SOCIAL PERCEPTIONS OF DRINKING WATER QUALITY IN SOUTH TEXAS

A Senior Scholars Thesis

by

VICTOR MANUEL GARCIA, JR.

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2011

Major: Environmental Geosciences

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Director for Honors and Undergraduate Research: Sumana Datta

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ABSTRACT

Social Perceptions of Drinking Water Quality in South Texas. (April 2011)

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The lower Rio Grande Valley (LRGV) of Texas is one of the poorest regions with the largest population lacking suitable water supply in the entire United States. The region is characterized by low-income, rural and peri-urban communities called "colonias." Nearly half of the 238,000 colonia residents face known infrastructure deficiencies in water, sanitation, or both, while nearly one-fifth have unknown water and sanitation status. In this study, water quality issues and the politics of water quality in the Lower Rio Grande Valley were examined, notably trying to assess the gap in social perceptions between key water managers and the colonia residents. A semi-structured interview methodology was used upon the key water managers in order to gather their insight on the topic. It was found that a gap in social perception did exist between the key water managers and the residents, as those interviewed saw no harm in the ingestion of the water supplied to them. Moreover, the key water managers supplied several differing opinion as to why they believed the colonia residents had the perceptions they did, among which were: the media, lack of education, the residents being overly cautious,

and the surface water aesthetic problems. With the population of the region growing quickly, and only more problems seeming to be coming up in the near future, this gap in water quality perception between the key water managers and colonia residents is something that will continue.

DEDICATION

I would like to dedicate this thesis to all who have helped me along the way.

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I would like to thank my advisor, Dr. Wendy E. Jepson, for her guidance and support throughout the duration of this project. It was because of her encouragement to apply for this program and pursue undergraduate research that this is has all been made possible.

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NOMENCLATURE

ATF	Apalachicola/Chattahoochee/Flint
CWA	Clean Water Act
EPA	Environmental Protection Agency
IBWC	International Boundary Water Commission
KTB	Keep Texas Beautiful
LRGV	Lower Rio Grande Valley
MUD	Municipal Utility District
SDWA	Safe Drinking Water Act
SUD	Special Utility District
TCEQ	Texas Commission for Environmental Quality
TNRCC	Texas Natural Resources Conservatism Commission
TPWD	Texas Parks & Wildlife Department
TWDB	Texas Water Development Board
WHO	World Health Organization
WSC	Water Supply Company

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CHAPTER I

INTRODUCTION

"How a country manages its water resources determines the health of its people, the success of its economy, the sustainability of its natural environment, and its relations with its neighbors" (Iza and Stein, 2009).

Water is an essential part of the well-being of all life on earth, yet 1 billion people throughout the world still do not have access to safe drinking water for their daily needs. Few people seem to realize the importance of water in their everyday lives, especially those who have it readily available for them, like most people do in developed countries such as the United States and Western Europe. This is why water governance is an important aspect of water resources management today. The goal is to effectively develop a water management program in the most fair, efficient, and sustainable way possible. Of very great importance is that the hydrological cycle and ecosystems involved should not be affected beyond their means of recovery. Water management has a longstanding idea throughout the course of humanity. The most important reasons behind water management were to transport water for consumption, washing, power, and irrigation (Iza and Stein, 2009). Also, the ability to control floods, store water in

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This thesis follows the style of Geoforum.

reservoirs for times of drought, and carry away waste made water an important tool. However, with the recent exponential increases in world population over the past 200 years, our society has become water-obsessed in ways of industry and agriculture, to the point where competition for water has begun causing numerous problems. Rather than merely transporting water, now it must been done so in an efficient way, that will satisfy all "competitors", including individuals, industry, agriculture and wildlife.

In essence, it is the duty of our governments to safeguard our water resources so that all people for generations to come are protected. Effective legal frameworks are needed in order to achieve integrated water resources management. In most countries, the current policies in place for water management are severely outdated, amassed over time from different methodologies and ideas. These policies should be worked on and eventually reformed. But the long and arduous task depends on the political will and leadership of the country. In order to be successful in water management, you need very clear policy and an established legal structure, so that the recognized system is given priority (Iza and Stein, 2009).

With the usage of good management practices, social and environmental benefits will soon follow, such as: clean drinking water and sanitation, all around good health of citizens, hydroelectric power, irrigation for agriculture, improved economy, wildlife biodiversity, recreation and tourism, friendliness between neighboring countries. On the contrary, poor water management practices can have destructive effects, such as:

increased disease and suffering, lack of power, shriveled crops, famine, desiccated ground, dried-up lakes and silted harbors, and tensions and conflict between neighboring countries.

One major area of concern is drinking water quality and access. In this thesis, I will explore one key aspect of water governance: the social perceptions of drinking water quality by stakeholders and water actors in the lower Rio Grande Valley (LRGV), located in southern Texas on the international border with northeastern Mexico. This area is one of the poorest regions, with the largest concentrations of population, in the United States. Often times, residents in the region's colonias --low-income, peri-urban or rural subdivisions—are unsure as to the quality of the drinking water supplied to them. Instead, they purchase their drinking water from purified water vending stations or grocery stores, which are conveniently scattered throughout the LRGV. Though the residents continue to purchase from these water vending stations and grocery stores, it seems that water managers and other key water actors in the water governance regime do not perceive that there is a problem with water quality in the area.

This chapter provides the background necessary to situate the study on perceptions of drinking water quality among key stakeholders in the lower Rio Grande Valley. The first section reviews the current literature on water governance in general, paying attention global scale dynamics. It is then followed by two sections that review the water governance in the United Stated and in Texas, both regimes that bear on the

process of delivering drinking water to consumers. The final section states that while we know from ongoing research (Jepson, 2010) that low-income consumers perceive the region's drinking water as not potable for drinking, water managers are less concerned. A study on the social perceptions of water among the key stakeholders in the water governance regime will reveal important difference among the colonia residents and the water managers. Moreover, an analysis of these differences will provide new insights into the underlying limits or problems with regional water governance that inhibit the provision of adequate drinking water to the poor.

Water governance

Global

The World Health Organization (WHO) states that access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection (WHO, 2008). Water governance involves coordination at the global, national, and local levels, in order for proper assessment to occur. There a lot of problems with water scarcity and flooding, especially with changing precipitation patterns which will be further enhanced in the future by global climate change. It is important for water managers of local water systems to be aware that many of the problems they face will be at a higher level beyond their governance. If water managers do not take this into account, they could possibly face an extreme situation where their hard work and knowledge would become void by other larger (national or global) developments. An example given by Hoekstra (2006) is the Dutch River delta. The

water managers in that area will have an uphill battle ahead of them with the sea level rise and change in river discharges in the area, caused by the changing global climate.

Water pollution problems that seem to be localized in just one area always have underlying global and national consequences. Probably one of the largest sources of pollution throughout the world is excessive use of fertilizers, which can affect large water bodies and put people in densely populated areas of the world at risk. These fertilizers cause disturbances in the natural cycles of nutrients such as nitrogen and phosphorus. This pollution can be widespread and is essentially a global problem. One example of this is the dead zone located off the Louisiana coast in the Gulf of Mexico, caused by the excessive fertilizers brought down from the runoff of the Mississippi River. As a result, reproductive problems could occur in fish, as well as fish kills. Other bottom-dwelling sea creatures such as clams, lobsters and oysters are affected as well. Many people in this area along the Gulf Coast subsist on catching and selling seafood, of which this problem could be detrimental to their livelihood as well as the health of the Gulf of Mexico ecosystem.

In addition, the number of countries that are facing water shortages is increasing, causing them to find ways to conserve or import their own water resources. Because there is an increase in water demand, it is necessary to find greater efficiency in our everyday uses. This efficiency can be achieved at the local, basin, and global levels. An example given by Hoekstra (2006) is giving water preference to more water-efficient crop types than

non-efficient water crops will be of huge benefit. Crops such as maize, rice, onions, and melons could use half as much water to grow per unit when compared to sugarcane, citrus, and cotton (Brouwer and Heibolern, 1986).

Nations can show this water dependence is several different ways. They can rely on inflows from other countries in the basin as well as water on border lakes or rivers. This can be a huge problem and cause international conflicts. Mexico and the United States have shown problems in the case of the Colorado River, which now has trouble reaching the Sea of Cortez after being diverted so much to supply the Southwestern United States with water. What used to be the boundary between the Mexican states of Baja California and Sonora, the river now runs dry in many places and is a mere trickle in others. The lush estuarine zone at its mouth has now become desiccated. Many people in that part of Mexico face the same water shortage problem that people in the United States face, both countries sharing the arid area; however, much of the water never reaches the Mexican side at times, causing conflict between the two nations. With this area of the U.S. becoming more heavily populated, perhaps the Colorado River will cease to connect to the Sea of Cortez in the future as diversions are likely to increase further. Another form of water dependency is virtual water import dependency, which is the reason water is considered a global geopolitical resource. Due to increasing scarcity of water, its unique character that prevents substitution and its uneven distribution throughout the world, the increasing dependency of water-scarce nations can be exploited politically by those nations that control the water.

The fact that there is a huge difference in the water footprints of people in the United States and those of many African, Asian, and Latin American nations shows that our water usage habits follow other trends in global inequity. Hoekstra states that, "Due to its increasing scarcity and uneven distribution across the globe, water is gradually becoming a geopolitical resource, influencing the power of nations" (Hoekstra, 2006). The countries in the world with the largest populations, China and India, are fortunate enough to have great water self-sufficiency. This is because they have very low water footprints among their citizens compared to the United States. If the citizens of these countries used water in the same casual manner as Americans, their situation would change drastically and they too would be facing major water deficits. Now as both countries move towards being more industrialized, they will begin to see problems arise in getting water resources to all its residents. It is necessary to see how these problems will be handled in the future

United States

A huge success in U.S. water management has been providing safe drinking water to most Americans through their Clean Water and Safe Drinking Water Acts, which have greatly altered the life span and health of U.S. citizens within the past couple of decades. Yet, even within the U.S., there are still major challenges to water governance.

