DEFINING PERCEPTIONS OF WATERSHED MANAGEMENT IN A GREAT PLAINS AND IN AN ANDEAN WATERSHED

By

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Abstract

The goal of this thesis project was to explore the perception groups related to watershed management in a Great Plains and in an Andean Watershed. It is essential for watershed stakeholders to acknowledge that there are different perceptions about watershed management among themselves. The Q methodology is an innovative and dynamic interview method that uses qualitative and quantitative data to interpret participants' perceptions.

In Kansas, the stakeholder group displayed three perception groups: hands-on rural residents; detail oriented urban and suburban residents; and pro data collection and conservation of natural functions government official. The Andean watershed also displayed three perception groups: Manizales needs proactive measures to prepare for future landslide events; it was not waters of Manizales, it was nature; and preventing the incrimination of specific institutions. A better understanding of the contrasting perceptions of individuals making up both of these stakeholder groups can substantially improve water resource management.

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CH 1: THESIS INTRODUCTION

A major challenge to addressing today's environmental problems is the fact that most parties involved have different points of view or perceptions regarding the appropriate solutions to these problems. Based on the Geographic framework of Robert David Sack, the collection of the experiences in place we have had in the past are the basis for our perceptions and points of view. Our interactions with the society and nature found in a specific place are the underlying basis for the meaning that we attach to certain aspects or situations. Therefore, since we all come from different places, when confronted with an environmental problem, we all have different perceptions about it and different proposed solutions to the problem and what we ultimately consider to be "in place" and "out of place" (Sack, 1997)[1]. For an example of the Geographic framework using the case study developed in chapter 3 of this thesis, see Fig 1.

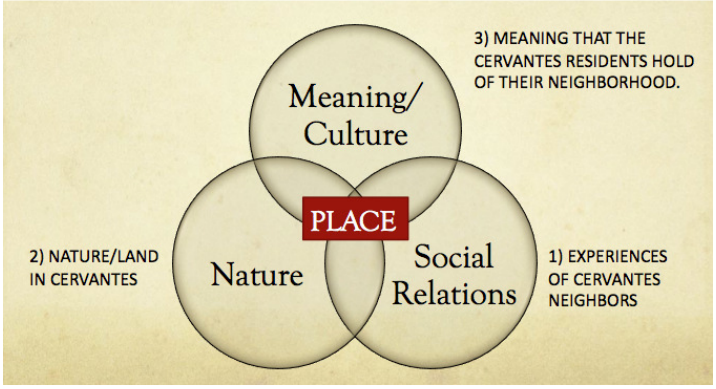

Figure 1. Figure by author. Example of the Geographic Framework in the case study: Defining Perceptions of Watershed Management in an Andean Watershed.

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[1] Social Relations in place making are ultimately related to what Sack calls "In/out rules", the rules governing, for example, who is allowed in a region (place) and who is not, and such rules may be unspoken, involving cultural norms, customs. These rules extend to the natural and cultural realms as well.

Meaning of place is related to the ideologies, impressions, discourses, narratives, and culture that shape a place.

The Nature of a place + the Social Relations that happen in this place impact the Meaning that an individual holds of that specific place.

This geographic framework allows us to comprehend our relationship with the natural world, and therefore, our role in the preservation or decimation of our surrounding environment. It is well known that natural resources worldwide are in great need of preservation and conservation for the success of upcoming generations. In order to recognize our role in the efforts towards the fulfillment of this goal it is imperative that we acknowledge the impact that we have in our local environment. In watershed management for example, it is recognizing that we all reside in a watershed and that we as a "watershed community" have a critical role in the quantity and quality of water that we and other organisms consume. The way we use and discard water impacts all organisms residing downstream from us in a direct or indirect manner. As water is vital for life and its sustenance, it is our responsibility to consciously make use of this precious resource. The way we carry this process out, as mentioned above, is dependent on our personal perception on the urgency to conserve the water resource.

During my undergraduate career, I became interested in water quality issues of the drinking water source where I reside, near the Clinton Lake Reservoir in Lawrence, Kansas. I met a number of individuals who were, and still are, passionate about the conservation of this drinking water source. Among these individuals was the coordinator for the Upper Wakarusa Watershed Restoration and Protection Strategy (UWWRAPS) group. While the coordinator had been retired for a number of years, he decided to take on the challenge of using the Clean Water Act as a tool to mitigate the negative impact that non-point source pollution ultimately has on the Clinton Lake Reservoir. The main strategy of UWWRAPS is to use financial incentives, like cost-share programs, to entice landowners to participate in the implementation of what are called best management practices (BMPs). These BMPs help reduce non-point source pollutants from entering bodies of water in the watershed. The mentoring relationship that emerged between the UWWRAPS coordinator and me contributed to the publishing of my undergraduate senior project, *Taste and Odor Problems in Clinton Lake Reservoir's Drinking Water*, in The Journal of Undergraduate Research at the University of Kansas.

Through our many conversations I understood the incredible challenges that the coordinator faced in order to protect the drinking water source for watershed residents.

Among these challenges was the fact that, as time passed, fewer landowners in the watershed were willing to participate in the cost-share programs. This is a problematic situation simply from a funding perspective; if funds to participate in these programs are not spent, then it casts doubt on the need for the UWWRAPS program in the first place. The funds could be directed to other WRAPS programs with more active landowner participation, and the UWWRAPS could ultimately dissolve. We came to the conclusion that a major impediment to the adoption of BMPs by the watershed landowners is their perceptions regarding the implementation of BMPs. The landowners who have already participated seemed either to be truly interested in water resource conservation or to be interested in the monetary incentive as a reason to participate. Those participants who have not participated yet are hesitant landowners who need to be approached in an unconventional manner.

There was an evident need to understand the points of view and perceptions of these landowners regarding the BMP adoption process in order to approach them in a more efficient manner. This exploration would ultimately allow the UWWRAPS to move forward in their efforts to protect the water resources of the Upper Wakarusa watershed. The UUWRAPS is composed of a Stakeholder Leadership Team (SLT), representing the stakeholders in the watershed, including hesitant landowners. Therefore understanding the perceptions of the SLT may provide insights regarding the perceptions of those hesitant landowners.

The Q method, described in more detail later, provided the perfect way to explore these perceptions. This methodology provides the flexibility of working with small numbers of participants, while at the same providing a holistic view of the participants' perceptions. In order to obtain this holistic view, this methodology utilizes qualitative and quantitative analyses that complement each other during the data interpretation process. I believe that the method provides the tools necessary for a researcher to obtain as accurate a representation as possible of the perception differences and commonalities within a pool of stakeholders on any given issue.

Based on the fact that re-establishing conversations with hesitant landowners may be challenging, any future conversation about entering a cost-share program for implementing BMPs requires a targeted approach to result in landowner participation. In order to target these

exchanges best, the UWWRAPS coordinator and I agreed to ask the stakeholders participating in my study about the practices they believe help to achieve, or do not help achieve, riverbank stability. Two of the main pollutants targeted by the UUWRAPS are high nutrient input and high sediment loads. Riverbank instability has the potential to contribute significant quantities of both pollutants. Riverbank stability projects are often some of the most expensive projects out of all the other practices funded by cost-share programs. Furthermore, implementing a number of less costly BMPs, also funded by cost-share programs, can prevent riverbank instability. The Q methodology used in this study therefore focused on a number of BMPs that help mitigate riverbank instability and that also help mitigate pollutant input.

The Q methodology will provide the UUWRAPS with three main pieces of information: identification of different perception groups within the Stakeholder Leadership Team; identification of BMPs that most everyone agrees helps riverbank stability (consensus agreement statements); and identification of BMPs for which there is no agreement among the groups that they help riverbank stability (consensus disagreements statements). As the UUWRAPS SLT divides into different groups of people who share perceptions regarding riverbank stability, so does the population in the Upper Wakarusa Watershed. Therefore, the perception groups within the SLT may provide insights regarding the different perception groups that may be present in the watershed and that need to be acknowledged prior to future conversations. Recognizing that there exists different perception divides and commonalities among the UUWRAPS members might also prompt reassessment and evaluation of this group's dynamics.

The consensus statements are the most important tools that the Q methodology can provide the UUWRAPS group. The consensus agreement statements in this study are the BMPs that all participants, no matter what perception group they are in, agree do help riverbank stability. On the other hand, the consensus disagreement statements are the BMPs that all participants agree, do not help riverbank stability. Knowing the BMPs that all participants agree with and those that participants do not agree with may overlap with hesitant landowner's perceptions regarding riverbank stability. These statements serve as tools to start conversations with hesitant landowners about engaging in BMPs in ways that may be more welcomed than

other ways (for example, making BMPs purely voluntary, or conversely, strictly required and enforced by laws and regulations). Re-establishing conversations with these landowners having this knowledge on hand may lead to improved BMP adoption.

The topic of watershed management, and the use of the Q methodology in the study of perception among groups, are the primary connections between the two case studies of this thesis: the Wakarusa Watershed in Kansas and the Chinchina watershed involving the municipality of Manizales, Colombia. Watershed management in both regions involves the responsible leadership of institutions and governmental offices, in addition to the active involvement of stakeholders and community members in the watershed. In this thesis, watershed management in Kansas focuses on the implementation of proper BMPs in order to improve the quality and quantity of water in the watershed. The city of Manizales, Colombia is currently working in the early stages of water conservation in the Chinchina watershed, with the implementation of a plan for the use of water resources (PORH). Watershed management in Manizales is directly related to authorities' priorities to provide water security for the citizens of Manizales.

Watershed management in Manizales is illustrated using a 2011 case study of a landslide disaster that led to 48 casualties and over 20 days of no water for the city of Manizales and the surrounding municipalities. The steep mountains where Manizales is located, inadequate land-use planning in the city, and increasing torrential rains often lead to catastrophic landslides twice a year during the rainy seasons. During the later months of 2011, the city of Manizales suffered a catastrophic series of unfortunate events that impacted the citizens in a number of ways. The main inspiration for exploring this case study was the fact that my own grandmother, who still resides in Manizales, was affected by this event. The physical strain of carrying water in the steep hills of the city, and the uncertainty of when the situation was going to end, pushed my grandmother into a nervous breakdown. She had to spend a number of days in a mental hospital of the city. Being overseas, and with not much that I could do, I decided to write about this 2011 disaster in an attempt to shine light on the consequences resulting from inadequate water resource management.

As in other Latin American countries, major stakeholders in the watershed have significant power on the decision-making processes regarding the management of the city, including water resource management. In Manizales more specifically, the major water utility company's president is also the mayor of the city, who appoints the manager of the utility company. With each changing mayor, the manager of the utility company Waters of Manizales (Aguas de Manizales) also changes, forcing the company to change its vision, mission, and focus as often as every two years. This constant instability in leadership prevents Waters of Manizales from establishing long-term goals, because each incoming manager is often focused on leaving their personal mark during their time in office. This turnover affects the ability of Waters of Manizales as an institution to focus on the water security of future generations of Manizales citizens.

This was clearly witnessed in the fact that the back-up water treatment plant for the area, Niza, had been out of service for a number of years, increasing the vulnerability of the city to face a complete lack of water if the only working treatment plant, Luis Prieto, suffered some unexpected damage. This is exactly what happened when a large landslide significantly damaged Luis Prieto. The inadequate maintenance of the water distribution network is also evidence of the short-term vision of Waters of Manizales. The aging network requires more frequent and specialized maintenance. During one of the unfortunate landslide events of late 2011, a large pipe ruptured in the neighborhood of Cervantes, killing approximately 48 individuals and leaving a significant number of displaced families. A number of people stated that when the water distribution system was being reactivated, the pipe in Cervantes started leaking immediately. Despite community reports to the authorities, these reports were not acknowledged and therefore no expert was able to foretell the upcoming disaster. The next day, the pipe ruptured, adding to the tremendous chaos in the city. Today, Manizales citizens still live in fear, reporting seeping slopes indiscriminately.

In the Q method study carried out in Manizales, major stakeholders interested in the proper management of the watershed were interviewed. Most of those interviewed have decision-making power over the management of the watershed. Therefore, their responses would provide an indication about the aspects that need to be addressed in order to prevent

similar catastrophes in the future. The Q method provides participants with a private space to reflect and express their feelings about the topic at hand. This non-threatening space could encourage stakeholders to share ideas that they may not be comfortable sharing with other stakeholders. While a participant's opinions may incriminate themselves or the institution they work for, the anonymity associated with the Q method allows for more freedom of expression.

It is hoped that information regarding the perception groups, consensus agreement, and disagreement statements may provide a starting point for better watershed management. It would be interesting for stakeholders to witness the differences and commonalities in perception regarding the aspects that need to be improved in the city to prevent similar disasters in the future. Recognizing that not all major stakeholders of the city perceive water management in the same way may be eye-opening for a number of authorities. Knowing what are the perception groups may also provide insights regarding the inner dynamics of the power system in Manizales, which may be the basis for potential changes in management.

A number of media sources in the city of Manizales have shown interest in the results of this thesis, which may be a potential medium for dissemination of results. Additional data collected during fieldwork in Manizales will be analyzed and published in media sources and potentially in peer-reviewed journals. The Kansas Q study has already been published by the UUWRAPS, and a webinar was held at the Kansas Department of Health and Environment, which showed interest in the expansion of this study. The innumerable lessons learned during this thesis project and specifically, the lessons learned from using the Q method, are invaluable as I proceed onward to doctoral studies and research.

The goal of this thesis project is to explore the perception groups related to watershed management in a Great Plains watershed and in an Andean Watershed. It is essential for watershed stakeholders to acknowledge that there are different perceptions about watershed management among themselves. Knowing the number of different perception groups and their characteristics may ease stakeholder group dynamics and decision-making processes on watershed management. Additionally, it is critical for stakeholder groups to know aspects that they agree and disagree on when approaching a problem. Having a commonly agreed pathway serves as a proactive and targeted tool for a faster and more efficient problem resolution. At

the same time, the identification of common disagreement areas should prevent unnecessary conflict during problem resolution.

