with senior water rights. *Senior* water rights and *Junior* water rights are relative; if a well owner's permit predates someone else's, they are the senior water rights holder. If there is ever insufficient water to meet all water rights, the oldest water right holders have the first right to use the water. The Water Appropriation Act protected water users by preserving the vested rights of the senior permit holders, and their rights could remain superior to new appropriation rights created under the act, as long as they used the water at least every three years (Water Appropriation Act 1945; Peck and Owen 1995). When permits are first approved, the permit holder usually has a five-year period to use the water and fully perfect the right. Following that, the DWR reviews the water usage over the permits first five years, and decides if the permit can be certified as a water appropriation right. The permit, therefore, sets the conditions under which a water right may be developed because the use of water in the permit's conditions is what perfects the right. While it is only mandatory for large-capacity wells to get permitted, in some cases domestic well owners also go through the process of permitting their wells.

Kansas has three types of water rights, each with a different level of restriction. Vested water rights are ones which predate the 1945 Appropriation Act; they are not affected by restrictions and therefore not constrained by contemporary limitations (Ashworth 2015). Senior water rights are slightly limited and junior water rights are restricted the most, as withdrawals by junior water right holders can theoretically impair nearby senior right holders (Peck 2002). More recently, senior water rights holders have sued for (and won) impairments from junior water rights holders (Ashworth 2015). The Kansas Water Office clearly states,

> Water rights do not constitute ownership of such water, only the right to use it for beneficial purposes. The date of a water right, and not the type of use, determines the priority to divert and use water at any time when supply is not sufficient to satisfy all water rights. (2014:6)

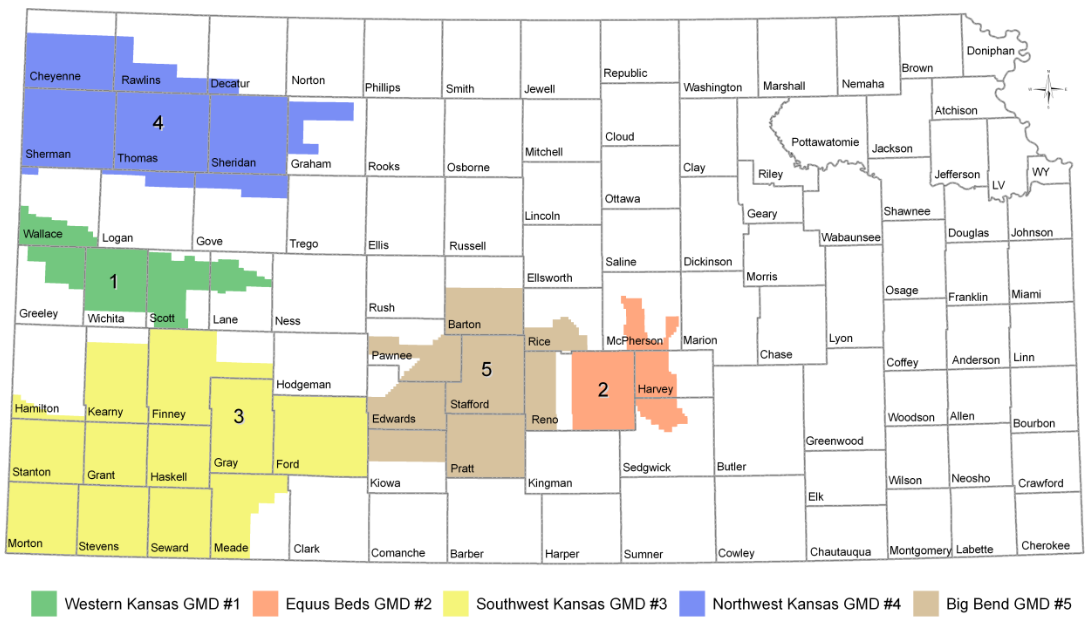
Kansas water law does not consider domestic water usage to be "beneficial," a term largely reserved for agriculture. If the water is used to irrigate commodity crops, it is legally beneficial.

Basic legislative policies on water resources reveal a tension in groundwater usage in the late 1970s and early 1980s. As the Kansas Water Resources Board was developing a State Water Plan in 1977, it said that the state of Kansas will encourage and promote "the maximum beneficial use, control, and development of the water resources of the state…[it must consider] maximum economic development of the water resources of the state for the benefit of the state as a whole" (Peck 1980:33). As a consequence of the combined mandate of beneficial use alongside the value of irrigated crops and corn-fed cattle, intense irrigation appeared to be the best economic option for the water supply of western Kansas. Irrigated acreage in the state hit its peak in the mid-1970s. Kansas essentially regulated its groundwater by using it to intensify production (Schrag 2014). The emphasis on development was exemplified by the approval of thousands of water permits and established rights. Therefore, the overallotment of groundwater is generally not due to farmers exceeding their water rights. The driver of groundwater depletion is the sheer number of permits that have been approved. Over 40 percent of water rights holders in the state do not even use half of their total allotment, and about one-sixth of farmers use only 10 percent of their allotment (Ashworth 2015). Exceeding a water allocation comes with penalties that can include a $500 fine and up to six months of jail time (KDA 2015). Repeat offenders face even larger deterrents: exceeding water allocations repeatedly could result in fines of up to $1,000; the fourth offense would be penalized with a 10-year suspension of well pumping (Carpenter 2015). These penalties may improve record-keeping, but they do not reverse the over-appropriation of the permits and rights to irrigation water. As it happens, some well owners in my study have acknowledged that their neighbors have lied about the presence of nearby wells when applying to get their wells permitted. In light of these behaviors, one of the 50-year Vision's action items evaluates changes to the Water Appropriation Act, which includes developing a water right violation and enforcement process that is better-enforced and implements more stringent fees for violations (KWO 2014). While few water rights holders exceed their allotment, the number of allotments is very high, which contributes to the depletion of the High Plains aquifer.

By 1980, the Water Resources Board requested that the Water Plan be changed to include conservation and to prioritized groundwater management and conservation as much as it has development. Every five years, the KWO updates the Kansas Water Plan, a key tool used by the state to address current water resource issues and estimate future needs. The State Water Plan was initiated by the 1963 State Water Planning Act. This legislative statement concerns water resources in Kansas and enables the state to develop long-term goals and update the plan as the goals are reevaluated. The KWO makes recommendations for updating the plan, but it must consider the legal framework set in place by the state and maximize benefits from development while ensuring management and conservation will benefit the state as well (Peck 1982).

Governor Brownback's 50-year Vision for the Future of Water in Kansas required tremendous efforts from the Kansas Water Office, as it is tasked with designing long range goals that include developing adequate water supplies for beneficial use. The Kansas Water Plan's priorities include "[Reducing] water-level declines rates within the Ogallala aquifer and implement enhanced water management in targeted areas… [and] Conserve and extend the life of the High Plains aquifer" (Liu et al. 2010:1). The State Water Plan is generally devoted to improving water quality and quantity, and it will implement the 50-year Vision by providing milestones every five years to measure success towards achieving the Vision. In 2014, KWO and the Kansas Water Authority established 14 regional planning areas across the state to manage water supplies within the region instead of taking a basin-wide or statewide approach (Governor Brownback stresses the importance of local control). These separate stakeholder groups are working to come up with goals and solutions in their own areas. Their formation was approved in conjunction with the 50-year Vision, and each region is expected to emphasize management, conservation, and development (KWO 2014). The KWO has been critical in soliciting feedback from residents across the state to describe the intent of the 50-year Vision, making it a key organization for networking and outreach.

Map 1b. Kansas Groundwater Management Districts



Source: Kansas Department of Agriculture (2014)

In 1972, Kansas created five Groundwater Management Districts (GMDs) to supervise well extractions. The Groundwater Management Act was intended to uphold the Water Appropriation Act by preserving basic water law doctrine, while establishing the right and responsibility of local water users to determine their future with respect to groundwater use (KWO 2014). These Districts are five clusters of counties that overlie certain portions of the High Plains aquifer and encourage water rights holders within their boundaries to use irrigation water prudently and improve their awareness of extractions. Local management is in the hands of GMDs, which were created to establish the "right of local water users to determine their own destiny with respect to the use of the groundwater" (Fund 1993). Each GMD has a Board of Directors who represents the district's water users. Board members are elected every three years and are responsible for fairly assessing groundwater management needs and adopting new policies to meet those needs (Equus Beds GMD 2014). The DWR Chief Engineer has the authority to approve proposals for groundwater management plans.

Yet when GMDs were first created, their primary mission was to allocate groundwater resources to maximize crop yields. This led to a tremendously unsustainable over-allocation of water rights. In the 1960s-70s the number of water right appropriations skyrocketed along with the spread of center pivot irrigation; in western Kansas the number of permits and rights are now nearly 40,000 (Ashworth 2015; Johnson 2015a). Over-pumping the aquifers was not a primary concern of GMDs when they were first formed, as people assumed that the High Plains aquifer was inexhaustible (Buchanan et al. 2015). It was not until 1977 when the Water Appropriate Act was amended to make appropriating water without obtaining a permit from the Chief Engineer a criminal offense, making it one of the first steps in penalizing water law violations (Peck 1980). In 1978, the legislature updated the GMD Act to allow the Chief Engineer to propose and establish IGUCAs (Intensive Groundwater Use Control Areas) in areas of particular concern. This provision gives the Chief Engineer the authority to reduce permissible withdrawals by any water rights holder—which can be challenged as a "takings" because water rights are property rights in the state (Peck 1995). IGUCAs are considered the most effective available tool around the legal barriers to limiting overdrafts. An IGUCA formation allows the Chief Engineer to call for special controls in a given area if groundwater levels have declined excessively and require regulation in the public interest (Fund 1993). The controls of an IGUCA can include closing an area to new appropriations and reducing groundwater withdrawals, even from senior appropriators.

One of the key contemporary legal battles over water rights in the state began in 1989 and involved the Cheyenne Bottoms Wildlife Refuge, which saw its streamflow and surface water supplies diminish due to excessive groundwater pumping. The Bottoms sued for infringements to their senior water right, and in early 1992 the Chief Engineer finally came to a decision that mandated water use reductions and cutoffs through the create of an IGUCA. All the water rights users had to give up some portion of their allocation in order for every permit holder to have some access to groundwater. This decision set a precedent because it mandated reductions. The Cheyenne Bottoms decision (technically known as the Wet Walnut Creek IGUCA) signaled the state's ability to enforce basic water law and to reinterpret existing laws and management tools. Instead of western water law, the decision made across-the-board reductions mandatory. During the state’s development phase, “first in time, first in right” may have been fair, but this doctrine needs to be highly modified. When groundwater supplies became over-allocated, as was the case in the Cheyenne Bottoms, the question of reallocating resources is the fundamental challenge facing groundwater users and policymakers.

GMDs are a unique form of district that provide a degree of local control over the groundwater depletion problems in western Kansas. Their management plans must be approved by the DWR Chief Engineer. GMDs have certain requirements that influence water user charges; they can request the Chief Engineer declare an IGUCA within the district, require meters, and adopt and enforce conservation policies. GMDs or eligible voters within a GMD can start a petition to recommend that the Chief Engineer designate an IGUCA whenever they discover an instance of groundwater mining. GMDs can also attempt to address existing rights within their districts. GMD 4 has followed a metering policy on all new wells since 1980 and has a safe yield policy for all new development, meaning that appropriations cannot exceed annual recharge. This district has been a leader in adopting innovative conservation policies, requiring all new wells follow a conservation plan (Fund 1993). The district also discussed a zero depletion policy for all water rights in 1990, but the Attorney General stated that it would violate the Western Water Law and be the equivalent of taking property. Legally, requiring water rights cut offs or reductions violates the “first in time, first in right” doctrine. A water right is a property right, therefore reducing it “without compensation constitutes a taking” (Fund 1993). Compensation for mandating a watering reduction would be very high, so it is not an option. However, if Kansans could agree on accurate prices on other components of water usage, like the fuel costs associated with high-capacity well pumping, commodity crops, or groundwater itself, it would help extend the life of the aquifer. IGUCAs are more effective than the GMD-based restrictions, which may not request stringent cuts or omit the oldest water rights. For decades, the High Plains aquifer simply has not been able to support all water rights, and cutting off development or halting new permits will not be enough to stop groundwater declines. IGUCAs have the control to implement across-the-board pumping restrictions on all water rights holders in a given area, which is a necessary step to stabilize water tables.

The current rate of groundwater withdrawals is faster than the rate of recharge, which leads to aquifer depletion. This has enormous economic implications for western Kansas, because cutting off irrigation completely would lead to an estimated loss of $300 million annually for the region (KSU 1998). Bill Graves, the Governor of Kansas from 1995-2003, set a goal of zero depletion of aquifer levels—which essentially would require withdrawal rates to stay within recharge rates and drastically cut well pumping. This measure was opposed by farmers and the farm lobbyists, who claimed the goal was too extreme (Davis 2003). Such resistance should be expected, since water rights are legally property rights and reducing the water rights of Senior holders violates the doctrine of prior appropriation. Few property holders would support a reduction or loss of part of their property. In 2011, Governor Brownback encouraged landowners to curtail their consumption with the signing of HB 2451, which eliminated the state's "use it or lose it" water policy that gave water rights holders the incentive to maximize their water consumption in order to maintain their right to extract groundwater. The Governor acknowledged the implications of rethinking appropriations for the future of the state:

> We must save our water and conserve so we may extend the useful life of the Ogallala Aquifer. Those of you with substantial water permits, I am now asking you to step up on behalf of your children and grandchildren. I ask you, if you have options, don't use the water. Save it for them...Without water, we have no future. (Office of the Governor 2011)

Pumping the aquifers into extinction was not an initial concern of Kansas policymakers and irrigators until water rights holders began to see their well yields decline and state's water tables dropped dramatically. In the later 1970s and 1980s, when the groundwater levels reached unprecedented lows, GMDs realized the severity of their over-allocation. Since then, they have been working to promote efficient irrigation practices. The GMDs are organized by area landowners and large-scale groundwater users, and they attempt to extend the life of the aquifers by limiting irrigators' water allocations and establishing safer yields for groundwater removal. More specifically, the districts restrict new (Junior) wells more than the wells of the established (Senior) users. GMDs allow local land owners and water users to be directly involved in regulating and restricting their groundwater withdrawals. Additionally, in 2011 a group of 110 farmers within the fourth GMD in northwestern Kansas created a Local Enhanced Management Area (LEMA). This group formed their own conservation plan and agreed to reduce their irrigation pumping by 20 percent. The locals defined their target of 20 percent, which was approved by the GMD board and then the Chief Engineer, given the LEMA is a state program.[5] Since reduced pumping rates lead to greater future groundwater availability, this restriction of irrigation is expected to extend the life of the aquifer in this area by roughly 25 years (Steward et al. 2013). Geologists recently estimated that modest reductions in pumping would stabilize water levels over key portions of the High Plains aquifer in Kansas. For instance, the Ogallala aquifer has an average annual decline of 18 centimeters in northwest Kansas, but wells in the region would only need to cut pumping by 22 percent to keep extraction rates within recharge rates in non-drought years (Butler 2014; Butler et al. 2014).

The Kansas Legislature has a growing interest in halting overdrafts and achieving such stabilization because it would preserve aquifers. Since the LEMA calls for a 20 percent reduction in average annual pumping over a five-year period, it suggests that the stabilization of water tables is possible through policymaking and new management frameworks at local levels—which is totally aligned with the small-government goals of the Vision. Short-term stabilizations can potentially eliminate drawdown (the temporary lowering of water tables caused by extractions) but the management structures need to be in place (and precipitation levels need to provide the aquifer with adequate inflow) for the pumping to remain even with recharge. GMDs 2 and 5, which overlie the Equus Beds and Great Bend Prairie aquifers, respectively, manage the aquifers based on safe yield policies, meaning that the water rights cannot appropriate more water than is recharged into those aquifers (Buchanan et al 2015). Adopting such policies over in the GMDs over the High Plains aquifer would require a tremendous decrease in water usage that would have a huge impact on farming practices and the economies of the communities in those GMDs.

State law requires all water rights owners submit an annual report of their usage to the Kansas Water Office (Stover 2013b). In 1988, the Kansas Legislature mandated that all water right holders file an annual water use report, adding that noncompliance would be penalized with a $250 fine (Peck 1995). In the hopes of deterring failure to report well pumping to the DWR, KDA officials now plan to raise the fines for water rights users who fail to submit an annual report to $500 (Carpenter 2015). Kansas is one of the few states that maintains a self-reporting

[5] Water Conservation Areas (WCAs) are another option similar to LEMAs. WCAs are voluntary restrictions set by a group of farmers. All of the neighbors can come to an agreement of cutting back, so they do not have to stay overly-concerned about the Tragedy of the Commons.

water use program, and the KGS and KWO have incredible working knowledge of water rights, which makes them highly regulated rights relative to other states (Wilson et al. 2015). When the Kansas legislature mandated that well owners submit a usage report to the Kansas Water Office, it did not require domestic well owners send information about their wells. Despite Kansas's groundwater regulation, which mostly focuses on high-capacity wells, *the groundwater withdrawals of domestic wells are not monitored and do not have to follow water rights restrictions*. Most of the areas of the state now have fully-appropriated or over-appropriated groundwater supplies. In these areas, individuals, cities, and industries will not be able to apply for new permits to the Chief Engineer, so if they want additional water they will have to purchase water rights from willing sellers (Peck and Weatherby 1994). With that said, since low-capacity wells used for domestic functions do not require permits in many parts of the state, one could conceivably augment their supply without acquiring additional permits if they relied on domestic wells. I refer to this reliance on low-capacity wells to sneak around permitting restrictions, or the expenses associated with relying in public water as the "domestic well loophole."

The exemption of domestic wells from the appropriation requirement has important consequences for managing aquifers. Accurate estimations of groundwater availability cannot be made if non-agricultural groundwater removal continues to be ignored. To illustrate how domestic withdrawals have not been monitored, consider an example from the eastern-most Groundwater Management District, GMD 2, which overlies the Equus Beds aquifer. In an effort to better understand groundwater withdrawals, GMD 2 has recently required *all non-domestic wells* in the district to be metered by the end of 2015 (Equus Beds GMD 2013). Although an important step towards tracking groundwater extractions, this move still excludes domestic consumption. Kansas only monitors high-capacity wells, but other High Plains states (Wyoming, Colorado, and New Mexico) require permits for all wells, including domestic wells (Ashworth 2006). If domestic usage continues to be overlooked, it could impact well users, agriculturalists, and municipalities. For example, groundwater studies in Salina, Kansas, estimate that households in the city remove nearly 1,000 acre-feet (325 million gallons) of groundwater annually (Wilson et al. 2008). The findings in Salina imply that if domestic wells are not monitored, it could lead to intense competition for groundwater supplies and disputes among water rights holders who are legally ensured to their water allocations. Well-owning Kansans should therefore practice water conservation in both agricultural and non-agricultural settings. Researchers interested in the welfare of the High Plains aquifer need to examine how people reliant on its groundwater adopt water-saving routines in addition to their perceptions of water usage.

RESEARCH AGENDA

This dissertation probes domestic water conservation and provides a more accurate sense of groundwater usage. To better understand household water usage, I surveyed well owners and non-well owners across the state, with a primary focus on analyzing how reliance on aquifers changes Kansans' tendency to conserve water. Investigating well owners' dependence on groundwater will generate insight concerning resource management in the High Plains. The guiding research questions of this project are: (1) How is domestic water usage influenced by well ownership, especially during droughts? (2) Does well ownership bring about a new definition of environmental citizenship and stewardship, specifically an urge to protect groundwater by exhibiting a form of groundwater citizenship? (3) Are Kansans who reside in GMDs approaching water conservation differently than Kansans who reside elsewhere? (4) How does a well's specific function change the relationship between water usage and well reliance? Generally, my dissertation explores how well owners' attitudes about water influence their decision-making, and how their practices are contoured by groundwater concerns.

As I will show in the upcoming chapter on the literature related to my study, researchers have closely analyzed the adoption of "pro-environmental behaviors" with demographic variables (e.g., age, class, sex, political affiliation, urban and rural residence). Some research indicates that greater support for climate change policies were predicted by higher income, being African American, and older age (Dietz, Dan, and Shwom 2007), and that political views remain an important predictor in political action on climate change as well (McCright and Dunlap 2011b; Dunlap and McCright 2015). I anticipate that water conservation will be a pro-environmental behavior that is closely associated with water supply infrastructure. Previous work on rural families in the High Plains suggests that without a municipal water supply, families developed a sense of frugality "that lingered after the faucet replaced the water bucket" (Foth 2010a). Connections to public water infrastructures are a critical part of resource accessibility, and should therefore be associated with different standards of water usage. *Wells represent a key component in water supply infrastructure that influence important pro-environmental behaviors;*

therefore, I anticipate that the presence or absence of a well will serve as a useful predictor compared with other demographic variables that have been previously studied in the social sciences.

I hypothesize the correlation between water conservation techniques and well dependence will be influenced by two crucial variables: geographic residence and the function (or purpose) of the well. According to this prediction, respondents who reside above the High Plains aquifer will practice water conservation more regularly than respondents who do not live in GMDs. One promising test site for this study will be Sedgwick County, which contains the state's largest city, Wichita. Sedgwick County boasts nearly 58,000 wells alone, over one-fifth of all the wells in Kansas, and the northwest corner of the county overlaps the Equus Beds aquifer and is part of GMD 2. Wichita's unique reliance on groundwater emerged in the early 1940s, when the city leased land in Harvey County (to the north), drilled wells, and diverted water roughly 20 miles south to Wichita (Peck 1995). More recently, the city has increased its residential water rates. Incidentally, virtually all of the wells recently constructed in Sedgwick County are listed as "lawn and garden" wells, which are low-capacity wells that are only intended for outdoor usage. Since low-capacity wells do not need permits and do not have to comply with most lawn watering restrictions, lawn and garden wells can be installed to bypass lawn watering restrictions and avoid water rate hikes—another facet of the domestic well loophole. Interestingly, according to records of registered wells, about one-third of all domestic wells in the state are used for lawn and garden watering (KGS 2013a). Research on well ownership and domestic water usage suggest that many households dig private wells when large-scale changes like price increases or rationing are introduced (Thomas and Salerian 1987). Some well owners' relationships with their wells might incline them to actually *disregard* water restrictions instead of parsimoniously using their well water.

This leads to my second prediction: that the relationship between well ownership and water conservation will be moderated by the type of well in use. While I provide more details about moderated relationships in the fourth chapter, I should note that moderation analyses can determine whether water conservation varies between well owners of different types of wells. In order to fully investigate the issue of moderation, I distributed surveys to owners of a variety of wells (e.g., domestic, lawn and garden, irrigation, and livestock). Exploring the spectrum of well owners enhances my understanding of how certain wells are associated with specific watering practices, and examining the connection between a well's function and its owner's conservation practices is vital to my research agenda.

One of the seminal articles on sociological dimensions of water management framed water-related policymaking as a "wicked problem" (Freeman 2000), meaning that there is no clear-cut solution that benefits all stakeholders and therefore the problem is essentially permanent (Rittel and Webber 1973). If sociologists strategically utilized their perspectives to analyze local (ground)water management organizations, it could improve water resource management, and my project emphasizes the importance of applying environmental sociology and policy to conservation efforts in Kansas. Sociology can augment water supply challenges by examining the interface between well owners and the agencies that are connected to centralized planning, municipalities, agribusiness, and aquifers. As argued in Chapter 4, this research also makes contributions to environmental sociology through its application of ecological Marxism and discussions of neoliberalism (the political promotion of economic growth) in the High Plains. Marx argued that capitalism organizes the conditions of production in a way that exceeds an ecosystem's ability to renew its resources, creating a "metabolic rift." Furthermore, I argue that the interests of large agribusiness actors and individual farmers in Kansas are in contradiction, though they appear to be compatible on the surface. Neoliberalism instills an ethic of economic growth among citizens and corporations, but economic competition, risk-taking, and individualism tends to benefit the most powerful, largest economic players (such as Confined Animal Feeding Operations) and hurts less influential producers (such as private farmers).

It is important to emphasize why the tragedy of the commons is not simply rooted in a problem between the group and the individual—it is class conflict. Market relations accentuate wealth and power differences because the entrepreneurial class has more purchasing power and creates a situation of unequal exchange. Global food production has placed an immense burden on the residents of the High Plains who have access to large groundwater formations, but the individual agriculturalists are pressured to grow foods that are subsidized, monocropped, and demanding on water supplies. Scarcity itself is an aspect of capitalist relations, but its specific form is determined through the international food order (Friedmann 1982). Industrial agriculture companies have been central to the exploitation groundwater supplies across Kansas. The application of markets to nature allows the capitalist class to transform land from a property of the commons into commodified private property (O'Connor 1988). When entrepreneurs extract resources for production, they modify nature and influence future interactions of communities with their ecosystems—particularly when they withdraw resources more quickly than they can be naturally replenished. Sustaining high levels of growth *without* commodifying groundwater (and therefore not using market signals to generate economic activity) seems ironic in the context of neoliberalism. If groundwater is free, it has an inadequate exchange value, which will require policymakers to disobey the neoliberal notion of low government intervention and actually invest more in planning. In the hopes of slowing the rate of water table declines and ensuring economic growth in the future, conservatives in Kansas have subtly acknowledged that championing economic growth has also lead to the exploitation of the state's finite water supply. The goal of securing a long-term water supply therefore calls into question the role of the government planning. Suffice it to say, this research aims to make important policy recommendations that could provide a framework for developing more effective groundwater management policies, and, in turn, preserve aquifers. Before continuing to the next chapter, which presents the relevant literature, I must conclude this chapter with a word about the importance of my work.

BROADER IMPACTS

Household water usage and well reliance have not been sufficiently studied in the High Plains. This dissertation analyzes well ownership and domestic water conservation in Kansas, which should provide researchers and policymakers a more accurate sense of how structural conditions influence environmental behaviors and attitudes. Currently, Kansas only monitors high-capacity wells, but evidence suggests that low-capacity wells can also contribute to groundwater losses (Wilson et al. 2008). Any extractions exceeding recharge are not safe and will ultimately jeopardize aquifers and many aquifer-based communities. Sustainable groundwater management can only be achieved if withdrawals are kept within recharge rates. Furthermore, if water is not conserved for both domestic and agricultural purposes, then domestic usage will eventually compete with the water needed for food production. Competition for water will remain a key struggle for decades, especially as climate change has a "growing impact on agriculture due to changing rainfall patterns… warming temperatures, aridity, and greater uncertainty" (White 2013:109). Simply put, water security is a critical starting point for food security (Black 2004), and contextualizing domestic watering practices within specific groundwater formations and infrastructural systems can improve the understanding of how resources are managed for all uses.

It would be easy to blame irrigation for all of the state's water troubles. Irrigated agriculture is the primary water consumer in Kansas and it produces the largest overdrafts.[6] Nevertheless, I contend that domestic water usage is a valuable, yet neglected, component of groundwater extractions in Kansas, and households should also use groundwater judiciously. Several municipalities rely on groundwater, and while household usage only represents 1 to 3 percent of all the groundwater pumped in the state (WSC 2012; Maupin et al. 2014), and 10 percent of all the water used in Kansas (KWO 2014), this is not the case for its most urbanized counties. Douglas, Johnson, Sedgwick, Shawnee, and Wyandotte counties have some of the largest cities in Kansas, where residential requirements represent most of the water usage (KWO 2014). Reducing household water usage in these communities would be a significant achievement. Urbanized water consumption has taken its toll on aquifers throughout the country, making indoor water usage a critical component of groundwater losses. Farmers across the nation have sold their water rights to expanding cities as water use has shifted from rural to urban consumption (Prud'Homme 2011), which implies that municipalities will need to invest more in conservation efforts to preserve their surrounding farming communities, and improve their resilience as they enter an age of water scarcity. Sociologists have recently outlined how household energy consumption is linked to climate change (Ehrhardt-Martinez et al. 2015); through this research, I intend to make a modest step forward in understanding how domestic water usage contributes to overdrafting.

Furthermore, even in communities where domestic water consumption constitutes a modest percentage of overall groundwater pumping, the extractions attributed to household usage should not be overlooked. While the potential ramifications of climate change in the Great Plains are difficult to assess, the evidence suggests that Kansas will continue to face warmer, drier growing seasons (Brunsell et al. 2010). The Midwest normally experiences a slight reduction in rainfall seasonally as spring transitions into summer, but warmer temperatures can induce rapid declines of summertime precipitation (Wang et al. 2015). In an era of worsening droughts, communities reliant on aquifers would be wise to closely monitor even the relatively small volume of water typically used by households. This is particularly important for rural

[6] At least 84 percent of the water drawn in Kansas is used for irrigation (Stover 2013a). This estimate is slightly lower than other approximations, as the Water Systems Council (WSC) has placed irrigation's consumption to represent 90 percent of the water used in Kansas (2012). Sophocleous and Sawin (1997) estimated 92 percent of groundwater usage in the state is used for irrigation.

communities, since groundwater is the drinking water source for 90 percent of the rural population in the United States and nearly all of the nation's self-supplied sources draw from groundwater supplies for domestic water (Lemley and Wagenet 1993; Maupin et al. 2014). While the 50-year Vision mentions the importance of keeping water tables stable enough to support small-capacity domestic wells (KWO 2014:30), *well owners* themselves are not explicitly mentioned once in the document, yet their relationship with the High Plains aquifer is pivotal to preserving the state's groundwater supplies. On a larger note, nearly 15 percent of Americans, some 45 million people, rely on private wells for household and drinking water, including 364,000 Kansans (CDC 2012; WSC 2012). Well owners therefore constitute a population of particular importance, as their concerns about groundwater supplies can influence their decisions to implement conservation strategies. Regardless of rainfall or water table fluctuations, well owners must balance their practices with their hydrologic realities. Policymaking can help achieve such transitions. Growth (and perhaps life itself) in the semiarid plains is contingent on carefully managing surface water and groundwater supplies.

Groundwater withdrawals also affect water availability beyond the sites of extractions. Rapid reductions in an aquifer's saturated thickness often lead to surface water changes that can be detected far from the wells making the withdrawals. In fact, the interaction between groundwater and surface water is critical to understanding the broader consequences of unsustainable groundwater removals. Substantial overdrafting upsets the natural balance of how aquifers are recharged because wells intercept groundwater that is otherwise discharged into rivers and streams. When extractions are large enough to significantly shrink an aquifer's saturated thickness, these lowered water tables coax surface water percolation into the aquifer, which is referred to as induced recharge (Sophocleous and Sawin 1997). As a result, groundwater extractions can magnify water scarcity because the lowered water table attracts surface water, causing reductions of streams and other bodies of surface water adjacent to depleted aquifers. Groundwater systems are not isolated from the hydrologic cycle, as fluctuations in regional aquifer systems can cause changes in surface systems. Declining stream flows in the Arkansas River, located in south-central Kansas, illustrates the collateral damage caused by the intense mining of the Ogallala aquifer. This river has been reduced to a dry streambed because its streams are no longer fed by groundwater. In fact, due to insufficient groundwater supplies, "the major perennial streams are gone in the western half of the state"

(Butler 2014). Additionally, large irrigation withdrawals in northwest Kansas have caused streamflow declines in the region since the 1940s (Whittemore 2015). Simply put, the base flows of perennial streams suffer tremendously when the water table is lowered.

Since surface-groundwater systems are interconnected, the massive groundwater extractions in the Great Plains have brought about changes to surface water resources. Understanding these complex interactions and conceiving groundwater and surface water as a region's full "water budget" will be crucial to effectively manage water resources (Kranz et al. 2004; Pun 2014). Groundwater declines that lead to a loss of surface water represent how damaging dewatering feedback loops can be, particularly in an agricultural region projected to face severe droughts and heat waves. With the looming prevalence of "tipping points," which occur when small changes can push ecosystems into irreparable damage or collapse, such extractions should be seriously avoided (Lenton et al. 2008). Environmental stressors have become so robust they are pushing ecosystems to the brink; even minor changes could result in cascading, long-term consequences that permanently damage ecological systems.

Furthermore, earth scientists now acknowledge that human agency—namely, the generation of throughput[7] and greenhouse gas emissions—is a serious determinant of geologic conditions, resulting in a new geological epoch known as the Anthropocene (Crutzen 2002; Zalasiewicz et al. 2008; Rockstrom et al. 2009; Zalasiewicz et al. 2010; Steffen et al. 2011; Clark 2014; Molina et al. 2014). The modern biosphere represents a fundamental change in the evolution of the global ecosystem, as the production and assimilation of fossil fuels have now created a "technosphere," a system including humans, technology, and the biosphere (Williams et al. 2015); new evidence now suggests that the human influence in the global biosphere and ecosystem engineering are almost inescapable (Boivin et al. 2016). Moreover, social interactions and interference with the hydrological cycle has altered how water functions in the biosphere, resulting in a "hydro-social cycle," not merely a hydrologic cycle (Swyngedouw 2009). In this new era of social and climatic hybridity, "Natural forces and human forces became intertwined, so that the fate of one determines the fate of the other" (Zalasiewicz et al. 2010:2231). Anthropogenic warming exacerbates droughts because higher temperatures increase evaporation

[7] This is the amount of energy and matter involved in economic cycles, including resource extraction, production, use, and disposal of commodities.

and reduce levels of surface water (Williams et al. 2015). Warmer conditions “dry out” the surface, making hotter temperatures responsible for precipitation deficits.

Overall, droughts and heatwaves are each *individually* not extremely problematic for ecosystems and vulnerable populations, but when combined, their severity becomes amplified. Researchers investigating the intensity of California’s drought now confirm that upwards of 25 percent of the droughts’ severity has been caused by warming related to increased greenhouse gas emissions; the state’s aridity is also expected to be prolonged because of the anthropogenic warming (MacDonald et al. 2016). Intensifying droughts have now caused the partial collapse of food webs and species interactions, signaling an abrupt shift within ecological networks that fundamentally threatens many species’ existence (Lu et al. 2016). Unfortunately, periods of low precipitation and high temperatures are expected to coincide more frequently in the United States (Mazdiyasni and AghaKouchack 2015), suggesting that aquifers will be increasingly utilized as water supplies. This is sociologically important because groundwater declines represent hazards that will make well owners particularly vulnerable to drought. Groundwater-dependent communities are in biophysically risky locations, but their overall drought vulnerability is disproportionately distributed on individuals with private wells.

Evidence also suggests that stationarity, the tendency for ecosystems to operate within an expected range of fluctuations, has been lost forever (Milly et al. 2008). This implies that climate records and models projecting climate change could become less reliable, since the loss of stationarity essentially infers changes that constitute a different planet. Despite the best efforts of climatologists, climate remains difficult to predict (Forman 1995; Barnosky et al. 2012). Scientists measuring major environmental events have recently concluded that environmental change is now happening faster than any other time in history, as previous geochemical events came about nearly a thousand times slower than they are now (Naafs et al. 2016). Researchers will have more challenges modeling climate change scenarios because the “unchanging envelope of variability” previously found in natural systems has become destabilized (Milly et al. 2008:573). What is worse, due to the thermal inertia of climate systems, previous and current releases of greenhouse gas emissions are going to drive climate feedbacks in the future. With atmospheric and oceanic concentrations only escalating, it is already too late to stop some level of warming (Solomon et al. 2009). In February 2015, carbon dioxide concentrations registered 400 parts per million (ppm), the highest concentration recorded (Biello 2015); later that spring, the planet experienced the warmest May on record (NOAA 2015). Climate scientists now confirm that 2015 was the hottest year ever recorded, and high levels of greenhouse gases are one of the main drivers of global warming (NOAA 2016; Blunden and Arndt 2016). Atmospheric concentrations of carbon dioxide are expected to rise for decades, and carbon dioxide levels are increasing faster than they have in hundreds of thousands of years (Readfearn 2016). The world's concentration of carbon dioxide is now on track to remain *permanently* above 400ppms—a "point of no return" (Betts et al. 2016; Slezak 2016).

Scientists have cautioned that preventing an abrupt "state shift" in the earth warrants restoring normalcy in the biosphere via urgent reductions of emissions (Barnoksy et al. 2012). Leading economists now confirm that low carbon energy production is now the only viable option, and "high-carbon growth will eventually be self-destructive" (Carrington 2016). Scientific advances in the field of "extreme event attribution," which identifies whether extreme events can be attributed to human activity, now provide evidence that anthropogenic warming will continue to increase the intensity of heat waves and droughts (EDF 2016). Human activities could force climate systems into a new state defined by less predictable behavior, "One of the most important impacts of climate change will be its effects on the hydrological cycle and water management systems, and through these on socioeconomic systems" (Young, Dooge and Rodda 1994:90). Climate change ushers in larger, non-stationarity changes, and these fluctuations erase what it means to have a "normal" climate.

As the climate of the Great Plains and the American West becomes less predictable, areas prone to drought must acquire a precise understanding of groundwater availability to prepare for a new hydrologic reality defined by more frequent, intense water shortages. Hydrologists now accept that climate change introduces new uncertainties into the hydrologic cycle, and that social structures are major intervening factors of water availability: "…it no longer makes sense to study only natural hydrological cycles. For this reason, some studies have started to consider the impact of human interventions on the hydrological cycles…" (Oki and Kanae 2006:1069). Studying routines of conservation and managing water supplies will be critical in an era of warmer climates and grueling droughts. Groundwater estimates in Kansas do not currently monitor the groundwater removal associated with domestic demand; therefore, studying domestic water usage will give communities, researchers, and policymakers a more detailed grasp of groundwater availability. Aquifers, as well as the infrastructures and communities drawing from aquifers, must be thoroughly examined in order for Kansans to develop coordinated drought adaptation policies, and domestic water usage will be an increasingly important variable when researching the future of groundwater across the state. As I explain in Chapter 2, arrangements of water provision, specifically municipal supplies and private wells, influence water consumption in ways that are sociologically important.

CHAPTER SUMMARY

> Chapter one explained the background of water consumption in the state and contextualized the role of the High Plains aquifer in Kansas. It also introduced the guiding research questions and importance of the study. Groundwater development has emerged as a major problem in western Kansas, particularly in the second half of the twentieth century, yet the sociological dimensions of this remain understudied. Examining well owners, whose decisions play a large role in the severity of overdrafts, creates a picture of the interaction between the hydrogeological, political-economic, and communal structures in the High Plains. Given the reports of rapid groundwater depletion, well reliance must be carefully analyzed. By studying the water conservation practices of well owners in the High Plains, my project provides new insights about a group of individuals who rely on the largest aquifer in the nation. Understanding domestic water consumption's impact on water tables will become ever more valuable as climate becomes less predictable. Managing water will be one of the greatest environmental challenges of the future, and all forms of water usage, including domestic watering practices, will influence groundwater availability. The agency and behaviors of well owners (and the policies that regulate their water usage) need to be synthesized in order to extend groundwater supplies. In the next chapter, I outline how the relevant literature has influenced my approach for studying well owners and water supply infrastructure.

Chapter II: Related Literature

This chapter details the research on groundwater, domestic watering practices, pro-environmental behaviors, water supply infrastructure, communities of practice, and well owners. It also describes my rationale for emphasizing well ownership as an important determinant in the normalization of watering routines. My study draws on theories of sustainable practices, which allows me to conceptualize well owners as a specific community of practice defined by their conservation routines and connection to their groundwater supplies. Private Water Extraction Mechanisms (WEMs) and municipal systems represent different systems of water provision, which affects the users' relationship with water in a number of ways. Urban centralized water systems are more secure than private wells, they also outline the borders of citizenship. I argue that water usage is influenced by infrastructural context, but the presence or absence of a well signifies a critical piece of infrastructure that has gone understudied within the literature on sustainable practices, the sociology of water usage, and citizenship. In fact, I contend that well ownership will moderate watering routines and should be much further analyzed in pro-environmental behavior research.

GROUNDWATER MEASUREMENTS IN KANSAS

Effectively managing water resources requires clear information on groundwater and surface water supplies. Despite its importance, groundwater volumes are more challenging to measure compared to surface water supplies because monitoring large aquifers is expensive and complex (Famiglietti 2014). Fortunately, the Kansas Geological Survey (KGS) constantly produces new findings on groundwater and oversees thorough, well-managed webpages outlining aquifer withdrawals. The KGS has measured groundwater levels in Kansas since 1997, data previously acquired by the United States Geological Survey (Davis 2003). KGS organizes and disseminates information on subsurface water through its website, which includes changes in groundwater levels, databases on wells, and lists of water rights in Kansas. KGS's Water Information Management and Analysis System (WIMAS) lists the quantities of water appropriations and the historical water usage for water rights, along with maps outlining the authorized places for irrigation and the points of water diversion for industrial, irrigation, municipal, and other types of water rights. Local, state, and federal agencies use the information provided by KGS to determine water appropriations and take regulatory actions. Landowners, irrigators, industrial users, and other well owners can use these resources to monitor water tables and make informed decisions about groundwater use.

Changes in the state's groundwater levels are monitored by the KGS-sponsored Annual Water Level Measurement Program, which posts the saturated thickness beneath approximately 1,400 agricultural wells in 47 western counties in the *Kansas High Plains Aquifer Atlas*. This atlas is updated every January as it tracks the depth to the water table for each respective well (Miller, Buchanan, and Brosius 1999; Buchanan 2013; also see KGS 2013b). In some areas the saturated thickness has been reduced as much as 60-70 percent since irrigation well pumping started in the mid-1940s (Butler 2013). Well usage is further monitored by the Kansas Water Office (KWO), a small agency that develops solutions to water resource problems by constructing a State Water Plan. KWO also keeps track of annual reports submitted by water rights owners, as state law requires all water rights owners submit an annual report of their usage (Stover 2013b). These reports (and others) are considered by the policymakers responsible for short-term water conservation goals, making the timely delivery and accuracy of reports key for governing groundwater.

One of KGS's most extraordinary collections of data regarding groundwater usage is its records of wells dug in the state. Whenever a well is dug or plugged by a drilling company, they file a Water Well Completion Form (WWC5). This form outlines where the well is located, its depth, how it will be used, and the nearest possible sources of contamination. There are nearly 250,000 WWC5s on file that have been individually scanned into the database, which date back to 1974 (see KGS 2013a). The dataset also reports the well owner's contact information, making it one of the few datasets on well owners in Kansas. Despite the state's impressive organizations and records of groundwater measurement, the present system for tracking aquifer depletion fails to measure how domestic wells contribute to groundwater removal; therefore, the current estimated withdrawals are being guided by incomplete data. Accurate estimations of groundwater availability cannot be made if the groundwater removal of low-capacity wells continues to be ignored. When the Kansas legislature mandated that well owners submit a usage report to the Kansas Water Office, it did not require domestic well owners send information about their wells. As outlined in the first chapter, many portions of the state do not require low-capacity wells to be metered, and even though other states demand permits for wells of all capacities, Kansas excludes domestic wells. By analyzing domestic water conservation among both high-capacity and low-capacity well owners, my research addresses a facet of this incomplete record-keeping.

DOMESTIC WATER USAGE AND CONSERVATION

Water *consumption* and *usage* are not technically synonymous, as consumption refers to water that is lost from a particular catchment area (rivershed) or groundwater supply (aquifer). Usage describes water that is withdrawn from its source to be used for some purpose, but later returned. It is challenging to decipher the proportion of domestically-used water which is completely removed from its original source. For this reason, I use *consumption* and *usage* interchangeably. Since my dissertation measures domestic watering practices, some water associated with domestic usage eventually gets returned to its original supply, but it depends on the households' infrastructural context and how their water supplier manages the water used domestically. When describing larger watering practices, like irrigation and livestock watering, some water is lost through evaporation or incorporated into a plant's stock or an animal's body for growth. On the note of usage, water *reuse* is appropriately using wastewater that has not received treatment; water *recycling* is using wastewater after it has undergone treatment processes to get the water ready to use again (Sedlak 2014). Interestingly enough, Chanute, Kansas was home to the first potable water recycling facility in the nation, built in 1956 to temporarily provide relief from a drought (Metzler et al. 1958). Nestled in the far southeastern corner of the state, Chanute is located in Neosho County, an area that has the highest annual participation in the state and is not very reliant on groundwater (my survey received only 3 respondents from Neosho County, none of whom were well owners).

Distinguishing consumption from usage helps researchers understand the renewable and non-renewable properties of water, but water supplies are conceptualized into even more multi-dimensional categories than the consumption/usage dichotomy. Researchers rely on three labels to classify water by its source and cleanliness: blue, green, and grey water (Hoekstra 2013). *Blue water* is represented by surface and groundwater sources and is typically generalized as being nonrenewable or slowly-renewable. Groundwater irrigation farming is bolstered by utilizing blue water supplies, which are challenging to restore, in addition to rainfall. Roughly half of irrigation water that is pumped from groundwater supplies actually gets used by plants; the remainder can flow into the ocean, evaporate into the atmosphere, or return to the aquifer as recharge (Kustu, Fan, and Robock 2010; Wada et al. 2016). *Green water* is rainwater, and since dryland farming only uses rainfed crops, it does not use blue water supplies and survives solely on green water. Within Kansas, 84 percent of the wheat production comes from dryland farms (Hoekstra 2013), so this crop does not rely heavily on irrigation stemming from blue water (groundwater) supplies.

Greywater is the water that becomes polluted during its usage.[1] As it is used, freshwater often assimilates pollutants that make it unfit for future usage. After it is used and dirtied, it is transformed from blue or green water into greywater. Households can invest in greywater systems which directs the water that has been previously used by laundry washing machines, dishwashers, and showers towards other uses, typically associated with outdoor watering (Pabich 2012). Lightly-dirtied greywater can be reused for some practices, which reduces the demand for freshwater coming from blue or green supplies, but proper greywater management needs to be recognized as a means for improving water quality in many parts of the world. Virtually all domestically-used water in Latin America and India is discharged directly into the nearest stream or river, making poor domestic management a major pollutant of riversheds (Black 2004). Finally, while the term water *shortage* refers to the actual physical amounts of water available (which typically occur from a lack of rainfall, aridity, or changes in climate), water *scarcity* is the inability to meet needs, usually molded by social and political dimensions that can be a social construct or the result of affluence, lifestyle choices and expectations (Lankford 2010). Studies of water usage typically address not only the volume of water used by specific practices, but also the green, blue, and grey components associated with those practices. My project is specifically concerned about the role that groundwater plays in the lives of well owners in Kansas, so to apply the lingua franca of water researchers' taxonomy, my dissertation probes the conservation routines associated with the usage and consumption of subterranean blue water.

Although water conservation can pertain to agricultural, industrial, or commercial consumption, my focus is primarily on indoor and outdoor domestic usage. Resource conservation has been studied since the 1970s, and many of the terms used to describe conservation ("efficient use", "sustained yield", "stretching the supply," and "resource savings") can be applied to the conservation of water, which I define as a deliberate reduction of water usage through behavioral changes or technological efficiencies.[2] Governor Brownback's 50-year Vision describes and promotes water conservation in several ways:

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[1] Blackwater (water typically used in toilets that contains urine and feces) is sometimes included in the category of greywater.

[2] This definition has been influenced by other general definitions of water conservation, such as "Activities designed to reduce the demand for water, improve efficiency in use, and reduce losses and waste of water" (Beecher and

• Strategically emphasize information and education regarding the importance of water and water conservation practices
• Implement additional or enhanced water conservation policies and practices
• Reduce barriers and increase development of locally driven conservation and management plans
• Encourage conservation planning in economic development and business recruitment
• Increase adoption of watershed practices that reduce future water supply loss.
(KWO 2014:14)

The estimates regarding the percentages of household water usage used by specific appliances, and how much water can actually be conserved via the installment of water-saving appliances, vary from study to study. One study estimates that typical patterns of indoor consumption in the US devote 85 percent of water to bathing or showering, flushing the toilet, and laundry washing (Black and King 2009). Researchers in the UK established that average water consumption is comprised of 34 percent for toilets, 20 percent for showering and bathing, and 17 percent for dish washing and kitchen sink usage (Medd and Shove 2007). However, other research suggests that the three largest indoor water users—toilets, showers, and washing machines—only account for half of overall household water consumption when lawn watering is included (Sedlak 2014). My synthesis of the literature on domestic water conservation has led me to believe that technological efficiencies—installing efficient toilets, washing machines, dishwashers, showerheads, and faucets—can reduce indoor water usage by 45 percent (Inskeep and Attari 2014). This figure is close to a median estimate put forth by studies examining the investment-based approaches to improve water conservation.[3] Despite these varied statistics offered by numerous studies, most indoor water usage is used for toilets, showers, and laundry washing; therefore, efforts to conserve water should target these associated technologies and frequency of usage.

Optimizing water's domestic usage inherently requires efficiently using it, but improving the use per unit of production (or getting the most "per drop") can still lead to a growth in the total volume of water used as efficiency improves. Watering industries have reported that water

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Laubach 1989), and "The wise use of water with methods ranging from more efficient practices in the farm, home and industry to capturing water for use through water storage or conservation projects" (Waskom and Neibauer 2002).

[3] Other studies of domestic water consumption estimate that investing in a low-flow showerhead, faucet aerator, and efficient toilet) can reduce indoor domestic usage by 33 to 50 percent (Vickers 2001; Western Resource Advocates 2003; Black and King 2009).

consumption can increase even as technological and consumptive patterns improve, leading to a phenomenon known as Jevons Paradox (Jevons 1865)—where the "saved" resources made available by new techniques are used for additional usage and the savings are completely offset. Thankfully, there is sparse evidence suggesting the Jevons Paradox occurs within the context of freshwater use (Ward and Pildio-Velazquez 2008; Crase and O'Keefe 2009). Even though the average gallons per day used domestically by residents of the United States remains somewhat higher than the amount of water typically used in other developed countries, overall domestic water usage in the US has declined due to more efficient water using devices (Fishman 2011). For instance, over the past two decades, water-efficient fixtures have enabled cities in California (and the state itself) to reduce or stabilize their municipal water volumes while increasing their population (Reese and Sangree 2014). These trends are promising, but as droughts are expected to test the resilience of communities reliant on aquifers, the investment in appliances still needs more attention.

Technological efficiencies are important for conserving water around the house, but curtailing water usage by adopting new habits can offer substantial savings as well. Reducing toilet flushes, limiting showers to five minutes, and washing full loads of clothes have been found to be among the most effective indoor actions households can adopt to conserve water. Modest curtailment—deliberate behavioral adjustments for saving—can lead to a 30 percent reduction in water usage, but it is slightly less effective at cutting overall indoor conservation than utilizing water-efficient appliances (Inskeep and Attari 2014). Moreover, evidence suggests that behavioral changes to conserve water are challenging to permanently routinize. Curtailment methods of reducing household demand are typically widely adopted only during droughts or water supply shortages (Vickers 2005; DeOreo 2006). If behavioral changes of water usage are usually temporary, and if climate change exacerbates the aridity of the High Plains, studying the permanent adoption of conservation behaviors becomes all the more important.

Estimates suggest that Kansans use water domestically at rates similar to other Americans—consuming roughly 81 gallons a day (Kearney et al. 2009; Kenny et al. 2009). Studies on household water usage generally frame it under two categories: indoor and outdoor water usage. While the indoor component is largely stable across the country (Americans use about 60 gallons a day for indoor usage), there is greater variance in outdoor usage, specifically during the summer, when peak consumption is difficult to predict (Mayer et al. 1999; Chambers et al. 2005). Households with lower occupancy see a rise in per capita consumption (pcc) as do residences in hot areas. Climate is a key factor in outdoor demand, as cooler, wetter regions require less water to sustain lawns, plants, and gardens than hotter, drier climates (Chambers et al. 2005).

The large variations in precipitation and temperature in the United States adds tremendous nuance to these national averages, and researchers interested in water consumption should acknowledge the importance of disproportionality, the over- or underrepresentation of a behavior or occurrence within a given place. The differences between low and high water users often are not captured by averages. Many communities in the American West are influenced by "the humid fallacy" (Davis 1998), the environmentally inappropriate mindset that maintaining a lifestyle of prolific water consumption in arid landscapes is sustainable. Wes Jackson (2010) encapsulates this idea with his point that settlers came to the semiarid plains with the expectation for it to be a wetter region. Agricultural interests in the High Plains, specifically the promotion of growing crops or lawns requiring irrigation, have not adapted their vision to fit the Plains environment. Lawns now cover a Texas-sized area in the United States, some 63,000 square miles, about three times more than any other crop (Milesi et al. 2015). While 38 percent of US households never water their lawn, lawn watering (or lawn irrigation) uses more water than any other residential watering practice (Mayer et al. 1999). After a few years of watering, traditional lawns begin to use more water than pools of the same size (Stevens 2015b), and given the drought facing the western half of the United States, the maintenance of grass lawns is a major barrier to reducing domestic water usage in areas already facing water shortages (Glionna 2015).

The United States has lessened its obsession with lawn watering in recent years, as cities in the southwest US are replacing their lawns with vegetation that consumes less water (Bounds 2001). Xeriscaping (which refers to landscaping designs that save water) has emerged in parts of the arid Southwest as a cost-effective form of water conservation, and greywater usage is gaining recognition as a substitute for potable water used for outdoor watering (Gelt 1993; Christova-Boal, Eden, and McFarlane 1996; Jeffrey 2002; Noah 2002; Po, Kaercher, and Nancarrow 2003; Domenech and Sauri 2010; Fishman 2011; Pabich 2012). Smart controllers and timers for lawn watering can only save about 10 percent on average (Sedlak 2014), but the EPA (2009) estimates that limiting lawn watering to twice a week and can cut outdoor water consumption by 30 percent without major landscaping modifications. All of these water-saving techniques are important and promising, but their application to well owners has not been thoroughly-studied, nor have the attitudes and perceptions of domestic water conservation among well owners. In this project, I outline how both Kansas well owners and non-well owners implement specific domestic water-saving practices and hold certain attitudes about their water usage.

PRO-ENVIRONMENTAL BEHAVIORS AND ATTITUDES

Researchers first investigated the public's environmental concern during the 1970s (Tognacci et al. 1972; Bruvold 1973; Buttel and Flinn 1974; Bowman 1977a; 1977b). For the most part, social scientists have measured the public's outlook on pro-environmental behaviors (PEBs, behaviors that minimize the negative environmental impact of actions) like recycling and water conservation with self-reported survey responses. Unfortunately, it has been well-documented that data collection via surveys can contradict manifest actions, which suggests an "attitude-behavior gap" (Kollmuss and Agyeman 2002) or "dual realities" (Corral-Verdugo 1997) in which self-reported behavior and observed behavior do not match. Substantial discrepancies between responses and actions often occur because respondents tend to answer questionnaires in socially desirable ways.[4] Regarding attitudes and perception of water conservation specifically, a study done in the mid-1990s showed that "…attitudes, habits, and values were poorly correlated with water consumption" (Aitken et al. 1994:147), again providing evidence of dual realities.

Conservation activities and personal sacrifices are among the behaviors and intentions included in the primary indices of pro-environmental behavior (Armel et al. 2011). Examples of behavioral adaptation include reduced water consumption, installing efficient technologies, rainwater harvesting, or lowering the frequency of water-consuming practices such as showering or laundry washing. While PEBs can include civic actions like signing petitions, marching, and policy support, individual or household-based PEBs like recycling, conserving energy, and buying green or organic goods are most commonly studied. A number of studies use quantitative methods to accurately develop measures of environmental awareness, conservation attitudes, and pro-environmental attitudes and behaviors. One common metric for environmental action is the incorporation of multiple survey items related to a variety of environmental behaviors. Research

[4] Among others, see Heberlein 1973; Luyben 1982; DeMaio 1984; McGuire 1984; Hamilton 1985; Bird and Rapport 1986; Groves 1989; Ungar 1994; Sadalla and Krull 1995; Corral-Verdugo 1997; de Oliver 1999; Beattie and Sale 2009; Whitmarsh 2009; Beattie 2010.

suggests that environmentalist actions tend to be correlated with each other. For instance, recycling and other pro-environmental behaviors (buying organic foods, using public transportation) are connected. These co-variances are known as environmentalist "spill-over effects" (Thogersen and Olander 2006; Whitmarsh and O'Neill 2010).

What encourages behaviors that are beneficial to the environment? The adoption of each PEB is complicated, and a variety of statistically modeled theories used in social psychology seek to explain PEBs. Researchers employing the Feminist Political Ecology framework note that water provision and consumption is closely linked to gender and class (Truelove 2011); recent studies suggest that women participate in more private-sphere pro-environmental behaviors than men, leading to a "feminization of environmental responsibility" (Littig 2001; Dzialo 2016). [5] Private-sphere environmental behaviors (recycling, saving water, buying organic) are feminized tasks (Dzialo 2016). Sociologists have already stated that "change to lifestyles requires similar changes to an individual's volumes of resources, and to the infrastructural and material arrangements that constrain consumption" (Southerton, Warde, and Hand 2004:39-40).

Environmental sociology has been inspired by the social psychological model of human behavior put forth by Fishbein and Ajzen (1975) which often uses individual attitudes or norms to predict concrete behaviors. Building off this, Stern (1995; 1999) proposed that environmental values and concerns inform behaviors in the values-beliefs-norms (VBN) theory, one of the most comprehensive attempts to explain environmental concern and behavior. Generally, the theory proposes that values influence beliefs about the environment, which shapes PEB adoption. Researchers have implemented VBN to study how moral considerations are keys to understanding conservation behavior and support for climate change policies (Kaiser, Hubner, and Bogner 2005; Dietz et al. 2007; Yeboah and Kaplowitz 2016). This framework provides a powerful explanatory outline that places environmental beliefs and behaviors into a causal chain: individuals' values are posited to drive beliefs, and, in turn, norms. Given this important and widely-implemented framing, my project seeks to understand if VBN theory can be augmented

[5] Many publications outline the political and gender gaps with PEBs and support for climate change policymaking. Women report slightly more concern about climate change than men and are more aligned with scientific consensus on climate change (McCright, Dunlap, and Xiao 2013); political orientations are strong predictors of environmental concern (Dunlap, Xiao, and McCright 2001). McCright and Dunlap (2011a) note a "conservative white male" effect, in which conservative white males are more likely to deny climate change than other demographic groups. Support for environmental protections decreases as support for the dominant social paradigm increases (Dunlap and Van Liere 1984). Nevertheless, the influence of water supply infrastructure has yet to be considered.

by investigating the environmental attitudes and awareness levels of well owners and non-well owners in Kansas. This would essentially connect values to behaviors while controlling for differences in water supply infrastructure.

Spaargaren (2004) made the argument that daily routines should be seen by environmental sociologists with a contextual approach that combines the roles of human agency and social structure. The infrastructural perspective is useful for environmental sociologists in particular because it places special emphasis “on the ways in which modes of design, production, and distribution at the provider end of the chain do, or do not, correspond with certain modes of access, use, and disposal at the consumer end of the chain” (Spaargaren 2004:21). I apply this lens to water supply infrastructure, which can promote liberal or conservative water usage with their ability to make access to water convenient (or perhaps overly convenient).

Consider the practices or rituals conducted within different infrastructural contexts. Monitoring agricultural runoff, checking well yields, pumping costs, depth to the water table, and testing water quality are all practices associated with well ownership.[6] Health researchers have conceptualized regularly testing domestic water supplies as well stewardship and groundwater stewardship, as well as a vital pro-environmental behavior (Imgrund, Kreutzwiser, and DeLoe 2011). Well owners therefore constitute a “community of practice” (Lave and Wenger 1991; Wenger 1998), a group defined by similar routines and boundaries of performance. I contend that these distinct well monitoring practices of well owners reinforce their awareness of their specific groundwater supply, and consequently, alter their water usage. Once a member of that community, “people become the carriers of a practice, reproducing and sustaining it as an entity through repeated enactment” (Walker 2014:187). Well owners’ investment in their private supplies makes the lifestyles of well owners different from those of non-well owners, and studying their lived experience as aquifer stewards is paramount to developing appropriate policies for groundwater management.

Researchers have defined communities along cultural practices, social network connections, locations, shared identities and senses of belonging, and collectively managing their environment (Eng and Parker 1994; Strang 1997; 2004; Rivera 1998; Brint 2001; Flora, Flora, and Fey 2004; Gilchrist 2009, Blackshaw 2010; Fairbrother et al. 2013). All of these can be

[6] The maintenance associated with private rainwater and greywater supplies has also been closely studied in recent years (Pabich 2012; Vannini and Taggart 2013).

applied to well users. Furthermore, a community can also refer to a group of people who actively communicate and engage with each other around a shared connection to a geographic space (Robinson 2014). Making comments and participating in discussions of groundwater management or other information exchange are some of the habits for individuals involved in communities of practices. In order to keep their shared routines synchronized, members within a community of practice need to manage their collective base of knowledge. Community practices are sustained on the knowledge, attitudes, or awareness levels that define community membership (Nelson and Winter 1982). A community's collective identity plays an important role in individuals' behaviors and coping reactions to disasters (Erikson 1976); residents living in drought-prone areas tend to integrate adaptation strategies into their daily lives (Subbiah 2000). All forms of water usage require a community of practice, "a particular way of life that embeds a person in a network of people who support that practice, so that the 'performance' of that practice leads to satisfaction and self-esteem" (DuPuis 2002:216).

Well owners require a series of "environmental heuristics" (Spaargaren 2004), rules-of-thumb used by citizens to establish how to live sustainably within a region reliant on groundwater. Such heuristics can harness the social rationale for conserving resources in a way that fits practically into daily life.[7] Part of that practicality, however, would require well owners to make informed decisions about how to cautiously extract groundwater during droughts. For that reason, groundwater pumping can be connected to Hobfoll's Conservation of Resources (COR) theory (1989). Hobfoll's argues that individuals stockpile resources to ward off stress during difficult times; when someone becomes uncertain or worried about the future, they utilize their saved resources in order to cope. While his work focused on the labor market and economic resources, the COR framework can be applied to natural resource management. As Zamani and colleagues (2006) note, COR theory is well-suited to formulate hypotheses on how individuals perceive the consequences of environmental disasters, particularly drought. Contemporary depletion of the aquifer across Kansas ranges from a 10 to 70 percent loss in thickness, making water table declines a serious threat for some communities (Butler 2013). Applying COR theory to the conservation and management efforts of these groundwater communities can facilitate researchers' understanding of how Kansans perceive the threat of drought.

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[7] Examples of environmental heuristics include using public transportation and buying locally-produced groceries as opposed to driving individually and purchasing food that was mass-produced.

Research on private domestic wells suggests they are dug primarily to ensure a water supply, and not necessarily to conserve water (Thomas and Salerian 1987; Thomas, Syme, and Salerian 1987). Hypothetically, COR theory can frame wells as an investment in securing or replenishing stockpiles of resources (groundwater), and wells can be used to augment a private water supply. Studies indicate that investing in a well can be seen as an adjustment in response to resource scarcity (Keenan and Krannich 1997). The theoretical principles of COR, such as the emphasis on protecting resources and vulnerabilities stemming from lost resources, explain cognitive- or individual-level attitudes towards disasters. Moreover, the motives for conservation may be immensely different for well owners and non-well owners. Groundwater pumped from a well is free, so relying on wells can lower municipal water bills for well owners. This implies that lawn and garden wells could be associated with liberal water usage, since the function of the well is to augment a water supply for outdoor watering on a small scale—what other researchers and I classify as nonessential domestic water, water that exceeds the amount needed for drinking and basic hygiene.[8]

By focusing on social structures, systems of provision and infrastructure are no longer external variables but brought to the center of the analysis. Particular circumstances (including droughts, groundwater declines, water rate increases, or watering restrictions) and infrastructures (such as publicly provided water and household plumbing) might lead people to adopt green environmentally-abusive lifestyles even if their core values of environmentalism would suggest otherwise. Drawing from infrastructural theory, COR theory, communities of practice, and the VBN model, my study aims at quantitatively assessing a variety of water conservation behaviors and attitudes among Kansans with different water supply systems. For a brief synopsis of other popular PEB frameworks, consult the appendix.

Attitudes are relatively enduring, making change difficult. Evidence suggests that attempting to increase PEBs via cognitive fixes—a change in attitudes—is neither the most reliable nor the most effective way to achieve such results. For instance, one study attempted to

[8] Previous scholars have called the water used for purposes in excess of bathing, cleaning, and drinking “inessential” (Black 2004:13). Toilets, clothes washers, showers, faucets, and dishwashers are the main indoor end uses of water and for the purposes of my research I treat indoor uses as essential. Outdoor water end uses are more challenging to identify because watering lawns, gardens, trees, washing vehicles and sidewalks, and recreational purposes like swimming pools, sprinklers, or hot tubs are not often delineated in the domestic water research (Inskeep and Attari 2014:Fig. 1). Watering gardens can be considered a vital purpose if the gardener needs to produce for sustenance or a source of income, but since lawn irrigation is the primary user of outdoor domestic use, nearly all outdoor water usage at the household level is considered nonessential (ibid.).

promote energy conservation by informing consumers about neighborhood electricity use, but it failed to reduce energy usage (Heberlein 2012). Lifestyle shifts and local campaigns are examples of Giddens' new ethical spaces (1984) yet there has been relatively little work on how these new ethical spaces can assist in reducing consumption. While persuading people away from consumerist habits on ethical or environmental grounds remains challenging, unlocking how innovations in systems of provision can influence resource consumption remains a promising avenue for PEB research. Environmental views have been thoroughly-studied, but it is challenging to consistently connect environmental beliefs with water conservation. This implies that more research on environmental actions needs to be done, and it is still important for social scientists to examine how these attitudes and behaviors affect the domestic consumption of critical resources like groundwater.

When an individual's attitude differs from their behaviors, it is possibly due to structural obstacles beyond their control. While social psychologists might emphasize social desirability biases to explain the discrepancies between *Behavioral Intention* (BI) and actual *Behaviors* (B), sociologists would note the structural components that limit PEBs. Noticeable numbers of environmentalists often behave in ways that are not indicative of their environmental concern, which is an obstacle to understanding actual environmental practices. Focusing on redesigning the structures in which behaviors occur is a way environmental sociology can be applied to PEB research. Sociologists have assessed how the contexts of natural, social, and economic systems shape and constrain energy consumption practices (Ehrhardt-Martinez et al. 2015); they generally investigate PEBs by considering how the social environment promotes structural, rather than cognitive, change (Bell 2012). Theorists of consumption often move beyond individualistic approaches and view consumption not as a matter of personal choice; but rather acquired practices that are mediated through social and technical environments. A structural understanding of organizational systems is seen as more valuable than an analysis of personal lifestyles for many researchers in the field, who "concentrate on [the] aspects of consumption associated with infrastructure-based goods and services" (Southerton et al. 2004:1).

WATER CONSERVATION CAMPAIGNS AND PUBLIC AWARENESS

Cognitive fixes usually take time, and since attitudes are not often closely related to PEBs, investing more in restructuring social settings and the technological landscape can serve as structural ways to change an individuals' environmental impact. Social pressures to use or conserve resources are some of the most important drivers of resource usage because they reward or discourage individual PEBs. Internal positive sanctions—the feelings of pleasure derived from compliance with social norms—are individual, cognitive motives to behave in accordance to social pressure. Moreover, internal negative sanctions, or the guilt associated with resisting social norms, can steer people away from patterns of resource usage that are deemed socially unacceptable.

Water wasting has been an example of this for decades. To respond to a drought in the late 1980s, Tucson, Arizona, hired a "water cop" to enforce water-waste regulations and fines for excessive lawn-watering; the town encouraged residents to give the officer anonymous tips about their neighbor's excesses via a hotline (Parfit 1993). A more recent, well-publicized example of this is the popularity of "drought shaming" among Californians, a process whereby people use social media to call attention to incidents of water wasting in an attempt to humiliate people into using water more thoughtfully during droughts (Rocha 2015; Walters 2015). According to recent polls, Californians perceive drought as a growing problem, and two-thirds believe their neighbors are not doing enough to save water (Baldassare et al. 2015). Changing norms—social expectations—are more influential to the performance of PEBs than adjusting attitudes, which makes social norms fundamental in changing behaviors. Since norms are behavioral regularities, investing in their changes can play a large role in PEB adoption. Cognitive fixes are challenging to successfully apply, so structural and technological fixes are promising avenues for facilitating behavioral change.

It is important to note that natural changes can shrink the attitude-behavior gap. Water conservation attitudes are actually closely related to environmental factors like precipitation. Dry spells instill stronger, more positive attitudes towards water conservation and also improve the correlation between attitudes and behaviors (Trumbo et al. 1999). Overall, individuals who believe droughts are indicative of long-term supply problems modify their domestic consumption (Syme, Nancarrow, and Seligman 2000). Evidence suggests that awareness of surface water availability, and knowledge of droughts, can improve water conservation efforts; however, little research has been done on whether groundwater overdrafts are a factor in water conservation attitudes.

Researchers have analyzed the effectiveness of campaigns on domestic water conservation for over two decades (Trauth 1989; de Oliver 1999; Pumphrey 2006). Investigating San Antonio's voluntary and eventually mandatory water restrictions in the late 1990s, de Oliver (1999) concluded that not only did residents overrate how much water they conserved, but they thought voluntary water conservation was pointless if their neighbors did not conserve. This parallels work by Corral-Verdugo and colleagues (2002), who suggest that conservation efforts only work if they are perceived to be shared by the entire community. Other studies suggest that the attitudes and beliefs of the majority of the public are essential for successful water conservation campaigns (Trauth 1989; Syme et al. 2000). Researchers have also examined the effectiveness of conservation campaigns among private and public utilities. Public utilities are more proactive in asking their customers to conserve water than privatized utilities (Kallis et al. 2010), and users are less receptive to conservation efforts under fully privatized water utilities (Howarth and Butler 2004). While many water customers prefer voluntary and market-based policies to promote water conservation instead of policies that mandate cuts (Attari et al. 2009), research suggests that neighborhood- and community-wide conservation efforts are more successful.

Information campaigns during dry years in the 1970s reduced water usage by 15 percent in the western United States (Gilbert 1978). More recently, cities across California acknowledged the severity of their drought by not only emphasizing conservation strategies as a vital role for surviving in a semiarid climate, but also scrambling to preserve local water supplies with water recycling projects and capturing rainfall as opposed to searching for more distant water supplies (Spotts 2016). In March 2015, California declared that its reservoirs had one year of water left, and it spent a billion dollars to fight its megadrought. Following that, Governor Jerry Brown issued the unprecedented mandate requiring Californians to cut municipal use by 25 percent. Most of this goal expected to be reached by imposing cutbacks on lawn watering and the reduction mandate did not apply to farms (Nagourney, Healy, and Schwartz 2015). In an effort to reduce save water, residents of the state not only cut back on their lawn watering, but also stopped watering trees—even though trees were exempt from Governor Brown's mandate to cut water consumption (Fears 2016b). In June 2016, following the final month of the Governor's water restrictions, utilities calculated that the state came within 0.9 percent of achieving the unprecedented goal of a 25 percent reduction (Barnitt 2016).

Communities in California investigated how to best alter its residents' patterns of water usage in order to reach Governor Brown's mandate of reducing non-agricultural consumption. The water department of Santa Rosa offers a package that replaces a household's toilets, showerheads, and faucets with ultra-high efficiency models for only a $7 monthly charge on their water bills (Weiser 2014). These upgrades ultimately save customers money because the new devices use much less water. Conservation campaigns actually became quite successful in the west during the 1987-1993 drought, where cities like Tucson and Santa Barbara adopted rebate programs for replacing toilets and offering water audits (Conniff 1993; Parfit 1993). When communities make an effort to invest in conservation, it appears to be much more effective than promoting individual efforts, but these campaigns need to move beyond technological efficiencies:

> If a utility really wants to reduce water consumption, [raising water prices and offering rebates for installing water-saving appliances] will only go so far; serious conservation will require a fundamental change in public attitudes about the value of water and the role that water utilities play in determining how it can be used. (Sedlak 2014:240-41)

Research suggests that there is a lack of financial incentives for households to conserve water because municipalities typically offer utilities at rates so low that wasteful usage often results in little to no financial penalties (Olmstead and Stavins 2009; Inskeep and Attari 2014). Between 1980 and 2000, a third of water utilities in the United States adopted progressive pricing approaches in which water rates increase with the volume of water used (Olmstead, Hannemann, and Stavins 2007). In this tiered pricing structure, each additional gallon of water increases in price after a household's daily water use exceeds its first block allocation (which typically covers most indoor, but not outdoor, usage). Unfortunately, this price signaling has little effect on the biggest (wealthiest) water users, who do not typically change their consumption after the new billing systems are adopted (Nataraj and Hanemann 2011). Perhaps the price signals are not sufficient enough to change behavior, particularly if the largest municipal water users can afford to pay exorbitant costs for their lawn care. Researchers investigating household energy consumption and the effectiveness of public education efforts have made similar claims. While reducing household energy demand by 20 percent can yield a smaller utility bill, "this savings comes as a result of convincing every household member to adjust their behavior dozens of times a day, every day, for a year. For a household of four people, that could amount to thousands of actions or decisions a month…" (DeWaters et al. 2015:2). Utilities are generally cheap, and even though saving them is a good habit, many customers are not offered persuasive economic propositions to conserve.

Regardless of some innovative pricing, the demand for outdoor domestic watering remains intractable, even in uncertain climates. Following the El Nino-fueled rainstorms in late 2015 and early 2016, residents of gated communities in California insisted that the emergency water restrictions be lifted. Homeowners in some communities actually faced fines in the summer of 2016 if they did *not* maintain a green lawn (Serna 2016). One director of a home owners association contended that sacrifices are no longer necessary: "I have not been flushing my toilet, I've been taking Navy showers and putting my landscape at risk under the emergency circumstances. But I don't want to have to do that when we're not in an emergency" (ibid.).

The calls to re-ignite the humid fallacy during a severe drought are symbolic of the enormous social pressure to conform to landscaping standards in order to preserve property values. Many wealthy Californians argue that the conditions no longer warrant conservation measures—a premature assumption that normal precipitation has resumed and that the aftermath of one of the most exceptional droughts in the nation's history has been erased. Researchers note that extreme droughts create sizable water deficits that take several years to overcome, "We need to think about drought over longer time scales. The first wet year doesn't necessarily solve the longer-term problem" (Margulis et al. 2016). The drought was a tremendous opportunity to implement better management policies and prepare for more intense droughts, but "California runs the risk of behavior relapse. Never before has the state been as aware, as galvanized, as committed in water conservation efforts. Nor have we needed continued efforts as much as we do now…" (Barnitt 2016; see also North 2016). Instead of building on its gains under Governor Brown's reduction mandate, many in California appear to be moving backwards and shunning advances in conservation. Once some of the state's reservoirs became full, beginning to drain them again is far from prudent management; given the West's vulnerability to drought, communities should remain cognizant of their drier, hotter future. In order to promote a permanent change in lifestyles, *The Los Angeles Times* Editorial Board issued this statement:

> It's tempting to believe that the state has weathered some dry years and that the brimming northern California reservoirs will now allow us to return to wet-year habits and lifestyles, but those days are gone forever. *If the drought emergency is over, it's only because drought is no longer an emergency, but a permanent*

> *reality*. Mandatory state-imposed water restrictions have been lifted for now, but wasteful uses of water remain under a permanent ban, and water agencies and their customers would be wise to be ever more respectful of water and ever more parsimonious in their use of it. [emphasis added] (2016)

WATER SUPPLIES AND PRACTICE

Water Supply Infrastructure

Water provided by public suppliers reaches a majority of people in the United States, roughly 268 million, while self-supplied sources provide nearly 45 million Americans with their domestic water (Maupin et al. 2014). [9] The history of centralized drinking water supplies and sewage treatment provides a background that differentiates urban and rural communities, and the urban water story is one of technological mastery in which water is shipped to residents from distant locations. Miles of municipally-subsidized pipes, and the treatment plants that keep towns' water supplies clean, are well-hidden from urban settings. The sewers and pipes necessary for such a sophisticated delivery system make up the unseen spaces of cities in a "complex labyrinth of connections that bind urban space into a coherent whole" (Gandy 2014:28). Municipal water infrastructures might even represent a "concealed landscape" due to their invisibility and taken-for-granted reliability.[10] Modern municipal water systems have been designed to be unobtrusive and hide their function; they monopolize professional water management and encourage the public to surrender their control of water to experts. During the urbanization of the United States (roughly 1790 to 1870), Americans began rethinking how they accessed water: it was to be brought in and easily available in urban centers via advanced technologies, hydraulic engineering, and hidden infrastructures (Smith 2013). On the other hand, wells—and the impact of groundwater extractions—tend to be more visible in rural spaces. Rural water landscapes are dominated by agricultural water usage, which is largely reliant on local, private wells that require individual monitoring, attention, and investment.

Urbanization played an enormous role in the development of publicly-funded sewage management and municipal water supplies and changing water utilities via public funding were crucial to urban development. The engineering priority to meet the growing demands of cities

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[9] Just under 2 percent of households in the United States have no running water (Parfit 1993).

[10] To summarize how the technological approach to water management prevailed in cities, historian Georges Vigarello wrote, "The modern town was based on a concealed infrastructure" (1988:181).

trumped the ecological needs to conserve resources, and engineers were fulfilling a major public health concern (Black 2004). Health fears were a large motivator for engineering projects, as disease control was seen as too great a responsibility to be left for individuals' habits of waste management. Public administrations subsidized water infrastructure because private companies could not deliver services to everyone who needed it. Since clean water is a common interest, and its access is a public health issue, the state was put in charge of its provision and management (Black 2004). Clean water is a conduit for good health because it provides the means for washing, bathing, laundering, and cleaning, but polluted water serves as a channel for spreading diseases and exacerbating poor hygiene. The reduction of diseases like diarrheas, along with parasitic and viral infections, requires a reliable flow of clean water into households and the removal of their dirtied water.

Building waterworks involved conceptualizing a reliable water supply as a "public good," "common good," and "in the public interest"; investment in city provisions were labeled as essential in growing urban areas across the United States (Smith 2013:56). Reformers in the sanitation movement claimed that water was a cure for filth and disease. Water would be of particular importance for the cleanliness of cities, which had several problems of waste disposal and blackwater management before sewers, toilets, and other hydraulic advances were installed. The cleansing of cities was also intertwined with the cleansing of individual bodies, as regular washing "would keep [the body] from becoming vulnerable to disease and hazardous, not to mention offensive, to the rest of the social body" (Smith 2013:166). Globally, improved drinking water sources now reach 88 percent of the population, due largely to the enormous expansion in access over the 1990s and 2000s (Hemson 2015). The call for good sanitation justified public water supply investments around the world, but the need for hygiene education was overlooked, particularly in developing countries. The installations of pumps, pipes, and treatment facilities require longtime users of private Water Extraction Mechanisms (WEMs) to learn how to maintain them, as they were not familiar with centralized or public command. A safe water supply cannot improve community health without informing citizens and changing their behaviors.

The hegemony of technical expertise began displacing traditional approaches to waste management and sanitation, but it was not a seamless transition. Lack of demand was a main problem for the first water supply facilities, which offered some of the first improved sources, such as household taps, rainwater collection systems, encased wells, and pumps and replaced the unimproved sources (streams and open wells), which offer less reliability and sanitation. Unless residents traveled long distances to an unimproved water source, they might not require an improved source near or within their homes.[11] In fact, people in rural India had a long-standing preference for open, unsanitary defecation areas (dug pits) to the more expensive private toilets (Black 2004). In Africa, handpumps are the preferred means for accessing shallow groundwater (Lubwama, Corcoran, and Sayers 2015). Rural Africa is dominated by unimproved sources; less than half of the population has access to improved supplies and piped water is basically non-existent for the poorest households (ibid.). While 768 million people around the world use unimproved sources of drinking water, 40 percent of those without improved water supplies reside in sub-Saharan Africa (Mehta and Movik 2015). If the convenience and health benefits are not appreciated, people may resist improved sources—especially if the public infrastructures require them to become involuntary customers and fund the projects. Engineered water supplies get costlier and more complex as pollution and demand increase and reliable sources become strained or overused. When a community values improved water supplies over unimproved water supplies, it must also support the enormous investment required to maintain these infrastructures.[12] Services might not necessarily meet needs of a community because needs are socially constructed. This phenomenon of delayed interest in domestic water consumption has been problematic for the construction efforts behind municipal infrastructure.

> …despite endless international rhetoric about "management by demand," many programs run by donors, governments and municipalities still fail to consult with prospective users. They ignore all their own precepts about stakeholder participation and decision-making at the local level, and carry on in full "we know what is best for you" mode. For example, they insist on boreholes when people would prefer open wells. Not surprisingly, when they then ask the beneficiaries to

[11] "There are also culturally embedded reasons that dictate local people's preferences and knowledges regarding water. For example, a village woman may prefer to collect water for drinking from a hole in the river bed rather than government-supplied water from a tanker. The river bed is farther away from her home, but she may value the outing and also prefer the taste, and its quality may also be better than water provided in the tanker, which counts as an 'improved' source" (Mehta and Movik 2015:42).

[12] The construction of household connections required a tremendous amount of faith in engineers and planners to combine electrical and water supply systems. Cleaning and transporting water are energy-intensive processes. Worldwide, water supply networks and treatment plants require as much as 15 percent of all electricity produced. This makes the delivery of sanitary water a relentless component of energy demand, which is also aggravated by hydrologic changes, contaminated supplies, droughts, and water scarcity. In some municipalities, customers pay only a fraction of operating costs for the water distribution system, and underfunded governments and utilities are unable or unwilling to provide maintenance to repair the outdated infrastructure (Gall 2015).

> pay for boreholes they never requested and don't particularly want, they baulk. (Black 2004:39)

Historians have argued that cities form an "infrastructure of ideas," (Smith 2013) an arrangement of political, economic, and social institutions. The development of water infrastructure is a helpful example of how the built environment is the manifestation of cultural beliefs and priorities. Progressively larger infrastructures provide support for the idea that nature has been mastered by technology, and they encourage consumption by drawing on distant bodies of freshwater to make water accessibility convenient for large groups of people. Water's physical properties necessitate the formation and planning of impressive infrastructures. Due to its bulky character, moving water over long distances is incredibly challenging. Storing water takes tremendous amounts of uncontaminated space; transferring it is energy-intensive. The movement and management of this heavy substance can be used to justify the construction of extremely advanced water provision projects and the agendas of constructionists who wish to exercise some level of mastery over nature. The social and physical layouts of cities are therefore inseparable because hydraulic engineering projects are embodiments of the city's beliefs in resource management, and the centralized control over water is the backdrop for urban interactions.

