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Tucker Colvin

University of New Mexico, Department of Geography and Environmental Studies

This thesis is approved, and it is acceptable in quality and form for publication:

Approved by the Thesis Committee:

Dr. Benjamin Warner, Chairperson

Dr. Chris Duvall

John Fleck

DRINKING WATER GOVERNANCE FOR WHOM?

AN INSTITUTIONAL ANALYSIS OF RURAL DRINKING WATER SYSTEMS IN NEW MEXICO

BY

TUCKER COLVIN

BS: ENVIRONMENTAL SCIENCE – MONTANA STATE UNIVERSITY, 2014

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Science

Geography

The University of New Mexico,

Albuquerque, New Mexico

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DEDICATION

I dedicate this thesis to my mother, Peggy Colvin, who continues to be my biggest role model and has always supported and encouraged me, and to my late father, Scott Colvin, who gave me a wonderful upbringing and continues to influence my life path.

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ABSTRACT

Rural community drinking water systems in New Mexico are facing many challenges, including a lack of personnel, deteriorating infrastructure, lack of funds, overly burdensome and confusing regulation, environmental concerns, and concerns over water rights. Governing agencies are creating vulnerability by making managers prioritize some issues and neglect others. Water systems designated a Mutual Domestic Water Consumers Associations are especially problematic because they are small and managed by volunteers but have as much regulatory burden as larger municipalities. I use the theory of institutional work to explain how an institution that was originally designed to help low-income and rural communities is now harming them. It is also a racially discriminatory institution as these water systems are more often in majority Hispanic communities. Instead of state agencies existing and serving community drinking water systems, the situation has flipped so that drinking water systems appear to be serving the existence of governing agencies.

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Introduction

Like many water systems all across the United States, drinking water systems in New Mexico, USA are facing numerous and serious challenges. The vast majority of residents in the state rely on community drinking water systems, defined as "a system that serves at least 15 service connections used by year-round residences or regularly serve at least 25 year-round residents" (Public Water Systems Compliance Report 2017). Not having adequate drinking water severely hampers resident's ability to lead health and successful lives. Because of this, it is important to understand the state of community drinking water systems in New Mexico and examine their vulnerability and what challenges they face. Recent literature has identified these challenges nationally, with the American Water Works Association identifying renewal and replacement of aging water and wastewater infrastructure, financing for capital improvements, and long-term water supply availability as the top three issues that community water systems face (AWWA 2019; see also McFarlane & Harris 2018). Allaire et al. (2018) spatially examine hotspots of violations to the *Safe Drinking Water Act* and finds that the US Southwest has more violations than other regions of the country. It has also been determined that due to limited resources and economies of scale, small drinking water system typically have more difficulty in overcoming challenges than larger systems (Mosheim & Ribaudo 2017). Because of these findings, New Mexico is an ideal location to examine the challenges that water systems are facing and to what extent these challenges are making rural water systems vulnerable. Because drinking water systems are largely governed at the state level, it is also crucial to examine what role the institutional and regulatory environments play.

In order to get a comprehensive understanding of the situation of drinking water governance in New Mexico, I interview managers of rural drinking water system to learn about their needs and concerns and what they are doing to manage them. I also get their perspective on institutional dynamics, including their relationship with governing institutions. The institutional structure of a water system, such as Mutual Domestic Water Consumers Association (MDWCA), Cooperative, or Municipally Owned, has a substantial effect on how managers are able to handle issues, and because of this, I further examine these institutional

structures. Governing institutions, and their regulations and assistance, also have a large impact on water systems, so I further analyze them to learn what role and impact they have.

This research takes an institutional approach, which means that institutions determine how a system is governed, including how people interact with each other and with the resources they are utilizing. Institutions are defined as rules and norms and determine who holds decision making power (North 1991). For my research methodology, I use mixed methods and grounded theory. Mixed methods combines and draws on the strengths of both quantitative and qualitative data (Creswell 2014). Grounded theory allows me to enter the situation with no theory and then create and test my theory as research progresses (Strauss & Corbin 1994). My qualitative research consisted of 6 in-person interviews with water experts and 30 in-person interviews with managers of rural drinking water systems from all across the state. The purpose of these interviews was to learn the issues rural water systems are facing from the people who are on the ground running them and what they are doing to manage these issues. Qualitative research also consisted of examining state government institutions and relevant non-governmental organizations (NGOs). Quantitative research consisted of comparing water system data to spatial and demographic data to see what communities were associated with which institutional structure. This research did not include water systems on tribal land due to the different institutional environment and challenges in conducting research on tribal land.

This paper is broken into two chapters that examine the situation of rural community drinking water systems in New Mexico from different angles. Chapter 1, titled "The creation of vulnerability" focuses on the needs and concerns of rural drinking water system managers and what they are doing to manage them. I then assess how these factors affect the vulnerability of water systems. The primary research question for this chapter is,

- What are the needs and concerns of rural drinking water system managers across New Mexico and how do they contribute to the vulnerability of drinking water systems?

My research finds that rural drinking water systems in New Mexico face six main challenges, which include not enough local people being engaged in running the water system, lack of funds and difficulty receiving outside funding, deteriorating infrastructure, confusing and burdensome regulation, environmental concerns, and having enough water rights or losing

water rights. Some managers were also very concerned about regionalization of water systems, but others thought it could help them. While some of these issues are more tangible, such as aging infrastructure and environmental concerns, other problems are "constructed," including burdensome and confusing regulations and challenges in finding funding. Many water systems, particularly MDWCAs, are managed by volunteers, and they are tasked with a substantial about of work and responsibilities, and because of this they lack experienced people who want to be involved with the water system. Because the people they do have are spending so much time keeping up on regulations and navigating bureaucracy, they are not planning for the longer-term issues of aging infrastructure and environmental threats. Governing institutions have more power than water systems and they determined certain issues were important, but water system managers argue that these issues are not as big of issues as the issues that were created by the regulations. These "constructed" problems are making rural water system more susceptible to perturbation because managers are spending less time and effort addressing longer-term environmental and infrastructural issues, and are therefore increasing their overall vulnerability. The regulations themselves are not the issue, as managers largely do support the requirement for having clean and safe water and they want to prevent financial fraud, but they have been created in a way that makes it challenging for small and rural water systems to comply with.

Chapter 2 takes a more in-depth look into the various state and NGO governing institutions, and the different institutional structures of water systems. The main research questions for chapter 2 are,

- What are the circumstances that have influenced why a community chose a specific institutional structure for their drinking water system?
- How does the institutional structure of a community drinking water system influence its ability to meet its goals?

I determine that the institutional structure of a water system is influenced by the size and household income of the community. I focus on the institutional structure of MDWCA, because they are the most numerous and the interviews indicated that MDWCAs are struggling more than water systems with other institutional structures. MDWCAs are among the smallest water systems but have as much regulatory burden as larger municipally owned

systems. Because they are a subdivision of the state government, they are eligible for more public funds. However, the median monthly water rate for MDWCAs is among the highest, so the increased regulatory burden for increased funding eligibility does not appear to be a good tradeoff. MDWCAs are also in the lowest income and predominantly Hispanic communities.

The institutional structure of MDWCA was created in 1947 to give more state resources to low-income rural communities to improve their drinking water systems and promote public health (Clark 1987). It was widely seen as a successful measure, but in the many years since its creation, it has become a negative and racially discriminatory institution. To argue how this happened, I use the theoretical lens of institutional work, which is defined as purposive actions that create, maintain or disrupt institutions (Lawrence & Suddaby 2006). The institution of MDWCA has remained statutorily relatively constant, but tangential institutional changes through increased regulation and oversight placed upon MDWCAs have drastically altered it as an institution. Because so much reinforcing institutional work has also been placed upon it by actions such as increasing the number of MDWCA systems, hiring regulatory staff, and conducting trainings for MDWCA managers, the institution of MDWCA is very strong. Because it remains strong, it would take a great deal of disrupting institutional work to significantly alter it. Governing agencies are aware of many of the issues with MDWCAs but there are no good alternative institutional structures if communities still want to be eligible for state funds. In this situation, institutional work has been explicitly political and has acted on MDWCAs by tangential regulatory legislation. This institutional work has shifted power away from rural communities and their drinking water systems and toward the state government.

The two chapters in this paper are written to be read independently. Because of this, there is significant overlap in content. The two chapters take different paths, use different theoretical lenses, and have unique findings, but they both come to the same overarching conclusion. State governing agencies no longer are existing and serving community drinking water systems. Instead, this situation has flipped, and water systems seem to be existing and serving governing state agencies. The reason is because, as chapter 1 explains, governing agencies are causing systems to become vulnerable and as chapter 2 explains, institutional work has shifted power away from communities and toward the state government.

Chapter 1

The creation of vulnerability

Chapter 1 Introduction

New Mexico, USA is a largely rural state with most of the population outside the larger towns along the Rio Grande relying on small community drinking water systems for delivery of potable water to their homes. These community drinking water systems vary greatly and include differences in type of water source, source water chemistry, number of connections, age of the water system, the institutional structure of the water system, and who is running it. Because of all these variables, different water systems face many different challenges, but overall, literature shows small water systems tend to have more difficultly overcoming these challenges than large urban water systems (Mosheim & Ribaudo 2017).

There is a growing literature documenting the issues that water systems are facing and where water systems that appear most vulnerable are located (see McFarlane & Harris 2018; Stanford 2008; Kline 2017; Allaire 2018). However, these studies focus on either large datasets, legislation and institutions, small case studies, or trends in literature. There is a lack of on the ground research to see what challenges the people running these small water systems are facing and what they are doing to meet these challenges. This is especially important in New Mexico because as Allaire et al. (2018) found, water systems in the US Southwest have more *Safe Drinking Water Act* violations and appear to be more vulnerable than the rest of the country. They also found there are more violations in rural areas than urban areas.

Because of this research gap, I found a need to learn from the people who are tasked with running rural water systems in New Mexico, as they can give insight into what issues they are facing and what they are doing to handle them. What are the needs and concerns of rural drinking water system managers across New Mexico and how do they contribute to the vulnerability of drinking water systems?

I find that rural drinking water systems in New Mexico are facing numerous issues including not having enough local people engaged in running the water system, deteriorating

infrastructure, lack of funds and difficulty receiving outside funding, confusing and burdensome regulation, environmental concerns, including drought, wildfire, and contamination, and concerns of having enough water rights or losing their water rights. Regionalization was also a concern for many system managers, but others saw it as a solution to many of their challenges. I found all these issues not to be separate, and that they had large influences on each other. Institutions were important factors, including state government institutions and the individual institutional structures of water systems. Navigating bureaucracy was a huge challenge for most small water systems. Regulating and funding institutions that are supposed to promote safe and affordable drinking water for consumers are making rural water systems more vulnerable. Instead of government agencies serving and promoting the existence rural drinking water systems, the situation has flipped so that water systems seem to be serving and providing for the existence of governing institutions.

Managers are tasked with so many "constructed" problems that also tend to be "today problems," such as keeping up to date on regulations, that they are not putting as much thought and effort into the longer-term issues of aging infrastructure and environmental concerns. If vulnerability is defined as the exposure and sensitivity to perturbation and the system's ability to adapt (Adger 2006), then this situation is increasing water system's sensitivity and exposure to perturbations, and because they lack having enough experienced people running their systems, they have low adaptive capacity when faced with serious and abrupt challenges. Regulating institutions have more power than water systems and they decided that water quality and financial fraud were significant issues that needed addressing. However, managers argue that the way these issues are being addressed is creating even bigger issues for them: the people who are actually managing and operating rural community drinking water systems.

There was also the general sentiment among water system managers and other officials that drinking water systems in New Mexico are starting to fail. However, water systems may be failing in terms of satisfying regulations, but they do not seem to be failing in delivering water to their community. Rural water systems may be very vulnerable if the required outcome is delivery of water and satisfying all regulatory requirements, but if the desired outcome is only the delivery of water then systems are not as vulnerable.

Community Drinking Water Systems in New Mexico

New Mexico has 570 community drinking water systems, with the vast majority of them serving small communities. In New Mexico, a community drinking water system is defined as "a system that serves at least 15 service connections used by year-round residences or regularly serve at least 25 year-round residents" (Public Water Systems Compliance Report 2017). In 2018, approximately 269,000 people in New Mexico, accounting for 14 percent of the population, received their drinking water from a community water system serving populations less than 5,000 people, and 444,000 people, or 24 percent of the population, from a system serving less than 10,000 people (Community Systems Water Quality 2018). All community drinking water systems are subject to EPA regulation and quality standards. In New Mexico, drinking water systems are regulated by the New Mexico Environment Department (NMED) Drinking Water Bureau, which is a state entity tasked with enforcing regulation passed by the federal *Safe Drinking Water Act* (1974, 1986, 1996).

Drinking water systems on tribal land were not included in this study for multiple reasons. Tribal water systems are not governed by NMED and have a much different institutional and regulatory environment. There are also added barriers in conducting this type of research on tribal land. Permission must be granted by each Reservation or Pueblo. Because of the added research challenges and different institutional environment, drinking water governance on tribal land is beyond the scope of this research.

Non-tribal water systems in New Mexico consist of a variety of institutional structures, with the most prominent ones being Mutual Domestic Water Consumers Associations (MDWCAs), Water and Sanitation Districts (WSDs), Cooperatives, Non-profits, Investor Owned, and Municipally Owned. The institutional structure of a water system is important because it largely determines the regulatory requirements of the system and what financial resources are available. As will be shown, these regulatory requirements are causing substantial challenges to small water systems and because different institutional structures serve different communities, the regulations are also having different impacts on different communities. MDWCAs are the most numerous institutional structure and account for 37 percent of total community drinking water systems in the state. Along with WSDs, they are technically subdivisions of the state government. MDWCAs, WSDs, and municipally owned

systems are considered public entities and are subjected to more financial regulation than the other institutional structures, which are considered private. Municipally owned systems and WSDs serve larger communities than the other institutional structures, and on average MDWCAs serve communities with the lowest household income and communities with predominantly Hispanic populations.

New Mexico rural water systems also face numerous environmental issues. As with other areas around the globe, average annual temperatures across New Mexico are increasing and expected to continue to do so (Lehner et al. 2018). The US Environmental Protection Agency predicts that wildfires will become more frequent and severe in the coming years due to increased temperature and large fuel loads from decades of fire suppression (EPA 2016). More uncertain however is how greenhouse gasses will affect moisture, because the US Southwest is already an area with highly variable precipitation patterns (Lehner et al. 2018). Nevertheless, large and hot wildfires dramatically alter the hydrology of streams and watersheds that communities rely on by contaminating the water with soot and heavy metals, creating conditions for flash floods, preventing aquifer recharge, and destroying water intake and treatment infrastructure (U.S. Global Change Research Program 2018). Because of all these factors, it is important to understand how rural water systems in New Mexico are handling these issues and what role institutions play.

Vulnerability of Social-Ecological Systems

Drinking water systems can be considered social-ecological systems. A social-ecological system refers to the interactions between users and resources in a common-pool resource system (Ostrom 2007). It can include governance of resource use, maintenance of the resource, and the broader ecological and political-economic systems (McGinnis and Ostrom 2014). For social-ecological systems, stresses that contribute to vulnerability can be anthropogenic or naturally occurring. Examples of stresses include drought, flood, extreme weather events, wildfire, biologic infestations, economic or societal change, war, disease, or other political-economic factors.

For a social-ecological system, vulnerability is the exposure and sensitivity to perturbation and the system's ability to adapt (Adger 2006). Exposure can be thought of as the magnitude, amount, and duration of stresses and sensitivity is how much the social-

ecological system is affected by those stresses. Adaptive capacity is the ability of a system to evolve to accommodate these new stresses (Adger 2006).

A vulnerable system is one that is susceptible to threats, does not have the necessary resilience to withstand those threats, and does not have sufficient capacity to adapt (Elias et al. 2018). Although vulnerability can be thought of as an equation of exposure, sensitivity, and adaptive capacity it also incorporates broader social topics including power, marginalization, and social structure because these all have a large impact on why a system is vulnerable or who is negatively affected (Smit and Wandel 2006). A thorough understanding of a social-ecological system incorporates politics, economics, and sociology, and because of this it is more useful to discuss contextual vulnerability with a human security framing as opposed to outcome vulnerability with a scientific and technical framing (O'Brian et al. 2007). Technical fixes can help decrease vulnerability, but in order to better understand a social-ecological system, an approach should be taken that incorporates aspects of political ecology (Taylor 2013). A society, an ecosystem, or a social-ecological system does not become vulnerable in a vacuum; there are political, economic, and societal forces at play that are causing that system to become vulnerable, and sometimes by making one social-ecological system less vulnerable another one becomes more vulnerable (Mosse 2007).

For community drinking water systems in New Mexico, stresses can include environmental factors such as wildfire, drought, flood, and contamination, but can also include overly burdensome regulation, lack of funding, and failing infrastructure. As I will show, the ability of a water system to address these stresses is highly dependent on its institutional structure and how they interact with governing institutions. I look to see what these stressors are, how people are managing them, who they are affecting, and what it means for rural water systems as a social-ecological system.

Methodology

For my research, I use grounded theory and mixed methods. Grounded theory is defined as, "a general methodology for developing theory that is grounded in data systematically gathered and analyzed. Theory evolves during actual research, and it does this through continuous interplay between analysis and data collection" (Strauss & Corbin 1994). To learn from them what their needs and concerns are, I interviewed 30 managers of rural

drinking water systems across New Mexico. I entered this situation without having a theory of what their situation was. After a number of interviews, I created a theory and then used subsequent interviews to test this theory.

Mixed method research is defined as "an approach to research in the social, behavioral, and health sciences in which the investigator gathers both quantitative (close-ended) and qualitative (open-ended) data, integrates the two and then draws interpretations based on the combined strengths of both sets of data to understand research problems" (Creswell 2014, p. 2). In my research, the qualitative data included the interviews with water managers and also an examination of material published by governing institutions in order to understand their role in water system governance. Quantitative research consisted of an analysis of water system data and demographic data with the goal of testing and further expanding on the theory created during the interview process. Both the qualitative and quantitative data constantly informed the direction of each other.

The interview process consisted of six in-person interviews with water experts from various governing entities and 30 in-person interviews with drinking water system managers across all regions of New Mexico. The 570 community drinking water systems in New Mexico were randomized and those serving more than 5,000 people were eliminated, as less than 5,000 residents is the definition of a small system used by New Mexico Rural Water Association. From the top of the randomized list, our research team emailed and called the administrative contacts for the water systems and then scheduled in-person interviews. In order to get 30 managers to agree to an in-person interview, we went through approximately one-third of the 570 community drinking water systems. This biased our sample to select for managers who were more willing to put time into their water system and were willing to discuss their system with university researchers. Because of this, it is likely that the systems that we visited are doing better than the average rural water system in the state. The administrative contact for different water systems held different positions. The administrative contact was most often the president of the water association board or the public works person in a municipal government. Occasionally, the administrative contact was the water system operator or the accountant, and they usually referred us to someone who was more involved with the system's day-to-day operations. The goal was to interview whoever was most familiar with the system and responsible for meeting state regulations. In

this paper, I simply refer to this person and the "manager," but they may hold different positions. On occasion, our interviews included many people involved with the water system, such as the board president, other board members, operators, or accountants.