The Q methodology is one available method that helps in obtaining different perceptions in a group of people, and also provides areas of agreement and disagreement in a group of people. The Q methodology is an innovative and dynamic interview method that uses qualitative and quantitative data to interpret participants' perceptions. This methodology has been typically used in the disciplines of psychology and political science, and it is currently transitioning into the disciplines of environmental sciences and geography.

This thesis will utilize the Q methodology to determine the perception groups among the stakeholder leadership team of the Upper Wakarusa WRAPS (UWWRAPS) regarding riverbank stability. Instability of the riverbank in the watershed has a significant impact on the quality and quantity of the Clinton Lake Reservoir, problem that is the sole target of the UWWRAPS. Furthermore, this thesis will also utilize the Q method to explore perception groups among major stakeholders in the Chinchiná watershed, regarding disaster preparedness through water resource management. This information aims to acknowledge aspects that need to be addressed in the city of Manizales in order to prevent catastrophes like Manizales Sin Agua 2011.

There are four chapters in this thesis, including the introduction. Chapters two and three develop the case studies, and chapter four is the conclusion of the thesis. Chapter two is titled Defining Perceptions of Watershed Management in a Great Plains Watershed. This chapter's literature review starts with a description of a number characteristics of landowners who adopt or reject best management practices (BMP), it goes on to talk about the barriers and solutions for BMP adoption and finishes with a discussion about the role that landowner perceptions may have on BMP adoption. An overview of the Q method usage in BMP perception, serves as a transition to the physical and human geographic context of this case study. Next, a more detailed discussion of the Q methodology and the steps involved in the execution of this method. The results present the perception groups and the interpretation of their perceptions through qualitative and quantitative data. Lastly, the discussion section is focused on the cost-share programs and the areas of agreement and disagreement between

the Stakeholder Leadership Team of the Upper Wakarusa WRAPS. The conclusion for this chapter allows us to transition to chapter 3, which presents the exploration of perceptions of watershed management in the Andean watershed of Chinchiná.

Chapter 3 is titled Defining Perceptions of Watershed Management in an Andean Watershed. It starts with a literature review that explores the consequences of urban water mismanagement, followed by a number of suggestions for reforms in urban water management are presented including the need for data collection. There is an introduction of integrated water resource management and other alternatives for urban water management. A discussion of the major categories of watershed stakeholders follows, finishing the literature review with the land use and water resource plans in Colombia, and a discussion of perception on urban water management. The physical and socioeconomic context in the city of Manizales is then presented to frame the development of the Manizales sin Agua 2011 case study. The Q methodology and its application to this case study are developed in this section, followed by the interpretation of results, the discussion and the conclusion. As in chapter 2, the interpretation of results provided the perception groups in this case study, the discussion section presents the agreement and disagreement statements, and the chapter closes with a short summary found in the conclusion.

Chapter 4 presents the thesis conclusion as a reflection of what was learned during the process of writing this thesis. This reflection includes personal lessons involving the use of Q methodology and it ends with a discussion of the connections between both case studies. I hope the reader enjoys this thesis as much as I enjoyed exploring perceptions through the Q methodology in such different geographic areas.

CH2: DEFINING PERCEPTIONS OF WATERSHED MANAGEMENT IN A GREAT PLAINS WATERSHED.

This chapter utilizes the Q method to explore the perceptions of the Stakeholder Leadership Team of the Upper Wakarusa Watershed Restoration and Protection Strategy (WRAPS). It provides a description of the perception groups that emerged after the Q methodology qualitative and quantitative analyses. This chapter also provides the areas of agreement and disagreement between the Stakeholder Leadership Team. These areas are composed of best management practices that help or not help riverbank stability in the Upper Wakarusa Watershed. Riverbank instability has a significant impact on the water quality and quantity in the watershed, which is the main focus of the UWWRAPS. The chapter starts with a literature review of challenges and solutions to best management practice adoption and implementation. This literature review continues with the perceptions of best management practices in the Great Plains and the role of the Q methodology in this analysis. The chapter continues with a presentation of the physical and human geographic context, followed by an extensive explanation of the Q methodology, finishing with the interpretation of results and discussion.

Abstract

Mitigation of non-point source pollutants in Midwestern agricultural regions has proven challenging because there are a large number of landowners in each watershed, making it unfeasible to pin down specific responsible parties. As a result, environmental authorities have favored voluntary incentives over mandatory regulations. Cost-share programs (see Appendix 1 for examples of cost-share programs) provide a financial incentive for volunteer participation in the implementation of different best management practices (BMPs) to reduce contamination from agricultural activities. While the financial incentive was thought to be sufficient to obtain participation in the program, at this time, a significant number of landowners are hesitant to participate.

Those landowners who shared the same objectives as the cost-share programs readily implemented BMPs in the past. Conservation groups, however, have not been successful reaching out to those who have not implemented such practices. Unfortunately, those reluctant to participate seem to be significant contributors to agricultural pollutants in the watershed. In sum, as one participant from this Q method study participant noted, "The low hanging fruit has already been picked." Now it is necessary to take a different approach in our attempts to better understand those hesitant landowners. Unearthing the underlying reasons for this lack of participation in programs that aim to reduce water pollution has been the subject of multiple studies reviewed below.

Literature Review

Sample Characteristics of Adopters and Rejecters of BMPs

Farming communities in the US, and potentially worldwide, are often subjected to policies that encourage the adoption of BMPs. Most of these policies attempt to reach a wide variety of farmers; however, this often leads to generalizations about their personal agricultural goals. For example, it is often assumed "that farmers' behavior is homogeneous […] and constrained by profit maximization goals" (Bumbudsanpharoke, Moran, & Hall, 2009, p. 226). Yet not all landowners adopt or reject BMPs based on personal economic standards.

This literature review shows that the decision making process may be influenced by a variety of aspects, including land ownership, demographics, the size of operation farmers manage, and their aversion to risk. Those farmers who work their own land instead of a rented plot are more prone to invest and adopt BMPs (Featherstone & Goodwin, 1993; Gillespie, Kim, & Paudel, 2007) and reduce the use of agricultural chemicals, such as pesticides (Gillespie et al., 2007). In terms of gender, males are more likely to seek information and employ BMPs based on their own preferences (Gillespie et al., 2007). Older farmers are less likely to invest in new conservation technologies (Featherstone, & Goodwin, 1993); this may be due to the lack of information or unfamiliarity with these practices. When knowledgeable of these practices,

however, older individuals successfully find BMPs' applicability to their land (Gillespie et al., 2007). Large farm households, corporate farms, and small cattle producers are more likely to show concern for land maintenance (Gillespie et al., 2007) and invest in conservation practices (Featherstone, & Goodwin, 1993; Gillespie et al., 2007). Farmers who prefer to avoid losing their crop production to natural phenomena, such as droughts (Saarinen, 1966), prefer to secure a payment from the government for participating in conservation programs (Houston, & Sun, 1999).

This literature review therefore shows that tenants, females, uninformed older farmers, small farm households, non-corporate farms, large cattle producers, and farmers avoiding risk should be targeted for participation in conservation programs. This is just a sample of the characteristics that represent the farming community. A broader number of variables might allow for a deeper understanding of individual cases in different geographic areas, especially when dealing with farmers who are persistently hesitant to participate.

Barriers and Solutions to the Adoption of BMPs Through Cost-Share Programs

In addition to the characteristics described above, there are certain barriers that should be considered when attempting to increase participation in the cost-share programs. While financial profit may be of concern to certain farmers, there are other obstacles to participation. For example, requirements such as the lengthy commitment and effective maintenance of BMPs, the rigidity of the program regarding some practices, and the lack of awareness about the program and its benefits, have been shown to prevent farmers from participating.

Finances

Large operations often focus on optimizing their yields to obtain the maximum amount of profit possible. In attempts to maximize profit, it is often necessary to farm all land available to the tenant or landowner (Cable, Fox, & Rivers, n.d.). Therefore, even the land along rivers and streams might be farmed. The majority of those who farm to the edge of rivers and streams face a number of long-term problems, such as river bank destabilization, increased

runoff of sediment and agricultural chemicals such as fertilizers and pesticides, and erosion from the river cutting vertically into the ground as it flows. Head cutting of a river is often the most worrisome feature for those farmers concerned with profits, as significant amounts of land are lost to the river and an eventual loss of profit occurs (Kara, Ribaudo, & Johansson, 2008). This phenomenon should be a powerful motivator for those farmers hesitant to participate in cost-share programs due to the direct impact on their future income. However, the consequences of not adopting BMPs to prevent the loss of cropland occur at such a slow rate that a current tenant or landowner may have moved on before the impacts become severe.

Those who depend heavily on farm production for the majority of their income seem to avoid enrolling in conservation programs as some practices associated with these programs often entail retiring cropland for conservation (Loftus, & Kraft, 2003). These programs offer monetary incentives for maintaining the land under conservation practices. Cost-share programs, for example, pay for approximately 70% of the best management practice installation cost and the conservation reserve program (CRP) offers “an up-front and one-time CRP Signing Incentive Payment of $24.71 per hectare ($10/acre) along with a Practice Incentive Payment equal to forty percent of the eligible installation costs” (Loftus, & Kraft, 2003, p. 81). While these incentives are substantial and can be combined to reduce costs further for the farmer, conservation programs often confront situations where the farmer is still dissatisfied with this help. Sometimes, financial needs become a priority even when farmers agree with the benefits related to the use of BMPs, such as the increase of water quantity and improvement of wildlife habitat (Olenick, Kreuter, & Conner, 2005).

For some of those farmers who implement conservation practices, financial aspects remain an important motivation to continue participating. While farmers may be interested in extending contracts for conservation, monetary aspects weigh heavily in their decision (Kurzejeski, Burger, Monson, & Lenkner, 1992). In addition, some farmers expect to continue receiving subsidies for pollution control (Bielders, Ramelot, & Persoons, 2003). To maintain and increase farmer involvement, these monetary stimuli need to remain in place, in addition to cash and in-kind incentives based on market value of their products (Bumbudsanpharoke et al.,

2009). Financial incentives continue to be a major part of conservation strategies, however, alternatives to this approach need to be developed as governmental funding for conservation programs seem to be in the decline.

Timeframe and Maintenance

Though financial incentives may significantly influence farmers who are considering getting involved in conservation practices, there are other circumstances discouraging farmers from participating. These include the labor needed to maintain a BMP in good condition and the mandatory length of time needed to keep a BMP on their property and still get paid. Cable et al. (n.d), found that even when farmers were offered more than 100% of the rental value of the land, they refused to participate, with the main reason being having to deal with the maintenance at a long-term period (Cable et al., n.d.). Specifically, these farmers did not want to lose the opportunity to farm the riparian areas on their property, as it would mean losing additional yield and therefore additional profit. While the offered financial incentive would overcompensate the loss of profit, the time and labor required to maintain the riparian area fencing, especially after a flood, was a drawback for those farmers (Cable et al., n.d.).

Individuals who do not depend entirely on farming activities for income also find that the necessary dedication of time and labor for maintenance of BMPs are drawbacks. Olenick et al. (2005), found that these farmers prefer short-term (5-10 year) contracts for keeping BMPs on their property (Olenick et al., 2005). Individuals who farm as a hobby, only on weekends and/or evenings, see the implementation of BMPs as requiring intensive labor and intensive management efforts (Gillespie et al., 2007). Considering the limited time they spend farming, they prefer to dedicate themselves to animal care and cropland-related activities instead of the maintenance of BMPs. This aspect further reinforces the fact that policies regarding the promotion of conservation practice adoption need to be targeted and individualized. In order to recruit persistently hesitant farmers, it is necessary to understand their individual situation and perceptions of BMPs.

Flexibility and Bureaucracy

Farmers are also deterred from participating by requirements for the long-term proper maintenance of BMPs and complex bureaucratic procedures to participate in conservation practices. Bumbudsanpharoke et al., pointed out that "bureaucratic barriers, such as government regulations, paperwork requirements, participation and eligibility requirements" (Bumbudsanpharoke et al., 2009, p. 231) may keep farmers away. It is suggested instead to use simpler regulations and provide more flexibility during the application processes (Bumbudsanpharoke et al., 2009). Olenick et al. suggests that flexibility should include exchanges between governmental agencies and landowners on cost-share incentives (Olenick et al., 2005).

Flexibility on policies embedded in the adoption of conservation practices should lead to obtaining a personalized structure of BMP implementation, benefitting all parties involved. To draw in hesitant farmers, information and aid should be made as accessible as possible to farmers, especially those who have been discouraged with the complex process of applying and implementing BMPs on their property may draw the attention of hesitant farmers. It is most important to allow for flexibility and compromise between the parties involved in order to promote the common environmental good of improving water resources in a watershed.

Education

It should be a priority of all the institutions interested in water conservation to provide accessible education about the application process and benefits of the cost-share programs. Studies have shown that the dissemination of information pertaining to cost-share programs is in the hands of the Natural Resources Conservation Service (NRCS) (Gillespie et al., 2007; Loftus, & Kraft, 2003). Although this organization has developed substantial material for farmers (Loftus, & Kraft, 2003), it seems that it has not been enough. It was shown that the lack of information is one of the main reasons for non-adoption of BMPs (Bielders, Ramelot, & Persoons, 2003; Bumbudsanpharoke, Moran, & Hall, 2009; Gillespie, Kim, & Paudel, 2007; Hadrich, & Van Winkle, 2013; Kurzejeski, Burger, Monson, & Lenkner, 1992; Loftus, & Kraft, 2003) and this obstacle should be simple to overcome.