Clean Water Act

The Federal Water Pollution Control Act of 1948 was the first law passed that brought awareness to water pollution in the United States. The current Clean Water Act is based on the amending of the Federal Water Pollution Control Act of 1948. This law was first introduced to the Senate in 1971 and was considered by the Senate's Public Works Committee. It was then passed by the Senate and the House of Representatives in 1971 and 1972. It was then signed into law by the Executive Branch, under President Richard Nixon, in 1972. Further amending in 1977 of the Federal Water Pollution Control Act of 1948 resulted in the Clean Water Act (CWA) of 1977. The 1977 amendments established structure for regulating pollutant discharge into United States' waters and the EPA was given authority to implement pollution control programs (EPA, 2010). Also, it was made unlawful for any person to dump pollutants from any source into navigable waters, unless a permit is obtained. Funding for the construction of sewage treatment plants was provided as well as recognition for addressing problems caused by nonpoint source pollution (EPA, 2010). During the late 1980's, efforts were made to bring awareness to runoff pollution expelled by industries. To try to amend this problem, the CWA allows voluntary programs that include cost-sharing with landowners. Also, regulatory approaches were established to improve "wet weather point sources" such as urban storm sewage systems and construction sites (EPA, 2010).

According to the Environmental Protection Agency, the purpose of the Clean Water Act is to regulate pollutant discharge into United States waters and to regulate quality

standards for surface waters. After the passing of the CWA, the EPA has been able to implement pollution control programs. These programs have included establishing wastewater standards for industries and creating water quality standards for surface water contaminants. The goal bestowed by the CWA is to restore and regulate the chemical, physical, and biological significance of our navigable waters to be able to support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water" (EPA, 2010).

Recently, Clean Water Act programs have evolved into a more holistic approach and have implemented watershed-based strategies. This has allowed the protection of healthy waters and attempts of reinstating the damaged ones. This approach also allows for stakeholders to gain and maintain state water quality as well as other environmental issues (EPA, 2010).

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) is the principal federal law in the U.S. that ensures safe drinking water to the public. It was first introduced into the Senate in 1973, and was signed into law by President Gerald Ford in 1974. Since then, the SDWA has been amended twice, in 1986 and 1996. With the intention of protecting the nation's public drinking water supply, it requires many regulatory actions on water sources; including rivers, lakes, reservoirs, ground water wells, and springs. It covers nearly 170,000 public drinking water systems serving most cities and towns, schools,

businesses, campgrounds, and shopping malls. Those Americans whose water comes from private wells, specifically wells serving fewer than 25 persons, are not required to be protected by these federal standards (EPA, 2004). The SWDA authorizes that the EPA set the national health-based standards for drinking water in order to protect against both naturally occurring and man-made contaminants that may be found in drinking water. It is then the job of the water systems to work together to make sure the EPA standards are met. Most oversight over water systems under the SWDA is conducted by states. States can apply to EPA for something known as "primacy," which allows them to implement the SDWA within their jurisdictions, only if they can prove to them at their standards are just as strict as those of the EPA. Almost all states in the union, excluding Wyoming and the District of Columbia, have received this "primacy" title.

The 1996 Amendments to the SDWA took an important forward step in drinking water protection by mandating that states perform source water assessments for each public water system. These amendments also recognized the need for source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water (EPA, 2004). This new approach enhances the quality of drinking water by protecting it from source to consumption. It was the 1996 amendments that gave us a better definition of a public water system, defined as follows: "public water system means a system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals.

Such term includes (i) any collection, treatment, storage and distribution facilities under control of the operator of such system and used primarily in connection with such system, and (ii) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system" (EPA, 2004).

Although the Safe Drinking Water Act is law, there are still numerous sites throughout the United States that do not have safe drinking water. According to the EPA, as of 2006, only 89.3% of community waters systems were in compliance with all federal standards (EPA, 2004). Public water systems are responsible for ensuring that contaminants in tap water do not exceed the standards. Water systems treat the water, and must test their water frequently for specified contaminants and report the results to states. If a water system is not meeting these standards, it is the water supplier's responsibility to notify its customers. Many water suppliers now are also required to prepare annual reports for their customers. Water quality is something that cannot be taken for granted, and it is the duty of the SWDA to ensure the health of all Americans.

Environmental Protection Agency

The U.S. Environmental Protection Agency, commonly just referred to as the EPA, is an independent federal agency responsible for environmental protection in the United States. Formed and recognized by President Nixon in 1970, it served as the main coordinator for environmental programs in the United States since several programs and

agencies were in existence. Thus, the EPA was formed to oversee agencies, grants, research projects, statues, and other environmental conscious activities.

Officially opened in December 2, 1970, the U.S. Environmental Protection Agency has grown dramatically over the years in numbers and funding. It has created infamous statues and set strict regulations for companies in the U.S. From the years 1970 to 2002, the EPA's annual budget has increased from $1 billion to more than $7.3 billion dollars. Also, its work force has increased dramatically from a mere 4,000 employees to a strong 18,000 employees (Anderson, 2011).

From 1970 to the year 2002, the annual budget and their work force has increased dramatically with noteworthy environmental acts that have made great impacts in the United States. The EPA first reached success in the year 1972, two years after it was created, concerning DDT pesticides. Silent Spring, written by Rachel Carson in 1964, publicly brought about the environmental impacts that DDT pesticides have on wildlife populations, thus having an influence on the American people with a more environmental conscious outlook. The ban on DDT pesticides by the EPA gave significance to its earlier years. Other previous accomplishments that are noted in EPA's overall achievements include the Clean Water Act, the Safe Drinking Water Act, and the ban of chlorofluorocarbons to ensure an enhanced protection of the ozone layer. Furthermore, the EPA has created more than twenty-four statutes that have and are currently being implemented and enforced throughout the country. Although there are

other programs that have some responsibility for environmental protection, EPA oversees regulatory programs that are, at times, delegated to the states (Anderson, 2011).

The main task or mission statement that the Environmental Protection Agency has adopted is to protect human health and to preserve the natural environment, including air, water, and land. Within the EPA, you can find numerous subcommittees that focus on different areas of protection and preservation. The Office of Groundwater and Drinking Water works jointly with states, tribes and other collaborators to ensure safe drinking water for the public and protection of groundwater. It works closely with different organizations, citizens, and communities around the United States to further its cause that is defined above. They also carry out scientific research methods and create a database to employ and alter new and existing regulations. Also, the Office of Water, similar to the Office of Groundwater and Drinking Water, has a more general overview of its goals and responsibilities concerning water. The Office of Water focuses on quality of drinking water, but also looks at watersheds and aquatic ecosystems to further sustain activities, fish, wildlife, and plants. They have begun drafting an action plan, named "Strategic Plan", to reach their goal of progression of human health and environmental protection in the next five years. The Office of Water has declared that it is their main goal to "protect and restore our waters to ensure that drinking water is safe, and that aquatic ecosystems sustain fish, plants, and wildlife, and economic, recreational, and subsistence activities." (EPA, 2010)

Controversy surrounds the EPA with industries stating strict regulations are causing negative economic impacts while environmentalists state the EPA is too lenient causing public health and the environment to suffer. Overall, the EPA has seen considerable success throughout the years and has continued its mission for a healthier and cleaner environment for the US and its people.

Successes and failures in U.S. governance

One of the most amazing feats accomplished by the United States and its new technology is the successful diversion of water out in the West part of the country. Without this newfound technology and techniques, it would not be possible to simultaneously support agriculture and large cities like Las Vegas, Los Angeles, and Phoenix. Despite successes such as this, difficulties are also frequently encountered. For example, there has been a failure to address regional water problems on a timely basis. The Hurricane Katrina incident was caused by levee failures, which caused nearly 2,000 casualties and $91 billion of economic damage. The mismanagement of the levee system by the US Army Corps of Engineers has been put to blame. Also, just recently, there have been extensive water shortages in the Southeastern US and California. The shortages have been blamed on rapid population growth in these areas that already lack water sources, especially California (Lyon, 2009). The city of Atlanta, Georgia was in such anguish that it only had three months water supply left before heavy rains replenished their system. Since then, a huge court battle pertaining to the river basins in the area has been going on, as the state of Georgia is trying to make the

Apalachicola/Chattahoochee/Flint (ATF) River Basin a navigation free basin, so that potential drinking water releases to the Gulf of Mexico will instead be stored, in case another drought were to occur.

Another major problem with water governance in the United States is the differing principles used across the nation. In the Eastern states, specifically New England, riparian law is used. Riparian law is "designed to hold water users responsible for returning water undiminished in quality and quantity" (Lyon, 2009). Only those owning property contiguous to a water body (i.e. stream or lake) have right a water right. In the Western states on the other hand, it is based on prior appropriation principle that is on a first-come, first-served basis. Similar to what policy is in Texas; the senior right holders get to pull their allocated amount before any junior right holders. During dry years, many junior right holders will not be able to receive their allocated amount of water. This causes a lot of problems, specifically for several problems for enforcement because of the differences. There is little the United States Government can do to interfere with how states manage their water, even if they disagree with their management styles, as it is protected under the 10thAmendment of the Constitution (Anderson, 2011). The amendment states that "powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people". In this case, the national government was not granted water management powers, and has since been granted to each of the 50 state governments.

Texas

In Texas, there are three main state agencies that have the jurisdiction over water issues. The Texas Water Development Board (TWDB) is responsible for planning and funding projects that enhance water availability. The Texas Parks and Wildlife Department (TPWD) oversees the wildlife of the state, specifically management of important fish, shrimp, and oyster industries having sustainable fresh water supplies. However, it is the Texas Commission on Environmental Quality (TCEQ) who is responsible for protecting and monitoring the state's water quality, as well as allocating the use of surface water using the Texas Water Code. Groundwater in Texas is allocated by the property owner and is not regulated by any state agency.