The interviews were transcribed and then coded into themes using the qualitative research software NVivo 12. Themes included topics such as concerns that the interviewee may have, their interactions with different governing agencies, and their opinion on regionalization. Coding the interviews into themes allowed me to see, for example, how many interviewees discussed finances as an issue. It helped me easily compare different answers to the same question, such as "If you had a magic wand, what would you change about how the system is managed?" This tool also allowed me to draw connections from certain issues to other variables, such as the institutional structure of that water system.

The interview findings informed me which governing institutions warranted further research. I examined documents and other material published by state regulatory agencies and NGOs to better understand their role and also to compare the perspectives of the interviewed managers to how the agencies viewed themselves.

The interviews also told me what spatial data were likely to be relevant. Community drinking water system data was obtained from the Drinking Water Watch database through the New Mexico Environment Department (NMED) (https://dww.water.net.env.nm.gov/NMDWW/). To get the data in a more usable format, we submitted a public records request. The institutional structure of water systems was found through the New Mexico Secretary of State's website (https://portal.sos.state.nm.us/BFS/online/CorporationBusinessSearch). Data for drinking water rates was obtained from the NMED website (https://www.env.nm.gov/drinking_water/rates/). Demographic data was obtained from the US Census American Community Survey 5-year average from 2012 to 2017. Supplemental mapping data was acquired from New Mexico Resource Geographic Information (https://rgis.unm.edu/). All spatial data was analyzed using ArcMap GIS 10.6.

Results

The interview questions were organized into four main sections, which include general information about the water system, how the water system is managed, their needs and concerns, and possible solutions. The interviews were semi-structured, with the goal of letting the interviewee describe their situations without being influenced by our thoughts or what they thought we wanted to hear. The water system managers we interviewed managed a wide range of water systems, including variation in how big their system was, how old it was, and where they get their source water from. They were also managed in different ways, such as being organized as different institutional structures and what role different people have in running the system. For their needs and concerns, the interviews revealed six main themes:

- Lack of personnel and engaged citizens
- Deteriorating infrastructure
- Lack of funds and difficulty receiving outside funding
- Overly burdensome and confusing regulation
- Environmental concerns, including drought, wildfire, and contamination
- Concerns of having enough water rights or losing water rights

For solutions to these concerns, managers had different opinions on what would help them, and all of them had an opinion on regionalization and if it would help them or if it was an additional concern.

Personnel and engaged citizens

One of the issues that came up most often during our interviews was that water system managers were struggling to get residents involved in managing and operating their system. This was generally the case for MDWCAs and other institutional structures with a volunteer board. There are many reasons for residents not wanting to be on the board, including the amount of effort required, not getting paid, taking on the responsibility, not having knowledge of water systems, and having to interact with upset water users. Small communities also simply had a small pool of people available to manage their water system.

Board members are all volunteer, so people must take on the responsibility with no financial compensation. Because it is volunteer, people either manage a water system on top of another job or they are retired. There were a substantial number of interviewees who were happy managing their water systems, but many expressed that they did not want to do it and were just managing it because they thought no one else would. As one interviewee stated,

- Imagine you living, having to provide for your family, just living, and then going and having to do research about water, and how you get water, and what is this, and what is that, and how to do this, and how to do that. I mean, imagine that. That's total burnout. You're totally done by the time... after a year. Or people think, "Oh, cool. I'm going to be a board member. I'm going to tell people. I'm going to make sure things are done right, and we're going to do this, and we're going to do that." Then reality hits and you're like, "Screw this. I don't even make a dollar for all this stress, all this pressure." It's weighing on individuals.

Another manager expressed a similar concern regarding state regulations and said,

- Yeah and imagine if you're a board member and you have a full-time job and you're trying to get these questions answered, it's just not going to happen. So, navigating through all of that, that's the key. Navigating, if you can navigate and you're persistent you can, you can find your way. But the average volunteer, it’s asking a lot.

Many of the managers interviewed were even quite bitter that they were the ones stuck with running the system. As described by one manager,

- We redid our bylaws and went to a five-member board. At that point I was the one stupid enough in the room to stick my hand up and say, "Sure, I'll be president." I've offered to resign at every annual meeting, and nobody will let me.

Another manager said,

- And no good deed goes unpunished, my friend. Let me tell you. In this type of business, it does not. It's difficult to deal with that because sometimes, you just want to say, "Well, everybody go to hell. I'm doing this for free," because you gain nothing, but making sure your water turns on, your toilet flushes, and that your trash

> is thrown beyond that. It's quality of life. And so, other than that, you get nothing, but you get all the responsibility.

When asked if they think there is this particular type of person in rural New Mexico who becomes a drinking water system manager, some responded with, “No, nobody wants to do it” and “Those dumb enough to stick up their hand and volunteer. All the rural systems are all volunteer jobs, so it's people that are just caring enough that are willing to spend some time doing it.”

Most water systems are required to have elections for board members, but many expressed that they didn’t have enough people to run. A couple managers stated that they unknowingly got elected to the board and said that if you don’t want to be officially on the board, you better start showing up to the meeting and get involved voluntarily. Other managers stated, “[we] had elections, and nobody showed up. Nobody registered and then nobody showed up to run or to vote because there's nobody to vote for.” “It was a sham because nobody was running and nobody voted, but whatever, we met the requirement.” People are thinking of creative ways to incentivize people to come to their meetings. Sometimes this is to try to get people to come so they can persuade them to become board members, but often, systems just need to have a quorum of water system members to vote on issues like changes to water rates or by-laws. People bring baked goods, offer water bill discounts to people who come, and one manager even signaled they were going to raise rates, just so people would show up to complain, even though they were not actually planning on raise rates.

The reasons why residents were not involved in managing the water systems varied by community. Many small towns in New Mexico that are in scenic locations or close to recreation sites have seasonal residents. They had a hard time finding engaged people who were around all year. Other small communities have a problem with young residents moving away to larger towns or they complain the young people that are there are too busy.

Many of the people managing and operating water systems are older. There were three main reasons for this. One is that for some people, the water system is their baby and they don’t want to let other people run it, so they run it for decades. Second, people who have time to run water systems are generally retired. Third, people are put in a management position and feel like they can’t leave because no one else will take it over. Many people joked about how

they are going to be doing it until they die. When asked how long they see themselves running the water system, one manager said, “Probably until I die. Because nobody else wants it.” Another manager said, “Essentially it’s a lifetime position because nobody else wants it. Truth is, we don’t want it either.”

There is also a lack of certified operators in rural areas and many of the ones that do exist are elderly. A manager described this situation by saying,

- Finding a good quality operator is extremely difficult. The guy we have is great, but he’s pretty long in the tooth. He's almost 80 years old. Does he want to be climbing around, digging around out in the rain? No. Where do we find a new one?

Another manager said, “So, when we had those leaks, we had 70 and 80-year-old men out there digging ditches in the middle of winter, middle of summer, whatever.”

Finding an operator is difficult and often times they live in distant towns. Some managers described situations where they would essentially do everything and then the certified operator would come and do something like tighten the last bolt.

Many managers complained that by being a board member you also have to deal with upset residents and neighbors. Broken water mains are a big issue and when that happens, many people don’t have water in their homes and are upset with the manager until it gets fixed. Residents also get upset when water rates are raised. Many systems have problems with people not paying their water bill. When this happens, managers are faced with deciding whether to just let it go or to turn water off to someone’s house. Many of these places are tight-knit communities, so you may end up turning water off for to your neighbor or family member, or you turn off water to someone else’s family member and then they get upset with you. As one manager described, if you decide not to turn off water, you have no way to force people to pay their water bills. They said,

- People are getting free water because water boards are afraid to go and shut off water. There's no system to shut off and warn people that hey, if you don't pay. Can you imagine living in a small community with three or four hundred people and you shut off your uncle's water or here you know your grandmother's water. And so you're dealing with that and that's a problem.

To state how this is affecting board member retention, one manager said, “The water board members get burnt out, and then there's no one else who wants to serve on the board because they've been abused for so long.”

Infrastructure

Along with water systems all over the US, most water systems in New Mexico have been around for a long time and some of their infrastructure is starting to fail. The biggest infrastructure issue for rural water systems in New Mexico is leaky pipes and water main breaks. Most pipes have been in the ground for many years and are starting to deteriorate. This results in more water main breaks where people are without water and managers and operators have to go find and fix the break, but perhaps more importantly leaky pipes result in water loss from the system. Not only is this wasteful, it drastically increases the water use of the system, the cost of pumping water, and the wear and tear on equipment, especially pumps. Some interviewed manager’s systems were losing around half of their water they were producing out of their leaking pipes. Another manager said that for their three well systems, one well was essentially dedicated to adding the amount of water to the system that they were losing. Deteriorating pipes were the main infrastructure concern for managers, but they also were facing aging wells, pumps, storage tanks, meters, and computer systems.

Funding

Deteriorating infrastructure would likely not be as big of an issue for water systems if they were able to receive sufficient infrastructure funding. However, there are many different funding streams available to water systems. According the Environmental Finance Center Network (2019) there are 34 different funding streams available, although different sources are only available to certain systems based on the size of the system and the institutional structure. It does not appear that there is a lack of dollars meant to go to water systems; instead it seems that managers don’t know how to access them or there are too many hurdles to jump to get them.

The issue of not knowing what funds are available is an issue for many reasons; one of which is that there are so many other tasks, such as complying with regulations or working a full-time job. This makes it so people don’t have the time to devote to investigating all the different funding mechanisms available for their institutional structure or population.

Another reason is that institutional structures are opaque. Usually, everyone is on the same page, but occasionally the manager thinks they are one structure, the state thinks there are another one, and their article of incorporation may be another. Additionally, different people call the same institutional structure different names, or they say they are an institutional structure that does not technically exist.

Even if managers do know what funds to apply for, there are barriers in getting them. First, water systems that are subdivisions of the state government, such as MDWCAs and WSDs, are required to be up to date with their financial audits if they want to receive any state funds. They are required to be audited regardless of requesting funding, but from talking to managers, it appears that withholding funding is a way for the state to enforce that requirement. It is understandable that the state wants water systems that receive state funds to financially responsible, but it is an additional barrier and cost for them.

For water systems to receive some sources of infrastructure funding, they must first have a preliminary engineering report. One manager described the government being an obstacle in them getting a grant by saying,

- In a way it is an issue because they're getting in the way. When the government gets in the way it's a problem. To be able to replace that well, we have to get an engineering assessment. We have to get it assessed by an engineer. That's going to cost about $30,000 to do what I already know we need to be done. It's a needless cost on a small water system. If you want a grant you have to get an engineering assessment on your entire system. That's probably about $50,000, if you want a grant. If I want a grant and you're making me pay $50,000 just to apply to get a grant there's no guarantees. Why should I do that?

Another manager said, “So now, not only do you have the cost of refurbishing it, now, you have the cost of an engineer... Or even legal fees they require... Nothing's easy.”

One system we visited had so many problems with water quality regulations that they just assumed they were in violation and constantly told customers that they were under a boil water notice. They would receive priority funding if residents are in danger of acute and serious health violations, but apparently their violations are not serious enough. They

couldn't afford the treatment to get them out of violation, so they felt they were stuck. They claimed that there were many systems in this same situation.

Because many water systems are deteriorating and funding is difficult to obtain, many systems are patching their water systems with "infrastructure bandages." Many systems need to replace all of their piping, but they don't have the funds to do it, so they keep patching pipes and putting small fixes on things. As one manager described, making old infrastructure work can cost more money and said,

- I'll tell you, we had a booster pump go down. One of my colleagues takes [it] in, they're taking [it] in [on] their own dime, you know, gas, and you know, all the way to Albuquerque. Or when I'm doing stuff, I'm doing it on my own. It's costing money.

Another manager described the extra effort that it takes when systems aren't working properly by saying,

- We were having problems with our pumps and our pump house, actually, the electrical breaker. Literally, I had to be there at night, waking up two, three times at night to go and turn on the pumps manually so that in the morning when every single individual gets up and takes a shower to go to work, there would be water, and that is the responsibility of a board member. It's tough. It's really, really tough.

Regulations

Another issue that came up frequently during the interviews was that regulations were too difficult to comply with. The number of state government regulatory requirements varies by system institutional structure, number of connections, and revenue, but there is a minimum of seven and a maximum of eleven reporting requirements (New Mexico Environment Department, Tools & Resources for Public Water Systems). These include water quality monitoring, Consumer Confidence Reports, water use, taxation, water conservation, Open Meetings Act, financial audit reporting, annual budget reporting, quarterly budget reporting, corporate entity reporting, and underground utility reporting. All these reports are administered by eight different state agencies and are due with different frequencies during different times of the year.

On top of these regulations, water systems have their own regulations dictated by their system by-laws. What these are depends on the institutional structure of the water system, but for MDWCAs, they must have regular meetings, have a quorum to make decisions, have multiple and an odd number of board members, and hold board elections in November, which was a new regulation that most managers did not appear to know. Additionally, all community drinking water systems are required to have a certified operator. There are different levels of certification based on the number of system connections, but operators must take an exam to initially be certified and then must keep up on continuing education credits from workshops or other trainings.

Meeting all of these requirements seems to be much more of a challenge for smaller water systems that larger ones because they are managed by volunteers and the smaller a community is, the smaller the pool of people who may be willing to put in the time and effort in satisfying these requirements. People in small communities clearly described this situation by saying,

- We need the State people to consider this smaller rural community as far as we still need to follow the regulations in order to provide safe water to our customers. But some of the things that they are requiring small systems to fulfill, they have us at the same level as the big municipalities. And it creates a hardship for us because we don't have the income. And most importantly, we don't have the people. We just don't have the people.
- Back in the day it was pretty lax. So we're just trying to keep up with all the regulations and stay in good standing with everything so we can continue moving forward. It's almost a full-time job.

Keeping up with the regulations and paperwork requires a different skillset than general day-to-day operations of a water system. It requires that people have a level of understanding of how government and reporting works. Many of the managers we interviewed were people who had a background in related fields and expressed that they didn’t understand how other water systems could stay up on it, including one that said,

- You get a small board of normal Joe people. I don't know how they do it. I don't know how they keep track of the regulations and what they can do, and what they can't do. I honestly don't know how they do it. I can't imagine they're in compliance.

Many managers complained that regulations were placed upon them, but they aren't given the resources to meet them. This may be through what some called "unfunded mandates," which are regulations the state and federal governments create, but do not give water systems money to comply with them. Others complained that the state will not tell them what they need to do to fix their situation and get in compliance. A manager described their relationship with state regulators and said,

- To talk to us about what we're doing wrong. I would love to hear less about what I'm doing wrong and how I can solve the problem. Because that seems to be what the state is really good at, is, "You're doing this wrong." "Well, how can I solve it?" "Oh, I'm not allowed to tell you that. I can't give you ideas on how to fix it because if I tell you one thing, it sounds like I'm favoring something." And it's like, really just between us, you can tell me. I'm not going to tell them. I just want to fix this so that you're not out here all the time, and I'm not hearing from you every two, three months.

In general, offering assistance is not the role of state government agencies, but the state government is the main entity that water systems interact with, so managers are often times looking to them for assistance. Water system managers want to be in compliance and provide safe drinking water, but many don't have the ability to do it, and the state is not helping them get there. Another manager said,

- Just, you know, whether filing paperwork or certain things and it's like you can give me a paper and what good if I don't understand it. I'm asking you for help. And then, I don't know, I just had two board members tell me they've been on there... We've all been on here about... Oh maybe just over half a year. And somebody said, "Oh, I can't wait until January. I'm not dealing with this anymore."

With so many regulations and requirements to keep up on, many managers don't even know what they are missing. When asked if they were having difficulty with regulations, one

manager said, “Not particularly. I mean, we're complying with every rule that we know of. I'm sure there's a bunch we don't know about, but no, that's not the issue.”

One of the biggest themes that managers spoke of when it comes to regulation is that running a water system used to be about providing the actual water, but now it has turned more into a desk job because of all the paperwork. One water manager said, “I used to be about 70% outside, now I'm about 80% inside. So I'm doing a lot of paperwork and that's not really what I like to do, I like to be outside.” Many managers expressed that providing water to residents wasn’t the challenge in managing a system, it was staying up to date and compliant on all the regulations.

In general, water system managers were not arguing that there should not be regulations, they would just like them to be easier to comply with. One interviewee stated,

- And in addition to having to report and provide all the documents and meet all the other requirements, EPA requirements, and they should happen. I mean you should test your water, you should make sure it's safe. You should be accountable for the revenue that comes in and goes out and answer to the state, for that you should. You should have oversight.

Rural communities want water that is as high of quality and regulated just like larger towns, they just don’t have the resources that larger towns have to comply with all the testing.

Environmental concerns

Before starting this research, I believed that one of the biggest issues that managers were facing were environmental concerns, such as drought, fire, and floods. This turned out to not be the case, not because these are not issues, but because they seem to be faced with so many other tasks that they are not thinking about these issues. Water systems have so many “today problems” that they are not thinking as much about environmental concerns, because those tend to be “tomorrow problems.” Unfortunately, natural disasters can strike abruptly, and then environmental issues are no longer “tomorrow problems.”

Many managers said that they were not concerned about wildfire because they believed that there was not enough vegetation around them to burn. At times this claim surprised us, but it would take another study to determine an objective fire risk compared to what water

managers' perceptions of fire risk was. System managers who have had wildfire impact their source water were among the only ones who said it was a major concern. However, when asked if they would have said it was a risk before the fire occurred, they said they probably would have said they were not concerned about fire. When wildfire was mentioned, many more managers brought up the concern of having enough water in their systems to fight fires. They discussed not having enough pressure, and many talked about how the diameter of their water pipes didn't allow them to have fire hydrants.

Only a couple systems claimed that flooding was a risk for their water system, but surprisingly, quite a few systems cited lightning as an environmental issue. Lightning would strike their tank or wellhouse and destroy the electronics. This would make the tanks not realize they were low, or make the well pump not run.

The majority of the managers interviewed said that drought was a concern, but they had very different perceptions about why it was an issue. Many dismissed it because they believed New Mexico is a dry state and therefore it is always in a drought. Others had concerns with how decreased rain and snow would affect their source water. Many managers were more concerned about drought because of what it meant from a community relations standpoint. As discussed earlier, maintaining a good relationship with water consumers can always be a challenge. When there is a drought, this relationship becomes much more tense. One interviewee described this situation by saying,

- That's always a concern because it increases the demand for water and people tend to steal water from their neighbors, from fire hydrants. And from a customer service perspective they might accidentally leave their water hose on and say they didn't and things like that, and that we might be lying about their meter readings. So, when you see high drought and people using more water, then they're having to pay more for it because they use more, they really take it out on the customer service people. "I didn't use that much, you're lying, I sent my money you must have spent it." People can get very very angry and threatened to kill you. Things like that can be really bad for you. Oh yeah. Oh yeah. Really nasty. And call over and over and over and over again. Harass you, so I hate drought. I hate it for that reason because it really sets people on edge. And it's a trickledown effect. Yeah. And so you lose a lot of people. A lot of

people who used to do this in their communities say no more because you can't even go to the store because you're being harassed.