Farmers with lower levels of education are most in need of education regarding conservation programs (Bielders et al., 2003; Gillespie et al., 2007; Hadrich, & Van Winkle, 2013). Bumbudsanpharoke and Bielders (et al. 2009) suggested comprehensive educational packages, including information about environmental problems, environmental benefits, available BMPs to address the problems, and the savings related to the implementation of new practices. Bielders et al. (2003) suggested that the actual application for various cost-share programs should also be included in these comprehensive packages. Gillespie et al. (2007) explains that education has a significant effect on farmers' decisions to adopt BMPs. He explains that education received from the NRCS has been shown to influence the perceived applicability of conservation practices on farmers' land. In addition, education also influenced perceptions about unreasonable costs of implementation. Therefore, farmers who obtained education about BMPs were less likely to declare non-applicability of the practice and high costs as the reason for rejection (Gillespie et al., 2007).

Education has been shown to increase landowner participation in conservation programs, including cost-share programs. This result has been found in institutional efforts toward the conservation of water, soil, and wildlife via BMP implementation on livestock, cropland, and orchard operations (Bielders et al., 2003; Bumbudsanpharoke et al., 2009; Gillespie et al., 2007; Hadrich, & Van Winkle, 2013; Kurzejeski et al., 1992; Loftus, & Kraft, 2003). According to Hadrich and Van Winkle, "having cost-share funding available is not a sufficient incentive to adopt BMPs" (p. 226). Education, followed by a targeted and individualized approach, should lead to successful adoption and maintenance of BMPs.

Environmental Policy Inflexibility

The role of inflexibility in current environmental policies is a highly debated topic, especially when trying to reach a compromise between farmers and governmental agencies. As demonstrated above, farmers seem to favor targeted and individualized approaches and these may be fruitful alternatives when dealing with hesitant farmers. Landowners may be drawn to participate because of the possibility of financial and technical help for BMP implementation, but also because of the possibility of molding positive conservation practices to their particular

situation. The ultimate goal of this compromise should be to maximize the conservation impact on water, soil, and/or wildlife. Therefore, there is a fine line between the wants and needs of the farmer and the standards that an environmental authority needs to follow to obtain the most conservation impact.

Although more flexibility in environmental policies has been shown to elicit interest of hesitant farmers, other studies show that stricter policies may increase the adoption of BMPs (Featherstone, & Goodwin, 1993; Kara, Ribaudo, & Johansson, 2008). Stringent policies seem to have a positive effect on the adoption of specific BMPs like grassed waterways and erosion control plans. However, stringent policies may need to be accompanied by higher incentives in order to accrue significant participation, especially in conservation programs that depend on volunteer participation, like cost-share programs (Kara et al., 2008). In other words, limiting the flexibility and possible individualized implementation of BMPs should be compensated with significantly higher incentives. This option, however, may be implausible, as funding for conservation programs has been significantly decreased in recent years.

Some believe that instead of inducing people to volunteer through increasing financial incentives and increasing rigidity, the government should make environmental conservation a requirement for all farmers. It would then no longer be necessary to attempt to understand the reasons for refusing to participate and the need to reach an agreement and consensus among governmental agencies and farmers. Instead, the implementation of BMPs would be required for all farmers and those who refuse to participate could potentially face legal consequences. Gillespie et al. (2007) suggests that those persistently hesitant farmers will rarely adopt BMPs unless required by law.

Requiring conservation practices by law, however, may be extremely unpopular. Many farmers in the Midwestern US are unwilling to participate because they feel they would lose independence to governmental programs that may come in and attempt to change how they use the land. Some regard these programs as a threat to their freedom to manage their land the way they please (Olenick et al., 2005). Participating in conservation programs sometimes requires significant amount of land dedicated to BMPs, depending of course on the amount of mitigation required to reduce non-point source pollution from the agricultural practices

employed. It is likely that some individuals will not agree with making environmental conservation a requirement for these reasons.

Farmers sharing this point of view may put up significant resistance and possibly destabilize the farming community instead of conforming and coming forward to participate. Forcing farmers to participate in conservation programs may drive away those considering continuing the management of existing BMPs, those who were considering applying for conservation programs and did not do so before, or those who had recently adopted BMPs through the cost-share programs but decided to support those farmers who do not agree with policy changes. Making the adoption of conservation practices a requirement in the US may not be a viable option in the near future. Meanwhile, alternative options to increase farmer participation in conservation programs should be explored and developed.

Support of governmental institutions regulating local conservation organizations is necessary when attempting to increase the flexibility of environmental policies. Reaching farmers who are hesitant to enroll in mitigation programs, and who are engaging in farming practices that significantly contribute to non-point source pollution (Loftus, & Kraft, 2003), may take a range of different approaches not considered before. This may bring positive results and may allow further progress in farmer participation, compared to severe policy changes that may erase all progress achieved to date.

Networking and Recognition of Community Leaders

Farmers' distrust of governmental institutions often leads to hesitation to participate in conservation programs funded by the government, including cost-share programs. Wary farmers often also distrust individuals working for organizations that make use of these funds and who may try to recruit them to participate in conservation programs. However, there are other farmers who decide to take a chance and take the first step forward in participating. These farmers often become an example for those who may be contemplating participating but who do not want to be the first ones to take the risk. More than becoming an example, these farmers often become informal leaders who are able to help other farmers with questions and concerns in a more informal fashion. Most importantly, these informal local leaders are trusted

by the community and often serve as educators on conservation practices that bring benefits to the farmer in the short- or long-term.

It is important to recognize publicly the positive impact that early participants, and farmers who followed in BMP adoption, have on the community and the environment. Various studies have acknowledged the importance of community recognition of the benefits and positive effects that landowners have on the health of the ecosystems found in their land and surrounding areas (Olenick et al., 2005). This recognition is thought to be more powerful when coming from individuals involved in conservation efforts and the farmer's colleagues and friends (Greiner, Patterson, & Miller, 2009). This recognition serves as an important incentive for farmers to continue their efforts toward environmental conservation, and most importantly toward sharing their experiences with other farmers.

Those farmers open to adopting new conservation practices have been found to successfully influence their surrounding network. Loftus and Kraft (2003) observed farmers influencing their neighbors and friends positively to participate in conservation programs. These connections are not only optimal for influencing other farmers to participate, but also for spreading information more efficiently. A farmer is more likely to welcome information presented by a community member than if presented by an outsider. As a member of the community carries out this task, the information presented is more welcomed than if presented by an outsider. According to Baumgat-Getz et al. (2012), a BMP adoption approach should be targeted and should use networks of farmers to allow communication among members of the farming community regarding the benefits associated with BMP implementation.

Target Specific

Some research has focused on developing outreach efforts that specifically target farmers who persistently hesitate to participate in conservation programs. Resources for organizations funded by governmental agencies such as watershed protection groups are increasingly limited. Therefore, it is imperative for them to make efficient use of the resources they have on hand. According to Rosemberg and Margerum (2008), after the target group has been identified, it is critical to evaluate the types of landowners and to find the best ways to

motivate them in the adoption of conservation practices. By doing this, the interest group efficiently uses the resources available.

Targeting conservation efforts has the potential of increasing participation levels and achieving pollutant load reduction set by environmental authorities (Loftus, & Kraft, 2003). Specifically, Featherstone and Goodwin (1993), add that a targeted approach has the potential of decreasing non-point source pollution. Featherstone and Goodwin's (1993, p. 80) study looks specifically at erosion control and the decline of sediment input. The authors explain:

> *Non-targeted programs will cause erosion investments to be made by individual producers in line with their economic incentives and the largest conservation expenditures per government dollar will be achieved, but not necessarily on the most erosive land. However, if most erosion problems are experienced on those farms which currently do not invest in long-term conservation improvements, non-targeted programs will not reduce erosion by as much as targeted programs.*

Some governmental agencies, such as the Watershed Restoration and Protection Strategy, have already targeted their efforts to those groups of landowners located in geographic areas that most significantly impact the state of natural resources nearby, i.e. agricultural activities near a stream or river. The remaining task is to further target efforts to reach those persistently hesitant landowners who, as mentioned by the authors, may be major contaminators.

Featherstone and Goodwin (1993) explain that if the major contaminators are those farmers not yet enrolled in conservation programs, targeting them should eventually help reduce contamination. Adopting conservation practices and maintaining them over a significant period of time are conditions for successful implementation; however, it was discussed above that shorter-term contracts might be more attractive to persistently hesitant landowners. A long-term commitment may be a drawback to cautious landowners who may want to try the implementation of BMPs short-term before making a long-term commitment. Though this situation may not be optimal, it may be better to have those hesitant farmers in the door instead of to intimidate them with long-term contracts. If the analogy of the "low hanging fruit

has already been picked" holds true, it may be necessary to use approaches to entice the participation of important landowners.

BMP Perceptions

National and international studies have called for a deeper inquiry about the perceptions of landowners regarding the implementation of BMPs. Some have found it surprising that more research has not been done concerning opinions and reactions to "environmental policy instruments" (Bumbudsanpharoke et al., 2009, p. 226). In the US, Gillespie et al. (2007) addressed the lack of BMP adoption by Louisiana producers in the beef cattle industry, highlighting that there seemed to be reasons worth exploring that prevented these producers from adopting BMPs. The authors go on to emphasize the need for understanding these underlying reasons for the refusal of BMP implementation in order to successfully target important landowners.

Investigating the perceptions and beliefs of landowners should shed light on more targeted steps to take in natural resource conservation. These investigations may help policy makers find more suitable approaches when talking to landowners about the long-term implementation of BMPs. In a study of Texas landowners' perceptions on ecosystem services and cost-sharing management, Olenick et al. (2005) concluded that "future research should address the extent to which landowners can be encouraged to participate in […] land management programs aimed at enhancing ecosystem services" p. 259. In the Midwestern state of Kansas, Featherstone and Goodwin (1993) looked at the factors that influence Kansas farmers' decisions to invest in long-term conservation practices. The authors acknowledged that it is important for policy-related decision-making actors to acknowledge and understand the aspects that influence Kansas farmers' decisions about investing in conservation practices. The exploration of additional, poorly understood perceptions and points of view of landowners in various geographical areas might hold the key for alternative approaches by policy makers to expand participation and increase success in the conservation of natural resources.

Perception of Conservation Practices

Differences in perceptions and beliefs vary within and between different geographical locations. There are differences and commonalities among farmers in different nations as there are within a small geographic area in the same watershed. This is the source of the failure of current one-size-fits-all policies. In Australia for example, for some farmers, the implementation of conservation practices is based on motivations to "pass on land in good condition, produce high quality food, enjoy farm work, feel independent, and look after the environment" (Greiner et al., 2009, p. 89). In the United States, these decisions are based on different motivations like "profit-maximizing, […] valuing the environment only to the extent that it provides direct personal benefits, and a sense of obligation to […] future generations" (Greiner et al., 2009, p. 89).

Additionally landowners within the US have diverse motivations and beliefs on the implementation of conservation practices. In Oregon for example, a study showed that "landowners believed they had a moral obligation to be a good steward of the land" (Rosenberg, & Margerum, 2008, p. 483). In contrast, Kansas landowners' decisions to implement wildlife conservation practices was shown to be influenced by not only by their "enjoyment of watching wildlife" but also by the belief that "preserving wildlife for future generations [was] very important" (Cable et al., n.d., p. 6). These motivations acknowledging and addressing the diverse views and perceptions of adoption of conservation practices within a nation is important, especially at the sub-watershed scale, where the farmer and the conservation agency need to compromise in order to improve the condition of natural resources.

There are a considerable variety of stakeholder viewpoints concerning the improvement of the condition of natural resources in a watershed. Rosenberg and Margerum (2008) acknowledge, "landowner preferences even within a small geographic location is an important indication of the difficulty in reaching diverse audiences to promote restoration practices" (p. 493). Farmers who have had a bad experience in the past due to inabilities to communicate and compromise with other stakeholders, be it with other farmers or governmental agencies, may not want to be approached again about the possibility of BMP implementation. For example, in a study carried out by Bela Das (2011) "planners, managerial personnel and engineers" (p. 916)

tried to approach a bank stabilization project by "predominantly emphasiz[ing…] design-based engineering solutions (construction of spurs and embankments) to solve the problem […] however, this view was proved wrong later […] as bank erosion [...] continued with the situation becoming worse" (p. 918). This example may be the result of failure in communication and the lack of a second opinion, possibly from the farmer, about how to ensure the success of the project. It would also be erroneous to imply that ideas proposed by the farmer are guaranteed to work. A compromise and evaluation of each particular situation is necessary in order to be successful.

Some farmers prefer to skip possible disagreements that might come when working with the cost-share programs provided by governmental agencies and implement conservation practices on their own. However, those who can afford to do the process independently are very few. Often, those who genuinely want to adopt conservation practices and who do not have the funds to implement them independently, decide to enroll in cost-share programs. Unfortunately, more often than not, those who would like to participate and are not located in priority areas, or cannot afford the remaining amount after the cost-share subsidy, are not eligible to participate. Priority areas are determined using the Soil and Water Assessment tool, which finds areas that contribute significant amounts of runoff and therefore sediment and nutrients to the watershed (UWWRAPS, 2012). As discussed above, it would be optimal to have certain flexibility from governmental agencies in these cases. Limited funding and other constrains make this option difficult. Other individuals may enroll in cost-share programs for other reasons; however, the focus is on those farmers who are motivated to implement conservation practices for reasons other than financial gain. According to Greiner et al. (2009, p. 98), conservation practices are "adopted particularly by […farmers] who pursue lifestyle and conservation goals and are intrinsically motivated to adopt conservation practices". While efforts to promote this way of life may seem unreachable, a change of heart by those hesitant farmers who present significant pollutant loading would benefit all parties involved.

Clearly, as more individuals in priority areas adopt stronger attitudes toward conservation, goals to reduce pollutant input would be reached faster and natural resource conditions would improve more quickly as well. According to Lynne et al. (1988, p. 18):

> *Attitudes favoring conservation raise the levels of effort [from farmers], suggesting that if attitudes are strengthened there may be less need for dependence on technical assistance and other net income-enhancing programs such as cost sharing and tax incentives.*

At this point in the process of attempting to persuade hesitant farmers to participate, the bottom line seems to be that the farmer has to demonstrate some of these attitudes in order to adopt conservation practices. These attitudes may ensure that landowners will adopt conservation practices in the long-term and will invest in successful management. The main incentives would be conservation for future generations, personal enjoyment, or simply to be a good steward of the land.