The TCEQ, headquartered in Austin, Texas, has been in existence in the state of Texas since 1993 when it was formed by the Texas Legislature. However, it has had a presence in the state before this time as the TCEQ was a consolidation of the Texas Air Control Board (1965) and the Texas Water Commission (1985). At its creation, it was known as the Texas Natural Resource Conservation Commission (TNRCC), but acquired its new name in 2002. It enforces the state's environmental regulations and issues air and water permits to businesses throughout the state. The mission of the agency is to strive to protect Texas's human and natural resources while still allowing for sustainable economic development. Our goal is clean air, clean water, and the safe management of waste. It monitors the quality of the water in numerous surface water bodies throughout the state through its 16 regional offices, each with its own water

quality analysts. The water is collected on a 3-month cycle, thus all water bodies are tested four times per year. The TCEQ manages many projects in the state that are helping in aiding the water quality of the state. One includes the Clean Rivers Program, which was passed by the legislature in 1991. It was passed in response to the concerns that water resources and their issues were being addressed separately rather than as a whole. The legislation requires that each river basin be assessed using a certain water quality management approach for the watershed/river basin. Funding for this program comes from charging the water permit holders fees. Helping the TCEQ with the program are 15 agencies, including 12 river authorities, the International Boundary Water Commission (IBWC), one government council and one water district (TCEQ, 2009). Also, the TCEQ partners with Keep Texas Beautiful (KTB) on Texas Waterway Cleanups. The purpose of the cleanups is to help prevent litter around waterways in order to maintain the quality of the surface water. According to the KTB website, 16,333 volunteers cleared 930 miles of Texas waterways in 2009. Also, the KTB partners with the TCEQ in conjunction with the Take Care of Texas program, with the purpose of encouraging all Texans to change their lifestyles in a positive manner that will help improve the air and water quality, conserve water and energy, and reduce waste. The main focus is getting people to put forth a community effort in the cleanup of rivers, lakes, ponds, creeks or streams that they interact with every day (KTB, 2004). All of these programs are designed to aid the water quality in the state of Texas and therefore improve our drinking water quality. Though, the Texas Commission on Environmental Quality does much for the state of Texas, it still has encountered

significant criticism in the past because of its close relationship with industry, primarily in regards to Air permitting. Sunset reviews are done every 10 years for all state agencies, in order to examine whether the agency is still viable, or if changes need to be made to its structure. A sunset review took place in early 2011, in which some organizational restructuring was done for the commission.

The TCEQ maintains water governance in the state of Texas using the Texas Water Code. This water code is one of the most complicated and detailed of all other states in the nation. It is said by many at TCEQ that if you can master the Texas Water Code, "all other states' codes read like a children's book". It is under the Texas Water Code that the TWDB is organized. The board is the state agency primarily responsible for water planning and for administering water financing for the state. The Texas Water Code defines the state's water as being all ordinary flow, underflow, and tides of every flowing river, natural stream, and lake, and of every bay or arm of the Gulf of Mexico, and the storm water, floodwater, and rainwater of every river, natural stream, canyon, ravine, depression, and watershed in the state is the property of the state of Texas (State of Texas, 2005). Also all water imported in from outside the state, transported through any of its navigable streams, is also property of the state as well.

Water may be appropriated, stored, or diverted only for domestic and municipal reasons (especially human and domestic animal livelihood), agricultural and industrial uses, mining and mineral recovery, hydroelectric power, navigation, recreation and pleasure,

followed by other beneficial uses, in that preference order. It is the duty of the citizens of the state to honestly use water and help maintain the biological soundness of the water bodies. Each year, every person who has a water right issued by the commission must submit a written report to the commission containing all information required by the commission to aid in administering the water law and in making inventory of the state's water resources. No report is required of persons who take water solely for domestic or livestock purposes. The right to take water necessary for domestic and municipal supply purposes is paramount and unquestioned in the policy of the state. The Texas Water Code also bars any person from depositing any sort of pollution into surface water, including dead animal carcasses, scrap metal, discarded buckets or pails, garbage, ashes, or any other thing which might pollute the water or obstruct the flow.

In order for any person to appropriate any state water or begin construction of any work designed for the storage, taking, or diversion of water, a permit from the commission needs to be obtained. When a permit is issued, priority of the appropriation of water is based upon the date of filing of the application. During times of extreme drought, those with priority are allowed to put the permits into effect first, meaning those with the most recent permits may get the short end of the stick. During an inspection while interning at the TCEQ, a problem pertaining to this was encountered. The inspection was in a secluded country club in the Fredericksburg area of the Hill Country, in which people downstream were complaining that they weren't getting water downstream of the Pedernales River, which is diverted at the country club. The country club has numerous

small dams for diversion into their water features. However, in the time of drought of summer 2009, their permit was not given priority. Thus, water had to be flowing out of the property. They denied taking water out the river, but eventually, after further investigation, a water pump was found which they did not mention to us prior. The pump was forced to be turned off and they were fined for the incident. This is just one example of priority of appropriation in the state of Texas. In Texas, you can also dig your own artesian well, which is an artificial well in which the water table will be above the ground surface. A person is entitled to drill an artesian well for domestic purposes or for stock raising if it on that person's own land, and if when water is reached containing mineral or other substances injurious to vegetation or agriculture, the artesian well must be securely capped or its flow controlled so as not to injure another person's land or properly plugged so as to prevent the water from rising above the first impervious stratum below the surface of the ground.

One of the most important aspects of the Texas water code is its ability to allow creation of special districts, such as Municipal Utility Districts (MUDs), Drainage Districts, and Irrigation Districts, among many others. These are named in particular because of the huge presence they have in the Lower Rio Grande Valley (LRGV), the focus of the study. Also of huge importance are water supply companies (WSCs), which are non-profit organizations that also have influence over water in the LRGV.

Local

Water supply companies

The Rio Grande Valley has a very complicated and fragmented structure in terms of water. With the mix of irrigation districts, special districts, and water supply systems, it is hard to distinguish one entity from another when looking at the grand scheme of things. MUDs are political subdivisions of the State of Texas authorized by the Texas Commission of Environmental Quality. They provide water, sewage, drainage and other services within the MUD boundaries and are formed when property owners within the boundary petition the formation of the MUD to the TCEQ. WSCs are non-profit corporations which serve rural areas of a county where city service cannot be provided. It is important to point out that there are some major differences between MUDs and WSCs, especially in the areas of financing and regulation. The most significant distinction is that MUDs are recognized political subdivisions of the state, while WSCs are not. This means that MUDs have to comply with many more state regulations, such as the Texas Election Commission, and WSCs do not. MUDs can obtain federal and state grants and/or loans for capital improvement projects and have a tax base and general funds (State of Texas, 2005).

The Rio Grande Valley has many water supply systems spread throughout its four counties. The county with the most in number was Hidalgo County with 24, followed by Cameron County with 22, Starr County with 8, and lastly, Willacy County with 5 water supply systems. The largest system, located in Cameron County, was the Brownsville

Public Utility board, as it supplied water to approximately 139,722 people (2009 estimate). Other larger systems throughout the Rio Grande Valley include: City of McAllen, serving 123,531 people, Harlingen Water Works System serving 79,000 people, and North Alamo WSC serving 70,578 people (Duhigg, 2009).

Drinking water in poor communities

The quality of drinking water for many residents living along this stretch of the Mexican border in deep Southern Texas frequently gets overlooked. In an area where irrigation dominates, poverty is widespread, and many can be found living in sub-standard communities known as colonias, simple things such as having decent tap water flowing through your pipes can be a huge enterprise. With the drinking water in the Lower Rio Grande Valley being governed by various water supply companies (WSCs) and municipal utility districts (MUDs), it is up to the managers of these entities to decide just how good the water going through those pipes is.

The bad stigma for drinking water quality in the Lower Rio Grande Valley is not a new idea. However, despite previous cases that would tell indicate otherwise, the managers of many of these entities supplying water will tell you that the water they are issuing the customers has passed all water quality standards and is not of any health risk to anyone. This brings up a key point that needs to be addressed, which is: water managers and other key actors making the water quality decisions in the Rio Grande Valley all state that their water if of the utmost drinking quality, when their customers think otherwise.

Additionally, it is difficult for many people living in the colonia communities to participate in improving their water quality because they don't know what steps to take or who to communicate with. Thus they rely on the purified water vendors for all their drinking water needs. Therefore, this study will explore the social perceptions of drinking water among the variety of stakeholders in the region to identify how differences in perception and understanding of drinking water issues informs environmental decision making and water governance practices and outcomes. The next chapter will review in detail the methodology that will be employed to describe and assess the perceptions of drinking water quality in the region.

Water quality issue in LRGV

This study sets to out to determine the different aspects of water quality perception in the LRGV. Why exactly is it that many colonia residents have this view that their tap water is of unhealthy quality? A look into the demographics of the area shows that the LRGV traditionally has been one of the poorest metropolitan areas in the nation, along with traditionally high unemployment rates, which should even be here because a lot of the unemployment goes unreported. Adding to the poverty, the population of the area is increasing at higher than average rates, due to high birth rates and immigration. These pressures are creating problems in housing, transportation, welfare, education, and infrastructure. As noted previously, the most dramatic result of these socioeconomic forces is the growth of colonias in rural areas. In the LRGV, colonias are usually called "subdivisions" or "additions", and some lack sewage facilities, drinking water,

electricity or gas utility service. Many are developed where flooding of irrigation canals is a chronic problem, putting them at risk when natural disasters such as hurricanes come through. The soils in the area are clay so they have low permeability, and shallow water tables help carry pathogens to low areas where ponding occurs and children play. Residents may have to drive for miles to retrieve water from public water vending stations. Some residents, out of convenience or necessity, swim and bathe in or draw drinking water from contaminated irrigation or drainage ditches that run near developments. Many efforts to combat the problem have been carried out, including bringing rural water drinking supplies to these areas. However, in some cases, it has made problem worse, because now there is more wastewater than can be treated.

In taking a deeper look into the drinking water quality in the region, specifically Hidalgo County, a severe lag is evident. The main source of water for the water distribution companies is the Rio Grande River, best known for marking the boundary between the United States and Mexico. The Rio Grande River is in a constant state of pollution due to agricultural runoff and industrial waste from both the U.S. and Mexican sides of the border. Many times, it is forgotten that the river is a shared resource, and impacts and consequences of impaired water quality are shared. Under the Clean Water Act and the Safe Drinking Water Act, the EPA has established regulations that require states to produce annual reports on the amount of contaminants found in their drinking water, known as the Consumer Confidence Report. These regulations created by the EPA state

there is a health concern in a water system if a chemical has been consistently testing positive for more than five years (Duhigg, 2009).