A few managers who ran systems with shallow wells were concerned with contamination from septic tanks, although they never brought this up as a main concern. A few managers brought up issues of water quality in regard to levels of arsenic, uranium, manganese, and iron. Some complained how expensive it was to treat, but others talked about how people have been drinking that water for their whole life and wonder why it is unsafe now. One interviewee said,

- Like I said, I've drunk this water all my life and I'm still healthy. I'm 78 years old. It's not hurting me because the amounts are so minute. When you fail, it's just like I said, a 0.01 and they'll make you fail parts per million. We don't have any babies that are sick or nothing that we know.

Source water protection plans are currently being promoted by the state government and NGOs. They are not required by any regulation, but they are supposed to help communities identify and mitigate possible sources of contamination. Even though they are being promoted, most interviewees did not know what they were. A couple had them and were very dedicated to following them, but others confused them with other programs, such as sanitary surveys. Overall, environmental concerns seem to be more of a topic of concern for state officials and NGOs than the people who are managing the water systems.

Water rights

Water rights are a hot topic in New Mexico and all across the western US. Water rights were a concern for most water systems, but they were rarely a top issue. The one interviewee who did list water rights as a top concern said, “That has always been my concern, losing our water rights to somebody else. That's one of my big concerns…We're very lucky we have good water, good and safe drinking water, and we are the envy of the State probably.” Many rural communities are very old, and some towns used to have higher populations, so they have plenty of water rights that are quite senior in the prior appropriation system. Newer communities or subdivisions generally did not have as many, or as senior, water rights and for them it was more of a concern.

One interesting aspect of water rights for drinking water systems is the idea of *beneficial use*. This is the idea that in order to keep your right to use water, you must use it for something beneficial. Communities that have more water rights than they use do not want to lose them, so they sometimes promote things like gardens so people will use more water. However, this is a catch-22 because they also want to conserve water, so they do not deplete their aquifer, or wherever they are getting their water from. There is not a direct relation of water availability and water rights, so in order to prove more beneficial use, some communities are choosing to use more water rather than conserve it. Increased water use has other negative effects, including increased wear and tear on pumps and other equipment.

All community water systems are supposed to have a 40-year water development plan for the Office of the State Engineer. Some communities are trying to argue that they might grow and add connections to their water system, so they need to keep all their water rights. Many communities think that the state was looking to take their water rights in order to meet New Mexico's water delivery obligations to Texas. The topic of water rights came up often in the context of regionalization.

Discussion

As discussed, drinking water system managers are facing many challenges and have differing opinions on what the solutions to these challenges are. The issues they face may seem separate, but they are related to each other in many ways. The most explicit example of this is that communities are struggling to get people to run their water systems because there are so many challenges that they face. The managers are faced with complying with confusing and burdensome regulations involving environmental and water quality issues as well as financial reports and audits. They also are the ones who deal with maintaining old infrastructure or trying to receive finding to replace infrastructure. They are also concerned about their water rights. It appears that because managers have to navigate so many challenges, they are hardly thinking about environmental threats. This only seems to change when there is an emergency and a fire decimates a watershed, a flood takes out a well or pipes, or a well runs dry during a drought. These are concerns that the state and NGOs are thinking about, but most managers of small rural water systems do not have the time or resources to be proactive with these threats. However, many water systems in New Mexico

have not been fortunate in having environmental concerns continue to be “tomorrow problems.”

The water systems that this situation seems to be the most problematic for are MDWCAs. They are among the smallest water systems, so they have the smallest pool to draw managers from, they have among the least amount of money because of the small amount of rate payers, and they are managed by volunteers. Some systems are managed very well, and people described them as “gems,” but for many others, this is not the case. People are dedicated, but they mostly do not have the time or knowledge to adequately run their system and keep up on all the paperwork. One manager described their situation as,

- Well, considering I am by no means any kind of an expert on these matters. They needed somebody to sign checks some time ago, and so I said, "Well, I guess I could do that," and I got in the water board, so I became the chairman. And like the president and some other institutions in our world, I don't know anything.

Water boards for MDWCAs might do better if members delegated tasks, but as one interviewee said, “most of the time, in the boards, you maybe have three to five members in these small systems, but you only have one person that does everything.” This lack of human resources contributes to the vulnerability of this social-ecological system.

Water system managers are tasked with many natural problems such as deteriorating infrastructure and environmental concerns, but the larger issues seem to be “constructed problems.” Issues such as navigating bureaucracy and not having people to manage systems because they are not paid, are not necessarily inherent in the interactions between the ecosystem service of providing the resource and the users of that resource. These problems have been constructed by governing institutions. The environmental regulations, financial regulations, and funding sources are not in themselves problematic, but the issue is that communities don’t have the resources to navigate the confusing nature of them. To be clear, most managers were not arguing for decreased or no regulation, they would just like it to be easier to comply with. This could be done by streamlining and consolidating the processes and reporting requirements, or it could be done by giving small water systems more resources.

These constructed issues, as well as more tangible issues of deteriorating infrastructure and environmental threats are contributing to the vulnerability of rural drinking water systems in New Mexico. Water system managers are not able to adequately address these longer-term issues because they are spending so much effort on the constructed issues. The state and federal governments have power over drinking water systems, and they see water quality and financial fraud as big issues. Water system managers agree that these are issues, but for them, they are not as big of issues as the issues that the state created by try to solve them. Water system managers only have so much capacity and requiring them to put in more effort into the issues the state believes are important, makes it so they are putting less time into other issues that could be more important from other perspectives. The government is creating vulnerability by having managers spend time on issues they believe to be important, which then take attention away from longer-term issues that can have significant negative impacts down the road. However, the government does not want to have less strict regulations for rural communities than urban ones, as that would create inequities and environmental justice issues.

Not having enough people to run water systems decreases their capacity to adapt to stresses that may be caused by deteriorating infrastructure or the environment. The state government and other organizations are promoting the idea of regionalization as a way to increase adaptive capacity. Regionalization may refer to neighboring water systems physically connecting their pipes, or it can refer to increased cooperation or sharing of resources. By doing this, they are trying to make rural water system more like urban ones, which decreases the differences in abilities to satisfy regulatory burdens. Officially, regionalization is being promoted for *capacity development,* which is the idea that water systems develop adequate technical, managerial, and financial capacity to maintain their systems (EPA. Building the Capacity of Drinking Water Systems). By consolidating resources and achieving economies of scale, systems are better able to sustain their operation.

Drinking water system managers usually had strong opinions, either positive or negative, about regionalization. All of the interviewees who expressed positive sentiment about regionalization did have some reservations, but they thought aspects of regionalization could be very positive for their community. One interviewee described the dynamics of small rural communities by saying,

- The young people leave. They come to Albuquerque, Las Cruces, or they leave the state. And so, what we see happening with the rural communities are smaller or older people who live there on a very fixed income, so you don't have a lot of people to pay to replace the capital to replace pumps and drill wells. You don't have a lot of people who understand, who can navigate through the financial part of managing a system or reporting to the state.

This interviewee brought up many of the same points that the state brings up when they are promoting regionalization. Another interviewee described that if the state set up a regional office it could create employment opportunities by saying,

- And the other point that I think that would be positive one, regionalization, you'd probably employ three or four people, a water operator, an accountant, that could go around and check each and every well house and the upkeep of it. So, it would actually create full time employment, which, in this area, most people commute out. There's not a lot of employment here.

Another reason why they thought it could be beneficial is because of the amount of responsibility that they have, and they would really like the state or some other entity to take on some of that responsibility. However, people may want to give the state more responsibility, but they don't want to give them control. Expressing their skepticism, one interviewee stated,

- I think, like I said before, I think I will love their help, but not as a regional. I would love for them to come and say, "What do people need? How can we help you?" But not say "You're going to have to join my club and we're going to make the rules, and you're going to follow my rules. And if you're not, you're out of the system." No, I don't want that. We all... We've got our own rules, but we do need their help, monetary, maybe even designing, they got designs, they got everything. Lawyers, those things we can use from them, but as for us to become one region. No, I'll never... Not on my watch. I will protest it. Really, I will protest.

Almost all interviewees expressed the importance of having local control of their water system. One reason for this was having good community relations. One interviewee described this by giving the example of, "'Oh my God, grandma left her water on, what can

we do?' I can solve that problem in three minutes. Could you imagine trying to solve that if it had to go to some other mechanism?" Having local control is also important because of the need of having intimate knowledge of how a system runs. When discussing regional management, one interviewee said, "I don't know how they could do that. There's a lot of little different systems, but they all have different situations. It's not like buying a pair of socks where one-size-fits-all. It doesn't work that way."

One of the biggest reasons why people are hesitant to regionalize is because of trust and independence. They were skeptical of the state government and trusting neighboring communities if they took on more of a role. A lot of the skepticism was due to water rights and financials with either the state or a neighboring community trying to take water rights or using them to subsidize their customers or pay off a loan. For many communities, water is cultural, and it is important for them to manage their water system because of what that means to their community. One manager expressed their opinion of the government by saying,

- I don't want that to happen at all because every time the government steps in and does something they make it expensive, inefficient, and unreliable. I don't necessarily want to give up all my power. I just want to give up the responsibility and work.

Although the state is trying to promote regionalization as a formal agreement, many water systems are already informally regionalized. They may share parts, ask for help from other managers and operators, and receive new information and ideas from each other. An interviewee described this by saying,

- We have relied on them. We had a deal here where we lost our operator and had to call another system and they came in before we had this operator that we have now. I had to call him in to help us out and he did. They were very good people. They didn't want anything from us in payment or anything like that. They just came to help.

Another interviewee said, "That's what's nice about being small communities, we still help out each other." When discussing the manager of a neighboring system, one interviewee said, "Without that leadership, guidance, and experience we'd be hosed. Having to figure it out for yourself and cover all your bases? I can't imagine."

Because water system managers are facing so many challenges, they seem to be turning to their neighbors for assistance. This may have always happened, but currently, the conditions seem right for neighboring communities to self-organize into informal regional operations that may simply share knowledge or even share parts, labor, and water.

By formally consolidating resources and increasing the rate base, state agencies and some NGOs believe that systems will decrease their sensitivity to perturbations and increase their adaptive capacity. It is my view that regionalization is a tool that can be helpful in some situations, but I believe it should not be pursued as a blanket policy for all water systems. By doing this, other important aspects of vulnerability are being ignored, including what local control of water means to communities, how communities view their sovereignty and state control, the histories of community's relationship with the government and other communities, and the socioeconomic status of the communities that may be most vulnerable. The managers who said they were open to regionalization were also the ones who said residents don't think about water after they turn off the tap. Managers who were against regionalization generally said that their community highly values water and people do think about it, even when they turn off the tap.

The water systems that seem to be the most vulnerable are MDWCAs. They are among the smallest and are subjected to as much regulation as larger municipalities. Generally, they are in communities that have low median household income and communities that are predominantly Hispanic. Because of this, the vulnerability of rural drinking water systems in New Mexico is a social justice issue. Because they have less wealthy residents and have challenges receiving funding, they are the systems that seem to be applying more "infrastructure bandages" on their aging water systems. When describing what new infrastructure would mean to a community, an interviewee said,

- That means less electricity, less the pumps would wear out as fast, less maintenance bills. I remember hearing something years ago that it costs a lot of money to be poor. And you know it really does. And I really feel that's what how it is for this, for a lot of rural communities. You know their water systems, even their water systems. So that's what worries me. That's what keeps me up at night.

Water quality regulations are positive for public health, and financial regulations and auditing are positive due to the improved fiscal responsibility and decreased embezzlement, but how these regulations are administered is a problem. Because policies and excessive bureaucracy are making rural drinking water systems more vulnerable, who is drinking water governance really for? Instead of government agencies serving and promoting the existence rural drinking water systems, the situation has flipped so that water systems seem to be serving and promoting the existence of governing institutions.

However, there is no single entity that is at fault for this situation. I do not want to sound necessarily anti-government and do not think the New Mexico state government is at fault for this situation. The institutional structure of MDWCAs was created in 1947 to give state resources to rural and poor communities to improve their drinking water infrastructure in order to promote community health (Clark 1987). This situation may have originally been successful, but the problem seems to be that throughout the years, so much regulation has been placed on these water systems from institutions at the state and federal level that they are no longer able to satisfy them, and for all the reasons discussed, are starting to fail.

Among managers and state officials, there is the general sentiment that some small rural water systems are starting to fail. However, they may fail in terms of meeting requirements and regulations, but I believe they are likely going to continue providing water for their communities. Many of the water system run by the interviewed managers had recent violations, with some of them having many violations. Even though these water systems were in violation, they were still delivering water to their residents that they claimed was safe and of high quality. Most of the violations listed on NMED's Drinking Water Watch database for the water systems we interviewed are minor violations relating to missed test or reporting deficiencies that do not necessarily jeopardize people's health. For all water systems, Administrative Compliance Orders and violations for community water systems sometimes include a water quality violation, but most of the violations are related to missing water quality tests, not notifying the public of missed tests, or not distributing Consumer Confidence Reports (CCRs) to residents (New Mexico Environment Department, Enforcement Actions). Although these requirements are important, it does not necessarily mean that water systems are not delivering safe water.

A community and its residents need water to survive, so people will go to great lengths to provide water. Although they are getting burnt out, mangers are very dedicated to their communities. One manager said, “It's kind of like we're doing this for our community, for the good of the community and what's the point? Nobody wants to participate.” Other managers said the reason they did it is because no one else would, so they were the ones to step up to the plate. Although some systems really do not have anyone to run them, it seems like for most of them someone will make sure that residents receive drinking water. As one manager said,

- But it is people from the community kind of rising to the occasion, to the need. Then it's like, "Okay, we've got to have water if we're going to be here, we've got to have water." And somehow decade by decade we've managed to do it. It's funny, I mean, I kind of see myself as like in a line of people, going back further than I know and hopefully going on into the future. We've got issues we've got to solve, but there's been enough community spirit to sustain it so far.

Chapter 1 Conclusion

The majority of the 570 community drinking water systems in New Mexico are small and rural. Because there is a trend of drinking water systems across the US not performing well, especially in small rural communities and in the Southwest US (Allaire et al. 2018), it is important to see what challenges the actual managers of rural drinking water systems in New Mexico are faced with. To do this, our research team interviewed managers of rural drinking water systems all across New Mexico. We found six main concerns, which were lack of personnel and engaged citizens, deteriorating infrastructure, lack of funds and difficulty receiving outside funding, overly burdensome and confusing regulation, environmental concerns, including drought, wildfire, and contamination, and concerns of having enough water rights or losing water rights. Water system managers were doing a wide variety of things to counter these threats, including informally collaborating with neighboring communities. We found that although many of these issues seem to be separate, they are very much related. The biggest example of this is how small communities are struggling to find people to run their water systems. This is largely because the people who are running them have to deal with all the other issues, and most of the time they are volunteers.

Although some of the problems that water managers are facing are more tangible, such as aging infrastructure and environmental concerns, many of their problems are constructed. These constructed problems include overly burdensome regulations, difficulties receiving funding, and concerns over water rights, which all then in turn contribute to the problem of not having enough people to run the water system. The federal government, through the *Safe Drinking Water Act* which is enforced by the state of New Mexico, has decided that water quality is a big issue and the state government has decided financial fraud is a big issue, and because of these issues they created regulation to address them. Because governments have more power than drinking water systems, they have more of a say in what are and are not issues from a regulatory standpoint. Our interviews show that water system managers generally do not think they are as big of issues as the issues that were created by the regulatory burden, at least for water systems of their size. Because managers are spending so much effort on satisfying their regulatory requirements, they are spending less effort dealing with other problems, specifically aging infrastructure and environmental threats. Through this process, the state regulating agencies are creating vulnerability for small and rural drinking water systems. Vulnerability is increased by making systems more exposed to infrastructure or environment related disturbances. It is also increased by water system's decreased adaptive capacity caused by there being less people willing to be involved in running the system. This lack of people being involved is a problem created by the huge amount of work it is to manage a water system, which is partially due to the regulatory burden and difficulty in navigating bureaucracy.

If governing agencies are increasing the vulnerability of rural drinking water systems, then what is their function? They do serve an important role, but the execution of their policies seems to be in a way that is not actually advantageous for small communities or their drinking water systems. The reason for this is not due to there not being a need for regulation or that the state agencies are doing a poor job; rather, it is because institutional structures that may have once been successful are now outdated. This situation makes it so instead of state agencies working to promote the existence of rural drinking water systems, rural drinking water systems are now working to maintain the existence of state agencies. This situation is not beneficial for small rural communities, and the ones that seem to be affecting the most are lower income and predominantly Hispanic communities.

However, as I argued, communities are likely to continue to deliver water to their residents. And although it might not be tested, it will largely be the same water that they have been delivering for years. Many managers believed that something is going to have to change soon, which possibly means their systems looking more like larger urban systems. When discussing either giving water systems more resources or having the state take over their system, one manger said:

- So I believe that's going to happen at some point. I think it's inevitable. I might not be around to see it, but I just don't see any other way unless they can provide the resources to hire people that are qualified to stay on top of all this stuff. So in a sense, it's the same thing.

In the end many managers thought that either the state is going to have to give them more resources, they are going to have to take over the system, or systems will no longer be able to be in compliance with regulations. There is irony in that increased bureaucracy and regulations may in fact make systems more vulnerable and less likely to succeed in satisfying regulations.

Chapter 2

Shifting of power dynamics through institutional work

Chapter 2 Introduction

Like many water systems across the United States, rural drinking water systems in New Mexico face numerous challenges in delivering safe drinking water to households. These challenges can include water quantity, water quality, finance, regulation, and public relations. These issues can be greater in rural areas than in urban settings for numerous reasons, including access to resources, expertise, and capital (Mosheim & Ribaudo 2017). Resources available for water systems are largely determined by institutions. Institutions are defined as rules and norms and determine who holds decision making power (North 1991; Ostrom 1990). In this case, this includes the higher up governing institutions such as the state government and non-governmental organization (NGOs), and includes the institutional structures of the water systems themselves, such as cooperatives, privately owned systems, or Mutual Domestic Water Consumers Associations.

Government agencies and NGOs play a large role in how water systems are managed in New Mexico. Different government and NGO institutions have different functions and relationships with rural drinking water systems. What are these institutions and how do they shape the communities and water systems that they serve?

The institutional structures of drinking water systems themselves also have a large role in how systems navigate different challenges. What are the circumstances that have influenced why a community chose a specific institutional structure for their drinking water system? How does the institutional structure of a community drinking water system influence its ability to meet its goals?