> As individuals crowded into growing cities and transformed a natural setting into a built one, they were themselves changed by the circumstances of the urban life they were fashioning. They worked at city occupations, interacted through city institutions, and conducted themselves according to city customs and practices—including drinking city water. In the process, they became city people. (Smith 2013:162).

Water supply systems are not only structured by community demands for water, they also structure the routines that enable water-intensive practices. Demand is therefore configured by the networks that channel and deliver resources, "These systems are themselves subject to continual reproduction" (Medd and Shove 2007:53). The construction of infrastructure itself is based on anticipated demand, and investing in large water supply and disposal systems assumes a long-term pattern of demand. Urban political ecology studies the socio-ecological systems that produce unequal access to water within cities and how everyday watering practices reinforce the production of classed relations (Swyngedouw 2004). Furthermore, the sociology of water usage has suggested demand management and demand forecasting—proxies for curtailing and predicting future water requirements for municipalities—can tools to alleviate the pressures facing the centralized water systems of cities (Browne, Medd, and Anderson 2013). It should be noted, however, that private WEMs could be linked with different levels of demand than public infrastructures. Investigating these forms of water provision, and their associated standards of usage, would improve the body of research on environmental infrastructure, which has focused primarily on urban centers struggling to meet the demands of their growing populations.

The Emergence of New Practices

Not only must cities financially invest in public water systems, the practices encouraging the development of those infrastructures (such as using water more liberally) must also become normalized:

> Infrastructures of reservoirs, pipes and pumps have enabled the majority of city dwellers to adopt what have become, by and large, taken for granted water consuming routines. They have also enabled the development of now normal expectations such as those associated with toilet flushing, power showering and jet-pressure hosing. (Medd and Shove 2007:47)

As human manipulations of the environment made water easily accessible within cities, everyday life embodied different understandings of health, cleanliness, and leisure. Improved sources typically bring water inside the house, which increases consumption dramatically, as they encourage more washing and bathing (Black 2004). The provision of clean water in urban spaces changed attitudes towards sanitation and the symbolic significance of water (Gandy 2014). Demand, therefore, is contingent on acquiring the socially transmittable standards of cleanliness and domestic watering practices overall.

With the arrival of water connections in the households of cities in Europe and the United States starting around 1860, bathing moved from public bathhouses to private households; it became a routine associated with private, leisurely cleaning and relaxation (Wright 1960). In the following decades, bathrooms, bathing, and cleanliness became a means of impressing guests and displaying good taste, and household connections to municipal water allowed for a remarkable spike in practices embedded with water usage. It only took a couple years in the early 1920s for Americans to double their number of baths (ibid.), as household water connections seemed to erase the previous centuries of water scarcity and usher in an “age of easy water—an era of plentiful, reliable supplies of clean water, accessible to population centers” (Prud’Homme 2011:113). Such changes suggest that water supplies and water delivery systems are connected to water consumption, and examining how those with private supplies and public supplies promote patterns of consumption affords a deeper understanding of pro-environmental behaviors.

Sociologist Elisabeth Heidenreich's (2004) concept of flow spaces summarizes how technology combines cultural ideals with materials. She contends that the development of waterworks led to a shift towards more individualized experiences of resource use for personal pleasure. For instance, bathing became a pleasurable experience, not just a routine for cleaning skin, and indoor plumbing and toilets became valuable symbols of cultural capital in addition to representing high standards of bodily hygiene and cleanliness (Wright 1960). Water provision underpins not only the consumption of water, but also how it is valued; the consumption of water increased as people attached status to cleanliness and hygiene (Shove 2003a; Southerton et al. 2004). Water use in municipalities became a source of hygiene routines and

> …a marker of civilization…Access to water came to be depicted as a precursor for the production of modern citizens. This implied much greater volumes of water use than in the past. (Bakker 2010:54-55)

The maintenance of the elaborate infrastructure behind modern, improved drinking sources led to the reconceptualization of water. Suffice it to say, private and public water provision systems should be expected to influence domestic water usage. For the purposes of my study, the source of a household's drinking water is of critical importance, as different sources engender different standards of consumption.

To understand how water is consumed, sociologists consider the material elements and social relationships that are integrated in watering practices (Medd and Shove 2007). Water consumption largely takes places as a means to accomplish different practices of personal care and displays of status. The majority of domestic water use is embedded in practice, and households themselves are embedded within larger natural, social, and economic contexts that affect water usage and opportunities for conservation. Water's embeddedness within practices and standards of cleanliness connect it to social status. Profligate uses of water, like maintaining lush lawns, gardens, or pools are displays of wealth or decency that are expected by many homeowners and neighborhoods. Curtailment actions, therefore, frequently face barriers of sociocultural resistance. Reductions in showering, laundry washing, or toilet flushing frequencies are deviations from social norms that might be associated with unhygienic or lower-class lifestyles; if water saving practices are stigmatized, households may not readily adopt PEBs. The lack of will to conserve water should therefore not be seen as simply a lack of environmental stewardship or concern about natural resources, but also an adherence to the social construction of what decent, normal water usage entails.

Water is especially required for practices in the domestic sphere. Sociological theories of consumption tend to analyze resource usage within social contexts and explain consumption choices and practices within those settings. Norms are tied to social settings, and norms are influential because members of a community follow the actions of others (in part because of positive and negative sanctions). Consumption is therefore regarded as “a form of social communication and an expression of culture, rather than an activity that is carried out primarily to satisfy individual desires” (Ehrhardt-Martinez et al. 2015:100). In this framework, intense water consumption can be linked to social esteem and position. Thorstein Veblen’s classic work, *The Theory of the Leisure Class* (1899) outlined that publicly consuming goods and services connotes high status in a materialist society. Since status is relative, people’s consumption is influenced by that of others, and most people aim to fit within their social networks. “Veblenian” consumption can yield high water usage, particularly in the context of the home; green lawns, swimming pools, and clean vehicles fit within this status dynamic of publicly consuming resources. People complete “rich, rewarding, and deeply human activities” (Heyman 2005:116) through material consumption. Therefore, conservation efforts may not resonate within networks of individuals or households concerned with impression management. Researchers have investigated how sets of practices are unlikely to change unless broader social networks adopt a large commitment to environmental behaviors. Reclaiming consumption, or reducing one’s consumption in concert with others, “is more easily achieved in an area with public meeting points, the presence of other households committed to reducing consumption, and the opportunity to conspicuously display one’s daily practices around sustainable consumption” (Kennedy 2011a:1). Household networks can remove the barriers for members to experiment with decreased consumption.

Culturally-informed behaviors shape patterns of water use and are therefore critical to resource relations (Johnston et al. 2012). It is important to note that internal sanctions can operate both as a mechanism of social pressure not only to *conserve* resources (as in the example of drought shaming) but also to *consume* resources (if a neighborhood standard is to have a lush lawn or a swimming pool). Resource consumption cannot simply be regarded as functional or useful; it is also symbolic. Social relationships produce water's core meanings, which influence how it is managed and consumed (Strang 2004). In modern consumer culture, consumption is an expression of individualism, and one of "the most important means by which we become agents in our day-to-day lives" (Sack 1992:3). Consumption "choices" are choices about conveying a particular lifestyle, and about individuals' desires to be perceived by others in specific social contexts:

> Self-identity… is not something that is just given… but something that has to be routinely created and sustained in the reflexive activities of the individual… It is *the self as reflexively understood by the person in terms of her or his biography* (Giddens 1991a:52-53).

Individuals can convey their identity with new products and adopting consumption patterns to "produce one's self." Fitting in as a member of a (wealthy) community requires a devotion to mimicking the selections of other community members. One mechanism that explains the increased demand for resources is the "Diderot effect," the notion that items should match each other (Shove and Warde 2002), which leads to the continuous replacement of possessions, or a never-ending upgrade of possessions and equipment that adds social pressure on others to pursue consumerist lifestyles.

Sociologically analyzing status and consumption can help explain the attitude-behavior gap. Again, individuals could hold strong environmental attitudes but continue to consume resources excessively due to their social position. The social pressure to use high quantities of water around the house can also be linked to Bourdieu's cultural capital (1984), a knowledge base centered on consumption and lifestyle tastes that boosts social status. Consumer behavior is constrained by normative limits connected to certain levels of cultural, social, and economic capital: "Money, cultural orientations and networks influence access to, judgment of and the satisfactions received by engaging in different forms of consumption" (Southerton, Warde, and Hand 2004:38; see Bourdieu 1997). Social explanations for the attitude-behavior gap include the commitment to comfort and the peer pressure to consume resources in order to maintain social status, as both are often linked to high degrees of resource use (Gifford 2011). Habits are held in place not only by infrastructure and technology, but also by social beliefs.[13] Learnt consumption

[13] Previous research on sustainable consumption suggests that demand is designed and institutionalized by infrastructure (Strasser 1999) and also social expectations (Shove 2003a).

behaviors are part of an individual's "habitus" (Bourdieu 1990), their persistent patterns of thought and action which are central to their identity, and therefore not easily changed.

The sociology of water usage has generally emphasized that water consumption is a collection of practices with social values but are also taken-for-granted. Gardening, showering, and washing dishes and laundry are all examples analyzed by social scientists (Askew and McGuirk 2004; 2007), and water use has interested sociologists studying habitual and routine practices of consumption. As habits, many water using behaviors are performed without deliberation, but they are learned and culturally rooted (Shove and Warde 2002; Warde and Southerton 2012). Since they are predictable and routinized, it is difficult to adopt new, resource-saving habits. This is particularly true when infrastructural modifications rearrange the accessibility of resources and enable them to be easily consumed. Sociologists studying the cultural shift from non-daily to daily showering argue that technological advances in water heating were a main reason behind the frequency change (Hand, Shove, and Southerton 2005), which in turn changed standards of comfort and cleanliness (Shove 2003a; 2003b). Showering habits cannot be reduced to individual decisions nor to infrastructural developments alone, but rather the broad sociocultural changes that occurred under the reconfiguration of urban water supplies. As one of the discretionary water-consuming activities, showering has great potential for water conservation (Willis et al. 2011; Stewart et al. 2013). It is a particularly important practice of water consumption, not only because some studies suggest that it consumes up to 33 percent of the water used for indoor domestic purposes in urban areas (Beal et al. 2011; Willis et al. 2013), but also because it mainly consumes hot water. Water conservation via shorter or less frequent showering can reduce energy usage and GHG emissions.[14] Resource-intensive consumption through ordinary routines is often normalized throughout society, making the social barriers to conservation efforts challenging to overcome.

The gap between PEBs and attitudes is not just related to individual characteristics such as a lack of awareness of their consumption habits or social constraints, but also infrastructural realities, like the availability of seemingly endless supplies of domestic water.

> In the home, water supply technology encourages visions of an unlimited resource, and yet the spatial isolation in which people live makes reliable access to this seem uncertain. Meanwhile the absence of opportunities to integrate

[14] In fact, California's aggressive water conservation efforts have reduced the state's annual energy consumption by a surprising amount—enough to power 135,000 homes for a year (Smith 2016).

> identity and agency at a local level creates a complex set of pressures to sanitize the body and the house with as much water as possible. In an individuated social space, vague wishes to be community-spirited or ecologically friendly are readily subsumed by much more powerful desires to express familiar or individual agency, affluence, life and fertility through the control and liberal use of water in the house and garden. People therefore experience a tension between their domestic usage and their dependence upon—and responsibilities for—wider environmental, social and economic realities. (Strang 2004:208)

Technological structures influence social standards of resource consumption, which in turn contours routines. Therefore, individual water use occurs as a consequence of available options: "Consumption is not only an outcome of personal attitudes and intentions or connected with the fulfillment of utilitarian needs, but is related to the changing social, economic, and technical organization of everyday life" (Southerton et al. 2004:7). Infrastructure sets the stage for individuals' interactions with natural resources, and if water systems or household plumbing determine how water moves throughout the house, it can be challenging to select and perform conservation routines. As Wendy Pabich documents in *Taking on Water* (2012), a book that painstakingly outlines the process of installing grey water systems, homeowners interested in reusing their own water are often stymied by the infrastructure of their home's plumbing. Several studies have focused on public and private water infrastructure and the organizational influences on domestic water usage during drought (Ivey et al. 2004; Duane and Opperman 2010; Kallis et al. 2010). Given the research conducted on domestic water conservation, it seems appropriate to expect structurally-based patterns of behaviors among well owners and non-well owners. Municipally-provided utility systems could theoretically engender a sense of underpriced, under-appreciated water. Private water systems, due to their more limited access and reliance on finite groundwater supplies, are likely the sites of more cautious water usage.

In the context of water supply infrastructures, private WEMs can offer an advantage that municipal supplies likely cannot: due to the practices associated with well maintenance, wells are properly arranged structures to encourage water conservation and can also bridge the attitude-behavior gap. The presence or absence of a well signifies a change in "spatiality," Heidegger's (1978) phrase to describe how materials form the settings for human activities. People face material constraints that limit what they can do, and spatialities guide performances. Waterscapes, systems of water dispersal that are products of human imagination intended to change the direction of water, can include dams, irrigation infrastructures, pipes, and household connections (Strang 2013). Waterscapes also include wells, but their influence on standards of usage and the perceptions of excessive usage are not fully understood. Sociologists studying sustainable practices note that the environmental impact of household electricity consumption is determined by the amount used, yet it is also shaped by how the electricity is generated (by coal, nuclear, hydroelectric, solar, or wind) (Ehrhardt-Martinez et al. 2015). Similarly, I argue that the collective impact of household water usage is shaped by a community's watering norms and the infrastructure providing the water. The previous sociological literature on existing systems of water provision and practices (Medd and Shove 2007; Browne et al. 2013) has not accounted for the infrastructural differences associated with private wells. Domestic water demand has been carefully studied by researchers in the United Kingdom, were water sectors must deal with the water availability extremes brought on by climate change (including floods, droughts, and heat waves). Most domestic water usage research emphasizes large-scale infrastructural solutions to balance supply with demand, and water supply infrastructure is generally defined as a centrally-controlled utility within urban contexts. While water experts are trying to uncover the nuances of "technological, infrastructural, or behavior-based changes [in water consumption]" (Browne et al. 2013:1020), they have primarily focused on urban settings and municipalities and has not sufficiently analyzed the watering practices associated with private supplies. My research addresses this limited definition of systems of provision by studying the influence of non-centralized water supplies among Kansans.

The material dimensions of social life have shaped how scholars frame resource management. Theories of sustainable practices emphasize the cultural settings of consumption and investigate how resource-consuming practices are defined within certain contexts (Shove 2003a; 2003b; Shove and Spurling 2014). Elizabeth Shove (2003a; 2003b) studied how water-consuming habits (showering, laundering, and flushing the toilet) are normalized by existing infrastructures, technologies, and standards of cleanliness. Context, technology, and infrastructure all play a role in how households consume water, and the sustainable practices literature suggests that water supplies influence the normalization of water routines. Therefore, the mechanisms providing a household's water shape its residents' interpretation of frugal, or excessive, water usage. WEMs and municipal systems represent different suppliers of water, which affect the users' relationship with water in a number of ways. For instance, the motives behind conservation practices need to be explored. My study contributes to this body of research by establishing if well owners and people relying on metered city water have different incentives to conserve water. Those with municipally-provided water see conservation as a cost-savings technique (Pumphrey 2006; Fishman 2011), while well owners might conserve water to extend their groundwater supply. Simply put, developing a sociology of domestic water consumption requires consideration of the contexts surrounding these everyday routines. Uncovering the social factors that influence water usage, and the socialization processes that instill habitual water consumption routines, are areas of environmental sociology in which my research is invested. Recall from the opening chapter that a central research question of this dissertation is: Does using a well increase one's propensity to conserve water domestically? To answer this, I incorporate that question into the literature on infrastructure and water supplies.

Sociologists investigating the reproduction of conservation behaviors have not adequately explored how wells, as systems of water provision, contribute to the definition of sustainable routines. Municipal water systems can deliver seemingly endless supplies of safe, affordable water and therefore have changed the evolution of domestic water usage (Wright 1960; Glennon 2009; Fishman 2011). In contrast, private wells are instruments of more humble water provision, and draw from nearby, finite groundwater sources. Applying the notion of spatiality to water supplies can contribute to theories of sustainable practices and specifically water conservation routines. Mary Fund, a farmer and the executive director of the Kansas Rural Center, attributes her conservation practices to her upbringing in a home without running water: "If you carry all your bath water, you can learn to do a good job with a real small amount" (Foth 2010a). Other researchers have documented how households without running water have to haul in water and develop unique watering schedules to keep their usage to a minimum (Parfit 1993). Accessing water without public infrastructure requires the exhaustive chores of digging a private well or hauling water. Therefore, I hypothesize that the differences of spatialities between those with municipally-supplied water and private supplies are associated with different norms of PEB adoption. Sociologists have yet to study the technical arrangements associated with private WEMs, despite the fact that they have called for the examination of

> relationships and interactions between processes of supply and the dynamics of consumption, [since] the design and organization of institutions and infrastructures is especially important when thinking about the consumption of, and the demand for, ordinarily "invisible" resources like water. (Medd and Shove 2007:37)

A dominant assumption within the literature on sustainable practices is that transforming inconspicuous habits of consumption requires making the practices more visible, or placing taken-for-granted behavior out of the unconscious realm (Hobson 2003). Yet individual lifestyles also interact with social and material contexts, and when habitual consumption is disrupted (for instance, if water consuming practices are disturbed by droughts) the taken-for-granted character of routines becomes seriously questioned. This is particularly true among gardeners, who undergo a process of conscious renegotiation of their garden watering during water shortages or neighborhood watering bans (Chappells, Medd, and Shove 2011). When the structures that provide resources or enable resource consumption are stressed, some routines or levels of consumption become unrealistic. These disturbances in resource provision can lead to a new evolutionary path for habitual practices.

Fine's (2002) concept of "systems of provision" refers to the activities, technologies, and institutional arrangements that unite to provide a good or service. Water can come from municipal systems or private wells, and my research explores how different systems of provision contour patterns of consumption and construct demand and resource awareness. As systems of provision become central to enacting everyday behaviors, individuals become "undeniably part of these systems… when they are reshaped, parts of our lives are reshaped" (Guy and Marvin 2001:27). The processes of regulation, abstraction, treatment, and usage are interdependent aspects of specific systems of provision (Medd and Shove 2007). Furthermore, production and supplies shapes standards of consumption through "pathways of dependency" (Arthur 1994). The estimated demand, the costs of constructing systems of provision, and the feasibility of delivering resources are critical calculations for the organization of waterworks and their technologies, "past decisions and developments shape avenues for present and future decisions about the provisioning of goods and services" (Southerton et al. 2004:7). Pathways of dependency lead to "technological lock-in" (ibid.), whereby daily practices and systems of provision reinforce the current process of resource consumption. Technological systems are reinforced, self-promoted systems that become increasingly standardized via social momentum or inertia (Hughes 1983; Joerges 1988). Infrastructure, the material arrangement for allowing certain forms of resource consumption, sets the conditions for "choice sets":

> The package deal of choices which are available as a result of a particular set of policies, and which preclude other choices. A choice set is a collection of

> interconnected acts of consumption, and other behaviors that come with them, and the production and infrastructure that supports them. (Levett et al. 2003:42)

Personal attitudes and fulfilling daily needs are incomplete explanations for unpacking routinized consumption; the sociological approach acknowledges social and technological structures that influence everyday life. In this project's framing, part of the wickedness of water problems (Freeman 2000) arises as technical, political, natural, and social pressures interact in ways that destabilize the infrastructure of water delivery. It is sociologically important to consider the effects of water distribution networks that make the patterns of domestic water consumption possible, and I apply this idea to analyze water conservation and well ownership.

Sociologists have used the concept of systems of provision to look at the infrastructural and social arrangements in which water consuming practices are embedded (Medd and Shove 2007), but "infrastructure" is largely taken for granted as "municipal supplies" in the field. The existing infrastructures in rural communities constitute rural water systems and private WEMs, but have not been fully incorporated into the literature associated with sustainable practices. Moreover, while the representations of water users in sociology refer to them as "citizens," "customers," or "consumers," well owners are responsible for their own service provision, and are more involved with their water supply than the typical recipient of municipal water. Sociologists investigating sustainable practices also have called for improving empirical studies by developing methods to analyze the diversity of per capita consumption (Medd and Shove 2007). Studying infrastructure, and sampling those who live beyond the public water supply and rely on groundwater, can afford researchers the opportunity to account for and analyze heterogeneity among household and individual consumption patterns. Researchers of water usage desire to understand not just households, but systems of provision: "Systematic research that would identify and compare different systems of provision with respect to selected water-consuming practices would make possible the identification of where opportunities for effective intervention lie within these systems" (Medd and Shove 2007:62). By focusing on the spatialities which include wells, my research broadens the sociology of water consumption.

Furthermore, Fitzsimmons' (1989) notion of cultural landscapes—areas defined or shaped by human environmental practices—can be applied to well reliance. Cultural landscapes are designed and redesigned through social arrangements and environmental conditions. The concept of cultural landscapes can help researchers uncover how people perceive and experience the land, and how those experiences influence community members' relationships (Mackenzie 2004). By applying this concept to well ownership, my work analyzes well owners' connections to their groundwater supply, and how their unique relationships influence water usage. While wells have been overlooked by landscape scholars (e.g., Olwig 1984; Fitzsimmons 1989; Zukin 1991), they are central to many well owners' associations with the land. Well owners' connection to their specific groundwater supply sets up their experiences with water, as wells are likely crucial components of spatiality. Moreover, water itself "lies at the intersection of landscape and infrastructure," (Gandy 2014:1) and therefore landscapes can be regarded as an overlap of cultural domains, technology, and hydraulic or natural environments. Cultural landscapes can frame the political support for growth and development by analyzing how "changing values and experiences of the land and its resources relate to changes in institutions" (O'Neill, Rudel, and McDermott 2011:126). Sociological insights on household resource consumption acknowledge the importance of social, natural and infrastructural contexts (Ehrhardt-Martinez et al. 2015)—but they have yet to reveal how households operate in a nuanced world of water provision. Studying well owners as a group embedded within a unique infrastructure can provide more insight on how patterns of consumption are socially defined. Studies of water consumption have explored the variables that explain patterns of variation in water usage, but the change of spatialities between well and non-well supplies represent a shift in infrastructural context that can further help explain differing patterns of water consumption.

Research conducted on water consuming practices in water-scarce Israel reveals that households are enormously flexible with their usage because intermittent supplies are part of everyday life (Selby 2003). People in different social and material situations react to supply problems constantly, and Israeli households with precarious drinking water supplies buy water tanks, use grey water in toilets, or even forbid children from playing outside to prevent their skin and clothes from getting dirty (ibid.). The takeaway is clear: as supplies vary, so do demands, and private wells constitute a system of water provision that has been overlooked by the sociology of water usage. Investigations of showering behaviors in Australia were conducted on 200 households, and the researchers' criteria for being selected in the study actually omitted households with internally-plumbed private supplies (like rainwater tanks) and only examined residences with municipal utilities (Makki et al. 2013). Private water supplies are missing from the body of literature on domestic watering practices, and the ability of environmental sociologists to predict PEB behaviors, like conserving water around the house via less frequent or shorter showers, could be improved by assessing combinations of water supply infrastructures. Given the difference in systems of provision, I contend that well ownership will affect the relationship between water usage and the other demographic variables previously analyzed in PEB research. Moreover, well owners, who are more directly involved with operating their private systems of provision, need to be studied as a group that has insight on how to live with limited groundwater supplies.

WELL OWNERS

Well owners constitute an important sub-population that has not been well-studied in the social sciences, with the exception of a couple case studies and surveys focused on populations in Asia (Dhawan 1987; Kumar, Singal, and Rath 2004; Shah, Singh, and Mukherji 2006). For a global perspective on well users, consider that over 25 percent of people on earth rely on groundwater supplies for their drinking water (Black 2004; Richey et al. 2015). In India, groundwater is the drinking supply for 90 percent of rural residents and 50 percent of urban residents (Nigam et al. 1998). One of the first surveys of Indian well owners was published as recently as 2006 (Shah et al. 2006), but even that did not provide demographic information other than they are mostly farmers. Dubash's (2002) work on well owners in India outlines how wells shape social relations, agricultural production, and agrarian institutions—which in turn govern access to economic development for rural communities. While well owners have been given some attention in the international literature, they have not been closely studied in the Midwest. Even though domestic wells provide drinking water for 364,000 Kansans (WSC 2012), they are not adequately researched or monitored. In the United States, many publications discussing well owners are newspaper articles focused on issues like well vulnerability to water supply contamination and water rights (Richards et al. 1996; National Driller 2002; Schreck 2009; Agricultural Week 2011), while contamination-related studies have surveyed private well owners (Lewandowski et al. 2008). There is a great deal to learn about well owners, as their behaviors, investments, and attitudes towards conservation will be an increasingly important variable when researching the accessibility of groundwater in arid parts of the state. If well ownership is connected to an ethic of environmental stewardship, it could offer a ray of hope in a situation vastly defined by rapid environmental exploitation. Wells are also part of the cultural landscape of Kansas and therefore need to be included in the analysis of conservation practices.

In order to frame well owners as a sociological subpopulation, I contend that the boundaries of municipal water provision reify the boundaries of residency and citizenship. Sociological work on citizenship has focused almost exclusively on its associated rights, rendering sociologists surprisingly ill-equipped to evaluate other benefits of citizenship (Bloemraad 2015). I hold that citizenship is not simply a project comprised of political rights, legal status, and a sentiment of group membership; it is outlined by access to municipal infrastructure. While citizenship is basically a legal status of membership within a particular political unit, there are benefits provided by the community that legitimize common political memberships. Being a member of a distinct citizenry has multiple advantages, but outsiders face multiple barriers, "if citizenship is a boundary demarcation between those 'inside' and 'outside' the membership circle, that boundary is not a single wall, but rather a series of fences that can be more or less inclusive, and which can overlap or cut across each other" (Bloemraad 2015:595). Environmental practices have impacted how researchers understand citizenship because environmental problems have threatened the rights enjoyed by citizens (MacGregor 2006). Some citizenship scholars have understood it as the benefits of public goods and social inclusion (Somers 2008), and I submit that sociologists can understand those advantages by learning about the boundaries of water provision and its associated infrastructure. It is conceivable that excluded residents require different standards of water usage, and therefore form communities defined by specific practices, priorities, levels of awareness, and attitudes based on their separation from city-controlled water sources.

By analyzing well owners and non-well owners, I investigate the nuanced relationships between the participatory facets of citizenship and water supplies. In fact, when it comes to environmental behaviors and awareness among the beneficiaries of public water supplies, citizenship might actually evoke a *lack* of participation among citizens. Regulatory frameworks aim to ensure that municipal water is safe to drink, but those protections are not provided to people reliant on private wells—making well stewardship and inspection key facets of well ownership (Kreutzwiser et al. 2011). Citizens who do not actively engage with their water supplies could be passive recipients of municipal water, while citizens who maintain private WEMs are more attuned to their source of groundwater. A similar comparison has been made by immigration and citizenship scholars, who contend that citizenship is more about passive rights-holding than “active participation in the political community” (Joppke 2010:146). Researchers note that citizenship and consumption are at odds with one another (Soper 2007), yet citizens have the ability to spark social change when they adopt conservation practices that challenge mainstream resource usage and shape cultural norms. Private well owners, as partial citizens, might actually display more proactive involvement with water management decisions than those who receive municipally-supplied water. This follows the notion that citizenship is largely political, and active citizens exercise their capacity as competent voters and political rights (Holston 2008).[15] Well owners remaining on the rural periphery without access to regulated water supplies demonstrate the intersection between citizenship and access to not just political or social resources, but also natural resources. Using this framing, citizenship is not evenly experienced by Kansans, in part due to conditions of hydrology and infrastructure.

If well owners are consistently attentive to their water supply, they will likely invest in conservation devices, deploy conservation routines, and stay informed of local water-related issues. The concepts of “agrarian citizenship” and “food citizenship” explore how citizenship is re-conceptualized in communities to promote community identity (Wittman 2009; Carolan 2016). These categories of citizenship frame environmental stewardship, investment in local food production, and political involvement as defining traits for members of rural social groups (ibid.). I contend that “groundwater citizenship,” a heightened level of participation in rural activism and resource conservation that private well owners engage to safeguard their water supply, is another useful conceptualization of citizenship. Furthermore, Dobson’s (2003; 2004) “ecological citizenship” describes a sense of personal responsibility that is expressed through consumption and community actions. It involves taking on a greater responsibility to produce positive environmental change with like-minded citizens, and reducing one’s consumption alongside others as an expression of citizenship—which Kennedy (2011a) calls “reclaiming consumption.” Ecological citizenship provides a view that emphasizes the duties and responsibilities citizens have to improve their community and environment, as Dobson (2004:3)

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[15] Holston also argues that voting practices are central for the political component of citizenship. On a related note, consider that citizenship can influence climate change beliefs and perceptions of climate threats. Using data from 128 nations, Running (2013) investigated the role of citizenship identity and concern for climate change. She found that those who strongly identify as being a global citizen are significantly more likely to view climate change as a serious problem, and she argues that they view climate change as a communal risk.

explains, "one of ecological citizenship's most crucial contributions to contemporary theorizing is its focus on the duties and obligations that attend citizenship." Just as Conca (2006:171) refers to a "watershed democracy"—a set of norms that normalizes surface water protection through state institutions—well owners could be seen as a political-inspired population that concerns itself with groundwater protection. By examining well-owning Kansans, I seek to show that water conservation and well stewardship serve as entryways into a citizen group that contributes to environmental change at local or regional levels. It is my contention that well owners fit these descriptions of a unique citizenry: they are a network of specific ecological citizens that I label groundwater citizens, and they reclaim consumption via the adoption of sustainable practices and altering local norms of water consumption.

Well owners engage natural supplies of freshwater differently than non-well owners, and therefore have a unique *water culture* (Johnston et al. 2012), a specific set of customs, behaviors, and knowledge bases that reproduce an ethic of stewardship towards water resources. The community's solidarity reinforces the citizens' sense of membership, local knowledge, and sense of participation to ensure effective local water management. Groundwater citizenship, which could also be seen as an awareness of groundwater's limits and the actions conducted to extend groundwater supplies, requires a series of "environmental heuristics" (Spaargaren 2004). Groundwater citizenship differs from urban citizenship, which pivots around the idea of providing a public utility instead of relying on individualized management. Following Holston's (2008; 2009) logic that the experience of city life is critical to the formation of citizenships and that survival on the periphery of urban centers produces a distinct brand of active citizens,[16] and the previous literature outlining how water supplies are critical for the formation of cities, water supply infrastructure is critical to the formation of citizenship. The designations of "urban" and "rural" are defined politically, and since water supplies change the boundaries of urban and rural communities, they also change the jurisdiction of politics and citizens. Linkages to a central water supply, which are brought by service pipes called *ferules*, transform individuals into urbanites, a population whose everyday habits draw from a shared water supply. Historian Carl Smith discusses this emerging type of urban citizenship at length in *City Water, City Life*:

> City dwellers recognized themselves as participants in a complex society at the moment when they realized that the quantity of water from the local well, stream,

[16] "…cities remain strategic arenas for the development of citizenship" (Holston 2008:22). Holston also refers to citizens of municipalities as "municitizens" (2008:263).

> or pump no longer met their personal needs and commercial demands… The need for a large, dependable, and accessible supply of clean water raised multiple concerns about individual and collective priorities. To build and manage a system that could provide this water required the expansion of heretofore limited city government and an accompanying large increase in the municipal budget. The imperatives of water brought to the fore conflicting ideas of the public good, including disagreements over what resources should be provided, and by whom, to that elusive entity, "the people," in a burgeoning capitalist democracy whose members were fiercely devoted to freedom of individual action and increasingly divided politically, even as they became more dependent upon one another. (2013:4)

The connection to a city water grid created a condition of separation of the human-made world from nature. Taking water from a distant natural source and importing it into household taps made water seem "naturally" abundant. Individual well owners, however, have not necessarily experienced the same degree of separation from their water supplies that their urban counterparts have. Private well owners must take water management into their own hands, while those with municipal connections are locked into a more distant relationship with their public utility, and it may be challenging for them to obtain water on their own or assess their influence on their water source.

Water supply infrastructure creates the boundaries of public participation in water management decisions, sentiments of belonging, and citizenship. Members of citizenry are a group protected by their legal status, but rural, well-owning Kansans are excluded from affordable, clean, and reliable municipal water. Historically, most large-scale water supply infrastructures focused public resources on

> …the privileged consumption of… urban residents; only these citizens are considered to be political constituents of society with full entitlements to state services… The distinction between citizens and populations is literally embedded in the city's infrastructure, thorough the interrelated production of subjectivities (subalterns versus citizens), spaces (the city and the slum), and infrastructure (the network versus the hand-dug well). (Bakker 2010:49).

The property rights choices of the collective not only include management, or the right to regulate internal use patterns, but also exclusion, the right to determine who has access (Schlager and Ostrom 1992; Ostrom et al. 1999). Citizenship manages social differences by legalizing them to legitimate privileges and inequalities, "citizenship is a measure of differences and a means of distancing people from one another" (Holston 2008:5). Access to public water has been regarded as an "emblem of citizenship" (Bakker 2003), and since many well users do not receive water supplied by local municipalities, individuals dependent on wells can be seen as marginalized citizens. Domestic wells are commonly utilized in areas served by onsite wastewater treatment systems, such as septic tanks, which can produce chemical contaminants that leach into groundwater sources (Schaider, Ackerman, and Rudel 2016). "Rural populations, particularly those dependent on stand-alone systems, are vulnerable to…'traditional' sources with unsafe water quality" (Hemson 2015:236). Rural citizens who draw from unregulated wells are exposed to water that does not meet the quality standards of the Clean Water Act at higher rates than the general population (Prud'Homme 2011). In an age of declining water tables, hotter growing seasons, and intense droughts, both city (centralized) and rural (private) supplies are in jeopardy. Sociologists have recently outlined how existing forms of social stratification greatly impact how disasters are experienced, and "the ways in which climate change impacts people is socially [moderated]" (White, Rudy, and Gareau 2016:6-7). In my view, water supplies are one of the great moderating variables for these differentials in vulnerability. If well owners are partial citizens, this has sociologically important takeaways:

1. They are disproportionately burdened by drought, which represents an environmental injustice.
2. Stewardship and citizenship are poorly connected, and the philosophical roots of citizenship need to better incorporate resource conservation as a duty of being a member of a community.
3. The private ownership of water supplies needs to be explored in order to see if it is linked to conservation, as do municipal control and the mechanisms municipalities currently use to promote conservation (such as raising water rates and offering rebates to install water-saving devices).

Scholars in various disciplines have noted that certain communities are more prone to water shortages than others. In *What is Water?*, Jamie Linton cleverly amended the old phrase, "water flows uphill towards money" by including: "drought is attracted [to] poverty" (2010:68). This statement characterizes a large discussion area within environmental sociology: the intersection between vulnerability to natural disasters and income inequality. Droughts create important environmental and socioeconomic challenges that disproportionately harm marginalized groups, such as the elderly, residents of rural communities, and the impoverished (Kallis 2008; Flint and Krogman 2014; Baldassare et al. 2015). Forty-five million people in the United States rely on private wells for household and drinking water (CDC 2012), and aquifer decline represents a clear environmental hazard that affects private well owners more directly than recipients of municipally-provided water. These differences in access to resources are illustrative of eco-apartheid, in which some citizens (non-well owners) have ecological benefits over others (Jones 2008). Furthermore, aquifers undergoing a high degree of overdrafting can be conceptualized as water "sacrifice zones," areas that are exploited for their easily-extractable water supplies.[17] Unsustainable groundwater extractions leave the individuals, households, and communities reliant on wells with little protection against drought. Communities with a large drinking water system have a greater capacity to implement drought-adaptation strategies like reallocating water and planning for droughts (Murti 2012), and droughts stress private wells more than public infrastructures. Therefore, the development of water supply infrastructure contributes to social inequalities and the formation of sacrifice zones. This serious problem speaks to the larger fields of vulnerability, environmental injustice, and at-risk communities that have fascinated sociologists because vulnerabilities reveal a society's deeper social problems:

> Social systems generate unequal exposure to risk by making some people more prone to disaster than others and these inequalities are largely a function of the power relations (class, age, gender and ethnicity among others) operative in every society. Critical to discerning the nature of disasters is a novel appreciation of the ways in which human systems place people at risk in relation to each other and to their environment… (Bankoff 2006)

The theme of environmental justice can expand the dialogue for social and natural scientists to share their insights and discover new ways to address disaster vulnerability and move environmental policies forward. In a way, epidemiologists who study well owners have already adopted well ownership as a socio-demographic characteristic (Murti 2012), but sociologists have not. Nearly 20 million people in the United States are sickened by waterborne bacteria each year (ibid.), making the quality of water supplies an important field within epidemiology. Epidemiologists interested in groundwater quality have framed well owners as a vulnerable population due to their exposure to contaminated groundwater sources, reliance on unregulated domestic water, and socioeconomic status (Schwartz et al. 1998; Imgrund et al. 2011; Murti 2012; Flanagan, Marvinney, and Zheng 2015; Wilson 2015; Flanagan 2016). Well owners are particularly challenged by groundwater contamination; managing private water

[17] The conceptualization of environmental sacrifice zones has recently been proposed by sociologists studying fossil fuel extraction and the energy industry, calling the resource stocks that were exploited in order to provide energy "energy sacrifice zones" (Harlan et al. 2015).

supplies is critically important for researchers studying wastewater treatment and groundwater contamination, and their studies survey well owners to assess their perceptions of water quality (Schwartz et al. 1998). The USGS National Water-Quality Assessment Program determined that across the nation, roughly one in five wells used to provide household drinking water have at least one contaminant present at concentrations higher than the EPA's Maximum Containment Levels (MCLs) or USGS Health-Based Screening Levels (DeSimone 2009). Private water systems account for over 95 percent of the EPA's water-related health violations; in California, one in six wells pump from water supplies that exceed federal water quality thresholds (Prud'Homme 2011). Around 30 percent of waterborne-disease outbreaks from 1999-2002 were attributed to contaminated domestic well water (DiSimone 2009). These health concerns reveal a need to increase awareness among rural households with private supplies, especially since they are responsible for maintaining those supplies (and in many cases, septic systems).

As a part of its recently-established Private Well Initiative (PWI), the CDC works with state and local health departments to conduct research on private well owners. It includes a group of researchers who distribute newsletters, hold monthly webinars, and make online presentations in a forum called the *Private Well Community of Practice* to address the critical need for safe private well water (see Kirkland and Hurd 2015; Susca and Rigrod 2015). The CDC's Division of Environmental Hazards and Health Effects shares research updates in the hopes of protecting these unregulated drinking water systems, which are not under the provision of the Safe Drinking Water Act (SDWA). Private wells are at the greatest risk because they are not subject to state and federal testing and treatment requirements, unlike public utilities. While the CDC researchers' concerns about well contaminants are necessarily targeted at domestic wells that supply drinking water, they work to promote effective strategies to address any risks associated with well ownership. Sociological research can facilitate a dialogue between well owners and researchers in Kansas, as Kansans served by private water supplies conceivably have perceptions of groundwater that would enable health professionals to improve their public outreach.

Contamination is one threat facing domestic well owners, but irrigators in particular are also threatened by extreme overdrafts, and large-acreage farmers express anxiety about their vulnerability to drought (Keenan and Krannich 1997). Farmers invest heavily in irrigation and technologies to cope with the environmental challenges of operating industrialized farms, yet constantly struggle to negotiate the uncertainty surrounding their water supplies (Sherval and

Askew 2012). California's drought has led to roughly 1,900 well failures across the state, including 1,500 domestic wells (Stevens 2015a). Well failures have forced secluded municipalities to reinvest in their aging well pumping infrastructure and consolidate their water districts, while well owners have to rely on donated water tanks and buckets to carry water inside their homes (Krieger 2014; Xia 2015). Running water is no longer consistently supplied in communities across central California, which forces families to rely on government-provided emergency tanks (Fears 2016a). These challenges illustrate how rural residents with shallow private wells suffer the most from excessive groundwater declines; it also implies that monitoring water usage becomes important during times of scarcity.

In addition to their unique spatialities and cultural landscapes, well owners are responsible for managing their water supply and perform well-monitoring routines. Since groundwater can be polluted by fertilizers, parasites, bacteria, and runoff, and the SDWA does not protect self-supplied sources, well owners are responsible for testing and monitoring the quality of their water supply. Agricultural runoff is the single biggest source of water pollution in the US, so farmers (especially those with domestic wells) must "self-police" neighbors' land use decisions in order to protect their groundwater supplies (Prud'Homme 2011). Nitrates can enter drinking water supplies via fertilizer runoff, and are a growing threat for well owners across the nation. Aquifers are notoriously challenging to clean once they are polluted, in part because groundwater travels so slowly, and it takes years for contaminants to degrade or become assimilated. Contamination issues are not quickly resolved, which makes runoff and pollution potential problems for well owners—and private wells are the owner's responsibility to test. Well owners in western Kansas can therefore be seen as a "disaster subculture" (Hussain 1997), one in which people develop specific coping mechanisms for survival in harsh environments. Organizational connections, such as the ones deriving from well owners in GMDs or LEMAs, can influence a community's coping traditions and social environment, and impose sanctions on members for following (or not following) the norms of water usage. While many studies have been done on domestic water conservation, pro-environmental attitudes, and well owners, few have analyzed them simultaneously.

Wells can be used to irrigate crops, water gardens, lawns, and livestock, or provide drinking and household water. Due to the diversity of well functions, well owners may constitute multiple communities of practice and display a range of behaviors and attitudes unique to only specific types of well owners. Water usage is shaped by many activities and technologies: "Change in demand results from shifts in the collective organization of services and from systemic changes in routines, habits, and practices" (Medd and Shove 2007:37). As I outline in more detail in Chapter 4, the relationship between well ownership and water conservation is likely moderated by the type of well in use, and owners of different types of wells could have different definitions of "appropriate" or "excessive" water usage. For instance, lawn and garden well owners could have unique watering practices, such as watering their lawn with large amounts of groundwater. When it comes to water conservation, lawn and garden well owners in my study might not match the previous research framing gardeners as an environmentally-conscious cultural group (Kiesling and Manning 2010). Evidence suggests that gardens are sites in which "routines and habits are deeply embedded" and watering is an embedded habit that gardeners do not easily break during droughts (Chappells et al. 2011:706). Lawn and garden well owners could be unaware of the negative environmental impacts associated with the maintenance of their lawn or garden (see Steinberg 2007), and if they are not connecting their watering routines to groundwater shortages, it would imply too little resonance. This would further suggest that some well owners are pressured by the humid fallacy and do not fit the characterization of groundwater stewards. Furthermore, any well owner who does not regularly test their well water for contaminants are displaying not only a lack of groundwater stewardship, but also a resistance to performing PEBs.

Research indicates that communities of practice emphasize the knowledge and shared interests more than actual practices (Robinson 2014), making the community really about resonance and shared knowledge first, then following practices. Communities of practice galvanize a shared construction of identity between members (Lave and Wenger 1991), but given the diversity of well functions and their prevalence in both urban and rural environments in the High Plains, perhaps well owners are multiple communities of practice. This dissertation probes if well owners are a singular community of practice who have adopted "a shared repertoire of resources: experience, stories, tools, ways of addressing recurring problems—in a short shared practice" (Wenger 2006) or if they have distinct performances based on how they use their wells. Social practice theory (Shove, Pantzar, and Watson 2012) frames water conservation as an environmental social practice—an everyday interaction within groups that promotes environmentalism. Studying this particular community (or communities) of practice will provide a sociologically-informed estimate of domestic groundwater consumption and insight on the subpopulation of millions of Americans who rely on private wells for their household and drinking water.

In environmental sociology, the influence of water supply infrastructure and the demographic variable of well ownership goes largely unproblematized. Researchers pay attention to demographics like race, class, sex, political views, and so on, but few pay attention to how water supplies contour the experiences with water and other natural resources. This research is part of a broader effort to investigate the influence of systems of water provision. Well owners have been overlooked in the social sciences, and this dissertation generates one of the only quantitative datasets on well owners in the nation used for social science research. My study frames well owners as a distinct social group that is disproportionately disadvantaged by groundwater depletion, and it investigates their routines of groundwater stewardship by focusing on their practices of water management. The results of this research can help environmental sociologists understand the importance of framing well users as a community of practice. Well owners remain a group specifically threatened by drought and will be especially vulnerable in the future if aquifers continue to be exploited. Due to their vulnerabilities and connection to groundwater, I anticipate that they have an acute sense of the scope of their usage and the limits of their supply. Wells are unique systems of water provision that I believe are associated with the adoption of PEBs related to water usage, and their extractions are also based on larger economic demands. This is examined in the next chapter.

CHAPTER SUMMARY

> In this chapter, I described the literature applied in my dissertation, which draws from sustainable practices, the sociology of water use, and research on well owners. Water conservation attitudes and behaviors have been studied, but more work needs to be done to investigate the connections between water supply infrastructure and practices of conservation. Whether through municipal supply systems or private wells, how households receive water influences the normalization of water use. By studying how well owners use water domestically, respond to drought, and prioritize conservation, this project will provide new knowledge on a subpopulation that relies directly on the largest aquifer in the nation. Additionally, figuring out exactly who well owners are (in terms of demographics) remains to be determined, as they are a population that has been overlooked by the social sciences. Conceptualizing well owners as a distinct social group, specifically, as a *community of practices, attitudes, and awareness*,

will contribute to environmental sociology by adding to theories of sustainable practices, vulnerability, and ecological communication. Private well owners, who are responsible for managing their own water supply, represent a subpopulation particularly vulnerable to drought.

Chapter III: Macro-Level Theoretical Framing

> In this chapter, I contextualize the agency of Kansas well owners within a neoliberal political structure and describe the structural roles they play in the state's economy. Well ownership and groundwater withdrawals are complicated by major contradictions between the environmental imperative of sustainable groundwater removals and the social demands for economic expansion. I hold that studying groundwater reliance contributes to the macro-sociological framework of Ecological Marxism, specifically growth machine theory, which emphasizes the exchange values of natural resources. My research locates groundwater withdrawals within broader processes of political and economic changes in Kansas. I study how groundwater shapes the interaction of nature and society, and how neoliberal institutions mediate that interaction and dictate levels of development across the state. While many high-capacity well owners' agency has been restricted by the structural forces associated with larger social policy and agricultural regimes, examining the attitudes and behaviors of the actors in the groundwater economy has implications for the resilience of rural communities in Kansas. As neoliberalism dominates Kansas governance, the policies managing well ownership and well owners' decisions and will play an ever-more influential role in aquifer preservation.

NEOLIBERALISM AND GROWTH IN KANSAS

Chapter 2 discussed how Pro-Environmental Behaviors (PEBs) involve trade-offs between values, social pressures, and standards of consumption. Private-sphere PEBs like recycling, buying organic, and so forth are practices strongly encouraged by the individualization of environmental responsibility. Regulating corporate responsibility to reduce packaging and applying chemicals on food is given less support as part of the neoliberal context in which "economic well-being… becomes associated more and more with individual self-management" (Wall 2000:262). The neoliberal project stresses individual choice and responsibility over the greater roles for the state to monitor the private sector (Cairns et al. 2013). This "environmental privatization" (Sandilands 1993) leads to a narrowed understanding of what it means to be an environmentalist—not an involved citizen, but an environmentally-conscientious customer. Individuals likely have several different ways to think about water usage—as a citizen, community member, or water utility customer. The social and practice-based meanings of water consumption are likely attributed to citizen and social status, but intentionally saving water for economic reasons suggest identifying with the role of a consumer. Dowie (1996) uses the phrase "environmental imagination" to describe the wider understanding of what should be done in response to environmental crises. In terms of drought in the High Plains, water supply awareness and infrastructure influence the responses to drought and call the environmental imaginations of its citizens into question. While the range of solutions to environmental problems has been narrowed by individualized practices or environmental privatization, it is important to not simply blame individuals for groundwater losses. It is important for individual citizens to do their part to reduce their water consumption, but the current state of aquifers in Kansas has been largely determined by neoliberalism, the lack of an established exchange value for groundwater, extreme swings in climate, and the demands of the larger food systems and agribusinesses that inhabit those systems.

In terms of water usage, researchers need to produce more than just physical facts about how groundwater is domestically and agriculturally used, they should also attend to the social effects of climate-related decisions (Stern 2016). Sociology can improve the understanding of environmental forcings by investigating how growth- and market-based decisions contribute to anthropogenic changes. In fact, sociologists have entertained the idea of reframing the Anthropocene (or the age of humans) as the *Capitalocene*, an age in which capitalism pushes the climate towards unprecedented extremes (Moore 2014a; 2014b). Understanding climate change—in addition to industrialized food production—as distinctly capitalist processes give sociologists a new way to interpret the historical geography of capitalism and the social and political systems affiliated with economic growth. As I will discuss in this chapter, the rural backdrop of Kansas is largely a product of a socio-ecological relationship in which the exploitation of aquifers and farmers have generated a hybrid landscape of unsustainable agricultural production.

This project contributes to environmental sociology by studying Kansas groundwater depletion within the context of neoliberalism—the promotion of economic growth and risk taking. Economic restructuring or structural adjustment has been thoroughly studied by globalization scholars interested in the relationships *between* developed and developing nations, but this chapter examines neoliberalism's influence *within* the United States, specifically within Kansas agriculture.[1] Using the work of Harvey Molotch (1976), I frame the farming communities in western Kansas as growth machines. For Molotch, cities are created and sustained through growth; communities use growth as a survival mechanism to adapt to

[1] For a study on the cultural influence of neoliberalism on sheep and dairy farming within New Zealand, consult Stock and Peoples (2012).

capitalism's growth imperative. The history of city water supplies can also be connected to growth machine theory, as waterworks advocates suggested that "watering the city" via centralized supplies would enable cities to grow as large as possible (Smith 2013:207). Molotch contends that localities generate economic growth by transforming the use values of natural resources into exchange values. The commodification of a community's land, resources, buildings, and labor is seen as development, or the transformation of a society to improve its ability to produce and accumulate (Castells 1977). Logan and Molotch (1987) divide community members into dichotomous groups: "residents, who use [a] place to satisfy essential needs of life, and entrepreneurs, who strive for financial return, ordinarily achieved by intensifying the use to which their property is put" (p. 2). Manuel Castells also argued that cities are structured around conflicting values and interests, which contributes to design of cities: "Urban structures will always be the expression of some institutionalized domination" (1983:xvi). The dominant value in growth machine theory is a commodity's exchange value, which perpetuates or facilitates the growth imperative. Urban settings are rife with struggles between entrepreneurs and residents over power, resources, and space: "only those things considered 'productive' by the dominant class of a mode of production are valued, while 'socially useful' but structurally rewardless activities are counted insignificant" (Castells 1983:71). If cities are the product of conflicting interests as Castells states, the primary conflict is between the entrepreneurs and development via the production of exchange values, and the residents and community-building and environmentalism via the continuation of use values.

Irrigation pumping, which has steadily depleted groundwater supplies since the 1940s, symbolizes the dominance of entrepreneurs' agendas. Entrepreneurial intensification leads to increased pressures on environmental resources, and while Logan and Molotch discuss air and surface water pollution, they overlook groundwater decline. Historians Karl Wittfogel (1957) and Don Worster (1986) have thorough discussions covering the competition for water in a variety of contexts and environments, and argue that securing a stable water supply is the most important step in expanding communities, nations, and governments. Molotch, Wittfogel, and Worster all emphasize that the competition for water is actually a competition for growth. When localities, states, and collectives of all sizes can obtain sufficient water, they can complete an assortment of growth-related tasks: agricultural, industrial, or municipal expansions. Water is not only indispensable but also highly functional—it is a means to any number of economic ends. As a basis for life, water is an "axis resource," one that underlies all others (Prud'Homme 2011), and as such its management is essential for growth. As previously outlined in Chapter 2, the symbolic meaning of water is attached to its practices of consumption; therefore, the utility (or use value) of resource consumption in daily life shifts according to broad sociocultural changes. Moreover, a resource's exchange value is influenced by usefulness and utility of its consumption, as well as whether it is a "positional good" (Hirsch 1977). Positional goods increase a user's status because they carry symbolic value and prestige. In the context of homeownership, standards of cleanliness, and displays of wealth in and around the domestic sphere, water is clearly a positional good. The utility of water also changes as residents attach meaning to high agricultural output and growth. In order to understand the dynamics of water consuming practices (from bathing to washing clothes; from watering lawns to irrigating corn) sociologists should analyze water with multiple exchange and use values.

Logan and Molotch hold that a community's economic elites influence how cities are governed. These elites invest in economic returns and increasing the exchange values of their land, which they frame as real estate. In contrast, environmental groups (primarily residents) seek to preserve the use value of specific resources. Growth machine theory frames residents and entrepreneurs as opposing forces, yet in the case of Kansas groundwater, it is often difficult to clearly outline the opposing agendas between those seeking to gain from exchange values and those prioritizing groundwater's use values. This is perhaps due to the political influence of the entrepreneurial class, who attempt to intensify land production and support the productivist agricultural regime (the commitment to industrialized and expansionist agriculture with resource- and fertilizer-heavy practices which increase output and productivity [Lowe et al. 1993], as well as greenhouse gas pollution [Biello 2016]). Logan and Molotch argue that entrepreneurs have more resources than residents and therefore dictate the governance of cities. In western Kansas, where farmers are politically influential, many community members prioritize exchange values. This adds to the notion of a growth ethic and makes the cities effectively growth machines.

The Kansas House, Senate, and Governorship are all controlled by Republicans, which has proven to be a beneficial political climate for the entrepreneurial class's most elite. Governor Sam Brownback has consistently supported a low tax-and-spend approach to governance, and one of his major goals as governor is to eliminate income taxes in Kansas, a plan summed up by his catch phrase, "The March to Zero." In 2012, he signed into law one of the largest income tax cuts in the history of the state, which lowered the sales tax, eliminated taxes on small businesses, and cut the top income tax rate by 25 percent (Peters and Paletta 2014). The bill removed income taxes for nearly 200,000 business owners and retains tax exemptions for 333,000 businesses (Johnson and Fund 2015). These tremendous political rewards for entrepreneurs reinforce Marx's interpretation of the state,[2] which he frames as an instrument of the ruling class:

> The bourgeoisie has… since the establishment of modern industry and the world market, conquered for itself, in the modern representative state, exclusive political sway. The executive of the modern state is but a committee for managing the common affairs of the whole bourgeoisie. (Marx and Engels 1955:11-12)

The basic assumption of growth machine theory is that entrepreneurs control local decision-making; they are seen as an elite group that structures political conversations, an assumption that supports Marx's view of the state.

The March to Zero exemplifies the legislation discussed by John Mollenkopf in *The Contested City* (1983). He argued that politicians are prone to give advantages to powerful beneficiaries "especially when they can be cloaked in the public interest" and the costs can be imposed on the general public (1983:5). The commitment to tax cuts in Kansas is expected to continue for years. A recent tax package (SB 270) stipulates that any growth in state revenues beyond 2.5 percent must be used to further income tax reductions beginning in 2019. To offset this tax cut, the bill changes Kansas tax policy by increasing taxes on middle- and low-income earners (residents) by $777 million over the next five years (Kraske and Murdock 2013) and increasing the state sales tax on food. This law was modeled after a proposal written by the American Legislative Exchange Council (ALEC) a nonprofit organization renowned for drafting bills for right-wing policymakers. Since the law's passage, the dramatic tax cuts generated a budget deficit of $344 million (Eligon 2015) and the state's credit rating was downgraded because it was not structurally balanced (Lambert 2014). Income taxes for individuals and corporations account for a quarter of the state's revenue, so unless consumer spending increases dramatically, Kansas will continue to face deficits (Johnson 2015b).

In order to pay for the tax cuts, the state's regulatory mechanisms, including the state water plan, have been defunded for years. The "social costs" of supporting the citizens of

[2] This dissertation applies Marx's vision of the state to neoliberal policymaking in Kansas. For an alternative conceptual framework that positions the state not just as an instrument manipulated by entrepreneurs, see Esping-Andersen, Friedland, and Wright (1976) and Altvater (1973). Regardless of Marx's framing, water utility managers "are rarely at the top of the political hierarchy" (Sedlak 2014:241).

Kansas—education, health care, law enforcement—have been passed on to volunteers, churches, and welfare agencies. Austerity policies have laid waste to the state budget and public services, and education has been targeted as the budget's largest discretionary item. On his campaign for reelection in 2014, Governor Brownback denied that he would cut education spending, yet his first budget announcement after the 2014 election season admitted that cuts to education would be unavoidable given the deficit (Johnson 2014). Kansas's new school funding law repealed the per-student funding formula and replaced it with block grants for each school district. The school finance bill, Senate Bill 7, which narrowly passed the house, cut district budgets so sharply that some schools had to end their 2014-15 academic years early (Lee 2015). Recent proposals for school budgets are widely disapproved by the general public and have been ruled unconstitutional by the State Supreme Court because the block grant funding plan allocates a level of funding found to be inadequate (Resmovits 2014; Pendergast et al. 2015). These lower revenues have also led to significant cuts in higher education, as the per-student state support for the University of Kansas has dropped 40 percent since 2000 (Semuels 2015). As the state continues to follow the low tax and spend doctrine, it will have to find ways to meet its obligation to fund education.[3]

Perplexingly, despite the economic devastation storming through Kansas, Republicans are ushered into office every two years by the voters.[4] Social issues and values remain extremely important to Kansas voters (due to pro-life, pro-creationist, and pro-traditional marriage sentiments) and neoconservatives have used the culture war to oust moderates across the state. This has resulted in an elected legislature that is far more conservative than its constituency (Pendergast et al. 2015). As Thomas Frank famously described in *What's the Matter with Kansas?* (2004), the social conservativism of the Kansas voters led the state towards extreme fiscal conservativism in the 1990s. "Like the French Revolution in reverse—one in which the sans-culottes pour down the streets demanding more power for the aristocracy—the backlash pushes the spectrum of the acceptable to the right, to the right, farther to the right" (2004:8). Even on a national scale, establishment Republican candidates often pander to a political base

[3] The revenue crisis is particularly important for education, as school funding for public kindergarten through high school represents 50 percent of the Kansas state budget (Johnson 2016c).

[4] Throughout my work, I use the term Republican to include mainstream conservative policymakers in Kansas, who typically adopt both neoliberal values (generally, reducing the role of government and emphasize market-based solutions) and neoconservative values (broadly, to use the state to promote a traditional value system in order to protect the cultural and ideological standards of the nation).

that is surprisingly hard to find in reality. Despite the fact that politicians who are climate change deniers represent over 200 million people, most Americans want elected officials to act on climate change (Ellingboe 2016). In fact, a majority of Republican voters believe that the United States should invest more in renewable energy in order to reduce pollution and create jobs, and growing numbers of Republicans believe that human activities are contributing to climate change (Echelon Insights et al. 2015; Leiserowitz et al. 2016). Furthermore, Americans consider water shortages and food shortages some of the most important consequences of climate change (Milman 2016). Nevertheless, both elected Republicans and those seeking office have often neglected to make climate change adaptation a political priority.[5] Farmers' concerns and plans to create sustainable food production are also largely ignored by popular candidates on both sides of the aisle (Heikkinen 2016). This is particularly troubling because farmers are a subpopulation with evolving practices and values that enable them to combat harsher growing conditions brought about by climate change, and conservation is embedded in their business model (Greenberg, Shute, and Simpson 2016).

Suffice it to say, some Kansas policymakers remain disconnected from their constituents. Two entrepreneurial forces immediately come to mind: First, the emergence of political echo chambers has changed the political conversations into ideological black holes. Communications scholars have described the relationship between media sources and their audiences as a "reinforcing spiral" in which partisan media sources influence their viewers' beliefs (Slater 2007). In turn, audiences select media outlets that support their perspectives, further hardening their views over time in a perpetuating cycle. The reinforcing spirals framework has recently

[5] This is particularly evident at the national level, as few Republican presidential candidates in the 2016 election cycle discussed the development of clean energy or the anthropogenic causes of climate change in the primaries. New Jersey Governor Chris Christie believes that the United States should not be a global leader in addressing climate change, a view with which most Americans disagree (Goldberg 2015). Jeb Bush's energy plan did not mention climate change and calls for an increase in oil drilling and the construction of the Keystone XL Pipeline (Goode 2015). Senator Marco Rubio said that any climate change action taken by the United States would "make America a harder place to create jobs…" (Sargent 2015). Ted Cruz consistently states that be believes the percentage of scientists agree that global warming has anthropogenic causes (97 percent) is based on a bogus study, and refers to a global warming pause as a means to dismiss the issue (Wittenberg 2015). To be clear, the studies that found a hiatus in warming did not use adequate timeframes of measurement to make a definitive conclusion (Lewandowsky, Risbey, and Oreskes 2015); the satellite data measuring temperatures have recently been recalibrated to better assess global warming and show no pause in temperature increases (Borenstein 2016). Moreover, if the global warming hiatus is happening, it is because the global ocean has stored over 93 percent of the excess heat generated by greenhouse gases in recent years, compared to the atmosphere's 1 percent of heat storage (Dijkstra 2015). Examining changes in oceanic temperatures and the intake in sequestration can explain minor pauses in surface or air temperature increases.

been applied to global warming perceptions, specifically skepticism among Americans and conservative media outlets (Zhao 2009; Feldman et al. 2014; Huertas and Kriegsman 2014). The International Conference on Climate Change, a gathering for climate denialists, epitomizes the echo chambers of global warming skeptics and their platforms (Freedman 2015). Such well-publicized denial (even though it is a minority view within the American populous) has fundamentally changed how the public engages (or does not engage) conversations of climate change. Environmental psychologists have found evidence that people opt towards self-silencing in order to avoid debates or appearing incompetent (Geiger and Swim 2016). If citizens carry inaccurate perceptions of others' opinions, and if they believe that avoiding the subject of climate change is a form of impression management around dissenting audiences, it can reify the already foreboding barriers for discussing global warming. Climate change beliefs remain entrenched in political partisanship, which contributes to a lack of widespread public discourse as to what the potential solutions for these serious environmental matters might be.

Moreover, Republican politicians have halted (and in some instances in Kansas, nearly reversed) legislation supporting clean energy development and addressing climate change. Kansas's Renewable Portfolio Standard (RPS) requires that 20 percent of its public utilities come from renewable sources. In early 2015 legislators voted to repeal the RPS mandates and replaced it with a "voluntary goal" (via SB 253 and HB 2373) even though 19.4 percent of Kansas power was already generated from wind (CEP 2015; Myslivy 2015).[6] Most conservative parties around the world accept the findings of climate science, making the platform of climate change denial in the United States globally anomalous (Batstrand 2015). Applying the framework of reinforcing spirals, one could reasonably argue that 56 percent of Congressional Republicans deny climate change because they surround themselves with information they want to hear and block out other information (Klein 2014; Jasny, Waggle, and Fisher 2015). Media outlets could improve their coverage of climate change studies, which would be enormously important because of their influence on the public's and policymakers' perceptions of the issue.

Second, business elites have become increasingly invested in forming partnerships in the government. In the United States, the major polluting industries (coal, oil, gas, and agriculture) have powerful lobbies in Congress, enabling market organizations to manipulate policies

[6] The rise of neoliberalism steered conservatives to oppose environmental policies and regulations (Dunlap and McCright 2015). Repealing the RPS is a clear example of this.

regarding global warming (Perrow 2010). Campaign and political contributions from the fossil fuel industry have maintained an environment of climate change denial among policymakers throughout the United States (Kennedy 2004; Pope and Rauber 2004; Bowen 2008; Coll 2012; Batstrand 2015). The nation's second-largest privately owned company, Koch Industries of Wichita, has been incredibly active in far-right politics. Charles Koch founded the Cato Institute and the Tea Party foundation Americans for Prosperity, and the Koch brothers have delivered crucial assistance to Republicans' campaigns in Kansas and across the nation. The Kochs famously pledged to spend nearly $890 million in the 2016 election cycle and Koch Industries is the top political donor to state elections in Kansas (Bender 2015). Nationally, the fossil fuel industry invested $107 million in Super Pacs in 2015 to Republican presidential hopefuls, accounting for a third of the entire party's campaign contributions for that year (Goldenberg and Bengtsson 2016). The millionaires and billionaires who funded the $30 million campaign to reelect Governor Brownback in 2014 kept their tax cuts, costing the state tens of millions annually. Less affluent Kansans are expected to fund those tax breaks (not to mention balance the budget) with higher sales taxes (Johnson and Fund 2015). This trend has emerged on a national scale since the Reagan administration (Lind 1996); tax burdens have been transferred from the entrepreneurial class to ordinary Americans.

Predictably, Brownback has defended these policies and new tax structures, attributing the revenue drops to President Obama's tax policies and the President's overall suppression of the business environment (Lambert 2014). When asked about the "adrenaline shot" Brownback claimed the tax cuts would give the Kansas economy three years after they were implemented, he said the state must stick with them and accruing the benefits would take more time. Until then, the Kansas is stuck with its anemic job growth, 0.1 percent for the 2014-15 year, lower than nearly every other state in the nation (Abouhalkah 2015). As it happens, economists around the country estimated that the tax cuts have had plenty of time to have an effect and concluded the March to Zero is failing (Kraske 2015). Apparently the Governor is convinced of this small-government approach regardless of what it does to his state. Governor Brownback might be sticking to his tax and revenue experiments due to "cognitive locking," (Blyth 2002) or the inability to design policies that are alternatives to the neoliberal approaches of reducing the role of government in the hopes of growing the economy. This illustrates his belief that entrepreneurs are reliable job creators who are responsible for initiating economic growth, and making life easier on the entrepreneurs will surely improve the lives of residents.

In the agricultural communities of Kansas overlying the High Plains aquifer, the economic interests of many residents and entrepreneurs historically seem to overlap. Farmers and ranchers apparently support the interests of the entrepreneurial class (the elite who benefit from the commodification of resources and the accumulation of exchange values). Many farmers can only make a profit if they have enormous spreads; the average farm size has grown from 456 acres in 1960 to 736 acres by the year 2000 (EPSCoR 2013a). Agricultural communities have encouraged economic growth by raising and slaughtering huge numbers of cattle and growing large quantities of corn, wheat, and soy—the increase in bushels-per-acre and the size of farms and ranches symbolize such efforts. This productivist shift (which is also referred to as intensification) has led to a lop-sided formation of agricultural output; nationally, 8 percent of farms produce 60 percent of the food grown in the United States (Hughes 2016). Productivist agriculture depends on the market for inputs; it needs increasing quantities of pesticides (Eke, Barnden, and Tester 1996), and it cannot survive without synthetic fertilizer (Altieri et al. 1983:45; Altieri 2005). Overall, irrigation complements the use of other inputs like fertilizer and is correlated with greater crop yields (Vaidyanathan 1999), making groundwater essential to the productivity of Kansas agriculture. Agricultural chemistry has enabled higher crop yields over the second half of the twentieth century, but this so-called "green revolution" has relied on planting crops that are herbicide resistant (Bell 2012). The applied herbicides can end up the water supplies that sustain the farms, thereby jeopardizing agricultural communities' resource bases.

Productivist agricultural systems demand ever-increasing levels of depletion, production, and even consumption. In this context, agricultural communities have not prioritized producing foods based on their environmental impact or water footprint, but they have grown virtually anything profitable (or heavily subsidized). Agriculture in the Midwest has undergone dramatic changes since the 1970s, as fewer farmers own more land and have reduced their crop diversity (Aguilar et al. 2015). Since they rely largely on their own labor, small farmers cannot produce food as affordably or as efficiently as large industrialized operations that substitute capital for labor and produce many more units.

> [The] attention to productivity has also acted as a smokescreen, directing energies away from other equally important problems that have plagued the world's smallholder farmers. Without access to markets, for example, yield increases benefit no one. The lack of markets for the world's smallholder farmers is a major problem—a problem that has only be exacerbated by policies promising cheap food. (Carolan 2011:6)

Historically, agriculture in the United States adopted the image of the small, independent farmers who first settled the Midwest in the late nineteenth century, even as export markets and crop prices impelled farms and ranches to expand and mechanize to fit the capitalist system. "Contrary to the highly romanticized notions of US agrarianism, farming was commercialized almost from its inception" (Guthman 2011:55). The current food order grew along with the global economy and the global marketplace, which further separated consumers from their food's production (Friedmann 1982). Decades of flooding the global markets with government-subsidized irrigated corn exacerbate the situation. The US government has applied subsidies (over $11 billion annually) to keep farms profitable, control their overproduction, and continue the neoliberal encouragement of agricultural exports (Environmental Working Group 2009). Consumers' decisions about their food are not only constrained by the corporate and political priorities which structure food production, but domestic politics are structured the larger international food system[7] in which they are embedded (Friedmann 1980). For instance, nearly 99 percent of US meat production is stationed within large-scale Confined Animal Feeding Operations (CAFOs), which are sites of intense pollution, disease, and water contamination, but this is not common knowledge for consumers (Tietz 2006; Olivier 2012); neither is the fact that large feedlots comprise most of the livestock production in southwest Kansas (Harrington et al. 2003).

The region of the south-central High Plains was the epicenter of the greatest agricultural crisis in the history of the United States, the Dust Bowl. This area is prone to extreme climatic shifts, making it a risky site for industrial agriculture. Cattle feedlots and meatpacking plants surrounding Garden City supply roughly 40 percent of the nation's beef (Opie 1993). The state's plants slaughter over 6 million cattle each year, and Kansas livestock has estimated value of $9.5 billion, making Kansas one of the top states in the nation for red meat production (KDA 2013).

[7] Food systems are broadly defined as the policies regulating how food is produced and the process of growing, storing, and transporting food (Kapuscinski 2016).

Corn-fed cattle is an industry with revenues that overshadow other foods in Kansas (USDA 2011). Moreover, high value irrigated corn remains a widely-grown crop because it is more profitable than less water-intensive crops like sorghum. The combined water consumption of beef and corn production makes industrial agriculture the largest driver behind groundwater losses in western Kansas. Industrialized agriculture is of particular importance in GMD 3, which covers southwestern Kansas and contains Garden City. Due to its vast corn farms and cattle lots, GMD 3 is the most groundwater-reliant portion of the state. It would be much less fertile without its massive underlying aquifer:

> …Gigantic rolling irrigation devices pump water from a subterranean aquifer that make this otherwise unthinkable crop [of corn] possible; feedlots the size of cities transform the corn into cowflesh… Take a drive through the countryside here, and you will see no trees, no picturesque old windmills or bridges or farm buildings, and almost no people. When the aquifer dries up, as it someday will—its millions of years of collected rainwater spent in just a few decades—you will see even less out here. (Frank 2004:53)

Given the enormous declines of groundwater in GMD 3 (Evans 2013; Steward 2013) it appears that the farms and towns in Southwestern Kansas have ignored their own hydrological landscape at a structural level for several decades. The 14 counties that make up GMD 3 consume 4,600 acre-feet of water *daily*, some 1.5 billion gallons (Sanderson and Frey 2014b). Groundwater models for this GMD indicate that the aquifer had a 30 percent reduction in groundwater storage compared to its underlying aquifer's predevelopment levels; it receives roughly 500,000 acre-feet of recharge each year, but it loses around 2 million acre-feet annually from well-pumping—and during the drought year of 1991 it lost an astonishing 2.7 million acre-feet (Liu et al. 2010). Furthermore, GMD 1 in Western Kansas had about a 60 percent reduction in water storage compared to its predevelopment levels, which is the greatest percentage reduction in storage out of all GMDs (Wilson et al. 2015). Virtually all of the water rights in these GMDs are authorized for groundwater irrigation, a key factor as to why the water is being mined.

Marx described capital's tendency to remove itself from its ecological bases. Its growth imperative necessitated the expansion of production beyond the productive capacity of the land's ability to renew its resources, leading to a "metabolic rift" (Marx 1976 [1867]). Metabolic rift analyses hold that capitalist agriculture is unsustainable because it undermines the capacity of its productive base—soil—to sustain production over time (Foster 2009:180). Metabolic rift scholars view capitalist agriculture as a "system of robbery, opposed to rational agriculture"

(Clark 2003:89): Capitalist agriculture robs soil by removing nutrients from soil in the form of commodified food without later giving nutrients back to soil to compensate for nutrients extracted (Foster 1999; 2002; 2009). This creates a "rupture or interruption of … [the] natural system" (Clark and York 2005:400) upon which agriculture is based. Given the system's dependency on irrigation, it could also be said that productivist agriculture robs groundwater reservoirs. These robberies are actually interconnected: soil erosion threatens irrigated farmland because irrigation can salinize soil (warm, arid conditions evaporate more of the water applied via irrigation, which leaves behind salts). By intensifying the production of high-input crops in semiarid climates, and relying on irrigation for most of the gains in crop production, slowly-recharging aquifers often do not have enough time to recover from tremendous extractions for watering corn and beef operations, especially during droughts.

Marx also stressed that humankind would grow alienated from nature under the logic of capitalist accumulation, due to the exploitation of resources and labor power (O'Connor 1998). Labor, in a way, is the mediator between humans and nature, and natural resources are constantly modified by labor. This theme of ecological Marxism is largely apparent in growth machine theory. The conditions of production—the infrastructure, labor, and natural resources used in creating commodities—are set by the entrepreneurs (or the bourgeoisie in Marx's language) and determine how the residents (proletariat) interact with natural resources. In the case of the High Plains aquifer, it has lost approximately 30 percent of its volume due largely to illogical food production. Holston's (2008) work on Brazilian citizenship emphasizes the differentiations based on citizenship, and to a lesser extent, rural citizenship has been shaped by productivist agricultural systems—a system that assumes abundant groundwater reserves for irrigation while also mandating that expensive irrigation systems be purchased at the farmer's expense.

High-powered wells are not only part of a unique water supply infrastructure used by many communities; they are the interface whereby humans modify groundwater supplies. The proliferation of high-capacity wells should be regarded as a development of productive forces that influence the conditions of production, as powerful well pumping technology enables the rapid extraction of groundwater. Their preponderance changed farming in the High Plains, and therefore, the way that labor mediates nature and culture. Wells are the sites of interaction between subterranean freshwater and growth machines in semiarid climates, and they are components of infrastructure critical to the cultural landscape of the West. Furthermore, the availability of groundwater made possible by wells affects land values. Analyses of farmland prices reveal that depth to the water table is a primary determinant of irrigable land in the High Plains (Torell, Libbin, and Miller 1990). Non-irrigated cropland averages $1,200 per acre while irrigated cropland averages $4,450 per acre in eastern Colorado (Bjerga 2015). Said one farmer who is transitioning to dryland agriculture, “We’ve built some pretty nice schools and some pretty nice hospitals, and *we have a nice tax base all based on irrigated ground*” [emphasis added] (ibid.). Given the enormous differences in economic values associated with wells, Kansans’ agency can be enabled or constrained by spatiality, the material constructions associated with the natural environment. The advent of high-powered wells changed crop output and selection in the High Plains, but the vision of producing input-intensive corn and cattle required a level of mastery that can only be temporarily achieved through groundwater mining in most parts of the state.

Capitalist modes of production organize the interaction between people and resource supplies, and producing massive amounts of cheap food in rural Kansas requires powerful wells for groundwater extraction.[8] Irrigation is seen as a technical achievement that can change a particular ecosystem in order for it to be deemed economically successful. Marx’s metabolic rift also encompasses a rift within the hydraulic cycle, specifically as groundwater supplies are not seen as part of ecosystems, but a separate resource that have no standing, a resource to expend in order to repurpose the land for entrepreneurial endeavors. If aquifers were seen as an important renewable segment of an ecosystem, instead of merely a resource that can be drained for the sake of temporally augmenting surface or irrigation water supplies, perhaps the metabolic-hydraulic rift in Kansas would not be so pronounced. Recall from the first chapter that Kansas reached its peak level of groundwater depletion as recently as 2010, and even if pumping continues, the state’s overall volume of well extractions will decline for the rest of the century (Steward and Allen 2015). This leaves the state particularly vulnerable for future droughts, and connotes that the resilience of food production in the High Plains will be tested.

O’Connor’s (1988) phrase “Culture makes nature” captures how ecosystems are cultural products; landscapes have been shaped by human’s land-use and water-use decisions to various degrees. Sadly, the agricultural landscape of the High Plains is now a “hybrid landscape,” one in

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[8] I use Carolan’s (2011) label of cheapness not to describe a foodstock’s affordability, but rather damaging externalizing food processes that do not reflect food’s total costs.

which technological and natural systems have become woven together at the expense of aquifers (Fiege 1999). Social scientists have long acknowledged the ambitious infrastructural projects associated with water provision. Elna Bakker (1984) and Mark Fiege (1999) studied how flood control and irrigation projects have changed the water ways of the West to convert the landscape into some of the most lucrative farm areas in the nation.

> The water flowing in irrigation systems is as much a social product of human organization as it is a natural commodity… [S]ociological issues are embedded in the operation of all irrigated systems, small or large: people must organize socially in order to secure water, transport it, divide it into usable shares, enforce rules for its distribution, pay for it, and dispose of unused portions. (Cernea 1991:43)

Pumping groundwater for unsustainable food production represents the problematic dialectic between humans and ecosystems, as economic systems that rely on growth exacerbate the tension between human instruments and natural processes (ibid.). Nature and the qualities of natural resources influence agrarian lifestyles, and groundwater provides the basis for irrigated agriculture (Dubash 2002). The proliferation of high-capacity wells is pivotal to understanding resource consumption as a strategy of capitalist interests, not merely residents. Market organizations have power over their environments based on their structural and technological operations (Levy and Egan 1998); therefore, studying the groundwater economy with the growth machine framework can advance theoretical discussions of capitalism.

This backdrop of groundwater exploitation offers a variety of support for the theories of Marx, Logan, and Molotch on various levels. Capitalism's growth imperative has intensified groundwater depletion and competition among farmers, which makes large scales of economy (and gargantuan levels of groundwater usage) essential for individual farmers and the communities reliant on the High Plains aquifer. When consumption inflicts unintended costs on others, it produces economic externalities, "a characteristic and all-pervading feature of the modern economy" (Scitovsky 1971:269). The neoliberal-style capitalism that many state politicians and voters support is, in effect, an economic system has little use for rural towns or small farms. Deregulation has driven Kansas agriculture into a permanent state of crisis, and just as Molotch speculated that growth is the economic essence of virtually any locality, farms themselves have become growth machines—increasing their size by over 60 percent from 1960 to 2000 (EPSCoR 2013a). As farms have grown, the number of farmers has decreased substantially for decades. Kansas has only half the farms it did in 1950 (Frank 2004), a trend that is seen nationally: "The United States is experiencing the greatest farm loss numbers since the mid-1980s" (Kreb 2003).

Farms are becoming larger and less numerous due to huge agribusiness conglomerates buying materials from farmers to sell at massive scales of economy. As previously mentioned, the entrepreneurial class invests in the exchange value of properties, but the agricultural interests of corporations (entrepreneurs) are different than those of farmers with small operations. Recent farm legislation in Kansas (e.g., the proposals to provide tax incentives for corporate farms) has created a climate that weakens farmers who cannot compete with the ever-more-powerful corporate interests (namely, Tyson and Cargill, known for their meat-packing plants throughout the High Plains, which has been responsible for dumping tens of thousands of tons of pollutants into US waterways). If the Kansas legislature drafts bills aiming to reduce regulatory burdens on businesses, Logan and Molotch's framework is applicable to Kansas agriculture because the interests of entrepreneurs have trumped those of smaller farmers. One might expect the agendas of farmers and Big Agra to be mutually beneficial, but entrepreneurial goals hurt, rather than help, resident farmers.

Consider the following: farming is an industry uniquely susceptible to problems brought on by laissez-faire economics, particularly because farmers cannot control the prices of their commodity crops. In every other market, producers can cut back production whenever prices get low, but farmers do not have this option. Instead, each farmer becomes more efficient and more productive to stabilize their earnings—but this pushes prices even lower. This is referred to as the "overproduction trap," and it can only be overcome by government regulations that stifle competition (Frank 2004:63). In a competitive market, profits are reinvested in the industry's efficiencies, which will cheapen its products (Scitovsky 1954). Further complicating food production are government programs that institutionalize market fundamentalism to boost crop prices, such as the Payment-in-Kind (PIK) program, which encourages farmers to grow less food, which would raise market prices (Rhodes 1989). As the free market searches for equilibrium between profits, prices, and efficiency levels, the farmers could be influenced to draw more from natural resource supplies like groundwater in order to keep their operations cost-feasible. Once most farmers innovate with intensifying practices like adopting irrigation and high-input crops, food prices fall while their commodities remain over-produced (Guthman

2011). The mentality of intensification leads to a spiral of more production, more inputs, and more reliance on aquifers (which are jeopardized by contamination from the operations themselves). Furthermore,

> If water levels do fall over time, the gap between the scale of agriculture and the optimal scale of irrigation will only grow, increasing the "threshold" size and farm required for groundwater irrigated agriculture. This trend can only be stemmed by… the development of institutional innovations… (Dubash 2002:15)

Marxist theorist James O'Connor (1984) holds that capitalist development destroys the traditional individuality and stability of small producers, while simultaneously encouraging an ethic of individualism. Stressing an individual's behaviors constrains policymaking decisions and serves to maintain the status quo because it "…obscures the extent to which governments sustain unsustainable economic institutions and ways of life, and the extent to which they have a hand in structuring options and possibilities" (Shove 2010:1274). Laborers are systematically dominated and exploited by the entrepreneurial class in ways that are often not always obvious, in part because "…Bourgeois thought dispenses with the concept of class struggle…" (O'Connor 1984:vii). While workers tend to support economic expansion in order to avoid unemployment, the tension surrounding food production and irrigation reveals an important distinction between *agribusiness* and *farmers*. In agribusiness, overproduction is ideal because lower food prices generate competition between farmers, which in turn leads to higher profits and perhaps more political influence. On the other hand, lower food prices spell trouble for individual farmers; Kansas net farm incomes dropped to their lowest level in 30 years in 2015, caused by lower prices for crops and livestock (Beachy 2016).