The LRGV, Rio Grande River, and Arroyo Colorado each have a storied past when it comes to water including problems with: arsenic, pesticides from agriculture, illegal dumping from Mexican maquiladoras, illegal raw sewage discharge, and brackish groundwater. Many of these problems came to light after the environmental movement of the 1970's. In the LRGV, they became most pronounced in the 1980's and 1990's, when a lot of attention was given to the colonias and their living conditions. In a study done by Black & Veatch Consulting Engineers in the 1980's, residues of DDT and its metabolites were found uniformly distributed in the sediment of the Arroyo Colorado between Llano Grande and Mission. Traces of DDE and DDD were found in the water collected from subsurface agricultural drains on several occasions. Small quantities of toxaphene were found were found from subsurface agricultural drains. Residues of DDT and its metabolites were NOT found in drinking water in McAllen, Mission, Weslaco, or Harlingen. Cadmium was also observed in the water collected from subsurface agricultural drains on some occasions as well. Mercury concentrations greater than EPA criteria for the protection of aquatic life were observed three times in the drainage ditches of the lower valley and in south Bay (Black & Veatche, 1982). These problems that the LRGV has previously faced have had an effect on the resident's mindset of their water quality to this very day, despite the many infrastructure advancements and improvements.

A study conducted by *New York Times* offers insight into which toxins have previously been recorded in the drinking water of Hidalgo County. The results showed that 15 out of the 24 cities in Hidalgo County have tested positive for certain chemicals in their water (see Figure 1). The chemicals that tested positive in the water most often include arsenic, trihalomethanes (TTHMs), lead, radium-226, and dibromochloromethane to name a few. The city that tested positive the greatest amount of times was Las Ruisas (Duhigg, 2009).

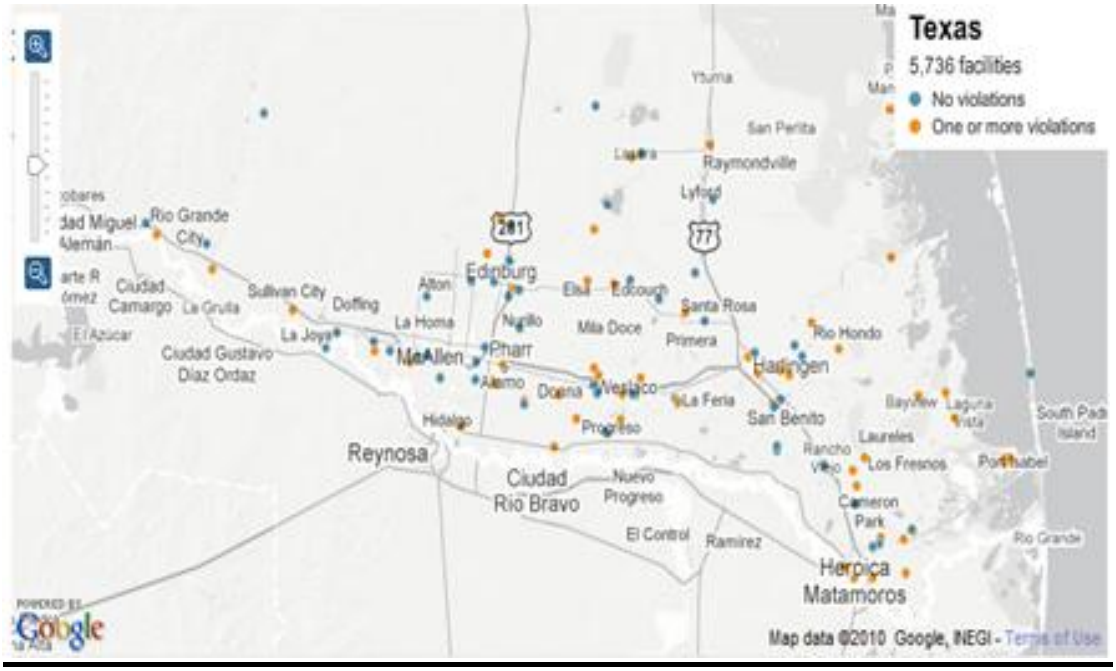


Figure 1: Water quality violations in the Rio Grande Valley
Source: New York Times, 2009

Though the sources of the pollutants were never pinpointed, nor found to be in significant amounts in the water supply, it brings a fear to the residents. Metals such as cadmium have been found in aquatic life, worrying residents because it is not

uncommon for families to catch fish from the creeks and eat them for sustenance. The groundwater problem is not much better in the valley either, as the brackish groundwater located beneath its soils is undrinkable (see Figure 2). This does not stop residents with no water sources from pursuing other options such as community water wells, which often are proved to be inadequate and are often contaminated due to improper well construction or inappropriate or insufficient waste-disposal practices. These dangerous conditions make for a huge health hazard to numerous residents throughout the Lower Rio Grande Valley.

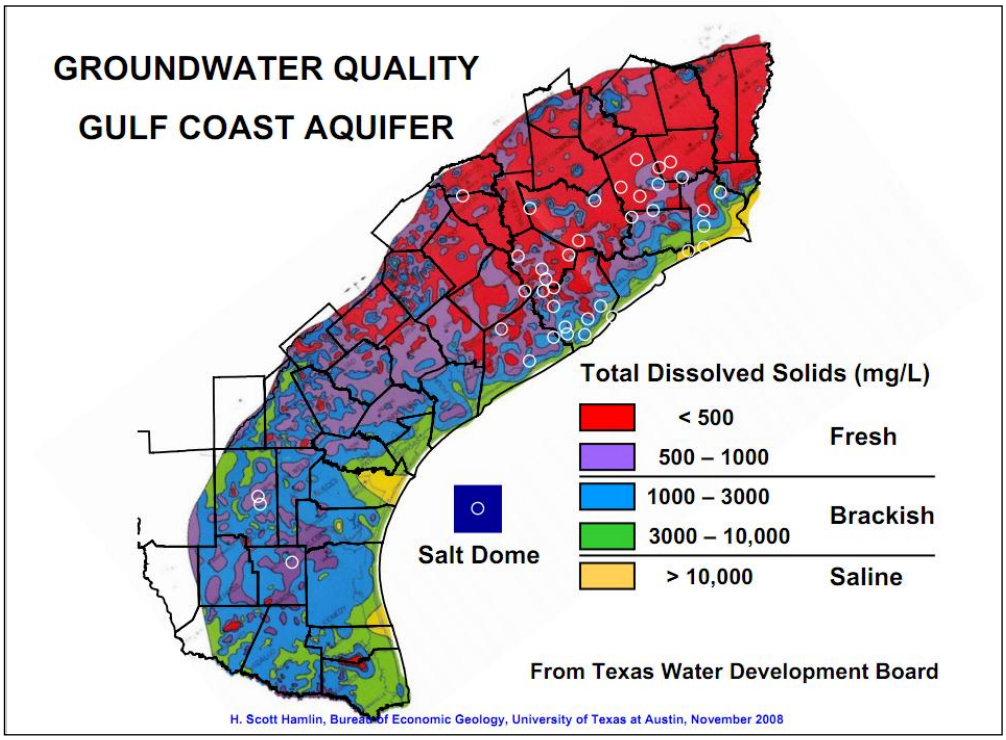


Figure 2: Groundwater quality in Gulf Coast Aquifer
Source: http://irrigationtraining.tamu.edu/presentations/sinton/Hamlin.pdf

A consequence of these hazardous water quality conditions over the past several decades is the rise of water vending stations throughout the Lower Rio Grande Valley. These water vending companies have been commercializing the access to clean water to the region's population. The companies have established water vending machines, known locally in the LRGV as "molinitos", in order to fulfill a market need for purified drinking water. Customers supply their own containers and walk or drive up to the different water vending locations to purchase the purified water at a cheaper price than they would pay for bottled water from a convenience store. The most famous of these companies are Watermill Express, Avant, Aquamax, and Waterplex. The companies have a promising future ahead of them in continuing to be a major source of drinking water for the LRGV region, with problems such as rapidly increasing population, low-income, and poor water quality showing no end in sight.

CHAPTER II

METHODS

Study region

The study region is the lower Rio Grande Valley (LRGV) in the extreme Southern tip of Texas, which lies just on the Northern Bank of the Rio Grande River. As seen below in Figure 3, the region is made up of four counties: Hidalgo County, Cameron County, Starr County, and Willacy County. The LRGV is highly urbanized compared, is separated from other major urban centers, such as San Antonio, Corpus Christi, and Laredo in Texas, and Monterrey in Mexico, by semi-arid ranching brush, and agricultural fields.

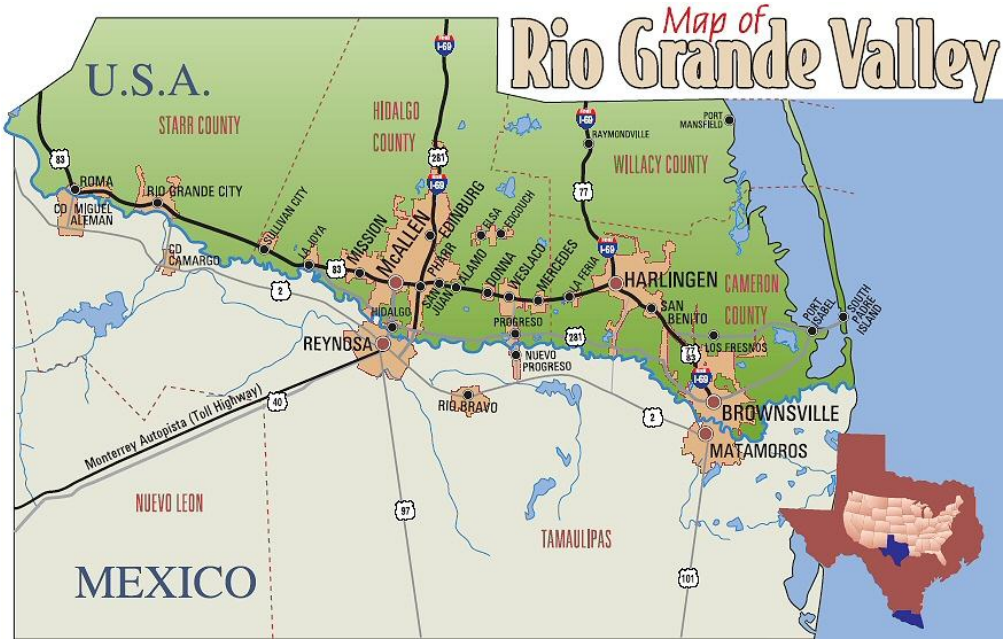


Figure 3: Map of Rio Grande Valley
Source: http://webhost.bridgew.edu/jhayesboh/counties/tx.htm

The LRGV's counties spread over approximately 4900 sq. miles, and have a population of just over 1.26 million people (2010 est.), an estimated 29.2% increase from the 2000 census. Hidalgo County is the largest and most populous of the four counties, with approximately 775,000 residents (2010 est.) living in the county (U.S. Census Bureau, 2011). The largest and most important cities in the area are Brownsville, McAllen, Edinburg, Mission, and Harlingen.