As I will show, community water systems chose their institutional structures based on population, income, and possibly other unknown factors. The institutional structure of a water system has a substantial impact on the ability of a community to meet its water-related goals because it dictates what rules they must follow, what resources are available to them, and how much regulation they must comply with. I found that water systems with the

institutional structure of Mutual Domestic Water Consumers Association (MDWCA) seem to be having the most challenges because they are among the smallest communities but have the same regulatory burden as larger municipalities. They are not able to pay board members, so the people managing the systems are volunteers and take on a significant amount of work and responsibility. Because MDWCAs are typically in lower income and predominantly Hispanic communities, the institutional structure of MDWCA is racially discriminatory. Through overly burdensome and confusing regulation, governing state institutions are creating challenging hurdles for MDWCAs and because of this it seems that instead of state governing institutions serving for the existence of drinking water systems, water systems, especially MDWCAs, are serving for the existence of the governing institutions.

To argue this point, I use the theoretical lens of institutional work, which is the idea that all purposive activity happening around an institution is either creating, maintaining, or disrupting that institution (Lawrence, Suddaby, and Leca 2009). The institutional structure of MDWCA was created in 1947 to help rural New Mexico communities improve drinking water systems to promote public health (Clark 1987). After this institution was created, purposive work has been consistently acted upon it through increased regulatory requirements, increased number of water systems under this structure, and more state governing institutions becoming involved. Actions that seem tangential and benign to the institution of MDWCA, such as water quality regulations, have had significant impacts to how MDWCAs function. This institutional work has gradually shifted the power balance away from rural water system and to the state government. Even though the legal statute for MDWCAs has remained relatively constant, tangential actions have made the institution of MDWCA greatly shift. These actions have also reinforced and created institutional momentum for MDWCA, so that even though it is quite problematic, it is a strong institution and continues to exist. It would take a great deal of disrupting institutional work to create significant change on the institutional structure of MDWCA and how drinking water in general is governed in New Mexico.

To explain this situation, I first take a deeper dive into the concepts of institutions and institutional work. I then examine the institutional structures of drinking water systems in New Mexico and the various governing institutions. For my qualitative field research, I conducted in-person interviews of managers of rural drinking water systems across the state

to get their take on institutional dynamics and what their biggest needs and concerns are for their water system. Because the institutional structure of a water system was determined to be very important for a water system's success, I perform a quantitative analysis of where water systems of different institutional structures are located. Because MDWCAs were found to be clustered, I quantitatively examine demographics of communities they serve and found that communities with MDWCAs typically serve lower income and predominantly Hispanic communities. In the discussion section of this paper, I discuss how finances and regulations are affecting water systems in various ways. These issues create problematic power dynamics between regulatory agencies and water systems that are not contributing to the success of drinking water systems. One important aspect of this power dynamic is the promotion of regional water systems by the state government and certain NGOs. I then use all these findings and the theoretical lens of institutional work to discuss how power has shifted toward the state government, why the institutional structure of MDWCA is racially discriminatory, and how water systems seem to be serving for the existence of state governing institutions, instead of the other way around.

Institutions governing social-ecological systems

To understand the relationship between the ability of a community drinking water system to meet its goals and the governing institutions and institutional structure of that system we must first explore how institutions relate to the management of social-ecological systems. A drinking water system can be described as a social-ecological system because it consists of a resource provided by an ecosystem and users who utilize that resource. Institutions are the rules and norms that affect how users interact with each other and with the resource. Institutions are defined as "the formal and informal rules and norms that guide human and organizational behavior and provide a degree of stability and predictability in social interactions" (Beunen and Patterson 2016). Bates (1994) argues that institutions are created when individualism clashes with social welfare. Rational individuals make choices that are socially irrational and to remedy this disconnect, institutions are created (Bates 1994). These institutions may be cultural norms, mutual agreements, or governmental control.

In his famous article, which is now seen as dated and problematic, Hardin (1968) describes what he calls "the tragedy of the commons" which is the idea that without institutional

regulations in place, individual users will exploit a common-pool resource and the result will be a tragedy, or a deterioration, of that common-pool resource. To remedy this situation Hardin proposed an institution; in this case the institution of private property (Hardin 1968).

Since his article was published, many people have responded and countered it. In addition to rebuking his claims that government intervention and private property was needed to govern common-pool resources, his work has been criticized as being racist. The Southern Poverty Law Center has identified him as a white nationalist and argues that he used his work to promote population control through forced sterilization of women, specifically women of color (SPLC, Garret Hardin). This is just one example of how entities use institutions to promote a personal goal. In the most prominent rebuttal, Ostrom (1990) uses game theory and gives examples to prove how groups can self-organize to obtain better societal outcomes for a common pool resource. Ostrom advocates for collective management of common-pool resources and gives eight rules that should be followed to have a successful institution. These eight rules are: commons need to have clearly defined boundaries, rules should fit local circumstances, participatory decision-making is vital, commons must be monitored, sanctions for those who abuse the commons should be graduated, conflict resolution should be easily accessible, commons need the right to organize, and commons work best when nested within larger networks (Ostrom 1990). In most contexts, water can be considered a common-pool resource and can be susceptible to the tragedy of the commons if the proper institutions are not in place.

These studies and arguments show that there is no overall best institutional arrangement. There is no water institution panacea; instead there are institutional arrangements that work well in different ways for different situations (Meinzen-Dick 2007). For drinking water systems in New Mexico, there are many different environmental and social variables present and therefore there is not an overall ideal institutional arrangement. It is important however to understand the variables that create ideal institutional arrangements for different contexts.

One arrangement that has gained recent attention is a polycentric governance structure (Jordan et al. 2015; Berardo and Lubell 2016). “Polycentric connotes many centers of decision making that are formally independent of each other… [t]o the extent that they take each other into account in competitive relationships, enter into various contractual and

cooperative undertakings or have recourse to central mechanisms to resolve conflict" (Ostrom et al. 1961). The benefits of a polycentric governance system include increased adaptation, trustworthiness, cooperation, innovation, and learning (Ostrom 2010). Polycentric governance explicitly fits in to the eight rules presented by Ostrom (1990), in that polycentric systems are systems that are nested within larger networks.

If the goal is to create a polycentric governance system, then it is important to understand how institutions are created and how they change. Ostrom (2007) discusses the idea that social, economic, and political settings influence the creation of institutions surrounding social-ecological systems which include a resource system, resource units, a governance system, and users. The interactions between the variables of these four entities create the outcome of that social-ecological system, whether that outcome is desirable or not. Out of all the sub-variables identified, ten are identified to affect the likelihood of self-organization to achieve a sustainable SES (Ostrom 2009). These ten variables are the size of resource system, productivity of the system, predictability of the system dynamics, resource unit mobility, collective-choice rules, number of users, leadership/entrepreneurship, norms/social capital, knowledge of the social-ecological system/mental models, and importance of resource.

Other studies have been done on what makes a robust social-ecological system, which is defined as "the maintenance of some desired system characteristics despite fluctuations in the behavior of its component parts or its environment" (Carlson and Doyle 2002). Anderies et al. (2004) identify the connections between resource, resource users, public infrastructure providers, and public infrastructure as crucial connections. They argue that the weakening of any of these connections makes the system less robust. Anderies and Janssen (2013) argue that the public policy process itself is a social-ecological system, and advocate for creating policies that are not necessarily the "right" policies, but ones that encourage experimentation, learning, and adaptation. They also note that by creating robustness in one way, vulnerabilities can be created in other ways. A good example of this can been seen in Anderies (2006). In order to address short-term fluctuations in a social-ecological system, institutions and infrastructure are created which may in turn make the whole system more vulnerable to major disturbances. This is what Anderies (2006) argues happened to the Hohokam in what is now Arizona. Irrigation institutions and infrastructure were created to

decrease short-term water stress, and these made the system vulnerable to flooding, a larger and more destructive disturbance.

New laws and new institutional arrangements should also take an ethical approach. Groenfeldt and Schmidt (2013) argue for a "values-based approach" to water governance where new water laws and institutions need to account for any externalities they create. In their case, that meant leaving some water in the Santa Fe river for non-human life. Water governance can also have surprising human consequences. Kuzdas et al. (2016) discuss how water governance structures can help create or mitigate violence.

In sum, a generalized ideal water governance scenario has different institutions that make up a polycentric structure, the institutions and the social-ecological system follow the eight rules outlined by Ostrom (1990), the system is robust through strong connections between its entities, and the laws are flexible and ethical.

When discussing how institutions are created or changed, it is useful to frame it using the theoretical lens of institutional work, which is defined as "the purposive action of individuals and organizations aimed at creating, maintaining and disrupting institutions" (Lawrence & Suddaby 2006, p. 215) As opposed to institutional change, institutional work also includes the actions that work to reinforce the current institution. For example, institutional work incorporates a situation where actors involved in an institution are performing actions that create a positive feedback loop that continually strengthens that institution.

There are many theoretical ways that institutional work can lead to institutional change, one of which is institutional momentum or inertia (Mahoney and Thelen 2010). This is the concept that the longer and more established an institution is, the harder it is to change it (Pierson 2000). More altering institutional work is needed to change an institution that has had more reinforcing institutional work. Another focus of research on institutional change has been on whether institutions evolve slowly and incrementally or if they change abruptly in dramatic fashion. Literature suggests it is likely some of both (Beunen and Patterson 2016). Incremental change can work in a positive feedback loop that then accumulates into a dramatic change (Baumgartner and Jones 1993). Mahoney and Thelen (2010) suggest that change is gradual and driven by political actors that take advantage of the flexibility of

institutional rules. Dramatic change can also come from exogenous shocks from environmental, social, economic, and political factors (Head 2014).

In sum, there are some main dichotomies present in the literature around institutional change and institutional work. These dichotomies are "stability vs. radical change…, emergent vs. intentional change…, and endogenous vs. exogenous drivers of change" (Beunen and Patterson 2016, p. 5). In this paper, I identify the mechanisms of institutional work and change for drinking water governance in New Mexico, with a focus on governing institutions and the institutional structure of Mutual Domestic Water Consumers Associations.

Methodology

This research project used grounded theory and mixed methods. Grounded theory is defined as, "a general methodology for developing theory that is grounded in data systematically gathered and analyzed. Theory evolves during actual research, and it does this through continuous interplay between analysis and data collection" (Strauss & Corbin 1994). For this project, using grounded theory meant that I initially went into the interviews without a theory of their needs and concerns or what the institutional dynamics were. After numerous interviews, I developed a theory and then used the subsequent interviews to test that theory.

Mixed method research is defined as "an approach to research in the social, behavioral, and health sciences in which the investigator gathers both quantitative (close-ended) and qualitative (open-ended) data, integrates the two and then draws interpretations based on the combined strengths of both sets of data to understand research problems" (Creswell 2014, p. 2). My mixed methods approach means that I used the qualitative data of in-person interviews with water system managers and quantitative data of water system information and demographic information. Combining grounded theory and mixed methods means that I started my research with quantitative and qualitative data and throughout the research, they constantly informed the direction of one another and were each testing the theories that were developed.

Qualitative methods include interviews with rural drinking water system managers and analysis of documents and literature from governing institutions. Quantitative methods consist of a spatial analysis of institutional structures of water systems and other

characteristics of those areas. The interviews were open ended for me to learn from the drinking water system managers themselves and those conversations then directed me to what governing institutions should be examined and what factors were important for the spatial analysis.

The interview process consisted of six in-person interviews with water experts from various governing entities and 30 in-person interviews with drinking water system managers across all regions of New Mexico. All 570 community drinking water systems were randomized and systems serving more than 5,000 people were eliminated, as that was the cutoff for a small system, going off the definition of a small water system used by New Mexico Rural Water Association. Starting at the beginning of the list we emailed and called the administrative contacts for the water systems and then scheduled an in-person interview. The administrative contact held different positions for different water systems. Most commonly, the administrative contact was the president of the water association board or the public works person for a municipality. On a rare occasion, the administrative contact was the water system operator or the accountant and when this was the case, they usually referred us to someone who was more involved with day-to-day operations of the system. Our attempt was to interview the person most familiar with the system and responsible for meeting state regulations. This person did hold different positions but is referred to in this paper as the "manager." Often times, we interviewed many people involved with the water system, such as the board president, other board members, operators, and accountants.

Water systems on tribal land were not included in this study. Drinking water systems on Reservations or Pueblos are not governed by the New Mexico Environment Department and have a different institutional and regulatory environment. Additional barriers exist in conducting research on tribal land, including needing permission from each Tribe or Pueblo. Because of the added research challenges and different institutional environment, drinking water governance on tribal land is not included in this study.

All the interviews were transcribed and then coded into themes using the qualitative research software NVivo 12. The interviews informed me which governing institutions warranted further research and which spatial variables were relevant. Data on individual water systems was obtained from the Drinking Water Watch database through the New Mexico

Environment Department (NMED) (https://dww.water.net.env.nm.gov/NMDWW/). A public records request was submitted in order to obtain the data in a more usable format. The institutional structure of water systems was found through the New Mexico Secretary of State's website (https://portal.sos.state.nm.us/BFS/online/CorporationBusinessSearch). Water rate survey data was obtained from the NMED website (https://www.env.nm.gov/drinking_water/rates/). Demographic data was from the US Census American Community Survey 5-year average from 2012 to 2017. Supplemental mapping data was obtained from New Mexico Resource Geographic Information (https://rgis.unm.edu/).

Water systems are unique spatial entities because they do not necessarily follow any kind of political boundary. My maps of water systems were created using ArcMap GIS 10.6 by taking the coordinates of every drinking water related piece of infrastructure in the state and finding the median center of those points for individual water systems. This then created one point for each water system. A problem arises when comparing water system data to other spatial data, particularly US Census block group data. When these datasets were spatially joined, the water system received the value of the block group that the one point for that water system fell in. This is not a problem for small communities, but it is less accurate for larger systems. Because the focus of this project is small rural water systems, this method was determined to be the best method for analysis.

Analysis and Results

Water Governing Institutions in New Mexico

The interviews with managers of drinking water systems reveal that there are multiple agencies of the New Mexico state government that they regularly interact with. These include the New Mexico Environment Department (NMED) Drinking Water Bureau, New Mexico Finance Authority (NMFA), New Mexico Department of Finance & Administration (NM DFA), the Office of the State Engineer (OSE), and the Office of the State Auditor (OSA). Other state agencies are involved with drinking water governance, but these are the ones that managers discussed the most. According to the managers, they interact with the agencies in the following ways:

- NMED is the agency tasked with regulation of issues like water quality and water operator certification.
- The NMFA and NM DFA are largely involved in financing grants and loans for water and community development related projects.
- The OSE oversees water rights.
- The OSA makes sure that water systems are audited so they can receive government funds.

The NMED is the state agency tasked with enforcing regulation passed by the federal *Safe Drinking Water Act* (1974, 1986, 1996). Multiple United States federal agencies are involved in governance of drinking water systems in New Mexico, most notably the Environmental Protection Agency and the Department of Agriculture.

In addition to government agencies, not-for-profit non-governmental organizations (NGOs) are involved in offering assistance and resources to rural drinking water systems. The organizations that were discussed most often in interviews are the New Mexico Rural Water Association (NMRWA) and Rural Community Assistance Corporation (commonly known as RCAC). NMRWA is the New Mexico branch of the National Rural Water Association whereas RCAC is the western US division of the Rural Community Assistance Partnership. All of these agencies and organizations are considered institutions because they have power to create the rules and norms that govern drinking water systems.

One of the most important roles for all the governing institutions is to provide money through grants and loans to assist in the operation and improvement of water systems. According to the Environmental Finance Center Network (2019), community drinking water systems in New Mexico have 34 different available funding mechanisms.

Institutional Structures of Community Drinking Water Systems in New Mexico

The eligibility of a community drinking water system to receive assistance from agencies and receive funding from different sources is largely based on its institutional structure. Every drinking water system in New Mexico must be organized as one of a number of different institutional structures that were created by the New Mexico Legislature. The most numerous and prominent institutional structures are Mutual Domestic Water Consumers

Associations (MDWCAs), Water and Sanitation Districts (WSD), Cooperatives, Non-profit Corporations, Investor Owned, and Municipally Owned.

MDWCAs are the most prevalent and account for 37 percent of the 570 community drinking water systems in the state. This structure was created by a legislative statute in 1947 with the purpose of giving resources to poor and rural communities so they could improve their drinking water infrastructure to provide safe drinking water to their communities (Clark 1987). Before this measure, most rural communities were drinking water from ditches, rivers, and shallow wells. The 1947 statute was updated and called the *Sanitary Projects Act* in 1965, although nowhere in the act does it say the phrase "mutual domestic" (Flynn-O'Brian & O'Leary 2005). The act has had numerous amendments, but the basic goals have remained the same. The creation of MDWCAs has largely been regarded as a success. In his foundational book, *Water in New Mexico*, Ira Clark describes MDWCAs in the following way:

- The speed with which local groups throughout the state organized mutual domestic water consumers' associations was indicative of the void which had existed. By the end of 1969, 139 had been completed to serve 5,477 families at a cost to the state of $1,187,000. These have brought water and sanitary facilities to low-income areas which would never have been able to afford them if left to their own resources alone, and have contributed significantly to promoting cooperative effort among rural residents in solving their common local problems. (Clark 1987, p. 360)

MDWCAs, as well as WSDs, are technically subdivisions of the state government. Because of this, they are eligible for more sources of state funds than other institutional structures. The main difference between MDWCAs and WSDs is that WSDs are able to provide wastewater treatment in addition to drinking water and operate more like a local government. Cooperatives are a common institutional structure of drinking water systems across the state and these are organized like cooperatives in other sectors; they are private entities where each member is partial owner. Because they are considered a private entity, they are not eligible for as many funding streams as MDWCAs, but they also are not subjected to as much financial regulation. Non-profit Corporations are also private entities, but they are not

necessarily collectively owned by the individual users of the water system. Investor owned systems are water systems that are privately owned by an individual or corporation that is looking to profit by selling water to consumers. Water systems of this institutional structure have even further limited grant and loan options. The last prominent institutional structure is municipally owned water systems and the people running these systems may be involved in numerous municipal functions, including wastewater and parks. As a local government, they are eligible for numerous loans and grants.

The report *Water and Wastewater Systems of New Mexico* (Flynn-O'Brian & O'Leary 2005) gives statutory details for all the different possible institutional structures for community water systems. From their statutory review, they find that the institutional structure of a water system is not always clear, and they find that some statutes do not specify if an institutional structure is considered a public or private entity, which would affect its reporting requirements and funding options.

Because all these different institutional structures of community drinking water systems in New Mexico have different mechanisms of funding and different reporting requirements, it is important to analyze how funding and assistance are helping communities and how regulations are affecting them. On top of this, it is important to see which communities have different institutional structures and if there are any patterns.

Spatial and Quantitative Analysis

For my quantitative analysis, I first look at where water systems with different institutional structures were located. For reference, I include a general map of New Mexico that includes labels of counties and select municipalities (**Figure 1**). With data obtained from NMED, I plotted the locations of all water systems in New Mexico, shown as **Figure 2** below.