> Because living standards in the region are now closely tied to groundwater consumption, further depletion is necessary to maintain living standards. Thus, water and wealth flow out of the region in a reinforcing process. As ecological unequal exchange continues, increasing the incentives to withdraw more water, intensifying the metabolic rift in a vicious cycle that undermines the viability of the agricultural economy in Southwest Kansas. Ecological unequal exchange undermines the natural resource base on which people's material livelihoods depend, providing incentive to deny the problem or delay addressing it, while reducing the capacity of people to act on the problem. (Sanderson and Frey 2014a:528).

The loss of small-scale operations run by individual farmers is an example of what O'Connor calls a "sectoral crisis," a crisis of accumulation within a specific industry. If farmers remain in a bushels-per-acre contest, the ethic of individual farming will not only drive the price of commodities down, it will likely exacerbate overdrafts (assuming they rely on irrigation). Ironically, the obsession with production has actually led to a loss in productivity globally: 38 percent of the world's total cropland has been despoiled by soil erosion caused by improper farming practices (Conca 2006). In the current set-up of the High Plains groundwater economy, well pumping determined less by ownership of the land (who farms it) than by effective control over how the land is used (agribusiness).

The relationship between agribusiness and farmers is an example of "economic domination," a situation that occurs "when one fraction [of capitalists] is able to impose its own particular 'economic-corporate' interests on the other fractions regardless of their wishes and/or at their expense" (Jessop 1983:91). Independent farmers are actually in charge of very little because their agency is constricted by the overall structural demands of corporate interests: "Food corporations aggressively promote beef consumption, since steaks and hamburgers are more profitable than lentils" (Perrow and Pulver 2015:61). Depending on the year's prices, ranchers can earn over three times from raising hogs than cattle (Rhodes 1989), which can be an enormous incentive for food producers that changes the diversity of the nation's food production. Animal feed represents 37 percent of the cereals grown globally (Hoekstra 2013), making it a major component of the planet's food systems and a tremendous user of water. Animal products use more water than plant products because of the need to grow animal feed—and corn is an incredibly thirsty selection for feed. Furthermore, first-generation biofuels directly compete with food production because the crops are not intended to be a food source, and next-generation biofuels require cropland that could otherwise be reserved for food production. Commercially-grown biofuels are generally supported by agribusiness, but the production of biofuels has led to sharp increases in food prices (Mitchell 2008). If corn-based ethanol production follows the federal government's plan to double in the coming years, the High Plains will lose an additional 368,000 acre-feet annually (Prud'Homme 2011). It is important to prioritize water management that can actually differentiate between growing food, feed, and fuel—that is to say, crop selection and the utility of the crops must be examined in an era of overstressed aquifers. Capitalism is not a system based on the free exchange of goods between individuals with equal buying power and access to resources, and this uneven relationship generates a competition for groundwater resources.

Groundwater withdrawals have grown among irrigators and other high-capacity well users throughout the towns (growth machines) in western Kansas. Studying the exploitation of groundwater in Kansas can be seen as studying the tension between the establishment of use and exchange values. Kansas water laws contend that groundwater belongs to the people of Kansas, as long as the water rights holders use it for a "beneficial use" (KWO 2014). Beneficial water uses, according to Kansas water law, do not include the various ways in which water is used domestically. "Beneficial" essentially means "beneficial for the economy." If the water is used to grow something profitable, it is not seen legally as wasteful. On the other hand, swamps and river bottoms—lands that are ecologically diverse, but not agriculturally developed—are seen as non-beneficial (Ashworth 2015). As Kansas Water Law was formulated over the middle twentieth century, the resilience of natural bodies of water (including aquifers) was not highly prioritized.

Recall from the opening chapter that water rights were over-allocated in order to ensure that groundwater was used to maximize crop yields, and that safe yield policies were not implemented. In fact, the three western GMDs (GMD 1, 3, and 4) have adopted "planned depletion" strategies, which allow up to 40 percent depletion of groundwater supplies over 20 to 25 years (Sophocleous 2000; Peck 2002). This attempt merely slows groundwater declines, but it does not keep them within recharge rates. Planned depletion strategies treat groundwater as a non-renewable resource, and it is not an approach that ensures the sustainability of the High Plains aquifer in Kansas. Implementing a planned depletion formula essentially guarantees that aquifers will ultimately succumb to the tragedy of the commons.

Furthermore, the State Water Plan is obligated to maximize benefits from groundwater withdrawals. The mandates for long-term preservation were not introduced until the over-appropriation of water rights became extremely problematic for irrigators. This implies that regulations were initially designed to enhance market growth, not to reallocate resources sustainably. The responsibilities of GMDs also reveal an important tension between the growth imperative and groundwater protection: voters within GMDs can petition the DWR Chief Engineer to designate IGUCA formations, or areas that can limit withdrawals of all water rights holders, regardless of the date of their right. If all water rights users are told that they will have to surrender some portion of their allocation in order for every permit holder to have some access (and prevent the tragedy of the commons) this would also reduce crop yields for some very intense irrigators. Irrigators who would be losing out on part of their water right (and who would conceivably be taking a pay cut) would probably resist petitioning for an IGUCA in their GMD. Simply put, suggesting the establishment of an IGUCA would probably be viewed as a threat to economic growth. Many residents within groundwater economies are dependent on irrigation water for their stability; therefore, it would be economically irresponsible for them to recommend limiting their own groundwater withdrawals. Despite the fact that the 50-year Vision aims to "Expand the LEMA concept so a proposal can come forward to the Chief Engineer from either GMDs, directly from local water right holders or other entities such as county conservation districts" (KWO 2014:20), it is important to keep in mind that these proposals require the voluntary sacrifice of reducing irrigation, which is in essence a potential barrier to economic growth.

Beneficial use is a legal phrase implying that groundwater's contribution to growing commodity crops is more advantageous for the state than its use values. This provides legal protection for commodifying water and managing it as a commercial lubricant. Given the legal terminology, groundwater has important properties that do not follow the traditional transformation undergone by many natural resources as they are stripped of their use values and granted exchange values. Well water is actually impervious to this transformation: a private well owner is not charged for the water their well yields. In fact, if groundwater belongs to the people of Kansas, then it is property "of the commons" and not easily marketable. Well water's use value is not transformed into an exchange value; it is used "freely." The *extraction* of groundwater is commodified: hiring well-digging companies, acquiring diesel fuel for running well pumps, and piping for irrigation systems are all large expenses that the owners of high-capacity wells must consider; however, the water itself is free.

In spite of the tremendous withdrawals from the High Plains aquifer, it is still treated as a "free" or unlimited resource. Proponents of irrigation have argued for decades that market signals will eventually halt, or at least slow, depletion. High energy costs associated with running well pumps, and low corn prices could put the water tables financially out-of-reach. Researchers at Kansas State University estimated that price increases in natural gas could dramatically reduce irrigation acreage and groundwater extractions (Buller and Williams 1990). Nevertheless, irrigators have sought special fuel rates to keep their energy costs low, while energy subsidies and federal farm commodity programs continue to keep the cheap supply of irrigated food economically feasible (Fund 1993). The subsidies and prices of groundwater, corn, beef, and fuel currently encourage irrigators to draw excessively from aquifers, not sustain them. High energy prices and low crop prices have influenced the management and efficient use of groundwater, arguably more than Groundwater Management Districts and state policies (both of which have focused on regional attention to resource conservation). Not surprisingly, calls for limiting overdrafts to stay within the rate or recharge are generally not supported in GMD 3. Groundwater is a free resource that increases productivity and profits, specifically with high-value but water-intensive commodity crops like corn. Aquifers are a critical part of the conditions of production, yet they have no exchange value. According to its use value, groundwater's role in industrial agriculture is essential, but since its market value is zero, it is overused.

In economics, a field concerned with the administration of limited resources, some natural resources are seen as so plentiful that they can satisfy all the human endeavors that extract or use them (air is seen as such a resource among economists). These are called "free resources" because there is no economic need to organize their use through market signals (Scitovsky 1971). While groundwater has not been conceptualized as a free resource, it would be a mistake to assume it is abundant and inexhaustible. In other words, groundwater has been mis-categorized as a free resource and it is actually a scarce resource—one that can only partially satisfy human wants and therefore requires exchange values. Economist Tibor Scitovsky (1971) wrote on the important distinction between free and scarce resources, and acknowledges that relationship between human uses and the supply of natural resources is constantly changing: "Society finds it especially difficult to recognize and deal with a problem where none existed before or to treat as valuable and learn to budget resources that, within memory, could be considered free and ignored with impunity" (1971:4). This passage nicely summarizes the current drivers of overconsumption of groundwater resources in Kansas. The people of Kansas cannot maintain their current relationship to groundwater because it is no longer tenable for it to be seen as "free." It is more valuable (and scarce) than its currently assigned exchange value (zero). Moreover, many of the tools used for water conservation (drip irrigation and technologies that minimize waste) have much higher exchange values (prices) than water's woefully inadequate exchange values. Investing in conservation technologies, therefore, can be economically problematic:

> The problem [driving overconsumption] is that the water itself is free, or next to free. So making an argument to spend money in order to save water, or better manage water, on the basis of the cost of the water itself makes no sense. It is often cheaper to simply take fresh source water than to purify and rescue the water you've already got… Although we don't often notice it, every gallon of water we use has an economic value—the value of whatever we can actually do with that water, whether it's boil a pot of rice, or grow an acre of wheat, or make a microchip. (Fishman 2011:144)[9]

If water's exchange value remains too low, or if it remains uncommodified, residents, irrigators, and agribusinesses will have little incentive to conserve. The depletion of aquifers, therefore, is more damaging to the residents than to business entities—which can disassemble their operations and move to another region after they have exhausted the free resources. During the most recent drought, one of the largest beef producers in the United States, Cargill, sold its Texas feedlots and shifted its production to Dodge City, Kansas (Genoways 2016).

Ecological Marxism contends that everything is treated like a commodity—especially natural resources, which is part of Marx's production conditions that are appropriated as a means of reproducing capital (O'Connor 1988:12). While this framework does not exactly fit how groundwater is seen in Kansas (because it is a commons resource) aquifers are still affected by the struggle over the conditions of production. Groundwater is seen as a free gift, and in the middle of the twentieth century the High Plains aquifer was thought to hold an inexhaustible amount of water (Buchanan et al. 2015). The conditions of production typically stipulate that commons resources are eventually commodified, but wells and groundwater are part of the conditions of production in many farming operations across Kansas that remain decidedly Common Pool Resources. Conceptualizing water as an "invaluable public good" clashes with the neoliberal political regime in Kansas. Agribusiness in the state has relied on aquifers to reproduce growth machines based on the profit and accumulation of vast supplies of water-intensive crops and livestock. This also has political support: while the Long-Term Vision promotes educational outreach to farmers that encourage less water intensive crop varieties, it gives very little mention to dryland farming (KWO 2014). In fact, one of the statewide action items for the Vision is to continue the devotion to beneficial uses by promoting the "development of markets for alternative crops with a focus on value-added agriculture such as

[9] This statement also applies to domestic, not just agricultural, water conservation technologies. Low-flow devices are expensive investments that might not pay off economically in households with low water rates.

livestock feed and biofuels" (KWO 2014:35). The commitment to traditional irrigation has provided political sanctuary for the largest water users in the state in the form of exceptions from conservation efforts. While the city of Hays has spent hundreds of thousands of dollars over the past two decades investing in domestic water conservation efforts and water reuse, the city decides that the largest water users would not be tasked with reducing their water consumption in the name of protecting "economic development" (KWO 2014:58). The importance of economic benefits and the security of the entrepreneurial class has forced cutbacks in other water-using sectors.

Moreover, entrepreneurs usually outline an "accumulation strategy" to appropriate their conditions of production; they follow a general model for achieving economic growth (Jessop 1983). The accumulation strategy for industrialized, agricultural capital in Kansas presumes that the natural preconditions in which its operations are embedded can supply sufficient free resources. Free groundwater makes farming corn and operating meatpacking plants in the High Plains cost-feasible. The assumption of free, abundant groundwater has been critical for the state's economy and its communities, whose essence, "in the present American context, is growth" (Molotch 1976:310). As another amendment to previous literature on cities, consider that Castells (1977) has suggested that industries seek to be lodged within urban systems rather than within rural communities located near raw materials and natural resources. Industrialized agribusiness has not followed this accumulation strategy; it has shaped the growth of rural Kansas communities and remains heavily reliant on the massive groundwater supplies in the High Plains.

These distinctions of groundwater play an important role in advancing growth machine theories. Farming communities in western Kansas thrive on extracting groundwater, a natural resource that is not straightforwardly commodified. While communities of all sizes are reliant on growing incomes, tax bases, populations, land allotments, and resource bases, the communities reliant on groundwater in Kansas are dependent on a Common Pool Resource that does not follow the traditional path of commodification that many natural resources are assumed to take in growth machine theory. Nevertheless, many of these communities are trying to establish economic growth as a norm in order to provide stability in a state emphasizing job creation, limited government, and tax cuts (tenets of neoliberalism). As neoliberalism became the political habitus of the United States, politicians across the nation welcomed the claim that economic deregulation improved general welfare. In fact, economists provide evidence that environmental regulations help profitability, not hurt it, because regulations prompt industries to invest in technologies and practices that reduce pollution, waste, and throughput while improving efficiency (Porter 1990; Earnhart and Rassier 2016). Neoliberalism has historically been tied to the Republican Party, but neoliberalism is not simply a Republican ideology. Many centrist or leftist politicians adhere to market fundamentalism and try to brand themselves as being "business-friendly" as well. The role of the state, according to this market-centered political theory, should be limited to the maintenance of "an institutional framework characterized by strong private property rights, free markets, and free trade" (Harvey 2005:2). As the regulatory capacity of Kansas was reduced, residents of rural Kansas could no longer protect themselves against larger accumulation strategies. Neoliberalism has ushered in the state-sanctioned corporate takeover of food production in Kansas, and therefore contributes to excessive groundwater depletion. There is not a water crisis per se, as much as there is a "crisis of water *management*" [emphasis added] (Munck et al. 2015:5).

Governor Brownback, in the hopes of sustaining economic growth, issued a 50-year plan for securing the state's water. This long-term vision sounds very similar to Maoist-style socialist planning, yet it is not centered on conservation for conservation's sake, but for economic expansion: "We've just got to use a lot less [water], but still maintain the economic activity and viability of western Kansas" (AP 2015). The Governor emphasizes the importance of local control for each of the state's 14 water regions rather than issuing statewide authority in the water vision plan. Nevertheless, there remain intrinsic tendencies in advanced capitalism for the state to intervene in commodification and production (O'Connor 1973). The state increases its investment in the relationship between production and consumption, because greater state involvement and planning in commodity production is needed to expand economic opportunities, tax bases, and ensure a stable economic climate. The Vision is, in effect, a neoliberal document that promotes market fundamentalism, according to its mission statement and guiding principles:

> Mission: Provide Kansans with the framework, policy and tools, developed in concert with stakeholders, to manage, secure and protect a reliable, long term statewide water supply while balancing conservation with economic growth…Voluntary, incentive and market-based water conservation and land management activities are the preferred tools for ensuring a reliable statewide water supply (KWO 2014:10)

Neoliberal ideals call for reliance on markets, but due to unavoidable externalities (the unintended costs associated with consumption and trade) state intervention is required at various levels of production. Growth and stability require planning, particularly in a state facing dwindling resource supplies and unpredictable climate swings. Securing water will need to be supported by a coherent set of policy targets, not by monetizing the aquifer and assessing its worth through economic analyses examining "beneficial uses."

Regardless of neoliberalism's prevalence in the state, Kansas policymakers need to come to terms with their semiarid environment. The state's longtime economic engine, high agricultural output, has exceeded its natural limits. Droughts and groundwater declines not only endanger water supplies across Kansas, they reveal an interesting paradox of neoliberalism: "excessive" government planning (which, in Kansas, would include adequately funding the Kansas Water Office, the State Water Plan, and water research) is required to achieve economic expansion based on dwindling supplies of natural resources. Since externalities are rarely internalized by adjusting prices to reflect the true cost of a product (Scitovsky 1971), the state's policymakers need to take responsibility to resolve any externalized nuisances of the Kansas groundwater economy and develop adequate methods of groundwater regulation. The State Water Plan has historically been funded by both the State General Fund and lottery funds, but Governor Brownback has not approved the Kansas Water Authority's request for full state funding ($6 million) and lottery funding ($800,000) through 2017 (Fund 2015). Kansas faces a particularly desperate time to be operating on shoestring budgets in terms of environmental security. Conservation districts will require more aid; dredging the John Redmond Reservoir will cost roughly $1 million in 2017; the Wichita Aquifer Recharge Project will need roughly half that amount (ibid.), but no budget requests seem likely to be approved under the March to Zero. *Zero resource management* seems to be the payoff for slashing taxes of the entrepreneurial class.

It is particularly important for regulators to acknowledge any negative externality associated with groundwater decline is the *opposite* of a "beneficial use." The public benefits from having stable water supplies, and elected officials have a responsibility to look after the welfare of their constituents. Leaving the neoliberal economy to its own devices, without a regulatory mechanism or an internalizing pricing scheme for groundwater, will likely impair the livelihoods and private usage of current and future Kansans. Balancing the welfare of Kansans with the interests of agribusiness will remain a challenge in this politically conservative state.

Incidentally, the Kansas Citizens' Sustainable Agriculture Committee lists the protection of water quantity and quality as one of the main principles of sustainable agriculture (Fund 1993). It also lists the provision of financial support of small and medium-sized family farms and rural communities, which suggests that beneficial uses for rural Kansans need to be seriously prioritized, as opposed to looking after the needs of agribusinesses and entrepreneurs. What might be beneficial for one group could be detrimental for another.

Conversations of environmental management within neoliberalism draw from many literatures, but it is important to note that the theories of O'Connor and Molotch are largely in the same ideological veins of Ecological Marxism. Both contend that commodification based on the devaluation of natural resources' use values compared to their exchange values drives the development of markets. Moreover, O'Connor echoes Molotch's thoughts on the entrepreneurs' political influence: "…bourgeois economic and social theory [contaminate] economic and social policy" (1984:220). While O'Connor emphasizes individualism as a key outcome of the bourgeois economic ideals, and Molotch arrives to his conclusions via an examination of use and exchange values, both afford a deeper discussion of neoliberalism. Neoliberalism is a political mentality that works in favor of Molotch's entrepreneurial class, and it also stresses O'Connor's individualism. In fact, O'Connor's neo-individualism and neoliberalism are essentially synonymous.

Castells and Molotch, however, have some differences in their analysis of cities: Molotch contends that economic conditions are a serious driver behind the process of urbanization, while Castells (1983) argues that new social interests expressed via grassroots movements play a crucial role in city formation. The city, for Castells, is a result of conflicting social interests, and he stresses the unique sociopolitical context in which community mobilization takes place. Mobilization efforts represent the collective organization of marginalized people (Castells 1983). Perhaps GMD organizations are marginal, in that they have not fully bested agribusiness interests and have failed to completely prevent groundwater decline (which continues almost unabated in GMD 3). While Castells focuses largely on *urban* marginality (the inability of the market economy or of state policies to adequately provide for city dwellers), I contend that well owners are affected by *rural* marginality—their wellbeing is not sufficiently provided by government planning or market structures. Small organizations face what is referred to as the liabilities of smallness—small group size makes a community predisposed to failure, and group size is a key factor in a group's success (Aldrich and Auster 1986). By applying the liabilities of smallness to my research, along with growth machine theory, I argue that rural Kansans face difficulty acquiring resources for prosperity and face more challenges than larger populations, which further supports the notion of rural marginality. Focusing on human vulnerabilities to climate change, there are unequal burdens endured by communities in "sacrifice zones" (Harlan et al. 2015) of groundwater extractions, and the residents of rural Kansas have lost their right to a reliable groundwater supply. Resource and food production crises are not uniformly spread across groups, and scarcity affects different groups of people with different intensities (Friedmann 1982). For instance, despite their resilience in the arid West, farmers in Montana are expected to lose hundreds of billions of dollars and tens of thousands of jobs each year due to climate change (Power and Power 2016). Marginality is a consequence of rural systems being unable to respond to the needs of their populations, and the residents reliant on wells are increasingly "marginal" as groundwater supplies are threatened. As I have argued in this chapter, rural decay and groundwater decline in western Kansas are outcomes of neoliberal state policies.

Molotch and Castells both bring urban analyses of Marx by arguing that cities best serve the interest of the dominant class according to a given mode of production. Groundwater drives the mode of industrial development in Kansas, a mode of production that is orientated towards economic growth and increasing agricultural outputs. Yet with a free resource that is becoming more limited, sustaining irrigated agriculture cannot continue past the middle of the century for most of the state. For Molotch, the city is a collection of social groups trying to survive in a capitalist setting via economic expansion. However, much like Molotch noticed that cities have to adapt to the growth imperative, Castells noted that the state has to reorganize itself to survive any social class divisions. It has to use the hegemony or political clout of the entrepreneurs to seem like the interests of business is really in the best interests of everyone else (i.e., the residents). Both scholars make the case that residents lack control over the development of their communities because entrepreneurial forces use the state as their instrument to direct urban development in a way that is most beneficial to accelerate growth. I contend that rural communities in Kansas also fit these descriptions. Furthermore, geographers have recently argued that urban space could not have been conceptualized without the transformation of human interactions with water (Gandy 2014). In a similar fashion, I suggest that the development of aquifers via high-capacity wells has fundamentally changed rural spaces in the High Plains. The development of nature, and the expansion of water infrastructure, has facilitated capitalist urbanization (Swyngedouw 1997; Bakker 2010). The similarities of the urban and rural settings arise out of their links to the interests of serious entrepreneurial agendas (in the case of Western Kansas, represented by Big Ag) and the residents here are largely independent farmers.

Karen O'Neill's *Rivers by Design* (2006) studied the social origins of water supply projects and construction around rivers to make comments on economic and political goals. She tells the story of development and authority in the United States through the story of river construction projects, and it argues that regional elites were the ones who called for a national flood control program. While flood control in Kansas is not central to her research, Kansas has constructed reservoirs on several of its major rivers as means of flood control and storing water for beneficial use. Each reservoir has distinct authorized uses, which include irrigation water supply, municipal and industrial water supply, recreation, and navigation support (KWO 2014). Flood control was the primary purpose built by the US Army Corp of Engineers, in Kansas and across the nation.

O'Neill's analysis fits growth machine by framing the entrepreneurs in the Mississippi and Sacramento valleys, not government officials, as responsible for large infrastructure programs. In a similar fashion, I contend that agribusiness has influenced the formation of a groundwater economy via infrastructure based on high-capacity wells and a massive Common Pool Resource in the form of groundwater supplies. The politics of groundwater development led to changes in relations between rural communities and local government. The cultural and political transformations of rural communities above the High Plains aquifer arose out of the linkages between local and state governments and the corporate agendas of industrial food manufacturers. Agricultural institutions reflect the interaction between nature and society, and those institutions "govern access to and control over the natural resources and shape economic development" (Dubash 2002:2). As mentioned in the first chapter, groundwater must be used for "beneficial uses." Since high-value irrigated corn and corn-fed beef generate the most economic "benefits," it suggests that groundwater exploitation and the influence of groundwater interest groups were institutionalized by the Water Appropriation Act.

Farming styles are selected based on economic, social, political, and technological structures (DuPuis 2002), and the practice of irrigation is contoured by the neoliberal political climate and productivist, industrialized agribusinesses in Kansas. The prevalence of growth machines in the semiarid High Plains necessitates a system of agricultural production that can control not only revamp the production conditions, but also the *growing* conditions, via irrigation (e.g., Mann 1990a; 1990b). Drier, warmer growing seasons are expected to make food production more challenging in the Midwest (Kendall and Hyndman 2014; Mazdiyasni and AghaKouchack 2015; Wang et al. 2015). Therefore, the infrastructures and institutions that manage water supplies must be sociologically investigated in order to alleviate the difficulty of sustaining irrigation in a harsher climate, and existing social theories must be applied to test their ability to explain the role of structural forces in challenging political and natural environments.

Precision refers to a theory's ability to enunciate its assumptions well enough that researchers have the guidance they need to design adequate tests. Theories that exhibit a high degree of precision improve the clarity of researchers' explanations, and theoreticians can improve their precision by recognizing where their explanations are inconsistent and make alterations to improve their explanatory power. Since groundwater is seen as a Common Pool Resource, or a free resource, any application of growth machine theory must be rethought. For that reason, groundwater economies can amend the Marxist concept of the conditions of production. I study groundwater management policies, neoliberalism, and watering practices in Kansas; my strategy of theory building proposes to modify Ecological Marxism. These macro-theoretical frames can be augmented by investigating how groundwater and use values shape markets. Dependence on groundwater changes agricultural economies in a way that elucidates power relations between farmers and agribusiness. "…existing social relations of production, both shape and are shaped by interactions with natural factors" (Dubash 2002:2). The groundwater economy's ecological base is a free resource, shrouded in negative externalities, and therefore it is necessary to draw from several overlapping bodies of literature to explain the exploitation of aquifers in present-day neoliberalism. A goal of this research is to enrich the aforementioned theories via an examination of a resource with high use value and low (or no) exchange value, and examine the forms of institutions and policies associated with groundwater management.

Economic sociology frequently employs the idea of social embeddedness to analyze power and privilege within market relations. Dealing with drought will require fundamental transformations to the groundwater economy, even though "It seems easier for us today to imagine the thoroughgoing deterioration of the earth and of nature than the breakdown of late capitalism" (Jameson 1998:50). This chapter recognized how rural water supplies are the product of power relations between entrepreneurs or agribusiness and residents or farmers. "Power relations play a huge role in how we are impacted by these socio-ecological entanglements, which socio-environmental problems we experience, and our broader attitudes towards environmental hazards and risk" (White et al. 2016:16). In Kansas, capitalist agricultural production caused a metabolic rift in the hydrological cycle (Sanderson and Frey 2014b). My larger theoretical contributions explore the ecological rifts between growth machines (generally described within groundwater economies and agribusiness policies) and natural resources (aquifers). In order to study the interface between nature and culture in Kansas, I employed solid empirical practices that generated a one-of-a-kind dataset on well owners, which I will describe in Chapter 4.

CHAPTER SUMMARY

> Sociology is capable of providing strong theoretically-informed studies of the political and economic backlash against climate change (or drought) adaptation. In this chapter, I outlined the larger theoretical frames applied in my dissertation, which draws from analyses of neoliberalism and growth machine theory. It focused particularly on the extent to which groundwater depletion corresponds to neoliberal economics. Private well owners' reliance on a Common Pool Resource precludes any analysis of growth machine theory in the traditional sense, as groundwater is not easily commodified. Therefore, investigations of groundwater are avenues that can amend Marx's concept of the conditions of production, as well as its associated literature. On the theoretical plane, I have proposed an adaptation of Marxist concepts of the conditions of production and ecological rifts, using the applications of Marx given by Molotch, O'Connor, and others. Establishing urban centers and landscapes favoring agribusiness interests (growth machines) is a process permeated with transformations of social power, citizenship, and natural resources, and water management is an integral component of that process. Understanding this is essential to achieving sustainable rural and urban development.

Chapter IV: Methods and Sample Overview

> This chapter presents the research design for this study and overviews my participants, approaches to data collection, analysis, survey construction, and proposed models. As outlined in the opening chapters, this project produces self-reported data on indoor and outdoor domestic water usage among well users and non-well users in Kansas and generates one of the only quantitative datasets on well owners in the United States used in social scientific research. My survey measures respondents' household conservation efforts, awareness of statewide water-related issues, investment in water-saving devices, environmental attitudes, responses to drought, and demographic information. The quantitative data comes from an online survey constructed using the online survey design company Qualtrics. This chapter highlights my rationale for implementing Planned Missing Data Designs, and how I studied nested effects through multi-group structural equation modeling (SEM). It also includes a summary of moderation and why that mechanism is relevant for my work. I conclude the chapter with a summary of the respondents' demographic information.

PARTICIPANTS

My study frames well owners (individuals with private supplies that draw from groundwater formations) as a distinct social group defined by their conservation practices and their disproportionate exposure to groundwater depletion and drought. Studying their domestic water usage—a missing component in groundwater estimates—will be necessary to ameliorate this environmental disadvantage. This project's dataset was based on responses to an online survey gaging the participants' behaviors and attitudes regarding water conservation and responses to drought. I obtained the well owners' home addresses from the KGS database of Water Well Completion Forms (WWC5s).[1] Since 1974, state law requires Kansas well drilling companies submit a WWC5 record when a well is drilled, reconstructed, or plugged (Wilson et al. 2015). After compiling an extensive list of addresses, I mailed over 7,000 notification postcards inviting Kansas well owners to participate in an online survey.

One minor goal of this study is to uncover who owns wells in Kansas, and my research explores their demographics in addition to the variables associated with water conservation. The demographics of well owners are unclear due to the lack of previous social science research on

[1] A vast majority of the wells dug in the state are constructed by well-digging companies, which submit WWC5s to KGS in order to keep a record of the wells dug in the state. Unregistered, hand-dug, or illegally-dug wells (privately dug) would be difficult to monitor and track and therefore are not studied in this project. Thankfully the KGS database of WWC5s has the records of roughly 250,000 wells in the state, so it grants access to several well owners' home addresses.

this subpopulation. By scanning hundreds of names of well owners in the online database of well completion forms, I estimate that two-thirds of private well owners in Kansas are individual men. Couples, small businesses, feedlots, churches, and cities also own a sizeable portion of wells, perhaps 25-30 percent, and roughly 5 percent of private wells are owned by individual women. Roughly four-fifths of the wells in the database are located in the drier areas of the state and are above the Ogallala, Great Bend Prairie, and Equus Beds aquifers, and judging from the addresses provided, most high-capacity well owners live outside towns in central and western Kansas, a distribution which scholars have previously acknowledged (Evans 2013; KGS 2013a). This distribution makes sense because the western parts of the state have scarce rainfall and are more reliant on groundwater.[2]

DATA COLLECTION

The KGS WWC5 database provides well users' names and mailing addresses, but does not provide their email addresses. Therefore, surveying this population with online questionnaires requires added planning and investment. Reaching my survey respondents required obtaining their mailing address (listed on their WWC5) and inviting them to participate in my online survey via notification postcards. Thankfully, mailing postcards is an established method to affordably solicit volunteers for online questionnaires (Cobanoglu, Warae, and Moreo 2001; Kaplowitz, Hadlock, and Levine 2004). The survey measured their household water supply, water-saving techniques, awareness of water supplies, reactions to drought, and demographic information. The demographic variables measure respondents' sex, age, education levels, political views, religious beliefs, marital status, race, residential/housing information, occupational and earnings information, and parenthood status. The KGS database of well completion forms allowed me to access a range of respondents who use wells: avid gardeners, ranchers, farmers, and domestic well owners. I also attempted to sample a modest number of former well owners, as the database contains records of the wells that have been plugged.

[2] As of March 2013, the water well completion records database run by KGS had over 236,000 WWC5s on file (see KGS 2013a). Approximately 104,000 were classified as domestic wells, of which 36,000 were for lawn and garden watering. Nearly 1,400 domestic wells double as wells used for livestock. Monitoring or observation wells are also very popular, as the state has 62,000, compared to 20,000 irrigation wells and 17,000 oil field water supplies, More than 6,000 are listed as feedlot, livestock, or windmill wells, and 2,400 are listed as public water supplies. 3,000 wells are listed as unstated or abandoned. Over 190,000 of the WWC5s are for wells that have been constructed, while the remaining 46,000 forms are records of wells that have been plugged (many of which have been abandoned).

Furthermore, I attained a sample of 420 Kansans from Qualtrics, which had a high percentage of non-well owners. Qualtrics uses a sampling frame from the Survey Sample International's (SSI) multi-sourcing panel recruitment model, which has a large number of diverse frames that generate representative random samples. This random sampling allows me to conduct research generalizable to Kansas and compare well owners to non-well owners. Respondents were given awards through the SSI's recruitment system, which are points that can be traded for SSI's incentives in the form of cash, prizes, charity donations or sweepstakes.

My research assistants and I collected 8,132 well-owners' addresses as part of their course credit in an individual undergraduate research course, a process that spanned three semesters and required seven research assistants. After scanning the addresses for deliverability at the post office, 7,037 were sent and the undeliverable addresses were removed from the address pool. For the purposes of examining how minor variations in survey design influence response rates, these notification postcards had different survey completion deadlines and color schemes. For instance, my signature was displayed either in blue or red ink, some postcards contained the phrase "or current resident" in the receiving address information, and I placed slightly different deadlines on the postcards for the request to complete the online survey. Understanding how these variations influence response rates is an interesting methodological footnote that sheds light on how to minimize nonresponse for online surveys, a point I discuss in detail in the appendix.

SURVEY DESIGN

Implementing innovative, modern surveying techniques can improve how researchers gather data from their respondents, and my project has been influenced by a number of advances in survey design. Survey methodologists have unlocked a fascinating way to think about data collection, one benefit of using contemporary surveying practices is the implementation of Planned Missing Data Designs (PMDD), a recent—but established—form of data collection. Planned missing data designs allow researchers to provide random portions of their survey to respondents, instead of their entire bank of survey questions, which keeps the questionnaire shorter. For example, by randomly assigning each of the respondents three-quarters of the total survey questions, survey length can be cut by 25 percent, thereby reducing the survey's fatigue factor. Designing abbreviated surveys allows respondents to answer the shortened survey more clearly than they would a lengthier survey, as respondents who participate in shorter surveys are less likely to submit incorrect answers due to fatigue (Dillman 2000). Therefore, randomly providing respondents truncated versions of the survey keeps the responses more trustworthy than data generated by full-length surveys. If a survey is split into four parts, an *X* set, an *A* set, a *B* set, and a *C* set, researchers can randomly provide respondents with a survey form consisting of XAB, XAC, or XBC combinations. This 3-form design was outlined by Graham, Hofer, and Mackinnon (1996), and the format has since seen innovative variations (Graham et al. 2006; Enders 2010; Graham 2012). Such an approach enabled me to randomly provide respondents one of three versions of the survey, in which certain portions of the survey were randomly missing. I have written a total of 61 survey questions, but using planned missing data allows me to assign respondents a random selection of 40 of those questions (or 50 if they are a well owner, as I had 10 questions on well ownership). This approach shortens each survey by nearly 20 percent, and it benefits my study because it makes the survey experience easier on the respondents and improves the accuracy of their answers. Since I have a large number of questions, it is appropriate (and courteous) to avoid giving respondents the entire pool of items.

Surveys with planned missing data make sense for a number of reasons. First, planned missing data designs increase the validity of the data because participants are more attentive for shorter surveys. Time constraints and keeping a respondent’s attention throughout the entire survey become issues as survey length increases, and research suggests that more taxing assessments can increase measurement error and respondents will be more likely to submit incorrect answers due to fatigue (Dillman 2000:9-10). Long assessments reduce data quality, so randomly providing respondents pieces of the survey instead of the entire survey keeps data more trustworthy. Secondly, less taxing assessments reduce the likelihood of respondents “giving up” or not completing the survey. This, in turn, should increase response rates. A 40-item survey does not seem as time-intensive as a 61-item survey, and respondents should find a shorter survey more manageable. The research on shortening surveys as a means to reduce fatigue and increasing response rates has been recognized for over a decade (Crawford, Couper, and Lamias 2001; Groves et al. 2004; Hansen 2006; McCarty et al. 2006). On a practical note, modern missing data designs also reduce survey costs, specifically printing and postage expenses with mailed questionnaires.

Table 4a. Overview of Planned Missing Data Designs following the 3-Form Technique

	Item set			
Form	X	A	B	C
XAB	1	1	1	0
XAC	1	1	0	1
XBC	1	0	1	1

Note: 1 = questions asked; 0 = questions not asked. Letters A-C refer to different sets of items. Source: Graham et al. 2006:326.

In my study, no respondent received a full-length questionnaire. Instead of distributing identical surveys, I have three different forms, each with a distinct collection of variables. Some questions were missing, depending on the form a respondent randomly received. In order to address those missing-at-random pieces of the survey, I used the Full Information Maximum Likelihood (FIML) approach, which is the most common missing data procedure in structural equation modeling (SEM) programs. FIML works by estimating the parameters with an algorithm that takes into account the presence of the available data and the missing data, which informs the values of the parameters and the standard errors. FIML (which is also shorted to ML, for Maximum Likelihood) works by reading the raw data one case at a time and uses the available data to maximize the ML function (Graham and Coffman 2013). Put another way, algorithms generate data which allow population estimates to be made; Enders (2010:56-85) has a clear summary on the mechanics of ML estimation. The estimates are intended to reflect the population, given the sample and the missing data: “FIML estimates a model in the presence of missing data, resulting in unbiased estimates of all model parameters… the result will be unbiased if missingness is missing completely at random” (Rhemtulla et al. 2012). In order for this to be done successfully, researchers need a sample size of at least 400, and I have a return of over twice that minimum. For more details about the benefits of PMDD, their strengths compared to full forms of survey designs, and details about FIML and other ways to manage missing data, please consult the methodological appendix.

DATA ANALYSIS

To analyze my quantitative data, I ran regressions to test the influence of well ownership on domestic water usage, conducted an analysis of variance (ANOVA) and T-test to measure the differences in mean scores for non-well owners and well owners, and performed SEM, a technique that estimates constructs, which are collections of related survey items. SEM has evolved into a practical multivariate tool employed by researchers in various disciplines to understand a multitude of issues associated with pro-environmental behaviors. I conducted the ANOVA and T-test using SPSS, and my CFAs and SEM using M*plus*, a computer program designed for SEM and missing data, which is freely accessible through the University of Kansas' libraries. I ran a variety of Confirmatory Factor Analyses (CFAs) estimating the constructs associated with water conservation. CFAs are used to test whether the measures of a construct are consistent with a researcher's understanding of that construct (Bollen 1989; Brown 2006), as factor analyses in general are tools for examining validity (Heise and Bohrnstedt 1970; Heberlein 1973). Estimating a CFA is usually done with the objective of testing whether the fit of a hypothesized model is acceptable.

Constructs are latent concepts that are not measured directly; their qualities have to be inferred by relying on a collection of variables selected as proxies. Therefore, I need to organize the indicators measuring respondents' water conservation priorities so they will accurately represent the pertinent constructs (e.g., investment in water conservation, awareness of water supplies and infrastructure, water conservation techniques). To do that, I occasionally relied on an organizational technique known as parceling, whereby modelers take two or more items and average them, and use the average as a manifest indicator rather than relying on individual items. For example, my questionnaire has a series of items focused on awareness of water-related issues in the state (the largest water users, the frequency of water shortages, the Governor's 50-year "Vision for the Future of Water in Kansas," and so forth). Given their overlapping relevance, it makes sense to combine these questions instead of keeping them separate. Using these items as separate indicators would quickly increase the complexity of my model, as there would be more calculations to make, more lambda loadings to estimate, and more residual variances to consider.[3] As mentioned in Chapter 2, attitudes can differ from behavior, which is a main challenge facing social scientists studying PEBs. However, attitudes, which still contribute to an individual's environmental decision-making, must be inferred from something. One of SEM's

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[3] For recent overviews of the foundations of SEM see Kline 2010; Little 2013:1-36, and on the benefits of parcels, see Little, Lindenberger, and Nesselroade 1999; Little et al. 2002; Little et al. 2013.
Lambda loadings are a measure of how much variance is shared with the construct, they signify the amount of information each indicator contributes to the definition of the construct. Residual variances are a measure of the variance that is unique to the indicator.
For more on parceling, please see the methodological appendix.

main benefits is that it relies on a collection of indicators to infer constructs, and modelers can organize those indicators in ways that most accurately extrapolate the inner workings of multifaceted concepts like environmental attitudes.

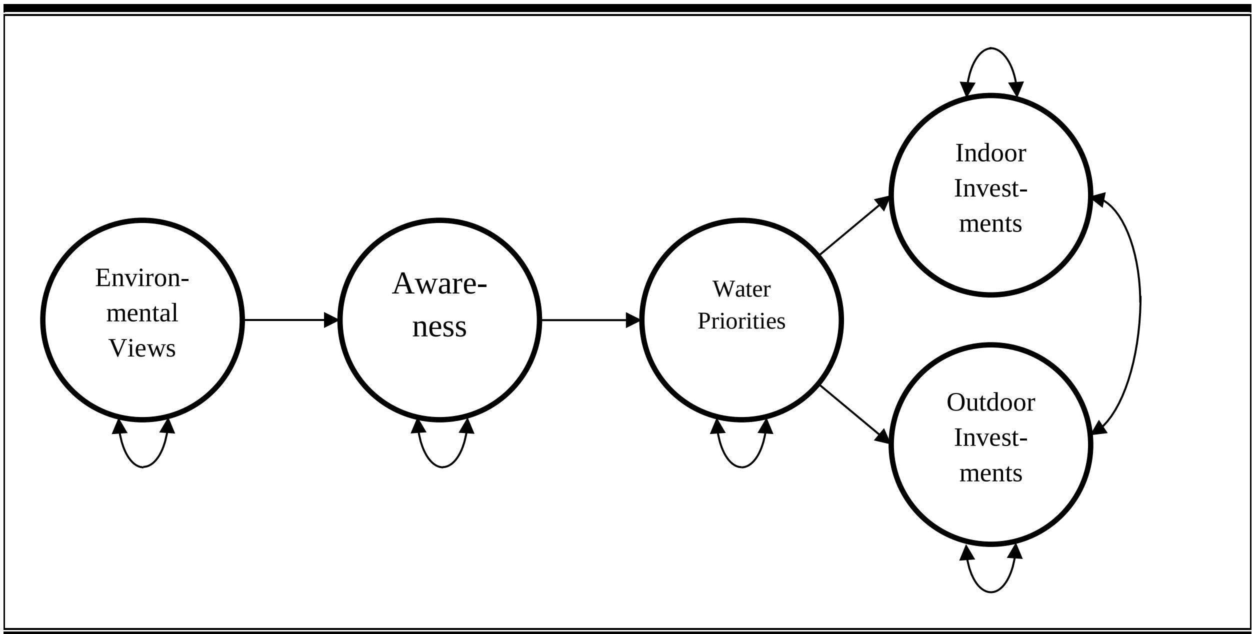
Testing the comparability of constructs is a practical way to analyze cross-cultural data (Little 1997). Given that my dissertation hinges on the well owner/non-well owner dichotomy, this research can serve as a modest step for understanding the generalizability of Kansans' relationships with water within two unique socio-ecological contexts. Factorial invariance is measurement equivalence, and it is a necessary standard to compare constructs across two or more samples. This equivalence addresses if the operational definitions of the constructs (and their reliable, true properties) are the same across groups. Testing for invariance is important for social scientists aiming to examine cultural bias or translation errors due to cultural differences between the subgroups in question (ibid.), invariance tests for item consistency are one of the main tests for modelers. If indicator intercepts are the same across groups, then the construct should be seen as stable across groups. However, if researchers are unable to achieve measurement invariance, it means that the indicators are changing across groups and it would be challenging to make justifiable comparisons across the groups. Since I intend to compare well owners to non-well owners, I must be able to pass invariance tests to ensure that the construct does not change across groupings of well owners and non-well owners, well owners who have no connections to city water supplies and those who do, owners of domestic, lawn and garden, feedlot, and irrigation wells, and also respondents based on their geographic position in the state. If I can establish measurement equivalence, I can examine the factor loadings to see how each indicator influences the formation of each construct across groups. I test for invariance using a Goodness-of-Fit (GFI) index that examines the change in Comparative Fit Index (CFI) from each model. For my data, the change in CFI from the configural model (in which the factor thresholds are fixed to be equally constrained across groups) to the metric model (in which the factor loadings are unique for each group) is less than or equal to .01, and the change in CFI from the metric model to the scalar model (in which the intercepts and the factor loadings are equal across groups) is less than or equal to .01.

Measuring water conservation across groups will allow me to study which respondents are most concerned about water usage. After establishing factorial invariance, some researchers might combine the data into one sample and estimate the structural model, but my research agenda is focused on well owner/non-well owner groupings. Analyzing the constructs' behavior in a structural equation model represents a turning point in the project: SEM takes those measurement models and estimates causal relations between the constructs. For example, awareness could conceivably trigger investment and behaviors that lower household water usage, which ultimately lead to some level of water conservation. Environmental psychologists have expressed confusion regarding if the social norms that promote PEBs arise from values and attitudes, or if attitudes produce norms (Heberlein 2012). SEM can study the causality between these associated constructs, which could improve researchers' understanding of the influence that structural and cognitive motivations play in environmental action. Unlocking how to create norms that direct PEB would be a valuable direction for environmental sociologists and social psychologists to take their future research agendas. At any rate, there are a number of directions these estimates can be taken, and I could run a diverse array of (atheoretical) models. As chapter 2 described, I rely on the work of Hobfoll's (1989) Conservation of Resources framework, Yeboah and Kaplowitz's (2016) implementation of values beliefs norms theory which guided my modeling decisions. A large amount of the analytical work for this dissertation is conducted with M*plus*. SEM is an unquestionably complicated method, and therefore time intensive. Nevertheless, it has the ability to answer several questions about water conservation, making it an appropriate analytical tool for this project. SEM is a complex series of hypotheses that consist of a measurement model (a set of multiple variables that form latent constructs) and a path model that describes relations of dependency between the constructs; fit indices are approximations of reality, not the probability that hypotheses might be true.

THE PROPOSED MODEL AND THE FINAL MODEL

Following a similar structure to the values beliefs norms theory, and the determinants of PEBs that have been established, this theoretical model draws from the VBN framing, and the examples portrayed in Doherty and Webler (2016) and Yeboah and Kaplowitz's (2016) work. Unfortunately, the model fit of the theoretical model (see Figure 4a) was far beyond the acceptable range, and I had to trim two constructs in order for the model to become acceptable. I dropped the construct measuring the water priorities because it had a correlation with the awareness construct greater than 1.000 (which is known as Heywood case, a correlation outside the boundaries of the range of standardized correlations). Those constructs shared a lot of

Figure 4a. *The Proposed Causal Model*. Environmental views predict awareness of water supplies, which predict the political prioritization of securing water, which predicts the outcome variables of indoor investments in water saving appliances for indoor and outdoor usage as the outcome variables.



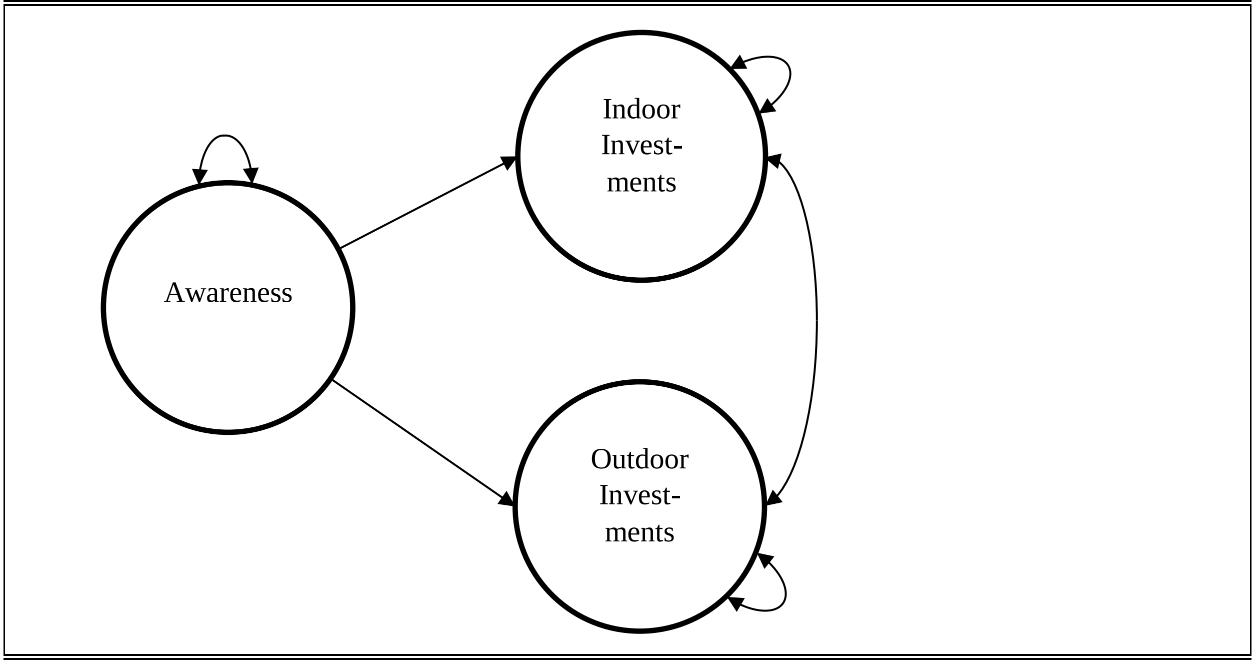
Note: The outcome variables will be interchangeable, and I will also test for reactions for droughts and water consumption. Environmental views are measured by favoring protection of the environment over economic growth, agreeing that we need a steady-state economy, and disagreeing with the idea that mankind was created to rule over the rest of nature. Awareness of water supplies is measured by understanding that agriculture uses the most water in Kansas, along with the parceled indicators measuring familiarity with xeriscaping and greywater systems; familiarity with the High Plains aquifer and Groundwater Management Districts, and familiarity with the Kansas Water Office, the Governor's Long-Term Vision, and the Kansas Aqueduct. Water priorities are measured by ranking water security in the top three political challenges for the state and voting on water-related policies in local or state elections. Investment in indoor water-saving appliances is measured by owning a low-flow showerhead, low-flow toilet, or water-efficient washing machine. Investment in outdoor water-saving appliances is measured by owning a timed sprinkler system and drip irrigation.

variance and my model could be simplified by removing the latent variable measuring respondents' prioritization of water security in Kansas. The latent variables of awareness levels and prioritizing water security potentially share so much information that if I include both of those constructs in the same model, it would have such a high correlation between those two very similar constructs that it becomes a rather questionable model—and I would be sacrificing a simpler model in the name of staying true to the theoretical or proposed model. Having a more sophisticated model with such strong correlations that it is challenging to outline the boundaries of each unique construct is not a logical modeling decision. With this dataset, it makes conceptual sense to use a simpler model (see Figure 4b). The reason I should not follow the proposed model is that in my data, these constructs have a large amount of overlap. In previous studies on the determinants of PEBs using SEM, those constructs were distinct or dissimilar enough to be modeled separately. In my dataset, the constructs of prioritizing and awareness are too similar to run a model with them separated. They share a lot of the same information—but overall it is conceptually makes sense to have these items organized the way they are in the actual structural model. The awareness items consistently measure the same thing because they are parceled indicators come from the same survey item, along with an item measuring respondents' ability to correctly identify irrigation as the largest water user in the state.[4]

Furthermore, I trimmed the construct measuring environmental views, which was keeping the models far outside of the range of acceptable model fit. Let me explore the possibilities for why the proposed model had such poor fit. While I had to settle for what worked, it is important to remember that designing latent variables requires a collection of indicators with shared variance are housed within a distinct construct. For example, the indicators associated with awareness of water supplies (understanding that agriculture uses the most water in Kansas, along with the parceled indicators measuring familiarity with xeriscaping and greywater systems, familiarity with the High Plains aquifer and Groundwater Management Districts, and familiarity with the Kansas Water Office, the Governor's Long-Term Vision, and the Kansas Aqueduct) can also be connected with, for instance, the indicators contributing information to the construct measuring water-related priorities (ranking water security in the top three political challenges for the state and voting on water-related policies in local or state elections). Yet structural equation modeling is a process for establishing the relationships and predictive associations between constructs, not the individual manifest variables that form the latent constructs. SEM stipulates that the indicators for each construct are only related through the covariance parameters connecting the constructs. Models are theoretical statements, and I had difficulty adequately fitting a model that supported theories that provide complex causal links

[4] Question 14: Which of the following do you think uses the most water in Kansas? If you are unsure, you may select "Not sure" for your answer. Private households; Industry; Irrigation; Cities; Note sure.
Question 25: Have you ever heard of any of the following? Please select all that apply: The High Plains aquifer; Groundwater Management Districts; The Kansas Water Office; The Vision for the Future of Water in Kansas; The Kansas Aqueduct; Xeriscaping; Greywater recycling; None of the above.

Figure 4b. *The Structural Model*. Investments in water-saving appliances for indoor and outdoor usage predicted by awareness of water supplies for non-well owners.



Note: The outcome variables will be interchangeable, and I will also test for reactions for droughts and water consumption. Awareness of water supplies is measured by understanding that agriculture uses the most water in Kansas, along with the parceled indicators measuring familiarity with xeriscaping and greywater systems; familiarity with the High Plains aquifer and Groundwater Management Districts, and familiarity with the Kansas Water Office, the Governor's Long-Term Vision, and the Kansas Aqueduct. Investment in indoor water-saving appliances is measured by owning a low-flow showerhead, low-flow toilet, or water-efficient washing machine. Investment in outdoor water-saving appliances is measured by owning a timed sprinkler system and drip irrigation.

that determine pro-environmental behavior. While I could have made a number of cross-loadings, which are connections between items in different constructs, I did not want to compromise my measurement model and decided to stick with the theoretical plans that were guiding my work to the best of my ability. To put simply, by using SEM, I am not testing the relationships between many of these variables at the manifest level; rather, I am making a statement that the latent variables (which are collections of manifest variables) are connected.

MULTI-GROUP AND MULTILEVEL DATA

My fascination with best practices has shaped the blueprint for my dissertation in other ways. For this project, establishing well owners as a social group is critical. While it is important to find out how the constructs associated with water conservation behave along the typical demographic divisions of race, class, gender, political affiliation, and so on, I organized my respondents along the lines of well ownership to examine if well owners and non-well owners approach domestic water usage differently. Additionally, comparing the conservation routines of respondents who reside above the High Plains aquifer to those who live elsewhere allows me to investigate how the constructs associated with water conservation behave geographically throughout Kansas. To do this, I employed Multi-group structural equation modeling, which is a way to measure how constructs perform across hierarchical organizations called nested data. The phrase *nested* implies that respondents belong in a certain context, and I organized my respondents based on their geographic residence at different units of analysis (e.g., residence in a specific county, GMD, aquifer zone, etc.). If my dataset were large enough, and I received sufficient responses from each county, I could detect changes in the constructs at the county level, at the level of GMDs, and other areas affected by drought across the state. Furthermore, for the variables that do not require SEM, I could also investigate nested effects using multi-group or multilevel regression.

Multilevel analyses have become an important component of quantitative sociologists' evolving toolkit, given the diverse scales and units of analysis for both social and physical data (Marquart-Pyatt, Jorgenson, and Hamilton 2015:371). Unfortunately, multilevel work generally requires a higher number of groups (over 30), but multi-group models are better for datasets with smaller numbers of groups (Little 2013). I could not run multilevel analyses with this dataset, but testing for invariance across groups and running multi-group models are appropriate measures that allow me to proceed with my research agenda. Multi-group SEM can address if the causal relationships between awareness of water supplies and reactions to droughts or investments in water-saving appliances are different for well owners and non-well owners, for well owners with municipal water supplies and for those without, and for domestic, lawn and garden, feedlot, and irrigation well owners. Theoretically, I could assess any GMD-level differences in the GMDs with a sufficient number of responses, but my primary focus of the nested data remains on respondents who live above the Ogallala, the Great Bend Prairie, Equus Beds aquifers, and in the rest of the state not overlying the High Plains aquifer. While my study focuses on water conservation among Kansans, it is important to consider geography and nesting effects. Since different segments of the aquifer respond to recharge and extractions in unique ways, Kansans

Table 4b. Schematic of a Four-Level Hierarchical Data Structure

Level 4: State	**Western Kansas (High Plains Aquifer)**					**Eastern Kansas**
Level 3: Aquifer	Ogallala Aquifer			Great Bend Prairie and Equus Beds Aquifers		Eastern Kansas
Level 2: GMD	GMD 1	GMD3	GMD 4	GMD 2	GMD 5	Non-GMD
Level 1: Respondent	$R_1, R_2, \ldots R_n$	$R_1, R_2, \ldots R_n$	$R_1, R_2, \ldots R_n$	$R_1, R_2, \ldots R_n$	$R_1, R_2, \ldots R_n$	$R_1, R_2, \ldots R_n$

who reside above one groundwater formation may require swifter conservation efforts than others. Examining measurements for individual counties or GMDs reveal that the aquifer's lifespan shifts from over 100 years to just a couple decades over short distances.

The idea of environmental actions being nested within certain contexts is particularly applicable to watering practices; the agricultural industry is contained and dependent on its surrounding natural environments (Mann 1990a). Sociologists have called for nuanced water security policies, suggesting that drought adaptation cannot be reduced to simple or "boilerplate" recommendations (Gasteyer 2008). Community resilience to aquifer decline is a complex set of interactions that occur in larger hydrologic and agronomic systems, which reveals the nested qualities of groundwater communities: they exist within precise ecosystems, experience different levels of overdrafting and recharge, and reside above specific supplies of groundwater. If I were to analyze Kansas well owners without considering the nested effects of geography, I would be ignoring the glaring hydrological differences between eastern and western Kansas.

Well owners are nested within counties, which are nested within Groundwater Management Districts, which are nested within aquifers. Kansans are clustered within certain communities that have unique access points to surface water and groundwater. Recall from the opening chapter that Kansas contains starkly different hydrological environments—surface water and precipitation are more prevalent in the eastern half of the state, while western Kansas relies heavily on its groundwater supplies. Due to this environmental nesting, my respondents should be considered geography-dependent. Observations in my dataset are not statistically independent, which violates a basic assumption of standard statistical methods. Ordinary statistical methods assume independence, and therefore are insufficient for analyzing hierarchically clustered data. While traditional analyses might be helpful for some variables of statewide interest, multilevel and multi-group analyses can be applied with much greater specificity and produce findings unique to a specific level of cluster of respondents. Ignoring the nesting effect might yield deceptive results, because traditional methods produce standard errors that typically are too small. This leads to confidence intervals that are also too small, p-values that are too low, and higher rate of Type I errors (Raudenbush and Bryk 2002). The issue of statistical dependence in nested data “necessitates the use of multilevel models that can produce more precise estimations than traditional regression techniques” (Cho 2008). Single-level methods of analysis ignore nesting effects, and conducting conventional analyses would generate misleading, perhaps useless, results. Again, the structure of my data does not allow for multilevel work, but I perform multi-group analysis that essentially allow me to test for the influence of residing in the “third level” provided in Table 4b—the geographic or nested effect of living above the Ogallala aquifer, the Equus Beds and Great Bend Prairie aquifers, or not living above the High Plains aquifer.

Multi-group analyses are pertinent for this study because they provide a statistical framework for assessing theoretical explanations at both the micro- and macro-level. Sociologists and water consumption researchers have used cluster analyses as a method for investigating variability in household water usage (Medd and Shove 2007; Willis et al. 2013), which is a less theoretically-driven form of multilevel analysis, because it lets the clustering unfold, whereas multi-group or multilevel modeling sets the scales up front. Cluster analysis is a classificatory process that identifies groups characterized by particular characteristics, and it can yield substantive results with appropriate sets of data and further refinement of deconstructing how water is domestically consumed. Overall, it is a method that retains the integrity of an individual case while exploring the similarities and differences within a particular sample. Sociologists frequently collect data that have a hierarchical structure, and many sociological studies analyze participants who are grouped within a specific context. If an analyst interprets the results of their data at the wrong level, they could commit what W.S. Robinson (1950) called the “ecological fallacy” by interpreting a larger group’s correlation (its ecological correlation) at a smaller subset of data or the individual level (see also Hox 2010). As Freeman (2000) noted, the “wickedness of water policy problems” arises due to their occurrence at multiple socio-political levels, making it necessary to conduct research at various levels.

> A particular strength of the sociological perspective is its foundation in approaches that recognize the nested nature of social systems form individuals and households to organizations, cities, states, and nations to global systems. The nested nature of social systems requires the acknowledgment that nations comprise numerous subunits, including states (or provinces), organizations, communities, households, and individuals… By considering the nested nature of social systems, such assessments can uncover the effects of agency, culture, social structure, institutions, power, inequality and spatial characteristics and the roles that they play in shaping and constraining our efforts to reduce climate emissions. (Ehrhardt-Martinez et al. 2015:202)

Even though multilevel or multi-group analyses are beneficial for environmental sociology and environmental policy research, and nested effects require a more nuanced organization of my respondents, analyzing my entire sample at the aggregated level will be very appropriate for answering research some of my research questions. For example, larger questions can be analyzed at the state level: Does well ownership influence awareness levels more than other demographic variables? Do Kansans conserve water domestically during droughts? These important questions require less precision and a holistic approach to the dataset.

MODERATION

One topic in casual analysis of importance in my work is *moderation*, which is an interaction. Moderators are variables that are influencers or context-changers; a moderator is a variable that alters the effect of one variable on another variable. If the effect of x on y depends on z, then moderation occurs when a change in z changes the association of x and y. Moderators reflect "a context or mode in which two or more variables are associated" (Little 2013:289); moderators are "third" variable influences, in that they affect relationships among two or more variables. Moderating variables modify the links between the independent and dependent variables, and SEM can clarify how the relationship between water usage and well reliance is moderated by the type of well in use. As I show in Chapter 6, owners of domestic wells have different associations with investments, awareness levels, or reactions to droughts than well owners with different types of wells. Testing for moderation could reveal if one group of well owners is more conservation-prone than other well owners.

Moderation is an important causal effect that has implications for my research. As the research agenda outlined in the first chapter, I hypothesize that the relationship between well ownership and water conservation will be moderated by the well's function. The type of well in use (domestic, lawn and garden, irrigation, etc.) may influence the association between watering routines and water supply infrastructure. Low-capacity domestic wells may not have the pumping capabilities, depth, or groundwater supply to deliver an abundance of water to their owners' household. This would obviously limit domestic usage and precipitate (out of necessity) water conservation routines. On the other hand, lawn and garden wells (which are also considered low-capacity) are only drilled for outdoor watering and could be a mechanism for obtaining a reliable source of non-municipal water to keep water bills low. I expect to find a connection between reliance on wells and prudent water usage habits, and hypothesize that the relationship between water consumption and well ownership will be moderated by the type of well in use and residence above the High Plains aquifer. This hypothesis is important to my overall study because it implies that a nuanced relationship exists between sustainable practices and water supply infrastructure, "Different systems of provision create different forms of demand" (Medd and Shove 2007:53). Social scientists studying water management convey that different groups and individuals have different interests in conserving a particular water supply (Mollinga 2008). Moderation should therefore be expected (and empirically demonstrated) among well owners, specifically with regards to their well's function.

Coding well owners along their wells' function required me to make decisions that focused on a handful of survey items that measured well ownership. After studying the dataset, I put the well owners into groups based on the capacity of their largest well. A domestic well has a typical yield of 5-20 gallons per minute, lawn and garden wells tend to have similar or slightly higher yields, and irrigation wells have yields of several hundred gallons per minute. Most of my well owning respondents (287 out of 412) indicated that they owned just one well, while the remaining 125 owned multiple wells. For the respondents who own a single well, it was easy to categorize them by the type of well they owned (they were placed in either domestic, lawn and garden, feedlot, or irrigation groups). For the owners of multiple types of wells, I coded them according to the well that was assumed to be the reasonably largest capacity and "rounded up" based on their largest well. For instance, there were several well owners who owned both domestic and feedlot wells (and nearly 1,400 domestic wells doubled as livestock wells in the KGS database). Since feedlot wells generally have higher capacities than domestic wells, I would code those owners of multiple wells as feedlot well owners. As another illustration, two-thirds of the irrigators in this study also owned wells used for non-irrigation purposes; their status as an irrigation well owner trumped their status as an owner of a smaller well. This coding ensured that my groups of well owners were as equitable as possible, and I was able to ensure that the owners of larger wells did not get washed out of the analysis by their status as an owner of multiple wells with various capacities. To establish the correct codes, I occasionally had to consult the survey item asking respondents “Why do you use your well?” Since I had far more small-capacity well owners than large-capacity well owners, these codes reduced the numbers of domestic wells the most, and the groups with smaller numbers of respondents (the groups with larger well capacities) stayed mostly intact. Of course, if a respondent owned multiple wells with the same well function (if someone owned multiple feedlot wells, for instance), they would still be coded as a single well owner. While this coding scheme cannot detect the influence of owning multiple types wells, it allows me to examine how the presence of the largest-capacity well changes well owners’ relationships with water.

As I argued in the second chapter, groundwater has different meanings and representations for well owners than it does for people without WEMs. The utility of aquifers changes as the function of the well changes, which reinforces the importance of moderation. To test for moderation, I classify well ownership as a *discrete moderator*: a categorical or nominal variable that I can use to compare correlations using a multiple group model or test for group differences that reveal moderated relationships (e.g., domestic well owner, lawn and garden well owner, feedlot well owner, or irrigation well owner). In a similar fashion, I also envision that well ownership and conservation routines will be moderated by whether or not well owners live in houses with municipal water connections, and by residence above the Ogallala aquifer, the Great Bend Prairie and Equus Beds aquifers, and eastern Kansas.

Generally, the sociology of water resource management focuses on social-behavioral dimensions and the incorporation of technology and infrastructure into social life (Bijker and Law 1992). Sociologists studying water usage have explored the meaning of water, particularly for indigenous groups, regulators, municipal suppliers, and water companies (Espeland 1998; Strang 2004; Medd and Shove 2007). The representation of water for well owners needs to be examined in order to investigate the meaning of groundwater supplies. In practice, water’s meaning is consequently different for irrigators, ranchers, gardeners, lawn care enthusiasts, and modest domestic users. If a well’s purpose influences the relationship between water usage and well ownership, it suggests a high degree of diversity among the individuals who are reliant on groundwater.

Reasons for conservation may be immensely different for well owners and non-well owners. Groundwater pumped from a well is free, so relying on wells can reduce the price of municipal water bill. This implies that lawn and garden wells could be associated with liberal water usage, since the function of the well is to augment a water supply for outdoor watering on a small scale—what other researchers and I classify as nonessential domestic water, water that exceeds the amount needed for drinking and basic hygiene.[5] Chapter 2 reviewed the literature which suggests that the demand for essential water usage can remain relatively constant (although technologies and new conservation routines can reduce the water needed to complete water-consuming practices more efficiently). This form of consumption is more consistent, making the demand "inelastic," while many outdoor uses of water are nonessential and have a more flexible range of demand. The motives for digging a specific type of well (for example, a low-capacity lawn and garden well) likely include keeping gardens and lawns adequately-watered and looking healthy. Gardens and lawns are sites of practices in which water consumption is embedded, but relying on a well instead of a municipal supply for garden or lawn watering might be a financial decision, especially in a place like Sedgwick County, which has increased water utility rates in recent years. Depending on their function and utility, wells can be seen as an investment for the wellbeing of a lawn or garden, a cost-savings device, and an additional water supply. The motives behind well ownership are therefore diverse and multifaceted, and further complicated by local water rates, watering restrictions, and infrastructures. As a result, these distinct motives can also moderate how low-capacity wells are used. While agricultural wells like irrigation and livestock wells do not provide households with water, the owners of these types of wells may be motivated to conserve water domestically out of stewardship for their groundwater supplies. If the efforts of GMDs encouraging efficient irrigation are especially influential, agricultural conservation behaviors will influence irrigators'

[5] Previous scholars have called the water used for purposes in excess of bathing, cleaning, and drinking "inessential" (Black 2004:13). Toilets, clothes washers, showers, faucets, and dishwashers are the main indoor end uses of water and for the purposes of my research I treat indoor uses as essential. Outdoor water end uses are more challenging to identify because watering lawns, gardens, trees, washing vehicles and sidewalks, and recreational purposes like swimming pools, sprinklers, or hot tubs are not often delineated in the domestic water research (Inskeep and Attari 2014:Fig. 1). Watering gardens can be considered a vital purpose if the gardener needs to produce for sustenance or a source of income, but since lawn irrigation is the primary user of outdoor domestic use, nearly all outdoor water usage at the household level is considered nonessential (ibid.).

household watering routines as well. Water is a metabolic piece of urban and rural life in Kansas, and it remains differentiated in its use. The statistical theme of moderation, therefore, is central to water-related discussions and management.

I designed my survey and notification postcards to encourage qualitative feedback from these participants. Roughly 27 percent of my respondents (236 out of 864) provided comments in optional open-ended questions on the survey. Of those 236 who left comments, 86 included their email addresses and other contact information if they wished to be contacted once the results were finalized. More importantly, 163 gave me additional comments discussing their concerns about water, their personal conservation routines and water sources, a detailed justification for their replies, concerns about the survey, and their involvement in my study. A research assistant and I coded the survey's qualitative responses and noticed a number of salient themes within that body of feedback. The participants' open-ended replies were another crucial source of qualitative data that made my analysis comprehensive and wide-ranging. Both the qualitative and the quantitative answers informed one another, and each category of survey items helped me reevaluate, or better interpret, the other.

When it comes to reporting information about SEM practices, McDonald and Ho (2002:78) state "completeness is essential." My methodological selections require an in-depth conversation of measurements, causality, and managing missing data. Describing the relationships between well reliance, residence above the High Plains aquifer, the type of well in use, and water conservation in Kansas are all within the scope of my research agenda. Multi-group analyses provide me with the tools necessary to see how water conservation changes across the state geographically, and at different levels of analysis—which produces valuable discussions and policy recommendations. For the findings of the pre-tests and the return rates of my notification postcards, consult the methodological appendix. There, you will also find the text for the notification postcards and the survey items, an explanation of how the trial and pilot responses informed the construction of my final survey's indicators, and the lessons gleaned from the pilot study.

SAMPLE OVERVIEW

I collected survey respondents with three solicitations: the panel obtained via Qualtrics, the first wave of surveys in March 2015, and the second wave of surveys in early May 2015. My overall response rate for the postcards sent to well owners was 6.3 percent, which produced 444 respondents. The entire dataset is comprised of 864 respondents, 452 non-well owners (52 percent) and 412 well owners. Of those well owners, 20 are former well owners, 143 are without municipal water supplies, and 249 have both wells and municipal water. Nearly half of my respondents (44 percent) live in GMDs, which are located above the High Plains aquifer. As I have stressed a number of times, geography is critical when describing access to groundwater in Kansas. While three-quarters (74 percent) of the non-well owners in my sample live outside of GMDs, a majority of well-owning respondents (57 percent) live in GMDs. A noticeable amount of well owners (37 percent) live in GMD 2, near the Wichita area. I received replies from 93 of the 105 counties in Kansas.

Two-thirds of the respondents are married or engaged, with a substantial majority of well owners (80 percent) being married or engaged. This is a racially homogeneous sample, which is to be expected in a predominantly Caucasian state. Nearly 95 percent of well owners, and 87 percent of non-well owners, are white; resulting in a sample in which 90 percent of the participants are white. Overall, my sample has a balanced sex distribution; 47.8 percent of the respondents are men. The sampling procedures used by Qualtrics equalized the sex distribution for my study, as the non-well owning sample is predominantly female (65 percent) while the well owners are just over 60 percent male. In this study, well owners are older than non-well owners and mostly clustered around their late fifties and early sixties (their mean age is 57, compared to 46 for the non-well owners). Approximately one-third of non-well owners are under 35, as opposed to just 9 percent of well owners.[6] The age discrepancies could be partially attributed to how Qualtrics finds survey volunteers, a vast majority of whom are non-well-owning Kansans. Recent focus groups of well owners in the Midwest and South also had strong majorities for males over 55 (Murti et al. 2016), so these findings mirror previous demographic assessments.

Since well owners occupy substantially more advanced stages in the life course, their age shapes many other demographic variables. Well owners have more education (52 percent have a bachelor's or graduate degree as opposed to 37 percent of non-well owners) and this could

[6] As it happens, recent estimates show that the average age of Kansas farmers is 59, and only 7 percent are under 35 (Johnson 2016d). The ages of well owners in this study closely mirror that, which implies that this dataset could be relatively generalizable.

partially be a function of the age differences between these groups. Parenthood is also a demographic variable that differs across these subpopulations. One-third of non-well owners do not have children as opposed to 15 percent of well owners; well owners also have larger families (about half of well owners have three or more children). With that said, age interacts parenthood, because 72 percent well owners have no children present, indicating that they are more likely to be "empty nesters" than non-well owners (53 percent of non-well owners have at least one child in the household). Employment status differs across these populations. All of the full-time students in my sample are non-well owners, as are all but one of the unemployed respondents. Roughly 28 percent of well owners are retired as opposed to 18 percent of non-well owners. Half of the non-well owners are working full- or part-time, compared to 63 percent of well owners. Furthermore, 56 percent of employed well owners have employment related to agriculture. In this dataset, 29 percent of the employed respondents work in agriculture.

Organizing the respondents by income provides a nuanced picture of well ownership and class. The mode income category for non-well owners is $20,000-39,999, which is probably related to this group's age, gender, and education levels. Well owners who have no municipal water supplies have a bimodal income distribution; with $40,000-59,999 and $150,000 or more being the most common ranges of household income. Well owners who have municipal water supplies are also wealthier than non-well owners, as their modal household income range is $100,000-149,999. Homeownership and residing in a one-family detached house is extremely high among all groups of well owners (approximately 95 percent), while just 4 percent of well owners are renters. Three-quarters of non-well owners live in a one-family house and two-thirds own their home. Across both groups, the modal population of the household is two people. These findings match previous research on well owners, which notes that well users range from low to high income—although that was only known anecdotally and there are not many sociodemographic studies of well owners (VanDerslice 2011; Fox 2016). Furthermore, even community water systems, which serve most of the US population, are not required to compile the demographics of their customers. Therefore, robust assessments of water supply disparities across sociodemographic lines are therefore challenging for analyzing both populations reliant on private and public watering supplies.

Slight political differences can be detected across these groups. Well owners are more likely to vote in local or state elections than their non-well-owning counterparts, and the modal description of their political views is "conservative" while non-well owners most frequently describe theirs as moderate. Just 3 percent of these respondents define themselves as "very liberal." Well owners appear to be more religious than non-well owners: one-quarter of non-well owners are non-religious, atheist, or agnostic, as opposed to 13 percent of well owners. The religious well owners are primarily Protestant and Catholic. When it came to religious *identity* (which included Born-Again, Charismatic, Evangelical, Mainline Christian, and so forth), "none of these," "Bible-Believing," and "Born-Again" were the most frequently-selected religious identities for all of my respondents. It should be noted, however, that non-well owners did not identify with any of the religious identities options at slightly higher frequencies than current or previous well owners.[7] Consult the sample overview tables at the end of this chapter for a complete rundown of the demographic frequencies. Not only do well-owning Kansans appear to be wealthier, older, better-educated, and more politically conservative than their non-well owning counterparts, they also have different standards of water conservation, water literacy, and political priorities that emphasize water management. All of these demographics are available in the sample overview tables, and the next chapter continues the discussion of the key differences between well owners and non-well owners in Kansas.

CHAPTER SUMMARY

> In this chapter, I presented the methodological techniques used in my dissertation. Sociology is a well-equipped discipline to investigate how human activities and the relationships between social institutions at multiple units of analysis can contribute to groundwater depletion. I described how I obtained my data and how I constructed my survey with Planned Missing Data Designs. I also provided short justifications for using a survey with planned, random missingness instead of a full form. My survey has been designed specifically for my analytical procedures (running CFAs and structural equation modeling). In order to ensure construct comparability between the well owners and non-well owners in Kansas, I test measurement invariance. Chapter 4 also reviewed my motivation for using multi-group analyses, which give me the ability to dissect how standards of household water conservation change geographically and at different geopolitical scales in Kansas. Moderation analyses can determine if domestic water conservation varies among those who own different types of wells.

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[7] While the demographics portion of the questionnaire made up about a third of all the survey items, I used planned missing data approaches for the political, parenthood, employment, and religious questions. Consult the sample overview tables at the end of this chapter for a complete rundown of the demographic frequencies, and consult the methodological appendix for a detailed assessment of the response rates and influence of stylistic changes on each postcard's response rates.