Q-Methodology and the Perception of BMPs

We used the Q methodology (Q) in order to explore the perspectives and views of stakeholders in the Upper Wakarusa Watershed. Q combines quantitative and qualitative data collected in a systematic process to investigate the subjective and holistic perceptions of participants (Brannstrom, & Persons, 2011; Bumbudsanpharoke et al., 2009; Dziopa, & Ahern, 2011). In Q, the quantitative and qualitative analyses are intertwined, thereby "increasing the level of research reliability and validity" (Bumbudsanpharoke et al., 2009, p. 226). Q disregards formal and informal associations among study participants and instead finds commonalities in perception. In other words, the Q method is not based on participant's affiliations to a group but instead finds commonalities among study participants regarding beliefs, perceptions, and points of views regarding a topic of interest (Brannstrom, & Persons, 2011; Jepson, Brannstrom, & Persons, 2012). The main purpose of the Q method is to use a holistic approach to identify commonality in discourses, perceptions, motivations, interests, and perspectives among stakeholders in order to find a common ground to successfully address a problem (Bumbudsanpharoke et al., 2009; Das, 2011; Dasgupta, & Vira, 2005). The role of Q has shown

to be of global importance in topics that explore viewpoints on environmental problems involving the interactions among society and natural resources.

Studies on perceptions of natural resources are of special interests to environmental policy makers. For example, the US Environmental Protection Agency (EPA) has used the Q method in order to evaluate programs with public involvement at contaminated sites (Webler, Danielson, & Tuler, 2007). The EPA found the Q method to be a valuable tool to find areas of agreement and disagreement in small numbers of participants. During the Q task, the EPA found that participants were able to define their own viewpoints and reflect on their role in the big picture (Webler et al., 2007). Other studies using Q include those addressing stakeholders' perceptions about participatory forest management in Dehli (Dasgupta, & Vira, 2005; Steelman, & Maguire, 1999), community acceptance of wind power in Texas (Brannstrom, & Persons, 2011; Jepson et al., 2012), and farmers' perceptions on BMP implementation in Thailand (Bumbudsanpharoke et al., 2009). No studies were found that used the Q method to determine stakeholder perception of BMPs in the Midwestern United States. The goal of this study is to use the Q method to find common perceptions of agreement and disagreement among the Upper Wakarusa Watershed stakeholders in order to facilitate efforts to maximize participation in watershed best management practices.

Physical and Human Geographic Context of Study

Upper Wakarusa Watershed and Land Use

The Upper Wakarusa watershed in North Eastern Kansas covers 367 square miles of land; the main bodies of water that drain it are the Wakarusa River (71%), Deer Creek (10%), and Rock Creek (14%) (UWWRAPS, 2012). The watershed has its origins in the eastern Flint Hills at an elevation of 1,200 ft, and its draining point is the Clinton Lake Reservoir located at an elevation of 850 ft. Four different counties share a percentage of their areas in the watershed: Shawnee County (40%), Douglas County (30%), Osage County (27%), and Wabaunsee County (3%) (UWWRAPS, 2012) (see Fig. 1).

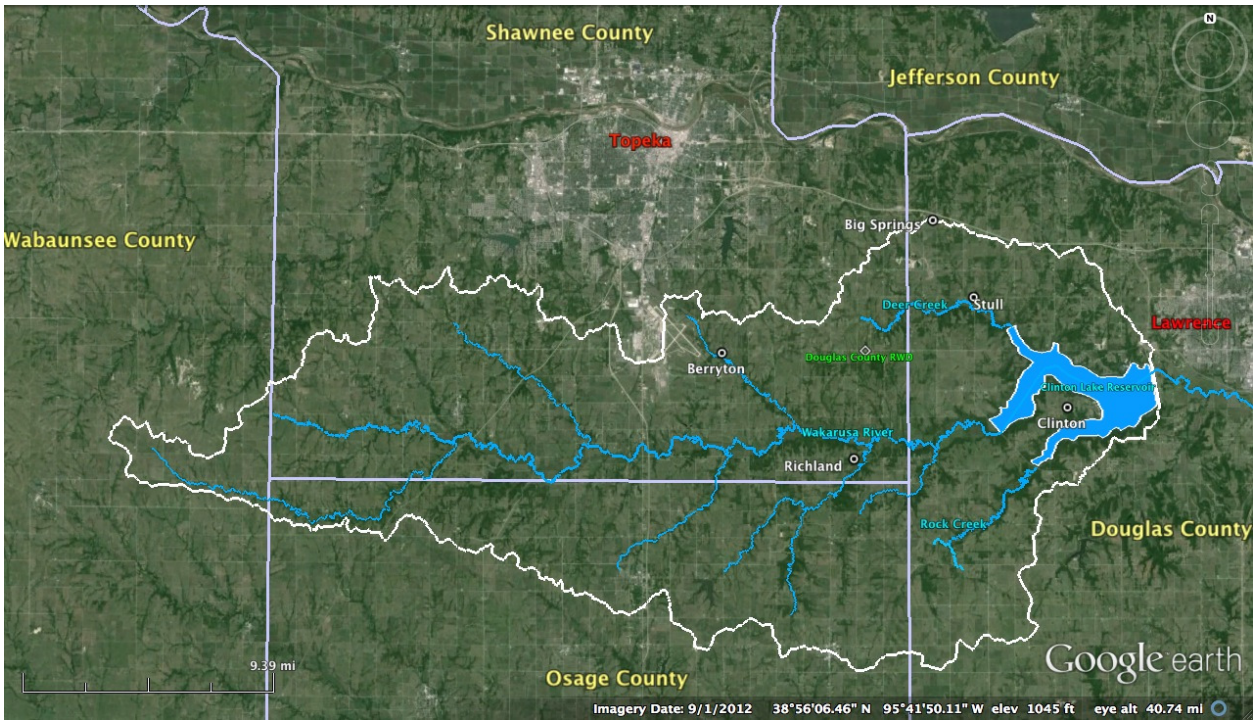

Figure 2. Upper Wakarusa Watershed (Mehl & Restrepo, 2012)

Cropland (~27%) and grassland (56%) are the major land uses in the watershed. Land used for cropland is terraced and non-terraced, and grassland areas are used for pasture, terraces, hay, conservation reserve programs, and other purposes. Other land uses in the watershed include woodland, water bodies, residential, alfalfa, pavement, farmstead, and quarry (UWWRAPS, 2012). The major crops grown in the watershed are corn (*Zea mays*), sorgum (*Sorghum bicolor*), and soybeans (*Glycine max*). Non-native pastures especially smooth brome are common in the watershed, and secondary forests are located along the main water bodies (UWWRAPS, 2012)(see Fig. 2).

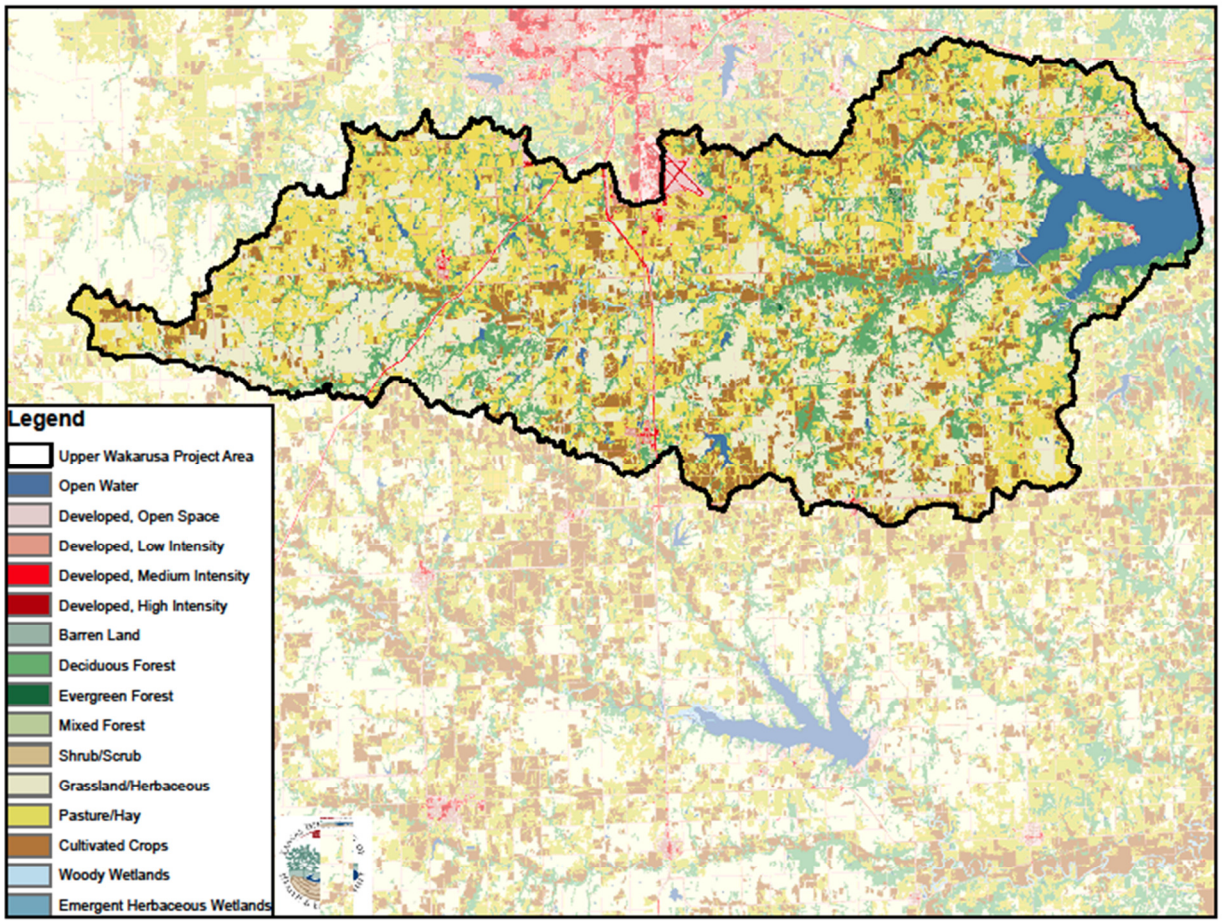

Figure 3. Land Use and Land Cover-Upper Wakarusa Watershed (UWWRAPS, 2012)

According to a personal communication with a staff member of the Kansas Department of Health and Environment's Watershed Management Section in the Bureau of Water, there are a number of BMPs that have been implemented in priority areas of the Upper Wakarusa watershed. While not all-encompassing, some of the conservation practices implemented during the last years are: diversions, terraces, underground outlets, wetlands, water and sediment control basins, cover crops, brush control management, fencing, grassed waterways, nutrient management, on-site wastewater systems, stream bank protection, watering facilities, well-decommissioning, ponds, as well as pasture and hayland planting. These BMPs have been implemented with funding from the WRAPS group and the Division of Conservation. It is important to keep in mind that a number of farmers adopt conservation practices independently or through help from other conservation groups.

The Upper Wakarusa Watershed Restoration and Protection Strategy (WRAPS)

The Upper Wakarusa Watershed Restoration and Protection Strategy (UWWRAPS) seeks to use the Clean Water Act (CWA) standards to address and mitigate the negative impact that non-point pollution has on Kansas's water bodies (UWWRAPS, 2012). The group's efforts are funded by the Environmental Protection Agency, the State Water Plan, and the State Conservation Commission. The Stakeholder Leadership Team (SLT) of UWWRAPS represents the interests of watershed residents. UWWRAPS uses a four-step process to track and evaluate their progress towards meeting their goals. In the first step, development, water quality challenges are determined and the SLT is organized. Steps two and three, assessment and planning, locate sources of non-point pollution and priorities are set regarding which areas to target. The last step, implementation, leads to the selection of BMPs that will most effectively allow for compliance of CWA standards of pollutant input (UWWRAPS, 2012).

The 9-Element Plan

The function of the 9-element plan is to delineate the "approach, methods, and measures of progress" that each Watershed Restoration and Protection Strategy creates in order to protect further non-point source pollution of watersheds nationwide. Environmental authorities determine if the 9-element plan is adequate to meet the Clean Water Act's standards, and based on that they provide funding for BMP project implementation (UWWRAPS, 2012).

The UWWRAPS' 9-element plan has three areas of concern are sediment, phosphorous Total Maximum Daily Load (TMDL), and bacterial levels in the water bodies of the watershed (UWWRAPS, 2012). These water bodies will eventually drain into the Clinton Lake Reservoir, which is used as a drinking water source for a significant number of watershed residents, in addition to being used for recreational purposes (Restrepo, 2012). In the 9-element plan, some of the appropriate BMPs to address high input of sediment loads also help mitigate high phosphorous TMDLs. BMPs that overlap include encouraging farmers to use continuous no-till farming techniques, to install buffers or riparian areas along streams, to install grassed water

ways, to install tile outlet terraces and wetland retention areas, and to implement stream bank stabilization projects (UWWRAPS, 2012).

According to a personal conversation with the UWWRAPS coordinator (personal communication 4 November 2013), the success of the UWWRAPS program relies heavily on the participation of landowners located in the priority areas of the watershed. Landowners' participation allows the UWWRAPS to demonstrate to environmental authorities that the funds received are being used effectively in the implementation of conservation practices. The coordinator explained that unspent funds raise a red flag to environmental authorities that might reconsider the effectiveness of the WRAPS group in carrying out their goals. "In the worst-case scenario, the funds are re-directed to another WRAPS group, and the UWWRAPS would disintegrate", the coordinator mentioned. In the past, those landowners willing to participate had already done so; however, only those hesitant to participate remain. While the 9-element plan delineates the best techniques to mitigate the three main concerns of the watershed, it does not discuss how best to increase participation in the program.