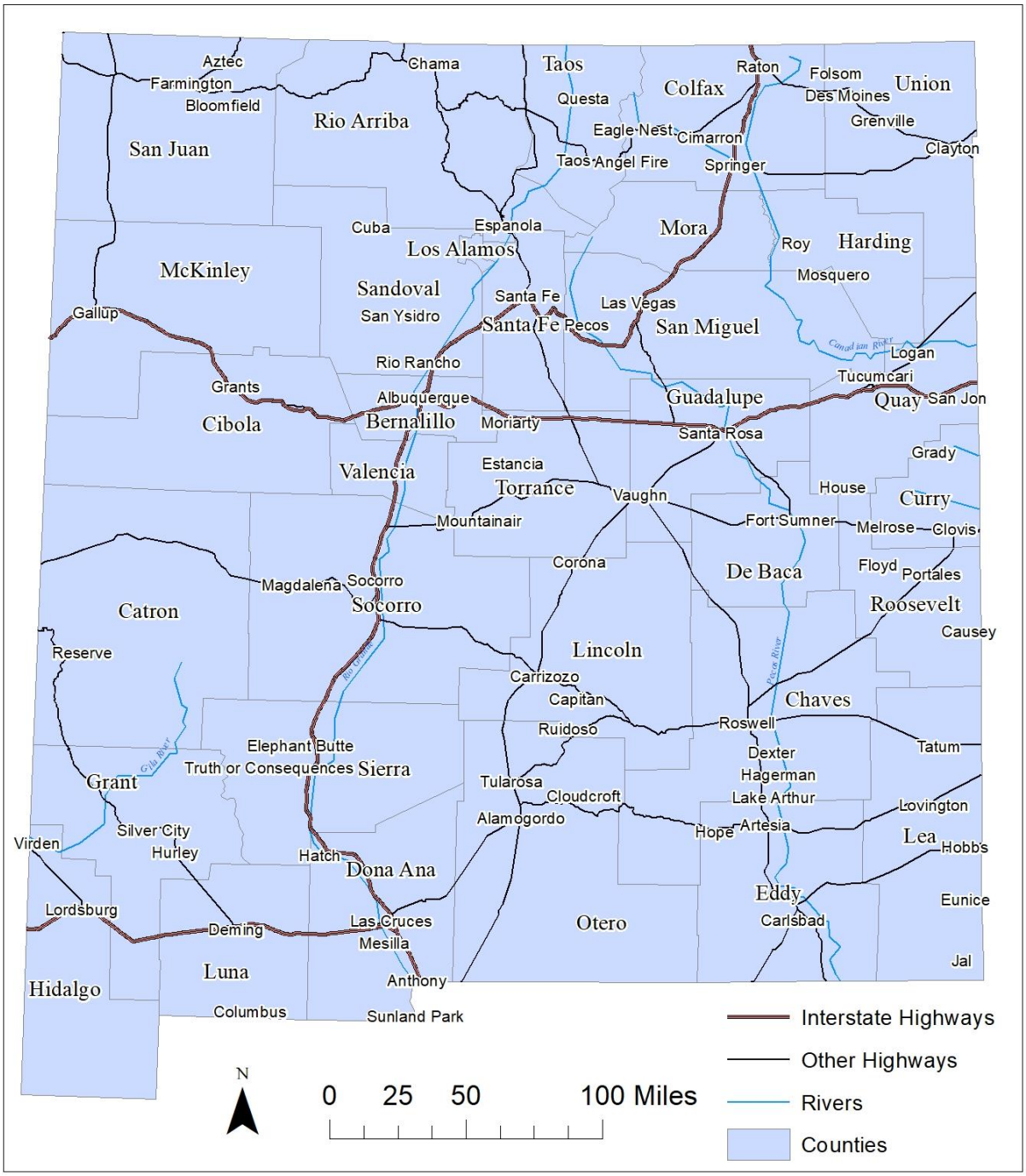
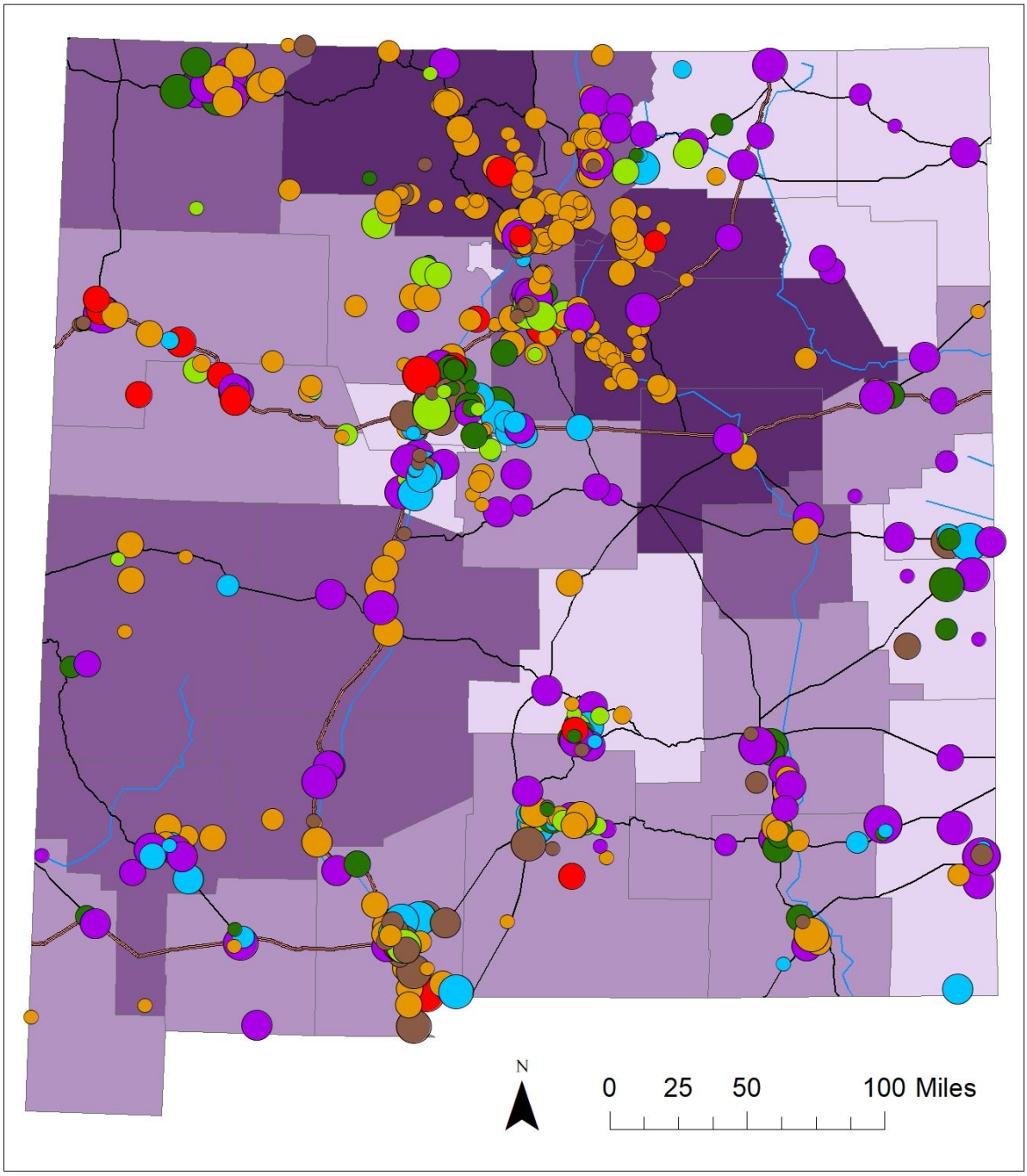


Figure 1 - Reference Map of New Mexico
Data Source: New Mexico Resource Geographic Information System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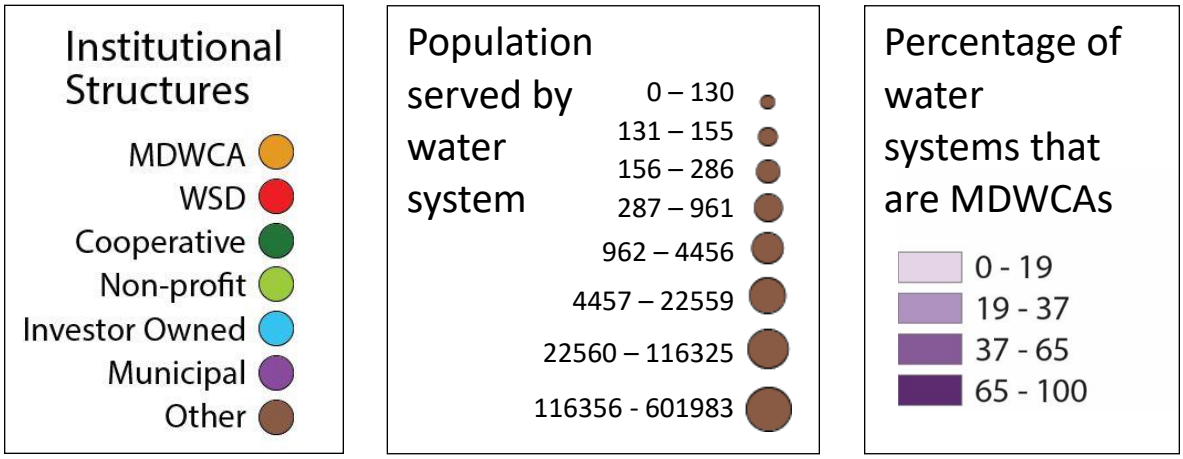

Figure 2 - Distribution of institutional structures of water systems in New Mexico. Colored circles represent different institutional structure and the size of circle represents the population served by each water system. Purple shaded regions represent the percentage of water systems in that county that are MDWCAs. State average is 37 percent.
Data source: New Mexico Environment Department. Drinking Water Watch.; New Mexico Resource Geographic Information System.; New Mexico Secretary of State.

The color of the dot represents the institutional structure and the size of the dot represents the population served. This analysis appears to show that institutional structures are spatially clustered. To see if this clustering was significant, I calculated the percentage of water systems in each county that were organized as MDWCAs. For the entire state, an average of 37 percent of water systems are MDWCAs, so that is the cutoff for the lighter and darker shades of purple on the map to visualize what location are higher than average and lower than average. Water systems in the counties of north-central NM are more likely to be MDWCAs than other institutional structures. Global Moran's I spatial autocorrelation test was used to determine clustering significance. With a p-value of 0.052 there is less than a ten percent chance that clustering on the county level is random. The same test was done with MDWCAs per census block group and that resulted in a p-value of <0.01, which shows that there is less than a one percent chance that clustering is random. The takeaway from this analysis is that the choosing of institutional structure by a water system is not random, there must be certain factors that influence it.

Next, I used data from the US Census American Community Survey to see the relationship between institutional structure and demographic information, specifically median household income and percent Hispanic population (2012 to 2017 average). The maps of median

household income per water system and percent Hispanic population per water system can be seen below as **Figure 3** and **Figure 4**, respectively.

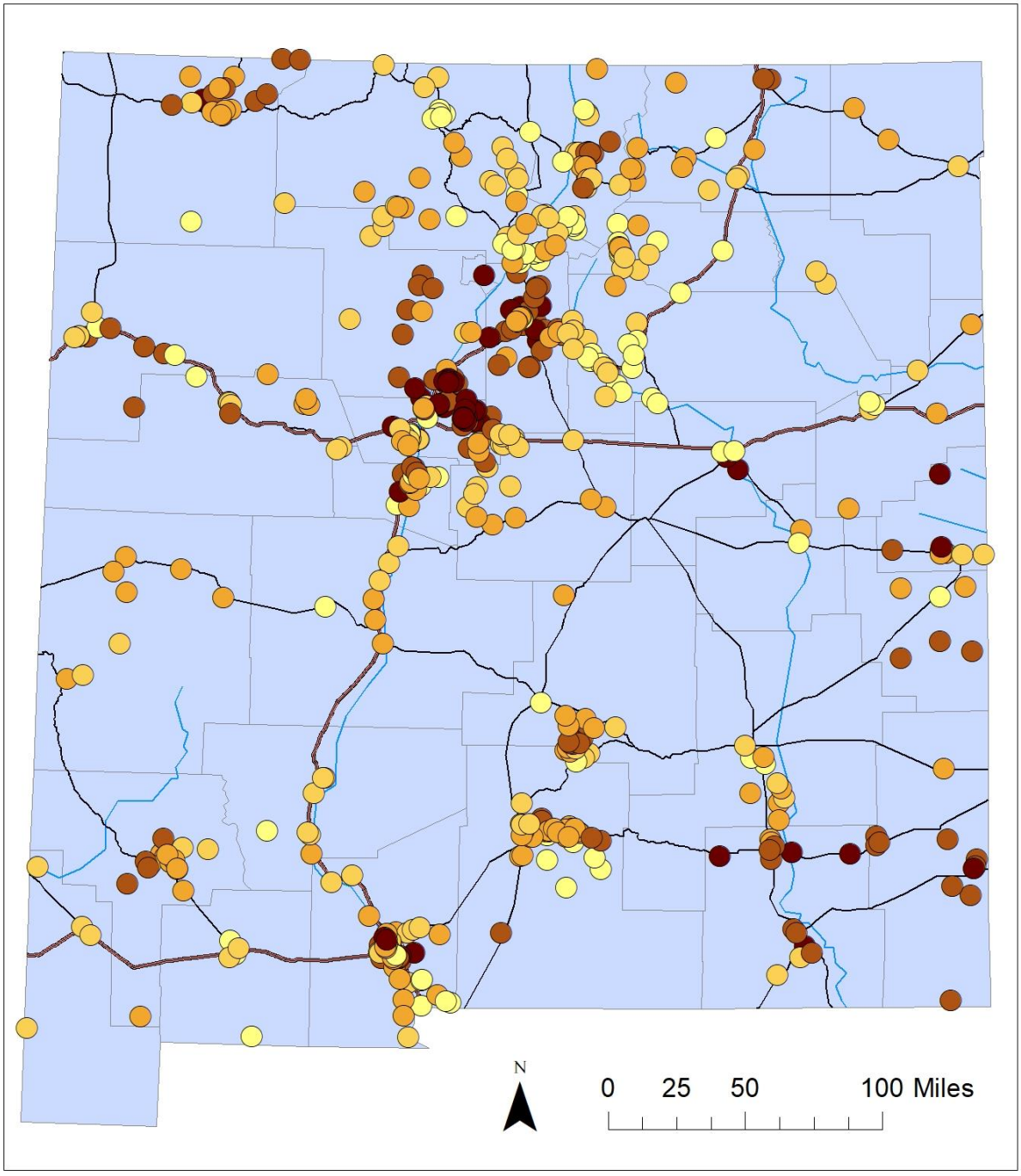

Figure 3 - Median household income of US Census Block Group served by water system.
Data source: New Mexico Environment Department. Drinking Water Watch.; New Mexico Resource Geographic Information System.; US Census American Community Survey, Median Household

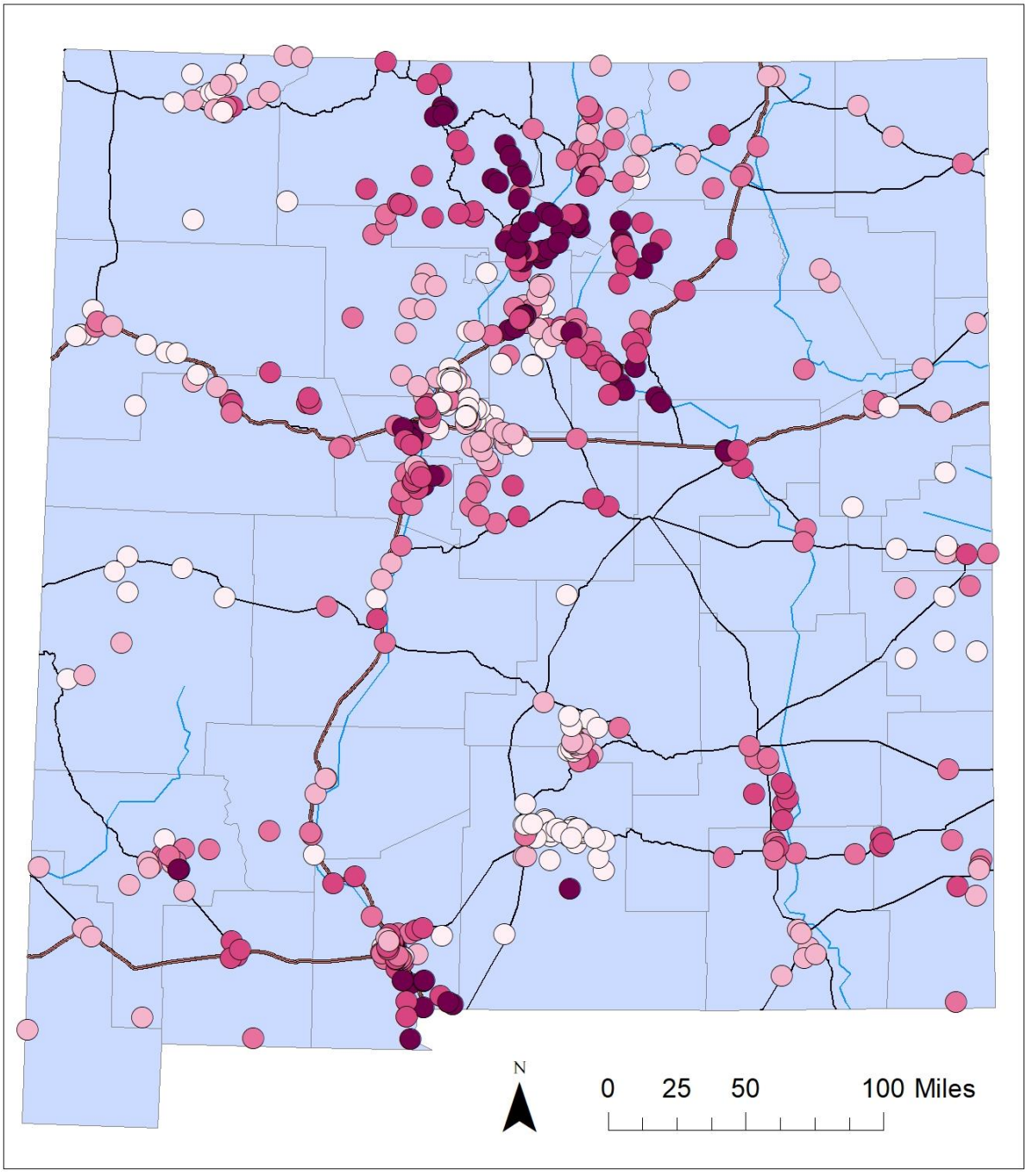

Figure 4 - Percent of residents of Hispanic or Latino origin of US Census Block Group served by water system.
Data source: New Mexico Environment Department. Drinking Water Watch.; New Mexico Resource Geographic Information System.; US Census American Community, Hispanic or Latino Origin 2012-2017 5-year estimate.

Graphs were made comparing the median of median household incomes for each type of institutional structure and the median percent Hispanic population for each institutional structure. **Figure 5** shows that communities with MDWCAs have the lowest median household income of any institutional structure. **Figure 6** shows that MDWCAs have the highest percent Hispanic population of any institutional structure.