SAMPLE OVERVIEW TABLES

Demographic Table 1. Respondents Organized by Geographic Residence and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Outside GMDs	326 (73.4%)	15 (83.3%)	65 (49.2%)	78 (33.2%)	484 (58.4%)
GMD 1	5 (1.1%)	0	2 (1.5%)	0	7 (0.8%)
GMD 2	85 (19.0%)	3 (16.7%)	31 (23.5%)	103 (43.8%)	222 (26.8%)
GMD 3	14 (3.2%)	0	17 (12.9%)	33 (13.9%)	64 (7.7%)
GMD 4	11 (2.5%)	0	9 (6.8%)	7 (3.0%)	27 (3.3%)
GMD 5	3 (0.7%)	0	8 (6.1%)	14 (6.0%)	25 (3.0%)
	444	18	132	235	829

Demographic Table 2. Respondents Organized by Marital Status and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Married or Engaged	251 (56.7%)	13 (65.0%)	114 (84.4%)	188 (80.0%)	566 (67.9%)
Widowed	15 (3.4%)	2 (10.0%)	6 (4.4%)	12 (5.1%)	35 (4.2%)
Divorced or Separated	47 (10.6%)	0	5 (3.7%)	12 (5.1%)	64 (7.7%)
Single	71 (16.1%)	3 (15.0%)	7 (5.2%)	14 (6.0%)	95 (11.4%)
In a Relationship, Never Married	16 (3.6%)	1 (5.0%)	0	7 (3.0%)	24 (2.9%)
In a Relationship, Previously Married	41 (9.7%)	1 (5.0%)	3 (2.2%)	2 (0.9%)	49 (5.9%)
	443	20	135	235	833

Demographic Table 3. Respondents Organized by Race and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
White	384 (86.9%)	18 (90.0%)	125 (95.4%)	218 (95.2%)	745 (90.6%)
Hispanic	8 (1.8%)	0	2 (1.5%)	1 (0.4%)	11 (1.3%)
Black	15 (3.4%)	0	2 (1.5%)	3 (1.3%)	20 (2.4%)
American Indian	5 (1.1%)	0	1 (0.8%)	0	6 (0.7%)
Asian	10 (2.3%)	1 (5.0%)	0	2 (0.9%)	13 (1.6%)
Another Race	5 (1.1%)	0	1 (0.8%)	3 (1.3%)	9 (1.1%)
Bi/Multiracial	15 (3.4%)	1 (5.0%)	0	2 (0.9%)	18 (2.2%)
	442	20	131	229	822

Demographic Table 4. Respondents Organized by Household Income and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Under $10,000	39 (9.0%)	3 (15.0%)	2 (1.7%)	6 (2.8%)	50 (6.4%)
$10,000-19,999	53 (12.2%)	0	4 (3.3%)	7 (3.3%)	64 (8.1%)
$20,000-39,999	90 (20.8%)	4 (20.0%)	9 (7.5%)	20 (9.3%)	123 (15.6%)
$40,000-59,999	81 (18.7%)	3 (15.0%)	23 (19.2%)	22 (10.3%)	129 (16.4%)
$60,000-79,999	62 (14.3%)	5 (25.0%)	22 (18.3%)	37 (17.3%)	126 (16.0%)
$80,000-99,999	37 (8.5%)	3 (15.0%)	20 (16.7%)	30 (14.0%)	90 (11.4%)
$100,000-149,999	42 (9.7%)	1 (5.0%)	17 (14.2%)	50 (23.4%)	110 (14.0%)
$150,000 or more	29 (6.7%)	1 (5.0%)	23 (19.2%)	42 (19.6%)	95 (12.1%)
	433	20	120	214	787

Demographic Table 5. Respondents Organized by Housing Type and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
One-Family House, detached	330 (74.5%)	19 (95.0%)	125 (93.3%)	231 (95.8%)	703 (84.1%)
One-Family House, attached	22 (5.0%)	0	2 (1.5%)	4 (1.7%)	28 (3.3%)
Apartment or Duplex	74 (16.7%)	1 (5.0%)	2 (1.5%)	5 (2.1%)	82 (9.8%)
Mobile Home	17 (3.8%)	0	5 (3.7%)	1 (0.4%)	23 (2.8%)
	443	20	134	239	836

Demographic Table 6. Respondents Organized by Residents in Household and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
One	68 (15.3%)	3 (15.0%)	19 (14.1%)	30 (12.7%)	120 (14.4%)
Two	177 (39.9%)	9 (45.0%)	78 (57.8%)	143 (60.6%)	407 (48.7%)
Three	83 (18.7%)	3 (15.0%)	17 (12.6%)	18 (7.6%)	121 (14.5%)
Four	56 (12.6%)	1 (5.0%)	10 (7.4%)	21 (8.9%)	88 (10.5%)
Five	39 (8.8%)	4 (20.0%)	6 (4.4%)	16 (6.8%)	65 (7.8%)
Six or More	20 (4.7%)	0	5 (3.7%)	9 (3.4%)	34 (4.1%)
	444	20	135	236	835

Demographic Table 7. Respondents Organized by Home Ownership and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Owned	295 (66.4%)	16 (80.0%)	130 (96.3%)	230 (96.2%)	670 (80.0%)
Rented	138 (31.1%)	4 (20.0%)	3 (2.2%)	9 (3.4%)	153 (18.3%)
Another Arrangement	11 (2.5%)	0	2 (1.5%)	1 (0.4%)	14 (1.7%)
	444	20	135	238	837

Demographic Table 8. Respondents Organized by Political Views and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Very Liberal	20 (4.5%)	1 (5.3%)	0	7 (3.0%)	28 (3.4%)
Liberal	64 (14.5%)	4 (21.1%)	16 (12.2%)	24 (10.3%)	108 (13.1%)
Moderate	194 (44.1%)	6 (31.6%)	32 (24.4%)	80 (34.5%)	312 (38.0%)
Conservative	124 (28.2%)	7 (36.8%)	59 (45.0%)	97 (41.8%)	287 (34.9%)
Very Conservative	38 (8.6%)	1 (5.3%)	24 (18.3%)	24 (10.3%)	87 (10.6%)
	440	19	131	232	822

Demographic Table 9. Respondents Organized by Sex and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Male	155 (35.4%)	9 (45.0%)	82 (61.2%)	149 (64.2%)	395 (47.8%)
Female	285 (64.8%)	11 (55.0%)	52 (38.8%)	83 (35.8%)	431 (52.2%)
	440	20	134	232	826

Demographic Table 10. Respondents Organized by Age and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Under 25	48 (11.3%)	2 (10.0%)	2 (1.6%)	2 (0.9%)	54 (6.8%)
25-29	44 (10.4%)	0	2 (1.6%)	9 (4.1%)	55 (6.9%)
30-34	39 (9.2%)	2 (10.0%)	3 (2.4%)	10 (4.5%)	54 (6.8%)
35-39	33 (7.7%)	0	4 (3.2%)	13 (5.9%)	50 (6.3%)
40-44	30 (7.0%)	1 (5.0%)	6 (4.8%)	9 (4.1%)	46 (5.8%)
45-49	34 (8.0%)	1 (5.0%)	9 (7.2%)	15 (6.9%)	59 (7.4%)
50-54	43 (10.1%)	4 (20.0%)	15 (12.0%)	21 (9.5%)	83 (10.5%)
55-59	45 (10.6%)	4 (20.0%)	21 (16.8%)	31 (14.0%)	101 (12.7%)
60-64	44 (10.3%)	2 (10.0%)	30 (24.0%)	45 (20.2%)	121 (15.3%)
65-69	37 (8.7%)	2 (10.0%)	19 (15.2%)	28 (12.6%)	86 (10.8%)
70-74	17 (4.0%)	1 (5.0%)	5 (4.0%)	17 (7.7%)	40 (5.0%)
75-79	7 (1.6%)	0	5 (4.0%)	10 (4.5%)	22 (2.8%)
80 and Above	5 (1.2%)	1 (5.0%)	4 (3.2%)	12 (5.4%)	22 (2.8%)
	426	20	125	222	793

Demographic Table 11. Respondents Organized by Education Level and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Less than High School	7 (1.6%)	1 (5.0%)	2 (1.5%)	9 (3.8%)	19 (2.3%)
High School Graduate	92 (20.9%)	1 (5.0%)	24 (18.2%)	29 (12.4%)	147 (17.7%)
Some College, No Degree	120 (27.0%)	5 (25.0%)	23 (17.4%)	47 (20.1%)	195 (23.5%)
Community College/Associate's Degree	59 (13.3%)	2 (10.0%)	20 (15.2%)	23 (9.8%)	104 (12.5%)
Bachelor's Degree	107 (24.0%)	7 (35.0%)	38 (28.8%)	73 (31.2%)	225 (27.1%)
Graduate Degree	59 (13.3%)	4 (20.0%)	25 (18.9%)	53 (22.6%)	141 (17.0%)
	445	20	132	234	831

Demographic Table 12. Respondents Organized by Number of Children and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
None	142 (32.2%)	5 (25.0%)	19 (14.3%)	34 (14.7%)	200 (24.2%)
One	66 (15.0%)	2 (10.0%)	14 (10.5%)	17 (7.3%)	99 (12.0%)
Two	116 (26.3%)	3 (15.0%)	32 (24.1%)	84 (36.2%)	235 (28.5%)
Three	79 (17.9%)	6 (30.0%)	44 (33.1%)	56 (24.1%)	185 (22.4%)
Four or More	38 (8.6%)	4 (20.0%)	24 (18.0%)	41 (17.7%)	107 (13.0%)
	441	20	133	232	826

Demographic Table 13. Respondents Organized by Number of Children Present in the Household and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
No Children Present	130 (47.1%)	8 (61.5%)	77 (76.2%)	128 (70.7%)	343 (60.1)
One	58 (21.0%)	2 (15.4%)	13 (12.9%)	15 (8.3%)	88 (15.4%)
Two	53 (19.2%)	0	4 (4.0%)	21 (11.6%)	78 (13.7%)
Three	23 (8.3%)	3 (23.1%)	6 (5.9%)	11 (6.1%)	43 (7.5%)
Four or More	12 (4.3%)	0	1 (1.0%)	6 (3.3%)	19 (3.3%)
	276	13	101	181	571

Demographic Table 14. Respondents Organized by Description of Current Employment and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Working full-time, part-time, or self-employed	151 (51.7%)	9 (64.3%)	54 (68.4%)	98 (60.1%)	312 (56.9%)
Unemployed	17 (5.8%)	0	0	1 (0.6%)	18 (3.3%)
Laid off/Looking for Work	3 (1.0%)	0	2 (2.5%)	2 (1.2%)	7 (1.3%)
Retired	54 (18.5%)	3 (21.4%)	18 (22.8%)	51 (31.3%)	126 (23.0%)
In School	11 (3.8%)	0	0	0	11 (2.0%)
Keeping House	38 (13.0%)	2 (14.3%)	2 (2.5%)	4 (2.5%)	46 (8.4%)
Multiple Answers	18 (6.2%)	0	3 (3.8%)	7 (4.3%)	28 (5.1%)
	292	14	79	163	548

Demographic Table 15. Respondents Organized by Employment in Agriculture and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Yes	24 (15.2%)	4 (44.4%)	29 (59.2%)	29 (34.9%)	86 (28.8%)
No	134 (84.8%)	5 (55.6%)	20 (40.8%)	54 (65.1%)	213 (71.2%)
	158	9	49	83	299

Demographic Table 16. Respondents Organized by Religious Beliefs and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Protestant	123 (41.3%)	4 (36.4%)	45 (50.6%)	93 (59.4%)	264 (47.7%)
Catholic	33 (11.1%)	0	26 (29.2%)	22 (14.2%)	81 (14.6%)
Latter Day Saints	2 (0.7%)	0	1 (1.1%)	0	3 (0.5%)
Jehovah's Witness	1 (0.3%)	0	1 (1.1%)	0	2 (0.4%)
Non-Religious, Atheist, or Agnostic	74 (24.8%)	4 (36.4%)	8 (9.0%)	22 (14.2%)	108 (19.5%)
Non-Denominational Christian	23 (7.7%)	2 (18.2%)	0	2 (1.3%)	27 (4.9%)
Other (Jewish, Muslim, Hindu, Buddhist)	42 (14.1%)	1 (9.1%)	8 (9.0%)	17 (11.0%)	68 (12.3%)
	298	11	89	155	553

Demographic Table 17. Respondents Organized by Religious Identity and Well Ownership

	Non-Well Owners	Former Well Owners	Non-Municipal Well Owners	Municipal Well Owners	Total
Born-Again	51 (17.1%)	3 (27.3%)	12 (13.3%)	28 (19.2%)	94 (17.2%)
Bible-Believing	44 (14.8%)	2 (18.2%)	21 (23.3%)	33 (22.6%)	100 (18.3%)
Charismatic	4 (1.3%)	0	2 (2.2%)	1 (0.7%)	7 (1.3%)
Theologically Conservative	4 (1.3%)	0	4 (4.4%)	5 (3.4%)	13 (2.4%)
Evangelical	10 (3.4%)	0	3 (3.3%)	6 (4.1%)	19 (3.5%)
Fundamentalist	2 (0.7%)	0	2 (2.2%)	1 (0.7%)	5 (0.9%)
Theologically Liberal	9 (3.0%)	2 (18.2%)	6 (6.7%)	5 (3.4%)	22 (4.0%)
Mainline Christian	30 (10.1%)	1 (9.1%)	11 (12.2%)	19 (12.2%)	61 (11.2%)
Pentecostal	8 (2.7%)	0	0	3 (2.1%)	11 (2.0%)
Seeker	7 (2.3%)	0	1 (1.1%)	1 (0.7%)	9 (1.7%)
Religious Right	4 (1.3%)	0	2 (2.2%)	0	6 (1.1%)
Moral Majority	5 (1.7%)	0	1 (1.1%)	3 (2.1%)	9 (1.7%)
None of These	120 (40.3%)	3 (27.3%)	25 (27.8%)	41 (28.1%)	189 (34.7%)
	298	11	90	146	545

Chapter V: Investigating Household Water Supplies and Groundwater Citizenship

This chapter focuses on well owners' differences from non-well owners. I contacted well owners by consulting a database of well owners' home addresses run by the Kansas Geological Survey; most non-well owners in this study were reached by a panel study conducted by Qualtrics. The two questions investigated in this chapter are: (1) How does well ownership influence domestic water usage in Kansas? (2) Does well ownership bring about a new definition of environmental citizenship and stewardship, specifically an urge to protect groundwater by exhibiting a form of groundwater citizenship? After summarizing the quantitative analyses conducted on the study participants' survey responses, I offer a sense of the qualitative responses that support my claim that water supply infrastructure creates boundaries that lead to different practices and communities. According to the response frequencies, regression results, ANOVA, and T-tests, my findings reveal that well owners are more likely than non-well owners to (1) rank water security as a high priority for Kansans, (2) base their vote on water policies, (3) deliberately conserve water more often, (4) express environmental motivations to conserve water, and (5) be more aware of the state's water supplies. This suggests that well owners exhibit "groundwater citizenship" and can be conceptualized as aquifer stewards compared to the general population.

INTRODUCTION

The previous chapters laid out my rationale for investigating the influence of water supply infrastructure and my hypotheses regarding its importance for studying water conservation efforts. I anticipate that the presence or absence of a well will be associated with significant differences in watering routines and political priorities. Given that estimates of groundwater decline and groundwater allocations do not incorporate the withdrawals of small capacity wells, well owners' domestic usage in particular will be of growing importance when researching the depletion of the High Plains aquifer. Most agriculture in the High Plains is reliant on groundwater, but it is imperative to look beyond the food production industry and investigate municipal and household demands. Sociological work studying communities reliant on groundwater call attention to the institutions and actors within and beyond the agricultural sector (Gasteyer 2008). To answer that call, this chapter investigates domestic patterns and communities of practice, as sociologists, water researchers, and well experts have done. In general, there is a growing demand to incorporate the social sciences into climate change research and investigate the underlying causes of environmental problems, including "the behaviors and interactions of individuals, communities, markets, nations, and all types of institutions" (Weaver et al. 2014:656). My research uncovers the connections among my respondents' reactions towards drought, which should especially benefit environmental and rural sociologists. For instance, if the experience of relying on a well instills a sense of water sensitivity or appreciation that is largely missing from individuals using municipally-provided water, it would suggest that well users approach their water usage with a distinct ethic of prudence or stewardship.

One goal of this chapter is to summarize how reliance on aquifers changes Kansans' relationships with water. I anticipate a connection between reliance on wells and efforts to extend local water supplies, and hypothesized that citizenship in rural Kansas is contoured by well ownership and knowledge of water-related issues. My study frames well owners as a distinct social group defined by water awareness, political priorities, and emphasis on conservation. Through this research, I attempt to identify why people remain cognizant of their water supplies, which should facilitate the creation of more effective drought adaptation policies and, in turn, extend the life of aquifers.

DO WELL OWNERS EXHIBIT A UNIQUE STYLE OF CITIZENSHIP?

Sustaining the High Plains aquifer in an era of problematic droughts requires an investigation of the individuals reliant on its groundwater. To depict how well ownership influences individuals' conservation efforts and citizenship, I regress a number of dependent variables associated with water usage on the independent variable measuring well ownership (0 = non-well owner, 1 = well owner). I also summarize the general differences between well owners and non-well owners by outlining their frequencies associated with particular survey items of interest that serve as proxies or components of citizenship, and conduct an analysis of variance (ANOVA) and T-tests.

Regression Table 5a provides the results of the regression analysis predicting the "well ownership gap" in water conservation efforts. According to the regression, well ownership has a significant, positive correlation with:

- Higher frequencies of deliberately saving water around the house ($b = .136$, $p < .01$) and being motivated to save water in order to extend a water supply ($b = .202$, $p < .001$)
- Owning a low-flow showerhead ($b = .240$, $p < .001$), low-flow toilet ($b = .185$, $p < .001$), water-efficient washing machine ($b = .223$, $p < .001$), timed sprinkler system ($b = .272$, $p < .001$), and drip irrigation systems ($b = .289$, $p < .001$)
- Ranking water conservation as a high political challenge for the state ($b = .191$, $p < .001$), as well as voting on water-related policies in local and state elections ($b = .106$, $p < .05$)

- The frequency of recycling glass, paper, newspaper, aluminum, plastic and so forth ($b = .104$, $p < .05$), and the frequency of composting kitchen or garden waste ($b = .106$, $p < .05$)
- Hearing of the High Plains aquifer ($b = .378$, $p < .001$), Groundwater Management Districts ($b = .462$, $p < .001$), the Kansas Water Office ($b = .268$, $p < .001$), the Long-Term Vision for the Future of Water in Kansas ($b = .205$, $p < .001$), xeriscaping ($b = .260$, $p < .001$), greywater ($b = .305$, $p < .001$), the Kansas Aqueduct ($b = .225$, $p < .001$), and awareness that agriculture uses the most water in Kansas ($b = .185$, $p < .001$)

Furthermore, well ownership has a significant negative correlation with shower length ($b = -.276$, $p < .001$). However, well ownership also has a significant, positive relationship with:

- Higher shower frequencies ($b = .121$, $p < .01$)
- Higher lawn watering frequencies ($b = .293$, $p < .001$), as well as longer lengths for lawn watering sessions ($b = 223$, $p < .01$)
- Increased lawn watering during droughts ($b = .259$, $p < .001$), as well as increased watering for the garden, orchard, trees, or other vegetation during droughts ($b = .208$, $p < .001$)
- Furthermore, well ownership has a negative correlation with taking shorter showers during droughts ($b = -.205$, $p < .001$).

Finally, well ownership does not have significant predictive associations with toilet flushing frequency, reduced toilet flushing during droughts, stopping lawn watering during droughts, stopping garden, orchard, tree, or other vegetation watering during droughts, irrigating less during droughts, irrigating more during droughts, or the frequency of using personal shopping bags when grocery shopping.

Generally, this regression implies that those with private systems of provision are a distinct community of practice given the positive association with deliberate water saving, prioritizing water-related issues as a political challenge, and the pro-environmental behaviors of recycling and composting. Well owners might also be described as a community of technologies given well ownership's positive correlation with water-saving appliances, although it is important to note that these conservation measures are also paired with *increased* outdoor domestic consumption (overall and during droughts). Pronounced associations exist between well ownership and investment in water-saving appliances, familiarity with water-related topics, and lawn care. Furthermore, well ownership is positively connected to recycling and composting, providing evidence of PEB spill-over effects discussed in previous research (see Chapter 2). Overall, water conservation efforts via the utilization of efficient technologies are better correlated with well ownership than most behaviors associated with drought-time curtailments.

Regression Table 5a. Standardized results for frequency of deliberate water saving, deliberately conserving water to extend supply, toilet flushing frequency, showering frequency, lawn watering frequency, owning a low-flow showerhead, owning a low-flow toilet, owning a water-efficient washing machine, owning a timed sprinkler system, owning drip irrigation, length of lawn watering sessions, length of showers, ranking water security as a challenge facing Kansas, voting on water-related policies in local or state elections, taking shorter showers during droughts, reducing toilet flushes during droughts, stopping lawn watering during droughts, stopping garden, orchard, trees, and other vegetation watering during droughts, irrigating less during droughts, increasing lawn watering during droughts, increasing garden, orchard, trees, and other vegetation watering during droughts, irrigating more during droughts, recycling frequency, frequency of using personal grocery bags while shopping, composting frequency, and awareness of the High Plains aquifer, GMDs, the KWO, the Long-Term Vision, Xeriscaping, Greywater, Kansas Aqueduct, and that agriculture is the biggest water user in Kansas on well ownership (n = 857)

	Beta Estimate	**P-Value**	**S.E.**
Practices			
Frequency of deliberate water saving	.136	.001	.042
Deliberately conserving water to extend supply	.202	.000	.046
Toilet flushing frequency	.000	.997	.044
Showering frequency	.121	.004	.042
Lawn watering frequency	.293	.000	.040
Indoor water-saving appliances			
Low-flow showerhead	.240	.000	.041
Low-flow toilet	.185	.000	.041
Water-efficient washing machine	.223	.000	.042
Outdoor water-saving appliances			
Timed sprinklers	.272	.000	.042
Drip irrigation	.289	.000	.052
Length of Water Using Routines			
Length of lawn watering sessions	.223	.002	.071
Length of showers	-.276	.000	.045
Political Prioritization of Water Security			
Ranking water security as a challenge facing Kansas	.191	.000	.041
Voting on water-related policies in local or state elections	.106	.014	.043
Decreased Indoor Usage During Droughts			
Take shorter showers	-.205	.000	.041
Flush the toilet less	-.072	.095	.043

Decreased Outdoor Usage During Droughts			
Stop watering lawn	-.054	.208	.043
Stop watering garden, orchard, trees, and other vegetation	-.025	.591	.046
Irrigate less	-.001	.988	.051
Increased Outdoor Usage During Droughts			
Increase watering lawn	.259	.000	.067
Increased watering garden, orchard, trees, and other vegetation	.208	.001	.059
Irrigate more	.125	.076	.070
Pro-Environmental Behaviors			
Recycling frequency	.104	.013	.042
Frequency of using personal grocery bags while shopping	.040	.337	.042
Composting frequency	.106	.012	.042
Awareness			
High Plains aquifer	.378	.000	.036
GMDs	.462	.000	.033
KWO	.268	.000	.040
Long-term Vision	.205	.000	.049
Xeriscaping	.260	.000	.046
Greywater	.305	.000	.040
Kansas aqueduct	.225	.000	.041
Agriculture as biggest water user in Kansas	.185	.000	.052

However, if well owners are in fact a unique community of practice, it is challenging to determine if they use lower volumes of water domestically than non-well owners. For instance, well ownership is significantly connected to owning a low-flow showerhead and shorter lengths, but also to higher shower frequencies. Nevertheless, the social conditions and circumstances that frame sustainable alternatives are critically important for analyzing PEBs, and environmental sociologists can advance the conversation of PEB-adoption by investigating the social and technical organizations in which certain behaviors take place. Well ownership appears to be correlated with several PEBs and water conservation efforts.

Table 5b is a cross-tabulation of well owners’ and non-well owners’ ranking of water security as a challenge facing Kansas. Among non-well owners, 40.5 percent believe securing water is one of the top three challenges facing Kansas, about the same amount as the percentage of non-well owners who think there are a handful other more important issues (41.9 percent).

The remaining 17.5 percent of non-well owners feel there are many other challenges more important than securing water for Kansas. On the other hand, over half of well owners (56.3 percent) believe that securing water for the future is in the top three important issues facing the state; 36.9 percent believe there are a handful of more pressing issues facing Kansas, and only 6.8 percent feel that there are many issues that warrant more concern than securing water. When voting in state and local elections, 29 percent of well owners say that water policies influence their vote, compared to 25 percent of non-well owners (see Table 5c). Interestingly, 57.8 percent of non-well owners admit that their votes are not influenced by water policy, while 64.2 percent of well owners say the same. Only 6.5 percent of well owners revealed that they do not typically vote in local or state elections, as opposed to 16.2 percent of non-well owners. Table 5d provides the frequencies for well owners and non-well owners' frequency of water conservation over the past year. A majority of well owners claim to deliberately conserve water on a daily basis (57.6 percent), which is higher than their non-well-owning counterparts (43.3 percent). The rationale for water conservation also differs among well owners and non-well owners. Non-well owners' most commonly-listed reason for water conservation was saving money on their water bills, as compared to well owners who emphasized multiple benefits (both monetary and non-monetary) associated with saving water (see Table 5e).

Table 5b. Frequencies for Respondents Organized by Well Ownership and Priorities for Challenges for Kansans (N = 554)

	Non-well Owners	**Well Owners**	**Total**
Securing Water in the Top Three Challenges	118 (40.5%)	148 (56.3%)	266 (48.0%)
A Handful of Challenges are More Important than Securing Water	122 (41.9%)	97 (36.9%)	219 (39.5%)
Many Challenges are More Important than Securing Water	51 (17.5%)	18 (6.8%)	69 (12.5%)
Total	291	263	554

Table 5c. Frequencies for Respondents Organized by Well Ownership and Voting on Water Policies in State and Local Elections (N = 556)

	Non-well Owners	Well Owners	Total
Yes, in Local and/or State Elections	77 (26.0%)	76 (29.2%)	153 (27.5%)
No	171 (57.8%)	167 (64.2%)	338 (60.8%)
Does not Typically Vote in Local and State Elections	48 (16.2%)	17 (6.5%)	65 (11.7%)

Table 5d. Frequencies for Respondents Organized by Well Ownership and Frequency of Deliberate Water Conservation in the Past Year (N = 567)

	Non-well Owners	Well Owners	Total
Never	48 (16.1%)	32 (11.9%)	80 (14.1%)
Once or a Few Times over the Year	46 (15.4%)	30 (11.2%)	76 (13.4%)
Roughly once a Month	43 (14.4%)	23 (8.6%)	66 (11.6%)
Roughly once a Week	32 (10.7%)	29 (10.8%)	61 (10.8%)
Daily	129 (43.3%)	155 (57.6%)	284 (50.1%)
Total	298	269	567

Table 5e. Frequencies for Respondents Organized by Well Ownership and Rationales for Conservation (N = 845)

	Non-well Owners	Well Owners	Total
Conserve to Keep Up with Demand	35 (7.9%)	33 (8.2%)	68 (8.0%)
Conserve to Save Money	183 (41.0%)	80 (20.1%)	263 (31.1%)
Conserve to Extend Water Supply	73 (16.4%)	114 (28.4%)	187 (22.1%)
All of These	164 (36.9%)	203 (50.6%)	367 (43.4%)
Do Not Conserve	50 (11.3%)	33 (8.2%)	83 (9.8%)

In order to test the hypothesis that well ownership has an effect on aforementioned variables, a one-way between-groups analysis of variance (ANOVA) was performed and the Welch correction statistics were analyzed for the variables that violated the assumption of homogeneity of variances.[1] This ANOVA evaluates the null hypothesis that there is no difference in Kansans' ranking of water security as a challenge, voting on water-related policies, frequency of water conservation, and motivations for conservation based on their water supply infrastructure. The independent variable, well ownership, included two groups, non-well owners and well owners.

The descriptive statistics associated with the dependent variables across non-well owners and well owners are reported in Table 5f. Non-well owners have a lower mean score of ranking water security as a serious challenge (M = 2.230) than well owners (M = 2.494), and non-well owners have a lower mean score of voting on water-related policies (M = 2.099) than well owners (M = 2.227). Well owners have a higher mean score of water conservation frequency (M = 3.911) than non-well owners (M = 3.500). Non-well owners and well owners had roughly similar means for conserving water due to concerns regarding the household's supply to keep up with demand (.079 and .083, respectively). Non-well owners had a higher mean score for being motivated to conserve water by saving money (M = .410) than well owners (M = .201), but well owners had a higher mean score for being motivated to save water to extend their supply (M = .286) than non-well owners (M = .164). The mean score for non-well owners being motivated to conserve water for all of those reasons was .370 and for well owners it was .506; the mean score for not conserving water was .112 for non-well owners and .084 for well owners.

[1] Prior to conducting the ANOVA, the assumption of homogeneity of variances was tested and was only satisfied for two variables based on Levene's F test, voting on water-related policies [$F(1, 554) = 6.320$, $p = .599$] and being motivated to deliberately saving water so the household water supply can keep up with the household's demand [$F(1, 843) = .051$, $p = .652$]. This means the variances for those variables are homogenous, but not for the remaining dependent variables. Ranking water security as a challenge, frequency of deliberate household conservation, conserving water to save money, conserving water to extend the supply, conserving water for "all of the above" reasons, and not conserving water violate the assumption of homogeneity of variance; therefore, I used the Welch ANOVA test for those variables. These variables are categorical, so I reported the Welch F statistics generated in the Robust Tests of Quality of Means. This test of equal variance shows the F test from an ANOVA where the response is the absolute value of the difference of each observation and the group median. According to the Homogeneity of Variances Tests (Levene Statistics' Significance Values) the differences in means between non-well owners and well owners violate the assumption of homogeneity of variance for ranking water security as a challenge, frequency of deliberate conservation, conserving water to save money, conserving water to extend the supply, conserving water for "all of the above" reasons, and not conserving water across these groups. For those results, I have provided the p values, degrees of freedom, and F statistics for the robust tests of equality of means based on the Welch test, which is a tests for equality of group variances and an ANOVA that is valid when the group sample variances are unequal. The differences in means between non-well owners and well owners did not violate the assumption of homogeneity of variance for voting on water-related policies and conserving water for the sake of the supply's ability to keep up with demand and for those values the original ANOVA values are reported. Consult Table 5g that table's note for more information.

Table 5f. Descriptive statistics for non-well owners and well Owners

	Owns Well	Number	Mean	Std. Dev.	SE
Ranking Water Security as a Challenge	Non-Well Owner	291	2.230	.728	.043
	Well Owner	263	2.494	.623	.038
Voting on Water-Related Policies	Non-Well Owner	296	2.099	.644	.038
	Well Owner	260	2.227	.555	.034
Frequency of Deliberate Conservation	Non-Well Owner	298	3.500	1.549	.090
	Well Owner	269	3.911	1.476	.090
Motivations for Conservation					
Keeping Up with Demand	Non-Well Owner	446	.079	.269	.013
	Well Owner	399	.083	.276	.014
Saving Money	Non-Well Owner	446	.410	.492	.023
	Well Owner	399	.201	.401	.020
Extend Supply	Non-Well Owner	446	.164	.370	.018
	Well Owner	399	.286	.452	.023
All of These	Non-Well Owner	446	.370	.483	.023
	Well Owner	399	.506	.501	.025
Do Not Conserve	Non-Well Owner	446	.112	.316	.015
	Well Owner	399	.083	.276	.014

Is there a difference in Kansans' ranking of water security challenges, propensity to vote on water-related policies, frequencies of deliberate water conservation, and rationale for conservation based on their household water supplies? The differences in means for most of these variables are significant across groups. The independent between-groups ANOVA and Welch corrections yielded a statistically significant effect for ranking water as a high priority facing Kansas [$F(1,550.425) = 21.152$, $p < .001$], voting on water-related policies in state and local elections [$F(1,554) = 6.320$, $p < .05$], frequency of deliberate conservation [$F(1,563.333) = 10.620$, $p < .01$], being motivated to conserve water by saving money [$F(1,835.722) = 46.510$, $p < .001$], extend the supply [$F(1,770.691) = 18.154$, $p < .001$], and the "all of the above" selection—which included being motivated by the supply's ability to keep up with household demand, saving money, and extending supply [$F(1,825.291) = 16.131$, $p < .001$]. The ANOVA and Welch correction yielded no significant results for the dependent variables of being motivated to conserve water based on concerns of the supply's ability to keep up with household demand, and not conserving water; there is no significant difference between well owners and non-well owners for those two variables (see Table 5g). For most dependent variables in the ANOVA and Welch test, however, the null hypothesis of no differences between the groups' means was rejected.

Private well owners express significantly higher scores in terms of ranking Kansas's water security as a higher priority, basing their votes on water-related policies, and conserving water more frequently than non-well owners. Well ownership is positively associated with ranking water security as a major challenge facing Kansas, which suggests that securing water for the future is a greater priority for well owners than it is for non-well owning Kansans. This validates my prediction that well owners would express more concern about the state's water supplies, and it is a marker of groundwater citizenship. Political scientists label groups of people who consider certain issues important as "issue publics" (Kim 2007); these groups are drawn to issues they consider essential. This finding suggests that well owners are an example of issue publics, a group of citizens that are uniquely defined by specific priorities. As members of the groundwater citizenry, well owners express more concerns about the future of water supplies in Kansas than their non-well owning counterparts, which also indicates that water supply infrastructure is associated with different political priorities. As my results show, water management policies have not influenced the voting behavior of a majority of Kansans in local or state elections, but well ownership is apparently linked to water-informed voting behaviors. Therefore, researchers interested in elections need to control for access to public utilities in order to assess the influence of municipally-provided benefits on voting patterns. Examining well ownership and the limits of public water systems challenge the previous notions that citizenship induces participation.

Table 5g. Welch correction of the one-way Analysis of Variance of non-well owners with well owners on ranking water security as a challenges facing Kansas, having votes in local or state elections being influenced by water policies, the frequency of deliberately saving water around the house, motivations for water conservation regarding concerns for supply's ability to keeping up with demand, saving money, extending supply, all of those motivations, and not conserving water

	Source	***SS***	***MS***	***df***	**F**	***p***
Ranking Water Security as a Challenge	Between	9.632	9.632	1	21.152	.000
	Within	255.315	.463	550.425		
	Total	264.948		551.425		
Voting on Water-Related Policies[1]	Between	2.302	2.302	1	6.320	.012
	Within	201.770	.364	553.799		
	Total	204.072		554.799		
Frequency of Deliberate Conservation	Between	24.248	24.248	1	10.620	.001
	Within	1296.355	2.294	563.333		
	Total	1320.603		564.333		
Motivations for Conservation						
Keeping Up with Demand[1]	Between	.004	.004	1	.051	.822
	Within	62.524	.074	843		
	Total	62.528		844		
Saving Money	Between	9.271	9.271	1	46.510	.000
	Within	171.872	.204	835.722		
	Total	181.143		836.722		
Extend Supply	Between	3.136	3.136	1	18.154	.000
	Within	142.480	.169	770.691		
	Total	145.617		771.691		
All of These	Between	3.913	3.913	1	16.131	.000
	Within	203.692	.242	825.291		
	Total	207.605		826.291		
Do Not Conserve	Between	.182	.182	1	2.086	.149
	Within	74.665	.089	842.511		
	Total	74.847		843.511		

[1] The values for these items did not violate Levene homogeneity of variances test and the original ANOVA values are reported

SS Sum of Squares
MS Mean Square
df Degrees of freedom in the numerator and denominator of the test
F The F test statistic for the equal variance test
p Probability that the means are equal across groups in reality

Note: The items without the notation represent the F statistic calculated using the Welch robust test for equality of means.

Interestingly, well owners have a significantly lower mean than non-well owners who espouse financial reasons for saving water in this study, which suggests that individuals with wells do not save water primarily to keep their utility costs down—they have other motivating factors. Well owners are significantly more likely to conserve water for the purpose of extending their supply than non-well owners, implying that they have a sense of stewardship and an awareness of their well's ability to remain reliable. Well owners also took an "all of the above" approach for their motivations to conserve water, which indicates that they prioritize conservation because they want to ensure that their water supply keeps up with their demand, it is a cost-savings technique, and it extends their supply. At any rate, these findings reveal an important difference among well owners: conservation is not just a cost-savings mechanism; it is a means for resource stewardship, a way to safeguard and manage their local supply. ANOVA results indicate that non-well owners convey less interest in extending their supply or selecting all of those possible options than well owners, but there is no difference between the means of well owners' and non-well owners' responses for conserving water for the sake of their supply's ability to keep up with their demand or not conserving water (see Tables 5f and 5g). Overall, I contend that these differences imply that well owners retain a form of citizenship linked to environmental stewardship: well owners have significant differences compared to non-well owners when it comes to prioritizing water security, voting on water-related policies, frequently conserving water and expressing environmental motivations for conservation compared to non-well owners.

Kansans express striking differences about their awareness of water-related topics, and many of these differences can be drawn along the lines of well ownership. Nearly four-tenths (38.0 percent) of non-well owning Kansans are unfamiliar of the High Plains aquifer, Groundwater Management Districts, the Kansas Water Office, the Vision for the Future of Water, the Kansas Aqueduct, xeriscaping, or greywater (see Table 5h). Well owners appear far more familiar with these subjects, as only 13.1 percent admit to not hearing of them. Nearly one-third (35.1 percent) of non-well owners have heard of the High Plains aquifer, in contrast to two-thirds (66.3 percent) of well owners. While slightly less than one-quarter (22.2 percent) of non-well owners have heard of Groundwater Management Districts, over 60 percent of well owners have. Well owners also appear to have more familiarity with the Kansas Water Office, as half of well owners (50.2 percent) have heard of the agency compared to 28.7 percent of non-well owners. Only 16 percent of Kansans are familiar with Governor Brownback's Vision for the Future of Water in Kansas, but controlling for household water supplies reveals that just 11.2 percent of non-well owners and 21.3 percent of well owners have heard of the Vision. Half of well owners in my study (50.2 percent) are familiar with the Kansas Aqueduct, as opposed to a third (32.4 percent) of non-well owners. Just 11.9 percent of non-well owners have heard of xeriscaping, compared to 26.0 percent of well owners. Both groups appear more familiar with greywater systems; 23.5 percent of non-well owners and 46.8 percent of well owners have heard of the term.

I previously established that irrigation is the largest user of groundwater in Kansas. As recommended by Rex Buchanan, the director of KGS, I gauged my respondents' awareness of how water supplies are being utilized in the state by asking if they thought private households, industry, irrigation, cities, used the most water in the state (I also gave them the option to select "Not sure"). Over four-tenths (41.7 percent) of well owning individuals could correctly identify irrigation as the state's primary water user, while just a quarter (27.9 percent) of non-well owners could. Researchers must understand Kansans' (specifically well owners) attentiveness to current events and proposals related to the state's water supply. Such details have not been sufficiently analyzed given the reports of rapid aquifer depletion in the state.

Table 5h. Frequencies for Respondents Organized by Well Ownership and Awareness Variables (N = 851)

	Non-well Owners	**Well Owners**	**Total**
High Plains Aquifer	156 (34.9%)	269 (66.6%)	425 (49.9%)
GMDs	99 (22.1%)	246 (60.9%)	345 (40.5%)
Kansas Water Office	130 (29.1%)	203 (50.2%)	333 (39.1%)
Long-Term Vision	50 (11.2%)	86 (21.3%)	136 (16.0%)
Kansas Aqueduct	145 (32.4%)	203 (50.2%)	348 (40.9%)
Xeriscaping	53 (11.9%)	105 (26.0%)	158 (18.6%)
Greywater	105 (23.5%)	189 (46.8%)	294 (34.5%)
None of These	170 (38.0%)	53 (13.1%)	259 (30.4%)
Irrigation Uses Most	83 (27.9%)	113 (41.7%)	196 (34.4%)

Note: Asking respondents to select which industry they thought used the most water in Kansas was a survey item that only appeared in two-thirds of the surveys (it was a planned missing data question). The number of respondents who submitted answers to that question is 569.

Table 5i. T-Test of non-well owners with well owners on awareness scale measuring familiarity with the High Plains aquifer, Groundwater Management Districts, the Kansas Water Office, the Vision for the Future of Water Supply in Kansas, the Kansas aqueduct, xeriscaping, and greywater systems

	Owns Well	**Number**	**Mean**	**Std. Dev.**	**SE Mean**
Awareness	Non-Well Owner	447	1.651	1.851	.088
	Well Owner	404	3.220	2.008	.100
	Mean Difference	**SE Difference**	**95% Lower CI Interval**	**95% Upper CI Interval**	
Awareness	-1.569*	.132	-1.829	-1.310	

* $p < .05$ ** $p < .01$ *** $p < .001$

I combined the High Plains aquifer, GMDs, KWO, Long-Term Vision, the Kansas Aqueduct, xeriscaping, and greywater awareness items to create a continuous scale of awareness levels with scores ranging from 0-7. The number of each respondent is familiar with produced their awareness score, and I conducted a T-test to analyze how the group means are different on the awareness scale.[2] T-test results reveal that well owners express more familiarity with each of those topics than non-well owners, and these differences are significant; well owners' mean score is 3.22 on the 0-7 scale, which is significantly higher than the non-well owners' mean score of 1.65 (see Table 5i). When it comes to water-themed subjects in Kansas, private infrastructure is connected to heightened levels of water supply awareness.

QUALITATIVE EVIDENCE FOR GROUNDWATER CITIZENSHIP

The first portion of this chapter summarized important quantitative findings, although I also designed the survey with openings for the participants to provide qualitative feedback that further distinguish well owners from non-well owners. The last item on the survey thanked the respondents for their time and invited them to leave their email address, if they wanted to be informed about the results of the study, along with comments or questions about the survey. Roughly 27 percent of my respondents (236 out of 864) provided comments in optional open-ended questions on the survey, and 163 offered additional comments that are a crucial supply of

[2] I could not include the item measuring if respondents could correctly identify irrigation as the largest water user in Kansas because the survey item only appeared in two-thirds of the surveys (it was a planned missing data question).

qualitative data which illuminates how well owners differ from non-well owners. Before discussing those comments directly, I must first unpack two clear differences in the responses between the non-well owners and the well owners to this final, optional question. First, the item completion rate for this question was much lower among the respondents who were part of the Qualtrics-collected panel, 89 percent of whom are non-well owners. Just over 11 percent of respondents in the Qualtrics sample left feedback, compared to 28 percent of respondents whose addresses were in the KGS database of WWC5s. After taking a 40-item survey (at minimum) that took a majority of well-owning respondents at least 10 minutes, having the energy to leave substantive comments for the researcher (or send emails) implies that over a quarter of the participants still found the topic of water in Kansas important enough to continue discussing it.

The second difference between these two groups was the type of responses they left in the final question. For the most part, the relatively small number of respondents in the Qualtrics panel who left comments were uniformly positive and encouraging; they thanked me for asking them to participate in the study and seemed supportive of the project overall, but relatively few left email addresses or expressed desire to be informed about the results of the study. The well owners not only replied to this option with greater frequency, but they also left more substantial and diverse comments. Many left email addresses and expressed concern about specific water availability issues, and the precision of their comments revealed a clear understanding of the water shortages in Kansas, suggesting that they are better-informed than the non-well owners. A handful of respondents from the KGS-retrieved sample referred to Governor Brownback with intense negativity and opposition to his management of water in the state:

> Brownback is an idiot. There is absolutely no reason to follow his agenda on water issues.
>
> I am aware of a plan by Gov. Brownback to run a water pipeline from the Missouri River to Western Kansas. I very much appose [sic] this.

Irrigation practices were discussed in several of my well-owning respondents' open-ended answers, who have blamed irrigators for the state's groundwater losses in remarkably informed comments:

> We will never be able to get our water table back, if every time it rains a few drops, the irrigators turn on their irrigation systems and drain the water table again… If we don't start monitoring the irrigation wells usage better, and make them stop using such amounts of water, we may never be able to get our water

> tables back… they need to be educated better and realize what they could possibly be doing to our future family members.
>
> In Southwest Kansas irrigators are pumping billions of gallons of water out of the aquifer that are not being replaced and Kansas politicians do not care. Household consumption is not the problem. For the last 30 years the water table has been dropping and is continuing to drop. Crop production and money is the problem.
>
> …irrigators should not be allowed to keep using water 2-3-4 years ahead…. Quit planting so much corn which takes so much more water than other crops.
>
> All sprinkle irrigation should be changed to burried [sic] drip.
>
> We need new water policies not run by farmers. The river in Southwest Kansas is an ecological mess. The time for fixing the problem was in the seventies and can only be fixed by someone without an economic interest in the result. The farmers are ruining the this [sic] part of the state with their greed.
>
> I believe [Kansans] should have a western Kansas future as growing only crops [that] do not require irrigation from rivers or aquafers [sic]. I do not support irrigation cropping at all.

Non-well owners did not leave comments with this level of specificity. Well owners clearly have a high level of knowledge about water supplies compared to average citizens, and their concerns about water availability deserve special attention.

Well Stewardship and Environmental Awareness

Contextualizing resource cognizance within specific groundwater formations and infrastructural systems can improve how researchers and policymakers understand natural resource management. The infrastructures and communities drawing from aquifers must be thoroughly examined in order for Kansans to develop coordinated drought adaptation policies, and educating the public will be increasingly important when researching the future of groundwater across the state. This has important implications for the resilience of rural communities, since groundwater is the drinking water source for 90 percent of the rural population in the United States (Lemley and Wagenet 1993). Research suggests that environmental consciousness is sharpened as individuals become exposed to hazards. Due to their active participation with their water supplies, it is reasonable to expect heightened environmental cognizance and conservation routines among well owners. One's knowledge of certain environmental issues and awareness of personal contributions to environmental degradation influences pro-environmental behavior (Oskamp et al. 1991; Fransson and Garling 1999; Barr 2006; Gilg and Barr 2006; Barr and Gilg 2007), and closeness to environmental threats can lead to more environmentally-conscious behaviors (Baldassare and Katz 1992; De Young 1996; Tanner 1999). Of course, private well owners are the most susceptible to groundwater contamination and reduced well yields, and they are disproportionately burdened by groundwater loss compared to those with municipally-provided water.

Researchers tracing the emerging discussions and concerns among well owners have stressed that the regional impacts of climate change (specifically with extreme events like floods

Table 5j. Well owners' opinions on their well's vulnerability, frequency of chemical testing, and frequency of water depth checks

	Frequency
Do you feel that your well(s) is vulnerable to decreased water yields or contamination? (N = 378)	
My well(s) is vulnerable to decreased water yields	112 (29.6%)
My well(s) is vulnerable to contamination risks	17 (4.5%)
My well(s) is vulnerable to both decreased water yields and contamination	76 (20.1%)
My well(s) is secure and reliable	173 (45.8%)
Has your well(s) been tested for chemicals (e.g., nitrates, iron, lead), bacteria, or pesticides? (N = 257)	
Yes, in the past year	28 (10.9%)
Yes, 1 – 2 years ago	37 (14.4%)
Yes, 2 – 5 years ago	42 (16.3%)
Yes, more than 5 years ago	55 (21.4%)
No, it has not been checked	76 (29.6%)
Not sure	19 (7.4%)
Has the water depth of your well(s) been checked, either by you or someone else? (N = 251)	
Yes, in the past year	67 (26.7%)
Yes, 1 – 2 years ago	42 (16.7%)
Yes, 2 – 5 years ago	44 (17.5%)
Yes, more than 5 years ago	33 (13.1%)
No, it has not been checked	47 (18.7%)
Not sure	18 (7.2%)

Note: The survey items measuring frequency of water depth and chemical testing were designed as planned by missing items, so they were not offered to all well-owning respondents.

and droughts), contaminants in groundwater supplies, hydraulic fracturing, and aging septic systems are all concerns of well owners (Fox et al. 2016). My survey captured a variety of well owners' views regarding their well water's safety and reliability (see Table 5j). While 45 percent of my well-owning respondents felt their well yields were secure, 30 percent said their well was vulnerable to decreased yields, only 4 percent of well owners felt susceptible to contamination, and the remaining 20 percent stated that both contamination and decreased yields are potential problems. The performances associated with well ownership (see Table 5j) suggest that most Kansas well owners are mildly concerned about groundwater contamination; 65 percent of well owning-participants test their water for chemicals, and 25 percent of respondents checked their wells annually or every 1-2 years (the recommended frequency by health professionals). Well depth seems to be a larger concern than well contamination, because 43 percent of well owners check their depth to the water table every 1-2 years; 19 percent say that they never check the depth of their well. Over one quarter of well owners never test their water for chemicals, but many well owners check their well's depth with more frequency—this is perhaps due to the relatively larger concern about decreased yields than contamination. If well yields are the primary concern of well owners, it stands to reason they would check their water depth more frequently than water quality.

It might seem odd that the most common frequency of measuring well depth is "in the past year," while the most common answer for frequency of chemical testing is "never." This finding could be connected to well owners' knowledge of their own groundwater source. Compared to other groundwater sources in the nation, the High Plains aquifer (and the groundwater in Kansas in general) is reasonably salubrious. If well owners are comfortable and familiar with their relatively clean groundwater, they might not feel an obligation to invest in testing water that they already "know" to be clean. Seven percent of the well owners in this study admit that they are not sure how frequently they test their well's depth or contamination and previous research shows that regular checks for well depth and contamination range from 18 to 77 percent (Murti et al. 2016). Overall, the routines associated with well maintenance can be very inconsistent, but that might not be a marker of lax well ownership—it could signify the confidence that well owners have in their supply. Rural citizens who draw from wells can be exposed to contaminated groundwater, yet one study of well owners noted that half the participants never tested their drinking water for contaminants (Schwartz et al. 1998). Interviews with well owners indicate that if they did not regularly test their wells for contaminants, it was because testing was inconvenient or the well owner did not notice any problems with their water (Imgrund et al. 2011). These health concerns reveal a need to increase awareness among rural households with private supplies, especially since well owners are responsible for testing and monitoring the quality of those water supplies and maintaining septic systems and the SDWA does not protect self-supplied sources.

Well owners express more familiarity with groundwater supplies across the state, but previous research on well owners also implies that they have a number of blind spots. One study of well owners analyzed their familiarity with water quality authorities and health departments, which revealed insufficient maintenance practices and knowledge about wells (Schwartz et al. 1998). Health researchers investigating well owners have consistently prioritized increasing awareness of well maintenance responsibilities among private well owners, even if those well-owning households tend to be satisfied with their well water. Water quality satisfaction is mostly influenced by satisfaction with flavor and perceptions of chemicals like lead, chlorine, or hardness (Doria, Piddgeon, and Hunter 2009). When well owners cannot perceive any unlikeable qualities in their well water, they typically forego testing for contaminants.

Such neglect has been a concern of many water experts, and groundwater safety researchers are struggling to make inroads in their attempt to get well users to routinize testing their wells (Fox 2016). Well water does not have to be tested more frequently than once a year, and testing might be easily forgotten because it is such an infrequent practice and therefore challenging to routinize. Diseases associated with arsenic in well water are a concern for health researchers studying well users—although many studies of well owners in the US are confined to individual states. In New Hampshire, for instance, 82 percent of well owners “always” or “frequently” drink their tap water, but 20 percent of well owners in the state have not spoken with anyone about the safety of their water (Susca and Rigrod 2015). Several hundred cases of arsenic-related diseases, including lung, bladder, and skin cancer, could have been avoided with proper well water testing and treatment in the state (ibid.). While well owners in this study are clearly more informed about water-related issues than non-well owners, the stewardship of wells and groundwater supplies is not a universally expressed by all well owners. Well owners who do not regularly check their well depth or test for contaminants are skipping pro-environmental behaviors that are indicative of groundwater stewardship, and this pattern reveals how some well owners could improve their environmental practices.

My notion of groundwater citizenship implies that access to natural resources plays an important role in how the boundaries of citizenship are defined. Other scholars have made similar arguments in the literature probing the politics of natural resources. Adunbi's (2015) work on Nigerian oil wealth discusses how natural resources are tied to ancestral promises of wealth; oil extraction redefines citizenship and birthrights for Nigerians who plan to give future generations' claims to ownership of the oil. Many Nigerians' identities are connected by a communal ownership of nature, a phrase Adunbi calls "oil consciousness"—an appreciation for the wealth-generating capacity of fossil fuels (ibid., p. 16). Oil's economic significance has produced solidarity within oil-rich enclaves that privileges the ancestral promise of oil wealth. Adunbi also describes "oil citizens" as a specific subpopulation in a region that produces wealth from oil extractions, and it implies that some individuals claim an ancestral connection to the oil wealth. Simply put, the state's capacity to achieve economic growth depends on successfully finding markets for its natural resources, which in turn can generate economic advantages for some citizens.

Both oil and groundwater extractions create enormous, transformative levels of wealth for the state and the communities above those supplies, but do Kansans feel that they have an ancestral promise to groundwater? The evidence provided by my study offers competing answers. On one hand, roughly half the respondents believe that securing water for the future is one of the most important challenges facing the state. One respondent evoked an idea of personal and communal responsibility to ensure that future Kansans have access to groundwater:

> [I] believe in recycling, conserving water and being a good steward of our earth for future generations…[I] do see wasteful water usage on lawns and believe that others could do better conserving water.

Interestingly, they continued for several more sentences about regulations, protecting the economy, and concern about job growth:

> [O]ur economy is severely struggling right now and we do not need to add any more burden to the American people with higher taxes, more government and the liberal agenda!

Another respondent wrote in that he felt pessimistic about attempts to protect water supplies:

> …future wars will probably be over water....and Kansas at some point will be a desert. Way past the time to start planning for future generations. I was on the Kansas Water Board in the 1980's… gave it up due to lack of interest about anyone taking the issue seriously.

Finally, one respondent essentially espoused *opposition* to the idea of a generational promise. He suggested that groundwater is for the people who have inherited or paid for the water rights, that irrigation is a temporary privilege, and that future generations will simply have to resort to rainfed agriculture after the aquifers can no longer support irrigation:

> Our economy is dependent on the water being pumped be it crops, livestock ethanol production or industry. Take away our water and you will destroy our community. It is better to let the supply decline gradually than to shut it off. I have paid top dollar for irrigated farm ground. I paid that amount based on the water availability. Take that away after the fact and you will have one hell of a fight on your hands. I view the water no different than oil. It is a natural resource that is being mined. Does anyone try to limit the amount of oil that is being pumped? …The state of Kansas is the one who encouraged the development, and over appropriated. When the water is gone we will move to areas that have water[,] and this community will return to dryland farming and pasture ground as it was meant to be. …Please do not think that I am foolish and wasteful with our water supply… I do however use it as a tool to make a living.

This respondent believes that oil and groundwater are each finite natural resources that should be utilized to benefit the present, rather than conserved for future usage. Despite his perspective that oil and groundwater are similar, oil citizenship and groundwater citizenship, as Adunbi and I have respectively defined them, differ based on their approach to conservation. While both ideas discuss livelihoods within resource-rich areas, oil citizenship promotes access to the *exchange* value of oil (oil wealth) in the future, while groundwater citizenship pivots around the idea of the aquifer stewardship to extend its *use* value into the future. At any rate, interviews with farmers and water experts in western Kansas reveal a looming pessimism among irrigators who believe the High Plains aquifer will be pumped dry: "It's kind of a ticking time bomb, and we kind of know it" (Pew Stateline 2013). These sentiments fit squarely within the planned depletion formulas introduced in Chapter 3, which frame aquifers as non-renewable Common Pool Resources. If an individual's resources are lost, or threatened with loss, it negatively affects their lifestyle and their sense of self; therefore, the identities of well owners, who have a unique relationship to water via their private supply, are threatened by inadequate rainfall.

Farmers produce food not just as an occupation but as a way of life and a form of self-expression (Stock and Forney 2014). Irrigation is a major component of farming operations for many farmers in southwest Kansas, which has a long history of water supply shortages and groundwater-fueled competition. The previous farmer’s comment implies that irrigation is a given, and that transitioning into a dryland operation would be less lucrative or even unreasonable given his present access to groundwater. Irrigation is likely part of how he defines farming, and restricting his water allocation would fundamentally change his farming techniques to a degree that he could not identify with the practice or lifestyle any longer. Furthermore, if he is committed to productivist mentalities, he may feel a moral obligation to continue relying on groundwater in order to “feed the world,” a responsibility commonly evoked by farmers (EPSCoR 2013a).

I have not found sufficient evidence that farmers in Kansas unanimously believe they have an obligation to fulfil an ancestral promise. In fact, some groundwater citizens are currently utilizing their resources to fuel their local growth machines, but these economies will have to be completely redesigned in the future if they use groundwater with no intent to save it. These findings suggest that natural resource extraction is connected to neoliberalism and the prioritization of economic growth, which some irrigators see as more important than giving future farmers the chance to irrigate. However, most of my irrigating respondents reported that they do not exceed their water allocations, and one even noted that there are harsh penalties for those that exceed their water right, which includes fines and jail time.

The state’s current political climate takes economic growth for granted, which was discussed during my application of growth machine theory. As Weber anticipated, economic expansion and large-scale production would drive scientists and planners to rethink how the modern economy functions, or else industrialized intensity would not stop “until the last ton of fossil fuel has burnt to ashes” (Weber [1920] 2011:177). To illustrate a similar point, this concern can be applied to aquifers in Kansas. If irrigators across the state do not feel an ethic to conserve water or redesign their operations for the future, if they feel that dryland farming is an inevitable challenge that future farmers will have to accept, and if they feel that growth in the present is more important than water accessibility in the future, then the intensive groundwater economy would inevitably screech to a halt, *once the last irrigation well ran dry*.

I have defined well owners as unique citizens, but do they see themselves as such? I did not ask that question in my survey, and therefore do not want to speculate on the ties within well-owning social networks in Kansas, but I will make the following comments. The traditional way of thinking about well ownership is generally guided by an ethic of private responsibility—that is to say, protecting private wells is the responsibility of the well owners and the collaborations of well owners. In the aftermath of the 2010-15 drought, private well owners started to support broader collaborations and have received more information about keeping their wells safe with the help of the EPA and CDC (Fox et al. 2016). The EPA and the office of pesticides have computational tools for measuring toxicity and contamination exposure, so well owners are opening the boundaries of their community to epidemiologists and groundwater researchers. The willingness and passion of many of my respondents suggest that sociologists could also make inroads with these rural Kansans.

However, well owners still might hold on to their status as water supply outsiders. Murti and colleagues (2016) show that well owners have mixed views about using public water supplies: some are open to transitioning to municipal water, while others are uninterested because they feel their well water is superior to chemically-treated city water, or the cost to connect to a water line would be too high if they live far from a public water source. There is also an "inside out" approach to problems (Fox 2016), meaning that the well owning population sees itself as a unique community and they are therefore the best-suited individuals to deal with their problems of groundwater contaminants and decline. It is possible that they see themselves as a distinct community, while policymakers and scientists are likely seen as outsiders.

Well owners interact with each other as unique citizen-neighbors in distinct ways: newer well owners ask long-time well owners for advice on how to address challenges with their well water, knowledge that the experienced well owners feel very confident in sharing (Murti et al. 2016). They also appreciate public notifications, reminders, and updates about testing for contaminants and measuring their water levels. Evidence suggests that a majority of well owners do not consistently (or ever) test their water and that many do not know how to test, when to test, and where to send their water samples (CDC 2010; Flanagan et al. 2015; Maier et al. 2014; Chappells 2015). Nevertheless, the research implies that they express interest in testing and improving their well stewardship: "private well owners do not test their water supply regularly, and they want more information and notifications about well water testing" (Murti et al.

2016:430). When it comes to their basic stewardship routines associated with well ownership, perhaps it is accurate to conceive well owners as a *community of liminal practices*. Investigations of the impacts of drought on private well owners have only just begun, which were first conducted during the drought year of 2012 (ibid.). Despite the epidemiological attention given to this subpopulation, my research shows that there is still much to learn about groups with alternative, private supplies.

Drawing from Luhmann's *Ecological Communication* (1989), I suggest that well owners have unique reactions to droughts and groundwater depletion. Luhmann holds that social groups only discuss environmental change when it has a social effect. Theoretically, once communities connect their own practices to undesired environmental changes (for instance, if well users recognize that their consumption of groundwater is leading to declining well yields) they begin to discuss and propose changes in response to environmental problems. To secure their Common Pool Resources, communities must establish rules preventing free-rider behavior. In the case of Kansas well owners, they could communicate the importance of new conservation practices though a function of what Luhmann calls *resonance*. It is through resonance, the reactionary perspective, that unique discussions about groundwater management can take place and spark specific reactions to groundwater depletion. Previous work on water quality has underscored that community-based environmental protections are only enacted after discovering that actions have environmental consequences (Flora et al. 2000). Again, such transitions require some degree of community-wide resonance. Communicating about a place can engender feelings of closeness and identity with that location (Stamm 1985; Hoffman and Eveland 2010). These discourses of communities of practice are particularly relevant for well owners, who use resonance to identify with their local water table. Future qualitative research projects could address this idea more directly.

Communities must collaborate in order to secure their water supplies (Cernea 1991), and this can be observed within the networks working to reduce their respective groundwater extractions. For instance, Local Enhanced Management Areas (LEMAs) in western Kansas are comprised of irrigators who recognized that pumping reductions will put water table extractions closer to recharge rates. Keeping the withdrawals to a level that will not permanently damage the aquifer will allow well users to access groundwater in the future. Therefore, well owners can be seen as more than just a community of practice—they can be framed as a community of *attitude*, specifically, one of resource preservation and groundwater stewardship or maintaining a responsibility of being politically literate. They could share the mentality that sustaining aquifers is their responsibility, and resonance may instill them with distinct attitudes regarding drought adaptation. The social networks that link local actors to GMDs can influence the urgency of drought response and the perceived importance of resilience in the face of groundwater depletion. For a larger geopolitical discussion about the discourse of water's political and sociological relevance, consult the hydropolitics portion of the appendix.

The findings of this chapter provide evidence of groundwater citizenship, but how large of a role does it play in the lives of well owners, and is it consistently expressed across well owners in different parts of the state, or among owners of different types of wells? Researchers have closely analyzed the adoption of pro-environmental behaviors with demographic variables (e.g., age, class, political affiliation, urban and rural residence), and I suspect that specific water conservation practices are pro-environmental behaviors that are closely associated with water supply infrastructure. Studies of water consumption have not found the variable that best explains the patterns of variation of water-related attitudes, but after discovering the heightened awareness of water supplies among well owners, along with their willingness to conserve water in the hopes of prolonging their supply, it would be reasonable to hypothesize that well ownership would affect watering routines more than other demographic variables that have previously been analyzed in pro-environmental behavior research. I test this hypothesis in the next chapter by examining the links between demographic characteristics and water conservation efforts. Framing well owners as a distinct social group, specifically, as a community of practice, attitudes, and awareness, would contribute to environmental sociology by adding to theories of sustainable practices, public opinion, and citizenship.

CHAPTER SUMMARY

> My findings show that well owners are more aware of the state's water supplies than the general population, they express environmental motivations to conserve water, they are more likely to invest in water-saving appliances, they are more likely to rank water security as a serious challenge, they are more likely to vote on water-related policies, and they deliberately conserve water more frequently than non-well owners. In addition to generating a rich quantitative dataset, my survey's open-ended questions provided qualitative information that illustrated important differences between well owners and non-well owners. This evidence suggests that well owners are a unique population of citizens in Kansas and that water

supply infrastructure contours the boundaries of environmental citizenship. Knowing which populations prioritize water conservation, and investigating if well owners are in fact unique groundwater stewards, will be of particular importance when researching the accessibility of groundwater in arid parts of the state. I contribute to the sociology of water and sustainable practices by providing a sociological assessment of groundwater usage. Behaviors associated with well ownership need to be precisely understood in order for Kansans to develop stronger drought adaptation policies, and protecting aquifers requires a sociological examination of those reliant on groundwater.

Chapter VI: Examining Well Ownership and Moderation via Confirmatory Factor Analyses and Multi-Group Structural Equation Modeling

> The previous chapter outlined how water supplies contour the boundaries of citizenship and pro-environmental behaviors and described general differences between well owners and non-well owners in Kansas. This chapter continues that line of inquiry by investigating well ownership as a demographic variable and as a moderator of the relationships between individuals' awareness of water supplies, their investments in water-saving appliances, and their reactions to droughts. To do this, I conduct a series of Confirmatory Factor Analyses (CFAs) in which demographic variables are correlated with the constructs representing Kansans' water literacy (or awareness of water-related topics), investment in indoor water-saving appliances, investment in outdoor water-saving appliances, decreasing indoor water usage during droughts, decreasing outdoor water usage during droughts, and increasing outdoor water usage during droughts. I then run multi-group structural equation models with respondents organized by well ownership, well owners who are without municipal water connections ("off the grid"), and those with city water, well owners who have domestic, lawn and garden, feedlot, and irrigation wells, and respondents who live above the Ogallala aquifer, the Great Bend Prairie and Equus Beds aquifers, and those who do not reside above the High Plains aquifer. Four findings emerge from the models. First, well ownership changes the associations surrounding water supply awareness, drought reactions, and investments in efficient watering appliances. While well ownership is significantly correlated to owning water conservation technologies, it is also associated with increased watering during droughts. Second, awareness levels are positively associated with the ownership of water-saving appliances, but are negatively associated with conservation behaviors during droughts. Third, well ownership combined with access to municipal water weakens the correlations between awareness and owning water-saving appliances and awareness and drought-time conservation routines. Fourth, the respondents overlying the Ogallala aquifer with higher levels of water literacy have a positive relationship with increasing their water usage during droughts. This suggests that they react to drought by using more, not less, water. That finding supports the Conservation of Resources theory, which holds that individuals conserve their resources during non-stressful times and use their resources during times of stress.

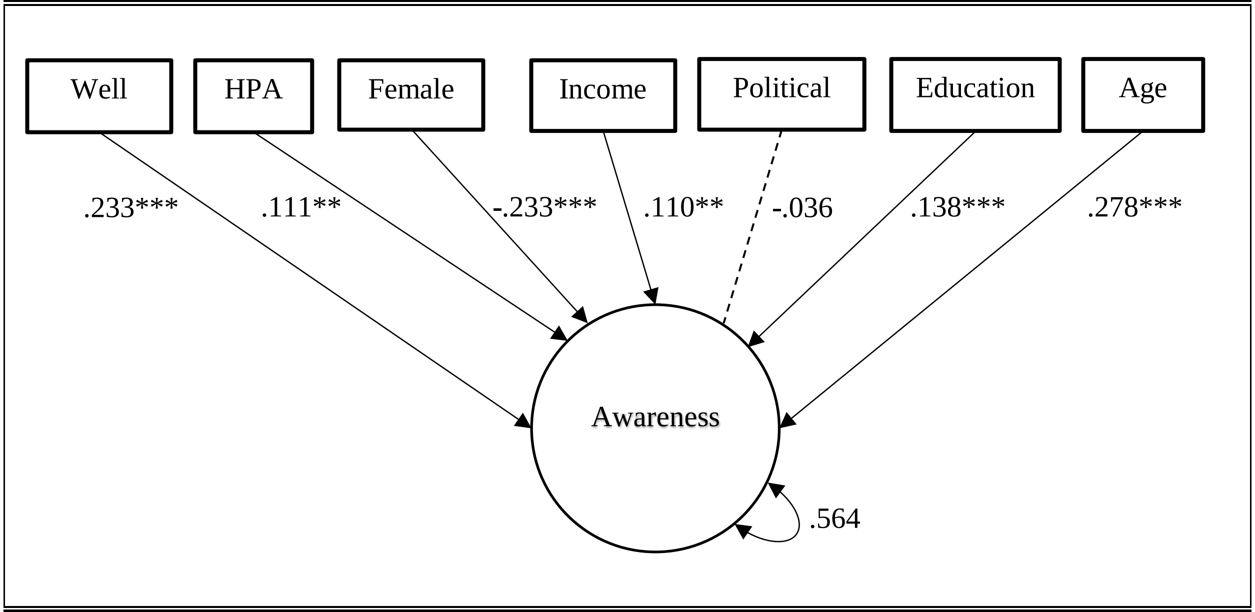
CONFIRMATORY FACTOR ANALYSES: WELL OWNERSHIP AS A DEMOGRAPHIC VARIABLE

As I described in Chapter 2 on the literature related to my study, researchers have closely analyzed the adoption of pro-environmental behaviors with demographic variables (e.g., age, class, political affiliation, urban and rural residence). I expect water conservation to be a pro-environmental behavior that is closely associated with water supply infrastructure, and other demographic variables' relationships with PEBs and water conservation will be moderated by well ownership. Previous work on rural families in the High Plains suggests that without a municipal water supply, families developed a sense of frugality “that lingered after the faucet replaced the water bucket” (Foth 2010a). Connections to public water infrastructures are a critical part of resource accessibility, and should therefore be associated with different standards of water usage. Sociologists have stated that “change to lifestyles requires similar changes to an individual’s volumes of resources, and to the infrastructural and material arrangements that constrain consumption” (Southerton et al. 2004:39-40). I hypothesize that wells represent a key component in water supply infrastructure that influence pro-environmental behaviors. In fact, I contend that well ownership and receiving municipally-provided water will have clear and significant associations with these constructs, making it a demographic variable that should be analyzed in future pro-environmental behavior research. Furthermore, I anticipate that the presence or absence of a well will moderate the relationship between water conservation and levels of water supply awareness.

In the first section, I use well ownership as an independent variable to predict several variables associated with water conservation efforts, PEBs, and water literacy. To illustrate the influence of well ownership on water supply awareness, I run a series of CFAs in which the well ownership variable is an independent variable along with traditional demographic variables to establish well ownership as an important predictor of latent constructs representing water literacy, using water-efficient technologies, and reacting to droughts. In these results, I will only discuss the regression coefficients between the dependent and independent variables; consult the CFA Measures Tables 6a through 6f in the appendix for the complete results of the factor loadings, residual variance parameters, and standard errors of the factor loadings. Furthermore, all of the results provided are standardized. I tried to let the exogenous predictors freely correlate in a CFA, but the model would not converge. To see how the exogenous predictors co-vary with each other (outside of a CFA) consult Covariance Table 6a in this chapter’s appendix. The significant correlations are represented by solid arrows in the figures, while non-statistically significant beta pathways are shown with a dashed line. Since my dataset has a low proportion of minority respondents (roughly 9.5 percent), I do not analyze the influence of race.

Figure 6a depicts how demographics, including well ownership, perform as independent variables with the latent construct representing water supply awareness. Out of all the predictors,

Figure 6a. CFA of awareness of water supplies regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 743)

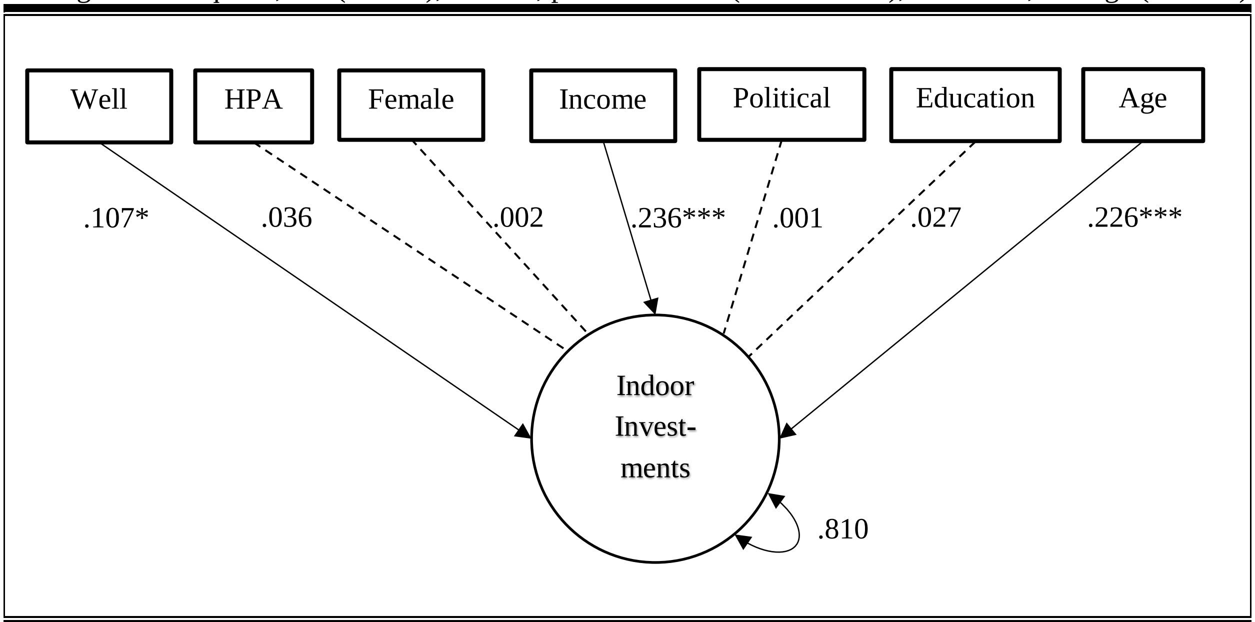


Model Fit: χ2 (23) = 74.491, p<.001; CFI = .873; RMSEA = .055
* $p < .05$ ** $p < .01$ *** $p < .001$
Note: Awareness of water supplies is measured by understanding that agriculture uses the most water in Kansas, along with the parceled indicators measuring familiarity with xeriscaping and greywater systems, familiarity with the High Plains aquifer and Groundwater Management Districts, and familiarity with the Kansas Water Office, the Governor's Long-Term Vision, and the Kansas Aqueduct. The parceled indicators are defined as continuous; the remaining indicator is categorical. When the constructs are endogenous, their standardized residual variances will not be equal to 1.0 even if identified with fixed factor identification.

age has the has the highest positive standardized correlation with awareness (b = .278, $p < .001$), followed by well ownership (b = .233, $p < .001$), education (b = .138, $p < .001$), residence above the High Plains aquifer (b = .111, $p < .01$), and income (b = .110, $p < .01$). Political views were not significantly correlated with water supply awareness.

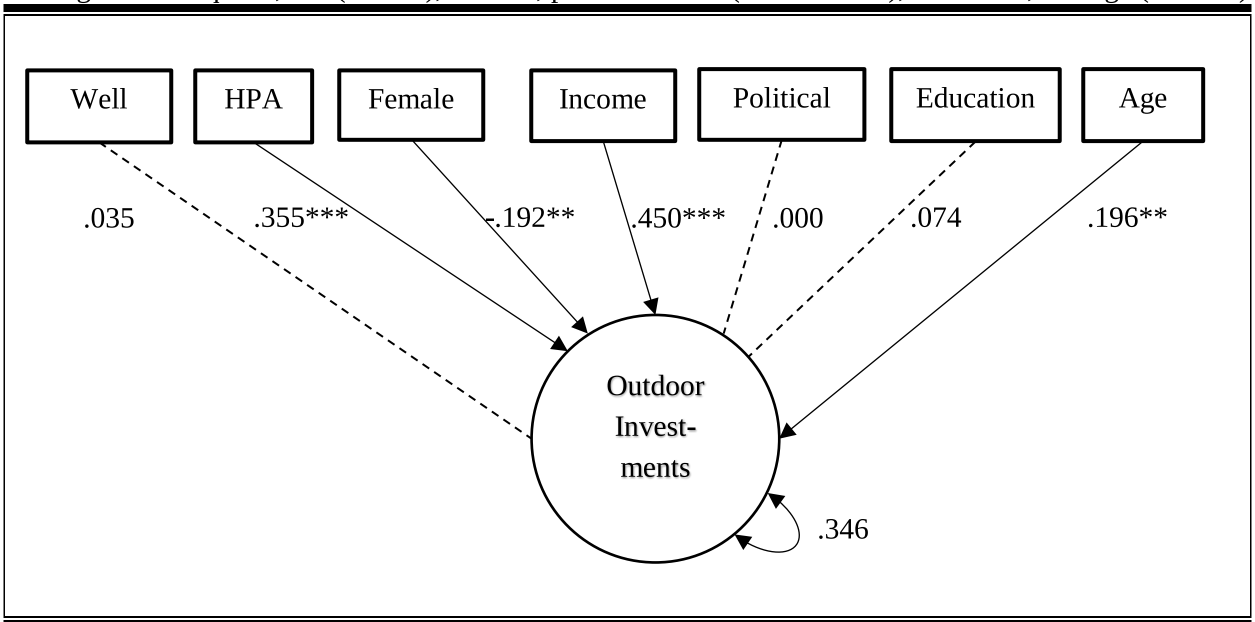
Figure 6b depicts how demographics and well ownership perform as independent variables with the latent construct representing ownership of indoor water-saving appliances. Out of all the predictors, income has the highest positive correlation with the latent construct (b = .236, $p < .001$), followed by age (b = .226, $p < .001$), and well ownership (b = .107, $p < .05$). Residence above the High Plains aquifer, sex, political views, and education did not have significant correlations with owning indoor water-saving appliances. Figure 6c shows how the

Figure 6b. CFA of owning indoor water-saving appliances regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 741)



Model Fit: χ2 (14) = 21.905, p=.081; CFI = .970; RMSEA = .028
* $p < .05$ ** $p < .01$ *** $p < .001$
Note: Investment in indoor water-saving appliances is measured by owning a low-flow showerhead, low-flow toilet, and water-efficient washing machine. These indicators are categorical.

Figure 6c. CFA of owning outdoor water-saving appliances regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 741)

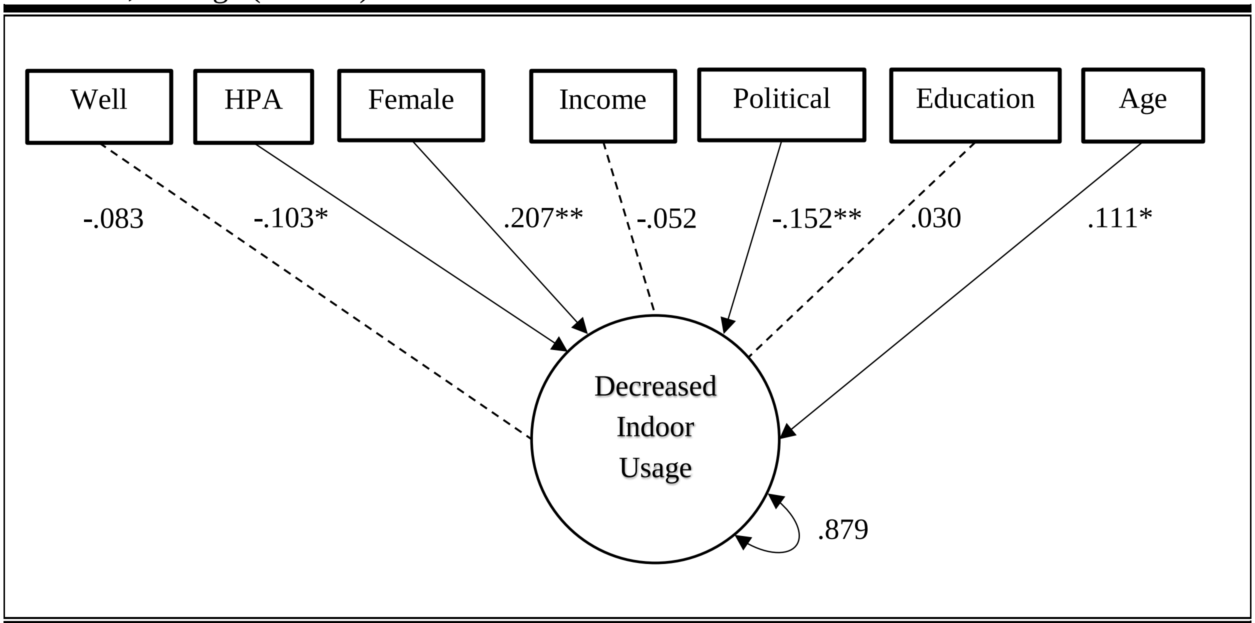


Model Fit: χ2 (7) = 16.739, p<.05; CFI = .919; RMSEA = .043
* $p < .05$ ** $p < .01$ *** $p < .001$
Note: Investment in outdoor water-saving appliances is measured by owning a timed sprinkler system and drip irrigation. These indicators are categorical.

independent variables predict the ownership of outdoor water-saving appliances; this CFA suggests a number of differences from the work on indoor investments. Well ownership, political views, and education are not significantly associated with the latent construct representing investments in outdoor water-saving appliances. Income has the highest positive correlation with the construct ($b = .450$, $p < .001$), followed by living above the High Plains aquifer ($b = .355$, $p < .001$) and age ($b = .196$, $p < .01$). Sex (female) has a negative association with owning outdoor water-saving devices ($b = -.192$, $p < .01$).

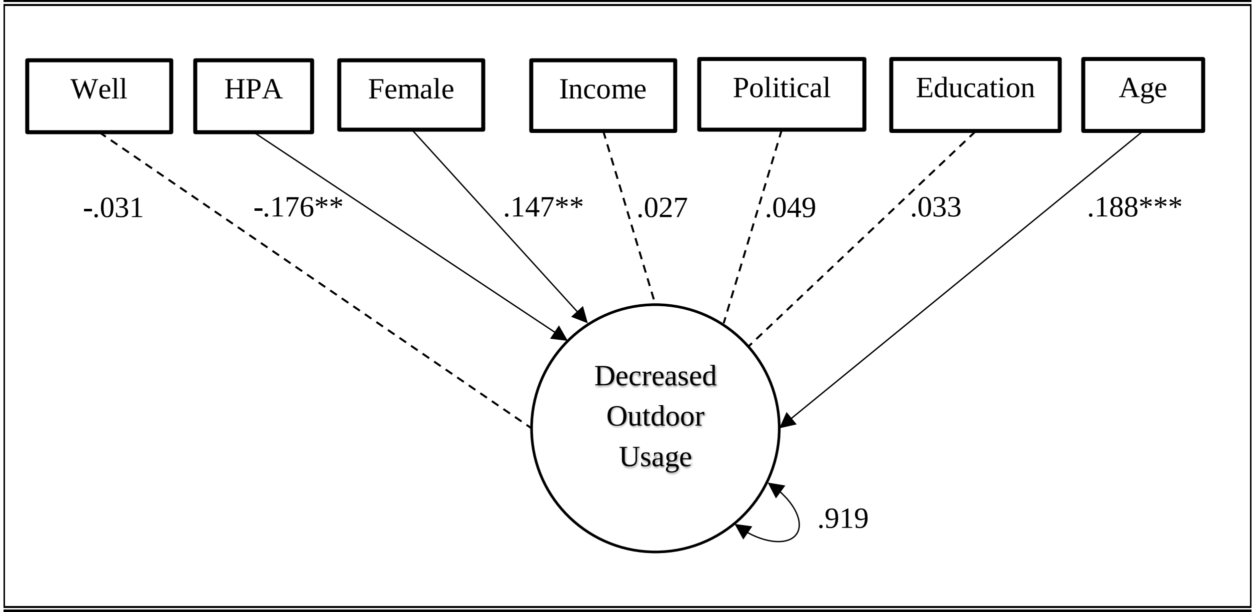
Figure 6d depicts how demographic variables and well ownership perform as predictors of the latent construct measuring reduced indoor watering practices during droughts. Out of all the predictors, sex (female) the highest positive correlation with the latent construct ($b = .207$, $p < .01$), followed by age ($b = .111$, $p < .05$). Political conservativism and residence above the High Plains aquifer have significant negative correlations with reducing indoor water consumption during droughts ($b = -.152$, $p < .01$; and $b = -.103$, $p < .05$, respectively). Well

Figure 6d. CFA of decreased indoor usage during droughts regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age ($n = 737$)



Model Fit: $\chi 2$ (7) = 16.594, p<.05; CFI = .991; RMSEA = .043
* $p < .05$ ** $p < .01$ *** $p < .001$
Note: Decreased indoor usage is measured by the indicators of taking shorter showers and flushing the toilet less during droughts. These indicators are categorical.

Figure 6e. CFA of decreased outdoor usage during droughts regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 737)

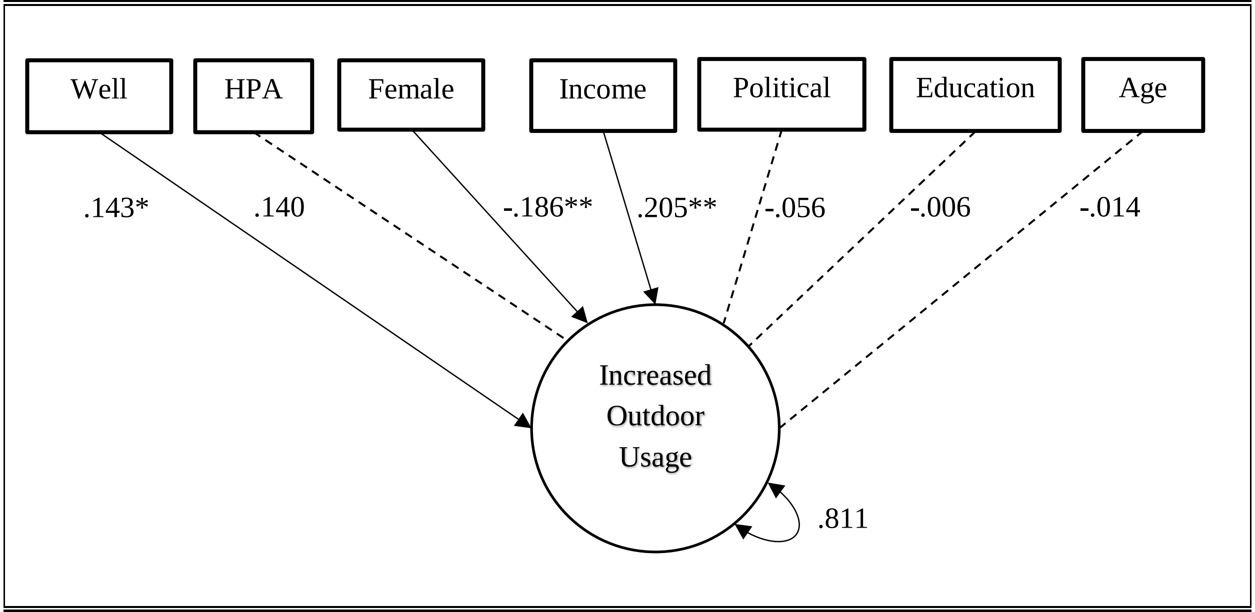


Model Fit: $\chi2$ (14) = 14.436, p=.418; CFI = .998; RMSEA = .006
* $p < .05$ ** $p < .01$ *** $p < .001$
Note: Decreased outdoor usage is measured by the indicators of stopping lawn watering, not watering the garden, orchard, trees, or other vegetation, and irrigating less during droughts. These indicators are categorical.

ownership, income, and education are not significantly correlated with decreased indoor drought-time watering. Figure 6e shows how the exogenous predictors correlate with the reduction of outdoor water usage during droughts, which has similarities to the previous CFA examining indoor drought reductions. Well ownership, income, political views, and education are not significantly associated with the construct gauging outdoor water-saving behaviors during droughts. Age has the highest positive correlation with the latent construct ($b = .188$, $p < .001$), followed by womanhood ($b = .147$, $p < .01$). Residence above the High Plains aquifer has a significant negative correlation with decreased outdoor water usage during droughts ($b = -.176$, $p < .01$).