According to the UWWRAPS coordinator (personal communication 4 November 2013), there are three main reasons for using riverbank stability to potentially increase the participation of hesitant landowners located in the priority areas of the watershed. The first reason is that riverbank stability projects aid not only in the reduction of high input of sediment loads but also in the reduction of high phosphorous TMDLs. The second reason is that riverbank stability projects require a significant amount of funding and preventing the instability of riverbanks may allow these funds to be used on other BMPs. The UWWRAPS coordinator believes that the effective implementation and maintenance of other BMPs should prevent the instability of riverbanks from occurring. According to the coordinator, riverbank instability is a strong indicator of failure in other BMPs in the area. Therefore, investing in these BMPs may prevent riverbank instability from happening at all.

The third reason for using riverbank stability in this study is that understanding which BMPs the SLT believes will help or not help riverbank stability will give the UWWRAPS insight about what other watershed stakeholders, including hesitant landowners, believe will help or not help riverbank stability. Having this information at hand will serve as a tool for the

UWWRAPS to establish a potentially fruitful conversation with hesitant landowners. It may be easier to approach a landowner with practices that he/she may be more willing to adopt. The UWWRAPS would proactively identify both the BMPs that potential landowners agree with, and those BMPs that help with bank stability prior to any conversations with hesitant landowners solving both problems at once.

Methodology

All Q methodology studies present two main features:

i. Data are collected through Q sorts. A Q sort is an arrangement of items or a model, (also known as the Q set), that each participant produces according to the subjective measurement that each participant attaches to each item i.e. agree/disagree. The researcher prepares in advance the Q set utilized in each Q method study (Watts, & Stenner, 2012d).
ii. Subsequently, the Q sorts of each participant are compared and contrasted with each other using factor analysis, which in turn finds commonalities and differences in the perceptions and view points of the participants (Watts, & Stenner, 2012).

Materials: Q Set Design and Content

The items that were sorted by study participants (called the Q set) was created by using the 2009 to 2013 *Watershed Happenings* newsletter, which reports the meeting minutes of the Upper Wakarusa Watershed Restoration and Protection Strategy (UWWRAPS) group. All activities that the newsletter mentioned regarding the implementation and adoption of BMPs were noted and organized into categories: assessments and inventories, training and awareness, and the actual BMPs. The selection of items and corresponding categories was revised, reduced, and confirmed during a thorough interview with the UWWRAPS coordinator (personal communication 15 November 2013).

Figure 4. Q Set Sample

The final Q set was composed of 24 items that can be found on Table 7. The Q set was presented in the form of 4” x 6” photo paper cards, which presented each item’s description in an 18-point font placed below a corresponding color photograph. The UWWRAPS coordinator provided some photographs; the rest of the photos and/or graphics were found online and properly cited under the item’s description (See Fig. 1).

Participants

The Q methodology does not require a large participant pool in order to reach its objective of establishing commonalities and differences in viewpoints among participants, to then understand, interpret, and compare them (Watts, & Stenner, 2012a). Nineteen individuals participated in the study. One participant refused to participate and other two did not respond to the participation request. Key informant recruitment of stakeholders of the Upper Wakarusa Watershed represented the majority of the sample with a few cases of participants resulting from snowball sampling. The group of participants displayed variation in gender, age, levels of schooling, titles or professions, years lived in current residence, and place of residence. There

were 7 females and 12 males all self-identified as white, with ages ranging from 20 to older than 61 years of age. The highest level of schooling among most participants was some college and beyond, with a few having trade, technical, or vocational training.

One participant loaded[2] significantly or shared points of view with two different perception groups (factors). In such a case in Q studies, their data are no longer incorporated in any of the analyses (see Table 1). According to the Q methodology, loading significantly in two or more factors (counfounding), disqualifies a participant from further analysis because of the methodology's underlying function of finding a common ground among groups of people differing on points of view about a topic. A counfounded participant may be thought of as already being in the "common ground" by his/her own nature. Being a counfounded participant and not being included in the rest of the analysis is not necessarily negative. On the contrary, identification of participant stakeholders like this may suggest they would be serve as a good mediator for conversations among the different perception groups in this study. His/her understanding of different points of view within the participant pool makes of him/her a key medium, especially during decision-making processes.

Some individuals identified with more than one profession or title; consequently, the sum of the individuals who identified with a particular profession or title is greater than the number of total participants (19). In total, there were 9 participants identifying themselves as landowners, 3 identifying as business owners, 5 identifying as ecosystems consultant, 10 identifying as government officials, 2 identifying as utilities employees, and 2 identifying as public officials. No participant identified as being a prominent community member.

Nine participants currently reside in rural areas of the Upper Wakarusa Watershed; 8 participants reside in urban areas; and, 3 participants reside in suburban areas. Seven participants resided in their current residence for 20 to 29 years; 5 participants have resided for

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[2] The significant factor loading is calculated using the formula 2.58* (1/√no. of items in Q set). For this study, the significant factor loading is ± .53 or above. Therefore, 18 of the 19 Q sorts loaded significantly on one of the three factors and Q sort 15 loaded significantly on two factors making it ineligible for this study. See Table 1 for all Q sorts in this study and their factor loadings. The sections below will develop the Q method used in this study in further detail.

10 to 19 years; 4 participants resided there their whole lives; 2 participants resided for less than 9 years; and 1 participant resided for over 40 years. See Table 8 for this study's demographics.

Procedure: Administering the Q sort

The Q sort was administered in the participant's place of choice, which included their homes, their work offices or conference rooms, coffee shops, and a shed in a park. Participants were provided with 24 4" x 6" cards of the Q set that needed to be ranked and a *Lona* or canvas with a hand drawn quasi-normal distribution of 24 4"x 6" boxes. A Likert scale ranging from -5 to +5 was written across the bottom of the quasi-normal distribution where each number, or ranking value, corresponded to a column of the distribution. In the quasi-normal distribution, a set number of items could be assigned to each ranking value in a forced-choice manner. Below the ranking scale, the word less was written in the extreme left, neutral was written in the central area, and more was written in the extreme right of the distribution. These labels visually guided the participant during the sorting process. See Fig. 2 for an actual image of the canvas used for this study.

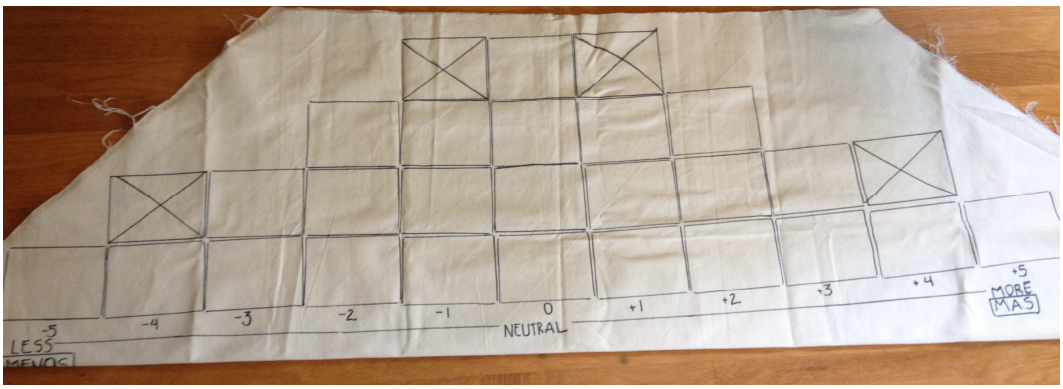

Figure 5. Lona or Canvas with Quasi-Normal Distribution

Before proceeding with the Q sort, informed consent was obtained from each participant, according to procedures approved by the University of Kansas Lawrence Campus Office for Human Subjects in Research. Participants were asked: how much does this item (the

one presented on the card) help or not help bank stability? Participants were instructed to place only one card per box in the distribution. Participants were advised to take as much time as needed in placing the Q set in the order they thought best represented their points of view on the subject of bank stability. They were also informed that they were going to find three different categories within the cards; training and awareness, assessment and inventories, and BMPs. Participants were reminded that there was no right or wrong answer and that their next task was to explain their rationale for putting the cards where they did. Most individuals took approximately 30 minutes to sort the cards and to place them in the distribution. See Fig. 3 for an example of a completed Q sort.

A post-sort interview was then conducted, varying in length depending on the participant's willingness to elaborate on their Q sort choices. Some interviews were as short as 15 minutes and some were as long as two hours. Results were recorded on the backside of the demographic survey using a random number assigned to each item in the Q set. The task ended with an open-ended question about the participant's opinion on why they thought some farmers were unwilling to participate in the volunteer incentive programs and what approaches they thought should be used to increase their participation and adoption of BMPs.

FACTOR ARRAY FOR FACTOR 1										
T/A: Training and awareness **A/I:** Assessment and inventory					11. A/I: stream reaches lacking grass filter strips					
			5. A/I: land use	15. Prescribed burns	7. A/I: cropland	18. Water and sediment basins	23. Livestock management			
		16. T/A: tmdls	2. A/I: soil types	10. A/I: ephemeral gullies	6. Erosion control: urban	17. Tile outlet terraces	22. Grass waterways	19. No till farming		
14. Ephemeral gullies	12. Rain gauges	13. A/I: Animal feeding operations	1. T/A: excess runoff	4. A/I: natural resources	3. Gradient terraces	9. Native grasses and plants	20. Cover crops	8. Wetlands	24. Revetments	21. Grass filter strips/ Vegetative buffers
Rank -5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Less	←----------				**Neutral**	----------→				**More**

Figure 6. Example of Completed Q Sort

Statistical Data Analysis

Q method is a tool to investigate subjective questions about "personal experiences, matters of taste, values and beliefs" through qualitative and quantitative techniques (Watts, & Stenner, 2012c). The Q method uses three unique transitions in its statistical data analysis: 1) from Q sorts to factors, 2) from factors to factor arrays, and 3) from factor arrays to factor interpretations.

1) From Q sorts to Factors

A total of 19 Q sorts were intercorrelated and factor-analyzed using the computer package PQMethod 2.33 (Schmolck, 2012). This analysis resulted in three factors, which were extracted and rotated by Varimax and then by hand (Brown, n.d.), explaining 68% of the study's variability or variance. Eighteen of the 19 Q sorts loaded significantly on one of the three factors. Factor loadings of ± .53 or above were significant at the $p<0.01$ level. The Unrotated Factor Matrix

presented five factors with Eigenvalues higher than 1.00; however, only three factors held significant loaders. See Table 1 for Q sorts loadings and associations with their respective factors.

Factor 3 presents only one significant loader; however, it was critical to include this participant as this individual has major weight over decisions involving natural resources in the Upper Wakarusa Watershed based upon self identification and profession. Therefore, this individual's decisions and perceptions may override those of other participants due to his/her position of power. It was imperative to gauge the effect that this individual's decisions, evidently based on his/her perceptions and beliefs, would have in the future of natural resources conservation in the watershed. In addition, the three factors used in this study explain a significant percentage of the variance in the study, almost doubling the suggested 35%-40% explicatory variance for a study to have promising results (Watts, & Stenner, 2012a).

Table 1. The Rotated Factor Matrix

	Loadings		
QSORT	1	2	3
1 mb001	0.6816X	0.4662	0.0096
2 rb002	0.6625X	0.1405	0.0322
3 jc034	0.8276X	-0.0206	-0.1903
4 jk005	0.7777X	0.1156	-0.1645
5 bb006	0.3528	0.2537	0.6004X
6 jb007	0.8619X	0.3091	-0.0860
7 ch008	0.7419X	0.3061	0.3921
8 fn009	0.7202X	0.3238	-0.2615
9 jt010	0.6957X	0.2652	0.1578
10 jb011	0.7285X	-0.2103	0.3209
11 kb012	0.5647X	-0.0986	-0.3688
12 bs013	0.6797X	-0.0154	-0.5063
13 db014	0.7475X	0.0539	0.4753
14 cg015	0.2282	0.5981X	-0.3432
15 sf016*	0.6706	0.6377	0.0042
16 lk017	0.7772X	0.2624	-0.3244
17 rr018	0.2992	0.7861X	0.1721
18 mh019	0.3879	0.8232X	-0.2075
19 th020	0.7167X	-0.0049	-0.0675
Eigenvalues	9.4096	1.8125	1.6877
% expl.Var.	44	15	9

Factor Matrix with an **X** Indicating a Defining Sort.

*Q Sort 15 is counfounded, or loaded significantly on two or more factors, in this case Factor 1 and Factor 2. This Q sort was not included in the statistical analysis.

The Q sorts that loaded significantly on a particular factor shared similar sorting patterns in the quasi-normal distribution. This indicates that these Q sorts may have similar viewpoints about the role that the Q set may have on bank stability. Therefore Q sorts 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 16, and 19, which loaded in Factor 1, sorted the Q set in a similar pattern, and it may be assumed that these Q sorts are from people sharing distinct viewpoints on bank stability. Q sorts 14, 17, and 18 on Factor 2 are from people sharing a viewpoint on bank stability, which is distinct from those on Factor 1 and Factor 3. Q sort 5 significantly loaded on Factor 3, reflecting an individual viewpoint on bank stability.

2) From Factors to Factor Arrays

A factor array is one Q sort arranged to represent the perceptions based on one factor (Watts, & Stenner, 2012b). Q sorts that loaded significantly on a factor are merged together to form a Q sort, or an array that represents the factor. The factor arrays are the main piece of information used to interpret and report the results of the study. The factor arrays for Factor 1, Factor 2, and Factor 3 are found in figures 4, 5, and 6.

3) From Factor Arrays to Factor Interpretations

The unique sorting pattern of each factor array is the basis for a careful and holistic interpretation of each factor (Watts, & Stenner, 2012b). Participants' comments and observations were quoted in order to create a comprehensive view of each factor and to complement the factor array interpretations. The direct reporting of the points of view of the particular individuals that loaded significantly on each factor reflects the holistic foundations of the Q methodology.