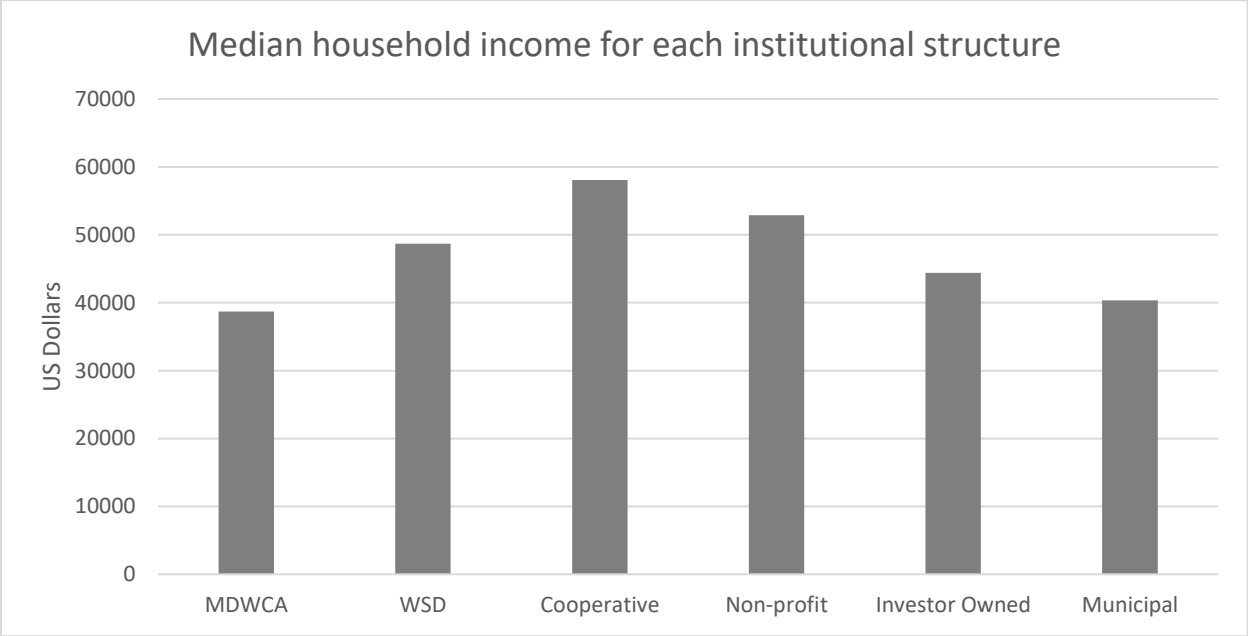

Figure 5 - Median household income of US Census Block Group served by water system.
Data source: New Mexico Environment Department. Drinking Water Watch.; New Mexico Resource Geographic Information System.; US Census American Community Survey, Median Household Income 2012-2017 5-year estimate.

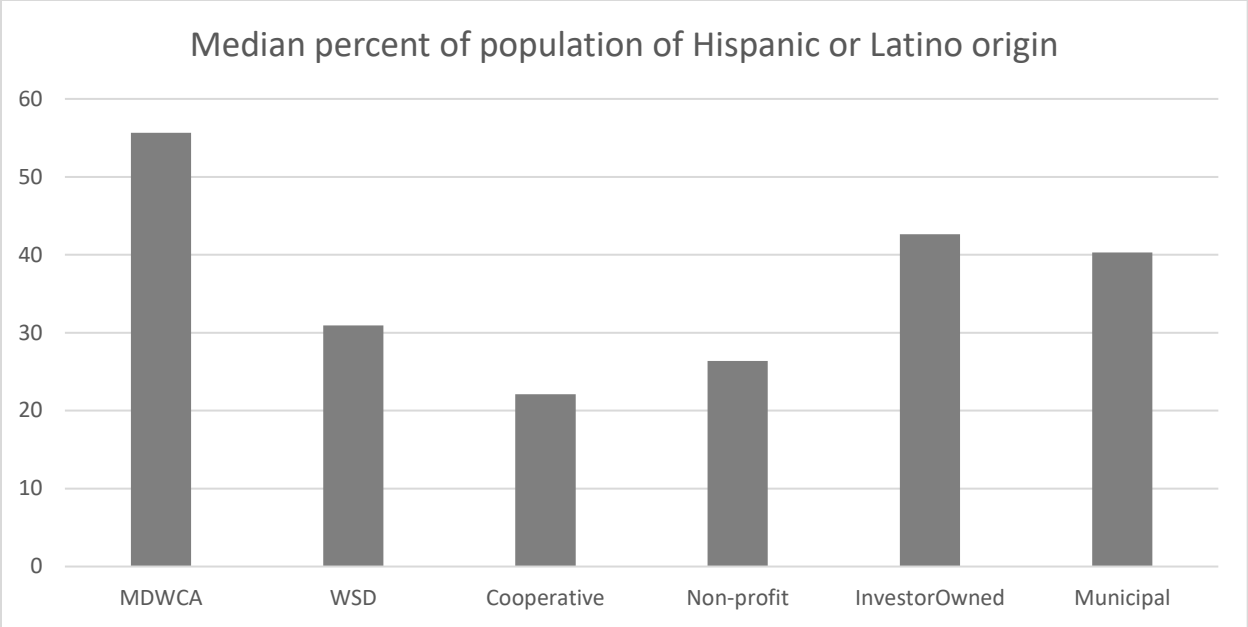

Figure 6 - Percent of residents of Hispanic or Latino origin of US Census Block Group served by water system. Data source: New Mexico Environment Department. Drinking Water Watch.; US Census American Community Survey, Hispanic or Latino Origin 2012-2017 5-year estimate.

To see if more funding options for MDWCAs translated to lower water rates, I used 2018 water rate data from NMED and created a graph of median monthly water rate for each institutional structure; seen below as **Figure 7**. This graph shows that water rates for MDWCAs are among the highest. I then normalized this data with the median household income data to see what percentage of household income was going towards a water bill; seen below as **Figure 8**. This graph shows that communities with MDWCAs pay a much higher percent of their household income to their water bill than communities with water systems of other institutional structures.

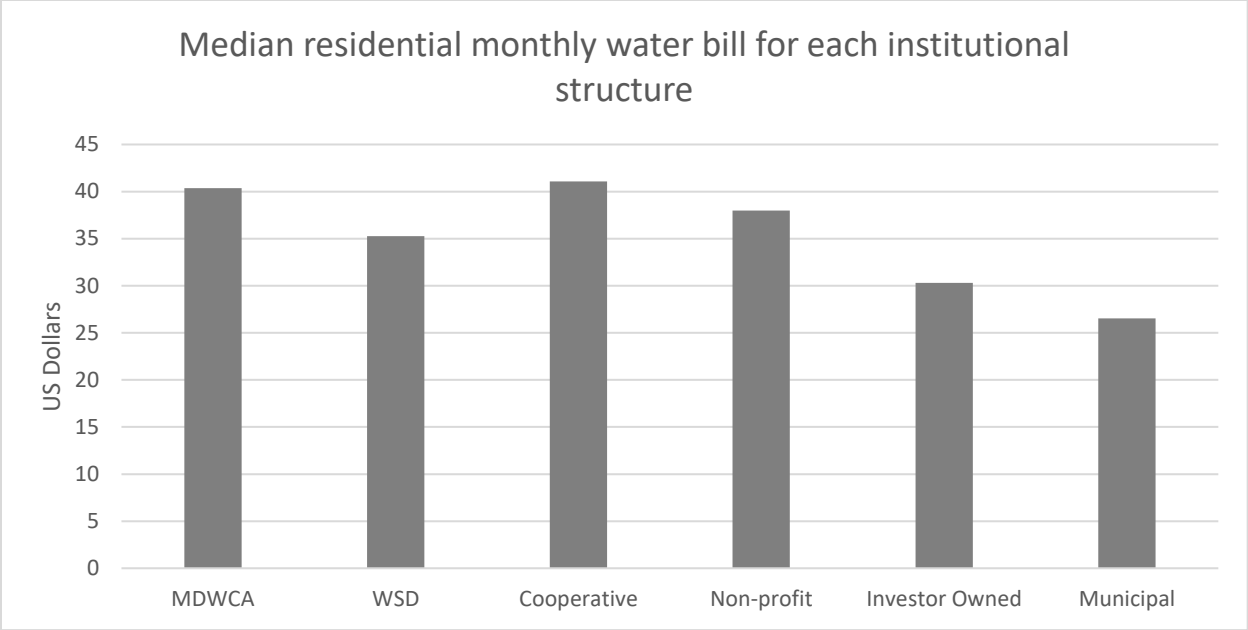

Figure 7 - Median residential monthly water bill for water systems of different institutional structures.
Data source: New Mexico Environment Department. Drinking Water Watch.; New Mexico Environment Department. Water and Sewer Rate Surveys. 2018 Survey Results

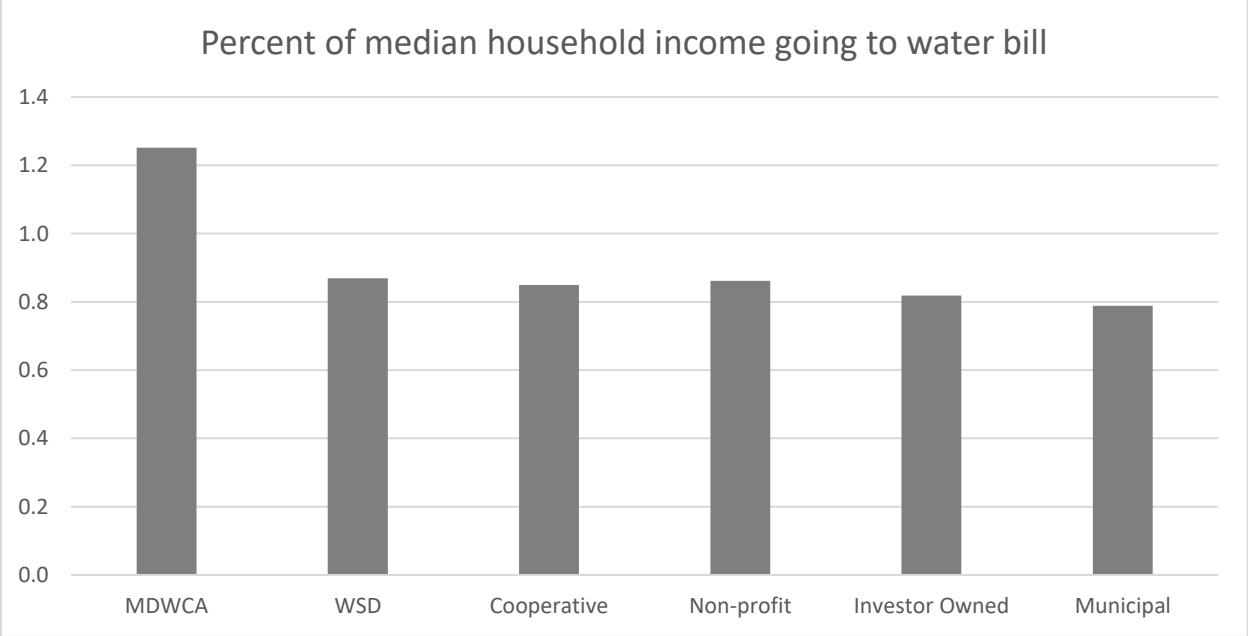

Figure 8 - 2018 water rate survey results divided by median household income for US Census Block Group served for each institutional structure.
Data source: New Mexico Environment Department. Drinking Water Watch.; New Mexico Environment Department. Water and Sewer Rate Surveys. 2018 Survey Results. US Census American Community Survey, Median Household Income 2012-2017 5-year estimate.

Interview Results

The purpose of the interviews was to get a perspective on drinking water governance from managers of drinking water systems and learn about their needs and concerns, and to see how they differed between institutional structures. All six of the major institutional structures previously discussed were included in the interviews.

Seven major themes emerged from the interviews with managers of the water systems. These include:

- Not enough local people engaged in running the water system
- Lack of funds and difficulty receiving outside funding
- Deteriorating infrastructure
- Confusing and burdensome regulation
- Environmental concerns, including drought, wildfire, and contamination
- Concerns of having enough water rights or losing water rights
- Regionalization as either a solution or a threat

Some of these topics were much more of an issue for some drinking water systems than others for reasons unrelated to the institutional structure, but the institutional structure did have a significant role in how systems navigate all these topics.

With a few exceptions, the water systems whose managers we interviewed were formed long before the current manager was involved, and they did not know why the institutional structure of their water system was chosen. Although, some managers did have a good idea of why that structure was chosen, and the characteristics of water systems do seem to corroborate these observations. The choosing of an institutional structure can largely be attributed to demographics. The first, and perhaps simplest, variable is the number of residents served. Out of the six major rural institutional structures, a few of them have a significantly different number of residents served. A graph of the median number of residents served can be seen below as **Figure 9**.

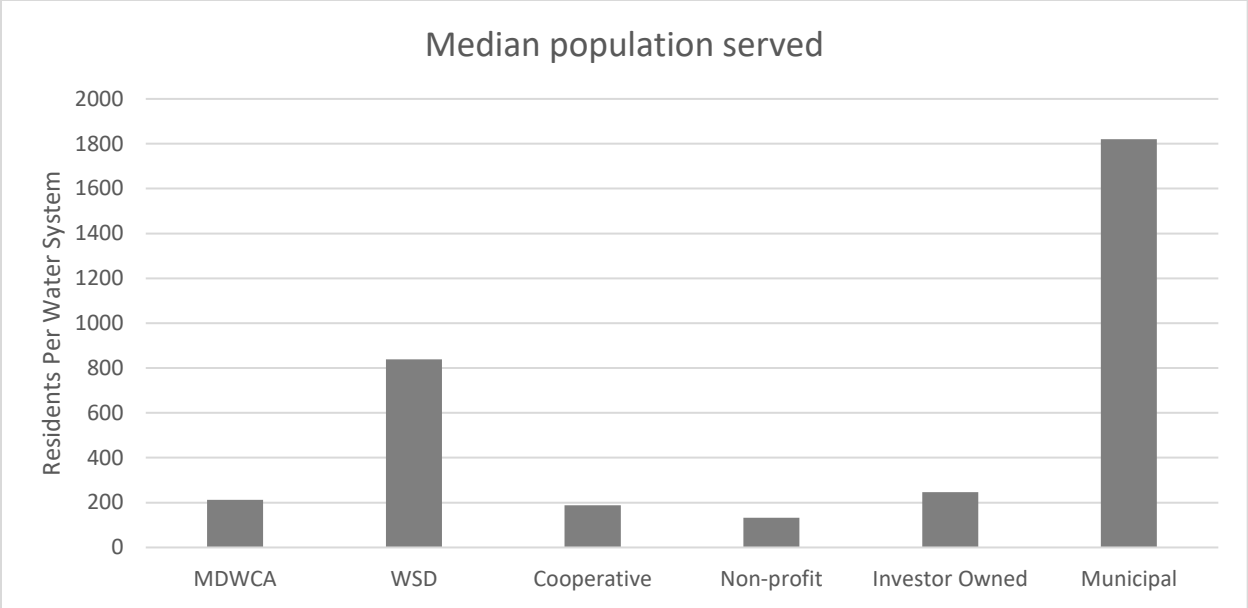

Figure 9 - Median population served for each institutional structure.
Data source: New Mexico Environment Department. Drinking Water Watch.

Municipally managed systems are much larger than all the other categories. These communities are large enough to have a municipal government that manages many town functions, including a drinking water system. The second largest median population served is Water and Sanitation Districts (WSDs). These communities tend to be slightly larger than the other institutional structures because they also can manage wastewater facilities, but they are not large enough to warrant a whole municipal government. MDWCAs, Cooperatives, Non-profits, and Investor Owned systems tend to be the smallest and houses are generally on individual septic systems.

Median household income (**figure 5**) distinguishes MDWCAs from the other institutional structures that serve the smallest communities. MDWCAs have the lowest median household income whereas Cooperatives have the highest. Non-profits and Investor Owned Systems are somewhere in-between. It is expected that MDWCAs serve lower income communities, as the original goal of MDWCAs was to improve drinking water for lower income communities (Clark 1987). It is also expected that Cooperatives serve higher income communities because they are likely to be more self-sufficient in fund generation because they are less able to receive monetary resources from the state. Cooperatives are technically

member-owned private entities, so they are subject to less fiscal regulation. The reasons why a community might choose Non-profit or Investor Owned as an institutional structure remains unknown.

Discussion

Finances and regulations

The main ways that governing institutions interact differently with different institutional structures are though funding of grants and loans, financial regulation, and regulation of water system by-laws and management. There are 34 different funding mechanisms for drinking water systems in New Mexico, identified by the Environmental Finance Center Network (2019), but not all of them are available to each institutional structure. Most notably, MDWCAs are subdivisions of the state government, so therefore are eligible for much more funding options than Cooperatives and Investor Owned systems, which are considered private water systems. MDWCAs are also the most numerous type of institutional structure so they often get more attention when talking to state water officials. All community water systems are subject to water quality regulation under the federal *Safe Drinking Water Act* (1974, 1986, 1996), but different institutional structures are subject to different amounts of financial regulation. Because MDWCAs and WSDs are subdivisions of the state government and because water systems have a history of embezzlement, they must be audited on a regular basis by a CPA. If they want to be eligible for any state funding, they must have their audits up to date and audits cost a significant amount of money for small water systems. Does their eligibility for state funds make up for this increased financial regulation? To answer this question, I obtained NMED survey data from water systems which showed how much each drinking water system was charging for 6000 gallons of monthly water use. The results, as seen in **figure 7**, show that the water rates for MDWCAs and Cooperatives are the highest out of all the institutional structures at about $40 per month.

The finding that water rates for MDWCAs are among the highest and equal to that of Cooperatives is significant for several reasons. First, it shows that even though MDWCAs are supposedly offered more financial assistance, it doesn't appear to be making drinking water any more affordable in those communities. Second, communities with MDWCAs tend to have a lower household income as seen in **figure 5**, which therefore means that they are

paying a significantly higher percentage of their monthly income for their drinking water. As shown in **figure 8**, households in communities with MDWCAs are paying over 1.2 percent of median household income for their water bill whereas households for all the other institutional structures are paying less than 0.9 percent. In sum, the communities with MDWCAs are subject to much more oversight and regulation and they are paying the highest relative price for their drinking water.

Smaller economies of scale for MDWCAs can explain part of the rate discrepancy, but it does not completely explain it. Water rates are lowest for municipally owned systems, which serve higher populations and have more rate payers. However, the second lowest rates are for investor owned systems, which serve communities of similar size to MDWCAs. Water rates for MDWCAs are among the highest for all institutional structures, so if the increased access to state resources was effective in decreasing cost to the community, their water rates should be at least not among the highest. The institutional structure with rates slightly higher than MCWCAs is Cooperatives, which are considered private entities and receive among the least amount of state resources. Non-profits and investor owned systems are of similar size to MDWCAs and have lower water rates and have less access to state resources than MDWCAs.