Figure 6f depicts how the demographic variables and well ownership predict the latent construct measuring increased outdoor watering practices during droughts. Out of all the predictors, income and well ownership had the only significant positive correlation with the construct ($b = .205$, $p < .01$ and $b = .143$, $p < .05$, respectively), while sex (female) had the only

Figure 6f. CFA of increased outdoor usage during droughts regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 737)



Model Fit: χ2 (14) = 47.308, p<.001; CFI = .700; RMSEA = .057
* $p < .05$ ** $p < .01$ *** $p < .001$
Note: Increased outdoor usage is measured by the indicators of increasing the amount of lawn watering, increasing the amount of watering for garden, orchard, trees, or other vegetation, and irrigating more during droughts. These indicators are categorical.

significant negative correlation with increased water consumption during droughts (*b* = -.186, *p* < .01). Residence above the High Plains aquifer had similar regression coefficient and p-values to well ownership but is slightly out of the range of statistical significance (*b* = .140, *p* = .052). Political views, education, and age, were not significantly associated with the outcome construct. Furthermore, this particular confirmatory factor analysis has a CFI value beyond the acceptable range of model fit (CFI = .700); examining the CFI would suggest that I should not accept this statistical model as true in the population; although its RMSEA is within the range of acceptable model fit (RMSEA = .057). The associations between the predictors and the latent variable implies that this model fits the data by meeting the RMSEA thresholds (which usually can be stretched to under 0.08). Since the CFA passes the acceptable thresholds of RMSEA, I will consider this combination of indicators and demographic predictors to be an adequate representation of the overall latent variable measuring increased water consumption during droughts with independent variables.

Reflecting on these six CFA figures, I can conclude that well ownership is significantly correlated with awareness of water supplies and owning indoor water-saving appliances compared with other commonly-used demographics. Well ownership has a positive correlation with water-related knowledge, and well ownership is a strong predictor of higher water literacy compared to traditional demographic variables. Residence above the High Plains aquifer is also positively associated with awareness levels, and one of the strongest predictors of owning water-efficient devices used for outdoor watering. On the other hand, living in western Kansas also has a negative correlation with saving water indoors and outdoors during droughts.

As a predictor of these constructs, sex offers interesting correlations. Female respondents have negative associations with awareness of water supplies and owning outdoor water-saving appliances. However, compared to the other independent variables, womanhood has the highest positive predictive correlation with decreasing indoor water consumption during droughts, along with the only significant negative correlation with increased water consumption during droughts. This implies that women may be less familiar with water supplies or water-related topics around Kansas and are less likely to seek technological solutions to reduce their water consumption than men, but they shift their watering behaviors towards more parsimonious conduct during droughts. This result also suggests that PEB individualization is not gender-neutral and women are more likely to participate in drought-time water saving approaches than men, even though womanhood has a negative association with owning outdoor water-saving devices and awareness of water supplies. Furthermore, my previous framing of groundwater citizenship was gender blind, but this finding implies that groundwater citizenship is ostensibly gendered; it can still be expressed among those with lower levels of water supply awareness and investments in water-efficient technologies. The influence of sex mirrors previous ecofeminist work outlining the gender-related concerns for environmental quality and gendered nature of PEBs (MacGregor 2006); while women in this study appear to express less investment in water conservation via low-flow devices, their curtailment during droughts suggests that they are environmental caretakers.

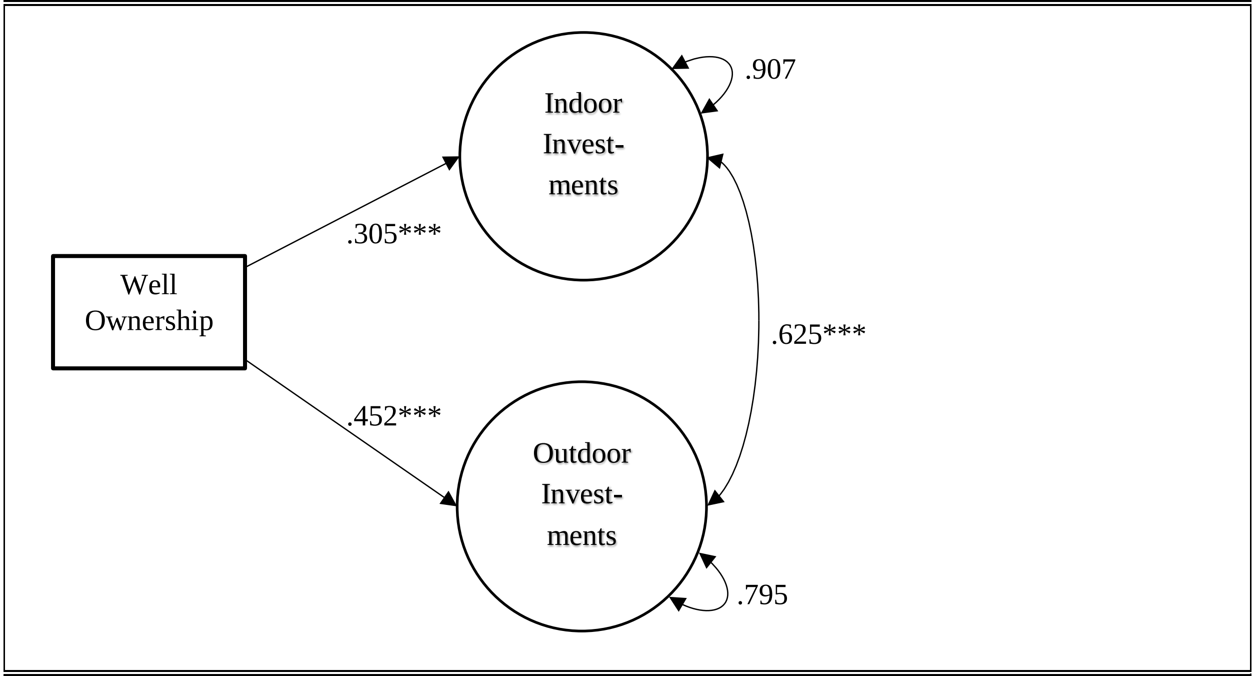
Income has a significant role in predicting most of these outcomes. It is a positive predictor of awareness levels, owning indoor and outdoor water-saving devices, and is positively associated with outdoor water usage during times of drought. In Chapter 2, I reviewed the instances of wealthy individuals resisting drought-time lawn watering restrictions, and this finding matches previous studies that investigate how the public display of water is associated to upper-class lifestyles. Like income, age is associated with a number of latent variables. It is positively correlated with awareness levels, owning indoor and outdoor water-saving appliances, and indoor and outdoor water conservation actions during droughts. Political conservativism is a less-reliable predictor; it is only significantly (negatively) associated with saving water indoors during droughts. Education is only significantly associated with awareness levels of Kansas water supplies, but not the remaining constructs. Overall, the CFAs reveal that household water supplies serve as important exogenous predictors that have been overlooked in previous PEB models.

In the next brief section, I examine well ownership's role as a predictor with the two sets of SEMs in which owning water-saving devices and lowering and raising water consumption as reactions to droughts are outcome constructs. I regress the survey item measuring well ownership on the investment constructs and drought response constructs to examine if owning a well is correlated with these latent variables.

Well Ownership, Investment in Water-Saving Appliances, and Responses to Drought

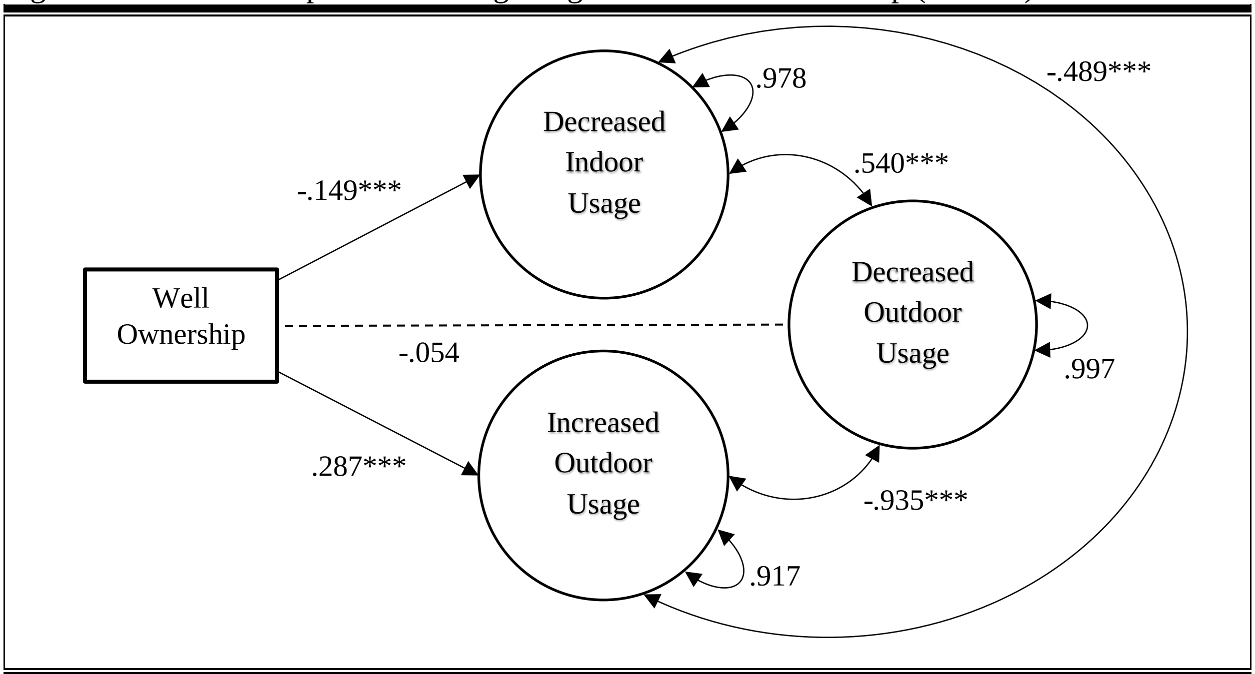
Figure 6g shows the model of regressing the outcome constructs of investing in water-saving devices on the independent variable measuring well ownership; Figure 6h shows the model of regressing the outcome constructs of reactions to droughts on well ownership. In these results, and in the following section discussing the results of the multi-group modeling, I will only discuss the regression coefficients between the dependent and independent constructs; consult the SEM Measures Tables 6a through 6j in the appendix for the complete results of the factor loadings, residual variance parameters, and standard errors of the indicators (factor loadings). Well ownership has a positive association with indoor water-saving investments ($b = .305$, $p < .001$), and a stronger positive correlation with outdoor water-saving devices ($b = .452$, $p < .001$). On the other hand, well ownership has a weak-to-moderate *negative* association with indoor water conservation during droughts ($b = -.149$, $p < .001$) and a positive association with increased outdoor water usage during droughts ($b = .287$, $p < .001$). There is no significant correlation between well ownership and the construct measuring decreased outdoor consumption during droughts.

Figure 6g. Model of owning water-saving appliances for indoor and outdoor usage regressed on well ownership (n = 847)



Model Fit: $\chi 2$ (8) = 18.739, p<.001; CFI = .979; RMSEA = .040
* $p < .05$ ** $p < .01$ *** $p < .001$

Figure 6h. Model of responses to drought regressed on well ownership (n = 846)



Model Fit: $\chi 2$ (23) = 61.965, p<.001; CFI = .982; RMSEA = .045
* $p < .05$ ** $p < .01$ *** $p < .001$

The regressions conducted within a series of confirmatory factor analyses and simple structural equation model reveal well ownership as an important predictor for many of the constructs of interest, along with geography, sex, income, and age. How do these constructs influence each other in a structural equation model, and does well ownership and geography change the associations between these constructs? I answer these questions in the next section by performing multi-group structural equation modeling.

MODERATION: WELL OWNERSHIP, MUNICIPAL CONNECTIONS, SPECIFIC WELL FUNCTION, AND GEOGRAPHY

How does a well's specific function change the relationship between water usage and well reliance? Are the relationships different for "off the grid" well owners compared to well owners who have access to municipal water? Do Kansans who reside in GMDs approach water conservation differently than Kansans who reside in the east? To examine how water supply infrastructure and geography moderate the associations between water supply awareness, conservation measures taken during droughts, and investing in water-saving technologies, I conducted a series of multi-group structural equation models. While it is important to find out how the constructs associated with water conservation behave along the typical demographic divisions of class, sex, political affiliation, and so on, I organized my respondents along the lines of well ownership to examine if well owners and non-well owners approach domestic water usage differently. Parceling the appropriate indicators together reduces the complexity of the models and it improved model fit—these models are adequate representations of their constructs.[1] The predictor construct (awareness of water supplies) uses the fixed factor identification by setting the theta value (the variance estimate that measures the amount of common information) at 1.0. I use marker identification for the outcome constructs in the models (either drought responses or investments in water-saving appliances), which fixes the factor loading of the latent variable's first indicator at 1.0. I had technical difficulties with M*plus* using the fixed factor identification method for the outcome constructs in the model.

As I described in Chapter 4, I was unable to conduct the modeling following the exact values-beliefs-norms structure, but I regressed the outcome variables on a construct that

[1] For brief reviews of fit indices, please consult Bollen (1989:256-89) and Little (2013:106-19). I briefly describe the parceled items in the notes under the figures throughout the chapter.

measured water supply awareness (which included three parceled indicators measuring familiarity with the High Plains aquifer, Groundwater Management Districts, the Kansas Water Office, the Governor's Vision, the Kansas Aqueduct, xeriscaping, and greywater systems, as well as an indicator measuring if respondents could correctly identify irrigation as the biggest water user in Kansas). First, I show how levels of water-related knowledge correlate to the ownership of water-saving technologies for well owners and non-well owners, then for well owners who do not have municipal water connections and those who have public utilities, then for owners of different types of wells (domestic, lawn and garden, feedlot, and irrigation), and finally for respondents organized into three geographic groups (1) residents who do not live in any GMDs, (2) residents who live in GMDs 1, 3, and 4, which overlie the Ogallala aquifer, and (3) residents who live in GMDs 2 and 5, which overlie the Equus Beds aquifer and Great Bend Prairie aquifer, respectively. Due to the low returns from most GMDs, I had to collapse responses from GMDs 1, 3, and 4 together, and put the responses from GMDs 2 and 5 in another group. GMDs 2 and 5 manage aquifers based on safe yield policies, so it makes more sense to couple them as one group, while leaving the GMDs that overlie the Ogallala aquifer as their own group. Following the standards laid out by previous SEM researchers who use GFI (Little 1997; Cheung and Rensvold 2002), for the most part these constructs can be considered comparable across groups of well owners and geographic residence. I conducted a series of multi-group CFAs to ensure the items are measuring the same thing across groups of well owners using tests of factorial invariance.[2] All the models except the ones measuring investment in water-saving appliances and awareness levels across residence groups and off-the-grid well owners compared to well owners with municipal connections achieved scalar (strong) invariance. For the constructs in the partially-invariant models, I examined whether the exogenous predictors used in the CFAs had a direct effect on any of the indicators, the results of which are provided in this chapter's appendix. Consult the invariance tables located in the appendix for a summary of the invariance tests.

[2] Another invariance test is the χ^2 difference test—also referred to as the delta method, which is calculated by finding the difference between parent (or configural) models and nested (or weak invariant or strong invariance) models. While the delta method is a sensible test for larger datasets, there are additional thresholds researchers can use to test invariance with smaller samples—namely GFI. For more on invariance testing, see Meredith (1964; 1993); Little (2013:137-79); Millsap and Yun-Tein (2004); and Pornprasertmanit (2012).

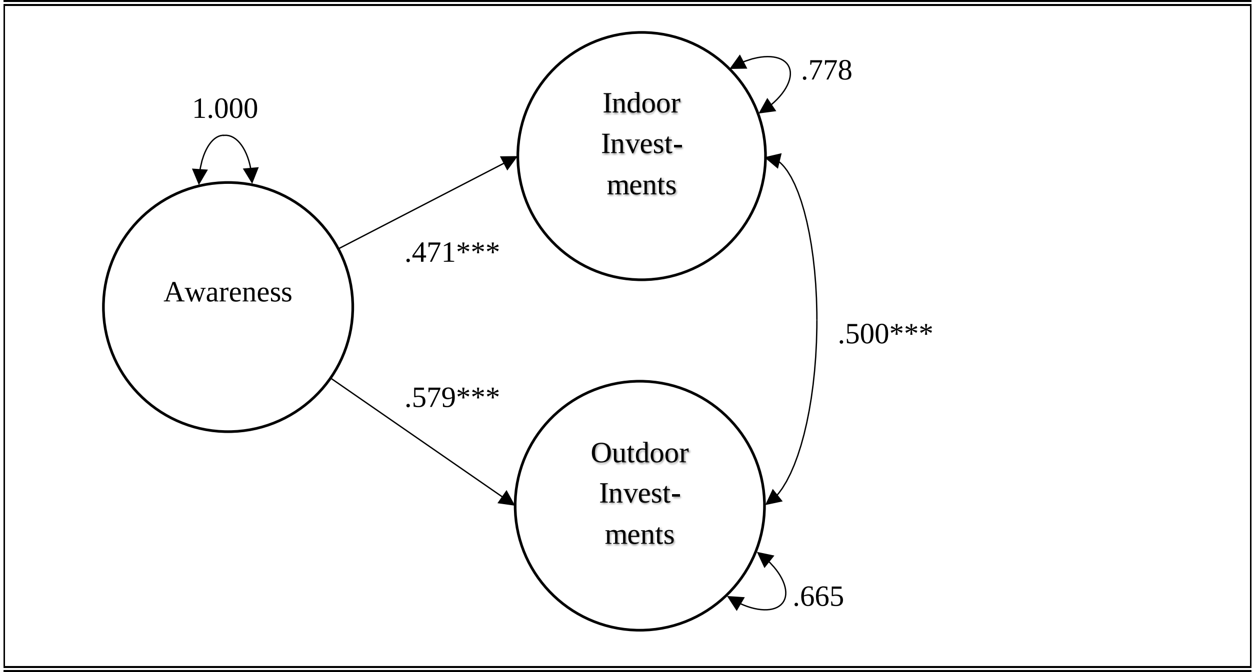
After investigating the models in which owning water-saving appliances are the outcome constructs, I ran a series of multi-group SEMs in which three drought outcomes (using less water indoors during droughts, using less water outdoors during droughts, and using more water outdoors during droughts), are conducted for well owners and non-well owners, "off the grid" well owners and those who have city water connections, the owners of different types of wells, and the respondents organized by geography. As I established in Chapter 2, outdoor watering practices are more flexible and responsive to droughts, and indoor water practices are relatively inelastic compared to outdoor techniques (which constitute the main driver in per capita variation for households in the United States). Following the previous water conservation literature, I only measure indoor water conservation efforts in times of droughts and did not write any survey items gauging respondents' increases in indoor water consumption during droughts. Asking about increases in indoor consumption during droughts makes little sense—would anyone flush their toilet more because of a drought? In earlier iterations of this research, I tried to run the model with all six latent constructs—the two constructs measuring investments along with the three constructs measuring drought responses regressed on water supply awareness construct. In addition to having unacceptable model fit, those multi-group models did not pass invariance tests, but these simplified models do.[3]

Water-Saving Appliances and Levels of Awareness

Non-well owners and well owners. Figures 6i and 6j depict the models of the multi-group analysis for non-well owners and well owners. For non-well owners, the correlations between awareness and indoor investments (b = .471, p < .001) and outdoor investments (b = .579, p < .001) are positive and significant. The same can be said about well owners' correlation for indoor appliances regressed on awareness levels (b = .338, p < .001), and for their outdoor appliances regressed on awareness levels (b = 438, p < .01). Note that the correlations between awareness levels and investments among well owners are weaker than they are for non-well owners.

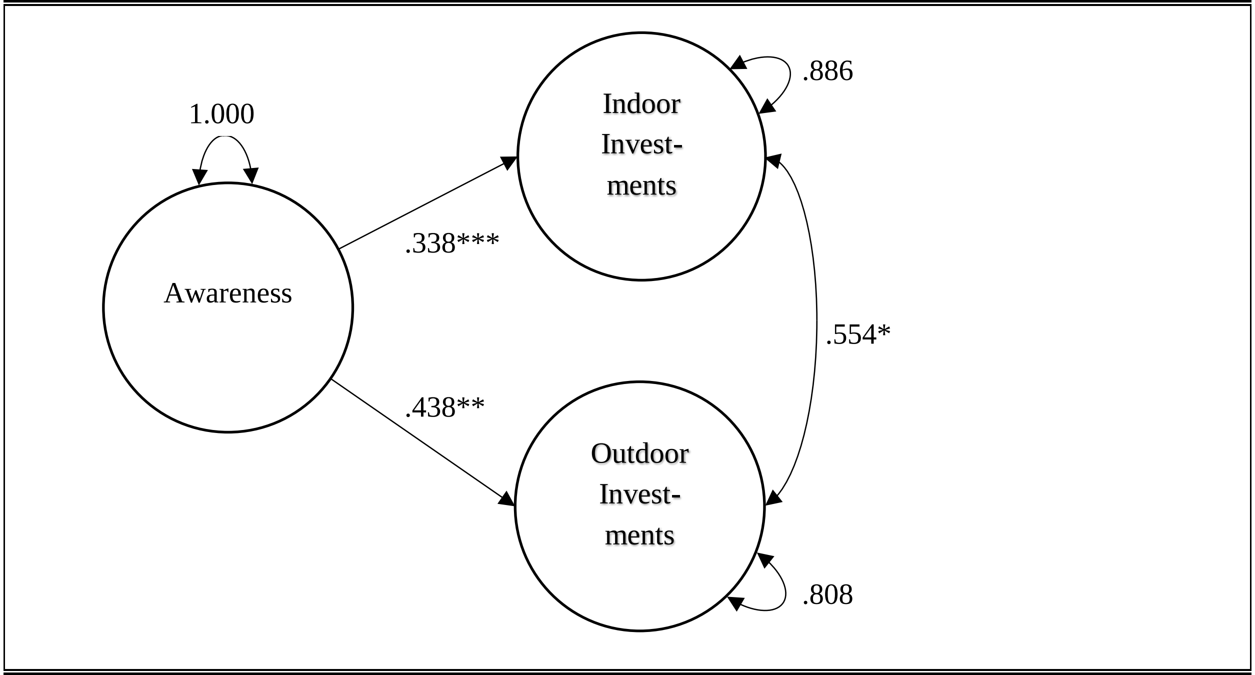
[3] I ran the model with all five outcome constructs (the constructs representing investments in water-saving appliances alongside the constructs representing reactions to droughts) being predicted by awareness levels, but could not achieve invariance across groups of different well owners without damaging model fit beyond the acceptable range. For that reason, I decided to keep my analysis to simpler, more numerous, models.

Figure 6i. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for non-well owners (*n* = 448)



Model Fit: χ2 (62) = 101.142, p<.01; CFI = .943; RMSEA = .038
* *p* < .05 ** *p* < .01 *** *p* < .001

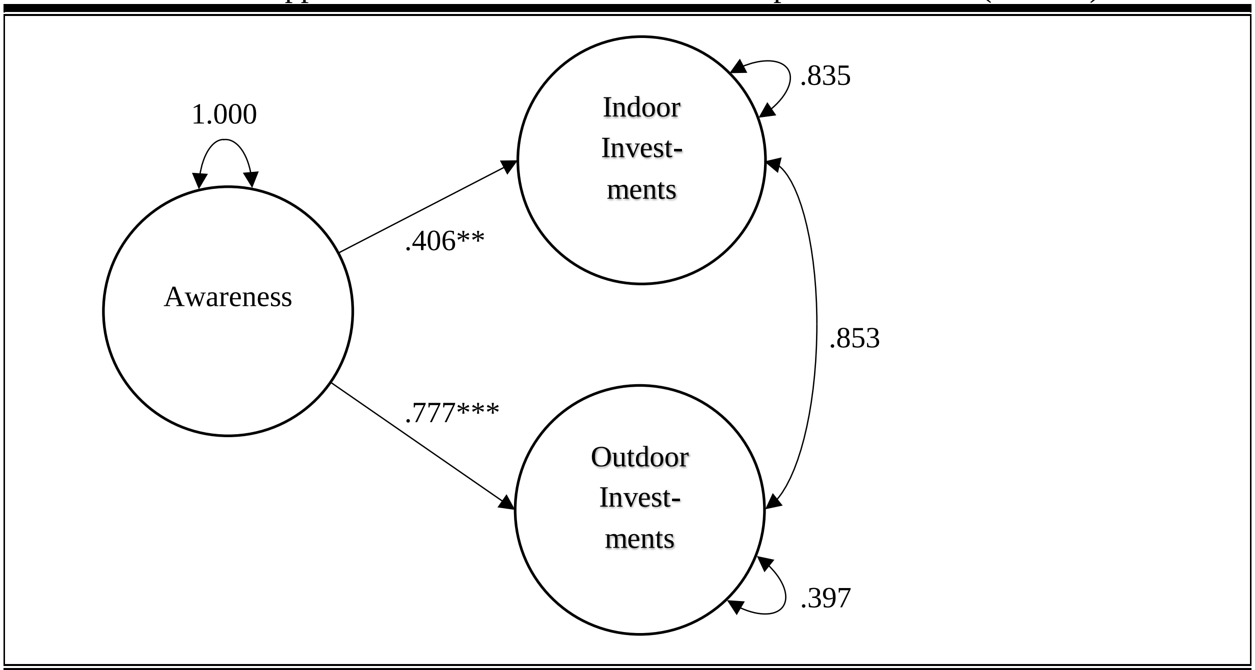
Figure 6j. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for well owners (*n* = 407)



Model Fit: χ2 (62) = 101.142, p<.01; CFI = .943; RMSEA = .038
* *p* < .05 ** *p* < .01 *** *p* < .001

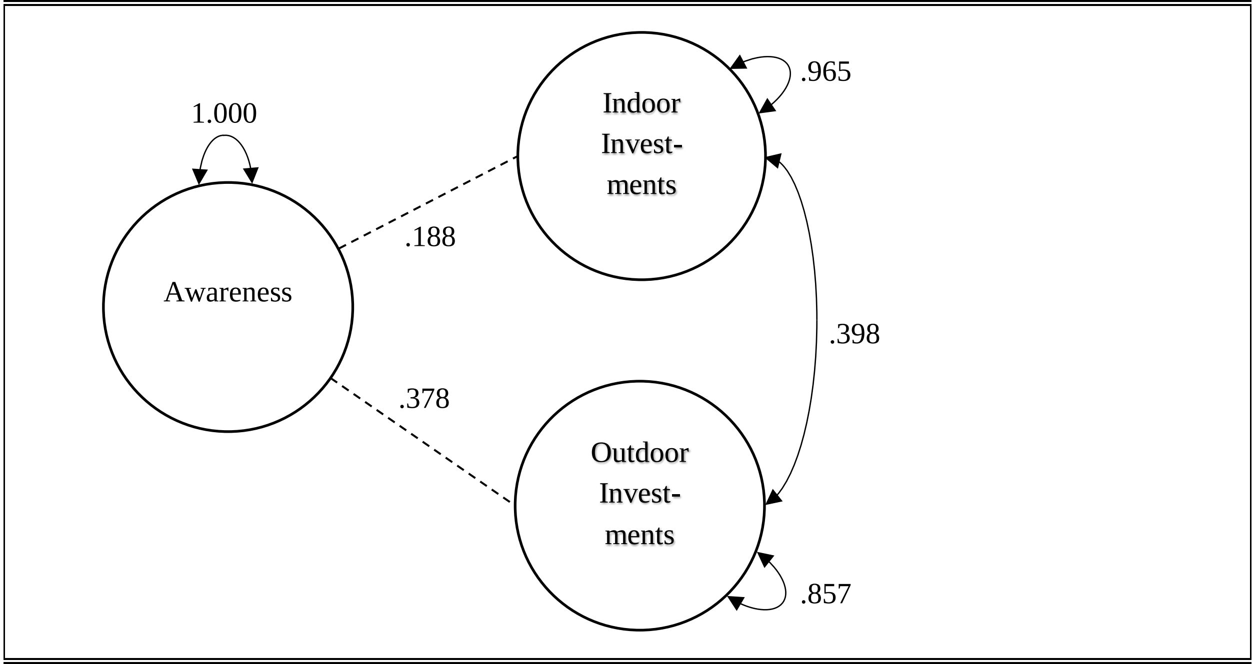
Well owners with and without municipal water connections. Examining the figures of multi-group SEM that organize well-owning respondents by well owners without a connection to public utilities and well owners with connections to public utilities show how water usage and well ownership is moderated by the presence or absence of publicly-provided water (Figures 6k and 6l). For well owners with no public water, there is a moderate positive association between awareness and investing in indoor water-saving appliances ($b = .406$, $p < .01$), and a stronger positive relationship between awareness and outdoor investments ($b = .777$, $p < .01$). For well owners with a public water connection, the association between awareness levels and indoor and outdoor water-saving investments is not significant, a key difference compared to the "off the grid" well owners. The combination of public and private water supplies moderates the association between knowledge of water supplies and owning water-saving appliances.

Figure 6k. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for well owners without municipal connections ($n = 141$)



Model Fit: $\chi 2$ (62) = 86.019, p<.05; CFI = .902; RMSEA = .045
* $p < .05$ ** $p < .01$ *** $p < .001$

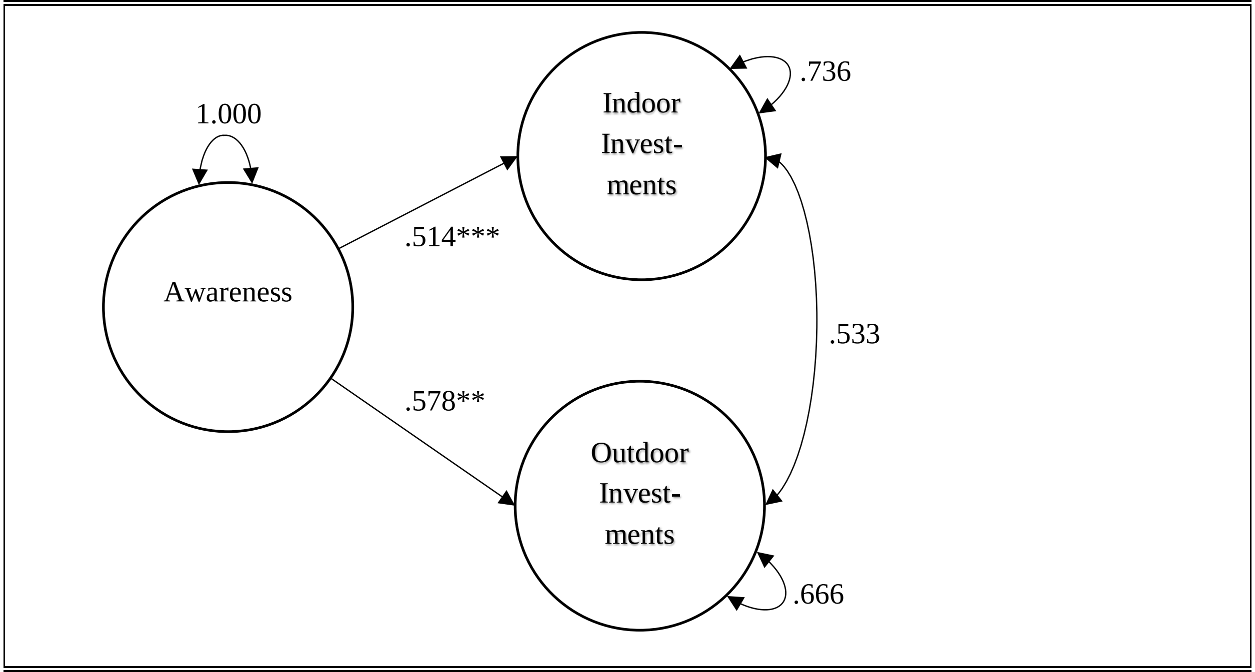
Figure 6l. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for well owners with municipal connections (*n* = 246)



Model Fit: $\chi 2$ (62) = 86.019, p<.05; CFI = .902; RMSEA = .045
* p < .05 ** p < .01 *** p < .001

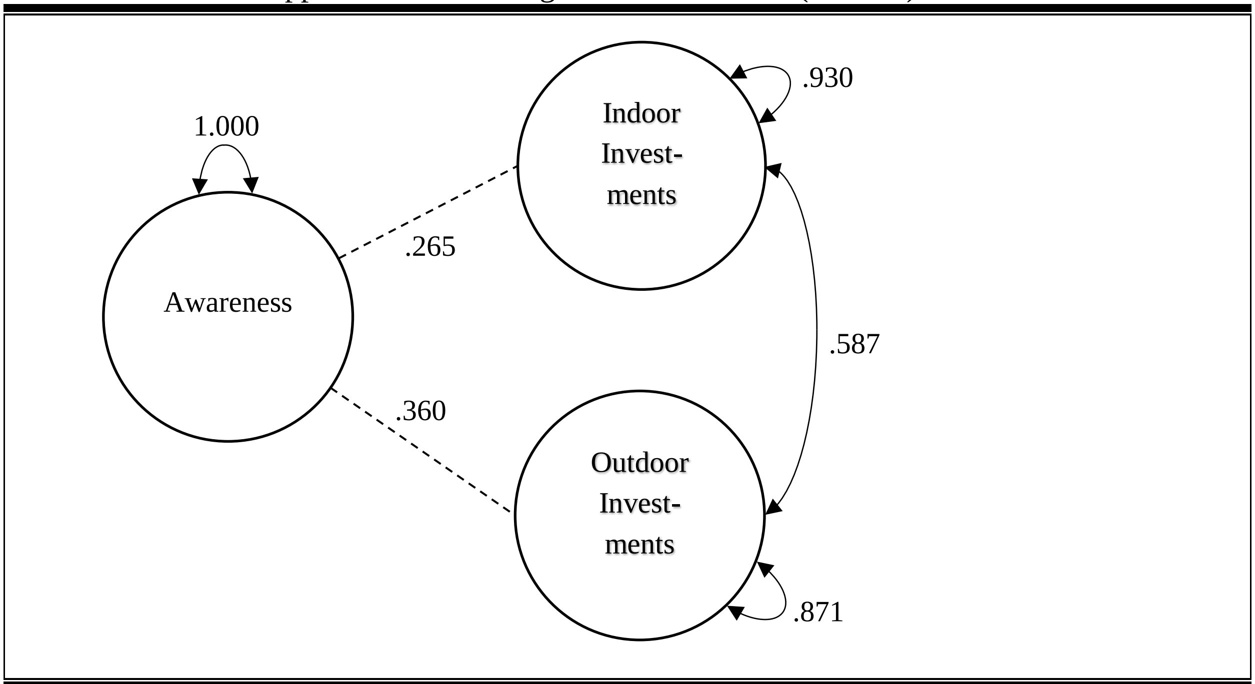
Domestic, lawn and garden, feedlot, and irrigation well owners. Figures 6m through 6p show the models for each specific type of well owner. The positive correlations between water supply awareness levels and owning indoor water-saving appliances and between awareness and owning outdoor water saving appliances are only significant for domestic well owners (b = .514, p < .01; b = .578, p < .01, respectively). Respondents who own lawn and garden wells, feedlot wells, and irrigation wells have no significant correlations between these constructs. Therefore, the function of the well changes the association between water supply awareness and investments; it is a moderated association. Increasing awareness levels could theoretically yield a significantly higher investment in water-saving technologies for domestic well owners than for well owners without domestic wells.

Figure 6m. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for domestic well owners (*n* = 145)



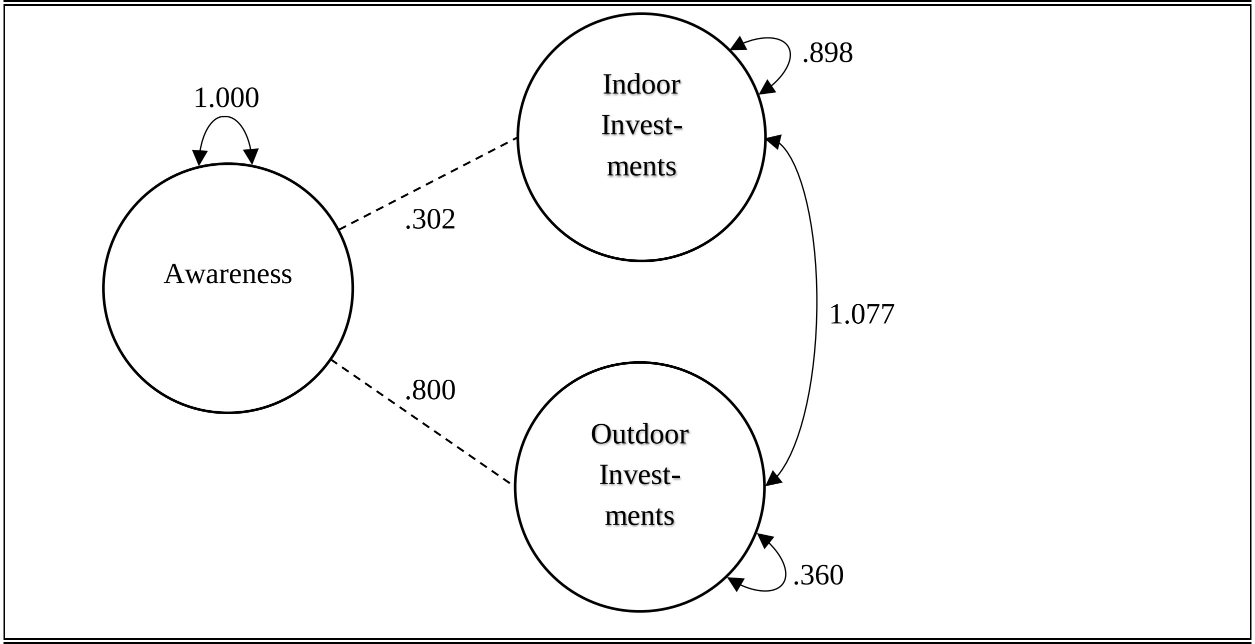
Model Fit: χ2 (135) = 157.232, p<.10; CFI = .913; RMSEA = .040
* *p* < .05 ** *p* < .01 *** *p* < .001

Figure 6n. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for lawn and garden well owners (*n* = 135)



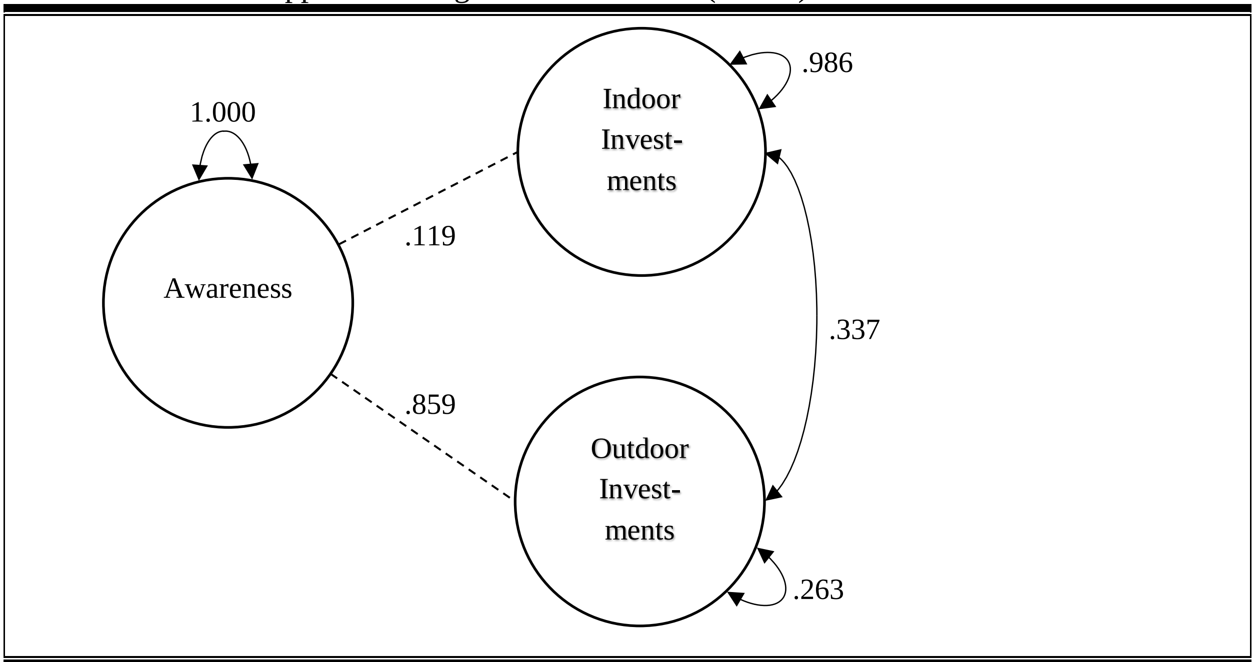
Model Fit: χ2 (135) = 157.232, p<.10; CFI = .913; RMSEA = .040
* *p* < .05 ** *p* < .01 *** *p* < .001

Figure 6o. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for feedlot well owners (n = 66)



Model Fit: χ2 (135) = 157.232, p<.10; CFI = .913; RMSEA = .040
* p < .05 ** p < .01 *** p < .001

Figure 6p. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for irrigation well owners (n = 61)

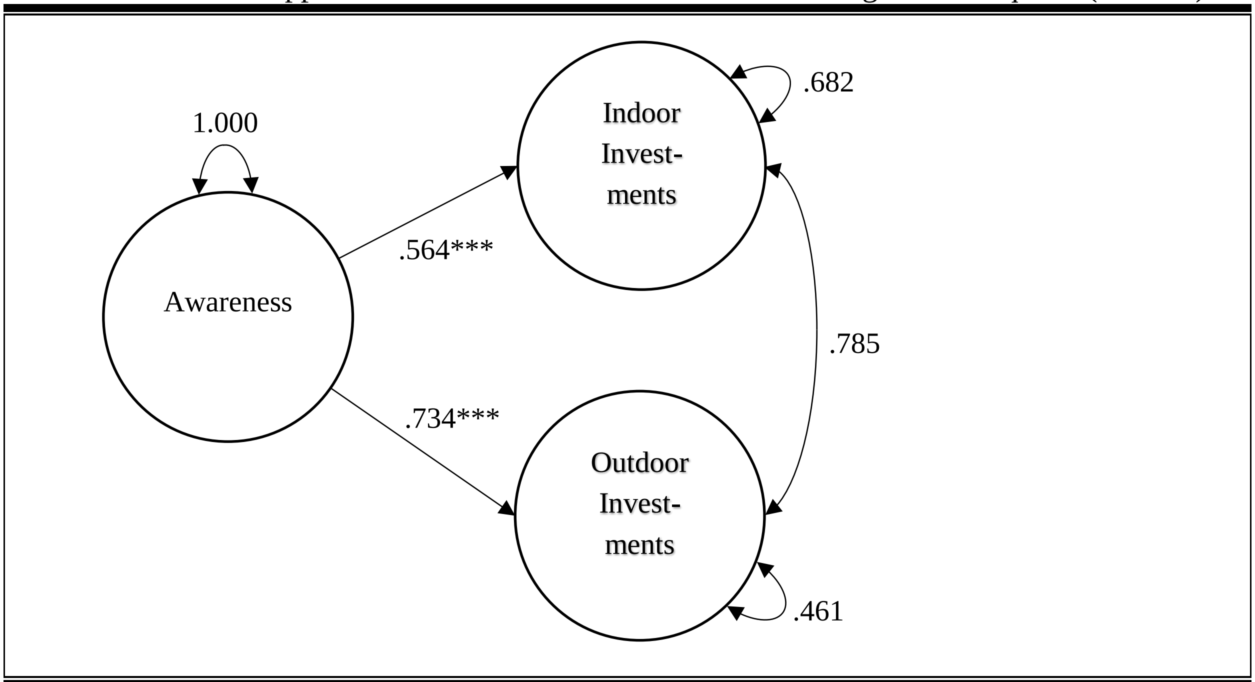


Model Fit: χ2 (135) = 157.232, p<.10; CFI = .913; RMSEA = .040
* p < .05 ** p < .01 *** p < .001

Residents living above the Ogallala aquifer, the Equus Beds and Great Bend Prairie aquifers, and those living east of the High Plains aquifer. Figures 6q through 6s provide the models regressing indoor and outdoor water-saving technologies on awareness levels with the respondents organized by geography. Roughly 4 percent of my respondents did not provide their county of residence, so the statistics associated with geography are slightly incomplete. The respondents who did not list where they lived have been removed from all analyses and conversations regarding geographic or nested effects; unfortunately this data cannot be imputed precisely nor easily obtained.

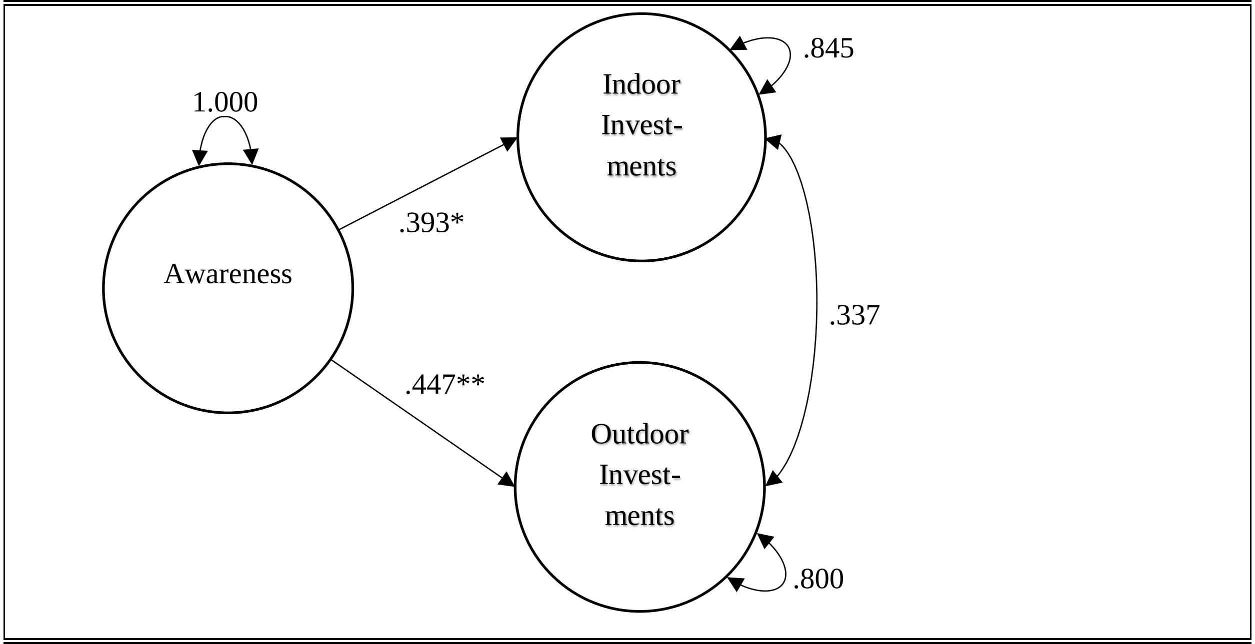
While controlling for well ownership and the type of well in use showed how the specifics of water supply infrastructure contour the relationship between awareness levels and investments, geography also moderates the correlations between the dependent constructs measuring water-saving devices and the predictor latent construct of awareness. A positive relationship between awareness and indoor investments ($b = .564$, $p < .001$) and outdoor investments ($b = .734$, $p < .001$) is present among the respondents who do not live above the

Figure 6q. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for those who do not live above the High Plains aquifer (n = 484)



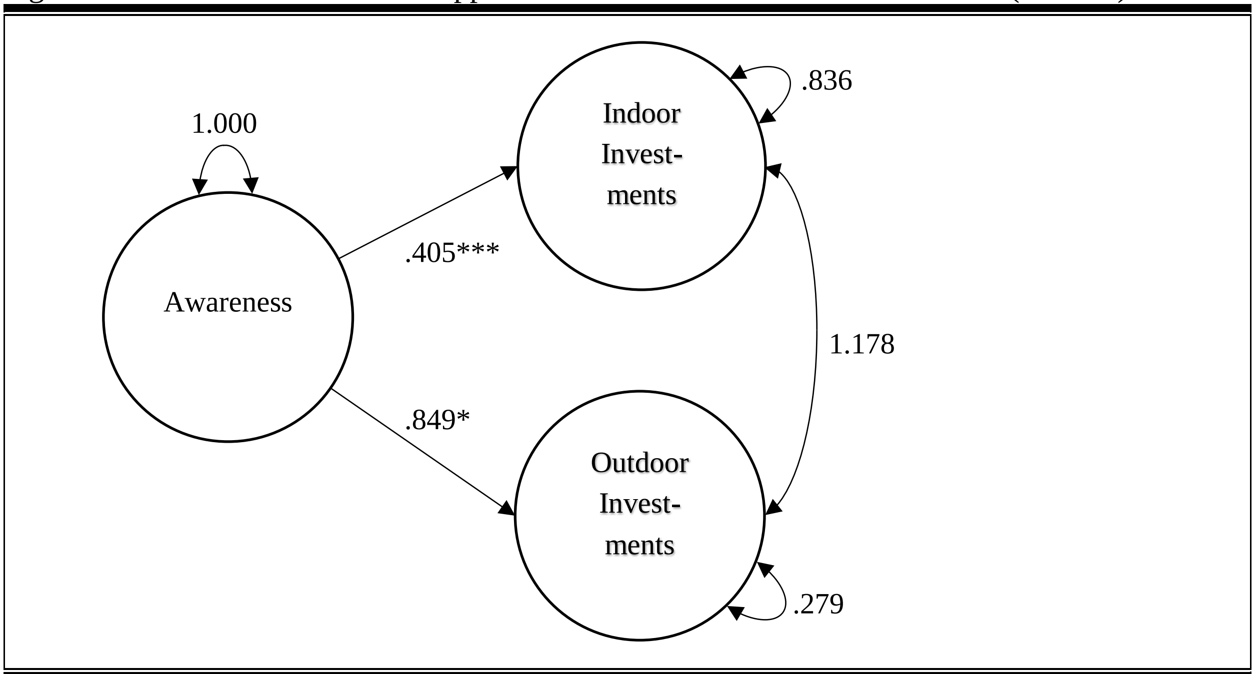
Model Fit: $\chi2$ (95) = 135.747, p<.01; CFI = .946; RMSEA = .039
* $p < .05$ ** $p < .01$ *** $p < .001$

Figure 6r. Model of owning water-saving appliances for indoor and outdoor usage regressed on awareness of water supplies for those who live above the Ogallala aquifer (n = 98)



Model Fit: $\chi 2$ (95) = 135.747, p<.01; CFI = .946; RMSEA = .039
* p < .05 ** p < .01 *** p < .001

Figure 6s. Model of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness of water supplies for those who live in GMDs 2 and 5 (n = 247)



Model Fit: $\chi 2$ (95) = 135.747, p<.01; CFI = .946; RMSEA = .039
* p < .05 ** p < .01 *** p < .001

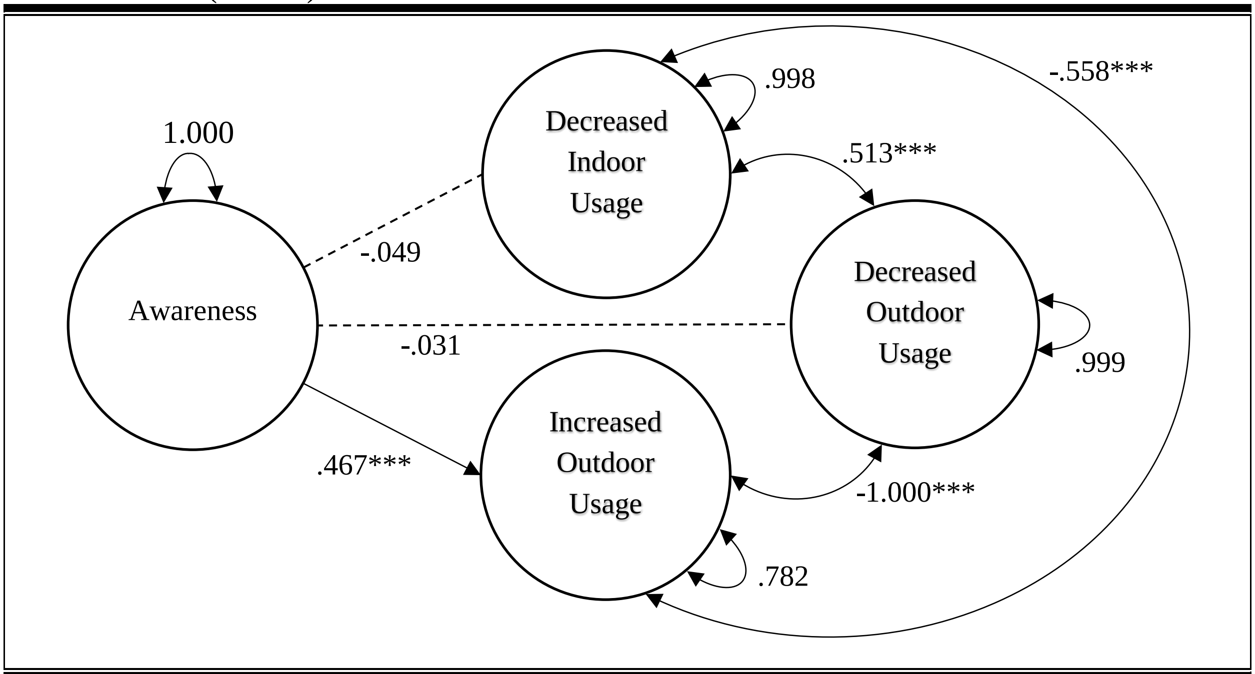
High Plains aquifer. Participants who reside above the Ogallala aquifer have a slightly weaker (significant) correlation for awareness and indoor investments (b = .393, $p < .05$) and for awareness and outdoor investments (b = .447, $p < .01$). Residents from GMDs 2 and 5, which overlie the Equus Beds and Great Bend Prairie aquifers, respectively, show slightly stronger correlations compared to their far-western counterparts for awareness and indoor investments (b = .405, $p < .001$) and for awareness and outdoor investments (b = .849, $p < .05$).

This result suggests that the relationship between awareness levels and owning efficient water technologies is slightly moderated by geography. With the exception of the strong association between awareness and outdoor investments for respondents living in GMDs 2 and 5, the correlation between water knowledge and investments becomes weaker as the groupings move from eastern to western Kansas. Regardless of geographic residence in the state, familiarity with water supplies is positively associated with owning such appliances. Overall, these results suggest that owning a domestic well changes the association between awareness of water supplies and investing in water-saving appliances. Therefore, water supply infrastructure should be analyzed as an important moderating variable for researchers who investigate resource conservation via technological efficiencies and cognizance of natural resources.

Responses to Drought and Levels of Awareness

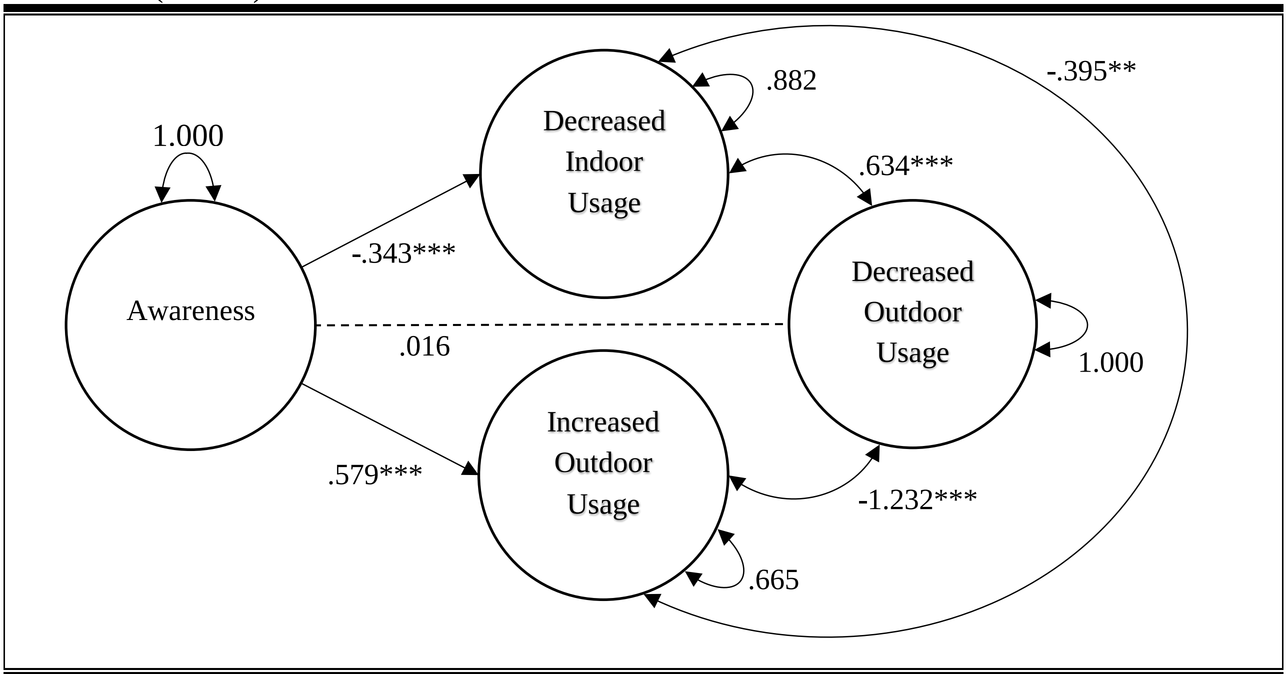
Non-well owners and well owners. Figures 6t and 6u model the influence of awareness of water supplies on the constructs measuring drought responses for non-well owners and well owners, and provide evidence that the relationship between water knowledge and reactions to droughts are moderated by well ownership. For non-well owners, awareness has a moderate positive correlation with increased outdoor water usage during droughts (b = .467, $p < .001$), but it is not significantly associated with indoor or outdoor conservation. On the other hand, well owners have a stronger correlation between awareness and increased outdoor consumption (b = .579, $p < .001$); and a significant negative relationship between awareness and indoor conservation during droughts (b = -.343, $p < .001$). For well owners, awareness levels are negatively associated with water conservation during droughts, implying that well owners' performances during droughts are shaped by their water literacy in different ways than non-well owners' drought reactions.

Figure 6t. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for non-well owners (n = 450)



Model Fit: $\chi2$ (114) = 211.493, p<.001; CFI = .957; RMSEA = .045
* p < .05 ** p < .01 *** p < .001

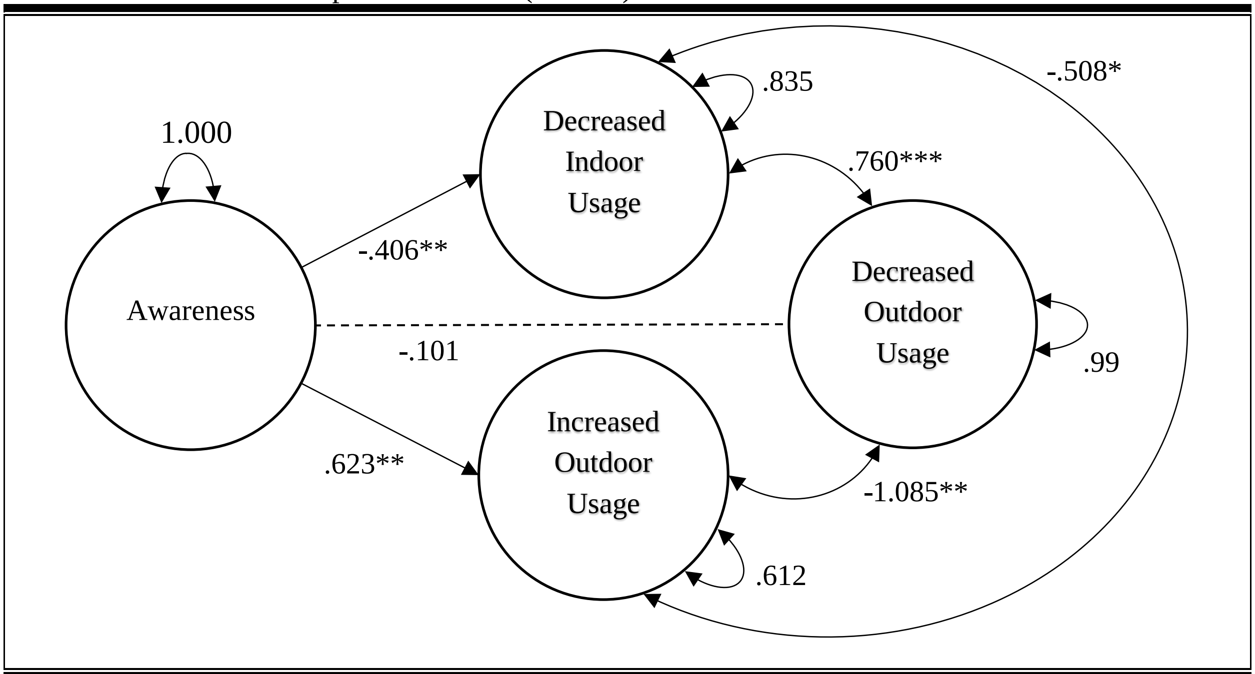
Figure 6u. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for well owners (n = 407)



Model Fit: $\chi2$ (114) = 211.493, p<.001; CFI = .957; RMSEA = .045
* p < .05 ** p < .01 *** p < .001

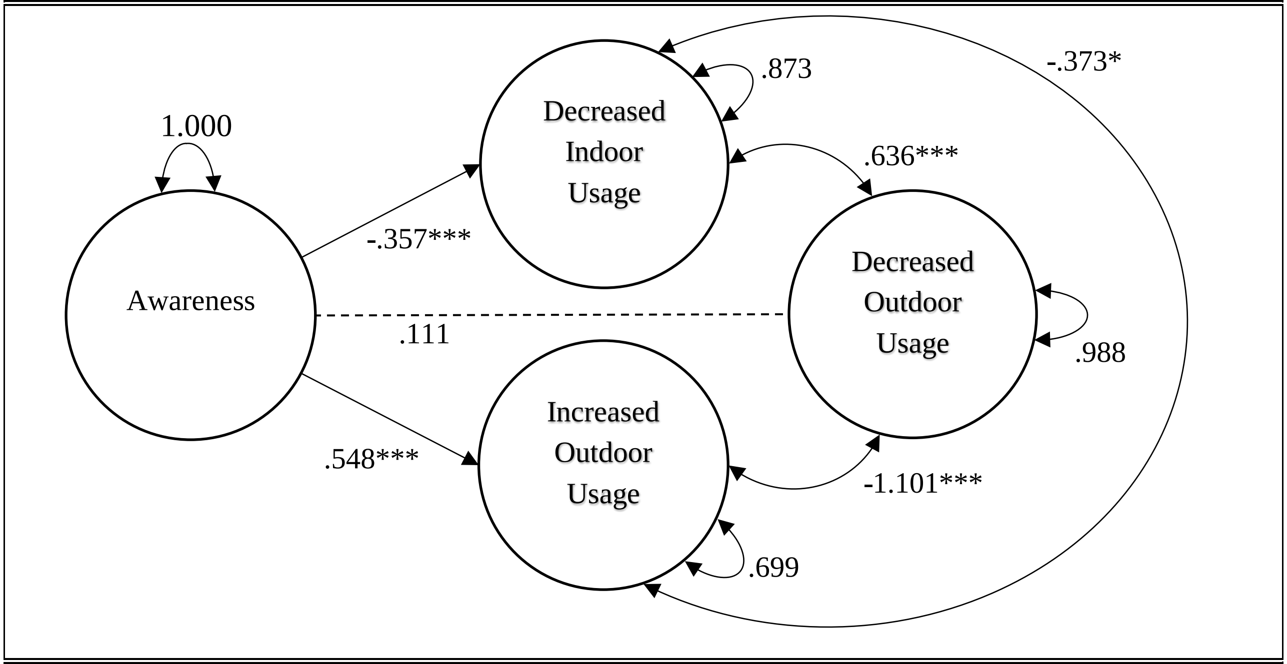
Well owners with and without municipal water connections. Figures 6v and 6w show the models for well owners without a connection to public utilities and well owners with connections to public utilities. When regressing decreased indoor usage during droughts on water supply awareness, both of these groups have weak-to-moderate negative correlations (b = -.406, p < .01 for "off the grid" well owners; b = -.357, p < .001 for connected well owners). Awareness has a stronger positive association with increased water consumption during droughts for both groups (b = .623, p < .01 for "off the grid" well owners; b = .584, p < .001 for connected well owners). Overall, the presence or absence of publicly-provided water only slightly weakens the relationship between awareness of water supplies and responses to droughts. Neither group has a significant correlation between reduced outdoor usage during droughts and water supply awareness.

Figure 6v. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for well owners without municipal connections (n = 141)



Model Fit: χ2 (114) = 164.168, p<.01; CFI = .983; RMSEA = .048
* p < .05 ** p < .01 *** p < .001

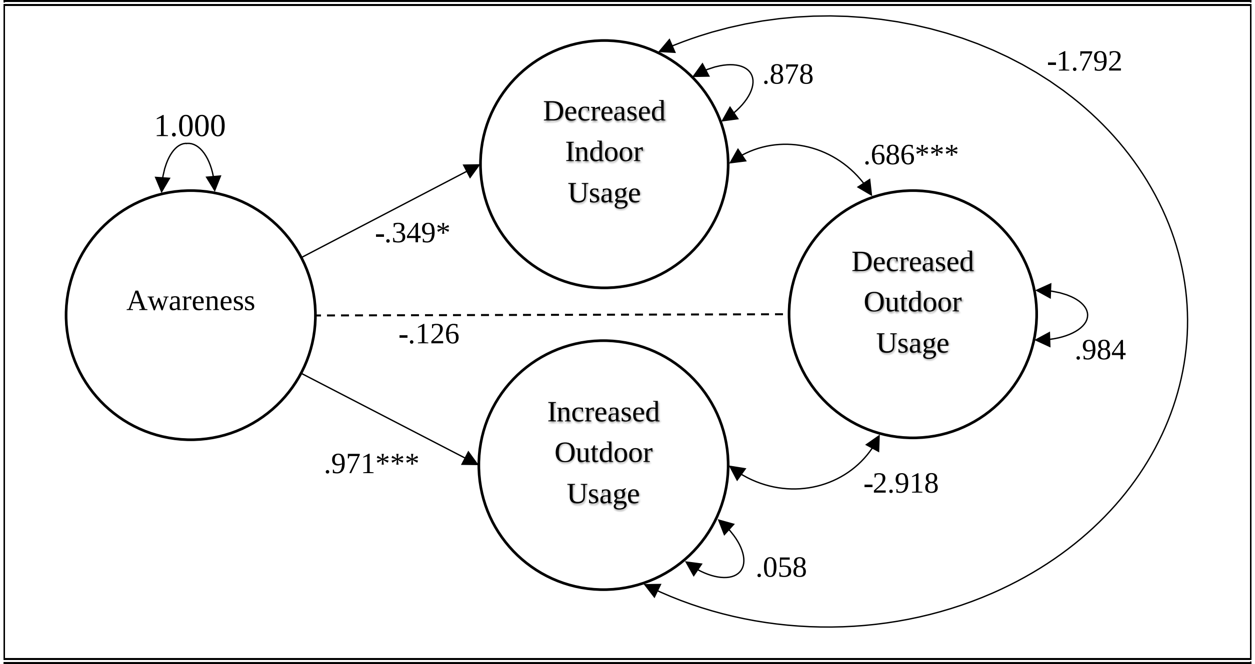
Figure 6w. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for well owners with municipal connections (*n* = 246)



Model Fit: χ2 (114) = 164.168, p<.01; CFI = .983; RMSEA = .048
* *p* < .05 ** *p* < .01 *** *p* < .001

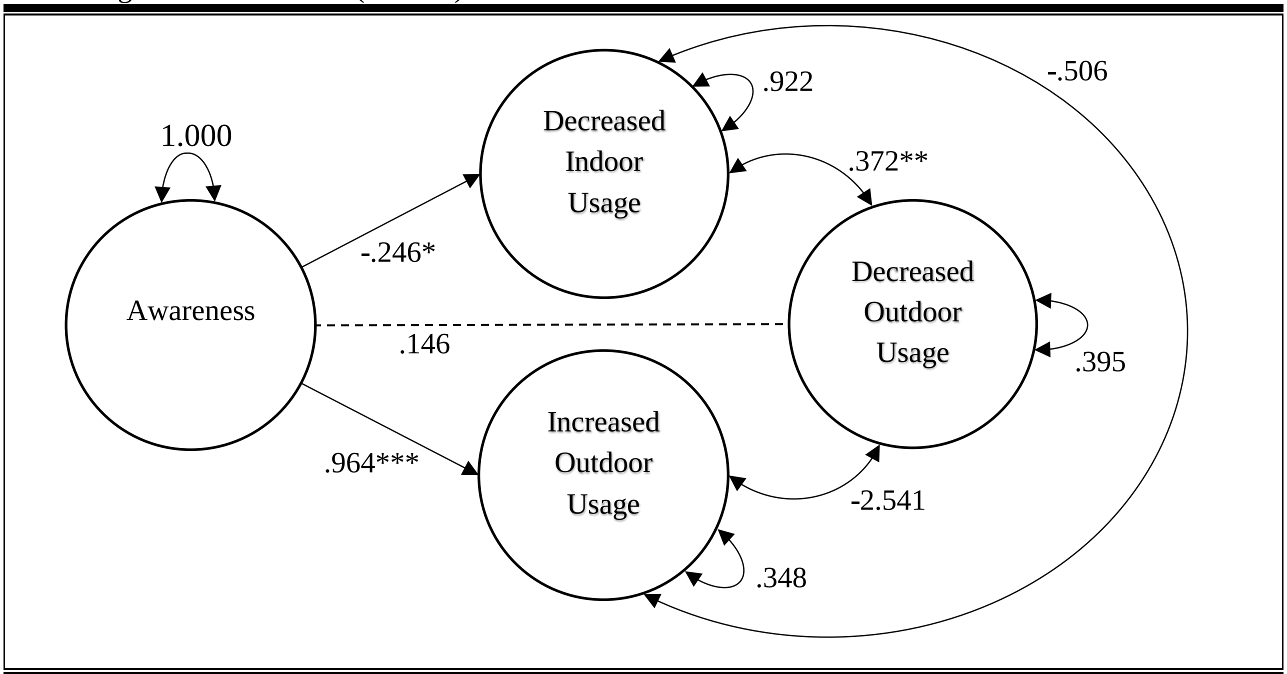
Domestic, lawn and garden, feedlot, and irrigation well owners. Examining the figures of multi-group SEM that organize well-owning respondents by the type of well they use reveal how drought-time water usage and awareness levels are moderated by well function (figures 6x through 6aa). For respondents with a domestic well, there is a strong positive association between awareness and increased outdoor usage during droughts ($b = .971$, $p < .001$) and a weak-to-moderate negative association between awareness and decreased indoor usage ($b = -.349$, $p < .05$). For lawn and garden well owners, the association between awareness levels and increased outdoor usage is also strong ($b = .964$, $p < .001$), but their negative association between awareness levels and decreased outdoor usage is slightly weaker ($b = -.246$, $p < .05$). While feedlot well owners do not have a significant relationship between awareness levels and both constructs representing decreased usage during droughts, awareness levels have a strong positive correlation with increased outdoor watering during droughts ($b = .978$, $p < .001$). Irrigation well owners reveal a significant path between awareness levels and increased outdoor water usage during droughts ($b = .942$, $p < .001$), with a moderate-to-strong negative relationship

Figure 6x. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for domestic well owners (*n* = 145)



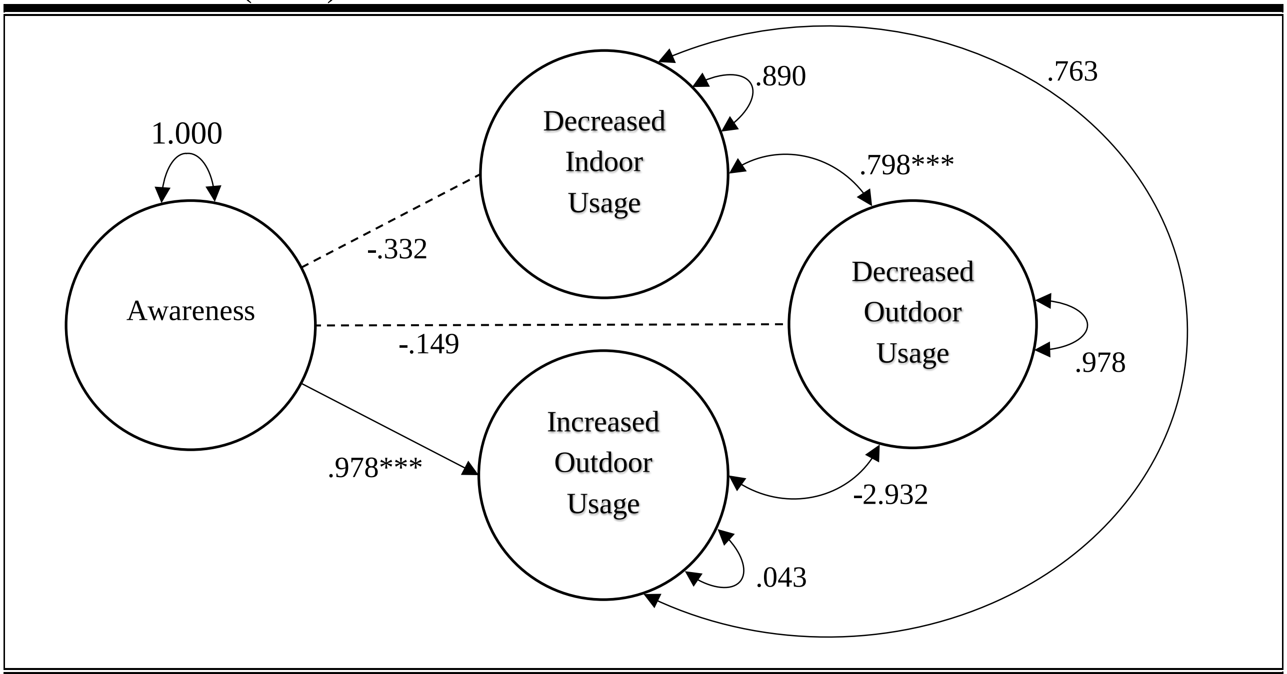
Model Fit: χ2 (247) = 359.798, p<.001; CFI = .898; RMSEA = .067
* *p* < .05 ** *p* < .01 *** *p* < .001

Figure 6y. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for lawn and garden well owners (*n* = 135)



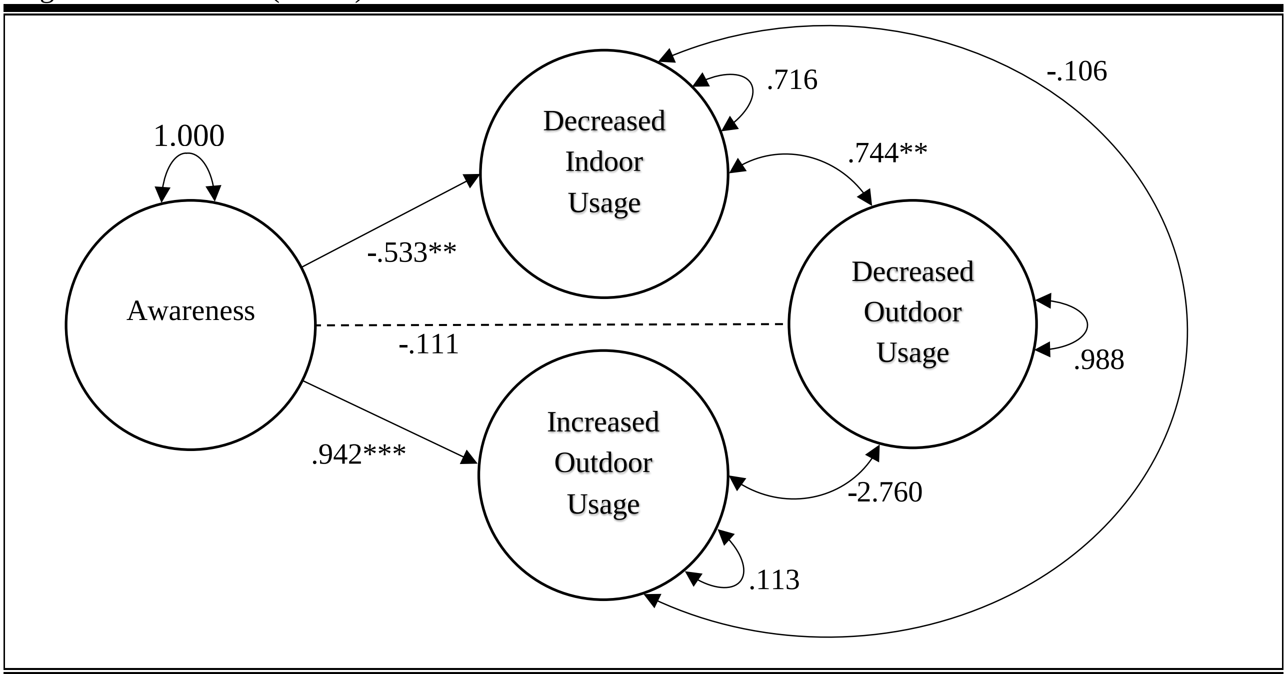
Model Fit: χ2 (247) = 359.798, p<.001; CFI = .898; RMSEA = .067
* *p* < .05 ** *p* < .01 *** *p* < .001

Figure 6z. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for feedlot well owners (n = 66)



Model Fit: $\chi 2$ (247) = 359.798, p<.001; CFI = .898; RMSEA = .067
* $p < .05$ ** $p < .01$ *** $p < .001$

Figure 6aa. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for irrigation well owners (n = 61)



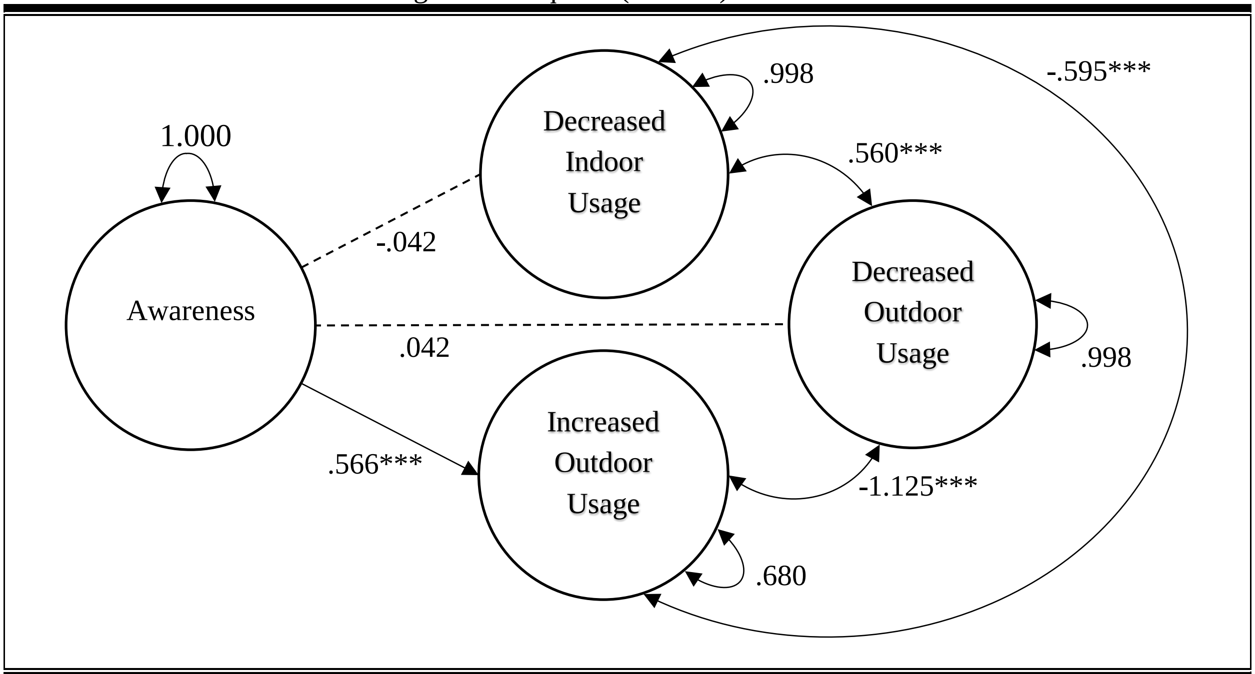
Model Fit: $\chi 2$ (247) = 359.798, p<.001; CFI = .898; RMSEA = .067
* $p < .05$ ** $p < .01$ *** $p < .001$

between awareness and decreased indoor usage (*b* = -.533, $p < .01$). Domestic, lawn and garden, and irrigation well owners have a significant negative correlation between the awareness construct and the construct measuring indoor conservation during droughts, but feedlot well owners do not. Each of these groups had high positive relationships between awareness and increased watering during droughts, but none of these groups have a significant correlation between awareness levels and the construct measuring decreased outdoor consumption during droughts.