The main goal of the factor interpretations is to uncover the views and perceptions of people who loaded on each one of the 3 factors. It is important for the Upper Wakarusa WRAPS group not only to understand that the group divides into three main perception groups, but it is also critical to know what perceptions are characteristic of each factor. These differences in perception among the UWWRAPS Stakeholder Leadership Team (SLT) members may reflect the variability in perception of other stakeholders in the watershed. These differences are assumed, for the purposes of this study, to be a preliminary basis for understanding the variability in perception of other stakeholders in the watershed. Most importantly, it may shed light on the perceptions of those high priority farmers who have been unwilling to implement BMPs.

The factor array interpretations present a demographic summary of the heavy loaders on each factor. Rankings of relevant items are provided by the item number followed by its ranking in a particular factor. For example, "(12: -4)" indicates that for this specific factor, item number 12, Rain Gauges, participants loading significantly on this factor gave it a ranking of -4.

The participants' comments used to clarify factor array interpretations are cited and denoted in italics (Watts, & Stenner, 2012c).

Results

Factor 1: Hands-On Rural Residents

Factor 1 has an eigenvalue of 8.34 and explains 44% of the variability in this study. Fourteen participants, with a similar number of middle-aged males and females, significantly associated with this factor. They are mainly college-educated landowners who have spent from 10 years to their whole lives in the same rural residence.

Participants who associated with this factor believe that the majority of the items presented in the Q set help bank stability to some degree. Items ranked positively are believed to have a more considerable impact on bank stability, either with BMPs physically acting on the riverbank such as revetments, or BMPs that indirectly help the riverbank by decreasing runoff quantity and/or velocity before reaching a body of water such as no-till farming. It is important to highlight that participants loading on Factor 1 emphasize that those items receiving low rankings are still critical in the efforts to prevent riverbank instability, but they need to be used as a foundation for the implementation of hands-on BMPs. Therefore, items that received negative rankings do not necessarily carry a negative connotation for Factor 1 participants. The participants that associate with Factor 1 believe that most items help riverbank stability, however not all at the same time. Each category of items, i.e. assessments and inventories, or training and awareness, has an important and specific place in the chronological approach that Factor 1 favors. According to the quantitative and qualitative analysis in the Q method, this chronological approach can be regarded as Factor 1 participants' collective perception on the proper approach to establish and maintain riverbank stability, and/or to mitigate existing deficiencies and instabilities.

Factor 1 participants' chronological approach starts with data collection by assessments and inventories (Item 2 *A/I soil types*: ranked -2, 5: -2, 4: -1, 10: -1, 7:0, 11: 0, 12: -4, 13: -3)[3], is followed by education through training and awareness (16: -3, 1: -2), and ends with structural or hands-on BMPs. This vision was a common trend among participants loading on Factor 1. Participants 8 and 11 explain the importance of this approach by stating that *"You can't do the BMPs without the training and awareness"* (participant 8). Additionally, participant 11 highlighted that:

> *"You have to start with assessment and inventories or else you are spending money that may not be productive …you are identifying the problem [and then you focus] on action items and trying to get a product in place. Inventory what you have … and plan through education [to] work with the public involved. I put education and assessments in the other side [negative rankings] but it is all chronological, where this [education and data collection] is the starting point to a final product".*

Education is perceived as a necessary tool for the inclusion of community members and other stakeholders of the watershed. Data collection is perceived as critical in order to best use the resources available to the Upper Wakarusa WRAPS group. While items in the categories of education and data collection were ranked lower in comparison to hands-on BMPs, stakeholders loading on Factor 1 acknowledged them as being essential in the successful prevention of riverbank instability.

The chronological approach, representative of the respondents on this factor, places particular emphasis on hands-on BMPs over assessments and inventories while maintaining these data collection methods as a central foundation for the mitigation of bank instability. This emphasis is evident when looking at Table 2 where 4/7 assessments and inventories were ranked lower in priority compared to the classifications of these items by participants on

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[3] Rankings of relevant items are provided by the item number followed by its ranking in a particular factor. Therefore, Factor 1 ranked item 5 (A/I of land use): as -2, 4 (A/I of natural resources): as -1, 10 (A/I of ephemeral gullies): as -1, 7 (A/I of cropland): as 0, 11 (A/I stream reaches without grass buffers): as 0, 12 (rain gauges): as -4, 13 (A/I of animal feeding operations): as -3.

Factors 2 and 3. Factor 1 loaders do not rank any of the remaining assessments and inventories positively (2: -2, 5: -2, 4: -1, 10: -1, 7:0, 11: 0, 12: -4, 13: -3). Participant 1 explained *"getting practices on the ground is more important than doing the assessments…[these] are a useful tool, but unless you turn those assessments into the actual practices, they are useless"*. At the same time, Participant 13 points out that although data collection does not result in a direct enhancement of bank stability it is still critical to the mitigation of the problem. The participant adds *"inventories are good because they let you know what you have…and… they let you focus and target your efforts".*

The clearest example of Factor 1 loaders' chronological approach for the mitigation of riverbank instability comes from their perceptions on ephemeral gullies and the assessment and inventory of ephemeral gullies. Stakeholders loading on Factor 1 ranked ephemeral gullies as the single least helpful item to the mitigation of bank instability (14: -5). Gullies are perceived as the strongest sign of bank instability and possible failure of other BMPs. Participant 1 explains, *"ephemeral gullies are a conduit for runoff to go into streams...[they] are a symptom of other things that are going on"* and participant 19 confirms *"ephemeral gullies [are] the symptom of excess runoff…and instability".* Although ephemeral gullies are the item that least helps bank stability, participants loading on Factor 1 perceive the assessment and inventories of gullies as being somewhat helpful (10: -1). Due to the fact that this assessment and inventory is linked to ephemeral gullies, the least helpful item in the Q set according to Factor 1 participants, it did not receive a positive ranking. At the same time, it was not ranked drastically negative in the normal distribution; Factor 1 participants' array (see graph below) shows this assessment and inventory of ephemeral gullies as being located among the rest of the assessments and inventories. Factor 1 participants located this assessment and inventory in a very specific area within the chronological approach: before hands-on BMPs but after ephemeral gullies and rain gauges, believed to be the least helpful items in the effort to prevent riverbank instability.

The priority of Hands-On Rural Residents' to follow a chronological approach, and therefore placing certain items in very specific places within this chronological approach, seems to constrain and somewhat contradict their perceptions on how to move toward riverbank

stabilization. Participants loading on Factor 1 regard ephemeral gullies as the least helpful item in the Q set, and their priority should include the use of assessments and inventories to determine where these gullies may be located. Factor 1 respondents' ranking of the assessments and inventory or ephemeral gullies do not reflect this prioritization, instead, this assessment and inventory is constrained to a certain area of the distribution as this area is where assessments and inventories are placed in the chronological approach. While Factor 1 respondents ranked the assessment and inventory of ephemeral gullies higher than other assessments and inventories within its own factor array, Factor 1 respondents ranked this assessment and inventory the lowest compared to loaders on Factor 2 and Factor 3 (10: -1; z=-.45, $p< 0.01$) (Table 2). This example shows the defining boundary between assessments and inventories, and hands-on BMPs in Factor 1 respondents' chronological approach. This necessary data collection step is held back to give way to more important hands-on BMPs in the eyes of Factor 1 participants.

Stakeholders loading on Factor 1 perceive that riparian areas, buffer zones, or vegetative buffers are the most helpful BMP in the mitigation of riverbank instability (21: 5). This BMP provides critical services to rivers and streams such as filtering of sediment and pollutants, increasing runoff infiltration, decreasing runoff velocity before making it to the water body, and decreasing flooding probabilities. Most importantly, vegetative buffers establish roots that stabilize the bank thereby preventing bank erosion. Participant 1 explains these benefits like this: *"buffers are the last line of defense before water goes into [the] stream from upland areas and we have to have deep rooted vegetation or trees…so that the runoff has an opportunity to go through a buffer before going into the stream.* Participants loading on Factor 1 understand that the implementation of vegetative buffers would be a major contribution in the efforts to achieve bank stabilization in the Upper Wakarusa Watershed. Participants 4, 10, 16, and 19 explain the role of vegetative buffers in the stabilization of riverbanks: vegetative buffers are *"mother nature's way to protecting streams and stream banks" (10)", "the roots and plants … hold [the] stream bank (4)", "having vegetation around [vegetative buffers] is probably the best thing you can do to control bank erosion (16)", "we don't have continuity in our stream banks so stabilizing the stream banks with vegetation and*

buffer areas has to be in the top [priority]" (19). While riparian areas may be the ultimate BMP to help bank stability, other BMPs may be more welcomed by farmers who do not wish to dedicate a significant amount of land to the implementation of conservation practices.

Farmers may more likely welcome those practices involving cropland conservation and livestock management. The participants loading on the Hands-On Rural Residents Factor ranked livestock management ((13; $z=-1.00$, $p< 0.05$), 23: 2) higher than Factors 2 and 3 participants, and they also favored cropland conservation BMPs (3: 0, 15: -1, 17: 1, 19: 3, 20: 2, 22: 2). For Factor 1 participants, cropland conservation practices include terrace systems, prescribed burns, no-till farming, cover crops, and grassed waterways. Factor 1 participants also emphasize the use of BMPs in combination with each other for maximum effectiveness. Therefore, both livestock management BMPs and cropland conservation BMPs may be combined in an effort to improve the quality and quantity of water in the manner explained above, in addition to also helping riverbank stability. Some of the most common combinations for loaders on Factor 1 are terraces with grass waterways and wetlands/basins (3: 0, 17: 1, 22: 2, 8: 3, 18: 1) *(participants 4, 7, 16, 19*), native grasses and plants in riparian areas (9:1, 21:5) *(participant 7)*, and no-till farming with cover crops (19: 3, 20: 2). Factor 1 participants especially favored no-till farming (19; $z=1.19$, $p < 0.05$) in comparison to Factor 2 and 3 participants.

Cover crops were not particularly favored by any Factor, and the reason seems to be the only recent reemergence of the practice and the fact that farmers in the region are putting it through a trial period. Participant 11 explains *"no-till farming and cover crops in combination is too young of a science right now".* On the other hand, Participant 2 remembered that his *"dad used to do this [cover crops] back in the 1940's, he used the yellow clover though which makes animals sick, but he would plow under in the spring and not use any fertilizers. Just from this cover crop you would not believe how much corn he would get... Now they are trying to educate about the cover crops".* There have been a number of farmers who have adopted cover crops and have shown to profit from it.

Farmers who have adopted cover crop practices during its reemergence have shown to benefit, especially when combining cover crops with other practices. For example, participant 2 reports that a member of the community used a cover crop and no-till combination and

produced *"10 bushels an acre more than he [an individual who was doing traditional farming] did".* There were other combinations of practices involving cover crops, i.e. using cover crops as foliage to feed livestock sometimes even during the winter *(participant 2 and 11*). However, it was clear that the combination of cover crops and no-till farming was the combination of BMPs that provided better yields. High yields resulting from the combination of no-till farming and cover crops were the result of a number of ecological services that this combination provides. Like riparian areas, the combination of cover crops and no-till provides a number of benefits to the farmer, unlike riparian areas; the plot used for cover crops eventually generates profit to the farmer. Therefore, the combination of cover crops and no-till presents an opportunity to benefit all parties involved—the Upper Wakarusa WRAPS, the farmer, and the watershed. Factor 1 participants found that benefits associated with the combination of no-till and cover crops included: *"helps keep the soil in place" (participant 7), "those two [practices] would be pretty effective [in increasing] soil fertility"(8*), and they ***"****help us emulate prairies to be more like a sponge" (1).* Stakeholders loading on Factor 1 believe that the combination of cover crops and no-till is beneficial to the farmer, improves watershed health, and provides greater bank stability. Participant 8 believes that no-till and cover crops *"could improve farming practices in the US dramatically*".

For participants loading on Factor 1, native grasses and plants are not a top priority BMP when addressing riverbank stability, but they are not completely under prioritized (9:1). Factor 1 participants do believe that it is optimal to have native grasses and plants in the vegetative buffers. However, if native grasses are not available for BMP implementation, other grasses may carry out some of the functions that native grasses do. While pollutant input reduction may not be as efficient when using non-native plants, it is better to use non-native plants than not using any vegetation at all (*participants 4, 8, and 9)*. The benefit of using native grasses and plants is the promotion of native riparian ecological services and native hydrology *(participants 10 and 19).* Participant 13 mentions, *"native grasses and plants … result in native hydrology and having good healthy riparian areas is going to hold the bank in"*. Factor 1 participants do not perceive native grasses and plants to be imperative when preventing riverbank instability

because it is believed that vegetation that is not necessarily native also works as *"control devices to disperse the energy of moving water" (12)*.

Factor 1 participants ranked revetments as being significantly helpful to riverbank stability (24: 4); however, it was believed to be helpful only as a last resource. It is important to keep in mind that Factor 1 participants' approach to riverbank stability is governed by its chronological approach. Therefore, those BMPs in the Q set that are perceived as being hands-on BMPs will be located towards the end of the chronological approach. These hands-on BMPs are located at the end because other BMPs like education and data collection need to take place first as a strong foundation in order to successfully implement hands-on BMPs. Revetments can be thought of as the most representative hands-on BMP to mitigate riverbank instability. Although other BMPs are regarded as hands-on, revetments physically hold on to the riverbank. Revetments do this with cut trees or rocks positioned on the slope to hold the bank in place when the bank is in a critical state. For this reason, although revetments received a high ranking by stakeholders loading on Factor 1, which places this BMP as the ultimate hands-on BMP on the chronological approach, it is believed to be of help only as a last resort. The placement of revetments as a BMP is confined to the positive rankings due to the underlying rule of Factor 1 participants' chronological approach.