For any water system, complying with all regulations is time consuming and takes a significant amount of effort and familiarity with the system. MDWCAs and WSDs are subdivisions of the state government and in addition to increased financial regulation, they have regulations governing the by-laws and management of their individual system. These regulations include having 3 or 5 board members, conducting elections each November, subjection to open meetings requirements, and requiring a quorum of water system members or board members to make any decision about the water system. In addition to financial and management regulations, they are still subjected to the requirements of the *Safe Drinking Water Act* and any other NMED regulation.

To describe the excessive regulatory burden placed on MDWCAs, one manager said,

- Probably the state would like us all to be mutual domestic, but some of my mutual domestic friends say, “You don't want to become a mutual domestic. Too much paperwork, too much regulatory compliance before you can do anything.” Like

> the contractor we worked with, he said he did some work for the mutual domestic in [another town]. And he said, "We can't do anything until everybody's signed off on five different levels."

Personnel

Whereas water systems in larger towns and municipalities have paid water system managers, all the board members of MDWCAs and WSDs are volunteer. They are required to have a certified operator, who is generally paid, and most systems have an accountant who might be paid, but they are not allowed to pay the board members, who are the people with the responsibility of keeping up on regulation. Most board member presidents also run the water system on a day-to-day basis. They are responsible for applying for grants and loans if their systems need funding for things like deteriorating infrastructure. These individuals are putting in an incredible amount of effort for being volunteers. Many of the interviewees describe it as a part time job. On top of the effort and time spent, they also bear the responsibility of providing safe water to their community and if there is ever a problem with the water, such as water not reaching houses due to a water main break, they are the ones who take the heat from upset residents and have to orchestrate the repairs. Some communities have issues with people failing to pay their water bill on time and then a board member must threaten to or actually turn off water to someone's house. This can be contentious in a small community and can alienate people and create enemies. With all of these responsibilities, it is not surprising to see that small communities are struggling to keep people engaged in running their drinking water systems.

Cooperatives are also managed by a volunteer board, but they tend to serve a different demographic population than MDWCAs, so they tend to have people with different skillsets on their boards. Cooperatives serve wealthier communities than MDWCAs and tend to have people on their board who have backgrounds in professions like engineering, accounting, and law. Because of this these backgrounds, they are able to do more of the "professional" work themselves and it is likely that they have better access to professional resources based on their knowledge and connections. To be clear, these backgrounds and skills do not mean that they are better at the day-to-day operations of running water systems, they are just better resourced and connected to meet requirements and regulations put in place by the state and

federal governments. Paying to hire engineers, lawyers, and other water professionals is a large expense for almost all the water systems we interviewed, but this expense is greater for poorer communities because they are less likely to have those people in their communities and on their board already.

During an interview, one manager described the increased bureaucracy and the "professionalization" of people who run water systems by saying,

- You have a lot of people that have been doing it for years and years. And if they can't get certified or if they can't actually manage the system, the paperwork part of it. They could probably do the actual footwork of it, and maintaining the actual waterlines, but it's the paperwork that probably gets people. That's my feeling."

Another manager discussed the type of person they think can successfully navigate the bureaucracy by saying,

- It takes a thinking person to really manage these nonprofits, these mutual domestics. It really does. There's a lot of things that don't make sense. As you start going and you start learning more and more about mutual domestics, it's always a contradiction, sometimes.

These quotes speak to the constructed challenges that are created by governing institutions that do not inherently come with managing a water system. These constructed challenges contribute to making the people who are running systems no longer wanting to or able to run them and makes it less likely that new people will want to or would be able to manage systems.

Power Dynamics

A majority of drinking water system managers interviewed saw regulation in a similar way. They understood the need for and supported financial and water quality regulations, but they complained that they were not organized or enforced in a way that made them easy to comply with. As discussed earlier, different institutional structures are regulated in different ways and have different resources available to them. Not only is there the issue that the institutional structures can have either negative or positive effects on different communities, it is also problematic that the institutional structures are not as straight forward as they seem.

The official institutional structure of a water system is listed on its *Article of Incorporation* that is housed at the water system itself and it is also listed on the Secretary of State's website, but occasionally the institutional structures listed are not the same. Furthermore, the managers of water systems may have a different idea of what institutional structure they are or think they are an institutional structure that doesn't technically exist. These findings were all revealed in our interviews and looking up water systems in the business directory on the Secretary of State's webpage (portal.sos.state.nm.us/BFS/online/). Because of this confusion, it appears that there is not necessarily this relationship of more regulation and oversight means more money and resources. This can be particularly problematic to MDWCAs because they have the highest level of regulation and oversight for their size. Some systems might be complying with all the regulation, but not realizing that with that regulation they are eligible to receive more money and resources.

This opaqueness of institutional structures is just one factor that contributes to a power dynamic between the state and individual water systems. The state government is a much more powerful force than small drinking water systems so the listing of the state is assumed to be correct. The governance of drinking water systems is a top down approach. The state controls water quantity through the OSE, water quality through NMED, and financial regulations through multiple agencies. However, the state has very little enforcement power. Drinking water systems can be given violations for many different issues, but from talking to the managers of the systems, the main way these violations effect water systems is by making it more challenging to receive state funding, with the exceptions of them being serious acute violations of water quality or running out of water entirely. Most managers interviewed complained that most of their violations were due to paperwork errors of being late on regular water quality tests. By financially punishing water systems for being in violation, it can be argued that the state is punishing communities who are most in need of assistance. However, there are so many funding mechanisms that water systems may have many other options, but a problem lies in that many managers do not know all the sources of funding. Funding streams are listed various places online and NGOs, such as New Mexico Rural Water Association and RCAC, have circuit riders that assist rural water systems, but many managers do not have access to or are not knowledgeable in computers and the internet and NGOs have limited capacity helping water systems find sources of funding.

Because of its history, New Mexico is a very interesting place to study water issues. In his book, Eric Perramond (2019) discusses how the water adjudication process of allocating water rights based on first use, has had negative effects on many communities across New Mexico, particularly communities who have long histories. The institutional mechanism of adjudication was supposedly fair and based on time, but it affected communities in arguably unfair ways. The institutional structures of water systems and the regulatory burden placed on them can be looked at in a similar right. Communities have provided drinking water for centuries, although many times it was non-sanitary, and increasingly through time, the government has had increasing presence in rural communities through drinking water regulation (Clark 1987). The regulations in themselves are not problematic, as everyone wants safe and clean water, but along with that enforcement comes increased government control and decreased community sovereignty. The fact that managers of most water systems are volunteer further problematizes this power structure. Managers and other board members are volunteer and are generally working other full-time jobs or are retired. As all the interviewed managers stated, running a water system is a huge amount of work. Not allowing managers to be paid means that many of them cannot afford to put in the time and effort required to run the system and keep up with regulation and paperwork. Although, paying them could create other problems and it would be an added expense for a small water system. Requiring board members to volunteer selects for older retired people to run the systems and because it is so much effort, other people rarely want to take over. Many times, the management of a rural water system falls on one person who many times say they are only doing it because no one else would.

The significant effort spent on regulations and paperwork combined with deteriorating infrastructure, difficult to get funding, and lack of engaged residents makes it so many systems are starting to somewhat fail. Out of the systems we visited and interviewed the managers of, some of them were in great shape, but many could be described as close to failing. Some of the main reason for this are old pipes that were leaking water almost as fast as the well could pump, lack of a certified operator nearby, failure to obtain funding for new infrastructure, manager burnout, confusing and overly burdensome regulation, and the fact that many board member and operators are quite elderly. These issues are not necessarily caused by the state government or regulations, but they have the potential to be exacerbated

by the institutional structure of a water system. Because the institutional structures treat systems differently, some water systems and communities are better equipped to deal with these issues. Similar to what Perramond (2019) describes in his book, water governance institutions that are meant to be neutral or help communities can actually harm some communities in unjust and unequal ways.

Perhaps the most significant way that drinking water governance institutions are affecting communities in unjust and unequal ways is with MDWCAs in lower income communities and communities of color, specifically communities with a higher percent of Hispanic residents. MDWCAs were originally created to improve drinking water in rural and low-income communities (Clark 1987). **Figure 5** shows that MDWCAs do serve communities of lower income that other institutional structures. However, I argue that the institution of MDWCAs are not meeting their goal in helping poorer communities because as **Figures 7** and **8** show, the water rates are not lower than other institutional structures, and furthermore, those communities are paying a higher percent of their income to their water bill. More troubling is the fact that communities with MDWCAs also have a higher percent of Hispanic residents, as seen in **Figure 6**, which means that lower income and predominantly Hispanic communities are subject to more regulation and oversight and are largely not seeing the benefit. The institutional structure is not reducing water rates and our interviews show that there is a lack of people willing to be involved in water systems, and the volunteer managers that they do have are not able to keep up with regulations and failing infrastructure. This becomes a social and environmental justice issue, as these are affecting low-income and predominantly Hispanic communities more than other communities.

When there is so much time and effort spent on day-to-day operations, satisfying regulations, and looking for infrastructure funding, it is easy to forget the ecological part of the social-ecological system that drinking water systems are. Communities face a plethora of environmental threats such as contamination, wildfire, drought, and flood. Originally, I anticipated our interviews with managers of rural water systems would largely focus on these issues and what they were doing to manage them. Managers are so preoccupied with other aspects of running a water system that they are hardly thinking about these issues. Environmental concerns are generally longer-term problems and managers are faced with so many issues that they need to deal with now. However, the day a wildfire burns a source

watershed, a well runs dry, or a septic tank contaminates a well, they are no longer future problems. The high demand from water system managers and the lack of resources makes it so communities are largely not able to be proactive on many things including environmental and source water concerns.

Meta-Analysis

The limitations of the interview data should be noted. As stated earlier, water systems were randomized, and our research team went down the list emailing and calling the administrative contact. In order to schedule 30 interviews, about one third of the 570 community drinking water systems were contacted. Because most water system managers did not answer our calls and email, call us back, or declined to be interviewed, we must think about who were the individuals that agreed to be interviewed. We do not know differences in characteristics of managers and water systems who decided to be interviewed and those who declined, but it is my assumption that those who agreed to the interviews were from water systems that were likely not in bad standing with the state government because we were researchers from a state-run university and were coming to ask them questions about their water system. Interviewees were assumed to see the need for the research because they took time out of their day to participate. It was apparent that interviewees were trying to find solutions to their problems and saw us as potentially helping. Because they were willing to participate, it was assumed that they were the managers that were engaged in putting effort into their water systems and were passionate about it. Because of all these reasons, it is my assumption that as a whole, the water systems managed by our interviewees were likely to be better ran than the state average. We did visit water systems that were struggling, but in those scenarios the managers were new, or they were doing everything they could with their resources. We also visited many systems that were run very well and had very few problems.

One interesting issue we ran into when asking managers about their institutional structure compared to others and if they liked the institutional structure that they had; managers were largely only knowledgeable in their institutional structure. When they were asked if they were happy with the institutional structure of their water systems, most of them said they were, but they had nothing to compare it to. So even though I am arguing that some institutional structures are problematic, particularly MDWCAs, most managers of MDWCAs

said there were happy with their institutional structure. What they were not happy with was the amount of scattered regulation, some of which happened to be specific to their institutional structure.

Solutions and Regionalization

Although I am critical of the state government and how they are managing drinking water systems, government officials are aware of the issues that water systems are facing. The problems stem from failing and outdated institutions, not the failure of individuals or even specific government agencies. Government agencies and NGOs provide many trainings and workshops all across the state to try to educate managers and operators on a variety of different topics. The NMED goes to individual water systems and conducts sanitary surveys and tells system managers what they need to do to ensure delivery of safe water and be in compliance. NGOs, such as New Mexico Rural Water Association (NMRWA), RCAC, and the Southwest Environmental Finance Center, help systems with budgets, securing grants and loans, as well as provide trainings and workshops.

One solution that many governing institutions see as a way to help rural drinking water systems is the creation of regional water systems or creating regional management offices that oversee multiple water systems. It is impossible to research drinking water institutions in New Mexico and not be bombarded with information and stances on regionalization. The state government is generally promoting regionalization, RCAC is strongly in favor of regionalization, and NMRWA views regionalization more as a tool that could help some water systems. The topic of regionalization often came up unprompted in our interviews and managers generally had a strong opinion either for or against it.

New Mexico State Government

While researching the institutions of New Mexico state government, I could not find a stated position on regionalization, but I did come across many telling clues as to what their position is. The 2000 amendment to the *Sanitary Projects Act* made it more difficult to create a new MDWCA. To make a new one, a community must not be adjacent or sufficiently close to a municipality or other existing water system. They must prove that consolidation to a nearby system is not possible. Because of this, very few new MDWCAs have been created. According to one interviewee, even with a team of lawyers, engineers, and hydrologists, it

was very difficult to create a new MDWCA, because they were already reasonably close to an existing water system.

Funding mechanisms also give a clue to how the state government of New Mexico views numerous small drinking water systems. A funding mechanism that came up in many of our interviews was the State Revolving Loan Fund that was created by the 1996 amendment to the federal *Clean Water Act*. Most of the money is federal, but the state does pitch in some money and dictates the terms of loans and who receives them. In New Mexico it is administered by the New Mexico Finance Authority. Below is the description of how New Mexico allocates its loan funds (State of New Mexico. Drinking Water State Revolving Fund State Fiscal Year 2020 Intended Use Plan):

- To become eligible for a DWSRLF loan, a System submits a project interest form (PIF) to the DWB [Drinking Water Bureau], and must have managerial, financial and technical capacity in order to be put on the Fundable List. The DWB maintains a multi-year Comprehensive List which ranks each project using specific criteria and ensures that the projects with the greatest need will be offered DWSRLF assistance first.

A few things stand out in this brief statement. First, water systems must already have adequate personnel to be eligible for funds. This can be a major hurdle for MDWCAs and WSDs because they rely on community volunteers to run their systems. This makes it so systems most in need may not have adequate personnel and therefore are not eligible for this significant funding stream, although many other loan and grant options exist. More telling about the state's goal for small water systems is the criteria for ranking systems. Systems receive extra priority points if they are trying to consolidate in some way. More points are given to physically connecting systems and a few points are given for plans to share resources (State of New Mexico. Drinking Water State Revolving Fund State Fiscal Year 2020 Intended Use Plan). Because of this, the state is actively promoting regionalization. The state also gives more points to systems that are currently in compliance with state and federal regulation. This funding is not based on time or waiting in line; it is solely based on priority points. This incentivizes systems to try to get as many points as possible, so they are more likely to get funding.

Why does the New Mexico state government want to regionalize water systems? I could not find a specific reason why on any document or on their webpages, but one reason is assumed to be "capacity development" which was promoted in the 1996 amendment to the *Safe Drinking Water Act*. The EPA defines it as, "Capacity Development is a process for water systems to acquire and maintain adequate technical, managerial and financial (TMF) capacity. TMF capacity enables water systems to have the capability to consistently provide safe drinking water to the public" (EPA. Building the Capacity of Drinking Water Systems). They contend that smaller water systems generally have lower TMF capacity, so therefor it is better to consolidate systems to increase capacity. This is similar to the concept of economies of scale. Particularly with water quality regulation, governments want all communities to have the same standard, or else there is an environmental justice issue. Larger communities may have the ability to comply with these regulations, but smaller communities may not. To solve this problem, governing institutions are trying to increase the TMF capacity of small water systems, in an effort to make them more like larger municipal water systems and able to more easily comply with regulations.

Another reason that could not be found in any government document or webpage, but was brought up by many of the managers we interviewed, is that for the state, it is easier to regulate and support fewer number of systems. Many interviewed managers complained that the state gives money in larger chunks to larger water systems because it means less paperwork and less oversight for them. This may or may not be true, but many managers of small systems thought this was the case and were bitter about it. It is no secret that the NMED has had chronically high employee turnover rates. It makes sense that the state would want to decrease the quantity and "professionalize" water systems in order to make it easier on their end to regulate them and provide assistance.

Rural Community Assistance Cooperation

A major player in rural drinking water systems, as well as communities in general, is Rural Community Assistance Cooperation (RCAC). They are a 501(c)(3) non-profit and are the Western US affiliate of the Rural Community Assistance Partnership (RCAP). They provide loans and various forms of technical assistance and trainings to drinking water systems and communities. Loan interest rates for drinking water systems are variable, but they state that

long term loans are generally around 5% and there is a 1% loan fee (RCAC 2019. Environmental Infrastructure Loan Program). There is no information on conditionally of their loans, but their Strategic Plan gives some insight to their motivations. The top two listings on their "Strategic Direction" in their "Strategic Plan" are "Form regional collaborations to achieve economies of scale and take advantage of new opportunities" and "Ensure communities, and especially schools, have access to and increase consumption of safe drinking water" (RCAC 2015–2019 Strategic Plan). The focus on economies of scale and increased consumption make it appear that RCAC's assumptions about water systems are based on a neo-classical economic model. RCAC receives the majority of their funding from federal and state grants, including from the New Mexico Environment Department (Rural Community Assistance Corporation 2019). These sources accounted for 69 percent of total revenue in 2019. They also receive a significant portion of their revenue from corporate donations and interest from their loan program. Because they lend to less traditional borrowers, their loans are mostly backed up and guaranteed by federal agencies. RCAC also holds significant investments in land, certificates of deposit, and corporations.

RCAC's website paints a specific picture of what rural means to them. There is an interesting quote on the advocacy section of RCAC's website that states:

- Sub-standard housing and poverty are commonplace in low-income rural communities. Many of these communities also face daunting challenges to access safe, clean drinking water and to develop other vital infrastructure. These issues are often overlooked in policy because rural communities lack the resources, training or social networks that are found in urban areas. Learn how you can advocate for the under-served population in the West. (rcac.org)

This sentiment implies that rural communities are not connected and need to be advocated for by outside groups. From my experience interviewing managers of rural drinking water systems in New Mexico, they generally have strong social networks and are well connected. Often times they appear to be great advocates for themselves.

New Mexico Rural Water Association (NMRWA)

Another prominent drinking water related NGO is New Mexico Rural Water Association (NMRWA). They are the New Mexico affiliate of the National Rural Water Association

(NRWA). The mission of the agency is to, "provide the highest quality training and technical assistance to rural water and wastewater utilities throughout New Mexico, and to represent the legislative and regulatory interests of our members" (NMRWA. About Us). Drinking water systems pay dues to be a member and receive numerous benefits. NMRWA does not directly provide funding, but they do help water systems receive funding from other sources.

Like RCAC, NMRWA receives a majority of its funding through federal and state grants; 68 percent in 2011 (New Mexico Rural Water Association 2012). However, they do not generate revenue through loan interest, and they do not receive significant corporate donations. They receive most of their other revenue from fees to attend their annual conference and annual membership fees for water systems and water related vendors and service companies. There is a significant difference between NMRWA and RCAC in that water systems are due paying members of NMRWA and they only focus on rural drinking water in New Mexico. RCAC does not have members, they operate throughout the Western US, and they are involved in issues other than water.