Residents living above the Ogallala aquifer, the Equus Beds and Great Bend Prairie aquifers, and those living east of the High Plains aquifer. For respondents who do not live above the High Plains aquifer, there is a moderate positive association between awareness and increased outdoor usage (*b* = .566, $p < .001$; see Figure 6ab). Respondents who live above the Ogallala aquifer in far-western Kansas demonstrate a stronger positive correlation with awareness levels and increased outdoor usage during droughts (*b* = .639, $p < .001$), as well as a negative association between decreasing indoor consumption during droughts and awareness (*b* = -.535, $p < .001$), and a negative correlation between awareness and decreased outdoor usage (*b* = -.292, $p < .05$; see Figure 6ac). The model conducted on the respondents who live above the Great Bend Prairie and Equus Beds aquifer shows a positive association between awareness levels and increased outdoor usage during droughts (*b* = .476, $p < .001$), and a negative association between awareness levels and decreased indoor usage during droughts (*b* = -.318, $p < .01$; see Figure 6ad).

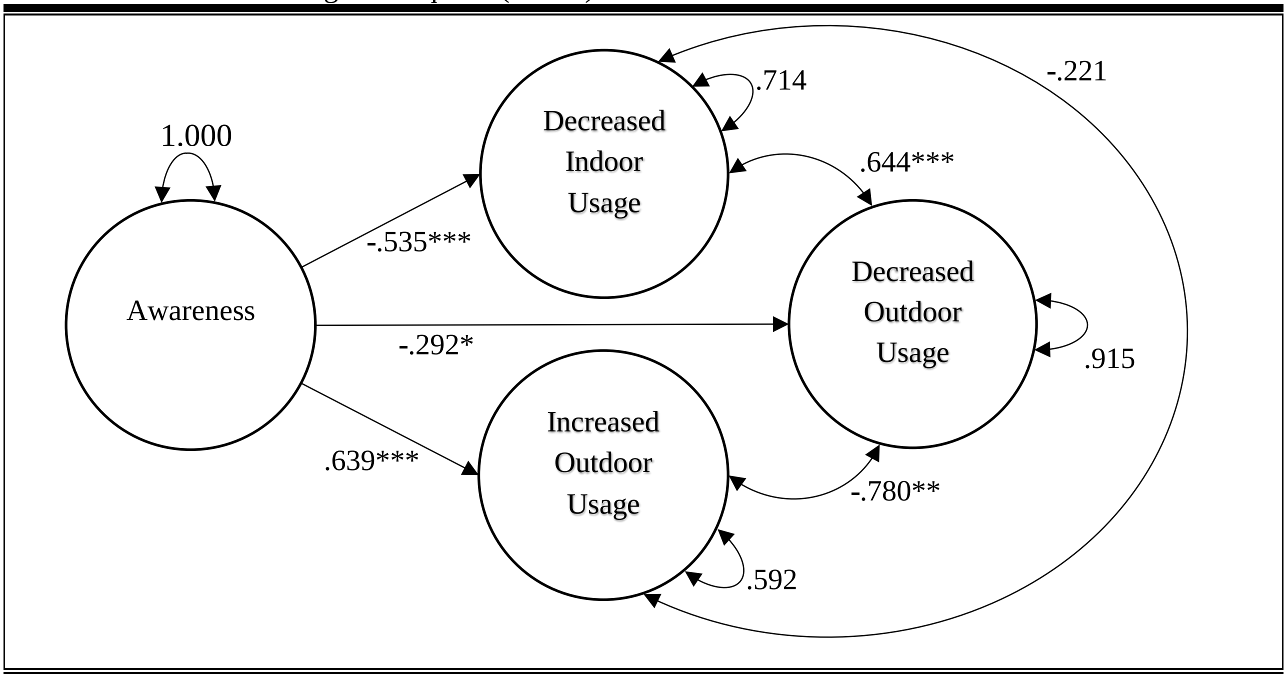
In terms of the significance of these relationships overall, the negative correlation between awareness levels and decreased outdoor usage during droughts is only significant for respondents in the Ogallala region; respondents in the eastern-most GMDs and living east of the High Plains aquifer do not have a statistically significant relationship between reducing their outdoor usage during droughts and their awareness levels. For the respondents who do not live in GMDs, awareness is also not significantly correlated with decreased water usage during droughts. On the other hand, for people in the Ogallala GMDs, awareness has significant negative relationships with decreased consumption. Additionally, the negative correlations between awareness and decreased indoor consumption are stronger among the respondents in the Ogallala aquifer region (GMDs 1, 3, and 4) than the participants from GMDs 2 and 5. The

Figure 6ab. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for those who do not live above the High Plains aquifer (*n* = 484)



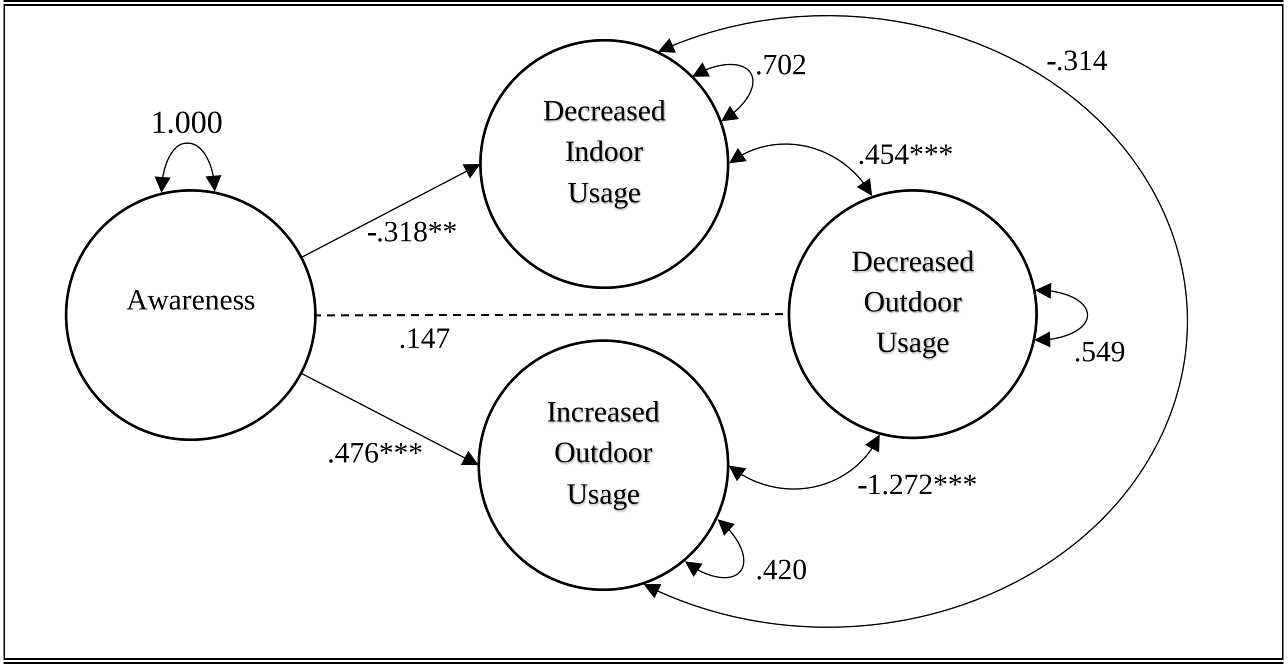
Model Fit: χ2 (179) = 255.242, p<.001; CFI = .963; RMSEA = .039
* *p* < .05 ** *p* < .01 *** *p* < .001

Figure 6ac. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for those who live above the Ogallala aquifer (*n* = 98)



Model Fit: χ2 (179) = 255.242, p<.001; CFI = .963; RMSEA = .039
* *p* < .05 ** *p* < .01 *** *p* < .001

Figure 6ad. Model of responses to drought (decreased indoor consumption, decreased outdoor consumption, and increased consumption during droughts) regressed on awareness of water supplies for those who live above the Great Bend Prairie and Equus Beds aquifers (*n* = 247)



Model Fit: $\chi 2$ (179) = 255.242, p<.001; CFI = .963; RMSEA = .039
* $p < .05$ ** $p < .01$ *** $p < .001$

positive relationship between awareness and increased outdoor usage is slightly stronger for the Ogallala-based residents than the other groups.

Perhaps these changes represent the different knowledge bases of respondents native to or familiar with the High Plains aquifer or western Kansas in general. Consider, for example, that familiarity with GMDs and the High Plains aquifer contributes heavily to the awareness construct for this group (consult the SEM measures tables in the appendix). Furthermore, the respondents who are more aware of their water supplies may also be more attuned to their level of water usage, the severity and length of droughts, and how they use water during times of low precipitation. If that is the case, the respondents who are more in tune with their consumption might also be answering the questions about water usage more accurately or honestly than the people with lower levels of water supply awareness. This would suggest that informed respondents are less likely to submit survey responses that have been nudged by social desirability biases. Additionally, the number of participants who state that they increase their water consumption during droughts can vary across these groups, and having a small number of respondents who increase drought-time water consumption in a particular group of the multi-group modeling could shape the relationship between awareness and increased consumption.

Four large and important findings emerge from these models. First, well ownership changes the associations surrounding water supply awareness, drought reactions, and investments in efficient watering appliances. While well ownership is significantly correlated to owning water conservation technologies, it is also associated with increased watering during droughts. Second, while awareness levels are *positively* associated with the ownership of water-saving appliances, they are *negatively* associated with conservation behaviors during droughts. Third, combinations of public and private water supplies slightly weaken the correlations between awareness and owning water-saving appliances and awareness and drought routines. I found that water supply awareness has a significant positive correlation with owning efficient watering devices and changing routines during droughts for the “off the grid” well owners, but not for well owners who also have city water.

Fourth, the respondents overlying the Ogallala aquifer with higher levels of water literacy are *not* curbing their domestic water usage during droughts. My research agenda predicted that respondents who reside above the High Plains aquifer will practice water conservation more regularly than respondents who do not live in GMDs. Furthermore, the second chapter described how curtailment methods of reducing household demand are widely adopted during droughts, and droughts tend to induce behavioral water conservation efforts. This suggests that droughts mean different things for people with wells and high water supply awareness. According to the chapter’s opening CFAs, residence in GMDs is negatively associated with conserving water during droughts, and the multi-group SEM shows that the relationship between water supply awareness and increased water usage implies that Kansans with high levels of water literacy are less likely to save water and more likely to use it during droughts, especially for those in the Ogallala region. This suggests that they are the opposite of Californians, who reacted to their extreme drought by using less, not more, water. The positive association between awareness levels and well ownership and investments in efficient watering technologies is a promising finding that implies a commitment to conservation, but watering *more* during times of scarcity is a sociologically fascinating practice. How can using a resource be a form of conserving it?

SAVING FOR A ~~RAINY~~ DRY DAY

> People think we're pumping this aquifer dry willy nilly. That's not what we're doing, we're trying to take care of it. – Southwestern Kansas Farmer (EPSCoR 2013b)

Well users are directly reliant on aquifers, particularly during droughts. Lane Letourneau, manager of the Kansas Department of Agriculture Water Appropriations Program, noted that the aquifer's greatest declines come during droughts, "That Ogallala aquifer did a lot of heavy lifting during the drought… We had crops (and feedlots) because of the Ogallala, but it really took a beating" (Chilson 2016). This comment illuminates how well owners are using *more* groundwater during the dry years—especially for outdoor purposes and agricultural production. Groundwater should therefore be seen not simply as a Common Pool Resource in a constant state of overuse; well owners are selective about their moments of extractions and probably do not have a reason to intensify their pumping during seasons with adequate precipitation. The relationship between groundwater extractions and competition is moderated by rainfall. Aquifers are moderated CPRs, and are called upon to replace rain in its absence. Well owners in particular appear to react to droughts in ways that many groups of citizens might intuitively resist—recall that Chapter 2 outlines how the general public can be influenced by water-saving campaigns during droughts. Assuming that the general public notices droughts and adjusts their behaviors in the midst of droughts, and given that well ownership appears to be connected to increased consumption during droughts, water supplies shape individual reactions and rationales for conservation. With that said, in non-drought years, well owners should not need to fully rely on aquifers because adequate precipitation would reduce the need to draw from groundwater supplies.

Nevertheless, this result raises a paradoxical question: can *increased* resource consumption represent a form of environmental stewardship? While groundwater-reliant individuals watch over their dwindling supplies, they also must inevitably, but cautiously, draw on them during intense water shortages. In this light, they can be connected to Hobfoll's Conservation of Resources (COR) theory (1989). Hobfoll's central argument is that individuals stockpile resources needed to ward off stress during difficult times; when someone perceives a moment of stability, they try to conserve or replace lost resources that can be harnessed during challenges. COR theory is well-suited to formulate hypotheses on how individuals perceive the consequences of environmental disasters, particularly drought (Zamani et al. 2006). Applying COR theory to the conservation and management efforts of these groundwater communities can facilitate researchers' understanding of how Kansans perceive the threat of drought. Research on private domestic wells suggests they are dug primarily to ensure a water supply, and not necessarily to conserve water (Thomas and Salerian 1987; Thomas, Syme, and Salerian 1987). COR theory can frame wells as an investment in securing or replenishing stockpiles of resources (groundwater).

Studies indicate that investing in a well can be seen as an adjustment in response to resource scarcity (Keenan and Krannich 1997); following COR, wells can be used to augment a private water supply. The theoretical principles of COR, such as the emphasis on protecting resources and vulnerabilities stemming from lost resources, distinguish the complexities of conservation in a way that harkens back to Aldo Leopold's work on resource management. According to his writings on farmers' embodiments of the conservationist ethic, "Conservation… is keeping the resource in working order, as well as preventing overuse… Conservation, therefore, is a positive exercise of skill of insight, not merely a negative exercise of abstinence or caution" (in Flader and Callicott 1991:257). In other words, drawing from a stock of natural resources in times of scarcity or stress does not automatically disqualify someone from being an environmental steward, but *over-users during times of abundance* can be ruled out. Recent research provides evidence that environmental considerations explain environmental citizenship behavior in a values-beliefs-norms framing; larger environmental priorities are influential precursors of PEBs (Yeboah and Kaplowitz 2016). Chapter 5 outlined how groundwater citizenship requires a grasp of usage and nearby water supplies; this chapter's findings imply that groundwater citizenship requires selective timing for making extractions.

Well owners, while responsible for groundwater extractions, can play an important role as aquifer caretakers by establishing a schedule that allows the underlying water table to recover during non-drought years. Paradoxically, the very people who are most active in the depletion of aquifers are also their protectors; their decisions play a large role in the severity of groundwater overdrafts. Groundwater citizenship above the Ogallala aquifer entails a reliance on groundwater during times of aridity, but that does not necessarily imply irresponsible resource usage. This recasting of stewardship follows Lister's (1997) and Curtin's (1999) arguments that citizenship should be described in terms of the nested sites in which practices of citizenship are performed and individuals establish their identity as ecological citizens in relation to their natural ecosystems.

As the first chapter mentioned, irrigation is the main contributor to the groundwater mining in Kansas; however, not all irrigation should be viewed as unsustainable. Most of the rhetoric surrounding aquifer declines in Kansas frames current irrigation practices as beyond “safe yield,” and the high frequency of irrigation permits depicts how aquifers are over-appropriated. After combing through my qualitative data, I am compelled to push back on the general assumption that all irrigation is unsustainable, and that irrigation becomes less pragmatic with each passing growing season. Presupposing that all (or even most) irrigation is done unsustainably dismisses the unique interactions between surface and groundwater systems. While some of the most heavily exploited portions of the High Plains aquifer will no longer be able to support irrigation unless bold cutbacks are implemented, recent estimates suggest that “…many areas of the aquifer are *in little danger of depletion in the immediate future*…” [emphasis added] (Haacker et al. 2016:239). In fact, due to their adequate inflows of recharge, the Equus Beds and Great Bend Prairie aquifers in south-central Kansas have a depletion timeframe of over three centuries (ibid.). I separated the respondents overlying the Equus Beds and Great Bend Prairie aquifers from the respondents overlying the Ogallala aquifer in part due to those hydrogeological differences. Many portions of the Ogallala aquifer south of Nebraska are experiencing tremendous losses in volume, but this decline is not equally pronounced across the entire High Plains aquifer.

Some groundwater supplies are fully-recharged and surface water percolates quickly and abundantly into smaller, shallow aquifers. “Safe yields” are determined by the withdrawals and the recharge of aquifers, and the groundwater supplies of Kansas have tremendous differences in terms of these renewable qualities. With an annually-recharging aquifer as a supply, irrigation can be conducted in a manner that does not contribute to water table declines when done with discretion. Brownie Wilson (2016) of the KGS attributes the higher recharge rates of the Equus Beds aquifer to its precipitation inflow and the water table’s closeness to the land surface, “It can be subject to stress from continued drought conditions like we saw in 2011 and 2012, but overall it is managed as a sustainable system.” Two respondents who understood this wrote:

> …we do irrigate crops commercially, but from an annually-fully-recharging alluvial aquifer…our aquifer would recharge with any resumption of rainfall,

> hence my response. Likewise with our irrigation wells, in the deeper Solomon River aquifer [in Northwest Kansas].
>
> Right now I think we are okay on water. I don't think our water table is down a great deal. We are located pretty close to the Arkansas River, that's why its [sic] not far to water.

This extraordinary understanding of specific groundwater sources illustrates the awareness that well owners (specifically irrigators) have of their water tables, one of the main themes of Chapter 5. Yet aquifers can sustain extractions that do not exceed their inflow, and in south-central Kansas, respondents appear to have found a type of groundwater management that allows for reasonable levels of irrigation. Perhaps these different ecological settings and moderating variables (well functions) are connected to different performances, and therefore, well owners might be more appropriately described as multiple *communities* of practice instead of a uniform *community* of practice.

Due to differences in withdrawals, recharge, and water table depths, the volume of accessible water in aquifers can vary greatly from one location to another. For instance, data produced by hydrographs (water level recorders) indicate that portions of the aquifer in Haskell County, located in southwest Kansas, can fluctuate over 120 feet during the growing season; meanwhile, an index well in centrally-located Thomas County has shown "remarkable consistency in its responses to pumping" (Buchanan et al. 2015). Since precipitation is higher and the water table is closer to the surface in central Kansas, the Equus Beds and Great Bend Prairie aquifers receive about 4 to 6 inches of recharge annually, or roughly 10 times the recharge of the Ogallala (Buchanan et al. 2009). Researchers actually detected a 30-inch *rise* in these eastern-most aquifers in 2013, but the Ogallala's saturated thickness continued to decline (Wilson 2014). While some places sit above thick water tables with more than a century's supply of water, other areas in Kansas have groundwater supplies that could be dry within fifty years (Butler 2013; Stover 2013a; 2013b).

How the well is used is also an important factor for applying the COR framework. Irrigation farmers might see droughts as a serious threat because low rainfall initiates more groundwater extractions, which would increase farmers' well pumping costs, spark a debate about neighboring water allocations, and perhaps hurt their crop yields. Rural sociologists have documented that farmers with large operations express the highest levels of concern about drought (Keenan and Krannich 1997); due to the resources serious irrigators have invested in groundwater reliance, they likely feel threatened by droughts. On a related note, lawn and garden well owners might see their well as a means of resilience in the face of drought, a tool for coping with dry growing seasons and keeping their lawn or garden fertile. Since these smaller-capacity wells are less expensive and make much smaller extractions than irrigation wells, lawn and garden well owners might not regard droughts as a threat *because* they have a well, which for them is an additional supply that ensures their gardening and lawn care practices can continue through dry years without dramatically increasing their utility bills. These two perceptions of wells reveal how droughts are experienced by different groups of well owners. Irrigators have a significant correlation with awareness and increased outdoor usage during droughts in these models; therefore, COR theory could be strengthened if the conversation of climate change resilience discussed how moderating factors like well function can influence the perception of disasters like droughts.

These results expose another possibility. Conceivably, well ownership can enable what Szasz (2007) characterized as an "inverted quarantine," half-measures that consumers take to modestly adapt to climate change or resource scarcity. Instead of politically mobilizing, letting their lawns fend for themselves, or redefining their watering routines, people install a lawn and garden well and invest in efficient watering devices so they can continue to use water "normally" without having to pay higher water bills or consciously change their behaviors during droughts. Instead of aggressively switching to a low-water lifestyle, small capacity lawn and garden wells can enable water consumption for some Kansans (as opposed to reducing it).

The research questions probing whether geography and well function change Kansans' relationships with water are designed to explore the influence of moderation and nested effects via multi-group analysis. Kansans who reside above the Ogallala aquifer have a weaker correlation between water-related knowledge and owning water-saving appliances than those who live above the Great Bend Prairie and Equus Beds aquifers, but the Kansans who do not live above the Ogallala aquifer have higher correlations between awareness of water supplies and using efficient watering technologies. In terms of these groups' reactions to droughts, Kansans living above the Ogallala aquifer have stronger correlations between awareness levels and increased watering during times of drought than Kansans living elsewhere. While I did not have an adequate number of respondents from GMDs 1, 3, 4, and 5 to analyze them all individually, I was able to collapse the respondents into groups based on their residence above the Ogallala aquifer, or if they lived in GMDs 2 and 5, and compare them to Kansans who do not live above the High Plains aquifer. These geographic nuances would not be revealed if the respondents were studied as a single group.

Non-well owners and well owners both have positive associations between the constructs measuring awareness and water-saving devices, but the correlations are slightly weaker for well owners. Isolating the well owners specifically, and conducting a multi-group model along the lines of the type of well they use suggests that domestic wells are the only type of well that yield a significant positive relationship between levels of water supply awareness and investments in water-saving technology. Droughts appear to elicit a stronger, positive correlation between water usage and awareness levels for well owners than they do for non-well owners. The correlations between water supply awareness, investing in efficient watering technologies, and drought-time adjustments appear stronger for well owners without city water than for well owners with municipal connections. While decreased outdoor watering during droughts was not significantly predicted by awareness levels for domestic, lawn and garden, feedlot, and irrigation well owners, droughts trigger a significant negative relationship between indoor water conservation during droughts and water-based knowledge for domestic, lawn and garden, and irrigation well owners. The positive relationship between outdoor water conservation during droughts and water-based knowledge is significant for all types of well owners. These nuances are evidence of moderation.

When measuring the outcomes of investing in water-saving appliances and curbing water usage during droughts, familiarity with water supplies is positively correlated with the former and negatively correlated with the latter. This implies that increasing Kansans' levels of awareness would theoretically increase the ownership of water-saving devices, but could a boost to awareness levels theoretically increase the water usage during droughts? As I previously mentioned, perhaps the respondents who are the most cognizant of their water supplies reacted to the survey question measuring drought responses differently than respondents who are less familiar with water in Kansas, and I do not want to encourage people to learn less about their water supplies. By applying the PEB literature to this project, I hold that increasing public awareness of water usage is a precondition for better water management. I also believe that this finding puts an amendment on the attitude-behavior gap that is so commonly documented in pro-environmental behavior research. Consider that water usage could be a highly selective process for well owners; by selecting to use more water *only* during droughts, the attitude of resource conservation can be performed by the selective timing of certain behaviors that require water consumption. Yet I have theoretical reasons (COR theory) to believe that this is not simply an instance of the attitude-behavior gap, it is a finding that suggests times of resource scarcity induce consumption, and times of resource plentitude induce moments of stockpiling. This finding produces an amendment to traditional discussions of PEBs: PEBs are selective behaviors that need to be timed correctly.

Previous research summarizes how attitudes and PEBs are not always closely linked, which makes environmental performances challenging to capture via surveys. In light of these findings, it might have been prudent for me to include even more survey questions measuring the "everyday" routines, or the "non-drought" routines, so I could compare the practices adopted during droughts to the practices adopted during non-drought times. Furthermore, I could have sharped the precision of the drought response question from "What do you do, or what would you do, in the event of a drought" to a more exact format: "Have you done any of the following during the 2011-2015 drought?" That type of recall question might have improved the accuracy of the response by giving participants a clearly defined window. At any rate, these results suggest that water supply infrastructure is an important component of citizens' resource awareness, investments in efficient technologies, and reactions to droughts. Well ownership seems to encourage a specific type of conservation—one that is enabled through the use of water-saving devices—but well ownership also is associated with increased watering during droughts, and it changes the relationship between knowledge of water supplies and drought reactions. Overall, Kansans with private wells could be electing to save water through technological fixes over deliberate drought-time reductions. While it is challenging to establish a sense of well owners' specific daily routines with these findings, their awareness levels and commitment to technological adjustments are encouraging, as are the association between well ownership and frequency of deliberate water conservation and the correlations of well ownership ranking water security as a serious challenge facing Kansas (as shown in the fifth chapter).

Furthermore, geographic differences remain an important component for researchers interested in nested effects. Society's embeddedness within ecosystems requires what Catton and Dunlap (1978; 1980) call a new ecological paradigm to ensure that sociologists consider the natural limits of human activities. This chapter contributes to this paradigm by studying the behaviors, awareness, and attitudes of water consumption over separate portions of the High Plains aquifer, a gigantic network of aquifers that each have different rates of recharge and withdrawals. One of the main ideas behind the Governor's Long-Term Vision is to implement conservation strategies at the local level—in fact, the Vision outlines a detailed call to "Measure Success with a Regional Approach" (KWO 2014:53). To some extent, I studied that in this chapter via the implementation of multi-group work, which requires a perspective that acknowledges the importance of nested effects and local, geographic nuances that may not be detected if all of the data were to be analyzed at the state level.

Again, it is possible that the social desirability bias is more influential for non-well owners. They appear to be more conservation-prone during droughts when it comes to their indoor practices, but if the people who do not have private water supplies are less in-tune with their consumption than their well-owning counterparts, they might not be a target population that can be expected to produce valid survey responses on water conservation tactics. While I do not doubt my own findings, it is important to state that awareness levels are influenced by well ownership.

As stated on numerous occasions, my study frames well owners (individuals with private supplies that draw from groundwater formations) as a distinct social group defined by their practices and their exposure to groundwater depletion and drought. According to Chapters 5 and 6, this claim appears to be accurate, but heavily nuanced. Well ownership not only increases technological conservation efforts and the frequency of other PEBs, but it also is connected to a unique reaction to droughts—one of increased outdoor usage and less water conservation indoors. The findings in the data-driven chapters reveal that household water supplies are important predictors of watering routines; therefore, they should be further analyzed in PEB research.

CHAPTER SUMMARY

> Using a sample of 864 well owners and non-well owners in Kansas and multi-group structural equation modeling, this chapter demonstrates that COR theory provides a useful theoretical foundation that offers an explanation for well owners' decisions. Investments in indoor and outdoor water-saving devices are frequently correlated with levels of water literacy for these respondents, who have been delineated along boundaries of geography and water supplies. Geography and well ownership change the associations surrounding water supply awareness,

drought reactions, and investments in efficient watering appliances. Individuals with private water wells can be framed as a distinct social group that is disproportionately burdened by drought, and well owners represent a unique community of practice that can improve how sociologists understand water supply management. In the remaining chapters, I will discuss how these standards of domestic water usage can produce new insights regarding water conservation policies. Groundwater losses are a key climate change challenge, and well owners' decisions about groundwater use will have important consequences for many communities in the Anthropocene. The next chapter discusses how my analyses of well owners has implications for future research and applied outreach.

Chapter VII: Limitations and Discussion

> Sustaining the High Plains aquifer in an era of severe droughts requires an investigation of the individuals reliant on its groundwater. Specifically, researchers must understand how the domestic routines of well owners contribute to overdrafts. This is important because household water usage and well reliance have not been sufficiently analyzed given the reports of rapid aquifer depletion and calls for improving resilience to drought. The interaction between natural resources and societies must continue to be emphasized in environmental studies; my research explores how this interaction is shaped by groundwater development and policy decisions. This project locates groundwater withdrawals within broader processes of political and economic changes; I study how private water supplies shape the interaction of nature and society, and how neoliberal institutions mediate that interaction and dictate levels of development. With this discussion chapter, I humbly submit policy recommendations based on the earlier results.

LIMITATIONS

No research can be conducted without constraints or weaknesses. The tests conducted alongside the ANOVA indicated that the variance between the groups of non-well owners and well owners was not homogeneous for a handful of categorical dependent variables. The proposed model was simplified and my analysis omits some items measuring various dimensions of water usage (e.g., respondent's perceptions of water shortage frequency and their impression of how long their local was supply will last). I had difficulty building a model that included a construct centered around water as a political priority for Kansans, and there are a number of causal (albeit atheoretical) pathways that might serve useful for theory building: are there multiple causal pathways leading to Kansans' awareness of water supplies? Are notions of liminality or inelasticity connected to Kansans' responses to drought? In the current study, I have coded well ownership as a categorical variable, but is there a non-controversial way to clearly conceptualize well ownership as a spectrum? Perhaps one survey item that I did not analyze, the measurement of how long well owners have used their well, could inform a new design in a variable describing well ownership. Supplementing the New Ecological Paradigm with a construct on environmental views (one that included respondents' levels of agreement with notions that mankind was created to rule over nature, the economy should be prioritized over environmental protections, and whether a steady-state economy would need to be adopted) was not achieved in my modeling. The empirical chapter outlined the selection of many of the survey's variables, but there are plenty of survey items and constructs that have not been fully analyzed in this project. Given the heavy majorities of older adult males in well owning populations (which can reach nearly 70 percent, according to other studies [Murti 2012; Murti et al. 2016]), the experiences of younger, female, minority well owners are not equally represented in this study. The influence of racial differences were not assessed because of the low proportion of non-white respondents (9.5 percent). Due to the smaller sample sizes of some of the groupings (respondents living in GMDs 1, 3, and 4, feedlot and irrigation well owners, and "off the grid" well owners), establishing significance or generalizability is potentially problematic. The well owners in my study all had professionally-dug wells which were dug by well drilling companies, but the views of well owners with hand-dug wells (which are typically older and shallower) are not expressed in this research.

On my demanding quest to collect data, I encountered a difficult problem that deserves particular attention. As previously stated, my research assistants and I were able to access the home addresses of Kansas well owners who were listed in the Kansas Geological Survey's database of Water Well Completion Forms (WWC5s). During the spring and summer semesters of 2014, and the spring semester of 2015, a total of seven undergraduate research assistants and I diligently collected 8,132 addresses from the KGS database. We tried to select well owners who had dug wells starting in the year 2000, and we aimed to oversample for women and minorities. In order to sample longtime or former well owners, we also collected addresses of well owners who recently had their wells plugged or reconstructed by a drilling company. Former well-ownership or the presence of a previously-functioning well might influence watering behaviors among Kansans, as water (formerly) provided by wells can conceivably have an effect on someone's water consumption. Wells and cisterns are similar in that regard, a few respondents expressed that they "grew up on well water" or "grew up with a cistern" and have used water sparingly their entire lives due to their water supply infrastructure. This echoes the point I have made throughout the project: water accessibility influences standards of water usage. Unfortunately, only 20 former well owners and 15 cistern owners completed my survey, making it difficult to examine the influence of previously using wells or relying on cisterns. Further, since the KGS database of WWC5s does not include information on hand dug wells, the experiences of maintaining those types of shallower wells have not been included in this project.

The KGS database is organized by county, and some sparsely populated counties (e.g., Allen, Jewell) had no more than a handful of private well owners with viable addresses. Given the distribution of groundwater (and precipitation) in the state, some counties are not geographically suited for a large number of wells. Scanning the counties with fewer well owners for a modest number of worthwhile addresses was often more challenging than collecting data from the counties with a plethora of addresses at our disposal. Additionally, the well drilling companies or individuals responsible for completing some of the WWC5s simply did not complete the form's contact information accurately—or at all. Many WWC5s have only the well owner's name and their city of residence. "Tom Smith of Olpe" is all the contact information provided for many well owners in smaller towns, particularly on the forms that were filed over a decade ago. Only selecting the addresses where wells have been dug since the year 2000 helped us avoid reading through forms that were likely incomplete or inaccurate. Moreover, going back further than 15 years increased the chances that the listed residents and the addresses no longer match, as some of those individuals could have moved or passed away. Even after taking that precaution, two widows sent emails to inform me that their late husband, who was listed on the notification postcard, had recently died.

The research team had to select recent forms that were most likely to be completely filled out and avoid sending postcards to empty homes; these challenges made collecting addresses at random virtually impossible. Even though KGS's database contains roughly 255,000 WWC5s as of August 2016, some of the forms did not provide mailing addresses or accurate information. In order to improve the accuracy of our address collection, the research assistants and I double-checked all of the mailing addresses provided on each WWC5 using online maps before including it in our collection of addresses. While we searched for the addresses in Google Maps or Yahoo Maps to make sure the address on the form actually led to a residence, and in many cases, the listed addresses did not appear in online searches. Minor labels like "Street," "Avenue," and so forth made some addresses unrecognizable to the search engines. The team carefully combed through every single county's records in the hopes of receiving responses from well owners all across Kansas. Not only is this important for analyzing the data with a multi-group or multilevel approach, it also allows me to see how the standards of water conservation change geographically across the state. I received replies from 93 of the 105 counties in Kansas.

Surprisingly, after the attempts to validate addresses online, a sizable portion of our addresses were still inaccurate. This reality was finally revealed when I sent the massive address list to a printing company, which required a preliminary screening of the addresses with the post office before they printed for the notification postcards' mailing labels. The post office reported that 1,111 of the 8,132 addresses (just under 14 percent) were "undeliverable." Apparently, over an eighth of well owners live in rural places so remote that even online search engines cannot accurately establish their addresses, and about one in eight of the Water Well Completion Forms for wells dug since the year 2000 is not accurately labeled. If this trend holds true across all of the private well owners in the state, and if the WWC5s are one of the only records of well owners' contact information, then the ability to reach the owners of potentially thousands of wells is seriously compromised. If 14 percent of all well owners in Kansas cannot be reached with the WWC5 records, a state with over 250,000 wells could be missing important information on the people overseeing nearly 35,000 wells. Using this database as a means to acquire mailing addresses was obviously vital for me to find well owners, but it is in no way comprehensive.[1]

A number of counties (Kearny, Norton, Rawlins, and Republic) had WWC5s with illegible handwriting and unfinished or woefully inaccurate contact information. Surprisingly, Sheridan County, which contains portions of the state's only LEMA, a local conservation framework organized by irrigating farmers, did not have many accurate addresses. This implies that the individuals charged with monitoring well construction in that county have not invested in recording accurate information about well owners, and it severely hurt my ability to analyze residents of the LEMA. I did not have a single respondent from Sheridan County, and only 4 responses from residents of Thomas County, the other county containing portions of the LEMA. The installation of a LEMA required an ethic of conservation, and *efforts* of conservation, over-and-above the regulatory standards of other counties overlying the Ogallala aquifer. Yet Sheridan's WWC5s appear to be as disorganized as some of the counties with poor-quality data. Furthermore, the low return rates from some of the most important policy-driven counties impair my ability to conduct thorough multilevel analyses. If my survey received insufficient data from the counties within a certain GMD, for instance, comparing the GMDs to each other (or to

[1] The KGS survey recognizes this issue and has taken steps to address it. They hired an undergraduate student from the University of Kansas, Cassidy Nelson, to contact well-drilling companies for missing information. He has identified and inventoried well cores that were previously not linked to specific locations.

residents who do not live above the High Plains aquifer) becomes very challenging. Fortunately, some counties had very accurate records and obviously invested a lot in insuring their WWC5s were correctly completed. Saline County had a very high percentage of deliverable addresses, as did Reno County (both of which are in central Kansas).

Each county has a distinct composition of wells that added another level of complication with my data collection. Recall that I am only interested in privately-owned wells registered as domestic, lawn and garden, irrigation, or livestock wells owned by Kansans. Montgomery, Miami, Neosho, Pratt, Rush, Seward, and Shawnee counties are just a handful of counties containing high numbers of injection, geothermal, monitoring, and remediation wells. These types of wells are typically listed under the ownership of the Kansas Department of Health and Environment, gas companies and gas stations, or municipalities. Finding private well owners in these counties was a challenge—despite the fact that most of them had accurate records. Absentee well owners—mostly irrigators who own farmland in Kansas but live out-of-county or out-of-state—were also concentrated within a couple counties. In addition to having inaccurate addresses, Kiowa County's WWC5s listed many out-of-state well owners. Located in southwest Kansas, Kiowa, incidentally, is home to the world's largest hand-dug well (Thomas 2004). Wabaunsee County had many absentee well owners, although they resided mostly in Topeka. Absentee well owners who resided within Kansas were eligible to complete the survey, but I did not deliver notification postcards to those living outside of Kansas. My study only had 28 absentee respondents, 10 of whom also own wells near their household). I will discuss policy recommendations in more detail later in the chapter, but my experience with the KGS WWC5 database leads me to one straightforward recommendation that could be relatively easily to implement: *update the Water Well Completion Form with a section for the well owner's email address in addition to their home address, and make sure the forms are electronically submitted so the issue of illegible handwriting is no longer an issue*. Updating the completion forms for ease-of-use in an increasingly online world will enable the KWO and KGS to contact this important subpopulation of Kansans more easily. The opening chapters discussed how domestic usage is not measured in Kansas because small capacity wells do not require meters. This renders Kansas's estimates of groundwater losses during droughts slightly incomplete.

Given the great number of irrigation wells in western Kansas, it would be reasonable to expect a large response from high-capacity well owners and residents from Groundwater

Management Districts. Many hundreds of irrigation well owners' addresses received invitations to participate in my study, yet only 61 irrigators took the survey. Perplexingly, despite the enormous number of wells and irrigators in southwestern Kansas, my return rate for the counties at the epicenter of the groundwater economy was abysmal. Finney County, for example, which contains Garden City and relies on its thick but rapidly-declining portion of the Ogallala Aquifer, yielded a mere 12 respondents. Only 64 of my respondents, 7.4 percent of my sample, were from GMD 3, an area defined by its groundwater reliance and its nearly 26,500 registered wells. Due to my low returns from GMD 1 (7 respondents), GMD 3 (64), and GMD 4 (27), I had to collapse these 3 far-western Districts into one category for my multi-group work and examine them as an "Ogallala" group. Furthermore, GMD 5, which overlies the Great Bend Prairie aquifer, had 25 respondents; I pooled those participants with the nearby Equus Beds GMD (GMD 2).[2] Thankfully, GMD 2, which is defined more by its residential areas and industry than agriculture, yielded by far the most responses out of any District. A total of 222 residents from counties in GMD 2 completed my survey. This number represents a full quarter of my respondents, and 146 of those respondents are from Sedgwick County alone. GMD 2 overlies the relatively small Equus Beds aquifer and contains the northwest portion of Sedgwick County and Wichita, the state's largest city. Sedgwick County has over 20 percent of all the wells in the state, so its contribution to my study met my expectations; however, the underwhelming response from irrigators and residents of southwest Kansas deserves more attention.

While my study was unable to acquire a proportionally large number of responses from irrigators and residents from Finney County, this should not imply that these people do not care about water. In fact, I can perceive two possible reasons for their nonresponse, and neither involves a lack of interest. For one, this population might have "research fatigue" because they live in an area of serious groundwater reliance, making this portion of the Ogallala aquifer very interesting for several researchers studying water usage and drawdown. Farmers across Kansas have been solicited for their participation in recent academic studies (EPSCoR 2013a; Gray and Gibson 2013); each year geologists request groundwater measurements obtained from hundreds of wells' depths (KGS 2013b). Irrigators might be tired of getting probed by researchers or discussing their wells, which could make residents of rural communities in western Kansas resistant to volunteering time for academic purposes.

[2] Thirty-five of my respondents, 4 percent, did not indicate their county of residence.

Moreover, well owners here might want to keep their usage private. It is likely that they care so passionately about their water supply (which has been declining in GMDs 1, 3, and 4) and their water allocations (which are restricted for junior water rights holders) that providing information about their usage could be interpreted as threatening to their allocations. If this is the case, I believe I have discovered an ironic pattern for groundwater researchers and survey methodologists to acknowledge in future studies. Survey research has long suggested that individuals who are interested in the subject matter of a survey have been generally more likely to complete it (Roeher 1963; King et al. 2001; Edwards et al. 2002). Perhaps the opposite is true for some well owners—specifically irrigators. In fact, I received an email from an irrigator who was obviously passionate and knowledgeable about groundwater, and his intense interest in water conservation (and perhaps disdain for someone he perceived as uninformed) explains why he did *not* complete his survey:

> I tried your survey this morning. I give up half way through. Your survey is typical of anything that happens in Eastern Kansas. You know nothing of our situation in Western Kansas. You would like to shut all irrigation down and save it for what? I am a farmer from Garden City. Our economy is dependent on the water being pumped be it crops, livestock ethanol production or industry. Take away our water and you will destroy our community…. Please do not think that I am foolish and wasteful with our water supply. My farm is one of the most efficient in this area. I do not "waist" [sic] water. I do however use it as a tool to make a living. I am all for being conservative and efficient, however I will do whatever the numbers for profit dictate. Find me a crop that uses less water and still makes me money and I will gladly grow it.

If participating in a study can be seen as disclosing sensitive information, it can introduce an element of vulnerability into the study, even if the research agenda greatly interests the participant. Furthermore, the high number of demographic questions apparently made some respondents nervous:

> I guess I'm confused why there where so many questions that did not pertain to WATER and/or water issues. Yes I believe that water and water usage is something to be taken seriously. What is your TRUE PURPOSE for this survey?

> What are you doing with all the information? Who has access to it and who are you giving it to?

The second chapter pointed out that public infrastructure crystallizes the boundaries of citizenry and outsiders. Well owners (and rural Kansans in general) might feel excluded from communities, or the larger legal and political apparatuses that influence their lives. A sense of exclusion could lead to hesitancy in completing a survey about water usage. If rural well owners do not feel included or believe they are truly equal citizens (because they lack the benefits of municipal utilities) they could be cautious to reveal information about their private water supply. T. H. Marshall's classic book on citizenship in sociology, *Citizenship and Social Class* (1950) describes the inclusiveness granted by citizenship, specifically the advantages of civic and political rights. It was later argued that this narrative is unhelpful for noncitizens because "citizenship functions above all as a device of external exclusion" (Joppke 2010:14). If citizenship is an exclusive and divisive category, it would imply that noncitizens or partial citizens are ostricized from decisionmaking in their surrounding communities. Such seclusion would likely lead to a lack of sympathy among rural Kansans, particulary for the research agendas of someone they see as an outsider or not fully informed about their water supply.

These qualitative responses reveal complicated mechanisms that make compiling a completely random sample difficult. Respondents' geography, occupation, views towards researchers, and water usage have all influenced the decision to participate in my study. The sensitivity of water accessibility changed how some of the most-informed respondents perceived my request for their participation, and it is hard to understand the rationale for why some respondents selected to participate or not participate in this survey. While a small number of respondents made it clear that they were hesitant to provide information because of their stake-holding with groundwater, I cannot speculate that this hesitancy is consistent across all well owners.

Despite these challenges, I do not want to give the impression that well owners are a distinct subpopulation that is prone to resist sociological assessment. As the tables in the methodological appendix note, a dozen respondents replied to the first notification by contacting me via email, explaining that they could not get the URL address provided on their notifications to work. This suggests that they were not discouraged after their first failed attempt to access the survey, and that they were willing to inform the researcher of their technical difficulties, volunteer their time, and offer their insight. After launching a new wave of surveys with updated URLs, I provided those respondents with links to the surveys of the second wave. Additionally, another dozen respondents returned their notification postcards via post to my office, informing me that they would like to participate in the study but did not have internet access or own a computer. They requested a paper copy, which I immediately sent with a pre-paid return envelope. Reaching this population is challenging because of their remote, rural locations and their occasional lack of internet access, but many respondents expressed a sincere devotion to this topic despite their initial technical problems or inability to retrieve online surveys. Even though a handful of hesitant or resistant postcard recipients caught my attention, I also stumbled upon at least two dozen eager volunteers. The lack of internet access should also be of interest to stakeholders in the Governor's Long-Term Vision: one of the research-based goals for understanding the state's water supply is to adopt an online water use reporting system to make information available to municipal customers (KWO 2014:38), but a small portion of Kansans are still not online. I continue the discussion of online surveys in the appendix.

As I discussed in Chapter 5, while I frame well owners as a distinct social group, my research needs more evidence to clearly establish if they see themselves as such. Conducting interviews would shed light on this topic. Personal stories about well owners as a community would provide "critical insight into why networks emerge, which specific concerns people have, how networks attract members, and how they persist in adverse situations" (Lejano et al. 2013:5). While interviews would have helped build a richer qualitative dataset to supplement the many open-ended survey replies, and they would have captured a more detailed record of well owners' practices and reactions to droughts, the timeline for conducting a survey in addition to interviews does not typically align with that of a Ph.D. Nevertheless, these limitations should not give pause to the project's overall conclusions: well owners are a unique subpopulation, their wells' function is a moderating variable for their reactions to drought and investments in water-saving appliances, and the relationships between awareness, drought responses, and investments in efficient technologies change geographically across Kansas.

OUTREACH AND FUTURE DIRECTIONS

Elizabeth Shove (2010) noted that the assumed role of the social sciences in environmental work amounts to measuring public awareness and PEBs. While sociology needs to take a far more expansive role in the climate change dialogue, these predetermined research agendas have led to important discoveries that should not be underestimated. Cognizance of water supplies is connected to water usage, and overall, public awareness about water usage is noticeably low. Research on water footprints notes that people are usually unfamiliar with their *indirect* water usage, the embedded water in the goods and foods they consume, not to mention the overall amounts of their domestic water usage (Hoekstra 2013). This research not only probed the possibilities of harnessing the collective efforts of a community of practice defined by water usage, but it produced a tremendous amount of material that reveals a community of awareness distinctly comprised of well owners.

Regarding the outreach for my study, after my defense, I will email a short report and thank-you note to the respondents who provided an email address and requested follow-up information about the research. I also shared my preliminary findings in a blog run by the Climate + Energy Project (CEP), a Kansas-based nonprofit organization that focuses on energy and water conservation techniques in agriculture and encourages informed policymaking (Ternes 2015). At the time of this writing (October 2016), I have also been assigned to make various presentations across the state with the support of the Kansas Humanities Council's series on water in Kansas. Future outreach could conceivably include making presentations at GMDs and sharing my results with GMD organizers, who would know how to include the information in their quarterly newsletters and meetings. GMD newsletters are widely distributed and contain several notices on groundwater that are relevant to well owners. Using multi-group analyses allows me to generate location-specific presentations. I anticipate that sharing these results would raise awareness about the importance of domestic water usage. During these meetings I could also interview groundwater experts, which would bolster my qualitative dataset and help me reevaluate my survey results. Additionally, my survey provides insight regarding public support for the proposed Kansas Aqueduct. While recent studies updated and evaluated the technical, legal, political, and financial feasibility of the Kansas Aqueduct (KWA 2015), to my knowledge, this project includes the only investigation of public opinion of that massive waterworks proposal, and sharing and publishing that information would be one way to keep Kansans informed of state policies and water supplies.

While GMDs primarily encourage farmers to practice efficient irrigation, their endeavors could influence farmers' household practices as well. In other words, I anticipate a positive correlation between irrigation conservation efforts and conservation practices beyond agriculture. Furthermore, I hypothesize that farmers, a population renowned for their skepticism of climate change (Prokopy et al. 2015), will not only express concern about drought and groundwater availability, but will be proactive stewards of groundwater. I expect this will be particularly true if they live above the High Plains aquifer—that is to say, if they reside in a GMD. This counterintuitive prediction implies that despite many farmers' climate change skepticism, they will acknowledge that droughts necessitate water stewardship in both agricultural and domestic spheres.

In accordance with VBN theory that is typically used to explain why women participate in more PEB than men, the gender gap in water supply awareness does not explain women's higher levels of private-sphere watering reductions during droughts. Looking to other factors (structural) to explain the feminization of water conservation during droughts—not to mention accessing a dataset in which running models on constructs measuring values and beliefs would produce acceptable fit indices without Haywood cases—is something that can be established in future projects. During this study's first year of conceptualization, I had a vague awareness that groundwater reliance was an important subfield within medical research. Some of the most easily-accessible newspaper articles on well owners in the US were warnings about groundwater contamination, and this gave me a general sense of the "state of the field" of well owner research. As my project matured and I met health researchers who specialize on well owners, I began to realize the serious issues facing unregulated, private supplies. Had I a clearer understanding of the potential medical interest in a dataset on well owners, and if my research agendas were more aligned with medical sociology earlier in my graduate career, I might have restructured the survey to include more questions about contamination issues and my respondents' confidence in their supply. The medical community would likely benefit from a dataset on the practices of groundwater testing (and well stewardship) among Kansas well owners. Since I still have all of the well owners' mailing addresses, not to mention the email addresses of 133 respondents who provided them in their post-survey feedback, this project could mark the opening of a small longitudinal study, perhaps one of great interest to epidemiologists.

Health researchers also can offer important insight regarding effective community outreach. Distributing educational materials that emphasize how affordable and easy well testing is (it only takes 10 minutes to collect a water sample and costs $15 to test well water for arsenic, with a recommended frequency of every 3-5 years) would be one way to promote well stewardship. Community well testing events and demonstrations are among the best ways to communicate with well owners about the importance of testing for contaminants in their groundwater (Susca and Rigrod 2015). This survey has found high levels of concern regarding water supplies among well owners, yet inadequate well stewardship remains an issue: 18 percent of well owners in this study never test water quality nor check well depth. Environmental sociologists typically concern themselves with environmental injustices, and in many instances, the people hardest hit by climate change are the ones least able to cope (Carmin et al. 2015). Groundwater losses in Kansas reveal a different paradigm for sociologists to consider: that well owners may not be "sitting ducks" or easy targets who are vulnerable to drought in hydraulic sacrifice zones. In fact, they could be more resilient to drought, not less, because of their familiarity with and exposure to droughts—and if they monitor their wells to ensure their supply is safe from contaminants, they would likely be securer. Western Kansas has a long history of aridity, and adjusting to fluctuations in rainfall is part of the lifestyle in these rural communities. Vulnerability to hazards is not distributed equally across different populations, and part of these various levels of exposure can be connected to water supply infrastructure. Well owners' lifestyles and properties could be fortified against dry conditions, especially if they have stockpiled or conserved resources during non-drought years. As my models implied, the relationship between high levels of water supply awareness and increased watering during droughts is positive. If Kansans have saved their water for a dry day, and follow the framework of COR theory, cautiously drawing from groundwater reserves can be a form of groundwater management.

This dissertation explores the water conservation tactics employed by well owners, and seeks to understand the influence of droughts, community efforts, and specifically policies enacted by GMDs. Using a multilevel approach will give policymakers a stronger sense of which scale is most effective for water conservation campaigns. As outlined in Chapter 1, Kansans have generally approached water management at the local level (Ashworth 2006). Most of the political efforts addressing water table declines have emerged at the sub-state level. Ambitiously, the High Plains Underground Water Conservation District in Texas has agreed to cut its pumping by 28 percent by 2016 (Postel 2012). Similarly, in Northwestern Kansas, irrigators in the LEMA within GMD 4 have agreed to reduce groundwater pumping by 20 percent by 2018 (Malewitz 2013). Even in communities not overlying the aquifer, domestic well owners' withdrawals are being noticed in some parts of Kansas. Local politicians in Ellis and Hays counties are working to reduce domestic water consumption, and in 2011 the city of Salina restricted lawn and garden watering from domestic wells (Stover 2013b). Comparing the conservation practices of residents living in different counties, LEMAs, or GMDs can be analyzed through multilevel methods.

Basically, MSEM allows me to answer questions such as, “Are statewide conservation campaigns more effective than campaigns at the local level?” “How do the residents of each GMD prioritize efficient water usage?” By seeing respondents as nested, these are the questions multilevel estimations can answer, and my work uncovers those patterns in conservation. One approach to analyze this type of data is to disaggregate the higher-level variables down to the individual level, so by assigning all the respondents with a particular GMD or county, I can examine how water conservation changes across the state with more precision. Following the effects of social structures at the micro-, meso-, and macro-levels can be more accurately understood with multilevel analyses. This is a tool that can benefit sociologists interested in understanding the importance of a particular social context (Ehrhardt-Martinez et al. 2015). Sociologists who employ multilevel analyses can shed light on climate adaptation practices and community knowledge, which will in turn influence policy and increase the understanding of how to promote adaptation at local, state, and even national levels.

The representation of water was somewhat explored here with the employment of moderation analyses, but how do the storylines around managing scarce resources, protecting the environment, and thrift emerge across the state? This work offers some explanation about various rationales for water consumption or conservation, and how they are summoned within private systems of water provision, but having more qualitative work to trace how the philosophical distinctiveness and utility of water is seen among Kansans could be one avenue for future research. Sociologists investigating water usage have called for the development of “data collection and analysis that combine quantitative and qualitative approaches and that generate better understanding of variety and diversity in everyday patterns of water consumption” (Medd and Shove 2007:v). This project designed and tested a survey instrument that examined routines and practices, so it contributed to the sociology of water usage on a methodological front, but more could be done to investigate the daily deliberations about water and the activities within the network of well owners in specific areas.

Multilevel SEM could merge social and environmental data around polygons of GMDs. Downscaling to specific regions or communities can harmonize units of analysis, which can be a major part of climate change research moving forward (Marquart-Pyatt et al. 2015). In my study, the organizational unit of GMD (or residence above the High Plains aquifer) was essential, but future studies could conduct analyses on seasonal temperature variations, precipitation, or other variables considered for multilevel work. Examining multilevel patterns along the lines of environmental realities are possible, but since social institutions play a major role in how water is distributed to citizens, the boundaries of social structures (including counties, GMDs, and so forth) are arguably more sensible dividers used to study nested effects. One action item in the Governor's Vision is to assess water management based on 14 planning regions, each with unique rivers, reservoirs, alluvial (or deeper) aquifers, and precipitation levels. The regional goals could be structured around levels of public support awareness, and community-level ideas could be revealed by that multilevel analyses. Furthermore, employing GIS (Geographic Information System) would display the spatial variations in water usage, conservation efforts, economy and population across regions. That level of spatial analysis is a unique contribution to the existing literature because it has not been widely used in sociology, even though sociologists have taken steps to study sophisticated ecological contexts (Downey 2006). Given that my dataset follows the organizational level of the KGS WWC5 database, my dataset's most precise geographic unit is at the county level; therefore, this dataset would not be particularly conducive for GIS analysis, which is capable of handling extremely precise (address-level) data.

Multilevel work can reveal how communities are different, which would provide useful directions for researchers who intend to study a particular unit in a case study. This opens the opportunity for a precise understanding of a small portion of the state while also framing it within a larger story of the groundwater economy. In order to elaborate on my survey findings, I could interview water experts, which would provide more insight for this project's findings and theses involving well owners and water supplies. This dissertation's data could therefore spark a phase of semi-structured interviews to supplement the quantitative data. Furthermore, since my dataset is primarily comprised of home owners and politically center-right, interviewing well owners who vary along those demographics can help explain any variance between those groups that were not explored in this project. Overall, the CFAs which opened Chapter 6 reveal that well ownership is an important predictor in water supply awareness levels, and is positively correlated with indoor, but not outdoor, investments in water-saving technologies (income remains a significant predictor of both). Living above the High Plains aquifer has a significant and higher positive correlation with outdoor, but not indoor investments. While womanhood is negatively associated with awareness levels and owning efficient outdoor watering appliances, it is significantly connected to conserving water indoors and outdoors during droughts with behavior deliberate changes. Political views, education, and age have modest predictive associations for each latent construct. With respect to stewardship, it is possible that religious views influence some respondents' rationales for conservation. My survey utilized two items on religious affiliations, which could be connected to water conservation routines in future projects.

While my study focuses on water conservation among many Kansans, both well owners and non-well owners, it is important to consider geography and nesting effects. Since different segments of the aquifer respond to recharge and extractions in unique ways, Kansans who reside above one groundwater formation may require swifter conservation efforts than others. When examining figures for individual counties or GMDs, the aquifer's lifespan shifts from over 100 years to just a couple decades. For instance, Sheridan County in northwest Kansas has a 90-year supply of accessible water on average, but areas within the county only have been reliant on a sliver of their remaining pumpage for decades (GMD 4 1991). The enormous variability from community to community illustrates the difficulty of developing a one-size-fits-all groundwater management policy, and therefore requires the adoption of multi-group modeling. As I mentioned in Chapter 2, sociology is equipped to clarify the social contexts of consumption decisions. Moreover, it is a discipline that can utilize methods that incorporate measurements of the natural world (like the boundaries of aquifers) into social sciences analyses. Water shortages, droughts, and groundwater declines can span large regions, but all water shortages are specific to a place or type of environment. Multilevel and multi-group analyses that investigate nested effects are *made* for investigating water supplies.

The idea of Integrated Water Resources Management (IWRM) to address freshwater crises aims to manage local, national, and global resources in an integrated framework to achieve water governance (Conca 2006). This is obviously an ideal, but policymakers need ideals to construct their frameworks for managing natural resources. The burdensome effects of natural resource exploitation typically remain localized, and multilevel data analyses can strive to understand how the local, national, and global scales can be proficiently connected. Thinking broadly about water shortages, it has been argued that "the world water crisis is a crisis of governance—not one of scarcity," (Mollinga 2008:9) and that water management should be seen as a site-specific and context-specific result of policymaking. Water resources are collections of river basins, aquifers, and landscapes, and these physical boundaries must be considered. Given the tremendous differences in precipitation and groundwater availability across the state, the concentration of wells in western Kansas, and the precise boundaries of each GMD, conceptualizing my data as nested will have tremendous policy implications. Recognizing the embeddedness of policies and well owners' decisions within broader social, political, economic, and environmental structures allows a level of accuracy not easily attainable through uni-level approaches.

POLICY RECOMMENDATIONS WITHIN A NEOLIBERAL POLICY REGIME

> One of the most pressing contributions [sociology] can make is to legitimate big questions, especially the ability of the current global economic system to take the steps needed to avoid catastrophic climate change. (Dunlap and Brulle 2015:430)

In Kansas, and across the planet, the principles of neoliberalism currently mandate that liberal market economics are the best approach for managing resources; neoliberalism redefines nature as a collection of consumable, sellable commodities (Cowell and Thomas 2002). "Everything is now for sale, even these areas of life, such as social services and natural resources, that were once considered the common heritage of humanity" (Strang 2013:21). Abandoning the protection of natural resources via the privatization of ecological commons has been ongoing all over the world, which has led to shifting the responsibilities for maintaining private resources away from governments and into the hands of private industries (Barlow and Clarke 2003; Strang 2013). Growth machine communities based on economic development might oppose expensive mitigation efforts and support the increase of drought vulnerability, such as intensifying development in drought-prone regions. In an age of neoliberal dominance, the benefits of growth are centered around entrepreneur's wealth, rather than the prosperity of residents. This, in turn, creates a social-ecological system in which natural resource extraction is greatly influenced by neoliberalism.

Thinking broadly about neoliberalism, its emphasis on growth encourages new attempts to commodify natural resources and efforts to solve ecological problems with markets. Framed generally as "economic rationalism" (O'Connor, Orloff, and Shaver 1999), neoliberalism holds that market expansion is the best way to improve livelihoods and manage resources. Neoliberalism elevates market exchange values over all other use values which leads to a commodification of natural resources (Molotch 1976). Foster, Clark, and York (2010) have criticized this generation of *natural capital* as a serious “transmutation,” a problematic strategy used by market fundamentalists to write off environmental limits. For Foster and colleagues, reconceptualizing nature in terms of exchange values as a form of natural capital is equivalent to “Putting price tags on species and ecosystems,” and will ultimately “subsume nature to the endless growth of production and profits” (2010:114). Since cost-benefit analyses cannot possibly contain all the information needed to make informed decisions, employing an economic analysis for dealing with environmental problems is “an ideology, a normative outlook disguising itself as a report on the nature of things” (Jamieson 2014:143). The commodification of nature fits within the framework of evolving neoliberal legal systems and capitalism’s growth imperative.

Growth machine theory suggests, however, that growth is achieved through a burst of market signals, the creation of markets, and the commodification of natural resources. Kansas is extremely reliant on groundwater; 70 percent of the water used in the state is obtained from the High Plains aquifer (Buchanan et al. 2009). Yet the state is trying to achieve growth using a resource supply that is essentially non-commodified. This research explores resource extraction based on use values instead of exchange values, thus making an important addition to growth machine theories in the High Plains. Simply put, the groundwater economy is unlike typical economies based on natural capital, and non-commodified groundwater plays an essential role among the growth machines of western Kansas. The commodification or taxation of groundwater, therefore, would have a large effect on how aquifer-reliant towns survive. Allow me to make a few recommendations to the Kansas tax structure.

If groundwater extractions were taxed, what level of a tax would be reasonable? The answer could be informed by the state’s current budgetary needs and its groundwater withdrawals. Recall from Chapter 3 that the State Water Plan requires a $6 million annual budget, and Chapter 1 noted that irrigation extractions from the High Plains aquifer reach approximately 3 million acre-feet every year. Given the variations in precipitation from year to year, a $2 per acre-foot tax should provide nearly enough revenue to secure funding for the SWP. Each year, irrigators have to submit water usage reports to the KWO, and the agency could then establish the year’s tax for each water rights holder. Kansas has the data and the ability to establish and calculate a per-acre-foot tax per holder, although the KWO, or perhaps the KDA-

DWR, would need to be given new authority to enforce and collect the tax with an amendment to the SWP. Such a project could also conceivably be overseen by the Blue Ribbon Task Force, which is tasked with designing methods for funding the SWP. Budget uncertainties have been a major problem for the Brownback Administration, so developing any proposal that would generate revenue and ensure that state programs are funded should be seriously considered.

Kansas farmers “confront a balancing act between their context, their identity and the farms and farmers they hope to become” (Nelson and Stock forthcoming). Chapter 3 focused on the circumstances pushing farmers towards groundwater reliance and conventional (productivist) operations, but policymaking can shape farmers’ contexts in a way that promotes best management practices. A $2 per-acre-foot tax might encourage some farmers to irrigate less, which would generate less revenue; however, it would at the same time allow portions of the aquifer to recover. If the tax was raised high enough over a period of decades, it could serve as a lever to slowly bring well-pumping closer to a safe yield policy. Hypothetically, a $2 tax set in place in 2020 could be raised each year by 20 cents, reaching $4 by 2030, and $6 by 2040. By that time, it would only require the extraction of 1 million acre-feet to fund the water plan. More importantly, only pumping 1 million acre-feet represents a decrease of extractions that would effectively bring the state’s groundwater removals very near a safe yield goal (Kansas’s portion of the High Plains aquifer receives just under a million acre-feet of recharge each year). Even a tax as high as $6 per acre-foot is lower than the accounting prices that have been recently calculated; studies estimate the value of pumping an extra acre-foot of groundwater for the average farmland in Kansas to be between $7 and $17 (Fenichel et al. 2016). The total economic impact of an acre-foot of water pumped out of the High Plains aquifer is roughly $80 (Ashworth 2006). A modest tax could serve as an offsetting policy that would generate revenue while reducing groundwater (over)reliance.

Chapter 1 described the enormous variation of groundwater availability across the state, and it outlined how groundwater declines are more severe in the southwest portion of the aquifer. Therefore, it would be completely reasonable for each GMD to establish its own tax rate for each acre-foot removed. The Governor’s Long-Term Vision for the Future of Water Supply in Kansas aims to guarantee that the state has water fifty years from now, which is a generous timeline for a hypothetical tax on groundwater consumption to gradually increase within each GMD. By the end of the 50-year Vision, an irrigation tax could be adjusted in a way that brings every GMD to a safe yield approach. If each GMD preferred to emphasize protecting senior water rights, they could also negotiate a different (higher) tax rate for newer water permits—say, permits predating 1960 could be taxed at one rate, permits predating 1970 at another, and so forth. This would be a form of revenue generation that would represent the state's Water Appropriation Act and respect the holders of senior water rights.

Furthermore, geologists have established that domestic, small-capacity wells can also remove several hundred acre-feet of groundwater a year (Wilson et al. 2008). This once again illustrates the importance of moderation—the relationship between water usage and reliance on groundwater is moderated by the well's function. High capacity wells in a GMD could be taxed on an acre-foot basis, while domestic or lawn and garden wells might be taxed at a higher rate. Using an acre-foot of water for indoor domestic consumption would be plenty of water for a year for most households, and well water taxed at a domestic rate of even $5 per-acre-foot probably would not be noticed by the householders. Groundwater removals from lawn and garden wells could be taxed substantially higher, given that their demand is non-essential—and most lawns and gardens are likely small than an acre. Small capacity wells could also be taxed at a smaller unit than an acre-foot (perhaps every 1,000 gallons). Whatever the unit, a tax signal (similar to a price signal) would have to be high enough to sufficiently reduce lawn watering. Unlike outdoor water consumption, indoor water consumption is "inelastic… [so] raising the price [would] not significantly change the amount people [consume]…" (Simms 2016). Moreover, times of crisis and resource scarcity (for my purposes, drought and moments of sharp water table declines) reveal how flexible or rigid so-called "everyday practices" are. As Chapter 1 mentioned, low-capacity wells in Kansas do not always require a meter, so in order to implement this tax, every well, regardless of its function and size, would have to be metered. Other High Plains states (Wyoming, Colorado, and New Mexico) require permits for all wells, including domestic wells, but Kansas only monitors high-capacity wells (Ashworth 2006). Nevertheless, having different tax rates for different wells in different regions would be an option for revenue generation and resource management on the political front.

I imagine a number of Republican policymakers and citizens (not to mention irrigators of all political stripes) might find a tax on groundwater removal highly controversial, but Kansans should consider the options granted by its long-established water laws. To my knowledge, there is nothing written in Kansas Water Law (since the Water Appropriation Act of 1945) that stipulates that groundwater cannot be taxed—only that it belongs to the people of Kansas and water rights can only be granted if the water has beneficial uses. Agribusiness using Kansas groundwater represents a multi-billion-dollar-a-year industry for the state, which makes attaching a $6 million annual tax on tapping the aquifer seem less aggressive. Such a tax could also be structured as a tiered progressive tax, or a volume-based tax, whereby the irrigator's first 500 acre-feet (or 1,000, or 2,000) could be taxed at one rate (say, $2 each), the next 2,000 could be taxed at $2.50, the next 2,000 at $3, and so on. A tiered tax system on groundwater withdrawals would encourage the highest users to curtail their pumping, try growing more drought-resistant crops, or even rely on rainfed operations. An irrigator would hypothetically be taxed $1,000 for withdrawing 500 acre-feet, roughly 163 million gallons. Eventually, it would make financial sense for many farms to become less reliant on irrigation. While a tax on groundwater would be new to Kansas, in rare instances well water has been taxed abroad. The decision to tax groundwater reduced groundwater extractions (but not private well digging) in Gujarat, India, an area experiencing rapid water table declines (Hardiman 1998). Levying a tax on resources can provide a motive to more cautiously draw from aquifers.

When it comes to the enforcement of Kansas water law, the state uses the doctrine of prior appropriation, but due to the overallotment of water rights (particularly those given out during the 1970s and 1980s), it is challenging to limit Junior water rights holders. Therefore, the state is actually withdrawing and allocating water closer to an *absolute ownership* or *reasonable use* doctrine—groundwater is something that is assumed to "come with the land" that can be used for beneficial purposes, even if it infringes on nearby landowners' abilities to access groundwater. While the Long-Term Vision calls for localized efforts in solving groundwater declines, it might have been more effective if it simply stated that Kansas would transition to a *correlative rights* doctrine (which is used in California) within the next fifty years. Correlative rights doctrines stipulate that well owners must respect neighboring landowners when making decisions about their pumping. The Vision also could have built on the updates made to the GMD Act of 1978 to reshape the role that IGUCAs (Intensive Groundwater Use Control Areas) play in future water policies. Chapter 1 summarized how the Chief Engineer of the Division of Water Resources has the authority to reduce the withdrawals of any water rights holder within an area of pronounced water supply disputes. The controls of an IGUCA can include closing an area to new appropriations and reducing groundwater withdrawals, even from senior appropriators.

IGUCAs are considered the most effective available tool around the legal barriers to limiting overdrafts. Establishing more IGUCAs, especially in some of the agriculturally-active ("beneficial") parts of the state, would be a bold, effective action. The state will soon begin assessing groundwater conditions and recharge rates in all five GMDs with a groundwater modeling project that will first target the Equus Beds GMD (AP 2015), which will further clarify the sustainable goals for maximum withdrawals. Mandating restrictions will demonstrate that Kansas still has the ability to enforce basic water laws in order to conserve its natural resources. "First in time, first in right," is no longer fair—especially in areas with over-allocated water rights. Having a Chief Engineer, and a Governor, who is willing to take criticism from irrigators and agribusinesses will ensure that some of the most vulnerable parts of the state will have water over the long-term.

Chapter 3 discussed Republican opposition for environmental protections and climate change denial, but there have been glimmers of hope that climate change will register as a serious issue for both parties in the current election year of 2016. It is clear that political affiliations are the strongest predictor in concern about global warming (Dunlap and McCright 2015; Harvey 2016), but climate denial is not a tenable long-term position for the Republican Party because it is largely limited to a dwindling group of white, conservative men (McCright and Dunlap 2011a; Nuccitelli 2016). The number of Americans who say there is no solid evidence of global warming registered a record low in 2016, only 15 percent (Mills, Borick, and Rabe 2016). In these political-charged and economically-uncertain times, a majority of Americans still would be willing to pay for a small carbon fee on their monthly utility bills (Greenstone 2016). 2015 was the hottest year on record, and heeding the warnings from the scientific community could give conservatives a platform to propose free-enterprise solutions and eliminate subsidies (Inglis 2016).[3] Evidence also suggests that Republicans have pivoted toward the center on climate change policies, "by acknowledging climate change, a candidate could appeal to voters who think it is ridiculous [to disagree] with the overwhelming consensus of peer-reviewed scientific research" (Geiling 2016). Climate change advocates also note the importance of environmental policies to young voters, and the growing numbers of constituents

[3] Republicans could market renewables as a form of economic security, as the global investment in clean energy has enabled global GDP to increase and global emissions to flat-line. This indicates that some economic activity is "decoupled" from resource consumption (Tong 2016).

who want political leadership that takes into account the urgency to reign in emissions (Lehmann 2016). This suggests that the denial gap will likely be shrunk in future election cycles, and that both conservatives and liberals can treat Anthropocene adaptation as a serious political priority. As indicated in the Kansas state legislature primary races during the summer of 2016, the rebuke of far-right Republicans suggests that pragmatic conservatives will reclaim their traditional position in Topeka.

Politically red states have actually shown that they can lead the way in renewable energy, as Texas, Oklahoma, and Kansas had the highest numbers of new wind energy projects in 2015 (AP 2016). Republican policymakers from the areas benefiting from renewable energy are now quietly compromising with Democrats to get tax breaks for wind and solar projects (Ryan 2016). Kansas has the second-largest potential wind market in the nation, and is fourth for its number of annual sunny days, so the state has barely tapped its solar power. “We can be the go-to state for cheap, renewable power,” said Dorothy Barnett, the director of CEP (2016). One-quarter of energy in Kansas is produced renewably, and that is expected to increase as the price of wind energy continues to drop. Wind energy is gradually gaining bipartisan support, which is great news for the general public. Out of all the hypothetical construction projects which would displease my respondents the most, the construction of wind farms was far more favorable to the construction of pipelines, nuclear and coal power plants, and fracking. Well owners also appear to be highly dismissive of large cattle or pig feedlots, which are notorious for jeopardizing surrounding water supplies with their intense demands for water and their propensity to contaminate groundwater sources. The protection of water supplies and the favorability of clean energy over dirtier fossil fuels are signs that Kansans have environmentally-conscientious preferences when it comes to energy development.

Environmentalism in the state goes even further, and water stewardship takes many organizational and political forms in Kansas. In January 2016, the Resource Conservation Partnership Initiative (RCPP) used a $13 million grant to pay landowners located in high priority watersheds in eastern Kansas to plant trees and improve woodlands. Research suggests that well-managed woodlands improve the quality of water in watersheds and prevents reservoir sedimentation (White 2013). Organizations like the Kansas Rural Center (KRC) and the CEP have spearheaded conversations with policymakers focusing on resource conservation and the importance of water, land, energy, and food production in Kansas. Through its website, CEP stresses that there are economically viable alternatives already being utilized by farmers and ranchers (Barnett 2016). Interestingly, farmers across the nation remain skeptical of climate change science and are Republican voters, while adopting conservation and adaptation techniques as growing seasons change (Bolstad 2016). KRC has called for advancing farm-to-table food systems that incorporate Kansas farms into the supply chain that provides Kansans with foods, while also urging for better food systems in their public forums across the state (Cottin et al. 2014). Redesigning the state's farming system would not only improve the economic viability of local farms, it will also protect water supplies within the state due to a reinvestment in diversifying crops and best management practices. If the state is going to prioritize local production and consumption, it will have to strategically manage its natural resources, which are essential for the state's long-term food production. Water legislation has moved in 2016, as two bills were introduced (HB 2510 and HB 2511) after the Senate Natural Resources committee agreed that the State Water Plan needed increased funding and the water plan would be split into an Eastern Kansas Water Plan and a Western Kansas Water Plan (Johnson 2016a).[4] Despite some Republican efforts to reign in environmental protections, eliminate clean energy mandates, and defang regulating agencies, resource conservation is still alive in Kansas, and the state has a number of agencies looking to augment its drought resilience.

Water policies formed at the state level could encourage dryland or no-till farming; different crops, seeds, and technologies promoted by large food companies can influence independent farmers' watering practices as well. All water problems are inherently local, but they often have linkages to larger political, economic, and environmental systems. Placing the onus of decision-making on smaller populations does not facilitate constructive dialogues between broader communities and partnerships within a particular hydrologic structure. While the political, social, and economic impacts of water scarcity are a growing cause of conflicts around the world (Barlow and Clarke 2003), social scientists have only begun discussing the importance of political sociology in the context of water resources management (Mollinga 2008). The social relations of power within a particular hydraulic context have to be explicitly studied;

[4] During a research competition at the State Capitol in early 2016, I spoke with Greg Graff, a representative from GMD 1 in far western Kansas. As we were discussing potential ways to fund the State Water Plan, he and I both agreed that the state needed a plan that adequately supported GMDs. Furthermore, I suggested that the SWP needs to be repurposed to improve coverage over western Kansas, and he agreed. This proposal is a step in the direction to invest in a more rationalized distribution of state funding.

therefore, the social groups reliant on aquifers have to be sociologically investigated. Hydropolitics (the conflicts and negotiations between policymakers on water allocations) have been at the forefront of environmental policy, environmental sociology, and public sociology studies (Ohlsson 1995; Turton and Henwood 2002; Mollinga 2008). Kansans and Kansas policymakers need to familiarize themselves with research that can shed light on consumption patterns and practices, specifically as those practices change across the state and within particular infrastructures. In areas with municipal supplies, standards of water usage, will differ from areas dominated by private well ownership.

Any discussion of the legal restrictions and allocations of groundwater pumping fits within the purview of previous sociological work. Discourse involving GMDs, water rights, and the Kansas Aqueduct are just a few examples of particular importance. Most of the research on water policy falls into professional and policy sociology. An environmental-public sociology of water usage in Kansas illustrates how the causes of groundwater loses are woven into the political and economic structures of the state and unlock parts of a necessary perspective to reduce and adapt to overdrafting. Sociology is generally devoted to analyzing the interaction between behavior and structure, and environmental sociology has the flexibility to apply a combination of lenses from environmental policy, law, history, and political sociology contextualized by a specific ecosystemic background. This allows for a richer understanding of the social embeddedness of resource management, political and economic decision-making, and the unique dialectics formed by humans and their natural surroundings.

The depletion of groundwater supplies, especially the High Plains aquifer, has been widely studied through the lens of natural sciences, but framing it as simply an environmental problem marginalizes the analyses of social structures that contribute to overdrafting. It is important for groundwater analyses to shift toward a perspective in which “people and societies are no longer viewed as external to the Earth system but as an integral and differentiated part of it—creating problems and holding the key to their solution” (Hackmann, Moser, and St. Clair 2014:654). As I mentioned in the first chapter, groundwater management has been commonly conducted at the sub-state level rather than at the level of the state. Large aquifer systems contain different segments defined by different rates of extraction and recharge, which makes “site-specific” groundwater policies more sensible. Not only have conservation policies been established at a relatively small scale, but conserving water has gradually gained wider public attention at local levels. Regional institutions can provide an alternative to more distant government control, as Agrawal argues that "regulatory communities" (local enforcers) can potentially be more successful at protecting the environment than larger centralized authorities (2005). The development of GMDs coincided with the larger environmental movement of the 1970s, a time of both local and national concern about environmental damage, and they also can also be framed as regulatory communities themselves.

Nevertheless, a number of outdated, impractical policies are still holding many Americans back from taking their water usage and land management decisions into their own hands. During the spring of 2016, a family in Sugar Creek, Missouri was told to remove a vegetable garden from their front yard because it did not comply with a recently-passed city ordinance requiring residents to meet a "reasonable expectation" for how the town manages its front yard appearances (Kristian 2016). Unfortunately, the social standards of keeping private properties aesthetically uniform have targeted unconventional gardens, which has restricted the use of small-scale agriculture in front yards. In an age of agribusinesses' domination of food production, one might expect localized agriculture and family efforts to grow their own food to be applauded, especially as consumers become further removed from the real costs of unsustainable food processes. Breaking the American addiction to lawns would be a serious improvement—not only for the reduction of domestic water demands, but also for encouraging farming or gardening landscapes and vegetable-rich diets, which can cut water and carbon footprints substantially (Hoekstra 2013; Scarborough et al. 2014). Only 4 percent of the fruits and vegetables consumed by Kansans are grown in state, a trend the state's "Local Food and Farm" task force hopes to increase to 10 percent by 2022 by working with grocery stores across Kansas (Johnson 2016b). Achieving local food goals would not only save the health care system millions of dollars, the food purchases would generate revenue that would reverberate within Kansas (known as the multiplier effect), support farmers, and reduces food miles (Holt 2016).

Through its *Plate of the Union* campaign, the Union of Concerned Scientists is working to advance many proposals that would give rise to the first National Food Policy (Bittman et al. 2016). The proposed reforms include promoting seasonal fruits and vegetables grown locally, transforming agriculture away from monocultures and towards diversification, rethinking livestock production by ending subsidizes for CAFOs, and educating farmers and the general public about farming through food education policies (ibid.). Not only would a national food policy make produce more affordable and make American consumers healthier, it would also give farmers and ranchers the opportunity to approach their operations' use of water in new ways. CAFOs are notoriously hazardous for surrounding water supplies (Tietz 2006); therefore, moving away from operations that stress water supplies would be one way to safeguard the High Plains aquifer.[5]

Kansas can also import ideas from other states which have faced grueling droughts. As mentioned in Chapter 2, communities in California have adopted inventive ways to reduce domestic water consumption in response to the state's extreme drought. Municipalities offer to install highly efficient toilets and showerheads for a modest charge on residents' monthly water bills. These renovations could be taken up by the water departments of cities across Kansas, regardless of the town's precipitation levels or access to freshwater. The city of Lawrence, for instance, has relatively adequate rainfall and is adjacent to the Kansas River, but it could still play an important role in the amount of water flowing into the Missouri River's basin. Consider the following scenario: if, in the face of a non-consenting public and a stripped state budget, the Kansas Aqueduct were constructed, it would divert over 3 million acre-feet of water from the Missouri River. States and other shareholders downstream of the massive aqueduct would insist that their water supplies in the river basin remain unscathed. In towns along the river where household consumption remains the primary water user, community-wide investments in efficient appliances would allow more river water to flow into the Missouri river basin. Disagreements and negotiations surrounding massive water transfers will only get tougher in the future, so having the riverfront communities on board with an "all-of-the-above" approach might be a mandate that some downstream interests will insist upon if large construction projects are going to be seriously considered.

Conservation campaigns, low-flow plumbing ordinances, and tiered water prices have transformed many residents in Tucson, Santa Barbara, and Santa Rosa into avid savers, but they have taken an aggressive stance on water wasters for decades. Since the drought of 1987-1993, traditional toilets, lawns, and prices have been replaced by more sensible domestic watering tactics. Learning from experiences abroad, researchers investigating Australia's relentless "millennium drought" (1997-2012) noted that investment in water conservation technologies

[5] As it happens, well owners in my study stated that the hypothetical construction of a hog farm would be highly concerning for them, which is likely due to their tendency to contaminate groundwater sources.

were the cheapest and quickest contributors to manage demand during droughts (Turner et al. 2016). Yet simply investing in technological improvements will not be enough for many communities to ensure their water, nor should those investments be the primary goal of conservation campaigns. Broad community involvement was needed to rally support for sharp reductions; therefore, households, businesses, agricultural interests, and governments all had to unite in order to establish an atmosphere of fairness and responsibility for saving water. Australia's successful community campaigns ultimately lowered demand by 37 gallons per person per day (ibid.). Such impressive cutbacks not only helped these drought-prone communities survive their intense dryness, they also reduced vulnerability to future droughts.

Research has been established that most people have low levels of water literacy and are unaware about the amount of water they use (Hamilton 1983); surveys indicate that Americans underestimate their residential water use by a factor of two (Attari 2014). Since many water consuming habits (showering, toilet flushing, and washing) are mostly invisible, people tend to miscalculate how much water they use. Moreover, individuals may have a lack of awareness about their water usage because utility bills can be devoid of the actual number of gallons of water used or the price of the water (Gaudin 2006). Consistently and clearly providing this type of information could motivate households to conserve water. Given the severe misperceptions surrounding domestic usage, water conservation efforts (through both technological and behavioral adjustments) are all the more important. It is important to note that many of the aforementioned studies do not consider if the household's water is provided by municipalities or wells.