Hidalgo County is one of the fastest growing counties in the nation, increasing over 36.1% from 2000 to 2010 (U.S. Census Bureau, 2011), with much of this increase promoting the development of more colonias in the area. Just west of Hidalgo County lies Starr County, which is one of the poorest counties in the nation, with a per-capita income of less than $10,000. Meanwhile, the LRGV as whole doesn't fare much better, with the average per-capita income coming in at just over $13,000. The LRGV has historically been an impoverished area, with its counties consistently ranking at the bottom rung of poverty on not only state lists, but national lists as well. In a poverty overview of the LRGV published in 1978, Michael V. Miller and Robert Lee Marill stated that the Valley "consistently ranks at the bottom in regard to almost every objective indicator of socioeconomic welfare" (Miller and Maril, 1978). Socioeconomic welfare in this sense includes such factors as per capita income, education attainment, health, and housing conditions. This fact still holds true to this day, over 30 years since Miller and Maril's publication. The fact that the awareness of poverty in this area has

been recognized for so long, and little has been done to curtail it is something very important to take note of.

The following are how the LRGV compares to the states of Texas and the United States as a whole in terms of these socioeconomic indicators:

Table 1: U.S. Census Bureau demographic information for LRGV 2005-2009
(American Community Survey 5-Year Estimates)

	Rio Grande Valley	**Texas**	**U.S.**
% Population with High School Diploma	59.7 %	79.3 %	84.6 %
% Population with Bachelor's Degree	14.6 %	25.4 %	27.5 %
Median Household Income	$29,476	$48,199	$51,425
Median Family Income	$31,584	$56,650	$62,363
Per Capita Income	$13,008	$24,318	$27,041
% Families below poverty level	31.9 %	13.2 %	9.9 %
% Individuals below poverty level	36.3 %	16.8 %	13.5 %
% Hispanic or Latino (of any race)	88.7 %	35.9 %	15.1 %

As noted from Table 1 above, the LRGV is predominantly Hispanic and the median family income is half of the of the United States average, and well below the Texas average. The LRGV also has a lower percentage of high school graduates and bachelor degree recipients, showing there is a lag in educational attainment in the area. The figure that is most evident is that the LRGV has more than double the percentage of

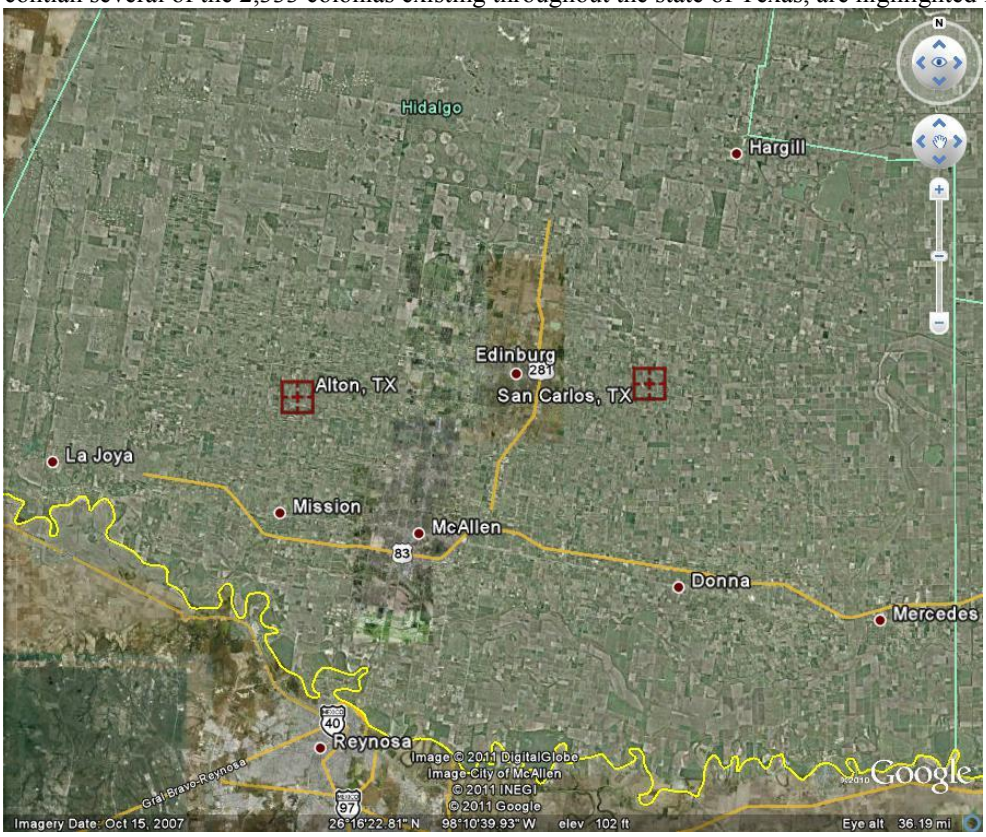
families below poverty level than the state average, and more than triple the U.S. average. These numbers are not improving either, as the income and poverty level gaps are increasing with the migration and population growth the LRGV is experiencing.

Communities of interest

The communities of interest in the study specifically are the colonias in Hidalgo County. *Colonias* is a Spanish term for neighborhood or community, though The Office of the Texas Secretary of State defines a *colonia* as a residential area along the Texas-Mexico border that lacks some of the basic living necessities, such as potable water and sewer systems, electricity, paved roads and safe and sanitary housing. The conditions of many of the colonia sites are comparable to developing countries, not what would be expected to be found on any map in the United States of America. This alarming development happens just a few miles out of sterile-looking cities such as McAllen and Mission, and may seem invisible to those who don't pay close attention (CHUD, 2010). Their proximity to these major cities can be seen in Figure 4.

This study of these low-income areas is necessary, especially focusing on the current inadequate physical infrastructure that many colonias are faced with that inhibit the quality of life of their residents, including: inadequate housing and a lack of transportation, water, energy, and communications systems, as well as poor economic conditions and opportunities, limited literacy and fluency in English, and low income.

Figure 4: Google Earth image of south-central Hidalgo County. The cities of Alton and San Carlos, which contian several of the 2,333 colonias existing throughout the state of Texas, are highlighted in red.



A major roadblock for the residents is they also lack understanding and accessibility of basic services and programs that may help them improve upon the many difficulties they face. The reality of life in the *colonias* is mostly unknown to anyone outside their boundaries, thus it is hard for the human dimension aspect to make an impact on many leaders who are in charge of making the quality of life of these residents all the more better.

The colonias of the LRGV can be broken up into three different categories, as shown below in Table 2:

Table 2: Water and sanitation status of colonias by county, 2006
Source: Parcher and Humberston (2007)

	Cameron			Hidalgo			Starr		
Type	**#**	**Pop.**	**Total (%)**	**#**	**Pop.**	**Total (%)**	**#**	**Pop.**	**Total (%)**
Green	93	25,753	54	270	42,748	27	96	15,631	45
Yellow	41	17,067	36	267	54,283	35	33	6,108	18
Red	42	4,786	10	136	17,253	11	105	12,885	37
Unknown	2	---	---	261	41,848	27	2	118	< 1
Total	178	47,606		934	156,132		236	34,742	

The "green" colonias are those in the best condition, having full water and sanitation service with no drainage problems. "Yellow" colonias, may lack both water and sanitation services and may also have drainage problems. "Red" colonias will be the worst off of the three, lacking both adequate water and sanitation services and more than likely having deplorable drainage conditions. Though Willacy County is not shown, a total of 1348 colonias are accounted for in this table, showing that the LRGV accounts for a large majority of colonias located in the state of Texas. Hidalgo County by far has the largest number, approaching 1,000 colonias, and possibly reaching the number by 2011. Another number to focus on is the percentage of colonias in the "Red" category. Almost 300 colonia communities are in this category, with an alarmingly large percentage coming from Starr County in this category.

Methodology

In conducting qualitative research and analyses, there are several different methodologies to be chosen from. The researcher must choose the methodology based partly on the research that is being done, as well as taking into account the given time and monetary constraints. Below are three of the most common methodologies: Q methodology, semi-structured interview, and questionnaire survey, some information about each of the methodologies, and then the chosen methodology being discussed subsequently.

Q –methodology

History

The method was developed by William Stephenson, a psychologist and psychiatrist, at the University of Oxford in the 1930s. The reason behind the name "Q method" is quite unusual. The letter "Q" was selected to emphasize that Q method was different from R method techniques. There are several discerning factors that set Q-methodology apart from R-methodology. In R research, respondents are the subjects and questions are the variables. R researchers look for patterns in responses across the variables for each person. In Q research, subjects and variables are inverted. Thus, the subjects of a Q study are the Q statements and the variables are the "Q sorts". The letter Q is also reputed to be representative of what Stephenson called *quansal units* (Webler et al., 2009). As Q participants sort statements into categories, quansal units demarcate the categories. Q researchers look for patterns across the variables (Q sorts) for each subject

(Q statement). They try to see if the saliency of one variable is related to the saliency of another variable. Q methodology use in the area of environmental studies is rapidly expanding. The Q methodology is a method used to reveal different social perspectives that exist in different subjects in environmental studies. A Q study reveals whether or not the individuals, or Q participants, agree with the given perspectives. Q method use can be advantageous over other forms of speech analysis in that the participants' responses can be directly compared in a consistent manner, since everyone is reacting to the same set of Q statements (Webler et al., 2009).

Uses in geography and environmental policy

Q method started out primarily as a research method for the fields of psychology, nursing, public health, education, rural sociology, and other social sciences. However, the usage of Q method has spread to include many areas of geography and environmental policy as well, being of great use as it is able to reveal different social perceptions that exist on a subject.