A number of participants agreed that revetments are some of the most expensive riverbank restoration projects and that the need for revetments can be prevented with proactive implementation of other BMPs (participants 1 and 19). Factor 1 participants' chronological approach to riverbank stability follows this idea. Revetments are located towards the end of the chronological approach; therefore, it would be the last BMP to put in place after the rest of the BMPs have been implemented. In order to follow this train of thought, revetments should have received the highest ranking in Factor 1 participants' chronological approach, because it would have been the last BMP to be adopted as a last resort. Yet, vegetative buffers received the highest ranking (21: 5). For loaders of the Hands-On Rural Residents factor, the presence of vegetative buffers is imperative in the efforts to mitigate riverbank instability. The prioritization of vegetative buffers over all other BMPs seems to have been the exception overriding the chronological approach characteristic of Factor 1

participants. A possible explanation for this occurrence may be that participants loading on Factor 1 view the proximity of vegetative buffers to the river or stream as having a more direct impact on riverbank stability.

Although revetments are regarded as a last resource BMP, participants who have used this BMP recounted benefits associated with revetments compared to not using any BMPs on his/her eroding riverbanks. Participant 2 mentioned that by utilizing revetments, he/she was able to capture the soil that his neighbor's eroding bank was producing.

> *"My neighbor …bulldozes all his trees out [of the vegetative buffer] then I get a lot of sediment coming down the stream and I put in some of this [revetments] here because it was cutting away some of my banks … some vegetation that I have there prevents the river from taking my bank, plus I took his soil and caught it and what he loses I gain".*

The implementation of revetments benefited participant 2 and possibly other landowners downstream. Other participants added that revetment use might also present a number of drawbacks, like the fact that they can *"get washed away by the river"(1)* and they are also thought to *"transfer problems from one site to downstream"(13).* Those loading on Factor 1 consider the use of revetments as a last resort as favorable; however, its lone use for riverbank mitigation does not seem to be recommended. As explained above, a comprehensive and chronological approach should be the basis to mitigate riverbank stability.

In summary, participants loading on Factor 1 are rural residents who share a unique and particular chronological approach to address bank stability. The chronological approach starts with data collection by assessments and inventories, followed by education through training and awareness, and ends with the implementation of hands-on BMPs. Factor 1 participants understand effective BMP combinations to prevent bank instability and to efficiently obtain the most benefits from crops and livestock related BMPs. While native grasses and plants are not a priority for Factor 1 participants they are not completely under prioritized. Instead, Factor 1 participants significantly favor other practices that mimic the natural state of the land and that are directly related to crop conservation, such as no-till farming. For Factor 1 participants,

healthy vegetative buffers are the most helpful BMP to bank stability and ephemeral gullies are the most significant threat.

FACTOR ARRAY FOR FACTOR 1										
T/A: Training and awareness **A/I:** Assessment and inventory					11. A/I: stream reaches lacking grass filter strips					
			5. A/I: land use	15. Prescribed burns	7. A/I: cropland	18. Water and sediment basins	23. Livestock management			
		16. T/A: tmdls	2. A/I: soil types	10. A/I: ephemeral gullies	6. Erosion control: urban	17. Tile outlet terraces	22. Grass waterways	19. No till farming		
14. Ephemeral gullies	12. Rain gauges	13. A/I: Animal feeding operations	1. T/A: excess runoff	4. A/I: natural resources	3. Gradient terraces	9. Native grasses and plants	20. Cover crops	8. Wetlands	24. Revetments	21. Grass filter strips/ Vegetative buffers
Rank -5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Less	←----------				**Neutral**	----------→				**More**

Figure 7. Factor Array for Factor 1

DISTINGUISHING STATEMENTS PER FACTOR

No.	Statement	FACTOR 1 (Hands-On Rural Residents) Z score	Rank
2	Assessment and/or inventory: soil types	**-0.72**	-2
10	Assessment and/or inventory: ephemeral gullies	**-0.45**	-1
11	Assessment and/or inventory: stream reaches w/o grass buffer	**-0.30**	0
13	Assessment and/or inventory: animal feeding operations	**-1.00**	-3
19	No till farming	**1.19**	3

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 2. Distinguishing Statements for Factor 1

Factor 2: Detail Oriented Urban and Suburban Residents.

Factor 2 has an eigenvalue of 2.85 and explains 15% of the variability in this study. Three participants significantly associated with this factor. They are all middle-aged male government and public officials with higher college education. They are urban and suburban residents of the Upper Wakarusa Watershed who have lived in their current residence from less than 9 years to up to 30 years.

Participants loading on Factor 2 seem to focus on two themes they perceive as significantly affecting bank stability: vegetative buffers, and ephemeral gullies. Factor 2 participants' approach to the mitigation of riverbank instability involves a thorough collection of information about these two themes using assessments and inventories while avoiding general or non-specific aspects like natural resources, land use, or cropland. According to Factor 2 participants, the implementation of vegetative buffers and the assessment and inventory of areas where these vegetative buffers may be lacking are the two most helpful BMPs in the mitigation of bank instability (21: 5, 11: 2). According to participant 17, *"the buffers are needed…for stream bank stabilization"*, participant 18 adds that the assessment and inventory of areas where buffers may be lacking *"might give you an idea about possible stream bank failure"*.

Factor 2 participants ranked ephemeral gullies significantly higher than Factor 1 and Factor 3 participants (14: 2; $z= .82$, $p< 0.01$)(see Table 3). It is important to note that although ephemeral gullies received a significantly positive ranking by Factor 2 participants compared to other factors, its ranking does not reflect how helpful ephemeral gullies are to bank stability. Instead, Factor 2 participants assigned a high ranking to ephemeral gullies to highlight how critical it is to address them in order to successfully mitigate riverbank instability. Participant 18 states,

> *"I was looking at [ephemeral gullies] not so much from them actually taking place but from a remediation stand point [where] being able to control ephemeral gullies…if they are going to the actual water body… then mitigation of these particular gullies can*

> *help a potential nick point on the stream bank which will keep it from eroding later on".*

Stakeholders loading on Factor 2 also regarded the assessment and inventory of these ephemeral gullies as being important in the mitigation of riverbank instability.

The assessment and inventory of ephemeral gullies received a positive ranking by participants loading on Factor 2 (10:1). As with vegetative buffers, the understanding of ephemeral gullies via data collection seems to be a priority for Factor 2 participants. Participant 18 mentions,

> *"[There are] areas where the stream bank is degrading [and] the formation of gullies accelerate [riverbank instability]. So having an idea of where these nick points may be on the stream bank itself, … might give you a good idea about where to look in regards to stream bank [instability]"*

The assessment and inventory of ephemeral gullies may also provide information about significant sources of erosion and sedimentation especially in areas with little to no history of riverbanks being compromised. Participant 14 mentioned, *"inventory of gullies is important especially in watersheds where you don't see a lot of stream bank erosion, yet you have a lot of sediment coming out the end of a watershed".*

Factor 2 participants emphasize the need for data collection on specific features or BMPs via assessments and inventories. Therefore, loaders on Factor 2 seemed also to favor the assessment and inventory of aspects that are not necessarily correlated with specific BMPs but that provide useful information, which may help prevent negative effects on riverbank stability. For example, participant 17 highlighted the importance of soil type data collection for successful riverbank stabilization efforts; "*we have done some bank stability projects where the soil type is such that the stabilization project just [did] not hold*". Participant 18 provided a different example stating that rainfall data is important in the efforts towards bank stability. This participant explained,

> *"precipitation events that can contribute to stream bank erosion [are] high intensity…short duration sort of flash or it can be a prolonged period of rain…so if you got a network in place to get*

> *an idea of what the precipitation was across a particular watershed then that can give you an idea of the type of flows that you might expect to see in that area"*

In contrast, Factor 2 participants did not present significant mentions of favoring broad or general assessments and inventories, such as that for cropland, land use, or natural resources (7: -3, 5: -2, 4: -1). This feature further reinforces Factor 2 participants' unique interest in collection of detailed and specific data regarding BMPs or features believed to mitigate riverbank instability. Additionally, Factor 2 participants did not find livestock-related BMPs and assessments and inventories as helpful to riverbank stability. The animal feeding operations assessment and inventory was not a priority for Factor 2 participants (13: -5) but was ranked somewhat close to the livestock management BMP (23: -1). This may hint that although livestock related aspects are not a priority for Factor 2 participants when mitigating riverbank instability, it is still valuable to maintain cohesiveness between a BMP and its corresponding assessment and inventory.

Although the inventory and assessment of cropland was not a priority for Factor 2 participants (7: -3), there was not a general consensus among Factor 2 participants, and some seem to favor a hands-on approach to cropland conservation using a combination of terrace systems, water and sediment basins, grass waterways, and tile outlets (3: 0, 17: 0, 18: 3, 22: 2, 17: 0). For example, according to participant 14, "*… if we are going to do tile outlet terraces, it would be best to discharge them to a basin or even better to a wetland to treat the dissolved nutrients and the dissolved pesticides … before it discharges to the stream".* A hands-on approach to cropland conservation using a combination of BMPs may be favored by a number of participants, however, not all of the participants agreed on the fact that BMPs promoting native hydrology, i.e. wetlands, should be used. Participants loading on Factor 2 tend to stay away from BMPs that preserve natural functions. This characteristic is evident in the low rankings assigned to wetlands, cover crops, and no-till farming (8:1, 20: 0, (19:1; $z= .49$, $p< 0.05$)).

This point of view is further confirmed by the fact that Factor 2 participants assigned the lowest rankings for native grasses and plants compared to Factor 1 and 3 participants (9: -3; z= -

1.00, p< 0.01) (see Table 3). According to participant 14, *"there is other vegetation that you can plant that is not necessarily native [and] is every bit as effective as native grasses to hold banks in place".* Participant 18 agrees with this statement saying "…*you should try to go with as native of a vegetation as possible but you also want to ensure the long term stability of the project. …any vegetation be it native or not can help bank stability".* The use of native grasses and plants is perceived to be of minor help to riverbank stability by participants loading on Factor 2. However, Factor 2 participants recognize the need for the presence of any type of vegetation in vegetative buffers in order to mitigate riverbank instability.

Education through training and awareness of the public and stakeholders of the watershed was not necessarily a priority for participants loading on Factor 2 but was not completely under prioritized (1: -1, 16: -2). Points of view regarding education seem to follow the idea that providing education may help certain landowners acknowledge the need to adopt conservation practices. However, there are those landowners who have received the training and are still hesitant to implement conservation practices. For example, participant 14's opinion on runoff education is that "*a lot of the producers out there can recognize when they have excessive runoff but they might not be as interested in addressing it".* Other participants called on the need to use better techniques when talking to landowners about topics that may become overly technical, such as TMDLs[4]. Participant 17 stated, *"a lot of landowners or the general public read about TMDLs and really don't understand they are contributors"*. Participant 18 proposes that the reduction of TMDLs may be possible through the implementation of other BMPs, *"from a public awareness standpoint you are getting to implementation of the TMDLs through other BMPs without even having to drill them on it [TMDLs]"*. Ultimately, education about the need to implement conservation practices to prevent bank instability should start with conversations about the potential landowner's loss of profit through long-term land loss *(participant 18)* and the negative impacts that this will have on future generations *(participant 17)*.

[4] Total Maximum Daily Loads (TMDLs) of pollutants that a body of water can receive in a day to still comply with water quality standards.

Participants loading on Factor 2 agree with the fact that revetments are helpful to bank stability as a last resort, however, the best size stream to obtain the most success with this practice is still debatable among Factor 2 participants. Participant 14 mentioned that revetments *"work for larger streams"*, however, participant 18 mentioned, *"in large streams that have high velocity, it's mixed success…I think it is a good BMP for maybe smaller streams".* Participant 18 provided an interesting insight that may explain the high ranking of revetments by Factor 2 participants. Participant 18 added that revetments might be a viable option for landowners who do not have the funds to implement other BMPs *"this type of BMP … might take place for relatively cheap to help stabilize stream banks in particular situations…[specially] for smaller streams where you might not [need as many] materials … to do your projects"*. For Factor 2 participants, revetments may be seen as a better than nothing solution for riverbank instability, especially in situations when limited funding is available and the riverbank condition has deteriorated significantly.

Participants loading on Factor 2 have a keen sense for detail in their approach to stream bank stability. Factor 2 participants' priorities to mitigate bank instability involve vegetative buffers and ephemeral gullies. Participants loading on this factor highlight the need to obtain the corresponding assessments and inventories of vegetative buffers and ephemeral gullies in order to determine their presence or lack thereof. Additionally, Factor 2 participants' characteristic attention to detail prioritized the data collection of specific aspects believed to impact bank stability, such as rainfall and soil type data. On the other hand, data collection of general or broad aspects, like cropland, land use, or natural resources was not a priority for Factor 2 participants. While cropland assessment and inventory was not favored by this factor, cropland conservation through the combination of certain hands-on BMPs was favored. These combinations included terrace systems, water and sediment basins, grass waterways, and tile outlets, and excluded BMPs that seem to promote native hydrology, like native grasses and plants, wetlands, no-till, or cover crops.

The area of residence of participants loading on Factor 2 brings a different perspective in the approach to riverbank instability. Participants loading on Factor 2 assigned a significantly high ranking to erosion control in the urban setting compared to Factor 1 and 3 participants (6:

3). This may reflect Factor 2 participants' residence in urban and suburban areas and it is a reminder of the pervasive presence of riverbank instability throughout the watershed.