Water researchers anticipate that a best-case scenario for successful municipal programs, which would employ rebated water-saving appliances, increased water prices, and progressive water rates could reduce a city's overall water consumption by 30 percent (Sedlak 2014). On the other hand, combining water conservation and water reuse measures in a decentralized water supply could cut potable water consumption as much as 50 to 75 percent (ibid.). That degree of savings could take a lot of pressure off cities, particularly if they lack the budget or the political will to invest in repairs or improvements for their water infrastructure. Unless water systems pump dangerous contaminants through cities like Flint, Michigan, or Pittsburgh, Pennsylvania, infrastructures around the nation will grow outdated and investing in them will have little chance of being prioritized—especially if the citizens most burdened by these municipal failures are racial minorities (see Schroering 2016). Furthermore, updating water supplies can serve as an opportunity to make progress with impressive water savings; by repairing aging infrastructure, Albuquerque, Seattle, and Boston all reduced their utility demands by 25 percent (Montaigne 2002).

Researchers recommend that conservation campaign strategies focus on altering habits, or unconsidered behaviors (Aitken et al. 1994). Getting residents to change their thinking about their daily routines and relationships with water, and learning new patterns of behavior, represent the next frontier for resource conservation efforts. Informing citizens of their embedded water usage or consumption of virtual water, limits of their water supplies, and redefining water usage within neighborhoods will teach people to recognize the opportunity to conserve water and acclimate to the water supplies of the twenty-first century. Having discussions about water itself can plant the seeds for successful water conservation efforts. Reframing water was a visible, axis resource instead of an invisible, taken-for-granted one will provide a reflective space that questions their automatic behavior and "carve out a new synoptic pathway" whereby household behaviors and daily routines become challenged (Pabich 2012:137). Part of improving water's visibility would likely include an increase in utility pricing, especially for high-volume households. Raising monthly water bills by $1 or $2 will undoubtedly face resistance, but citizens could be taught that paying for the enormous revitalization of water services in the nation is their responsibility as environmental citizens. It would behoove Kansas state regulators to approve a small surcharge on customers' bills to fund infrastructure replacement projects, especially since Kansas has 18 water systems that exceed the federal standard for lead (Hegeman 2016).

I am aware that as the past several pages have entertained the idea of taxing or raising the price of water. There are many robust arguments that water is an essential resource, it is a human right, and commodifying water through water marketization is unethical and extremely problematic when addressing issues of universal coverage (Conca 2006; Hoekstra 2013; Simms 2016). I briefly engage that literature in this chapter's appendix, and encourage citizens, entrepreneurs, and policymakers to consider new taxation and pricing mechanisms to ensure water is both accessible and conserved for future use. However, I believe that universal coverage will not be possible if groundwater economies continue to operate as if aquifers were a free resource. To be clear, water experts have stated that prices are an essential component of conservation, but utilities' pricing structures should not put resources beyond the reach of low-income households (Gomberg 2016). Universal coverage is important for any community, but tiered pricing structures could allow poorer customers sufficient access, while also encouraging wealthier users (high-use households) to be more responsible in their consumption.

The specifics are of great consequence, as are the policy recommendations and moments of environmental progress, but it is important to review the political environment of Kansas, which has greatly favored the entrepreneurial class and the continuation of unsustainable food production. As agribusiness-corporate agendas become accepted as the status quo over time, the strategies of agribusiness can become hegemonic. The prioritization of growth for the corporate giants, and the assault on the small farmers and their groundwater supplies, has been all-too-common in Kansas agriculture. Currently, the political and economic context indicates that the political capital in rural communities has accumulated among the entrepreneurs, not farmers.[6] Measuring community power is important with any application of growth machine theory because it pivots around the entrepreneurial elites' control over political priorities. Crop selection and irrigation practices are not simply decisions made by local farmers, ranchers, politicians, and entrepreneurs—rural communities face the detrimental impacts of subsidizing policies far beyond their state: "The choice of crop and the acres planted are mostly out of the hands of individual farmers, being decided by the rules of a farm-production program operated from the nation's capital" (Allen and Dillman 1994:73). Once harvested, the management and transportation of those crops is also beyond the influence of farmers. Grain companies are responsible for importing American grains to other nations, but these giant corporations have a history of reducing the quality of the product by mixing in dirt and gravel with grain as it is exported (Rhodes 1989). Tension between farmers and grain companies embody the division between agribusiness and farmers because the multinationals delivered foreign grain for profits while simultaneously jeopardizing the prosperity of individual farms.

Small farmers are rarely independent farmers, and their adjustments to policies and corporate demands have resulted in a food system that is environmentally harmful. Globally, agriculture now produces more greenhouse gas emissions than deforestation (Tubiello et al. 2015), and agricultural activity is a far more prevalent danger to threatened species than climate change (Maxwell et al. 2016). These realities suggest a troubling devotion to unwise land use. In

[6] Political capital is the ability of a group to control agenda-setting and resource distribution (Flora et al. 2004).

OECD countries, food production is responsible for 40 percent of organic water pollutants in water supplies, far more than any other industry (Black 2004). Sustaining groundwater supplies requires crop selection and diversification based on dryland approaches; transitioning to rainfed farming would be far better than committing to crops that require intense irrigation. Sunflowers, sorghum, and wheat are all less water-intensive than corn, but less profitable because of corn subsidies (Bjerga 2015). Corn yields could face up to a 20 percent decline globally by 2040 due to extreme weather (Schiermeier 2015), so helping farmers make more resilient crop selections (namely, by ending corn subsidies) will have enormous implications for the future of food production. More than ever, Kansans will need serious political leadership that encourages citizens of all walks of life to make smart environmental choices that will keep the state durable throughout the Anthropocene.

Social policy regimes are institutionalized patterns that influence the relationships between the state and other social structures. Those patterns include the economic, social, and political obligations of the state (Shaver 1990). Governor Brownback, who has an obligation to the state to improve the welfare of Kansans, has relied on a dogmatic following of neoliberalism in his attempt to complete this task. While governments typically support and subsidize economic growth for tax revenues and stability in order to gain legitimacy, the experimental brand of neoliberal policymaking has failed the state. Neoliberalism is not just a political ideology in Kansas governance. In the context of groundwater management and environmental protections, it is a *regime* because it drives the broader patterns of groundwater provision and regulation. One of the tenets of neoliberal policy reforms is the exacerbation of drought vulnerabilities among residents, specifically well-owning farmers. State policies can reduce drought vulnerability, but Republican leadership must acknowledge that this will take funding, planning, and investment beyond individual conservation behaviors. Water efficient technologies purchased by irrigators alone cannot eliminate drought vulnerability, especially in the long term. While they are important, the regulatory and political-economic frameworks maintain that individuals, not regulators, are responsible for groundwater declines, and the state will need to acknowledge the responsibility of governing bodies and agribusiness to protect its groundwater reserves.

The pressures placed on groundwater by agriculture and expanding cities necessitate a sociological assessment of how cities and rural regions share resources, and how agricultural practices and domestic practices can be adjusted to preserve declining water tables. In a time and place dominated by the social policy regime of neoliberalism, it is possible that agribusiness itself has been influenced by the growth mentality. As I noted in the second chapter, people accumulate cultural capital via social conformity or through distinguishing themselves. Social comparisons and identity formation can escalate consumption, as resource consumption carries symbolic meaning. The application of high volumes of groundwater to irrigate crops can increase farm yields, a feature that many farmers take seriously in a productivist agricultural regime. Corporate food regimes have led to energy and input-intensive farming that produces low-quality food that makes consumers unhealthy (McMichael 2000; Carolan 2011). As it happens, Beus and Dunlap (1990) provided dichotomous paradigms of alternative and conventional agricultural practices, a dominant framework within rural sociology. According to these paradigms, conventional farming is characterized by dependence on large, capital-intensive production, reliance on inputs, and an emphasis on competition, science, and technology. In this paradigm, external costs are often ignored and short-term benefits outweigh any possible long-term consequences. Farming approaches that rely on complex machinery push food prices beyond the reach of some of the world's poorest, so irrigation may boost yields and produce exportable surpluses, conventional farming can also destroy the livelihoods of the impoverished (Black 2004). On the other hand, alternative agriculture consists of smaller levels of production with an emphasis on cooperation, personal and community self-sufficiency, and local wisdom; external costs are accounted for and long-term outcomes are just as important as short-term gains (Beus and Dunlap 1990:598-99).[7] But neoliberalism has rapidly changed agriculture, and conventional agricultural practices remain the status quo under this social policy regime. These current structures are at odds with the recommendations of water policy experts, who have called for balancing uses, demand, and cost-effectiveness in food production, approaches that alternative

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[7] Conventional, mainstream agriculture is characterized by "capital-intensive, large-scale, highly mechanized agriculture with monocultures of crops and extensive use of artificial fertilizers, herbicides and pesticides, with intensive animal husbandry" (Knorr and Watkins 1984:x). Alternative approaches include farming practices that reduce farm chemicals, technology, and energy while promoting small farms, self-sufficiency and resource conservation. More specifically, alternatives include organic agriculture, sustainable agriculture, regenerative agriculture, ecoagriculture, permaculture, bio-dynamics, agroecology, natural farming, and low-input agriculture (Buttel et al. 1986). Critiques of Beus and Dunlap's framing have been made, and some evidence suggests that the conventional/alternative framing can no longer clearly explain agricultural practices in the United States. For instance, the adoption of pro-environmental practices and preserving family farms are identified in both conventional and alternative farming operations, but Beus and Dunlap only attribute those characteristics to the alternative agriculture paradigm (Kremer 2001).

farming operations have been taking (Black 2004). Over the next 40 years, droughts and floods will take tremendous tolls on global food production, which is expected to create what experts are calling an impending "food system shock" (Masters 2016). In the coming decades, the demand for food will increase while droughts will become harsher, and going back to local or native wisdom might prove to be a more successful strategy to climate change adaptation than technologically-advanced food systems.

Development in Kansas has frequently meant the interests of its farmers have taken a back seat to those of its agribusinesses. With a political apparatus that so strongly supports agribusiness over the needs of individual farmers, it is clear that markets need the state for support, and the state itself prioritizes growth. It is important not to mischaracterize neoliberalism: while it is the default ideology, it is not merely the promotion of free markets, because markets need the state for infrastructure, stability, and even government intervention if economic growth needs to be augmented (Nest 2011). It is not a doctrine of deregulation, but one of growth and risk-taking (Mirowski 2013), which often limits and weakens policymakers because their capacity to serve all citizens is reduced when they prioritize entrepreneurs.

Weak water-based governance is not unique to Kansas. Republican state regulators in Florida's Environmental Regulation Commission voted to increase the amount of over two dozen carcinogens that is permissible in drinking water supplies (*Tampa Bay Times* 2016). These lower water quality standards allow for higher levels of toxins to be released, which are typically discharged by polluting industries like paper mills, oil and gas companies, dry cleaners, and agriculture. Since the change proposed levels of byproducts cannot take effect without federal approval, it is now up to the EPA to reject these new standards (which no other state uses [ibid.]).

Governance has been described as "a government's ability to make and enforce rules, and to deliver services" (Fukuyama 2013:3). Despite the preponderance of climate change denial and fossil fuel interests in politics, there are examples of political efforts to redefine governance in the face of anthropogenic climate change. Kansas has to resist weak governance, and it needs governance that is protective of the interests of residents, not just entrepreneurs. It is unwise for a state so dependent on groundwater to exploit aquifers and create environmental sacrifice zones according to the whims of agribusiness at the expense of its citizens and communities. "When capital accumulation is made the organizing principle of the…state, both people and nature suffer egregious oppression in the sites where the wealth is generated" (Adunbi 2015:21). Given their proximity to and connection with aquifers, this research reveals how well owners are unique in their perceptions and attitudes towards natural resources. In the next, and final, chapter, I will summarize this project's main contributions, which can be stepping stones toward a more robust brand of environmental citizenship within the Anthropocene.

CHAPTER SUMMARY

> In this chapter, I outlined the projects shortcomings, the obstacles I faced in survey dissemination, future directions, and policy recommendations. Despite its limitations, this project added to its associated fields and unveiled the openings for future directions, particularly within environmental policy. Environmental sociology and the sociology of water usage has primarily focused on individual attitudes and behaviors, as well as the larger social structures that impede pro-environmental behaviors. Examining well owners (perhaps as an informal network or citizen group) can uncover the ways in which social groups are able to sustain their own level of commitment to managing groundwater withdrawals. In terms of outreach, upon the completion of rigorous survey analyses, I presented my findings to the participants who requested results, and plan to meet with groundwater experts who have valuable insight that can inform my interpretation of the quantitative data and framed my results, discussion, and concluding chapters. Drawing from ecological Marxists Harvey Molotch, John Bellamy Foster, and others, I suggest that the "transmutation" of utilizing natural resources as commodities—or conceptualizing resources as goods to be sold—does not apply to groundwater. Despite the valid arguments against water commodification, I hold that introducing a tax on large extractions of groundwater can improve how the state manages aquifers.

Chapter VIII: Conclusion

> My research investigates the demand for natural resources and the relevant institutions and infrastructures that shape resource management within socio-ecological systems. Specifically, I analyze the environmental awareness and routines of water use among Kansas well owners, a key social group whose water usage is pivotal to extending groundwater supplies. This project has taken modest steps in expanding the frontiers of the sociology of water usage by studying how infrastructure is applied to the subfield. Household characteristics, details of the practices that use water, and social histories and contexts have all been considered by sociologists, but private supplies and groundwater reliance have not. In the hopes of bringing water supply infrastructure more squarely into the purview of the discipline, I have examined how systems of provision influence individuals' views on water, as well as their consumption practices. With this concluding chapter, I reflect on my main findings and describe how my dissertation fits within the relevant fields of environmental sociology and policy. I connect my research to statewide (and occasionally international) contexts, and contemplate how it can assist future environmental efforts.

Over the course of this project, I developed a knack for spotting headlines concerning water supplies. One current event that caught my attention was the opening of a new bar in Minneapolis that only served tap water and well water from across the United States to its customers (Doctorow 2016; Lindeke 2016). The *Water Bar* was intended to stimulate discussions about people's connections to water supplies, and it serves as a social and artistic statement about how tap water is often regarded as a massive advancement in public health and sanitation—in short, an everyday miracle. Stories like the opening of the Water Bar showed me how popular discussions of water were becoming, and it was uplifting to hear that water supply infrastructure was shedding its invisibility and becoming more openly discussed.

While it would be an exaggeration to characterize the droughts in the United States from 2010-2015 as "nationwide," as I began this project, stories about water (or lack thereof) regularly made their way into the national news. Articles in *The New York Times* and *Time* magazine even put the collective plight of Western and Midwestern well owners in the public eye (Eligon 2012; Wharton 2012). Editorials in California newspapers frequently evoked images of burnt lawns, declining rivers and snowpack, disheartened farmers, and coming to terms with an "age of limits" and "water wars" (see Holland 2016). There appeared to be a unanimous consent that the United States was running out of water and the nation would need to take bold measures in order to protect its supplies. It seemed that Americans agreed they would have to cut back (regardless if they would actually change their behaviors, they supported the *principle* of conservation). I thought investigating the influence of water supply infrastructure on Kansans' propensity to conserve water would be an important and timely research topic, especially during the state's 2011-14 drought. When this research was in its formative stages, Kansas was in the midst of one of its worst droughts in decades. As I was putting my finishing touches on the project, most of the state was no longer considered to be under drought conditions and groundwater levels experienced their smallest decline in nearly a decade (Wilson 2016). If I embarked on this project a few years sooner or later, the statewide and nationwide discussions about drought and water policy would likely have changed the context of this story. Nevertheless, I believe that the influence of infrastructure still would have been noticeable, and well owners would have emerged as a unique social group based on their investments, attitudes, knowledge, and prioritization of water conservation.

In the early stages of research, one of the concerns raised by my committee members was that the variance of my results would be too narrow—that is to say, our initial impressions of well owners were that they were somewhat homogenous.[1] Demographically, that seems to be the case in Kansas: a majority of the well owners in my study are white, conservative men who live in relatively rural areas. Their self-reported water consumption, however, suggests that they have a range of watering practices that may or may not incorporate conservation tactics. While well owners are more likely to invest in water-saving appliances, have more familiarity with water-related current events, and prioritize water conservation more than their non-well-owning counterparts (all of which suggest they are a unique citizen group connected by access to a natural resource), their watering routines range from modest to impressive conservation efforts, and, surprisingly, also to liberal water usage during droughts. Moderation is an essential mechanism at play here, because the well's pumping capacity and its function influence how much water the household controls—similar to the way that non-well owners have a unique expectation based on the amount of water they receive from their public supply. Geography and residence above the High Plains aquifer also appears to be an important contextualizing force for these participants, as increased awareness levels of water supplies *increase* usage during

[1] While it would be valuable to discover if well owners all used water the same way, it would be a less interesting finding and perhaps more challenging to analyze.

droughts for all geographic groups, but higher levels of water literacy also significantly *decrease* the amount of indoor and outdoor conservation for respondents in western Kansas.

The reasons for watering or not watering, for using well or relying on city water, imply that water usage in Kansas is a rich, intricate story. It would be inaccurate to simply say that well owners consistently conserve water more than non-well owners, and not all of them are committed to reclaiming consumption. In fact, some well-owning circles are committed to reinforcing consumption, or insisting on outdoor water usage. Over 13 percent of well owners (55 out of 412) stated that they use their wells as a cost-saving option to lower their water bills, and virtually all of those respondents used their well to water their yard.[2] This suggests that a vast majority of well owners who use the domestic well loophole are doing so to keep their lawns plush while avoiding higher utility expenses. Well ownership, when framed as a moderated relationship, can actually be correlated to increased outdoor water usage—especially during droughts. While I was anticipating more devotion to saving water among well owners, my results suggest that their means of water saving comes more often from investing in technologies rather than radically changing their lifestyles or deliberately cutting back via changing their practices. These results are nuanced and complicated, and reveal that the story of well ownership is not one of homogeneity.

BROADER SIGNIFICANCE

The impact of climate change on groundwater recharge supports a "wet gets wetter, dry gets drier" scenario—and aquifers in the western US will likely experience declines in recharge (Meixner et al. 2016). Temperatures are expected to increase throughout the region due to climate change, and the central and southern High Plains aquifers will experience modest decreases in recharge—which would exacerbate existing water shortages (ibid.). With every 1-degree increase in temperature, the potential for evaporation increases 4 percent, which means that even when hot, arid regions get rain, the heat causes the precipitation to evaporate (Lohan 2016c). Given these harsh realities, water consumption and groundwater accessibility must be

[2] The remaining six well owners who did not use their cost-saving well for lawn watering stated either that the only reason they used a well was to keep their water bills lower, or to water their garden, orchard, trees, or other vegetation.

studied in order to adapt to the immense competition for water in the West and the semi-arid High Plains.

As a project that investigates the “infrastructure of ideas” associated with private wells, my research can serve as an opportunity for public outreach. If data collection is to be shared among different levels of government, and the administration plans to reinvest in critical water needs by promoting conservation and improving water systems, this dissertation’s dataset could be a valuable tool for additional research on well owners. Fixing the nation’s water-use data would “unleash an era of water innovation unlike anything in a century [because we]… lack the data necessary to make smart policy decisions” (Fishman 2016). Improved information would create a demand for additional studies and improve what water researchers know, and accurately measuring water usage would provide an immediate picture of how communities could use less water (ibid.). Given the ecological imperatives to wisely manage well extractions, creating a more involved, deliberate atmosphere of watering habits will be central for all well owners in the High Plains:

> The management of the High Plains aquifer is inextricably tied to the nation’s food security, economy, and environment. Continued water level decline is inevitable while current management policies continue, but the sustainability of this resource—the largest freshwater aquifer in the country—is a vital concern. *More concerted stewardship efforts must be put into place if we are to manage the depletion of the High Plains Aquifer in an economically and socially responsible way*. [emphasis added] (Haacker et al. 2016:240)

Advances in well pump technology have made groundwater the most extracted raw material in the world (Magee 2005); water from the High Plains aquifer is the main export of western Kansas, taking the form of corn, grain, cattle, and pigs (Opie 1993). Aquifers have been critical to human development, and will continue to be as the twenty-first century progresses. They are strategic freshwater reservoirs, providing 20 percent of the water used for irrigation, with almost no losses to direct evaporation (Zekster and Margat 2004). Groundwater is now the drinking water source for nearly a quarter of humanity, and even though it is relatively clean in many formations, if aquifers become contaminated they are almost impossible to clean (Black 2004). Fertilizers and pesticides can degrade shallow groundwater formations, making them unusable. Aquifers do not suffer the climate-driven variations that surface water supplies do, and their ability to reliably replenish themselves should hasten a tremendous push for groundwater-protective policymaking that ensures humans have a stable water supply in the face of wider climate swings. I anticipate that these policies will look different for communities with public (urban) and private (rural) water supplies.

WATER SYSTEMS IN RURAL AND URBAN CONTEXTS

When researchers study centralized water supply infrastructure, they typically study cities. When researchers study private wells, they often study rural communities. If anyone would like to study both, I recommend they study Wichita. Sedgwick County contains many recently-dug lawn and garden wells, but according to my data, three-quarters of the respondents from GMD 2 who have wells also get their household water from municipal connections. Most of the well owners in my sample actually have city water supplies, so one could make the case that they are not "pure" or "off the grid" well owners in the sense that their well is not their only source of water. This portion of the state appears to have synthesized both urban and rural landscapes (water systems), and these systems play unique roles in the city. In Kansas, those who lack connections to water distribution systems are reliant on private wells, but the function of lawn-and-garden wells in the Wichita area show that private wells can be used to augment household watering without using municipally-provided water. Even though well ownership in Sedgwick County is commonly used as a means to avoid higher utility bills (56 percent of all of the well owners who use their well to save money on their water bill live in GMD 2), it represents a unique area because of its reliance on both public and private water supplies. This could be an important distinction that gives communities a resilient quality in an age of harsher droughts. My research not only examines how to influence resource-intensive behaviors, it investigates how to establish the conditions that foster a mindset of consuming water from a finite supply, and an ethic of permanent respect for natural resources. Overall, it appears well owners are more likely to carry that ethic, and behavior, of mindfulness with them. Demand for resources is constructed by systems of provision—the activities, technologies, and institutional arrangements that provide a service—and wells shape demand differently than municipal utilities. Municipal utilities provide 86 percent of Americans with household water (Kenny et al. 2009), and most of the research done on domestic patterns of water consumption have been in urban settings with publicly-provided water (Mayer et al. 1999; Olmstead and Stavins 2009). The influence of private drinking water supplies remains understudied in this field, but my project analyzes the effects of municipal and private systems on conservation.

As I have studied different water supply infrastructures, I have modestly bridged the gap between urban sociology and rural sociology.[3] Most of the literature in the sociology of water usage analyzes patterns of domestic consumption within cities, supplied by public utilities. For instance, after studying sustainable housing projects in Europe, van Vliet and colleagues (2005:9) concluded that new arrangements of technical organizations change demands for utilities, even if the systems of provision are centralized: "it is not so much a matter of being 'on' or 'off' grid, but of negotiating different combinations and configurations of supply and demand." Yet well owners were missing from their analysis, so those researchers did not actually control for private supplies that were "off the grid." My project is not immune to the same challenge those researchers faced. Even in my study of private water supplies, it is important to acknowledge the pervasiveness of public water systems. City water is so widely used that most well owners in Kansas appear to be recipients of publicly provided water; out of the 412 well owners who completed my survey, 249 (60.4 percent) had a functioning well in addition to a connection to municipal water. Only 143 well owners (34.7 percent) were "off the grid."[4]

It is challenging for researchers to find a demonstration site of decentralized utility distribution in the developed world, and the impressive coverage of public utilities has valuable implications for environmental stewardship. Thinking broadly about this project, it generally investigated what it means to live in a developed, modern community, which is relevant for how citizens interact with natural resources. Infrastructure can reinforce the notion that water is limitless, as is the case with municipal systems; however, private wells provide an attachment to the landscape not easily portrayed by public infrastructure. Studying the influence of private supplies can become challenging when most well owners are also connected to city water. Nevertheless, the presence of wells symbolizes a different spatiality. Groundwater development, or the extraction of groundwater, is more pronounced than municipally supplied water. This is particularly true for irrigation, as the effects of large extractions of groundwater fundamentally change the landscape on a scale that far surpasses the use of municipal water. Well water's application is more visible than the engineered, concealed landscape of public (household) water.

[3] It is worth noting that "urban" in Kansas is defined differently than the locations of interest in many studies of urban water supply infrastructure. Mumbai, Sao Paolo, Los Angeles, Las Vegas, London, and so on are far larger than the largest cities in the state.

[4] The remaining 20 well owners were former well owners.

If agricultural withdrawals are also considered, then well water is obviously much more abundant.

Furthermore, most of the literature on well ownership analyzes rural populations. Investigating different water supplies reveals dissimilar social and natural environments that promote or discourage well ownership and connections to municipal water systems. The economic and cultural significance of water changes in these settings, in part due to their differing water supplies. High-capacity irrigation wells have produced a distinct biological, hybrid landscape in addition to sentiments and attitudes about water's use value, exchange value, and its conservation. Groundwater declines have also created an environmental injustice, which is of particular importance to sociologists. The renowned ecological Marxist John Bellamy Foster has acknowledged the tendency of environmental sociologists to call attention to the "impact of environmental degradation on distinct sociological groupings, conceived in terms of race, class, [and] gender…" (2009:164). My study of drought-prone well owners is also connected to the discussion of environmental vulnerability. When wells are threatened by groundwater depletion or contamination, "off the grid" well users need to be recognized as a "distinct sociological group" who lack access to reliable, municipal water supplies. Unifying the discussions within rural and urban sociology—while keeping within the conversations of ecological Marxism and neoliberalism—was necessary for me to focus squarely on domestic water usage, communities of practice, environmental attitudes, and resource management.

By investigating rural and urban water supplies, this project is one of many that seeks to expand the role of urban and rural sociology in order to inform policies (see Shucksmith et al. 2012), specifically water management decisions. Resource usage needs to be researched in a way that contextualizes its emergence within a specific infrastructure. What types of water supplies might lead Kansans to adopt pro-environmental consumption choices? As our water supply changes, how do we change?

RESOURCE PROVISION AND CITIZENSHIP IN THE ANTHROPOCENE

This dissertation explores the intersection between water, technology, and to an extent, the uneven distribution of modernity. Bakker (2010) offers clear examples how modernity is associated with changing the role of water through its distribution via water supply networks "Modernization… implies the industrialization of water… Large-scale irrigation networks were the rural counterparts to the urban water supply network. Both rural and urban supply depended on an unprecedented mobilization of raw water through large-scale hydraulic infrastructure." (p. 55). The sophistication of municipal water systems and high-capacity wells articulate the social and technological changes since the 1940s, an age defined by industrialization, production, and efficiency. Large-scale networks mainly provide water to households, and for roughly 85 percent of United States citizens, they are the only network available (van Vliet 2004). These massive infrastructures are seen as "failures" or "insufficient" when they do not meet demand, so they have developed a strategy of "oversizing" to cope with peak demands instead of operating to conserve or store water during periods of low demand (Chappells and Shove 2004). "When water managers thought about long-term planning, the answer was always the same: increase supply" (Gomberg 2016). Centralized utilities represent a system of provision that standardize consumption for many of their recipients, but the uncertain future of freshwater's accessibility will call into question the permanence of these networks: "the production of more sustainable systems of utility provision requires a transformation of collective social and material arrangements" (van Vliet et al. 2005:xi).

Just as the collective American food system is designed for overproduction, so too are its systems of water provision. Overproduction in any sector will make less sense the longer it is adhered to in an age of groundwater depletion and more severe droughts. An important social element of adapting to the Anthropocene will likely involve rethinking the visibility of water supply infrastructures, and Kansans need a new perspective that puts water more into focus. Cities have gone to tremendous lengths to keep water invisible and easily-accessible, not to mention a pillar of everyday life. If infrastructures become more flexible and open to environmental challenges, making the organization of these systems better-known to citizens might lead to a larger public dialogue about water management decisions. With that said, consider that Governor Brownback has literally called for a long-term *Vision* to secure water in Kansas. That is an appropriate title given that one of the determinants in water's overconsumption is its infrastructure's ability to hide it. Despite the criticisms directed at the Governor in the third chapter, I applaud his reliance on natural scientists and geologists, and for creating the Vision with the hopes of addressing the state's water supply needs. In my estimation, the merits of this project suggest that the social scientists should also play a far more active role in Kansas policymaking, and that policymakers should consult the experts in fields beyond the natural sciences in order to examine conservation efforts, nested effects, and the economic, political, and social structures that constrain the everyday water-usage decisions of Kansans. Fine (1994) describes food production as a system of provision and reflects on how policymakers are granted power in terms of how the political economy creates agricultural surpluses. As the political environment of Kansas suggests, policymakers need to invest more in understanding the science of natural resources, climate change, and food production in order to construct effective policies.

Transitioning to safe yield or sustainable water consumption will require individuals and households to change their watering routines, yet many of them will remain connected to a municipal grid that presupposes certain levels of demand. The actions (or inactions) of households are dependent upon the infrastructures to which they are connected (Otnes 1988). Utilities therefore create "captives" to their system of provision (van Vliet et al. 2005).[5] The disproportionality in water usage varies along the systems of provision in an area. Evidence suggests that everyday routines which inconspicuously require resources are particularly difficult to change when they are needed to achieve socially-noticed standards like cleanliness or comfort (Shove and Warde 2001). Water industry researchers have explored the sociology of water usage with the aim to better understand variability in water consumption and patterns of domestic water consuming practices (Medd and Shove 2007). Like theorists of sustainable practices and resource consumption, sociologists have indicated that water consumption is embedded in daily routines and takes place as a consequence of accomplishing several practices associated with cleanliness, hygiene, and status. Despite the daunting challenges of changing social conventions, current standards of consumption and environmental actions must be rethought if groundwater communities are to remain resilient in the face of unpredictable changes in precipitation.

Technical networks of provision define practices and normalize certain routines, but this is not immediately obvious. Individuals become accustomed to (and gradually appreciate) technology, so changing the relations between consumers and new combinations of technologies would allow for a redefinition of water provision to take place. Technological efficiencies in

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[5] Don Worster's *Rivers of Empire* introduced the "hydraulic trap," a syndrome of engineering promises to solve all problems of water scarcity, but policies and technologies often fail to meet these challenges, "technological dominance over nature became an obstacle to new possibilities… Today that sense of being trapped by our own inventions pervades industrial societies everywhere" (1986:329). While his analysis is focused at the macro-level, it would be reasonable to expect a type of large-scale "lock-in" that coincides with the hydraulic trap—a technological approach that narrows water management capabilities.

providing and consuming water are important because of the associated benefits (for instance, saving water also saves electricity), but it is important to recall that tools themselves shape practices. Therefore, technological solutions to resource management can change practices as they are infused with concepts of normal practices (van Vliet et al. 2005). When provided with new technologies, citizens are not isolated from the system of provision or their supply, they can participate and influence the organization of their production-consumption cycle (van Vliet 2002). Furthermore, when existing technologies arranged in new ways with other instruments, they open up the possibilities for new activities that can be situated or normalized in the future—and spark additional momentum for inventiveness among citizens (Barry 2001). The arrangements of water supplies have to be arrangements of possibilities, not captivities. For example, under California's new Sustainable Groundwater Management Act, farmers in Pajaro Valley will be paid for collecting and storing rainwater by the hundreds of acre-feet to be injected into aquifers and replenish groundwater levels (Nagappan 2016). The financial incentives are roughly $10,000 annually, and the project's developers forecast that they will add more farms each year (ibid.). The Los Angeles Department of Water and Power now promotes rainwater capture as a new way to augment their local water supplies and storing it nearby aquifers—similar to the systems Wichita recently designed (Weiser 2016d). Combined technological innovation with citizen innovation can lead to beneficial outcomes for both aquifers and their overlying stakeholders.

On multiple occasions, historian Don Worster called for citizens in the western United States to become river-adaptive and "think like a river" (1986:331; 1993). In a similar fashion, the citizens, policymakers, and businesses of Kansas need to think like an aquifer if they are to use groundwater sustainably. For decades, environmental activists have protested dam construction in the hopes of preserving rivers—one of the true motivations for "watershed democracy," which has become more mainstream and institutionalized (Conca 2006:172). Citizens focused on groundwater preservation also have the opportunity to develop a coherent, organized network of environmentally-conscious and politically-active citizens who are concerned about the well-being of aquifers. Water has been at the center of citizen activism and grassroots environmental movements, as illustrated by the Cochabamba movement in Bolivia during the late 1990s and early 2000s. Local leaders, peasants, and environmentalists coalesced against privatized water services and the rate hikes implemented by the corporation put in charge of the utility, Bechtel, to demonstrate to the rest of the world that water is a common good. Generating international support, and mobilizing against corporate greed, were pivotal rallying points for these protesters (Olivera 2004). Protecting water supplies from the profit motive and ensuring universal coverage were such connecting concerns for Bolivians that they even elected the Cochabamba movement's leader, Evo Morales, president in 2005 (Caniglia et al. 2015). The success of that particular environmental movement reveals the power water supplies have as a mobilizing force. In my view, groundwater citizenship demonstrates how the passion sparked by environmental ethics related to aquifers can potentially unite communities or influence their political priorities. Cochabamba's illustrative case of grassroots environmental movements confirms how water connects citizens as environmentalists and political agents, two features that critically define groundwater citizenship.

Despite the rapid declines in water tables throughout the state, my survey generated a number of positive findings that speak to those sentiments. Groundwater citizenship appears to influence many Kansans, especially private well users; they invest more in water conservation technologies and believe that their water availability is an important political priority. It is also reasonable to juxtapose the recipients of municipal supplies (who may be captives to their systems of provision), to well-owning citizens (who could be viewed as "autonomous" from on-the-grid water sources). The urbanization of water can result in social struggle based on citizenship, and I contend that the exclusion from access to urban services is still an issue surrounding the groundwater economy in Kansas. Nevertheless, while researchers have framed municipal provisions as structures that create "haves and have-nots" of utility provision (Summerton 2004), the "haves" are arguably restricted by an infrastructure that promotes unsustainable water consumption. Meanwhile, the "have-nots" take water management decisions into their own hands with their off-the-grid status. Well owners might be autonomous from excessive domestic watering practices, but perhaps they can also be considered captives to their water supply's *limits*. That is to say, their "captivity" is out of ecological necessity, which gives them a more sustainable approach to water usage.

Public and private systems of provision create significantly different contexts for consumption. Private wells are autonomous modes of provision that represent a system of self-management; they are systems that revolve around a model of demand by which self-providers meet their needs. Public systems constitute a "universal mode of organization," which leads to uniform services and passive beneficiaries (van Vliet et al. 2005). In communities across the nation, where the future of water is jeopardy, citizens and municipalities should consider redesigning water supplies with both universal and autonomous modes of organization. Providing universal coverage is obviously critical, but so is designing a system that is responsive, flexible, and managed around the limits of highly localized water supplies. Incorporating the ethic of self-management within a universal mode of production would not only redefine water demands, it would also reflect a new pair of priorities: accessibility and stewardship. Adapting to environmental pressures might require what Guy and Marvin (2001) describe as "unbundling," in which institutions fragment larger networks into smaller micro-organizations. Echoing Schumacher's (1975) famous work *Small is Beautiful*, unbundling emphasizes decentralized, small-scale technologies for their environmental advantages and ability to cover social needs. The Vision's first guiding principle is very well-aligned with this idea, as it states: "*Locally driven solutions have the highest opportunity for long term success*. Therefore, the intentional focus of the action items presented in the Vision are to provide the necessary tools and support to allow for greater flexibility and management of water resources at the local level" [emphasis original] (KWO 2014:10). An effort to re-prioritize small-scale organizations would reshape utility provision, and in the case of western Kansas, it would require networks to be scaled along the nuances of underlying water tables.

If such a transition toward unbundled infrastructures were to take place, I suspect that a new form of citizenship, perhaps similar to groundwater citizenship, would become more pronounced. It is therefore not unreasonable to state that this project not only speaks to the distribution of modernity, but also to the changes undergone by citizenship within modernity. In my view, well owners experience what Holston (2008) referred to as differentiated citizenship, a privileged status that denies rights and powers and therefore increases vulnerability. Currently, off the grid well owners are technically disconnected: they aim for self-reliance and have developed lifestyles compatible with an alternative technology removed from conventional systems. Achieving autonomy involves not only a reconfiguration of technology, it also requires the prioritization of new social conventions and environmental commitments.[6] Fortunately, most

[6] "…any radical change to lifestyles requires similar changes to an individual's volumes of resources, and to the infrastructural and material arrangements that constrain consumption. Of equal significance are the social consequences of appropriating a new lifestyle. To change a lifestyle an individual must quickly learn and appropriate new rules of behavior and norms of conduct in order to fit in with their new lifestyle group. Even if it is

well owners already express noticeable concern about (and awareness of) water supplies, and environmental motivations to conserve water. New citizenships can emerge alongside updated utilities and infrastructure.

In this project, I have claimed that public utilities are a key source of citizen rights, and the inability to access utilities is a source of marginalization. Studying water supplies can offer a unique perspective for hypothesizing the development of unprecedented participatory citizenships. Holston also refers to citizens of municipalities as “municitizens” (2008:263), and as infrastructures of cities change in the Anthropocene, it could give rise to a promising group of environmental municitizens who break from the standards of the entrenched regime of contemporary passive citizenship. Citizenship has been tremendously important for natural resource protection in the United States for the past century. Citizen groups calling for the protection of lands for their biodiversity have been instrumental in the formation of conservation areas (Aycrigg et al. 2016). “Numerous laws, policies, and programs have been developed to ensure their stewardship and long-term persistence” (ibid.). These conservation efforts will have to be pushed more seriously around the world to reverse the trend of habitat destruction, and citizenship could be a critical facet in the effort to conserve natural landscapes and resources (Palomo et al. 2014). Furthermore, acknowledging the standing of natural resources could be a growing component of citizens’ responsibility in the Anthropocene. Just as Wittman (2009) contends that “agrarian citizenship” influences rural communities to invest in environmental stewardship, I have offered evidence that the socio-ecological systems of groundwater communities are defined by a citizenship that prioritizes aquifer preservation. I argue that water usage is influenced by infrastructural context, but the presence or absence of a well signifies a critical piece of infrastructure that has gone understudied within the literature on infrastructure, the sociology of water, and citizenship.

Changing systems of provision can reignite decision-making and grant individuals more control of their resource consumption, making them less “captive” to a technological infrastructure that has not been designed to promote water conservation. In a way, such a project of organizational transformation is no longer a system of provision, but a system of *co-provision*

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possible to rapidly appropriate nuanced and context-specific rules and norms, this still leaves the actor open to social sanctions with respect to their ‘established’ social networks with whom they no longer share lifestyle orientations” (Southerton et al. 2004:39-40).

(van Vliet et al. 2005). Demand and supply would no longer be a top-down relationship between utilities and their recipients, but patterns of demand and supply would be collectively negotiated based on a new utility-user relationship. The changing landscapes of provision would require new configurations of technical and social arrangements alongside traditional arrangements (Chappells, van Vliet, and Southerton 2004). Private wells are clearly a self-managed system of provision, and they would likely play an important role in this restructuring of utilities.

Exploring the environmental advantages or disadvantages of one system or another also provides policymakers and citizens with a new perspective to understand the relationship between consumption and production. The challenge for policymakers is to help citizens find "ecologically rational ways of achieving the goals of daily life and of putting their green commitments into practice" (van Vliet et al. 2005:17). Not coincidentally, the Governor's Vision calls on every Kansan to commit to ensuring a reliable water supply. With droughts expected to ravage most of the western US, residents need groundwater citizenship in order to reframe water usage a civic duty, particularly when it comes to the future of water in Kansas. Existing networks make it challenging to rethink water provision, especially in cities. At present, utilities mediate demand, but in an unbundled grid, households could shift their resource consumption, as private well owners (self-providers) can. Co-provision would likely incorporate interrupted, instead of continuous, water supplies, in order to meet peak times of communal consumption. Additionally, the public water sector is currently constructed in such a way that water—a very heavy substance—sometimes has to travel several miles from its source to household taps, making water provision an incredibly energy-intensive layout (Lohan 2016d). If larger grids were unbundled, it would allow citizens to easily make more responsible watering decisions, as well as reducing the communities' energy usage.

Imagine the effects of a community water supply that not only provided clean, safe, affordable water to each of its citizens, but it also gave them the structure to reevaluate their expectations or practices to ensure that their demand does not exceed their supply. In an unbundled system of co-provision citizens would no longer be "captives" nor "autonomous," they would be self-providers with a responsibility to inform their network's managers of their daily or seasonal watering routines. These citizens would be expected to participate in a dialogue with their water providers, which would allow the providers to absorb the various fluctuations of household demands. This innovative system would require more engaged, responsible citizens, and well owners have expressed an ethic of environmental stewardship that can be galvanized in the creation of a new, adaptive organization of resource management. There is no doubt that self-managers or people who have voluntarily selected a private water supply represent a small proportion of citizens—only about 10 percent of Kansans are well owners. However, some of those citizens made decisions based on ethical principles related to their environmental concerns, principles that can drive major conservation efforts throughout the Anthropocene.

> Water conservation, as it is currently being practiced in most places, has an important role to play, but a more powerful strategy is needed to relieve the long-term, and growing, financial pressures on our centralized water systems. *Perhaps the best long-term solution to our water problems will be to abandon centralized water systems altogether*. [emphasis added] (Sedlak 2014:243)

Despite their advantage of widespread coverage, municipalities with centralized water systems can still incorporate new ways for promoting conservation routines from those who use private water supplies. Climate change is predicted to stress infrastructure and the ability to provide resources (Carmin et al. 2015), and researchers have acknowledged that water provision services of the future might move away towards centralized provision and begin to replicate more localized, private supplies (Sedlak 2014). Climate change adaptation, therefore, will continue to be closely associated with development and the role that centralized or privatized technologies play in the distribution of natural resources. In densely populated cities, centralized utilities appear to be the most feasible and efficient option for water distribution given the amount of available space and the investment in the pipe network, but they could still hypothetically be unbundled to become more responsive to demand shifts. Rapidly aging infrastructures cast doubt on the future and stability of urban water management, but urban water sustainability could be innovated through new designs in rainwater drainage, locally-adapted alternatives like on-site separation of human waste, and replacing leaky pipes (Larsen et al. 2016). Overhauling cities' abilities to be more responsive to changes in precipitation can also prevent damage caused by floods that lead to sewage overflows. In July of 2015, Topeka experienced a deluge of 4.5 inches of rain in just over one day, creating a sewage overflow of 50 million gallons (Kenward et al. 2016). Revitalizing infrastructural adaptability would therefore have profound importance for keeping water supplies safe in times of drought and heavy rain. Decentralized treatment systems could have even more potential in suburban and rural communities, where it is likely that new housing developments will construct their own constellations of regionalized wastewater treatment plants to recycle water (Lohan 2016a). The future of less-densely populated areas could contain an interwoven hybrid of centralized utilities and private supplies that will complement or replace public systems, which could reform public life and bring about new modes of environmentally-based citizenships.

Regardless of the urban or rural setting, resilience-building in the Anthropocene requires the consideration of spatial, or multi-scale, aspects which will "allow greater understanding of global sustainability challenges" (Chelleri et al. 2015:181). Erik Swyngedouw (1997) has argued that urban environments are integral in civilization's transformation of nature, and the "urbanization of water" pivots around major ecological transformations. Urbanized water also symbolizes (or enables) the commodification of water and the circulation of money to reinforce associated relations of social power.[7] Therefore, if water supplies transform into unbundled constellations of co-provision systems, it would signal new social relations—ones that prioritize the needs of residents, watersheds, and aquifers, not just the entrepreneurs or elites. Water infrastructure reflects power relations, and communities can make appraisals of how resources should be utilized to achieve cultural goals (White et al. 2016). To an extent, water supplies replicate the dominant social institutions and impose a particular view of the world (especially the domination of nature) on citizens. As Swyngedouw (2004) describes in *Social Power and the Urbanization of Water*, access to water infrastructure and natural sources shape the boundaries of urban centers. Cities are constantly redesigned through political and material struggles, and unbundled structures would signify a shift in power towards the residents, away from the elites. Larger infrastructures support the idea that nature has been mastered by technology, and they can be used to justify the construction of extremely advanced water provision projects and the agendas of constructionists who wish to exercise some level of mastery over nature—not to mention encourage consumption by drawing on distant bodies of freshwater. A movement towards decentralized systems would symbolize the humbled acknowledgement on the part of citizens and their representatives that communities are contained within unique ecosystems with various water budgets. Generally, governing commons resources requires institutions to incorporate the dialogues of policymakers with scientists in order to facilitate learning and change (Dietz, Ostrom, and Stern 2003). Protecting natural resources demands new institutional

[7] Social theorists have recently argued that environmental problems and social problems are intertwined, and power relations play an important role in how socio-environmental problems are defined (White et al. 2016).

responses, and citizens must collectively decide how to construct complex, efficient, and responsive social, economic, and political institutions that redefine notions of authority and stewardship.

GETTING THERE

The idea of unbundled structures is less utopian that it might appear. In fact, the Governor's Vision calls for regionalized, localized efforts to manage groundwater. One of the Vision's Statewide Action Plans is to "increase the regionalization of water supply to improve the long-term water supply reliability" (KWO 2014:29). The Governor obviously prefers small government, and precisely managing of water requires a strong community-based or local government. When it comes to water management, local control in Kansas has generated promising examples. The LEMA in Sheridan and Thomas Counties has extended the useable life of the aquifer by 25 years with the agreement to reduce irrigation by 20 percent (Steward et al. 2013). Overall, the occupations of farming and ranching are defined by resilience and inventiveness, and those in the LEMA planted and fertilized appropriately to keep their operations profitable while using less water (Chilson 2016). Having local control gives residents a better chance at controlling their destiny and allows them to apply their knowledge to find the solution tailored for their needs, all of which will be critical for water conservation within Kansas.

Unbundled designs have already been implemented in the energy sector, where utilities play an important role in sustainable residential practices. Merging new power grids and redesigning energy utilizes have been proposed across California, and these mergers are anticipated to take place alongside tremendous investments in wind power and solar energy (Ashton 2016). The surge in residential rooftop installations of solar panels since 2010 in the United States has been driven largely by local utilities' agreement to buy excess power from customers with solar panels (Eckhouse 2016). Utilities across Los Angeles are using new virtual power plants to link energy-efficient buildings, solar power generators, and batteries for energy storage to reduce energy demands during the peak hours and augment their energy networks with renewably generated electricity (Gallucci 2016). Virtual power plants incorporate small scale renewable energy projects coordinated by local governments—in this regard they operate like a "supply-side" system. Yet decentralized plants also focus on cutting consumption through efficiency and encourage users to power down and install smart meters, so they focus on the "demand side" of the relationship (ibid.). Since electric utilities have not found a way to store electricity, they need to produce exactly the same amount of energy that is being consumed. On the other hand, water utilities have tended to err on the side of overabundance in order to meet the times of highest demand. Simply put, the water sector should start to behave more like the energy sector in that supply and demand are in a persistent equilibrium, forging a new frontier in water storage and grid flexibility.

Importantly, the private sector can facilitate this transition. One of the companies leading the clean energy revolution is Google, which actually bypassed utilities that did not meet their renewable energy standards and now buy their power with a power purchase agreement with independent renewable power developers who build installations exclusively for the company (Spiegel 2016). In addition, Tesla has won a contract with California utilities to greatly improve their energy storage; when completed, the system will be among the largest lithium ion battery storage facilities in the world (Groom 2016). As energy-intensive companies look for larger amounts of renewable power, improve their renewable portfolios, and manage their own power supplies, they have forced energy companies to rethink the future of carbon-based energy production. Reducing both consumption and supply through emerging technologies and small-scale management provides the opportunity to drastically decrease waste while universally distributing resources with flexibility. Sociologists investigating natural resource conservation have established that local people living within environmentally fragile regions have different understandings about their environments than non-locals, and "without local involvement, understandings of local social differentiation and power, natural resources management schemes will likely be unsuccessful" (Gareau 2007). Under the watchful eyes of regulators familiar with the location, private industries can lead the way in managing supply and demand.

Nevertheless, it is hard to envision how such a long-term effort could be achieved without also having a strong statewide and interstate framework, in which the smaller government entities work alongside the larger political apparatuses for coordination, updates, recommendations, and funding. "If all… governments would set proper local standards, implement local regulations and make sure that enforcement takes place, there would be no room in this world to overexploit or pollute water resources" (Hoekstra 2013:3). To address the challenges associated with water supply protection, policymakers must explore the multilevel nature of water supply knowledge, governance, and policy implementations. Other scholars have already called for nested approaches with clean energy and energy efficiency implementation in a way that empowers local communities (Forsyth 2009; Bixler forthcoming). An eye for nested environmental challenges could

> …reorient policy away from the current focus on separable "international," "national," and "local" policy arenas to a more systematic consideration of how governance functions across multiple scales, and how traditional state-based policy measures can be integrated with networked, "bottom up," public-private, and market-based governance initiatives. (Bixler forthcoming)

The management of CPRs is deeply contingent on the broader social settings in which people self-organize and govern (Ostrom et al. 1999). Higher levels of government can help enforce agreements reached by local users, while also help with the assembly of interested parties to share information and design new environmental coalitions.

Unbundling does not have to lead to the weakening of larger state authorities; it can encourage dialogues at various levels and improve the accountability of residents, entrepreneurs, and policymakers—all of whom could be bound by a new style of citizenship predominantly defined by the protection of natural resources. "The problem of democracy becomes a question of how to manufacture a new model of the citizen…" (Mitchell 2013:3). A newly-designed water supply could be at the core of citizen formation. Furthermore, if residents began uniting around redesigned, localized water supplies, they will start forming new connections and relationships. An unbundled system of co-provision could realistically facilitate opportunities for interaction and community involvement—both of which have been linked to higher quality of life perceptions (Jeffres et al. 2011). The benefits associated with Community-Based Resource Management (CBRM), especially around water supplies, improve community development, the participants' ability to work together, and their acceptance of differences (Wilkinson 1991; Satria, Matusda, and Sano 2006; Stedman et al. 2009). Municipalities have the potential to be restructured in a way that improves drought resilience, and fragmentation of water supplies will require better organization.

Droughts loom on the horizon for communities across the planet, which opens the possibility for localized water management the acceleration towards unbundled structures overseen by citizens and water-conscious communities of practice and awareness. As growth machines, cities themselves are bastions of neoliberal governance, but they are also the principal sites for “the generation of oppositional movements and alternative social visions” (Leitner, Peck, and Sheppard 1999:312). There are promising examples in which better systems of provision (for water and other resources) have been designed. Villagers of the South African town of Mgwangqa collaborated with nearby governments and businesses to build their own water system in the late 1990s. In the process, they improved their capacity to stay engaged as decision-makers and citizens, and the project enhanced the local government’s capacity to coordinate with community members (Waddell 2005).

The dynamics of alternative agricultural networks can also provide the scaffolding for redesigning natural resource supplies in which consumers and citizens are initiators. Demand generally involves consumers balancing their social, professional, and private lives within systems of provision and distribution, but individuals and households can play a transformative role as changes are introduced and normalized in a community (Brunori, Rossi, and Guidi 2011). Thanks to the efforts of community organizations and devoted individuals who were intent on increasing Toronto’s reliance on local and sustainable food chains, the city’s food systems have shifted towards local supply chains (Friedmann 2007). Toronto became not only a community of practice, but a community of *food* practice that included involvement in a vibrant network of nearby organic farmers, businesses, and organizers who shaped how farm products move through local supply chains (ibid.). Farmer’s markets, which are driven by the interests of farmers, consumers, and community business, create closer ties between farmers and their customers (Hinrichs 2000). The model of community-supported agriculture is unique for its emphasis on community building around food production, land use, and nature (Kneen 1993).

Citing the importance of producer empowerment, Canadians have also developed a secure dairy sector that regulates and restricts supply; operating according to local agricultural supplies and distribution dynamics makes their agricultural sectors more resilient to food crises (Muirhead and Campbell 2012). The localization of food systems holds promise for rural development and uniting agricultural and urban communities and perhaps serves as a countermovement to globalization by shifting market relations towards a local level (Hinrichs 2003). Dairy farmers across Europe utilize institutional links and regional production economies in order to keep their production and consumption localized, which protects the economies of many rural communities (Long and van der Ploeg 1994; Van der Ploeg 1994). Managing supply with local supervision is an anti-neoliberal strategy that also ensures certain sectors of the economy no longer fall into the “overproduction trap” summarized in Chapter 3. Whether described as endogenous networks or communities of practice,[8] it could become widely adopted in the Anthropocene for social groups to serve as groundwater and surface water stewards. Just as localization is pivotal for sustainable food production, public water supplies could improve their long-term viability by promoting citizen involvement, offering workshops that inform community members about the challenges associated with water supply infrastructure, and facilitating dialogues between residents, entrepreneurs, educators, and policymakers.

Kansans should consider some of the bold actions that have recently been taken to redefine water supply infrastructures across the nation. Chapter 3 described how water supply projects and the development of rivers and aquifers are emblematic of larger economic and political goals (see O’Neill 2006). Yet devoting resources to massive construction proposals can actually impair the ability to manage a river basin or valuable bodies of freshwater. On the Klamath River in Northern California, four dams will be removed in 2020 because they never met their expectations to provide irrigation water and hydroelectric power (Blankenbuehler 2016). The area’s irrigators, tribes, and conservation groups made convincing cases that river restoration should be a natural process, not one of technological mastery. Giant dams were approved on the idea that they would simultaneously reduce floods while providing year-round water storage in arid regions. These construction projects have proved far less effective at achieving this because dam reservoirs lose hundreds of thousands of acre-feet to evaporation and leakage, effectively making the west’s water crisis worse (Lustgarten 2016). While water scarcity might be caused in part by environmental realities (droughts), consider that it is also contingent on resource management and planning. Importantly, most surface water development has usually been on a larger scale and financed and constructed by water administrations of government agencies. On the other hand, groundwater development has been undertaken primarily by private users and irrigators trying to compete in a productivist agricultural landscape (Llamas 2004). As long as residents rely on water management strategies that are realistic, communities are far less likely to run out of water. This is even the case in the developed world and villages without improved water sources, which have established water

[8] DuPuis (2002) uses Long and van der Ploeg’s (1994) phrase “endogenous networks” while also referring to communities of practice.

networks that integrate crop selections, household usage, and retention ponds and canals that reduce water evaporation and prevent soil erosion (Jitcharoenkul 2016).

As Charles Fishman concludes in *The Big Thirst*, “There is no leapfrogging over an aging water system” (2011:260). Hydraulic managers must attend to some of the most wicked shortcomings within the designs of their projects. If they continue to ignore problems of mismanagement and inefficiencies, no matter how many rivers they dam or aquifers they drain, their hydraulic missions will never be accomplished. If developers and politicians took water *management* into greater consideration, and if they addressed the inefficiencies of their water projects, they would not have to invest nearly as much in water *development*. Perhaps the very nature of constructionism, the ethic of changing nature through technology and waterworks projects to serve humans (Worster 1994), is to ignore the root causes of water scarcity in order to promote the manipulation of the rivers and aquifers via technological mastery over nature. The perspective that nature is a territory to conquer has led to a decontextualized misunderstanding of the natural world, which has impeded the ability to make informed watershed management policies (Conca 2006). Living within the limits of a river basin seems to be a more sensible approach than attempting to dominant a river and bend it to social agendas and continuing unsustainable agricultural and industrial practices in the semiarid High Plains. Kansans need to think like an aquifer and learn to produce food in a semiarid region with slowly-recharging aquifers through crop selection, pragmatic irrigation, or dryland operations.[9] Thankfully, promising research in agronomy has called for “deficit irrigation,” the application of water below full evapotranspiration requirements, to manage irrigation supplies (Fereres and Soriano 2007). When regulated correctly, deficit irrigation can increase water productivity because it only provides 60 to 100 percent of the crops’ full evapotranspiration needs (Misra N.D.). Of course, improving water productivity will also improve farmers’ profits. Irrigation will continue to take place under insufficient groundwater supplies in the future, so implementing a monitoring system that maximizes water’s role in crop production will be essential for achieving safe yield irrigation.

[9] “We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports. We have been quick to assume rights to use water but slow to recognize obligations to preserve and protect it… in short, we need a water ethic—a guide to right conduct in the face of complex decisions about natural systems we do not and cannot fully understand” (Postel 1992).

Resource consumption cannot simply be regarded as functional or useful, it is also symbolic. Social relationships produce water's core meanings, which influence how it is managed and consumed (Strang 2004). Patterns of consumption and systems of provision are interconnected, and consumption is a process shaped by consumers, technology, and social beliefs about resource usage. Adjustments to all of these are necessary for institutional change and utility reform. Within environmental sociology's analysis of pro-environmental behaviors, research suggests that individuals often need to learn about a problem (gain awareness) before they develop an environmental ethic (attitude) (Bell 2012). This is why education and outreach are so valuable—they represent a cognitive fix. While they often fail on their own, researchers need to acknowledge that awareness and attitudes combined can form solutions. If Kansans' awareness of environmental issues improves, it might instill an attitude that water conservation needs to be taken more seriously. In this light, an attitude-behavior gap could represent an emerging shift towards pro-environmental behavior. First citizens learn about a problem, then they feel a responsibility to address it, and then change behaviors to alleviate it.[10] It is not far-fetched to claim that Kansans could be learning about their water supplies in ways they previously have not, but their routines are taking time to develop and catch up to the state's environmental imperatives of judicious usage. This is where community efforts can be so important: collectively reducing consumption in a way that shapes local norms and updates cultural priorities of resource management could be a pivotal change. Without those conspicuous community-wide adjustments, "it is not clear that citizens will be willing to alter their consumption and behavior patterns" (Smith 2005:275). Elinor Ostrom (1999) has made a similar argument, whereby individuals often continue to act with self-interest until social norms are swayed by institutional, cultural, or environmental factors. This heightens the importance of examining water usage as a collective, not simply individual, behavior, not to mention the role of community efforts and courageous policymaking.

[10] "…when we do get that social reconstitution into place, we may well find that we're not completely satisfied with it—that the behaviors it encourages are not fully in line with our attitudes, maybe because we didn't get the result we wanted or because our attitudes changed once we did get it. That's okay. We're learning. We're always learning, for it's another dialogue, an ecological dialogue that virtual environmentalism depends upon. Or, put another way, virtual environmentalism means turning the Attitude-Behavior Split into the "Attitude-Behavior dialogue," where the difference between our attitudes and our behaviors is not a sign of our hypocrisy but a sign of our growing collective wisdom about what it is we'd like to do and how best to make it possible" (Bell 2012:286).

It is clear that successful water conservation efforts will take political leadership, not just informed individuals making smarter decisions. Surprisingly, most people who report high levels of concern about climate change do not take action to influence public policies (Doherty and Webler 2016). Social norms and self-efficacy are typically the main drivers for those individuals who protest, vote, and contact representatives, as is the belief that others were taking action (ibid.). Greater involvement in PEBs and civic action "involves recognition that acting as an individual is a less powerful form of resistance to consumer culture than acting as a group" (Kennedy 2011a:114). This suggests that wider conservation campaigns would be most successful if their communication efforts fostered the belief that like-minded individuals were participating in the political process, and they need to motivate the environmentally-concerned citizens to engage in political action:

> …efficacy beliefs are already high for alarmed individuals. This implies that communication efforts must move beyond messages such as "We can do it" and focus on creating a shared sense of responsibility and strengthening self-efficacy, response efficacy, and descriptive social norms perceptions. Strategies to promote action include encouraging opinion leaders to exert influence within their social networks and beyond; messages that demonstrate similar others engaging in public climate actions; and persuading the alarmed of the critical nature of their involvement and the effectiveness of their actions. (Doherty and Webler 2016:5)

Despite the fact that a majority of Americans are worried about climate change, it is challenging to maintain a dialogue about climate change and keep the public up-to-date via the curricula of science classes due to global warming's politicization (Grant 2016). Perplexingly, highly-respected natural scientists face difficulties explaining the risks of climate change to policymakers and the public, specifically if they are charged with being alarmists (Reilly 2016); even scientists' personal energy consumption can make them appear less credible if they do not practice conservation (Attari, Krantz, and Weber 2016). Powerful denialist forces make informing the public accurately about environmental problems seem controversial. Grundmann and Stehr (2012) note that scientists can create regulatory environmental policies, but they must channel their social prestige as "experts" and identify political "levers for action." Environmental sociologists have an obligation to raise important questions about the institutions that drive ecological destruction and challenge existing political and economic paradigms (Norgaard 2016). Scientific authority is currently organized in a hierarchy that places "hard" sciences above "soft" sciences, especially in environmental studies, but sociologists are skilled for understanding the social patterns and cultural definitions of water usage.

In this project, I outlined the institutional structures—namely, the legal, political, and economic traditions—that have insufficiently managed groundwater in Kansas. My evidence suggests that even though private wells are a key determinant in an individual's watering practices, Kansans still need more decisive policymaking to ensure that bold action is taken in time to preserve water for the next generation. When Kansans' water supply changes, they also are likely to change, but the state cannot rely on the stewardship of well owners alone to achieve the drastic cuts needed to maintain a safe yield approach to groundwater extractions. Water security will require a focused effort at the institutionalized level—not simply individual environmentalism. Environmental policy experts have noted, "When responsibility for environmental problems is individualized, there is little room to ponder institutions, the nature and exercise of political power, or ways of collectively changing the distribution of power and influence in society" (Maniates 2006:45). Similar to other research (Kennedy 2011b), this project has provided evidence that investigating consumption can serve as a way to discuss environmental policy due to the fact that communities of practice like well owners depend on routinized, shared behaviors. This field of work will remain an important guide for policymakers through the Anthropocene.

Policies and conservation campaigns can increase awareness, change attitudes, and push citizens to behave in environmentally-conscientious ways, so it is critical to understand the political strengths that Kansans currently have at their disposal. One of the state's primary tools to address water resource management is the State Water Plan, which is updated by the Kansas Water Office every five years. In order to make informed five-year updates that will improve water quality and other priorities, the KWO coordinates with local, state, and interstate partners. To be clear, the Kansas Water Plan serves as the implementation blueprint for the Vision, so the Vision could be seen as a series of successful five-year milestones that preserve the state's water far into the future. The Vision recognizes the economic importance of the High Plains aquifer, and it encourages local and individual programs (including the development of LEMAs) to conserve and extend the useable life of the state's groundwater supplies. It also calls on Kansans, as stakeholders, "to not only commit to ensuring a reliable water supply but also to act on that commitment" (KWO 2014:9). It is important to recognize that some Kansans are better-suited at committing to water conservation than others, and well owners have expressed environmental motivations to conserve water more than their non-well-owning counterparts. While well owners are not explicitly mentioned in the Vision, I foresee them playing a large role in creating local water policies, or even policies at a larger scale. All forms of water usage require a community of practice, “a particular way of life that embeds a person in a network of people who support that practice, so that the ‘performance’ of that practice leads to satisfaction and self-esteem” (DuPuis 2002:216). In my view, groundwater citizenship has the potential to reshape communities and networks so citizens claim a more active role in the creation of systems of co-provision.

Two of the main themes within the Vision are water conservation and water management, issues that I investigate at length in this project. Consider some of the larger action plans outlined within the Vision, and how well owners already adopt these practices, or could serve as advisers or community teachers, to share these ideas with others:

1. Conduct planning workshops to highlight successful case studies on development of regional water systems that provide examples of various approaches for implementation
2. Enhance public water supply planning assistance, including technical and engineering reviews of preliminary water supply proposals
3. Identify and recommend changes needed to state statutes and regulations that impede or prohibit regionalization and partnerships
4. Identify public water supplies with a single source of supply and, where appropriate, provide planning and financial assistance to develop secondary sources
5. Provide planning and financial assistance to water systems to facilitate interconnection opportunities among water supply systems to help address drought vulnerability (KWO 2014:29).

Recall from the opening chapter that the Vision was developed by input from Kansas citizens collected by the KWO, and Kansas citizens were expected to play a massive role in the design of this ambitious policy. Well owners represent distinct citizens because they are acutely familiar with many of the state’s challenges and living beyond the reach of the public water supplies mentioned in the action plan. Furthermore, as a subpopulation that is disproportionately burdened by drought, their (often daily) experiences with water shortages could serve as a robust addition to the community dialogue.

While I am on the subject of the potential *individuals* who should be included in long-term water planning, the SWP should also consider broadening the involvement of *institutions* that are not adequately mentioned in the Vision. As a student of the University of Kansas, and a long-time Kansan, I am aware of the importance that Kansans place on KU and the state's other large University, Kansas State University (KSU). KSU is well-respected for its focus on agriculture, and its Research and Extension programs are mentioned as important partners for the Kansas Water Office as they update the Vision and the SWP. KSU researchers investigating the decline of the High Plains aquifer have published widely-read articles (Steward et al. 2013; Steward and Allen 2015), some of which have even influenced Governor Brownback to call for urgent action. In addition to relying on the experts at KSU, many of the Vision's statewide action items include educational proposals in which community leaders promote local conservation decisions, and the Vision recommends that the Kansas Department of Education integrates water conservation into K-12 science curriculum. On a more localized level, the Douglas County Conservation District has collaborated with elementary schools and created educational programs that can teach public school children about water conservation. In an effort to promote water conservation practices and the adoption of water efficient technologies, the Vision has also identified many individuals and municipalities as role models for the rest of the state to follow with its "Be the Vision" outreach campaign. Fort Riley received the honor for its social marketing campaigns to encourage water conservation, and the town assessed its progress with a survey run by the KSU Sociology Department that measured knowledge and attitudes on water conservation. Outstanding developments are taking place all across Kansas, and the state has several individual and institutional leaders that are being recognized with their efforts to be the Vision.

The endeavors of KSU researchers, K-12 school teachers, and working partners of the Vision will be critical for a statewide outreach campaign that reinforces the value of water. Why is the University of Kansas—the state's largest university, home of the Kansas Geological Survey and dozens of professors and graduate students who have seriously researched water within their respective disciplines—not included in this important long-term strategy? With the submission of this dissertation, I hope to change the belief that KSU has an academic monopoly on advancing the state's agricultural agendas and conservation goals, and that KU researchers (especially in its Sociology and Environmental Studies Departments) should be seen as resources that need to be utilized in order to make informed water management policies.

Within a few decades, Kansas will quickly approach two ecosystemic limits: the end of its ability to draw vast quantities of irrigation water out of many portions of the High Plains aquifer, and the decline of rainfall in its most arid regions (Feddema et al. 2008; KWO 2014; Steward and Allen 2015). The problems of peak groundwater withdrawals and the breakdown of stationarity are connected, as both arise from and threaten the economic life created by a heavy dependence on groundwater. Both of these conditions allowed the agricultural economy of the state to flourish for the better part of a century, but these interconnected predicaments do not easily enter political debates on their own. Natural and social scientists collect data to measure the past and present with the hopes of predicting the future, and the alarming environmental forecasts should trigger a political response of engaging experts and seeking solutions—effectively speaking on behalf of nature. “The facts of nature speak only with the help of measuring devices and tools of calculation” (Mitchell 2013).

Groundwater’s ready availability, along with its free exchange value, allowed it to be consumed as if it were inexhaustible. The groundwater economy simply did not calculate the costs of agribusinesses using up Kansas’s limited stores of groundwater within a century. Agricultural economists and policymakers therefore need a new kind of economic calculation, one that accounts for the exhaustion of natural resources and the limits of expansion within a physically finite planet. Most mainstream economic thinking is based an assumption that the world has limitless space and resources, but continuing the depletion of resources without accounting for their ability to regenerate is ultimately uneconomic growth (Daly 2005). Growth-based communities might oppose mitigation efforts and support the status quo of drought vulnerability (such as intensifying development in drought-prone regions).

Importantly, utilities themselves are in the business of selling water, and the more water they sell, the more revenue they generate. “How do utilities encourage less use of water when their fundamental operations depend on revenue from selling the very resource requiring conservation?” (Luthy 2016). Increasing sales to meet expenses is an inappropriate model for conservation efforts; a much better approach would decouple consumption from revenues, or incentivize conservation with volume-based rates or fines for wastefulness (Gomberg 2016). If communities in Kansas or California (or anywhere else, for that matter), want to improve the water literacy of their citizens and routinize conservation practices, then the water agencies themselves should also have conservation goals (see Barnitt et al. 2016). Moreover, if municipalities treated conservation expenditures (such as the costs associated with fixing leaks or offering to replace traditional appliances with more efficient models) as *investments* instead of *costs*, over the long term they would see their energy, pumping, and storage expenses decline. At the same time, utilities will not invest in the expensive undertaking of making public infrastructure more efficient if water is cheap or not commodified, which provides further support for implementing tiered progressive prices. The pricing of water will be critically important in conservation efforts—especially since I found that "saving water" is the primary motivation for non-well owners to conserve. Public utilities should also encourage neighborhoods to understand the prevalence of any neighborhood conservation enthusiasts so they could not only connect with like-minded households, but also engage in a principled form of citizenship. This would have a ripple effect throughout the neighborhood.

> …living sustainably is made easier when one is surrounded by others who support a commitment to sustainability and encourage the adoption of additional sustainable practices over time… Acting alone, it is difficult to establish a critical presence of households committed to sustainability; acting with others, it is possible to create a sense of something larger, and of being part of a social network that serves an important response to the demand for a more sustainable society. (Kennedy 2011a:117)

The actions of citizen networks can reinvigorate environmentalism as a civic or neighborhood duty. I have argued that the boundaries of citizenship are contoured by municipal and private water supplies, and well owners represent conspicuous water users who will play a key role in redefining water consumption. Investigations of the impacts of drought on private well owners in the United States have only just begun, which were first conducted during the drought year of 2012 (Murti et al. 2016). Despite the epidemiological attention given to this subpopulation, my research shows that there is still much to learn about groups with alternative, private supplies.

Vulnerability to climate disasters is influenced by the victims' demographics (Cutter et al. 2008; Nagel 2016). This project hones in on the consequences of droughts for Kansans, specifically if they rely on groundwater, which will strengthen the understanding of disproportionate environmental burdens. Traditionally, hazards have been studied as geophysical problems, which frames vulnerability as location-dependent or proximity to a hazard (Cutter 2006). Personally experiencing a flood increases the likelihood of seeing climate change as a threat (Whitmarsh 2008); climate extremes have a negligible effect on perceiving climate change as serious (Marquart-Pyatt et al. 2014). Investigating vulnerability to drought as a social outcome acknowledges the relationship between how a society organizes its water supplies, and how that organization protects some residents (or ignores others). The disciplines of disaster research and environmental sociology have often investigated disaster vulnerability with distinct perspectives, but framing droughts as a consequence of broader political, historical, and economic processes should be used as a tool for dismantling their intellectual silos (Tierney 2012; Ryder forthcoming). The theme of environmental justice can expand the dialogue so social and natural scientists can share their insights and discover new ways to address disaster vulnerability and move environmental policies forward.

Early in this project I proffered the question, “What encourages pro-environmental behavior?” In the case of domestic watering practices, I claim that infrastructural differences can promote or discourage an ethic of conservation. If sociologists want to better understand the factors that drive water consumption patterns, they must consider wells as an underappreciated component of spatiality they have to acknowledge. Centralized infrastructures remove people from the effects of their consumption and can obscure a resident’s relationship with their natural surroundings. “A sustainable water system can be understood as one that maintains a level of service provision over the long term by adapting and coping with these dynamic components and contexts” (Mehta and Movik 2015:31). The research on PEBs suggests that attitudes based on direct environmental experiences are stronger and more tied to behaviors, as are attitudes tied to an individual’s identity (Heberlein 2012). Since well owners rely directly on aquifers, and overdrafting hurts their well yields, they might identify with the notion of groundwater stewardship and take on the role or identity of groundwater managers. Well owners are responsible for their water supply in a way that recipients of municipally-provided water are not: their daily water usage affects their own source of groundwater. This relationship should realistically augment a sense of groundwater stewardship.

As demonstrated in this project, the sociological imagination offers the means to expand the understanding of drought resilience by acknowledging the role that water supply infrastructure plays in Kansans’ water conservation efforts. Individual watering practices can be partially explained by the role that social context and infrastructure plays in shaping consumption patterns. The standards of “normal,” “extravagant,” “essential,” or “discretionary” water usage varies on cultural, regional, and infrastructural backgrounds. Well owners reveal significantly different patterns of practices and habits than non-well owners; geography and well ownership change the association of water supply awareness, drought reactions, and investments in efficient watering devices. Sociologists have called for “the development of an alternative framework for systematically analyzing and conceptualizing diversity and variation in domestic water consumption” (Medd and Shove 2007:3), but that goal cannot be achieved unless the researchers control for whether the systems of provision are public utilities or privately-managed. My study meets the challenge of developing a research method that accounts for variability and the differences in water-saving routines by exploring how infrastructure is unevenly spread across Kansas. Sociologists and sustainable practices scholars understand water consumption as the emergent outcome of a diversity of practices, but this project offers how those practices are formed around larger structures—specifically reliance on groundwater and private supplies.

The broader goal of environmental sociology is to offer recommendations for changes to structures that enable the social constitution of daily life to promote pro-environmental behaviors with increasing ease. Citizens’ practices are limited and made possible by their social organizations and material conditions (Bell 2012), and those practices have environmental implications that need a larger presence in collective and personal decision making. How can a community redesign the opportunities for PEBs, even when its residents are not deliberately considering their actions’ environmental consequences? Understanding the “everydayness” of water consumption is important for creating a discourse regarding better water management and access (Truelove 2011). I suggest that reassessing the infrastructures and political landscapes in which watering practices are determined can advance environmental sociology towards more decisive and precise policy proposals that will augment communities’ abilities to remain resilient during the looming droughts and heat waves of the Anthropocene. An informed citizen base could encourage the promotion of unbundled infrastructures, in which groundwater citizenship can serve as a communal heuristic, and also allow citizens to make educated decisions while voting and planning publicly-funded water works projects (avoiding systems of provision in favor of systems of co-provision). Furthermore, their concerns can hold governments responsible for environmentally destructive or inequitable water management (Bakker 2011). The Tuttle Creek Dam outside of Manhattan generated a huge protest against the Corps of Engineers due to concerns about failure to control floods on the Kansas River. Citizens cautioned politicians about the potential effects of selecting a large-scale project over smaller dams or dry dams that would only hold water during flood years (KHC 2016). Large-scale water supply infrastructures are the site for analyzing the intersection between governance and natural resources (O'Neill 2006), they can also serve as the sites for citizen-policymaker engagement.

This study reveals a more nuanced illustration of the dynamics of domestic water usage in Kansas—but where do the opportunities for change lie? Groundwater citizenship, like all forms of citizenship, requires public spaces for its practice, including town halls and online communities (as well owners have already shown with their Community of Practice Forum). Open communication within GMDs has been underway for decades, and the vision of citizen responsibility towards aquifers has found fertile soil in many parts of the state and within local political discourse. Perhaps it is necessary to democratically involve stakeholders to promote a brand of citizenship that changes individual behavior and foster values of stewardship in areas facing severe droughts and climate shifts. Sociologically assessing the institutions associated with groundwater use in Kansas reveal that innovation within current political, economic, and infrastructural institutions would making for promising agendas that can sustain access into the future. "The emergence, maintenance, and evolution of institutional solutions to irrigation coordination are necessary elements for sustained and productive groundwater use" (Dubash 2002:20). The current architecture of the groundwater economy in Kansas needs to be redesigned to reflect adequate exchange value, while also transitioning away from its tendency for overconsumption. In response to depletion, farmers could continue to coordinate a decrease in use, similar to the LEMA approach in northwest Kansas. Once those farmers mobilized, they effectively brought their extractions within a safe-yield range. Those are promising developments between the state and agrarian politics, but what can be done on the micro-sociological front? By undertaking a study of normalized routines within households that use private and public supplies, sociologists can shed light on how systems of provision structure the demand of those communities. Controlling for geography affords a deeper understanding of regional water consumption, and investigating the conservation efforts among respondents from Ogallala and non-Ogallala regions by conducting a detailed qualitative study on the habits of individuals in those communities would offer clarity on their daily, seasonal, and drought-influenced watering routines.

Despite contemporary literature discussing environmental vulnerability, communities of practice, and ecological communication, sociologists have not studied the routines of private well owners. I have outlined many meaningful avenues for sociologically studying water, and the sociology of water is a growing field in which this project makes contributions. Water conservation studies have demonstrated how infrastructure and social standards shape sustainable practices, and I applied this literature to well ownership. Well users are directly reliant on aquifers, particularly during droughts. Therefore, studying their routines, attitudes, and experiences will generate insight regarding the development of sustainable practices. Aquifers and well owners represent a socio-ecological system, and researching the sustainable practices of well owners will be key to aquifer preservation as the severity of droughts intensifies. While well owners' practices are social "in the sense that they are shared and recognized by others" (Hitchings 2014:105), their routines are also related to the threatening ecological reality of groundwater depletion. Well owners are unique in that they influence their own water supply through their daily routines of water usage, and conceptualizing their water conservation as a method of water supply management is an important step in discovering how this community of practice controls their water supply during droughts. Studying their domestic water usage—a missing component in groundwater estimates—will be necessary to ameliorate this environmental disadvantage. Agricultural and non-agricultural withdrawals will remain in competition over finite water supplies, and understanding conservation measures will be increasingly important in an era of groundwater depletion and harsher droughts.

CHAPTER SUMMARY

> The aim of this research was to convey, through survey findings, how well owners are more engaged with water conservation efforts than non-well owners. Their water literacy, prioritization of water as a political priority, frequencies of water conservation, and environmental motivation to extend their supplies all suggest that water supply infrastructure contour facets of environmentalism and that users of private water supplies can be reasonably conceptualized as aquifer stewards. As a whole, my project investigated the relationship between water consumption and provision with an emphasis of focusing on changing systems of provision from public utilities to private wells. This project can facilitate drought preparation because studying how Kansans use water domestically will provide important insight which can benefit areas beyond the state—or even beyond the High Plains—that will encounter similar water shortages. The loss of groundwater has been a growing problem in Kansas, where the future of the Ogallala aquifer is in jeopardy. While concern about droughts has improved water conservation attitudes and actions, researchers have not adequately explored if overdrafts have a similar effect on PEBs. This project examined if Kansans are conserving water in their everyday practices around the house, as well as how their systems of water provision influence their routines of water usage.

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Appendices

CHAPTER II APPENDIX

Synopsis of Popular PEB Theories

Social practice theories are unique from macro theories because everyday practices become the unit of analysis—they are framed as the roots of social order. Placing practices, situated in time and space and shared with other agents, at the center of the model is a key difference between the sociological and psychological models. The theoretical framework proposed by Ajzen (Fishbein and Ajzen 1975; Ajzen 1991), the Theory of Planned Behavior (TPB), asserts that an individual's belief about environmental actions influences their attitudes regarding that behavior. Additionally, social acceptance of the behavior and the individual's perceived ability to execute it shape whether or not a behavior should be attempted (ibid.). This theory has been adopted by researchers investigating PEB (Bamberg and Schmidt 2003; Steg 2005; Cordano et al. 2011), and applied in water conservation studies aiming to predict intentions that lead to consistent conservation behaviors (Lam 1999). Participants who performed ongoing curtailment measures to conserve water expressed moral obligations and positive attitudes towards conservation (ibid.). By framing the social practices themselves as the proper unit of analysis for researchers, Anthony Giddens' (1984; 1991) structuration theory claims to move beyond the "actor-structure" dilemma. In the field of sustainable water consumption, this social practices model analyzes the variety of lifestyles or "lifestyle groups." When Giddens' theory replaces Ajzen's and Patchen's, the conceptual foci of environmental research and policymaking changes to be more inclusive of structure and contextualizes norms and environmental behaviors. Giddens defines lifestyles as sets of social practices, which may vary considerably from the intensions of individuals. Individuals are more likely to alter their lifestyles when they believe they can make a difference in combating climate change (Goldblatt 2005). When an individual has a favorable attitude toward the behavior, a social network that supports or performs the behavior, and the behavior does not inconvenience them, they are very likely to participate in PEBs (Bamberg and Moser 2007; Wall et al. 2007; Lin 2012).

In a similar fashion, Patchen's (2010) Environmentally Significant Behavior Framework (ESBF) offers that PEBs are predicated on willingness to act, or intention, which is affected by social norms. ESBF is perhaps a slightly better accommodation for sociological analyses than

TPB because it weighs the significance of macro-level impacts more seriously, but both models still need a more thorough blend of the micro- and macro-level determinants. Of course, these models are heuristics and not grand theories of PEBs; while TPB serves as an important and reliable baseline for assessing PEBs, it primarily focuses on the individual, who is expected to behave as a rational actor. In the social psychological and sociological literature, theoreticians have faced difficulties connecting structural contexts, demographics, and the level of cognitive decision-making. Balancing the social influence and investigating underlying institutional components could strengthen the predictive power of TPB when applying it to PEBs.

METHODOLOGICAL APPENDIX

Pretests: Pilot Study, Qualtrics Panel Launches, and Survey Management

I collected responses from survey volunteers with three solicitations: the panel obtained via Qualtrics, a wave of surveys in March 2015, and a second wave of surveys in early May 2015. The panel generated by Qualtrics, also obtained in early March 2015, gave me a very brief window to examine how my instruments behaved "in action" before my notifications were mailed. The earliest respondents recruited by Qualtrics caught minor but crucial incongruences in the soft launch of the study that kept the questions in each of the forms the same (e.g., differences in selection options and wording). This project required running multiple surveys simultaneously, and it was critical to keep each survey form identical in the Qualtrics panel, the first wave, and the second wave. The wording of every item needed to be consistent, their placement in the survey had to be analogous, and the options should be identical across all forms. Even the slightest deviation in how questions were worded or ordered could make the respondents of one survey perceive the same item differently than the respondents of another, invalidating my results. After countless edits by my research assistants, committee members, and survey methodologists, closely examining the pilot study, and the Qualtrics panel soft launch, I could not find any variations between the items within each survey form by the time the main surveys were activated.