For example, in Steelman and Maguire (1999), the authors take a look into how the Q methodology can bring contribute to better selection and implementation of policies in regards to National Forest Management. In the study, it was concluded that value-free, objective solutions to the policy problems facing National Forest Management were not possible, and thus more public opinion was necessary. In order to accurately incorporate the public participant perspectives, the Q methodology was put to use. Steelman and

Maguire offer two different cases in which it was implemented, each with a different method of garnering their concourse, and then presented the strengths and weaknesses of each method used. There are two basic techniques for selecting the statements to be included in the Q sample—unstructured and structured sampling, and they used the unstructured sampling technique for the first case, which involved the Chattanooga watershed. This unstructured technique provides a survey of positions or perspectives with respect to the issue under investigation. As a consequence, unstructured sampling can suffer from bias in the sampling of topics. In contrast, structured samples purposely select statements to cover a range of topics and seek to avoid biases in over- or under-sampling of particular subject areas. In the second case, a focus group selected based on their diversified backgrounds and their interest in participating was used for the Q study.

Another study in which Q methodology has been utilized is Brannstrom (2010), and his study of neoliberal agriculture in Western Bahia state in Brazil. Once an isolated, desolate area, Western Bahia has become an important agricultural center for Brazil, which many millions of hectares of land being used for soy, cotton, and maize production. The region is a high-input, high-out agricultural area, with the great increase in agriculture bringing more people and wealth to the area, while also minimizing the size of the Brazilian Cerrado. Brannstrom conducted semi-structured interviews in western Bahia and Salvador in 2001 and 2007, in which he obtained Q sorts from 21 respondents. Brannstrom concluded at the end of his study that western Bahia portrayed a governance type that conforms to a “hybrid” description, in which the state has set

policy goals, but non-state actors are increasingly active in setting means and assisting in goal setting.

Summary

An advantage that Q methodology has over other forms of speech analysis is that the participants' responses can be directly compared in a consistent manner, since everyone is reacting to the same set of Q statements. The study begins by identifying bodies of literature for the area of discourse and the relevant population. Having done so, the second stage involves the collection of statements relating to the discourse. The concourse of statements can be composed of many different sources such as newspaper, website, and even personal interviews (Webler et al., 2009). Each Q statement is an expression of an individual opinion, with the statement being a short, "stand-alone" sentence that is easy to read and understand as well as have excessive meaning. The third step is the selection of a limited number of representative statements, called a Q sort, from all of those collected, gathering a small number of Q statements from each category decided upon. Next, the Q participants, which are chosen, based on their varying, but well-formulated opinions, are required to rank the statements against a scale. This is followed by the fifth stage of the process during which statistical analysis of the 'sorts' is carried out to enable the extraction of a few 'typical' sorts. Finally, these typical sorts are described and interpreted using Q methodology allows for the expression of individual subjectivity and provides a framework for the analysis of corresponding points of view (Webler et al., 2009).

Semi-structured interview

Semi-structured interviews provide a greater scope for discussion and learning about the problem, opinions and views of the respondents. While there are some fairly specific questions for the interview question list, there are usually a lot more questions which are completely open-ended. Open-ended questions are used to explore and draw different sides of the issue that may not come up in the more specific questions. With this in mind, the information collected from semi-structured interviews can be both qualitative and quantitative (Barribal and White, 1994).

Advantages and limitations

There are numerous advantages to using the semi-structured interview method. Interviews make it possible to collect complete information from the different categories of sample. Assuming that sampling was done properly, this can ensure a fair degree of validity of information (Barribal and White, 1994). It is possible for you to collect more complex information with greater depth and understanding, particularly when you use in-depth interviews. Interviews are more personal as compared to mailed questionnaire surveys, and tend to result in better response rates. As such, a smaller sample is needed than compared to that of a questionnaire survey. Flow and the sequence of questions can be controlled by the interviewer. In some instances, it is vital that questions be asked in a particular order for proper understanding to occur (Lewis-Beck, 2011). In the questionnaire survey case, the respondent may have the urge to look ahead and see what the questions are. This may actually lead to altered responses from what they would've

answered originally. The semi-structured interview method allows you greater control over the sample of respondents. Selection and interviewing of the respondents will be carried on until the necessary representative sample has been covered. Semi-structured interview method being less formal is a better way of catching the point of view of the people, and getting inside information (Barribal and White, 1994). Questions can also be revised as the interview and data collection process is taking place. The semi-structured interview method is a better way of catching the point of view of the people and getting more the most intimate information possible (Lewis-Beck, 2011).

There are also several limitations associated with the semi-structured interview method. It is rather difficult to analyze data obtained through interviews, especially when there is more qualitative data in response to open-ended questions. The interview process can be quite an exhausting experience, as many interviews may be done on the same day, ranging from the early morning to late afternoon, bringing fatigue to the interviewer (Barribal and White, 1994). It is important that bias is not introduced through the interview, as it can be seen that quality and content of the information can be influenced due to the close interaction with the participants.

Uses in geography and environmental policy

Semi-structured interviews are commonly employed in geography and environmental studies research because it can explore views and conceptual models of resource users. It

is a technique that allows the researcher to explore perceptions of resources and actions taken in resource use.

In an article out of *Land Use Policy*, we see Bohnet, et al. (2011) explore the potential of developing a typology of graziers to more effectively tailor policies and programs with the aim of improving land management outcomes. A conceptual model of the relationship between grazier and grazing land was developed so that both can, ideally, thrive through conscious and timely land management decisions made and implemented by the grazier. A successful grazier land relationship is likely to be consistent with value systems and social and economic factors, although the particulars of any individual approach may vary spatially and temporally (Bohnet et al., 2011). These factors, in particular graziers' values and motivations to follow a particular management strategy, guided the development of our typology of graziers. Australia's Bowen-Broken basin, which has been identified as a major contributor of sediment and nutrients that enter the Great Barrier Reef lagoon, served as a case study for this research. Three broad types of graziers emerged: (1) traditionalists, (2) diversifiers, and (3) innovators (Bohnet et al., 2010). The authors argue that by understanding graziers' values and motivations underlying each of the grazier types, government agencies and NRM organizations can more effectively tailor their policy and extension programs towards specific types of graziers and can work with specific groups to achieve reductions in sediment and nutrient runoff from grazing properties.

In yet another example of the usage of semi-structured interview in geography/environmental research is seen in Mapedza, et al. (2003) research in land use cover. The authors investigated the processes governing land cover change in and around the Mafungautsi Forest Reserve in Zimbabwe. This study site lies at the interface between the state and communal property regimes. Land cover change was analyzed using aerial photography for 1976, 1984 and 1996 within a Geographic Information System (GIS). Perceived change and its causes were investigated through governmental data sources, participatory mapping and interviews with the local community and forest guards. It was found that whilst forest cover within the reserve has remained constant, it has been steadily declining outside its boundaries (Mapedza, 2003). This decline, a result of agricultural expansion and demand for building materials and firewood, was perceived as more pronounced by local farmers than by the forest authorities. Semi-structured interviews were used in order to grasp the local residents' view over land cover change in the area.

Questionnaire surveys

Another method that can be used for such research is the questionnaire survey method. Surveys are familiar to most people, as many have had to fill one out previously in their lives. Whether it be for the decennial U.S. Census, or a customer satisfaction survey at a retail shop, surveys are familiar to almost all people.

Advantages and limitations

Surveys have many advantages over Q methodology and semi-structured interviews. For one, surveys are relatively inexpensive when compared to the others, since the others usually involve face-to-face interviews and thus, traveling. Surveys on the other hand would be mailed in to the intended participants, thus increasing the chances that each person can be involved in the sample. When faced with a very large sample size or large geographic area to study, this method will generally always be more cost and time effective, especially as the number of questions rises as well (Colorado State University, 2011). As a result of the large samples that can be produced, the results will be statistically more significant. Another advantage to surveys is that they are easier to analyze, especially in comparison to the semi-structured interview data. Data entry and tabulation for nearly all surveys can be easily done with many computer software packages. The familiarity with surveys makes it so that that people are less apprehensive about taking them. Surveys help reduce bias in the research that may be encountered with semi-structured interviews. Standardized questions make measurement more precise by enforcing uniform definitions upon the participants (Colorado State University, 2011). The researcher's own opinions will not influence the respondent to answer questions in a certain manner, since there are no verbal or visual clues to influence the respondent. Questionnaires are less intrusive than telephone or face-to-face surveys. When a respondent receives a questionnaire in the mail, he is free to complete the questionnaire on his own time-table. Unlike other research methods, the respondents are not interrupted by the research instrument some people might be scared

when answering questions. Usually, high reliability is easy to obtain--by presenting all subjects with a standardized stimulus, observer subjectivity is greatly eliminated (Colorado State University, 2011).

The cons of surveys are that the researcher must develop questions that are general enough to apply to all respondents (Colorado State University, 2011). This causes a deviation from questions that may be appropriate to some respondents. Also, surveys don't allow for reshaping/rewording (are inflexible) of its study design after the initial administering of it. Also, it is hard to ensure that the large number chosen for the sample will all reply to the survey. No participation or mishandling of the surveys may lead to a reduced number of returned surveys. It may be hard for participants to recall information or to tell the truth about a controversial question (Colorado State University, 2011).

Methodology chosen

The initial methodology chosen for the study was the Q methodology. Because of the rising use of Q methodology in environmental, geographical, and social studies, it was assumed that the methodology would be the correct choice. In November 2010, the Q participants were chosen based on specific qualities. Preliminary interviews for the Q participants were set to be done in early January 2011, in order to build the concourse, before a return trip to the LRGV in February 2011 for the Q sort to take place.

The collection of Q statements was performed from November 2010 through January 2011. The statement collection process was completed through newspaper and journal article readings, as well as from phone conversations, done beforehand, with the Q participants. From the full set of over 80 statements collected, a certain number were to be selected by the researcher to be representative of all views expressed by key water actors. A process of eliminating repetitive or similar statements from boxes was to result in the reduced number of statements.

However, just as the next steps in the Q methodology process were to be performed, the methodology was unfortunately forced to change. Due to several unforeseen circumstances, a modification was made from Q methodology to semi-structured interview. The biggest problem was the time constraints faced, which would not allow enough time to select the participants and follow through on the entire Q methodology process. One of the biggest problems that was never accounted for was the lack of participation from the participants. Twelve participants were initially selected as part of the study, with hopes of a snowball sample coming out of these twelve, allowing for more interviews. However, communication was a big issue due to all contact was being done either through email or telephone. With the problems encountered, semi-structured interview was the best choice for the given constraints.