NMRWA seems to be having somewhat of a turf war with RCAC. This is apparent from interviews with multiple parties and even apparent in NMRWA's vision statement of, "Our vision is to be recognized as the principal advocate and authoritative source of information and technical reference in respect to rural water needs and management" (NMRWA. About Us). Part of this rivalry is because they offer similar programs, including trainings and technical support, but it also seems to be because of their different stance on regionalization, and thus different political and economic assumptions. NMRWA is not universally supportive of regionalization. They describe it as a tool that can help some communities based on their particular situation.

Although a few interviewees had a negative perception of NMRWA because they viewed the annual membership fee as one more obligation and expense, most interviewees had a positive perception of NMRWA. This contrasts with RCAC. Many interviewees expressed positive sentiment for RCAC, but others had negative perceptions of them because of their position on regionalization and the fear that they wanted to take control away from the local

managers. Additionally, multiple managers accused RCAC of promoting regionalization in order to financially benefit an affiliated engineering firm.

NRWA released a statement on their position on sustainability in 2018 (NRWA 2018 Statement on Water Utility Sustainability). In this statement they call out other agencies for their blanket promotion of regionalization and argue that it can be a tool but should be left up to local communities. Additionally, they argue that "If communities are coerced to consolidate; one can almost guarantee future controversy." NRWA came out with another statement on sustainability titled *NRWA Statement on Small Water Systems – False Narrative* (2018). In this statement they claim that other entities are promoting the idea that small systems are not sustainable as a way to financially benefit themselves or, if coming from a state agency, as a way to reduce their regulatory burden.

Regionalization findings from interviews

How do the positions of these agencies compare to the perspectives of the people managing the rural drinking water systems in New Mexico? As previously stated, most managers of rural water systems had strong opinions on regionalization. The manager interviews consisted of managers from water systems ranging from formally regionalized, informally regionalized, and very independent. Some communities had gone through formal regionalization plans and were part of a larger system or were underneath an umbrella that handled logistics. Other managers were open to regionalization, which was generally the case when they were overwhelmed with numerous and time-consuming obligations. They would be happy for someone to come in and take it over. However, all systems did have some reservations in that it was important for their communities that water was controlled locally by someone in their community. Numerous other communities were adamantly against regionalization. Reasons include loss of water rights, sovereignty, exploitation, trust, finances, and practicality. Along with many states in the west, water rights are a contentious issue in New Mexico and have a long history behind them (Perramond 2019). Drinking water systems are assigned a certain number of acre-feet of water, which is defined as the quantity of water needed to irrigate one acre with 12 inches of water each year. Many systems are concerned that by regionalizing they are going to effectively be giving some of their water right to another community. Systems also are worried that by formally joining

with another system, they will be saddled with that other system's financial responsibilities or loan burdens. It appears that many times when regionalization is proposed, one system is in a better position with finances or infrastructure and if they join with that system, they are then going to also be responsible for that system. One system may be a winner in the deal and another could be a loser. Practicality also came up during interviews. Many rural systems are not close to other water systems and because of this, consolidating into one entity does not make practical sense.

As described above, regionalization may not be ideal for logistical reasons, but much more importantly, people are hesitant to regionalization because of what it represents: loss of control and sovereignty. In New Mexico, some people have a religious or spiritual connection to water and water forms community bonds. Many rural communities are very old and often the same families have lived there for generations. The people who manage water systems are generally individuals who have strong connections to the community. They view pushes to regionalization as negative for many reasons, and sometimes personally insulting.

Meeting state regulations is a major hurdle for rural communities. Although many see these regulations as important and in their best interest, the reporting and logistical burdens can be overwhelming. Because of this, many see regulation as a loss of community control for their system, especially when they are in violation and the state has to intervene. Communities want safe drinking water, but in many places, people have been drinking that water for generations. It is frustrating for them that government agencies are now telling them that their water is not good enough and they must spend money to treat it. It is easy to see now this can lead to resentment for government and regulating agencies. One manager even believed that the regulations were over-burdensome on purpose. They cause water systems to be in violation, so the state could come in and take control. Others don't go quite this far in claiming this exactly, but the sentiment was similar for many systems.

Urbanization is an issue as some young people leave for the cities, but it appears that especially in areas that have scenic landscapes, older and retired people are moving in. In some places where this is the case, people are worried about enough water rights to

accommodate the increased use. As far as this topic goes, every community is different, and one narrative does not apply for all rural communities in New Mexico.

Water experts also talk about how there is a lack of expertise in rural communities. This is true if water experts are considered people who are engineers, hydrologists, lawyers and the like. The "professionalization" of water likely came along with the adjudication process of the state trying to quantify water use and then again with the *Safe Drinking Water Act* (Perramond 2019). People must be properly trained and have certifications, which makes it so the person who may have operated a water system for years, is no longer certified to do it. This increases cost for water systems because they must hire outside operators, engineers, lawyers, and accountants.

Loss of sovereignty and control is perhaps the biggest reason that water systems are hesitant to regionalization. Many small communities that have their own water systems have been there for hundreds of years. These are often communities with a high percentage of Native American and Hispanic populations. They have long been marginalized and have had their resources and land taken from them. Communities are rightly hesitant to let the state or other outsiders come in and take more control of a natural resource. Many believe there are ulterior motives and would agree with the statement from NRWA that there is a false-narrative about small water systems being unsustainable and that regionalization is often promoted for financial interests.

One last reason that communities are hesitant to regionalization is that most are somewhat regionalized already. Contrary to the statement by RCAC that rural areas lack social networks, my research has found that rural water system managers are part of a tight-knit network of individuals and they seem to be well connected to politicians and state officials. Their systems may not be physically connected, but they rely on each other for expertise, sharing resources and parts, and physically helping each other fix issues, such as water main breaks. They do not see a need to create a formal agreement on consolidating their resources. If they want to cooperate with their neighbor, they are likely to do it organically. One interviewee who was very opposed to regionalization was already highly informally regionalized with neighboring communities. It appeared that they ran a handful of systems almost as one. Because they were technically each one system, there were also a handful of

people involved in running them. If they were regionalized into one system, this could make it so fewer people are running those existing water systems and could reduce the system's TMF capacity. People in these communities have been operating drinking water systems for sometimes hundreds of years. They do not see why just now it has become unsustainable for them to keep running their own independent system.

Neighboring systems collaborating with each other to run their drinking water systems is an example of collective-action where people from different communities work together to ensure reliable drinking water for their communities. Challenges, such as water main breaks, require a significant amount of resources to fix, and many small towns rely on neighbors for their labor and parts to quickly get their systems running again. Most systems say they do not *rely* on neighboring systems, but they clearly are in close contact with each other and are quick to help when a neighboring manager needs help or resources. Out of the ten reasons identified that effect likelihood of self-organization (Ostrom 2009), the three identified to have played the biggest role in this scenario are the size of resource system, leadership/entrepreneurship, and importance of resource. Most of these water systems are very small and only have a few people involved in their operation, so they are likely to need assistance when they have a large issue. Because there are so few people running the systems with limited resources, they have to be resourceful, dedicated to their community, and be strong leaders. Drinking water is obviously an incredibly important resource, so communities will find a way to get it at any cost, so therefore they are likely to use all the resources they have, including coordinating and collaborating with neighboring water systems.

Application of theory

Community drinking water systems in New Mexico are part of a complex social-ecological system that rely on an ecosystem service to provide a requirement for human life. How this social-ecological system is managed can have a large impact on the ability of individuals and communities to meet their goals. As described, drinking water governance is very much a top-down system, where the state government has strict control on the quality and quantity of water. There is a need for some sort of top down governance, or preferably a polycentric governance scheme, which does exist because there are many layers of decision-making

power. However, decision making power is skewed towards the state government, especially for MDWCAs which comprise of small, low-income, and historically underserved communities. These communities are given little decision-making power themselves and have the least amount resources to comply with the top-down decisions placed upon them.

There is a need for some sort of statewide institution to enforce regulations of water quantity, water quality, and financial resources because out of the eight requirements Ostrom (1990) lays out for successful collective governance, many are lacking when it comes to governance of drinking water.

First, source water does not have clearly defined boundaries. The control on water quantity is a peculiar institution because its history and origin do not necessarily translate well into today's current water situation. The current system of top-down management does not seem to be successful for many small drinking water systems, partially because some communities have excessive water rights whereas others do not have enough, but mostly because the system of allocating water rights does not translate to the amount of water actually available. Many drinking water systems have plenty of physical water available, but they lack the rights to it, whereas other systems have plenty of water rights, but do not have enough physical water. The state is getting a better idea of water availability, particularly groundwater resources, but there still seems to be a lack of knowledge.

Another one of the eight rules that is currently lacking is the enforcement of rules and graduated sanctions. NMED and the OSE do not have much power to enforce their regulations. According to water system managers, their main enforcement mechanism is making it more difficult for systems to receive state funds. There are more regulations for MDWCAs than other water systems their size and they are generally in communities with lower income and are predominantly Hispanic. For reasons previously discussed, they have more challenges in satisfying the regulations, and because they are lower income communities, the punishment of making access to funds more difficult has a larger negative effect on them than Cooperatives that generally serve higher income communities.

Perhaps the rule that is currently the most lacking is participatory decision-making. The board members of MDWCAs have relatively little say in how they manage their water system. MDWCAs are technically subdivisions of the state government, so the state holds

almost all the decision-making power. Managers expressed frustration in their lack of control over their system and the lack of resources given to them by the state. Many interviewees point out that the state is very willing to come and tell systems what they are doing wrong, but do not tell them what to do to fix issues. The role of the state government is to regulate, not necessarily to give assistance, but the state is the entity that water systems interact with regularly, so they are who people look to for assistance.

Robustness of a social-ecological system is defined as "the maintenance of some desired system characteristics despite fluctuations in the behavior of its component parts or its environment" (Carlson and Doyle 2002). My analysis shows that as a whole, drinking water systems in New Mexico are not very robust. As described earlier, water system managers face a plethora of challenges related to infrastructure, human capital, lack of resources, burdensome and complicated regulations, and environmental threats. If any of these continue to deteriorate or fail completely, water systems will likely not be able to continue to meet the "desired system characteristic" of providing safe and reliable drinking water to their residents and satisfy state regulatory requirements.

The institutional structure of MDWCA seems to be one of the more problematic aspects of drinking water governance in New Mexico and the theory of institutional work can do a lot to explain this. As Clark (1987) describes, MDWCAs were originally created in 1947 with the intent of giving state resources to rural low-income communities to improve or create drinking water systems in an effort to improve rural health. He describes this scheme as largely being successful. The *Sanitary Projects Acts* have updated the institutional structure, but the overall structure seems to have remained quite similar. Every time a new MDWCA was created, regulations were enforced, and state funding was dispersed, the structure of MDWCA was further strengthened as an institution. A main idea of institutional work is that no action taking place involving an institution is benign to that institution; it is either creating, maintaining, or disrupting that institution. For example, enforcing regulations upon MDWCAs maintains the institution and creates a sort of institutional momentum. The passage of new environmental or financial regulation may not specifically change the legal institutional structure of MDWCA in the *Sanitary Projects Act*, but new burden is placed upon them and does in fact alter MDWCA as an institution. This has happened so many times throughout the more than 70-year history of MDWCAs that even though the statutory

structure has remained fairly constant, the institution of MDWCA and what it encompasses, has been drastically changed. The concept of institutional work is useful in this scenario because even though legislation may not change MDWCAs specifically, it relates to MDWCAs and therefore must have some sort of effect on it.

In this situation, formal changes to related institutions have had a negative impact on MDWCAs, specifically through the creation of regulations. Because the creation of regulations did not coincide with more resources for MDWCAs, these tangential changes have shifted the power balance away from MDWCAs and the communities they serve and towards the state government. Regulation of drinking water is one of the main ways that many communities interact with the state government and this power shift in water governance has altered state politics as a whole. On top of this, it has had the strongest negative effects on small, low income, and predominantly Hispanic communities.

In addition to the change in power dynamics, these institutional changes have made water systems in these communities more vulnerable. In theory, stricter water quality regulations should benefit the people who live in that community. If water systems have the resources and knowledge to keep up on regulation and navigate the bureaucracy this could be the case. However, this is not the case for most small rural systems. Instead of being proactive and thinking about issues such as aging infrastructure and environmental concerns, managers are stuck wading through a confusing bureaucracy.

Another reason why the theory of institutional work is useful in this situation is because it does not appear than anyone was explicitly trying to shift the power dynamic away from rural communities. Purposive institutional creation, through passage of regulation legislation, performed work on the tangential institution of MDWCA. Politicians likely passed these regulations because they thought they would benefit communities. The regulations themselves would likely be beneficial, but they have been enacted in a way that has been net negative for small and rural communities.

I argue that MDWCA is an overall negative institution, but it is also a strong institution. Throughout its more than 70-year history, many water systems have joined the institution. Each time a system is added, it acts as reinforcing institutional work and makes the institution stronger. Reinforcing institutional work happens every time regulations are

enforced, a compliance officer is hired by the state, or when a training session is held for MDWCA managers. Even though some of these actions can be considered positive, they still can reinforce the institution of MDWCA and therefore reinforce the power structures that have been created throughout the years through various forms of institutional work. Because the institution of MDWCA is so strong, it would take a substantial amount of disrupting institutional work to significantly alter it. It is very difficult for water systems to legally change institutional structures, which was one of the main findings in the report *Water and Wastewater Systems of New Mexico* (Flynn-O'Brian & O'Leary 2005). Also, there are no good alternatives if communities still want to be eligible for state funding. Because of this, it could be better to alter the structure of MDWCA itself in a way that would make it more equitable and help reduce the vulnerability of rural drinking water systems in New Mexico.

Chapter 2 Conclusion

Community drinking water systems in New Mexico are facing numerous challenges. The people who manage these systems are faced with the physical challenges of day-to-day operations, maintaining aging infrastructure, and addressing serious environmental concerns. Our interviews with managers of rural water systems revealed that they are also faced with the challenges of keeping on top of a confusing and overly burdensome regulatory structure. The communities that this is negatively affecting the most are communities with MDWCAs, which are typically small, low income, and predominantly Hispanic. MDWCAs are subdivisions of the state government and are eligible for much more funding options than other institutional structures. However, MDWCAs have among the highest water rates, so it does not appear that having more grants and loans available to them is making water any more affordable. The trade-off of increased regulation for increased funding options does not seem to be paying off for MDWCAs as a whole.

Rural communities across the state are struggling in having enough people manage and operate their water systems. For most institutional structures, managers are not paid, but are tasked with a huge amount of work and responsibility. In addition to the responsibility of providing safe drinking water to their community, they are responsible for keeping on top of many different regulations. Not having enough experienced people has decreased their technical, managerial and financial capacity. The state government and RCAC are trying to

promote regionalization as a way to build this capacity, so their capacity is more on par with larger municipal water systems. Although regionalization could help in some limited situations, this solution is unlikely to solve the core issues, and can have negative implications in community sovereignty and identity.

Institutional work is a useful theoretical lens to analyze this situation. Institutional work is purposeful action that creates, maintains, or disrupts institutions (Lawrence & Suddaby 2006). Although the institution of MDWCA has not experienced significant legal change, tangential institutional changes have made MDWCA a very different institution than when it began. Because of these changes, it is no longer serving its intended function of helping low-income rural communities.

Throughout the years, actions such as increasing the number of MDWCA water systems, the increased number of regulations and sources of funding for MDWCAs, and an increase in personnel whose employment is then attached to the continuation of MDWCAs, can all be considered reinforcing institutional work that had made is so the institution of MDWCA is strong to this day. However, the institution of MDWCA appears to be creating more negative than positive outcomes. Most affected by these negative outcomes are communities that are rural, low-income, and predominantly Hispanic. The institutional structure of MDWCA may have started out positive and helped communities who were most in need, but through its more than 70-year history, is has become negative and racially discriminatory. MDWCAs likely always encompassed communities with a higher percentage of Hispanic residents, but it becomes racially discriminatory when it shifts from being something that helps underserved communities to something that is harming them.

This institutional change has shifted the power dynamic of drinking water governance in New Mexico. Power has shifted from communities to state governing agencies. Instead of state agencies serving for the existence and success of drinking water systems, the situation has flipped so that drinking water systems appear to be serving for the existence of state agencies. This dynamic does not promote long-term delivery of clean and safe drinking water to rural communities.

Conclusion

In the two chapters of this paper, I have argued that drinking water governance in New Mexico no longer appears to be for the water system; instead it appears that water systems are serving for the existence of state governing institutions. Chapter 1 shows this by explaining how overly burdensome and confusing regulations are adding to the needs and concerns of drinking water system managers and making the systems more vulnerable. It is also contributing to their challenge of not having enough people to manage their system because it requires a lot of effort and responsibility for no pay and little reward. Because water system managers are spending so much time on "today problems," such as keeping up on regulations, they are not thinking about and planning for longer term issues such as aging infrastructure and environmental concerns. With potential increasing climate uncertainty due to climate change, this is especially concerning. Because many water systems are lacking experienced personnel, they have a low capacity to adapt to environmental perturbations, which further increases their vulnerability. There is the general idea that rural water systems in New Mexico are starting to fail, and although this is somewhat true, water is important enough and communities are dedicated enough that they will likely continue to provide water to their community. Whether or not it is complaint with all regulations is another question.

Chapter 2 takes a closer look at institutional dynamics, including both governing institutions and the institutional structures of drinking water systems themselves. By using the theoretical lens of institutional work, I argue that although the legal institutional structure of MDWCA has remained relatively consistent, the institution of MDWCA has shifted greatly, particularly through tangential legislation of increased regulatory demand and oversight. Additionally, the institution of MDWCA remains strong because of all the reinforcing institutional work acted upon it through actions like increasing the number MDWCA water systems, hiring regulatory staff, and putting on trainings for MDWCA managers. To significantly alter the institution of MDWCA it would take a significant amount of altering institutional work.

Through this paper, I hope to create some amount of altering institutional work for the institution of MDWCA and for drinking water governance in general. I identify many flaws in how drinking water is governed in New Mexico, but it is likely much more difficult to

significantly improve it. However, I will offer some recommendations. First, it would be very beneficial for small water systems if they had less of a regulatory burden. Regulations and standards should not be decreased, they should just be consolidated in some way or government agencies should take more responsibility and a larger role. Second, water systems should be allowed to pay their managers. This would likely create other problems, but because one of their biggest issues is not having enough people to run their system, it would likely help to improve that situation. Another benefit of this proposal is that it would create employment. Employment opportunities are limited in rural communities, so even a very part time water manager position could help. Ideally, all or a significant portion of the money required to do this would come from the state government. Having paid managers could pay for itself by decreasing the need for regulatory enforcement and by having people more proactive on asset management and preemptively addressing environmental concerns.

Both of these suggestions are only ideas and would create winners and losers and most certainly create other problems. However, rural community drinking water systems in New Mexico are in a precarious position, and if action is not taken soon, the situation is likely to continue to get worse.

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