The pilot study was conducted in November 2014 and tested 75 notifications. It received a response rate of 8 percent, roughly 1.5 percent higher than both of my main waves of surveys combined. I selected 75 male respondents from Harvey County, a county that a research assistant and I intentionally oversampled so we had plenty of addresses to deliver postcards for both the pilot study and the main wave of the study. Pilot study participants received 25 XAB, 25 XAC, and 25 XBC postcards. Those respondents, to my knowledge, were able to access the survey in a higher proportion than the participants in the main study, as I received only one email from the pilot participants indicating trouble opening the survey with the URL provided on their notification postcard. They were able to take the survey after I emailed them a direct link for the survey that was generated by Qualtrics. The first wave of surveys precipitated several emails from respondents who were requesting different links. While I was grateful that so many people went out of their way to volunteer their time, I was disappointed at how many respondents had trouble accessing the questionnaire provided by the first notification's instructions. After troubleshooting with Qualtrics employees after the slightly rocky rollout, it became obvious that participants who tried to open the survey in some web browsers (specifically, older versions of Internet Explorer) were using technology that predated the programs that Qualtrics uses, and therefore were incompatible with the surveys. Having gleaned this lesson after the first notification wave (which probably cost me a substantial number of responses) I included very clear directions (avoiding old versions of web browsers; use high-speed internet connections) on how to access the survey on the notification postcard in the second wave. I also changed the URL generator used in the first wave (bit.do) to another URL generator that has a better reputation for cooperating with older web browsers (tinyurl). Those technical difficulties in the first round probably explain the similar response rates between both waves of the surveys (see Table A.1).

Summary of Data Collection

Given my 8 percent response rate in the pilot study, (6 out of 75 pilot notifications received responses) I estimated that collecting approximately 8,000 addresses and sending out one large wave of notifications would yield nearly 640 responses. Coupled with a generalizable sample of 420 Kansans that was obtained by Qualtrics, I intended to have over 1,000 respondents in my total sample. Unfortunately, my pilot study's response rate did not hold in my main wave of data collection, and I needed to distribute an unexpected second wave of notifications to collect more responses. This lengthened the completion of data collection by nearly six weeks, and postponed my data cleaning until the summer months of 2015. Thankfully, by mailing two waves of notification postcards, I gleaned a couple valuable lessons about notification design that can slightly influence response rates. Furthermore, because I had thousands of addresses to which I had to deliver postcards, and my survey was created using planned missing data designs, I had a unique opportunity to test how minor aesthetic variations alter response rates throughout my pool of respondents.

An ancillary benefit of PMDD emerged as I was planning my postcard mail-outs. Since each online survey required its own specific URL, it was necessary to print three different styles of notification postcards (one for each of the online surveys). I wanted to slightly tweak the notifications' designs to see if minor changes in deadlines would influence response rates. Using planned missing data designs affords researchers the opportunity to make modest adjustments to their surveys, which can in turn provide the researcher feedback as to which stylistic modifications yield the best results. To put another way, think of running a study using planned missing data not as running a single survey, but multiple surveys. I used the 3-form design (Graham et al. 1996) in all three of my waves of data collection; therefore, I had to design, finalize, and launch a total of nine surveys over the course of the 2015 spring semester. Once my data collection was complete, I then combined all the survey responses into a master dataset, which are the records on which I run my analyses.

My Qualtrics panel was conducted in early March, and I requested that Qualtrics obtain responses of 420 Kansans (140 responses for each of the three survey forms) in order to have a decent-sized sample to compare the non-well owners and well owners, and to keep my sample nearly generalizable. I timed the mailing of the first wave of postcards to the well owners located in the Kansas Geological Survey's database so they would arrive in the middle of March. Some of the notifications requested that the recipients complete the survey by Saturday, March 28; other postcards listed a deadline of Monday, March 30. At the very shortest, this window should have allowed recipients about 8 to 9 days to take the survey, and perhaps as many as 10 to 11 days. Another change that I made to the postcards was printing my signature in blue and red ink, as the color of the signature might influence the perceived authenticity or personalization of the notification (McDermott and Sarvela 1999; King, Pealer, and Bernard 2001). Finally, in the address line of the postcard, some of my notifications included a line that said "or current resident" beneath the respondent's name. Personalized addresses can influence rates of return on surveys, and testing these slight variations' influence on my sample of well owners represents an important point for reaching this population of primarily rural Kansans. During the second wave of delivering notifications, I removed any addresses of respondents who already completed the survey and changed the due dates so they left a similar window for completing the online questionnaire.

While response rates have been studied for decades by survey methodologists, the effects of personalization are not entirely clear. Overall, researchers have noticed a small increase in surveys and cover letters with personalized qualities (Carpenter 1974; Kahle and Sales 1978; Dignan et al. 1994; Rodgers and Worthen 1995; Dillman 2000; Edwards et al. 2002), yet personalization manipulations have also been commonly found to have no statistically significant effects on response rates (Jobber 1986; McCoy and Hargie 2007). Nonpersonalized questionnaires have even received higher response rates personalized in previous work, suggesting a negative effect of personalization (Houston and Jefferson 1975). Furthermore, Jobber (1986) suggested that personalization might be counterproductive when sensitive information is requested. By designing two of my three survey forms' notifications with the phrase "or current resident" I slightly lessened the personalization of the postcard.[1] At any rate, I doubt the lack of "or current resident" was highly influential; rural populations have long been established as less responsive to surveys than their urban counterparts (Roeher 1963). My survey has experienced this reticence within rural communities: while I received nearly 275 completions from small capacity (domestic and lawn and garden) well owners, my sample only had 61 irrigation well owners—a mostly rural group.

Personalization, however, has also been documented to have a positive influence on response rates with rural respondents (Dillman et al. 2007). In many of his publications, Don Dillman, the renowned survey methodologist and rural sociologist, emphatically supports personalization, a central tenet of his "Tailored Design Method" (2000) to surveys, or what I refer to as the "Dillman approach." The various postcard designs I used in my study do not convey tremendously different response rates, so even though Dillman believes in personalization, it had little, if any, influence on my project's returns. Simply put, each of these notifications yielded low returns, regardless of personalized methods and stylistic differences.[2]

In fact, the color of the postcard's signature seemed to have the most influence on response rates out of all the "tweaked" variables I tested on the notifications (see Table A.2). Notifications with blue signatures received slightly better responses than those with red signatures in the first wave, but those with red signatures were about even with the blue signatures on the second wave (performing better than the blue-signed notifications with the

[1] There is a small chance that this approach might have helped my overall return. Many of the completion forms in the KGS database contained inaccurate information. Not only could the well owners' address have been incorrectly recorded, but their names could have also been erroneously written down or misspelled. If the resident listed on the WWC5 was not correct, the current resident may have taken the survey even if the postcard's target participant was not currently present.

[2] Personalization is the process of convincing a respondent they are receiving the researcher's individual attention (Dillman and Frey 1974). I was unable to personalize the online surveys beyond including a well owner's name on their notification postcard (and having the option of including "or current resident" in the recipient information). However, for the dozen respondents who requested paper copies to complete, I hand-wrote the addresses on the delivery and return envelopes, personally signed the cover letter and IRB information page, and at the beginning and end of each survey I wrote a short note using the respondent's name, thanking them for their help.

truncated deadline, but worse than the blue-signed notifications with the extended deadline and without “or current resident”). However, on average, and in the aggregate, postcards with red signatures performed worse than their blue counterparts.[3] Maximizing a two-wave survey notification, according to my returns, suggests mailing an opening wave of notifications with blue signatures, a tight deadline, and inclusion of the phrase “or current resident” and a follow-up wave of postcards with blue signatures, a slightly extended deadline, and removing “or current resident” from the mailing label.

Based on these results, if a researcher can only afford (or has time for) one wave of mailed notifications, I recommend using a blue signature with a tight deadline and including the phrase “or current resident” after the respondent’s name. Paradoxically, this design had the highest return in the first wave, but the lowest response rate in the second wave. What accounts for this? Perhaps this most effective format attracted a “large” percentage of eligible respondents, and that pool of participants was starting to “flat-line” in their responsiveness. If a relatively high percentage of willing respondents react to the first notification, then many of the cooperative participants are no longer eligible to take the survey after the second mail out because they had already taken the initiative to complete the survey after the first mail out.

A final tweak that I made to each of the three survey forms had to do with an option Qualtrics provides for its survey designers. The experts at Qualtrics encouraged me to use a “request response” option on each of the questions in their panel study. This function prevents respondents from simply “skipping through” the survey without answering the questions. If a respondent does not answer a question, a notification appears on their screen requesting a response from the participant. The participant is allowed to proceed without answering and this function does not force them to answer any unanswered items on the screen, which allows this mechanism to remain approved for human subjects testing. In the sample obtained by Qualtrics, I used the request option for every question. For the XAB and XAC forms, I requested responses for the first segments of the survey which focused on water, and turned off the request response feature some of the demographic questions. In the XBC form, I used the request response function on as few items as possible—only the questions pertaining to well ownership, water supplies, and county of residence (which I need to establish how to code the respondent as nested

[3] Interestingly, postcards with red signatures were the most popular among former well owners, as nearly half of the 20 former well owners were respondents to the XAC notifications.

in a particular region of the state). Overall, this function did not make any difference for demographic variables. For instance, forms XAB and XAC had the request response activated for the respondents' total household income, and that item was completed no more frequently than other demographic questions that did not have a request response (i.e., marital status, religious identification, race, etc.). In form XBC, the question measuring income had the request response function deactivated, and again, that question was answered just a frequently as other demographic questions. Overall, each survey form was about 80 to 90 percent complete, whether the request response function was activated or not.

Justifications for Planned Missing Data Designs and Parceling

Researchers now have the computational infrastructure to feasibly work with missing data, as state-of-the-art missing data techniques can estimate population parameters from a dataset with missing data. As a researcher, I have an obligation to my volunteer respondents to make my data collection as efficient as possible. Surveys constructed with planned missing data create a less taxing survey-taking experience than complete survey forms, and because they save the respondents time and mental effort, they are a more ethical way to approach survey design. Furthermore, there is an issue of accuracy here: research suggests that more demanding assessments increase measurement error and respondents will be more likely to submit incorrect answers due to fatigue (Dillman 2000). Longer assessments reduce data quality, so randomly providing respondents pieces of the survey instead of the entire survey keeps data more valid.

Social scientists must keep in mind that one of the primary objectives of quantitative research is "to obtain unbiased estimates of the parameters of interest (i.e., estimates that are close to population values), and to provide an estimate of the uncertainty about those estimates (standard errors or confidence intervals)" (Graham 2012:5). Modern missing data procedures have been recognized as a great improvement over the traditional approaches of listwise deletion and mean substitution, and the estimation bias can be greatly reduced to acceptable levels (Collins et al. 2001, Graham 2012:1-46). All scientists who encounter missing data should use modern imputation algorithms to their advantage—not just in terms of reducing costs and increasing validity—but also by replacing lesser imputation methods for much better methods. Addressing the problem of missing data has been a popular topic among quantitative researchers and methodologists, and the advantages of PMDD compared to the classical (and astonishingly less accurate) approaches to missing data management have been widely reported.[1] ML was designed to yield unbiased parameter estimates, it often works “very much better than the older methods” (Graham 2009), and it produces “…statistical properties that are about as good as we can reasonably hope to achieve” (Allison 2002).

Pioneering missing data literature began with Rubin’s (1976) theory on missing data, which categorized specific types of missing data problems. Rubin’s work is an essential piece of the missing data field because it specifies the necessary conditions for estimating the parameters without knowing how the missing data is distributed—namely, if the missing data is missing at random. Crucial developments for addressing missing data issues came in 1987, when statisticians honed in on making reliable tools for missing data analysis, and when two publications provided the statistical foundations for missing data software development and described the ML and Multiple Imputation (MI) routines (Little and Rubin 1987; Rubin 1987). Thanks to computational advances, SEM software also made missing data analysis available, and those strategies were described in two influential articles (Allison 1987; Muthen, Kaplan, and Hollis 1987). Graham has called the late 1980s the moment of “the missing data revolution” (2012:viii).

The missing data revolution ought to set in motion an era in which researchers in the social and behavioral sciences no longer feel hesitant to become more accurate. Missing data advances have been employed for over twenty years, and since then various disciplines have been catching up to implement these practices. Modern imputation and missing data estimation procedures are gradually being seen as the preferred method, and using them is becoming the norm. In fact, “it is getting more and more difficult to publish empirical articles in top journals without using these procedures” (Graham 2012:279). These designs should be paradigm shifting, and it is my contention (and the contention of many others) that researchers should not simply approach missing answers as a problem, but learn how to make missing data “quantitatively manageable…[and] a tool they can utilize to improve data quality” (Littvay 2009:103).

In general, many methods concerning missing data fall under the general technique of imputation, where “[t]he basic idea is to substitute some reasonable guess… for each missing value and then proceed to do the analysis as if there were no missing data” (Allison 2002:11). Yet not all imputation methods are equally accurate, as missing data can be badly managed in a number of ways. One of the most common traditional approaches is mean substitution, which imputes a given variable's average score for any missing values. Problems immediately come to mind with this so-called solution. In the case of mean substitution, it is well-known to produce biased estimates and it greatly skews an analyst's ability to interpret the variances of the dataset. Methodologists have known that mean substitution should generally be avoided for nearly 50 years (Haitovsky 1968). More recently, it has been called "the worst of all possible strategies" (Graham 2012:51; see also Gleason and Staelin 1975; Brown 1994; Olinsky, Chen, and Harlow 2003; Enders 2010). Modern imputation approaches make more accurate estimations, are now easier to implement than mean substitution in SEM programs, and are a far better imputation strategy (Graham 2003; 2009; 2012; Graham et al. 2006; Little 2013).

Another popular conventional method for "handling" missing data is listwise deletion (or complete case analysis), the removal of incomplete assessments from the dataset. Throwing out incomplete records is lying about a dataset, and it is pretending that missing cases do not exist (mean substitution also suffers from the same delusion). If researchers intentionally remove data, their sample size will decrease and they will lose power because their dataset lost information. Eliminating data is wasteful, and studies concur that this is one of the worst methods available (Brown 1994; Wilkinson and Task Force on Statistical Inference 1999; Wothke 2000; Enders 2001; 2010). In order to express how modern missing data approaches are superior methods, consider this quote by Todd Little:

> …the classical approaches (listwise or pairwise deletion) are akin to surgery to remove the injured parts of the data. The modern approaches are akin to reconstructive surgery to restore the affected area to its original condition. Importantly, modern imputation is not plastic surgery to change or disguise the look of something—it is a restorative and reconstructive procedure. (2013:54)

Technological limitations and tradition have compelled researchers to commonly "deal with" missing data in very simplistic ways. Regarding the older approaches to missing data, the phrase "deal with" should be used in trepidation. One of the developers of PMDD, John Graham, has succinctly described the general shortcomings of traditional approaches:

> None of them were really designed to *handle* missing data at all. The word "handle" connotes dealing effectively with something. And certainly none of these methods could be said to deal effectively with missing data. Rather, these methods, usually described as ad hoc, were designed to get past the missing data so that at least some analyses could be done. [emphasis original] (2012:48)

Thankfully, reviewers have begun recognizing the advantages of modern missing data approaches, while the traditional approaches are slowly losing approval within methodological literature (Wilkinson and Task Force on Statistical Inference 1999; Little and Rubin 2002; Enders 2010). Even though the frequency of publications using ML and MI has increased, there is still a discrepancy between the practices recommended in methodological publications and those used empirically (Bodner 2006).

FIML procedures "…have started to become mainstream in statistical analysis with missing data, and are applicable in a much larger range of contexts than typically believed" (Graham 2012:3). Modern missing data procedures have been used in a number of different studies, not just in SEM, but also for logistic regression (Vach 1994; Allison 2002). Missing-by-design data collection has also been applied beyond survey data, as longitudinal field experiments have been utilizing these approaches. For instance, if a participant is absent for a measurement session in a longitudinal study, modern imputation approaches are used to address the missing values (Graham and Collins 2012; Roth, Johnson, and Young 2012). PMDD is used in the General Social Survey, the National Survey of Family Growth, and the National Assessment of Educational Progress (Roth et al. 2012).

Modern missing data estimation techniques are becoming more accepted in various methods of data collection and researchers continue to study which qualities constitute the best missing-by-design surveys. For instance, designing each set of questions with a balanced number of items has been recommended, and researchers have also noted the benefits of having auxiliary variables included in every survey (Collins et al. 2001; Graham 2003; Graham and Collins 2007; 2012; Enders 2010:127-63; Muthen and Muthen 2010). With these recommendations in mind, this dissertation's survey includes a high number of auxiliary variables to facilitate FIML, and the randomized sets (A, B, and C) each contain 11 items. All of the auxiliary and demographic variables are placed in the X set, so every respondent received those questions. Each respondent needs to complete some of the same questions in order for FIML estimation to calculate the population parameters—which is why each survey has a series of X questions provided. My survey's X set contains 28 items, and the A, B, and C sets all contain 11 questions each, giving each respondent, at the most, 50 of the total 61 questions. When the *missingness* (which is the pattern that missing data follows) is completely random in any dataset, it has no bearing on the results and the missing data can be easily imputed with modern missing data analyses. A successfully-executed PMDD study should have random missingness, which was a consideration of mine while constructing the surveys.

Another common approach for imputing missing data is the use of Multiple Imputation (MI). MI algorithms generate random samples of plausible imputations and fill in each missing value with a selection from that sample, but ML integrates the missing values out of the likelihood, which is more efficient. In larger samples that contain more missing information, ML estimates standard errors that are as small as possible, making it the clear choice for managing large quantities of missing values (Allison 2012). Missing data specialists recently indicated that ML estimates have less bias than MI estimates, even with small samples, so ML should be considered the best way to handling missing data in datasets of any size (von Hippel 2016). One drawback is that a number of software packages cannot perform FIML for some analytical procedures like logistic or other forms of regression. By comparison, MI is an easily accessible imputation approach; MI can be "readily applied to these and many other models, without the need for specialized software" (Allison 2015). Fortunately, most SEM software can do FIML for the datasets used in modeling, and the program in which I conduct my modeling, M*plus*, is the only commercial package that can conduct FIML for regression and SEM.

When conducing structural equation modeling, I combined related survey items together to create parcels. Parceling items that are related is known as facet representative parceling. This approach to parceling combines individual items which are associated with each other. For instance, in the case of the "awareness" related questions, the items are parceled because they are related; they are internally consistent; they are connected in some way because they are measuring a similar trait. Parceling will not only reduce the complexity of my model, it will almost assuredly improve model fit because it reduces the residual variance while the true variance stays the same (true variance is the variance that all of the items share, and what they have in common with the construct). It is important to emphasize that SEM is a method that teases apart the error variance from the true variance. With parcels, the error variance is "separated" at the manifest variable level. Parceling allows the commonality—the proportion of variance in the indicators shared by the latent variable—to stay the same, while the error variance decreases. My survey has been designed specifically for using SEM and utilizing parcels to estimate my larger constructs of interest. This should allow me to make very precise estimations of how each survey item is associated with water conservation and well ownership.

TABLES FOR THE METHODOLOGICAL APPENDIX

Table A.1. Response Rates of Both Notification Postcard Waves (n = 444)

Survey Form	First Wave Response Rate (%)	Second Wave Response Rate (%)	Average Response Rate (%)	Overall Response Rate (%)
XAB	2.984 (75/2,513)	3.435 (83/2,416)	3.206 (158/4,929)	6.287 (158/2,513)
XAC	2.451 (55/2,244)	3.092 (68/2,199)	2.768 (123/4443)	5.481 (123/2,244)
XBC	3.887 (88/2,264)	2.354 (51/2,166)	3.138 (139/4430)	6.140 (139/2,264)
Total	3.190 (224/7,021)	2.879 (202[1]/6,781)	3.217 (444/13,802)	6.324 (444/7,021)

[1] In the final analysis, 24 respondents were added to the overall collection of surveys. Twelve respondents in the first wave had difficulty accessing the survey and were redirected to a functional survey link using the second wave's URL. Additionally, 12 respondents requested to take a paper copy of the survey and were given a printed XBC form. When they returned their paper copies to me, I put their answers in the second wave of responses. The total of the rows, therefore, is not reflected in the overall total.

Table A.2. Returns of Qualtrics Panel and Both Notification Postcard Waves (n = 864)

Survey Form	Signature Color	Included "Or Current Resident"	Due Date	Total
Qualtrics Sample XAB	NA	NA	NA	140
Qualtrics Sample XAC	NA	NA	NA	140
Qualtrics Sample XBC	NA	NA	NA	140
First Wave XAB	Blue	No	March 30, 2015	75
First Wave XAC	Red	Yes	March 30, 2015	55
First Wave XBC	Blue	Yes	March 28, 2015	88
Second Wave XAB	Blue	No	May 11, 2015	83
Second Wave XAC	Red	Yes	May 11, 2015	68[1]
Second Wave XBC	Blue	Yes	May 9, 2015	51[2]
				864

[1] In the final analysis, I added 12 to this survey form, as a dozen respondents to the first wave had trouble accessing the survey and were redirected to a functional survey link using the second wave's URL. The total of the rows, therefore, is not reflected in the overall total.

[2] In the final analysis, I added 12 to this survey form because 12 respondents requested to take a paper copy of the survey and were given a printed XBC form. When their paper copies were returned to me, I put their answers in the second wave of responses. The total of the rows, therefore, is not reflected in the overall total.

Endnotes for the Methodological Appendix

1. Collins, Schafer, and Kam (2001); Allison (2002); Schafer and Graham (2002); Graham (2003; 2006; 2009; 2012); Graham, Cumsille, and Elek-Fisk (2003); Littvay (2009); Enders (2010); Johnson and Young (2011); Rhemtulla and Little (2012).

SURVEY

Sample of Postcard Text:
Longer deadline, blue signature, no current resident.

Fellow Kansan,
You have been selected to complete a short survey about your water usage. Roughly a month ago, a postcard was delivered to this address, and I wanted to make sure that you saw the postcard and could access the online survey. If you have not yet taken the survey, could you please visit **https://kansasedu.qualtrics.com/SE/?SID=SV_6lKFAcCRtEit55j** and complete it by **Monday, May 4**? If you have already taken the survey, you do not need to take it another time, and I am very grateful for your help.
When taking this survey, please use the newest versions of web browsers like Firefox or Google Chrome. You should also be able to access it using smart phones or tablets. If you have any trouble accessing the survey, please email me at **bternes@ku.edu** and I will help you open it.
Your participation in this study is important because it will provide a clear sense of how Kansans prioritize water conservation. Should you have any questions about completing the survey or how the responses will be handled, please email me.
I really hope you can find time to participate in this important study. Your time and effort are much appreciated, and I sincerely thank you in advance for both.
All the best,
Brock Ternes
Graduate Student
University of Kanas
bternes@ku.edu

Your Participation

The Department of Sociology at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time without penalty.

I am conducting this study to better understand water usage habits and perceptions of water among Kansans. This will entail your completion of a survey. Your participation is strictly voluntary and your name will not be associated in any way with the research findings. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission. Your answers will be kept **completely confidential**, and your name will never be placed on the questionnaire itself. It is possible, however, that someone other than the investigator, faculty supervisor, and research assistants may see your responses. If you would like additional information concerning this study before or after it is completed, please feel free to email me at bternes@ku.edu.

Completion of the survey indicates your willingness to take part in this study and that you are at least 18 years of age. If you have any additional questions about your rights as a research participant, you may call (785) 864-7429 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, or email HSCL at irb@ku.edu. When contacting HSCL, please reference HSCL #00001050.

Sincerely,

Brock Ternes
Graduate Student
Department of Sociology
Fraser Hall
1415 Jayhawk Blvd. Room 716
Lawrence, KS 66045
bternes@ku.edu

This survey is part of an effort to learn how Kansans feel about water conservation. Your answers and personal information will be kept completely confidential.

Thank you very much for taking the time to complete this survey!

1 What is your residence's current primary source of water?
It comes from the city/municipal/rural water supply
It comes from a domestic well
I (or we) have a cistern and/or capture rainwater and/or haul in water for domestic usage
My residence has BOTH municipal water AND a domestic well or a cistern
I (or we) use well water around the house, but I (or we) only drink bottled water
I (or we) use city/municipal/rural water around the house, but I (or we) only drink bottled water
Not sure

2 Do you have any of the following at your residence? (**Please select all that apply**)
A domestic well
A lawn and garden well
An irrigation well
A livestock or feedlot well
Some other type of well
A reconstructed well
A plugged well
A cistern
A rain barrel
A pond
I (or we) have a well, but it is located on a distant property, not close to our residence (e.g., in another county)
None of the above

3 If you have any type of well, how long have you used well water? (Either for domestic, lawn and garden, irrigation, a feedlot, or some other purpose)
Just in the past five years
5 - 10 years
10 - 20 years
More than 20 years
I used to have a functioning well, but do not anymore
I do not have a well

If you do not have a well, please skip page 2, and resume the survey with question 9 on page 3.

4 Why do you use your well(s)? (**Please select all that apply**)
It is used for indoor/domestic purposes, including supplying drinking water
It is used for indoor/domestic purposes, but NOT to supply drinking water
It is used for watering a lawn
It is used for watering a garden, orchard, trees, or other vegetation
It is used for irrigation
It is used for watering livestock or feedlot(s)
It is a cost savings option, so my water bills are not as high
Some other purpose

5 If your well(s) went dry, what would be the consequences? (**Please select all that apply**)
I would have to drill a new well
I would have to haul in water or use a cistern
I would have to stop watering my lawn
I would have to stop watering my garden, orchard, trees, or other vegetation
I would have to stop watering crops
I would have to sell livestock
I would rely on municipally-provided water (city or rural water)
I would have to move

6 Do you feel that your well(s) is vulnerable to decreased water yields or contamination?
My well(s) is vulnerable to decreased water yields
My well(s) is vulnerable to contamination risks
My well(s) is vulnerable to both decreased water yields and contamination
My well(s) is secure and reliable

7 If your neighbors have wells near your property, do you ever think that their well pumping hurts the yields of your well(s)?
My neighbors have wells and I think their pumping hurts my well’s yields
My neighbors have wells, but their pumping is NOT hurting my well’s yields
My neighbors do not have wells

8 Has the water depth of your well(s) been checked, either by you or someone else?
Yes, in the past year
Yes, 1 - 2 years ago
Yes, 2 - 5 years ago
Yes, more than 5 years ago
No, it has not been checked
Not sure

9 Has your well(s) been tested for chemicals (e.g., nitrates, iron, lead), bacteria, or pesticides?
Yes, in the past year
Yes, 1 - 2 years ago
Yes, 2 - 5 years ago
Yes, more than 5 years ago
No, it has not been checked
Not sure

10 Who pays the water bill at your residence?
I do (we do)
Landlord
Other
Not applicable/No charge/My household does not receive municipal water

11 Do you pay a monthly flat rate for water, or is the cost determined by metered usage?
My water is metered
I (we) pay a flat rate
Included in rent or condominium fee/another arrangement
Not sure

12 For a typical month, could you estimate the cost of the water and sewer bill for your residence?
Under $20
$20 - $39
$40 - $59
$60 - $79
$80 - $99
$100 - 119
$120 or higher
Not applicable

13 Please select your level of agreement or disagreement with the following statement: Increasing the price of water would encourage people to use less water in their homes.
Strongly agree
Somewhat agree
Somewhat disagree
Strongly disagree

14 Which of the following do you think uses the most water in Kansas? If you are unsure, you may select “Not sure” for your answer.
Private households
Industry
Irrigation
Cities
Not sure

15 How many years do you think your community's local water supply will last?
Under 30 years
30 - 50 years
50 - 100 years
100 - 200 years
More than 200 years
Not sure

16 In the past year, did you feel that water shortages were very common, common, rare, or very rare where you live?
Very common
Common
Rare
Very rare

17 What do you do, or what would you do, in the event of a drought? (**Please select all that apply**)
A drought does not, or would not, change my behavior
I would increase the amount I watered my lawn
I would increase the amount I watered my garden, orchard, trees, or other vegetation
I would irrigate more
I would take shorter showers
I would flush the toilet less
I would stop watering my lawn
I would stop watering my garden, orchard, trees, or other vegetation
I would irrigate less

18 In the past year, how often did you deliberately try to save water around the house?
Never
Once or a few times over the year
Roughly once a month
Roughly once a week
Daily

19 In the past year, how often did you feel like you or someone in your household wasted water?
Never
Once or a few times over the year
Roughly once a month
Roughly once a week
Daily

20 If you are an irrigator, have you ever exceeded your water allocations? That is to say, have you ever pumped more water than your water right permit authorizes?
Yes
No
Not sure
Not applicable

21 If you deliberately try to reduce the amount of water you use, what motivates you to conserve water? (**Please select all that apply**)
I am concerned with the ability of my source(s) of water to keep up with my demand
I conserve water to save money (either to reduce water bills or the cost of pumping water)
I conserve water to extend my water supply's future
All of the above
I do not conserve water

22 Do you use any water-saving devices or water-saving techniques in or around your home? If so, please select all that apply:
I do not use any water-saving devices or techniques
Low-flow showerhead(s)
Low-flow toilet(s)
A water-efficient washing machine
I (we) wash the dishes less frequently
I (we) water the lawn with timed sprinklers
I (we) irrigate crops with water-saving techniques or drip irrigation
Other techniques or devices (Please list those devices or techniques below)

23 What is the likelihood that you will install a water-saving appliance (e.g., a low-flow showerhead, low-flow toilet, a water-saving washing machine, and so forth) in the next year?
Very likely
Somewhat likely
Somewhat unlikely
Very unlikely

24 Kansas faces a number of challenges. Please select the statement that best describes your attitude regarding the future of water in Kansas.
I believe that securing water for the future is one of the two or three most important issues facing our state
Securing water for the future is one issue facing our state I personally care about, but I can think of a handful of issues that are more important right now
There are many issues that I personally care more about than securing water for the future in Kansas

25 Have you ever heard of any of the following? **Please select all that apply**:
The High Plains Aquifer
Groundwater Management Districts
The Kansas Water Office
The Vision for the Future of Water in Kansas
The Kansas Aqueduct
Xeriscaping
Greywater recycling
None of the above

26 Which best describes how frequently you watered your lawn over the past year?
Never (***If you never water your lawn, you may skip ahead to #24)***
Once
About once a month
At least once a week

If you do not water your lawn, you can leave question #23 blank.
27 When you water your lawn, how long do you typically spend watering (in minutes)?
____

28 During the past week, how frequently did you and the other residents in your home flush the toilet?
I (or we) tried to flush a couple times a day, or fewer if possible
I (or we) usually waited to flush after I (or we) used the bathroom a few times
Nearly every time I (or we) used the toilet
After every single time I (or we) used the toilet

29 In the past month (30 days), about how many times did you shower or bathe?
Under 10 times
10 – 14 times
15 – 19 times
20 – 24 times
25 – 29 times
30 – 34 times
35 – 39 times
40 – 44 times
45 – 49 times
50 times or more

30 Do you usually take showers or baths?
Baths
Showers

31 How long do you typically spend in the shower (in minutes)?

____

Please answer a couple questions about some other environmentally-conscious behaviors

32 How often do you recycle your glass, paper, newspaper, aluminum, plastic, and so forth?
Never
Occasionally
Most of the time
Nearly always or always

33 How often do you use your own grocery bag when shopping?
Never
Occasionally
Most of the times that I shop
Every time I shop

34 How often do you compost your kitchen or garden waste?
Never
Occasionally
Most of the time
Nearly always or always

Please answer a couple of questions about your views on environmental issues

35 Wind farms have been in the news recently. Would you prefer to see a greater proportion of your electricity obtained through wind power, even if it is slightly more expensive than using coal or natural gas for electricity?
Would prefer
Would not prefer
Not sure

36 Earlier this year, the Kansas Water Office and U.S. Army Corps of Engineers studied a plan that involved diverting water from the Missouri River to western Kansas. This project would involve the construction of an aqueduct 360 miles long and 15 pumping stations to transfer the water. It is estimated that the aqueduct would take 20 years to construct and cost $18 billion. If this water transfer system was scheduled to be built, would you support or oppose this project?
Strongly support
Somewhat support
Somewhat oppose
Strongly oppose
Not sure

37 Imagine that some construction is scheduled to take place near your neighborhood. Which of the following would DISPLEASE you the most if it were going to happen by your neighborhood? (**You may select more than one**)
Setting up wind turbines or building a "wind farm"
Construction of a nuclear power plant
Construction of a coal-fired electricity plant
Construction of a large corporate feedlot for cattle or pigs
Construction of an oil pipeline
Horizontal drilling and hydraulic fracturing or "fracking"

38 Climate change has been in the news recently. In your opinion, do you believe climate change is occurring?
Yes, climate change is now a serious threat
Yes, but it is not a very big problem
No, but climate change could be a problem for us in the distant future
No, climate change is not happening
Not sure

39 Please select the statement about the environment and the economy you agree with the most:
Protection of the environment should be given priority, even at the risk of sacrificing economic growth
Economic growth should be given priority, even if the environment suffers to some extent

Please select your level of agreement or disagreement with the following statements:

40 Mankind was created to rule over the rest of nature.
Strongly agree
Somewhat agree
Somewhat disagree
Strongly disagree

41 To maintain a healthy economy, we will have to develop a steady state economy where industrial growth is controlled.
Strongly agree
Somewhat agree
Somewhat disagree
Strongly disagree

42 The changes in the earth's temperature over the last century have been caused mostly by human activity, NOT by natural changes.
Strongly agree
Somewhat agree
Somewhat disagree
Strongly disagree

Finally, please complete a few questions about yourself

43 Please write the name of the COUNTY in which you live below: (For example, "Shawnee" or "Sedgwick")

____

44 What is your marital status?
Married or engaged
Widowed
Divorced or separated
In a relationship, previously married
In a relationship, but never married
Single

45 What race do you consider yourself?
White
Hispanic, Latino, or Spanish
Black, African American
American Indian
Asian
Another race

46 By your best estimate, what was your total household income last year, before taxes?
Under $10,000
$10,000 - $19,999
$20,000 - $39,999
$40,000 - $59,999
$60,000 - $79,999
$80,000 - $99,999
$100,000 - $149,999
$150,000 or more

47 How would you describe your current employment? (**Please select all that apply**)
Working full-time, working part-time, or self-employed
Unemployed
Laid off/looking for work
Retired
In school
Keeping house

48 Is your employment related to agriculture?
Yes
No
Not applicable

49 Which best describes your residence?
A one-family house detached from any other house
A one-family house attached to one or more houses
An apartment or duplex
A mobile home

50 How many people live in this home?
One
Two
Three
Four
Five
Six or more

51 Is your home owned, rented, or do you have another arrangement?
Owned by me or someone within the household (with OR without a mortgage or loan)
Rented
Another arrangement

52 Which best describes your political views?
Very liberal
Liberal
Moderate
Conservative
Very conservative

53 Have water policies affected how you voted in local elections or state elections?
Yes, in both local and state elections
Yes, only in local elections
Yes, only in state elections
No
I don’t typically vote in local or state elections

54 Are you male or female?
Male
Female

55 Please write your age here: __________

56 Which best describes your level of education?
Less than high school
High school graduate
Some college, no degree
Community college/Associate's degree
Bachelor's degree
Graduate degree

57 How many children do you have?
None
One
Two
Three
Four or more

58 How many children under the age of 18 currently live in your household?
No children present
One
Two
Three
Four or more

59 With what religious beliefs to you most closely identify?
Protestant (Methodist, Baptist, Lutheran, Presbyterian, Episcopalian/Anglican, Non-denominational Protestant)
Catholic
Latter Day Saints/Mormons
Jehovah's Witness
Non-denominational Christian
Non-religious, atheist, or agnostic
Other (Jewish, Muslim, Hindu, Buddhist)

60 Please indicate the one term that best describes your religious identity:
Born-Again
Bible-Believing
Charismatic
Theologically Conservative
Evangelical
Fundamentalist
Theologically Liberal
Mainline Christian
Pentecostal
Seeker
Religious Right
Moral Majority
None of these

61 Finally, after completing this survey, do you think you will start thinking about your water usage more than you would have if you had not been selected to take this survey?
Taking this survey will definitely influence my water usage
Taking this survey might change my water usage a little bit, but not much
I do not think taking this survey will change my water usage at all
I already took water conservation seriously before I took this survey, so it will not influence my behavior that much

Your questions and comments will be appreciated, either written in below, on the back side of this page, or via email (bternes@ku.edu).

If I may contact you again, or if you would like to learn about the results of this survey, please include your address below. Your contact information will be kept completely confidential.

Thank you for your participation!

CHAPTER V APPENDIX

Hydropolitics

Geopolitical narratives influence how people envision environmental problems (O'Tuathail 2006; O'Tuathail and Agnew 2006; Dalby 2009). The field of geopolitics studies the discourse of politics and collapses it into categorized narratives. These frameworks include using spatial generalizations that merge diverse areas under a single meaningful label, the identification of risks by employing spatial generalizations, and using the generalizations to justify some action or inaction based on those risks. One common geopolitical narrative frames water as a regionally-fixed resource that typically causes regional or international conflicts as it is divided among different political units. These are dominant narratives within policymaking (in the sense that states compete for water supplies) but the framework of this dialogue is deterministic because it assumes that states and nations are inherently competitive are averse to reach a solution via compromise (Agnew 2011). An alternative critical geopolitical narrative justifies cooperative political action. Water management and policymaking are culturally-based interpretations of water supplies, which are often formed via environmental geopolitical narratives. Although my respondents, as well as the policies and laws associated with groundwater management, do not use the phrase "environmental geopolitics," they are engaging a geopolitical discourse.

Hydropolitics are often public and highly relevant for communities and ecosystems, and they typically shed light on relations between localities, states, or nations. Research has investigated the high stakes of hydropolitical action at the international level (Zeitoun and Warner 2006), but conflicts within Kansas could be further explored. Farmers in the state are regularly competing for insufficient groundwater, both among themselves and also with growing domestic demands. Participants in groundwater management decisions frame their choices within a particular community and limited hydraulic space, which could lead them to promote locally-based planning over state-wide or national regulations. For instance, Governor Sam Brownback's 50-year Vision technically does not offer any state-wide solutions for guaranteeing the state's water supply; it encourages local decision-making. Following this logic, the communities and stakeholders closest to specific water problems (like groundwater depletion over a particular portion of the High Plains aquifer) are the most capable for constructing adequate solutions—which again reflects an "inside-out" approach to problem solving. Utilizing environmental geopolitics in terms of disparate microcosms of individuals sets the scale of water supply management solely on local actions. While this perspective clarifies how localized efforts can be improved, it does not address larger contexts associated with the decisions communities make regarding resource management. For instance, if irrigators in northwest Kansas respond to groundwater depletion by implementing a 20 percent reduction in pumping, their selection to set this standard needs to be connected to many larger hydrologic realities. Streamflows from rivers coming out of Nebraska and Colorado have been declining for decades, while proposals for augmenting the water supply of western Kansas include a major transfer of water from the Missouri River.

Managing water supplies is inherently political and involves the notion of controlling a politically-contested resource. Scholars have long acknowledged that conceptualizing an object as a natural resource conveys that the object in question can be managed and therefore used for state formation and economic growth (Wittfogel 1957; Worster 1985; Reisner 1993; Blackbourn 2006). The creation of water infrastructure is central to development, but large-scale municipal infrastructure rests on the social construction that water supplies are free, renewable, and exploitable. Infrastructure can reinforce the notion that water is limitless, as is the case with municipal systems; however, private wells provide an attachment to the landscape not easily portrayed by public infrastructure.

CHAPTER VI APPENDIX

Exogenous Predictors Covariance

Covariance Table 6a. Standardized correlations for demographic predictors

	Well Ownership	**HPA**	**Sex**	**Income**	**Political**	**Education**
Well Ownership	--					
HPA	.495***	--				
Sex	-.411***	-.228***	--			
Income	.413***	.182***	-.332***	--		
Political	.202***	.115**	-.153***	.067	--	
Education	.168***	.023	-.127**	.381***	-.092**	--
Age	.407***	.187***	-.218***	.212***	.146***	.142***

* $p < .05$ ** $p < .01$ *** $p < .001$

Direct Effects of Exogenous Predictors on the Indicators

In this section, I summarize my tests for direct effects of the exogenous predictors for the indicators of the three constructs which could only achieve partial strong invariance (awareness of water supplies, investments in indoor water-saving appliances, and investments in outdoor water-saving appliances). I trimmed the CFAs so only the predictors with a significant direct effect are provided in these results.

Indicators for the awareness construct. Overall, the parceled indicator measuring awareness of xeriscaping and greywater systems was regressed on well ownership (b = .100; p < .01), residence above the High Plains aquifer (b = -.086; p < .05), sex (female) (b = .114; p < .01), and education (b = .195; p < .001); the parceled indicator measuring awareness of the High Plains aquifer and Groundwater Management Districts was regressed on residence above the High Plains aquifer (b = .109; p < .01) and education (b = -.093; p < .05); the parceled indicator measuring awareness of the Kansas Water Office, the Long-Term Vision, and the Kansas Aqueduct was regressed on well ownership (b = -.081; p < .05), sex (b = -.129; p < .001), and education (b = -.105; p < .01). There are no significant direct effects on the indicator measuring if the respondents can correctly identify irrigation as the largest water user in Kansas. Regarding the negative direct effect between residence above the High Plains aquifer and awareness of xeriscaping, perhaps more could be done in terms of public outreach to inform western Kansans of those water-saving techniques. Regarding the negative direct effect between education and awareness of the High Plains aquifer and GMDs, perhaps more educated Kansans live in the eastern part of the state where they are less likely to hear of those western-nested items, or irrigators who are probably keenly aware of those topics have lower levels of education. The same likely holds for the negative effect Surprisingly, there is a slight negative direct effect between well ownership and awareness of the KWO, Vision, and Kansas Aqueduct, which is a contradictory finding from chapter 5, as well owners expressed more familiarity with those topics. That model fit, however, was not adequate, so it is not an acceptable representation of that particular relationship and I should not accept this statistical model as true in the population.

Indicators for the construct measuring investment in indoor water-saving appliances. Income plays an important role in whether or Kansans own water-saving devices in their homes. There is a negative and significant direct effect of income on owning a low-flow toilet (b = -.173, p < .05) and a positive direct on owning a washing machine (b = .182, p < .001), and a negative significant direct effect of sex (female) on owning a low-flow showerhead (b = -.215, p < .05). Water-efficient washing machines are high-priced appliances, so income's role in owning them makes sense, but installing a low-flow toilet perhaps is a hassle that is unappealing to those with higher incomes (perhaps due to homeownership or another unforeseen variable). The direct effect of sex suggests that men are more likely to invest in low-flow showerheads, which are considerably easy to install.

Indicators for the construct measuring investment in outdoor water-saving appliances. Interestingly, there is a significant negative direct effect between income and owning a drip irrigation system (b = -.214, p < .01). Perhaps if farmers have lower incomes, and farmers are more likely to invest in drip irrigation, that would explain this effect. However, there is also a positive significant relationship between income and the indicator measuring ownership of timed sprinkler systems (b = .117, p < .01); given the precious conversations about wealth, status, and the conspicuous consumption of natural resources, this seems like a wise investment if Kansans with higher incomes are also prone to lawn watering.

CONFIRMATORY FACTOR ANALYSES APPENDIX

CFA Measures Table 6a. Water Supply Awareness regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 743)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	0.472	0.777	0.035
High Plains aquifer and GMDs	0.908	0.175	0.026
KWO, Vision, and Aqueduct	0.616	0.621	0.030
Agriculture as biggest water user in Kansas	0.360	0.651	0.064
Predictors	**Beta Estimate**	**P-Value**	**S.E.**
Well Ownership	.233	.000	0.036
Residence above the High Plains aquifer	.111	.001	0.034
Sex (female)	-.233	.000	0.034
Household Income	.110	.003	0.038
Political Views (Conservative)	-.036	.297	0.034
Education	.138	.000	0.035
Age	.278	.000	0.036

Note: These residual variances, or the unique factors, are for the indicators measuring awareness of xeriscaping/greywater, HPA and GMDs, and KWO/Vision/Aqueduct. The remaining indicator's variance, which measures whether or not a respondent could correctly identify agriculture as the biggest water user in Kansas, is a threshold for the dichotomous categorical item.

CFA Measures Table 6b. CFA of owning indoor water-saving appliances regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 741)

	Factor Loadings	**Residual Variance**	**S.E.**
Indoor water-saving appliances			
Low-flow showerhead	0.715	1.036	0.051
Low-flow toilet	0.840	1.303	0.049
Water-efficient washing machine	0.526	1.073	0.055
Predictors	**Beta Estimate**	**P-Value**	**S.E.**
Well Ownership	.107	.039	0.052
Residence above the High Plains aquifer	.036	.454	0.047
Sex (female)	.002	.975	0.049
Household Income	.236	.000	0.054
Political Views (Conservative)	.001	.977	0.046
Education	.027	.588	0.050
Age	.226	.000	0.049

Note: These residual variances, or the unique factors, are thresholds for these dichotomous categorical items.

CFA Measures Table 6c. Model of owning outdoor water-saving appliances regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 741)

	Factor Loadings	**Residual Variance**	**S.E.**
Outdoor water-saving appliances			
Timed sprinklers	0.655	2.112	0.047
Drip irrigation	0.655	1.479	0.047
Predictors	**Beta Estimate**	**P-Value**	**S.E.**
Well Ownership	.035	.604	0.232
Residence above the High Plains aquifer	.355	.000	0.313
Sex (female)	-.192	.002	0.247
Household Income	.450	.000	0.086
Political Views (Conservative)	.000	.995	0.102
Education	.074	.206	0.071
Age	.196	.002	0.008

Note: These residual variances, or the unique factors, are thresholds for these dichotomous categorical items.

CFA Measures Table 6d. Decreasing Indoor Water Usage During Droughts regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 737)

	Factor Loadings	**Residual Variance**	**S.E.**
Decreased Indoor Usage During Droughts			
Take shorter showers	0.931	0.020	0.012
Flush the toilet less	0.931	0.387	0.012
Predictors	**Beta Estimate**	**P-Value**	**S.E.**
Well Ownership	-.083	.101	0.051
Residence above the High Plains aquifer	-.103	.024	0.046
Sex (female)	.207	.000	0.045
Household Income	-.052	.309	0.051
Political Views (Conservative)	-.152	.001	0.044
Education	.030	.541	0.049
Age	.111	.015	0.046

Note: These residual variances, or the unique factors, are thresholds for these dichotomous categorical items.

CFA Measures Table 6e. Decreasing Outdoor Water Usage During Droughts regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (*n* = 737)

	Factor Loadings	**Residual Variance**	**S.E.**
Decreased Outdoor Usage During Droughts			
Stop watering lawn	0.713	1.340	0.080
Stop watering garden, orchard, trees, and other vegetation	0.862	1.294	0.096
Irrigate less	0.177	1.349	0.079
Predictors	**Beta Estimate**	**P-Value**	**S.E.**
Well Ownership	-.031	.593	0.058
Residence above the High Plains aquifer	-.176	.001	0.053
Sex (female)	.147	.005	0.053
Household Income	.027	.648	0.059
Political Views (Conservative)	.049	.350	0.052
Education	.033	.543	0.054
Age	.188	.001	0.054

Note: These residual variances, or the unique factors, are thresholds for these dichotomous categorical items.

CFA Measures Table 6f. Increasing Outdoor Water Usage During Droughts regressed on well ownership, residence above the High Plains aquifer, sex (female), income, political views (conservative), education, and age (n = 737)

	Factor Loadings	**Residual Variance**	**S.E.**
Increased Outdoor Usage During Droughts			
Increase watering lawn	0.814	1.355	0.091
Increased watering garden, orchard, trees, and other vegetation	0.717	2.367	0.072
Irrigate more	0.660	-0.323	0.111
Predictors	**Beta Estimate**	**P-Value**	**S.E.**
Well Ownership	.143	.050	0.073
Residence above the High Plains aquifer	.140	.052	0.072
Sex (female)	-.186	.006	0.067
Household Income	.205	.004	0.072
Political Views (Conservative)	-.056	.381	0.064
Education	-.006	.934	0.073
Age	-.014	.847	0.073

Note: These residual variances, or the unique factors, are thresholds for these dichotomous categorical items.

INVARIANCE TESTS RESULTS

Invariance Table 1. Invariance Tests for Non-well Owner/Well Owner Comparisons of Awareness and Owning Water-Saving Appliances

Model Tested	**χ^2**	***p***	***df***	**$\Delta\chi^2$**	**Δdf**	**RMSEA (90% CI)**	**CFI**	**ΔCFI**	**Pass?**
Null Model	755.938		72						
Configural Invariance	90.125	<.001	50	--	--	.043 (.029; .058)	.941		Yes
Weak Invariance	97.646	<.001	55	7.521	5	.043 (.028; .056)	.938	.003	Yes
Strong Invariance	104.945	<.001	61	7.299	6	.041 (.027; .054)	.936	.002	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 448 non-well owners and 407 well owners.

Invariance Table 2. Invariance Tests for Non-municipal Well Owners/Municipal Well Owners Comparisons of Awareness and Owning Water-Saving Appliances

Model Tested	**χ^2**	***p***	***df***	**$\Delta\chi^2$**	**Δdf**	**RMSEA (90% CI)**	**CFI**	**ΔCFI**	**Pass?**
Null Model	318.175		72						
Configural Invariance	75.895	.011	50	--	--	.052 (.026; .074)	.895		Yes
Weak Invariance	77.332	.025	55	1.437	5	.046 (.017; .068)	.909	-.014	Yes
Strong Invariance	93.912	.004	61	12.184	6	.053 (.030; .073)	.866	.043	No
Partial Strong Invariance	84.235	.021	60	9.677	1	.046 (.018; .067)	.902	.007	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 141 off the grid well owners and 246 well owners with municipal water. For the partial strong invariant model, the threshold for the indicator measuring if respondents owned drip irrigation systems was freed for the municipal well owners group. Rural well owners are theoretically more likely to be irrigators than well owners with municipal water connections.

Invariance Table 3. Invariance Tests for Owners of Domestic, Lawn and Garden, Feedlot, and Irrigation Wells Comparisons of Awareness and Owning Water-Saving Appliances

Model Tested	χ^2	***p***	***df***	$\Delta\chi^2$	Δ***df***	**RMSEA (90% CI)**	**CFI**	**ΔCFI**	**Pass?**
Null Model	398.391		144						
Configural Invariance	126.681	.049	102	--	--	.049 (.003; .074)	.903		Yes
Weak Invariance	139.278	.061	115	12.597	13	.046 (.000; .071)	.905	-.002	Yes
Strong Invariance	157.161	.067	132	17.883	17	.043 (.000; .067)	.901	.004	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 145 domestic well owners, 135 lawn and garden well owners, 66 feedlot well owners, and 61 irrigation well owners.

Invariance Table 4. Invariance Tests across the three geographic groups (Ogallala, Great Bend Prairie and Equus Beds, and non-GMD residents) of awareness and owning water-saving appliances

Model Tested	χ^2	***p***	***df***	$\Delta\chi^2$	Δ***df***	**RMSEA (90% CI)**	**CFI**	**ΔCFI**	**Pass?**
Null Model	858.331		108						
Configural Invariance	104.367	.014	75	--	--	.038 (.018; .054)	.961		Yes
Weak Invariance	118.133	.010	85	13.766	10	.038 (.019; .053)	.956	.005	Yes
Strong Invariance	153.868	<.001	97	35.735	12	.046 (.032; .059)	.924	.032	No
Partial Strong Invariance	135.746	.004	95	18.122	2	.039 (.023; .054)	.946	.010	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 484 non-GMD residents, 98 GMD 1, 3, and 4 residents, and 247 GMD 2 and 5 residents. For the partial strong invariant model, the threshold for the indicator measuring if respondents owned drip irrigation systems was freed for the group of respondents living above the Great Bend Prairie and Equus Beds aquifers. The threshold for the indicator measuring if respondents were aware of xeriscaping or greywater systems was freed for the group of respondents living above the Ogallala aquifer.

Invariance Table 5. Invariance Tests for Non-well Owner/Well Owner Comparisons of Awareness and Responses to Drought

Model Tested	χ^2	***df***	$\Delta\chi^2$	**Δ*df***	***p***	**RMSEA (90% CI)**	**CFI**	**ΔCFI**	**Pass?**
Null Model	2420.920	132							
Configural Invariance	195.500	99	--	--	<.001	.048 (.038; .057)	.958		Yes
Weak Invariance	201.884	105	6.384	6	<.001	.046 (.037; .056)	.958	.000	Yes
Strong Invariance	214.463	113	12.579	8	<.001	.046 (.036; .055)	.956	.002	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 450 non-well owners and 407 well owners.

Invariance Table 6. Invariance Tests for Non-municipal Well Owners/Municipal Well Owners Comparisons of Awareness and Responses to Drought

Model Tested	χ^2	***df***	$\Delta\chi^2$	**Δ*df***	***p***	**RMSEA (90% CI)**	**CFI**	**ΔCFI**	**Pass?**
Null Model	3081.341	132							
Configural Invariance	157.475	99	--	--	<.001	.055 (.038; .071)	.980		Yes
Weak Invariance	153.553	105	3.922	6	<.001	.049 (.031; .065)	.984	-.004	Yes
Strong Invariance	165.737	113	12.184	8	<.001	.049 (.032; .065)	.982	.002	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 141 off the grid well owners and 246 well owners with municipal water.

Invariance Table 7. Invariance Tests for Owners of Domestic, Lawn and Garden, Feedlot, and Irrigation Wells Comparisons of Awareness and Responses to Drought

Model Tested	χ^2	*df*	$\Delta\chi^2$	Δdf	*p*	RMSEA (90% CI)	CFI	ΔCFI	Pass?
Null Model	1372.694	264							
Configural Invariance	267.631	199	--	--	<.001	.058 (.038; .075)	.938		Yes
Weak Invariance	285.143	211	17.512	12	<.001	.059 (.040; .075)	.933	.005	Yes
Strong Invariance	306.772	232	12.184	21	<.001	.056 (.038; .073)	.933	.000	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 145 domestic well owners, 135 lawn and garden well owners, 66 feedlot well owners, and 61 irrigation well owners.

Invariance Table 8. Invariance Tests across the Three Geographic Groups (Ogallala, Great Bend Prairie and Equus Beds, and Non-GMD Residents) of Awareness and Responses to Drought

Model Tested	χ^2	*df*	$\Delta\chi^2$	Δdf	*p*	RMSEA (90% CI)	CFI	ΔCFI	Pass?
Null Model	2261.094	198							
Configural Invariance	210.223	149	--	--	<.001	.039 (.026; .050)	.970		Yes
Weak Invariance	225.365	161	15.142	12	<.001	.038 (.025; .049)	.969	.001	Yes
Strong Invariance	256.721	177	31.356	16	<.001	.040 (.029; .051)	.961	.008	Yes

Note: A change in CFI of .01 or less is the threshold for the measurement model invariance tests. Sample sizes are 484 non-GMD residents, 98 GMD 1, 3, and 4 residents, and 247 GMD 2

STRUCTURAL EQUATION MODELING APPENDIX

SEM Measures Table 6a. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on well ownership

	Factor Loadings	Residual Variances	S.E.
Indoor water-saving appliances			
Low-flow showerhead	.685	.462	.046
Low-flow toilet	.790	.137	.043
Water-efficient washing machine	.600	.212	.047
Outdoor water-saving appliances			
Timed sprinklers	.615	.795	.049
Irrigate more	.615	1.471	.049

Note: As dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6b. Standardized model results of reactions to drought regressed on well ownership

	Factor Loadings	Residual Variances	S.E.
Decreased Indoor Usage During Droughts			
Take shorter showers	.931	-.352	.011
Flush the toilet less	.931	.045	.011
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.825	.067	.053
Stop watering garden, orchard, trees, and other vegetation	.679	.608	.057
Irrigate less	.177	.953	.070
Increased Outdoor Usage During Droughts			
Increase watering lawn	.822	1.840	.069
Increased watering garden, orchard, trees, and other vegetation	.684	1.558	.062
Irrigate more	.604	1.720	.073

Note: As dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6c. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for non-well owners (n = 448)

	Factor Loadings	Residual Variance	S.E.
Awareness			
Xeriscaping and Grey Water	.561	.685	.039
High Plains aquifer and GMDs	.804	.353	.050
KWO, Vision, and Kansas Aqueduct	.617	.619	.036
Agriculture as biggest water user in Kansas	.349	.581	.057
Indoor water-saving appliances			
Low-flow showerhead	.732	.458	.052
Low-flow toilet	.728	.184	.050
Water-efficient washing machine	.591	.178	.052
Outdoor water-saving appliances			
Timed sprinklers	.736	.835	.064
Drip irrigation	.736	1.516	.064

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6d. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for well owners (n = 407)

	Factor Loadings	Residual Variance	S.E.
Awareness			
Xeriscaping and Grey Water	0.440	0.806	0.047
High Plains aquifer and GMDs	0.746	0.444	0.066
KWO, Vision, and Kansas Aqueduct	0.543	0.705	0.050
Agriculture as biggest water user in Kansas	0.349	0.581	0.057
Indoor water-saving appliances			
Low-flow showerhead	.709	0.458	0.053
Low-flow toilet	.714	0.184	0.051
Water-efficient washing machine	.579	0.178	0.052
Outdoor water-saving appliances			
Timed sprinklers	.437	0.835	0.103
Drip irrigation	.437	1.516	0.103

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6e. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for well owners without municipal utility connections (n = 141)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.340	.885	.068
High Plains aquifer and GMDs	.829	.313	.099
KWO, Vision, and Kansas Aqueduct	.558	.689	.074
Agriculture as biggest water user in Kansas	.495	.118	.088
Indoor water-saving appliances			
Low-flow showerhead	.750	-.019	.086
Low-flow toilet	.803	-.217	.087
Water-efficient washing machine	.575	-.237	.084
Outdoor water-saving appliances			
Timed sprinklers	.562	.709	.100
Drip irrigation	.562	.967	.100

Note: For the dichotomous categorical items, the variance values are thresholds. In order to achieve partial strong invariance and avoid a Heywood case between the outdoor investments and awareness construct, the latent variance was constrained on the construct measuring outdoor investments in both groups, and the threshold for the timed sprinkler indicator was freely estimated.

SEM Measures Table 6f. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for well owners with municipal utility connections (n = 246)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.336	.887	.065
High Plains aquifer and GMDs	.829	.313	.118
KWO, Vision, and Kansas Aqueduct	.542	.707	.065
Agriculture as biggest water user in Kansas	.495	.117	.088
Indoor water-saving appliances			
Low-flow showerhead	.697	-.019	.077
Low-flow toilet	.747	-.217	.076
Water-efficient washing machine	.535	-.237	.077
Outdoor water-saving appliances			
Timed sprinklers	.382	.079	.120
Drip irrigation	.382	.967	.120

Note: For the dichotomous categorical items, the variance values are thresholds. In order to achieve partial strong invariance and avoid a Heywood case between the outdoor investments and awareness construct, the latent variance was constrained on the construct measuring outdoor investments in both groups, and the threshold for the timed sprinkler indicator was freely estimated.

SEM Measures Table 6g. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for domestic well owners (n = 145)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.332	.896	.060
High Plains aquifer and GMDs	.687	.527	.095
KWO, Vision, and Kansas Aqueduct	.586	.657	.069
Agriculture as biggest water user in Kansas	.499	.302	.081
Indoor water-saving appliances			
Low-flow showerhead	.711	.036	.078
Low-flow toilet	.795	-.173	.079
Water-efficient washing machine	.595	-.195	.087
Outdoor water-saving appliances			
Timed sprinklers	.627	.803	.127
Drip irrigation	.627	1.054	.127

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6h. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for lawn and garden well owners (n = 135)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.320	.897	.067
High Plains aquifer and GMDs	.718	.485	.107
KWO, Vision, and Kansas Aqueduct	.605	.634	.073
Agriculture as biggest water user in Kansas	.499	.302	.081
Indoor water-saving appliances			
Low-flow showerhead	.696	.036	.079
Low-flow toilet	.777	-.173	.091
Water-efficient washing machine	.582	-.195	.085
Outdoor water-saving appliances			
Timed sprinklers	.379	-.518	.246
Drip irrigation	.379	1.054	.246

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6i. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for feedlot well owners (n = 66)

	Factor Loadings	Residual Variance	S.E.
Awareness			
Xeriscaping and Grey Water	.307	.906	.081
High Plains aquifer and GMDs	.834	.305	.144
KWO, Vision, and Kansas Aqueduct	.620	.616	.097
Agriculture as biggest water user in Kansas	.499	.302	.081
Indoor water-saving appliances			
Low-flow showerhead	.591	.036	.108
Low-flow toilet	.660	-.173	.120
Water-efficient washing machine	.494	-.195	.101
Outdoor water-saving appliances			
Timed sprinklers	.370	.803	.378
Drip irrigation	.370	1.054	.378

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6j. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for irrigation well owners (n = 61)

	Factor Loadings	Residual Variance	S.E.
Awareness			
Xeriscaping and Grey Water	.316	.900	.083
High Plains aquifer and GMDs	.838	.298	.150
KWO, Vision, and Kansas Aqueduct	.603	.636	.103
Agriculture as biggest water user in Kansas	.499	.302	.081
Indoor water-saving appliances			
Low-flow showerhead	.776	.036	.112
Low-flow toilet	.868	-.173	.111
Water-efficient washing machine	.650	-.195	.085
Outdoor water-saving appliances			
Timed sprinklers	.252	.803	.403
Drip irrigation	.252	1.054	.403

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6k. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for residents not living in GMDs (n = 484)

	Factor Loadings	Residual Variance	S.E.
Awareness			
Xeriscaping and Grey Water	.569	.676	.047
High Plains aquifer and GMDs	.778	.395	.050
KWO, Vision, and Kansas Aqueduct	.587	.656	.043
Agriculture as biggest water user in Kansas	.363	.490	.062
Indoor water-saving appliances			
Low-flow showerhead	.753	.326	.048
Low-flow toilet	.779	.062	.048
Water-efficient washing machine	.624	.083	.050
Outdoor water-saving appliances			
Timed sprinklers	.509	.927	.108
Drip irrigation	.509	1.431	.108

Note: For the dichotomous categorical items, the variance values are thresholds. In order to achieve partial strong invariance, the threshold for the indicator measuring if respondents owned drip irrigation systems was freed for the group of respondents living above the Great Bend Prairie and Equus Beds aquifers. The threshold for the indicator measuring if respondents were aware of xeriscaping or greywater systems was freed for the group of respondents living above the Ogallala aquifer.

SEM Measures Table 6l. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for residents living above the Ogallala aquifer (n = 98)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.411	.831	.079
High Plains aquifer and GMDs	.745	.444	.125
KWO, Vision, and Kansas Aqueduct	.373	.861	.067
Agriculture as biggest water user in Kansas	.272	.490	.066
Indoor water-saving appliances			
Low-flow showerhead	.719	.326	.077
Low-flow toilet	.744	.062	.074
Water-efficient washing machine	.595	.083	.069
Outdoor water-saving appliances			
Timed sprinklers	.817	.927	.069
Drip irrigation	.817	1.431	.069

Note: For the dichotomous categorical items, the variance values are thresholds. In order to achieve partial strong invariance, the threshold for the indicator measuring if respondents owned drip irrigation systems was freed for the group of respondents living above the Great Bend Prairie and Equus Beds aquifers. The threshold for the indicator measuring if respondents were aware of xeriscaping or greywater systems was freed for the group of respondents living above the Ogallala aquifer.

SEM Measures Table 6m. Standardized model results of owning water-saving appliances for appliances for indoor and outdoor usage regressed on awareness levels for residents living above the Great Bend Prairie and Equus Beds aquifers (n = 247)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.536	.712	.064
High Plains aquifer and GMDs	.715	.489	.072
KWO, Vision, and Kansas Aqueduct	.566	.679	.061
Agriculture as biggest water user in Kansas	.342	.490	.066
Indoor water-saving appliances			
Low-flow showerhead	.685	.326	.058
Low-flow toilet	.709	.062	.059
Water-efficient washing machine	.567	.083	.055
Outdoor water-saving appliances			
Timed sprinklers	.384	.927	.160
Drip irrigation	.384	1.860	.160

Note: For the dichotomous categorical items, the variance values are thresholds. In order to achieve partial strong invariance, the threshold for the indicator measuring if respondents owned drip irrigation systems was freed for the group of respondents living above the Great Bend Prairie and Equus Beds aquifers. The threshold for the indicator measuring if respondents were aware of xeriscaping or greywater systems was freed for the group of respondents living above the Ogallala aquifer.

SEM Measures Table 6n. Standardized model results of reactions to drought regressed on awareness levels for non-well owners (n = 450)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.466	.783	.040
High Plains aquifer and GMDs	.867	.248	.063
KWO, Vision, and Kansas Aqueduct	.630	.603	.038
Agriculture as biggest water user in Kansas	.411	.606	.052
Decreased Indoor Usage During Droughts			
Take shorter showers	.902	-.289	.020
Flush the toilet less	.902	-.019	.020
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.897	.076	.061
Stop watering garden, orchard, trees, and other vegetation	.712	.599	.061
Irrigate less	.209	.943	.072
Increased Outdoor Usage During Droughts			
Increase watering lawn	.738	1.845	.106
Increased watering garden, orchard, trees, and other vegetation	.630	1.570	.090
Irrigate more	.608	1.818	.090

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6n. Standardized model results of reactions to drought regressed on awareness levels for well owners (n = 407)

	Factor Loadings	**Residual Variance**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.366	.866	.041
High Plains aquifer and GMDs	.804	.354	.058
KWO, Vision, and Kansas Aqueduct	.554	.693	.045
Agriculture as biggest water user in Kansas	.411	.606	.052
Decreased Indoor Usage During Droughts			
Take shorter showers	.954	-.289	.012
Flush the toilet less	.954	-.019	.012
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.755	.076	.071
Stop watering garden, orchard, trees, and other vegetation	.599	.599	.064
Irrigate less	.176	.943	.062
Increased Outdoor Usage During Droughts			
Increase watering lawn	.795	1.845	.074
Increased watering garden, orchard, trees, and other vegetation	.678	1.570	.068
Irrigate more	.654	1.818	.080

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6o. Standardized model results of reactions to drought regressed on awareness levels for well owners without municipal utility connections (n = 141)

	Factor Loadings	Residual Variances	S.E.
Awareness			
Xeriscaping and Grey Water	.280	.921	.068
High Plains aquifer and GMDs	.749	.439	.104
KWO, Vision, and Aqueduct	.580	.664	.080
Agriculture as biggest water user in Kansas	.609	.094	.086
Decreased Indoor Usage During Droughts			
Take shorter showers	.986	.002	.009
Flush the toilet less	.986	.109	.009
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.741	.152	.112
Stop watering garden, orchard, trees, and other vegetation	.603	.639	.104
Irrigate less	.009	.953	.095
Increased Outdoor Usage During Droughts			
Increase watering lawn	.822	1.364	.114
Increased watering garden, orchard, trees, and other vegetation	.644	1.158	.102
Irrigate more	.633	1.513	.113

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6p. Standardized model results of reactions to drought regressed on awareness levels for well owners with municipal utility connections (n = 246)

	Factor Loadings	**Residual Variances**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.278	.923	.063
High Plains aquifer and GMDs	.748	.440	.083
KWO, Vision, and Aqueduct	.563	.683	.068
Agriculture as biggest water user in Kansas	.609	.094	.086
Decreased Indoor Usage During Droughts			
Take shorter showers	.939	.002	.019
Flush the toilet less	.939	.109	.019
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.812	.152	.090
Stop watering garden, orchard, trees, and other vegetation	.661	.639	.083
Irrigate less	.009	.953	.104
Increased Outdoor Usage During Droughts			
Increase watering lawn	.877	1.364	.100
Increased watering garden, orchard, trees, and other vegetation	.687	1.158	.085
Irrigate more	.675	1.513	.106

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6q. Standardized model results of reactions to drought regressed on awareness levels for domestic well owners (n = 145)

	Factor Loadings	**Residual Variances**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.221	.951	.061
High Plains aquifer and GMDs	.587	.656	.073
KWO, Vision, and Aqueduct	.616	.621	.096
Agriculture as biggest water user in Kansas	.477	.300	.089
Decreased Indoor Usage During Droughts			
Take shorter showers	.953	-.037	.021
Flush the toilet less	.953	.090	.021
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.799	.260	.077
Stop watering garden, orchard, trees, and other vegetation	.621	.723	.071
Irrigate less	.127	.947	.091
Increased Outdoor Usage During Droughts			
Increase watering lawn	.670	1.346	.104
Increased watering garden, orchard, trees, and other vegetation	.558	1.152	.091
Irrigate more	.851	1.543	.142

Note: For the dichotomous categorical items, the variance values are thresholds. In order to address the Heywood cases, the latent variance was constrained on the construct measuring decreased outdoor watering during droughts and increased watering during droughts for all groups of well owners in both groups, and the theta values for the construct representing water supply awareness were freed for lawn and garden, feedlot, and irrigation well owners.

SEM Measures Table 6r. Standardized model results of reactions to drought regressed on awareness levels for lawn and garden well owners (n = 135)

	Factor Loadings	**Residual Variances**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.279	.922	.066
High Plains aquifer and GMDs	.778	.395	.084
KWO, Vision, and Aqueduct	.807	.348	.080
Agriculture as biggest water user in Kansas	.606	.300	.083
Decreased Indoor Usage During Droughts			
Take shorter showers	.945	-.037	.023
Flush the toilet less	.945	.090	.023
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.801	.260	.078
Stop watering garden, orchard, trees, and other vegetation	.623	.723	.072
Irrigate less	.127	.947	.091
Increased Outdoor Usage During Droughts			
Increase watering lawn	.605	1.346	.074
Increased watering garden, orchard, trees, and other vegetation	.504	1.152	.070
Irrigate more	.768	1.543	.090

Note: For the dichotomous categorical items, the variance values are thresholds. In order to address the Heywood cases, the latent variance was constrained on the construct measuring decreased outdoor watering during droughts and increased watering during droughts for all groups of well owners in both groups, and the theta values for the construct representing water supply awareness were freed for lawn and garden, feedlot, and irrigation well owners.

SEM Measures Table 6s. Standardized model results of reactions to drought regressed on awareness levels for feedlot well owners (n = 66)

	Factor Loadings	Residual Variances	S.E.
Awareness			
Xeriscaping and Grey Water	.204	.958	.065
High Plains aquifer and GMDs	.690	.524	.118
KWO, Vision, and Aqueduct	.631	.602	.109
Agriculture as biggest water user in Kansas	.462	.300	.085
Decreased Indoor Usage During Droughts			
Take shorter showers	.995	-.037	.000
Flush the toilet less	.995	.090	.000
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.801	.260	.079
Stop watering garden, orchard, trees, and other vegetation	.623	.723	.074
Irrigate less	.127	.947	.091
Increased Outdoor Usage During Droughts			
Increase watering lawn	.778	1.346	.105
Increased watering garden, orchard, trees, and other vegetation	.648	1.152	.109
Irrigate more	.988	1.543	.146

Note: For the dichotomous categorical items, the variance values are thresholds. In order to address the Heywood cases, the latent variance was constrained on the construct measuring decreased outdoor watering during droughts and increased watering during droughts for all groups of well owners in both groups, and the theta values for the construct representing water supply awareness were freed for lawn and garden, feedlot, and irrigation well owners.

SEM Measures Table 6t. Standardized model results of reactions to drought regressed on awareness levels for irrigation well owners (n = 61)

	Factor Loadings	**Residual Variances**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.208	.957	.068
High Plains aquifer and GMDs	.688	.526	.108
KWO, Vision, and Aqueduct	.610	.628	.112
Agriculture as biggest water user in Kansas	.459	.300	.107
Decreased Indoor Usage During Droughts			
Take shorter showers	.940	-.037	.039
Flush the toilet less	.940	.090	.039
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.797	.260	.077
Stop watering garden, orchard, trees, and other vegetation	.620	.723	.072
Irrigate less	.127	.947	.091
Increased Outdoor Usage During Droughts			
Increase watering lawn	.481	1.346	.144
Increased watering garden, orchard, trees, and other vegetation	.400	1.152	.127
Irrigate more	.610	1.543	.186

Note: For the dichotomous categorical items, the variance values are thresholds. In order to address the Heywood cases, the latent variance was constrained on the construct measuring decreased outdoor watering during droughts and increased watering during droughts for all groups of well owners in both groups, and the theta values for the construct representing water supply awareness were freed for lawn and garden, feedlot, and irrigation well owners.

SEM Measures Table 6u. Standardized model results of reactions to drought regressed on awareness levels for residents not living in GMDs (n = 484)

	Factor Loadings	Residual Variances	S.E.
Awareness			
Xeriscaping and Grey Water	.387	.851	.042
High Plains aquifer and GMDs	.766	.413	.065
KWO, Vision, and Aqueduct	.602	.637	.051
Agriculture as biggest water user in Kansas	.440	.505	.058
Decreased Indoor Usage During Droughts			
Take shorter showers	.937	-.289	.014
Flush the toilet less	.937	-.013	.014
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.802	.002	.058
Stop watering garden, orchard, trees, and other vegetation	.662	.534	.059
Irrigate less	.181	.924	.068
Increased Outdoor Usage During Droughts			
Increase watering lawn	.747	1.786	.117
Increased watering garden, orchard, trees, and other vegetation	.631	1.494	.085
Irrigate more	.599	1.747	.086

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6v. Standardized model results of reactions to drought regressed on awareness levels for residents living above the Ogallala aquifer (n = 98)

	Factor Loadings	**Residual Variances**	**S.E.**
Awareness			
Xeriscaping and Grey Water	.373	.861	.060
High Plains aquifer and GMDs	.980	.040	.114
KWO, Vision, and Aqueduct	.512	.738	.063
Agriculture as biggest water user in Kansas	.440	.505	.058
Decreased Indoor Usage During Droughts			
Take shorter showers	.973	-.289	.017
Flush the toilet less	.973	-.013	.017
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.969	.002	.074
Stop watering garden, orchard, trees, and other vegetation	.799	.534	.067
Irrigate less	.219	.924	.083
Increased Outdoor Usage During Droughts			
Increase watering lawn	.880	1.786	.093
Increased watering garden, orchard, trees, and other vegetation	.744	1.494	.083
Irrigate more	.706	1.747	.096

Note: For the dichotomous categorical items, the variance values are thresholds.

SEM Measures Table 6w. Standardized model results of reactions to drought regressed on awareness levels for residents living above the Great Bend Prairie and Equus Beds aquifers (n = 247)

	Factor Loadings	Residual Variances	S.E.
Awareness			
Xeriscaping and Grey Water	.387	.850	.050
High Plains aquifer and GMDs	.747	.442	.077
KWO, Vision, and Aqueduct	.618	.618	.058
Agriculture as biggest water user in Kansas	.440	.505	.058
Decreased Indoor Usage During Droughts			
Take shorter showers	.883	-.289	.030
Flush the toilet less	.883	-.013	.030
Decreased Outdoor Usage During Droughts			
Stop watering lawn	.749	.002	.087
Stop watering garden, orchard, trees, and other vegetation	.618	.534	.075
Irrigate less	.169	.924	.065
Increased Outdoor Usage During Droughts			
Increase watering lawn	.737	1.786	.102
Increased watering garden, orchard, trees, and other vegetation	.623	1.494	.094
Irrigate more	.591	1.747	.094

Note: For the dichotomous categorical items, the variance values are thresholds.

CHAPTER VII APPENDIX

Survey Methods

As previously mentioned, few dozen respondents had issues completing the online survey. After launching a new wave of surveys with updated URLs, I provided those respondents with links to the surveys of the second wave, so this slightly inflates the second wave's response rates of one of the survey forms (the survey that was connected to the notification with the red signature). I intentionally gave these respondents the link to the survey that received the lowest response rate in order to make the de facto returns of each of the survey forms more uniform. Additionally, another dozen respondents returned their notification postcards via post to my office, informing me that they would like to participate in the study but did not have internet access or own a computer. They requested a paper copy of the survey and were given a printed XBC form (when their paper copies were returned to me, I put their answers in the second wave of responses).

While I can think of very few disadvantages of constructing a survey implementing PMDD, it is important to note that this form of data collection takes considerable time and attention to detail. Managing nine surveys in a semester was a daunting task, but fortunately I intended on using the PMDD approach for my data collection well in advance, even during the proposal stages of my dissertation. This level of survey construction probably cannot be done correctly with a project conceived at the last minute. Over the course of my graduate studies, I had many experiences that taught me the importance of seriously investing in survey design. I also had the help of research assistants to ensure that my data management went smoothly. One RA noticed that Qualtrics edits the values of survey responses as the questions are edited, and I had to recode a few variables so they were consistently coded across surveys. For this type of questionnaire, the key word in "Planned Missing Data Design" is *planned*. Even though it took substantially greater investment than running a full-form survey, the PMDD approach is less taxing on the respondents, which makes this survey design more ethical than a full form. The survey's abbreviated length should also reduce error because it reduces fatigue. If a researcher has the means to obtain a large sample, and the computational resources to estimate the missing values, PMDD is the superior approach for studies with a large sample size.[1]

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[1] To review, I employ practical methods that clearly match my research agenda. Methodology is the most important aspect of research, and accurate data collection is a crucial starting point for any serious research project. By constructing my survey with planned missing data, I provided random portions of my survey to respondents (as

On the subject of surveys, while they remain the most efficient way to get a large sample of respondents, people can act inconsistently from their stated beliefs; their *Behavioral Intention* (BI) and actual *Behaviors* (B) are not always similar (Heberlein 2012). Self-reported intentions or behaviors do not always meet with manifest actions due to the social desirability bias, especially in studies of environmentalism. Furthermore, while I ask my respondents about their investments in water saving appliances like low-flow toilets, low-flow showerheads, water-efficient washing machines, drip irrigation, and timed sprinklers, water consumption can still increase despite the use of more efficient devices. The proportion of Kansas irrigators using drop nozzles skyrocketed from 20 percent in 1996 to 80 percent in 2005, but drip irrigation actually tempted farmers to water more acres and plant water-intensive crops, which in turn increased groundwater pumping (Fenichel et al. 2016). Detecting the Jevon's Paradox with a survey instrument would be very challenging—although it is encouraging to learn that many Kansans are investing in more productive watering technologies.

Water Pricing

Water is frequently regarded as a public good or CPR that has faced several attempts of being privatized (Bakker 2010). The notion of privatizing or monetizing water has faced resistance from many scholars in an array of fields. From an ethical and ecocentric standpoint, commodification completely ignores every non-human species' reliance on water because non-humans have no economic power. Bringing their standing into a monetary-based approach is very challenging, which is unjust due to water's position as an axis resource. It also has led to hydrologically irrational agricultural practices. Take, for example, the stance of Arjen Hoekstra, the developer of the "water footprint" concept, and a renowned water researcher:

> Leaving freshwater allocation to the market… is not a good idea. It's one of the worst ideas. [The] wise use of natural resources is not the private territory of the market. Freshwater is essential for life. …the major mechanism that changes the status of our freshwater resources is the economic mechanism of demand and supply of our daily commodities, like food, fibers, energy, minerals and so on.

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opposed to the complete survey), which kept the questionnaire shorter. Shortening the survey boosts response rates because less taxing surveys reduce the likelihood of participants not completing the questionnaire. Condensing surveys as a means to reduce fatigue and nonresponse has been recognized by survey methodologists for over a decade (Crawford, Couper, and Lamias 2001; Groves et al. 2004), and planned missing data designs are an established form of data collection that has been widely implemented (Graham, Hofer, and Mackinnon 1996; Graham et al. 2006).

> The market says: it's economically attractive to grow asparagus in the desert in Peru, so asparagus is grown in the desert in Peru and groundwater levels decline… Water is for free, so there is no way in which economies account for the scarcity of freshwater resources or the vulnerability of ecosystems to overexploitation or pollution. (Hoekstra 2013:1)

While Hoekstra's argument implies that market mechanisms are inappropriate for distributing water, he quickly engages the conversation of water pricing, suggesting that its use values are not adequately represented by its exchange values: "we see that water generally goes non-priced or grossly underpriced. As a result, there is insufficient economic incentive for water users to save water" (2013:7). If markets are in fact an unwise institution for allocating the resource, then the conversation of providing proper price signals becomes a moot point. As other researchers have claimed, Hoekstra argues that, "It is a myth that proper pricing is sufficient to guarantee sustainable use of a resource" (2013:8). If that is the case, then the exchange value of water, even if they are inadequate, would be irrelevant to anyone who contends that markets should not allocate water in the first place.

The opposition giving water a more robust market signal has also been described as an arrangement that pushes a necessary resource out of reach for low-income individuals. It further plays into a neoliberal framing of nature as a collection of goods that can be bought. Consider Simms' (2016) argument that "Price may be a tool, but the language of natural capital somehow reinforces the notion of nature as a mere factor of production, as opposed to being the parent company." The economy needs to be properly integrated into the environment so that ecological limits to growth can be understood, and free water is not fair when some individuals or households are using it in vast quantities—so much so that their neighbors are burdened by their extractions. While I acknowledge the arguments against these purported transmutations, and the opposition to market water, I contend that taxing large groundwater removals is a way for economists and policymakers to understand when a resource gets prohibitively expensive.

In his work *Conservationist*, Aldo Leopold stated, "We abuse land because we regard it as a commodity belonging to us" (see Flader and Callicott 1991). The case of groundwater in Kansas represents a phenomenon in which natural resources are abused because they are *not* commodified, yet play a key role in economic growth. Steep taxation can reflect an environmental limit, and prices can be measuring systems that can be utilized to recognize natural limits. Furthermore, I resist the notion of "out-pricing" low-income Kansans with wells out of their basic water needs, because my proposed tax is on very large amounts of water. An acre-foot of water should be plenty for indoor consumption in the typical Kansas household; therefore, a $2 to $6 tax per-acre-foot should be manageable over the course of a year.