Research process

The semi-structured interview process begun in late February 2011 and into early-March 2011. Of the twelve participants selected, only five were able to be interviewed. All interviews done were phone interviews, due to the distance between College Station and the LRGV. The participants were asked several questions using an interview script, with hopes that the best information and views possible on the topic of water quality and accessibility could be gathered. A different interview script was used between interviewees A1, A2, and A3, from the script used for B1 and B2. The difference was the extra questions asked to those working in water disbursement in order to grab a better understanding of how these different entities truly function. The information collected from those sets of questions was not used in the data analysis so that comparisons between all interviewees could be the same.

The interviewees consisted of:

Table 3: Description of Key Water Actors

Identification Number	Background Information
A1	WSC general manager
A2	SUD general manager
A3	WSC water operations manager
B1	public water system investigator
B2	colonia community employee

As seen in Table 3, the interviewees each had different positions in hopes of getting a wide range of opinion from the interviews. Upon completion of the five interviews, all were then transcribed in mid-March 2011. The resulting transcriptions were subsequently analyzed to distinguish the differing opinions of the key water actors.

CHAPTER III

RESULTS

Actor definition of great water quality

Before getting to the root of the research in seeking to address the gap in water quality perceptions, important information to gather from the interview participants was what their own personal definition of "great water quality" entailed. The responses varied, though several had similar ideas and themes. One respondent simply stated that great water quality is water that is "pure, sanitized, and good tasting" (interview, A1, 1 March 2011). Another respondent with a very direct response stated that great water quality could be defined as "water that is safe to not only consume, but to also use for other daily activities such as washing, bathing and on your vegetation" (interview, B2, 10 March 2011).

Others had much broader definitions. As mentioned by another interviewee, great water quality could be defined as "water that is consumable and that could be used for all-around purposes. The water would have to meet certain standards and fulfill the true purpose of water, which is life preservation (interview, A2, 10 March 2011)". It was noted by the interviewee that as science moves forward and advances, more problems will be found in the water. An example given was the water in the Northern-Northeast section of the country, in which traces of pharmaceuticals are now being found. Though this has not been the case in the LRGV, the future findings are uncertain. The

respondent also noted that clean drinking water in of itself will become more precious than oil or gold or anything else in the future.

Though some of the responses were very direct, others showed more confusion on how exactly to answer the question. One respondent expressed that the definition for great water quality from the tap is something that is difficult to put a finger on because it essentially is the same water used to wash clothes, water lawns, flush toilets, and take baths. If bottled water quality is wanted, then the citizens should be willing to pay more, and not have a problem using that same water for all these other actions. They said that "surely no person would want to flush their toilet with the bottled water recently purchased at the convenience store. Citizens cannot expect to have that quality of water, as it is just too expensive. The water of the Rio Grande Valley does have a different taste to it because it is surface water, it has organics and there is the heat in the area that causes issues with oxygenation of the water and algae" (interview, B1, 10 March 2011). The treatment of surface water is much more complicated in comparison to the treatment of pristine groundwater, such has is found in the Texas Hill Country.

Yet another definition gathered on great water quality was that it is water that "not just meets standards of the state, but also personal standards that customers are looking for. The state standard itself creates excellent water, above and beyond anything found anywhere else in the world" (interview, A3, 9 March 2011)**.** The respondent assured that systems work their hardest to not allow anything to happen that would worsen the

quality of water in the distribution system. If so, repairs are done so quickly. They further went on to say that "dealing with Rio Grande River water is a great challenge for the operators, yet when looking at what they have to work with, an excellent and safe product with great taste and odor is still able to be developed. Reverse osmosis water is a luxury in some sense, because you are not battling some of the problems you face in battling with river water, but there are water plants present in the LRGV that can match whatever a reverse osmosis plant is doing. Good quality of water is the kind of water you can go up to the faucet and drink and know it is safe to drink, as well as be happy to have the access to it" (interview, A3, 9 March 2011).

Social perceptions of key water actors

As interviews with the key water actors were taking place, it became evident that they did not share the same social perceptions in regards to their drinking water as colonia residents. As one respondent mentioned, "excellent water quality is supplied to them, better than most others (interview, A1, 1 March 2011)." This respondent went on further to mention that they have been drinking the water directly out of the tap every day for the past 35years. Three of the other respondents all answered very similarly, each mentioning that they too drank the water supplied to them by their companies, with little or no complaint. An important quote from one of the respondents that had a lingering impression was "Can the water smell better? Yes. Can it taste better? Yes. But it is safe to drink (interview, A2, 10 March 2011)."

Not all interviewees were in agreement on the ingestion of tap water though. One interviewee mentioned that it was much easier to force their self to consume water if it is in a bottled container, despite the fact that any water bottle could easily be filled up from the faucet. Convenience was to blame as they claimed it was easier to purchase bottled water from the store and put it in the refrigerator. They went on further to say that they never ingest the tap water "unless it is accidentally swallowed in the shower" (interview, B2, 10 March 2011). Despite this respondent's apparent attitude to towards tap water, they never outwardly claimed that the water was of poor quality.

Explanations for perception gap

Though the perception for water quality of each of the key water actors was quite similar, their explanations as to why the gap in perceptions between them and colonia residents existed showed differing results. This part of the interview was the most important in regards to the goal of the research.

The idea that the perception even existed was brought up by one respondent. They mentioned that they were not aware that anybody thought this of their water. However, after some discussion on the topic, they stated that "if they assume their water is unsafe, then I would assume it has something to do with lack of education" (interview, A1, 1 March 2011). Clarification was asked on the broad usage of the phrase "lack of education". The explanation was that residents were not aware of the great deal of work that goes into purifying the water from the river in order to make it potable. It was

mentioned that a trip to a distribution system could help solve their fears. The respondent never mentioned whether or not the info was available to the residents in any form so that the so-called "educating" could occur.

Another different view as to why the negative view of water quality exists is due to the unappealing taste and odor that LRGV water has. The interviewee mentioned that they were not aware of any company in the LRGV that did treat for taste and odor, the "aesthetic problems" associated with water. An easy fix they brought up for the residents would be for the residents to go out and purchase carbon filters. The water has the odor and taste it does because it is surface water. As the respondent said, "many people assume that if it smells bad, then it can't be good for you. The whole crux of that is that the majority of the time those smells are coming from the river algae and other species. Though this will give the water a slight odor, it in itself has no health effect" (interview, A2, 10 March 2011). One of the most important things mentioned by the respondent was saying that the water could be polished in order to treat for this taste and odor, but it would be at an extra cost and that quality-wise nothing would be gained.

Yet another perspective brought on by the respondents from the semi-structured interview on this existing gap of water quality perception was the problem with the media. It was conveyed that the residents of colonias assume that they are not being provided what everybody else in the region is being provided. This perception of social inequality comes up from past issues that have been highly publicized in colonias, such

as lack of water and sewage infrastructure. Now, despite the fact that many colonias have since been connected to water supply infrastructure, the idea that their water is still not equal to the water of the water the rest of the residents receive is definitely a problem faced by water managers. The interviewee mentioned that "the many people that think that bottled or watermill water is better because of commercials, newspaper, and word of mouth. We (distribution company) do not market our water, but there is absolutely nowhere else could you go, neither a convenience store or watermill distribution station, and buy 1000 gallons of water for just $1.25" (interview, A3, 9 March 2011).

A final explanation that was given from the interviews discussed that the various modes of education that are out there for the residents was to blame. This is somewhat contradictory to another respondent who cited a complete lack of education as the culprit. The interviewee stated that there has actually been much education and outreach performed towards colonia residents. Things such as making them aware of chlorine, fluorine, and other chemicals have gradually changed the resident's perception of their own water. Rather than proving to them that the water is of great quality because of the chemicals, rather they believe the added chemicals only make it worse. This problem is occurring to the point that they "naturally assume that they only way to get quality water is to purchase it in the store in a bottled container" (interview, B2, 10 March 2011). Additionally, the interviewee went on further to blame the propaganda that evolved in the early 1990's, in which much media attention was focused on the effects of tap water

on oral hygiene and oral health, and now citizens have becomes victims of this and are now overly cautious.

One topic that was only briefly touched on during the interview, but is also of huge importance is the equality of water service to all colonias. As seen in Table 2, there are many three different categories of colonias, each with differing infrastructure and water service situations. It was mentioned in one interview that "there were no colonias in the region of Western Hidalgo County that were not currently being provided service" (interview, A1, 1 March 2011). Despite the connectivity being available to the residents however, it was noted that the real issue stands to be that even though residents have accessibility, the burden for payment of connection to the system falling on them is too much. Interviewee B2 notes that "at the moment, there is no form of help available to the residents for situations such as these, and without $800-1600 being readily available to them, they may have to wait before that infrastructure could be introduced into their homes" (interview, B2, 10 March 2011).

The final interview involved some very key ideas that touched on several of the ones stated. It was immediately stated that the residents who are instead venturing out to buy bottled water for the convenience stores and watermills, have "every right to as an expression of personal choice. Tough work is being done in order to remove taste and odors, and any other problems such as turbidity from the river. Despite all the work being done, that personal choice may be because the residents truly believe that offered

in bottled form is safer or better tasting" (interview, A3, 9 March 2011). A lot of emphasis comes from the idea that if the water tastes funny or has a particular odor, then it is potentially hurtful to the consumer. All water systems add chemicals to their water, and the addition of the chemicals changes the aesthetics of the water. In the case with bottled or watermill water, the chemicals that were added to the water in order to clean it have been removed. The interviewee continues by mentioning that "these added chemicals, such as chlorine residual and fluoride, are only added to protect the consumer. Additionally, the water that is supplied to the watermill must travel through the same pipes as tap water to get to the distribution station, and the water for bottled water goes through the same process as tap water. This idea could also be a fault of the media, as perhaps the media is not doing as good a job as it possibly could. Public perception of bad water is tough to answer. A lack of education could also be the culprit, particularly in information regarding tap water and its process going out to the consumer " (interview, B3, 9 March 2011). Thus, it was stressed that it is important for the consumers to inform themselves a little better that the water companies are only adding the chemicals to protect them. Any bacteria or viruses that may want to make their way into the water that could be of potential harm are trying to be eradicated.

Previous issues and future outlook

Previously, and even to this day, the water systems in the LRGV have faced several obstacles that may have kept them from delivering the best services to the region they operate in. One such obstacle that was repeated on several occasions during the semi-

structured interview process was funding. Without having enough money to install and build the infrastructure to supply adequate water to all the people that were flocking to the LRGV in the 1970's and 1980's, a time this region became a very popular part of the state, many residents were left out in the dark. Keeping up with the growth was very difficult then, and it still difficult now. Loans are the primary source of funding for the water companies, and with the exorbitant costs associated with building, many water companies are left with large debt. Companies all seek to receive grants in order to relieve some of the burden of the huge costs, but loans are the main funding type available. Also, problems with the documentation and requirements for lending applications has been a problem, delaying the loan process for companies and in the process hindering development as well.

Another problem that has been seen previously is the poor management structure that several companies are faced with. Companies have been left idle for years at a time with little or no progress being accomplished. This was the case with the La Joya Water Supply Company, until it was court-ordered into private ownership, and then re-established as the now flourishing Agua Special Utility District (SUD).

The future outlook of water quality and improving infrastructure in the area was examined, as to see whether or not improvements could possibly be coming to the area. Due to the increasing population in the region, all respondents acknowledged that new water plants are being built to offset the increased demand and take stress away from

existing structures. The growth potential in the area should be matched by the growth potential from the new infrastructure being built. When asked if there was knowledge of any future plans for restrictions on water usage, all said there was no knowledge of any conservation or water restriction plans as the current systems were not yet utilized to capacity. This is despite that fact that demands on the water system are high in peak times of the year. If at any time difficulty getting adequate water from the Rio Grande River to the facilities to produce and then pump does occur, then there is a possibility, but it is not foreseen.

A problem going into the future is that the LRGV is growing fast, and one thing that needs to be looked at that agriculture is being phased out slowly and being replaced by industrial companies and residential subdivisions. The demand for water is changing from agriculture to personal use for these commercial and residential entities. Despite the change in land use, it is the irrigation districts that continue to have a hold on all this water. The irrigation districts now sell all their water to municipal and water companies in order to make their revenues, rather than getting them from the agriculture business. These water rights should be sold to the companies that actually need and use the water. Without this water right, companies using the water have no control on how water pulled from the Rio Grande River can be dictated. Companies could be able to build their own pumps and take care of themselves. It is something that needs to be looked at carefully.

The definite possibility of desalinization plants is becoming a huge part of the water regime in Cameron and Willacy Counties, which are much closer to the coast, Laguna Madre, and Gulf of Mexico. Hidalgo County leaders are having more difficulty in finding alternative water sources, being so far away from coast and with the brackish groundwater problem that are faced with. In the future, a focus on perhaps coming up with technology that would produce a higher yield from the brackish groundwater could have a huge effect on the water systems in the LRGV. With this groundwater option, companies could get away from water rights and could develop their own well systems, Going into the future, the respondents agreed that important topics on their plate are to obtain their our own water rights, figure out how do draw their own water from the river without having to go through another district, and how can they could research an economically feasible way of drawing groundwater and making it available in pockets throughout the region.

In looking towards the future of water of water security and infrastructure in the area, one respondent mentioned that a huge challenge the LRGV faces is the apathetic attitude that the topic is given. One interviewee mentioned that "most residents naturally assume that some higher being that understands water management better than they do will be take care of everything" (interview, B2, 10 March 2011). Because of this, it is acknowledged that the reality is that the citizens are more vulnerable because they are less informed. Decision are left up to all the water districts and development boards

assuming they have everybody's best interests in mind, and these decisions are usually a matter of opinion.

Also mentioned is that there is not enough emphasis being put on making the existing infrastructure in the LRGV better or stronger. They said that it is evident when we have had various natural disasters, such as Hurricane Dolly, how inept the current system is. It was Hurricane Dolly that struck the LRGV in 2008 causing $1 billion of damage, with its flooding rains exposing the poor drainage system of all four Lower Rio Grande Valley counties. With Hidalgo County being the largest county in the LRGV, in terms of both area and population, problems that aren't addressed will affect the other counties downstream negatively. If Hidalgo County is having an issue, it will naturally affect Willacy County and Cameron County.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

Through the semi-structured interview process, views of the key water actors that participated were able to be compared to previous perceptions gathered from colonia residents. The process allowed for flexible interviews to be adapted to each particular actor, allowing for information in which the respondent was most knowledgeable in to come out and be focused on. Each particular interviewee had great input to the research, some more in topics than others.

One problem encountered in the interview process was the fact that interviews were done over the phone. The lack of face-to-face contact with the respondents made it difficult to decipher whether or not all questions were being answered truthfully. Body language is very important, and the phone interview made this an issue. Also, face-to-face contact allows for a closer relationship to be established with those being interviewed, and perhaps more information could have been gathered then. An example of a question which this may have impacted is the question asking whether or not the respondents ingested the water from their tap. Four of the five answered “yes”, followed by explanations as to why. During the transcription process, close attention was paid to the voices of the respondents to note any tone changes, however, it is quite difficult to

determine complete truth given the circumstances. The manner and tone in which they answered the question offers the possibility that not all were completely truthful.

In transcribing the question asking about the gap on social perceptions, it seemed as if the reasons that each of the participants offered in reflecting on the gap that may exist between them and the colonia residents all have sound reasoning. Lack of education, taste and odor, media, and cautiousness were all to blame for reasons why the colonia residents have shied away from drinking their tap water. It sounds like a good argument to say that the culprit to blame could be any one or a blend of these points. It is particularly reassuring to hear the taste and odor because those were the main complaints being heard from colonia residents during a previous visit. Residents asked about the odd tasting water with a smell of dirt or chlorine associated as well. The case about connectivity cost of the water system to the resident's homes was also a very important point, because it brought to light the gap in social perceptions of water infrastructure. The key water actors are unable to accurately understand the economic situations that the residents are facing. Because the infrastructure is in place, the companies seem to think that they have already done their part, and will not care about the residents until their connection fees is paid and monthly payments begin to come in. Once this occurs, then they may begin to worry about their newly-connected customers.

As these companies look towards the future and the rapid population boom the region is experiencing, good things are being done for preparation. The construction of more

water plants, water towers, and miles of pipes being added all show they are bracing for this forthcoming increase well. Additionally, the adoption of alternate techniques and technologies such as desalinization and developing feasible ways to harness the brackish groundwater all have these companies looking forward towards the future. However, I think an important question begs to ask is how these developments will affect colonia residents. The exact placement of many of the new infrastructure was not mentioned, they could all be in rich, all-inclusive residential neighborhoods and near industrial companies. This is where the gap in social perceptions occurs, with the key water actors being so unattached from these hidden communities that they are not exactly aware of their sufferings. It was also evident that the mere subject of colonias, when brought up during the semi-structured interview, was not one that was favorable to the actors. Being that they have been given a lot of media attention over their sub-standard living conditions, the key water actors wanted to stress the good and sidestep the bad.

Conclusions

The first chapter of this thesis examined a background of water governance on scales from global to local, as well as water quality issues in poor communities and drinking water problem in the LRGV. Chapter II described three different methodologies for qualitative research and why the semi-structured interview method was chosen for this research. The next chapter analyzed the results garnered from the interview process.

As was determined through the qualitative semi-structured interview method, a gap in perceptions between colonia residents and key water actors in the Lower Rio Grande Valley does in fact exist. Despite the acknowledgment of its existence, there was little interest or concern on the minds of any of the key water actors as to how to solve the problem. For example, for the common complaint about the bad aesthetics of the water, one respondent suggested the residents go out and purchase carbon filters at the local Lowe's hardware store. This is an easy fix in their eyes and a way to curtail the residents' complaints, taking no account their education on the matter, economic situation, etc. Because the water actors stand firmly behind the idea that their water quality is great, the need for action to convince the residents is minimal. With this in mind, along with population growth at very rapid rates in the region, the assumption is that not only will the number of colonias continue to grow, but residents of these areas will continue to suffer, perhaps never being able to bridge this gap in water quality perception with their key water actor peers.

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APPENDIX A

Interview Guide – Key Water Managers

1. **Operations**
    a. How is decision-making structured?
        i. Leadership?
        ii. Stakeholder/Constituency representation
            1. When are elections held?
            2. How often?
            3. How are stakeholders notified of voting procedures?
    b. Financial resources
        i. What is the source of the money you use to pay for your operating costs? How is this distributed?
            1. Government?
            2. Investors/Donations?
            3. Customers?
    c. Explain billing structure for household consumers
    d. Maintenance
        i. Contract out with another company or is does the company have a department that handles this?
    e. Monitoring
        i. Is water quality monitored at certain dispersal points in service area or just at the treatment facility?

2. **Assessment/Reflection of History**
    a. Name three key moments that have helped you progress toward achieving your organization's/company's goals over the past 30 years (1980-2010).
        i. Water quality?
        ii. Infrastructure?
    b. Name three key setbacks that have been obstacles for achieving your organization's/company's goals over the past 30 years (1980-2010).
        i. Water quality?
        ii. Infrastructure?

3. **Futures**
    a. What are the three primary challenges facing water *quality* in the region?
    b. What are the three primary challenges facing water *access* in the region?
    c. Increasing demand
        i. The LRGV, especially Hidalgo County, are some of the fastest growing regions in the country. What are your plans for meeting increasing demand of water in the region?
            1. Do you have a plan in place for a conservation agenda?
            2. How do you plan to reconcile a stable supply yet increasing demand in an equitable manner?

4. **Perceptions of water quality**
    a. How would you describe the quality of the water your company supplies?
        i. Define "great water quality"
    b. Why do people assume the water quality is bad for your health?
    c. Do you drink the water this company provides?

APPENDIX B

Interview Guide – Key State Agency and Community Actors

1. **Assessment/Reflection of History**
    a. Name three key moments that have helped you progress toward achieving your organization's/company's goals over the past 30 years (1980-2010).
        i. Water quality?
        ii. Infrastructure?
    b. Name three key setbacks that have been obstacles for achieving your organization's/company's goals over the past 30 years (1980-2010).
        i. Water quality?
        ii. Infrastructure?

2. **Futures**
    a. What are the three primary challenges facing water *quality* in the region?
    b. What are the three primary challenges facing water *access* in the region?
    c. Increasing demand
        i. The LRGV, especially Hidalgo County, are some of the fastest growing regions in the country. What are your plans for meeting increasing demand of water in the region?
            1. Do you have a plan in place for a conservation agenda?
            2. How do you plan to reconcile a stable supply yet increasing demand in an equitable manner?

3. **Perceptions of water quality**
    a. How would you describe the quality of the water your company supplies?
        i. Define "great water quality"
    b. Why do people assume the water quality is bad for your health ?
    c. Do you drink the water this company provides?

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