FACTOR ARRAY FOR FACTOR 2										
T/A: Training and awareness					2. A/I: Soil types					
A/I: Assessment and inventory			5. A/I: land use	1. T/A: excess runoff	17. Tile outlet terraces	14. A/I: Ephemeral gullies	11. A/I: stream reaches lacking grass filter strips			
		9. Native grasses and plants	15. Prescribed burns	23. Livestock management	20. Cover crops	8. Wetlands	22. Grass waterways	6. Erosion control: urban		
13. A/I: Animal feeding operations	12. Rain gauges	7. A/I: cropland	16. T/A: tmdls	4. A/I: natural resources	3. Gradient terraces	19. No till farming	14. Ephemeral gullies	18. Water and sediment basins	24. Revetments	21. Grass filter strips/ Vegetative buffers
Rank -5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Less	←----------				**Neutral**	----------→				**More**

Figure 8. Factor Array for Factor 2

		FACTOR	
		2 (Detail Oriented Urban and Suburban Residents)	
No.	**Statement**	**Z score**	**Rank**
9	Native grasses and plants	**-1.00**	-3
14	Ephemeral gullies	**0.82**	2
19	No till farming	**0.49**	1

Note: Bold indicates significance at $p<0.05$; bold underline identifies significance at $p<0.01$. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 3. Distinguishing Statements for Factor 2

Factor 3: Pro Data Collection and Conservation of Natural Functions Government Official.

Factor 3 has an eigenvalue of 1.71 and explains 9% of the variability in this study. One participant significantly associated with this factor. This participant is a government official with college education, who has resided in the same urban residence from 20 to 30 years. This participant has significant leverage on decision-making processes regarding natural resource management.

After the statistical analysis involved with the Q methodology, participant 6 presented such a unique point of view that he/she did not associate with Factor 1 or Factor 2. It was imperative to include participant 6's Q sort as this participant holds considerable influence in the management of natural resources in the watershed. This participant's point of view may influence the execution of certain BMPs that help riverbank stability independent of the point of view of other members of the Upper Wakarusa WRAPS or other watershed stakeholders.

For the participant loading on Factor 3 (participant 6), the education of watershed stakeholders through training and awareness (1: 0, 16: -1), and data collection through assessments and inventories (4: 5, 2: 1, 5: 0, 10: 2, 11: 2, 12: -1) are imperative when addressing riverbank stability. Specifically, participant 6 ranked the assessment and inventory of natural resources a higher priority for mitigating riverbank instability (4: 5, $z= 1.97$, $p< 0.01$) than Factor 1 and 2 participants (See Table 4).

Participant 6 mentioned that the assessment and inventory of natural resources is his/her top priority, because it *"is a comprehensive overarching review within the community*". On the other hand, this participant did not regard the assessment and inventory of animal feeding operations and cropland as a priority (7: -2, 13: -5). Livestock management did not receive a high ranking nor was it completely under prioritized (23: 1), which reinforces the fact

that the participant loading on Factor 3 does not believe that livestock related BMPs should be a top priority when addressing bank stability.

The assessment and inventory of stream reaches lacking vegetative buffers and the assessment and inventory of ephemeral gullies both received the same ranking by participant 6 (10: 2, 11:2). However, the BMPs associated with these assessments and inventories, vegetative buffers and ephemeral gullies, were on opposite sides of the rankings from each other (21: 3, 14: -4). This participant believes that vegetative buffers help riverbank stability; however, it is not his/her top priority (21: 3). Participant 6's priorities to address riverbank stability are the assessment and inventory of natural resources (4: 5), wetlands (8: 4), native grasses and plants (9: 3), and vegetative buffers (21:3). On the other hand, ephemeral gullies and prescribed burns were both ranked as aspects that do not help riverbank stability (14: -4, 15: -3). According to participant 6, these features *"increase sediment [input] and contribut[e] exposed soils to the river"*.

This government official supports some BMPs that tend to promote the native hydrology of the land, such as wetlands, and native grasses and plants. However, this participant did not favor no-till farming or cover crop practices as priorities, which are cropland conservation practices that promote the native hydrology of the land (19: -3, 20: 0). In fact, the participant loading on Factor 3 assigned the lowest ranking to no-till farming (19: -3, $z= -1.18$, $p<0.01$). This may have been due to unfamiliarity with the practice as witnessed in other factors. According to participant 6, he/she did not *"really have a lot of knowledge [about no-till]"*, the participant knew that no-till farming helps by *"keeping some vegetation on the fields"* but did not develop his/her argument about the practice's functionality. His/her own need for experience with certain practices may be part of the incentive for participant 6's favoring education for watershed stakeholders.

Other BMPs associated with cropland conservation such as gradient terraces, tile outlet terraces, grass waterways, and water and sediment basins were not considered priorities by participant 6 (3: -2, 17: -2, 22: 0, 18: 2). This participant mentioned that the implementation of these crop conservation practices on an individual basis do not directly help bank stability. As an example, this participant mentioned that gradient terraces *"help at certain degree but you*

still have runoff coming from the terrace ends", a problem usually resolved with grassed waterways or other crop conservation BMPs. Participant 6 suggested that the combination of BMPs should help riverbank stability, therefore, terrace systems should help *"depend[ing] on how [they are] managed"*, and if they are *" combined with something else"*. Interestingly, water and sediment basins were ranked higher than the other crop conservation practices (18: 2). This may be due to the fact that these basins share a number of functions with wetlands, which received a significantly high ranking (8: 4) and are greatly favored by participant 6.

Revetments received the lowest ranking by the participant on Factor 3 compared to Factor 1 and 2 (24: -1, z= -.39, p< 0.01) (See Table 3). The participant loading on Factor 3 believes that revetments should be used as a last resource and it shows a lack of proactive riverbank management. According to participant 6,

> *"[I] put [revetments] on the negative side because that is right on the stream itself and it seems like you ought to establish erosion control practices higher in the headwaters as opposed to right on the stream itself".*

This point of view seems to be shared among all factors; however, the participant on Factor 3 was the only one assigning a negative ranking to revetments. Factor 1 participants placed revetments as a high ranking feature due to their emphasis on hands-on and chronological approach to bank stability, making it one of the last resort hands-on BMPs for landowners. Factor 2 participants consider revetments as a helpful resource to approach bank instability especially for landowners who were unable to implement other BMPs and whose riverbank has been significantly deteriorated. The stakeholder loading on Factor 3 believes that revetments should be the last option for a landowner to mitigate bank instability. Moreover, the participant loading on Factor 3 suggest that other BMPs should be implemented before the riverbank decays significantly and that other efforts should be set in place upstream to prevent negative effects on riverbanks downstream.

In summary, the priorities for the participant loading on Factor 3 are the assessment and inventory of a number of practices and the implementation of practices associated with the promotion of native hydrology and the preservation of the natural functions of the land. Therefore, the participant loading on Factor 3, ranked the assessment and inventory of natural

resources is the top priority, followed by the implementation of wetlands, native grasses and plants, and vegetative buffers. Other cropland conservation BMPs were not favored as being implemented individually; however, the stakeholder loading on Factor 3 acknowledged that the appropriate combination of these BMPs should help bank stability. The assessment and inventory of cropland and animal feeding operations were not a priority for the participant on Factor 3. The least helpful items according to Factor 3's participant were ephemeral gullies and prescribed burns due to their high sediment contribution to the watershed.

FACTOR ARRAY FOR FACTOR 3										
T/A: Training and awareness					1. T/A: excess runoff					
A/I: Assessment and inventory			3. Gradient terraces	12. Rain gauges	5. A/I: land use	2. A/I: Soil types	11. A/I: stream reaches lacking grass filter strips			
		15. Prescribed burns	7. A/I: cropland	16. T/A: tmdls	22. Grass waterways	23. Livestock management	18. Water and sediment basins	9. Native grasses and plants		
13. A/I: Animal feeding operations	14. A/I: Ephemeral gullies	19. No till farming	17. Tile outlet terraces	24. Revetments	20. Cover crops	6. Erosion control: urban	14. Ephemeral gullies	21. Grass filter strips/ Vegetative buffers	8. Wetlands	4. A/I: natural resources
Rank -5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Less	←----------				**Neutral**	----------→				**More**

Figure 9. Factor Array for Factor 3

No.	Statement	FACTOR 3 (Pro Education and Data Collection) Z score	Rank
4	Assessment and/or inventory: natural resources	**1.97**	5
19	No till farming	**-1.18**	-3
24	Revetments	**-0.39**	-1

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 4. Distinguishing Statements for Factor 3

	FACTOR 1	FACTOR 2	FACTOR 3
PRINCIPAL CHARACTERISTICS PER FACTOR	• **Chronological approach:** A/I→T/A→Hands-on BMPs	• **+ Ephemeral gullies** • **Detailed data collection (A/I):** *+ Riparian areas and ephemeral gullies*, soil types and rainfall *- General* themes like natural resources, land use, cropland • **+Urban runoff** (participant's residency)	• **+ Education (T/A)** • **+ Data collection (A/I):** *+ Natural resources* (higher than other factors) –Livestock management, cropland conservation = Buffers, ephemeral gullies • **- No till** (lower than other factors) • **- Revetments** (lower than other factors)
FAVORS	• *Buffers* (highest priority). • Prescribed burns. • Livestock management: combining traditional methods • *Cropland conservation:* combining traditional methods, *AND* practices that promote native hydrology • *No till* (higher than other factors).	• Cropland conservation using traditional methods	• Buffers • *+ BMPs promoting native hydrology* • Cropland conservation combining traditional methods.
DOES NOT FAVOR	• Ephemeral gullies	• Cropland conservation using native hydrology promoting practices	• Ephemeral gullies • Prescribed burns

Table 5. Factor Highlights

DISCUSSION

Cost-share

Finances

A number of study participants have witnessed or personally knew landowners who carry out farming practices up to the riverbank. According to study participants, the consequences were evidenced in soil and nutrient loss, high eroding and unstable riverbanks, increased probability for flooding, and ultimately expensive riverbank repairs. Although landowners may not always suffer the direct consequences of their unfavorable farming practices, it is highly likely that residents living downstream will. Participants of this study mentioned that education might be a useful tool for demonstrating the long-term benefits of BMP implementation, which will help riverbank stability.

Study participants mentioned that a number of landowners who understand the importance of BMPs have opted to pay for these practices themselves instead of using the cost-share programs. This allowed them to implement the practices the way they desired without compromises, while securing the long-term benefits of conservation practice adoption. Some participants commented that the focus seems to be upside down, where help from conservation programs should be specially available for those landowners who decided to implement BMPs on their own instead of waiting for cost-share program processes.

Timeframe and Maintenance

Participants of this study agreed that the amount of time and resources needed to maintain BMPs could be a drawback to a number of landowners who remain hesitant to adopt conservation practices. Participants added that 10 years seems to be the average requirement to maintain a BMP in a property. Moreover, if the property is sold, the proper BMP management is passed on to the new owner. If the new owner is not compliant, the funds directed towards the implementation of conservation practices are to be returned to the appropriate organization.

Flexibility and Bureaucracy

Increasing rules and regulations seem to be a deterrent to landowners who may be interested in participating in cost-share programs. According to study participants, allowing some flexibility in negotiation processes between landowners and groups like the Upper Wakarusa WRAPS, would allow for a much needed compromise between both parties ultimately benefiting the environmental condition of the watershed. Participants observed that conservation programs sometimes limits themselves with land use restrictions in the property during BMP management, or with the requirements for landowner participation in cost-share programs.

In terms of bureaucracy, a number of study participants agreed that providing a simple and affordable package deal for landowners seems to be an attractive feature especially to hesitant landowners. However, a number of landowners decide not to participate because they feel overwhelmed by the amount of paperwork and permits needed to participate in cost-share

programs. Participants of this study suggested that for riverbank stabilization projects for example, this package should include a completed permitting process ready to be signed by the landowner, and most importantly, a financial analysis. Participants added that this analysis should include the following evaluations: the acreage that would be lost if no vegetative buffer is in place, the profit and property that would be lost due to river damage, and the profit that would be recuperated by simply maintaining the productivity of the land adjacent to the river.

Education

Study participants regard education as a vital stepping-stone to watershed management and more specifically in the implementation of BMPs that have the potential to help riverbank stability. Participants especially highlighted the need for education regarding excess runoff, its effects on riverbank stability, and the benefits that come from controlling it. According to the study participants, it is important to target the landowners who do not attend training sessions, as they are believed to be the ones who need this information the most. Study participants suggested that education regarding TMDLs is best approached through technically light conversations. Therefore, information about other BMPs that may decrease TMDLs in the streams may be more successful with watershed residents. Lastly, study participants called attention to the need for educating urban and suburban watershed residents on fertilizer usage at household and business levels.

Environmental Policy Rigidity

According to the literature reviewed for this project, there should be an increase of monetary incentives with decreased flexibility and diminished individualized plans for BMP implementation. In other words, increasing rigidity of environmental policy or making the implementation of BMPs a requirement should come with greater financial incentive to the landowners. A number of study participants believed that making conservation practices a requirement would drastically improve riverbank stability in the watershed. A number of participants specifically mentioned that vegetative buffers should be required in order to improve riverbank stability. Therefore the conservation groups like WRAPS should institute this process. Participants assured that these projects are considerably costly, and without vegetative buffers in place, true riverbank stabilization is unattainable. Obtaining the

involvement of all parties may be challenging, but, according to study participants, some conservation groups have already achieved their goal of basing riverbank mitigation on real conservation efforts by requiring the implementation of vegetative buffers before moving forward to other bank stabilization projects.

Other study participants who agreed with this point of view had a number of reasons for supporting mandatory vegetative buffers to improve the state of riverbanks in the watershed. Study participants raised the point that if a landowner decides to participate in the cost-share programs to adopt other BMPs, it should be a requirement to implement buffers first in order to receive the technical and monetary benefits of this program. Other participants went so far to suggest that the landowner should receive a fine when there is sufficient documentation showing non-compliance. Participants pointed out a drawback from making BMPs mandatory—that enforcement is necessary to keep landowner compliance—to which it was suggested that part of the monetary incentive provided by the cost-share programs should be redirected towards enforcement and proactive implementation of BMPs. This would prevent long-term degradation of the watershed. This preventative measure will positively replace the current practice of revitalizing the watershed after damage has occurred.

Participants who favored the current approach to conservation practice adoption using volunteer programs reinforced the need for a number of aspects highlighted before. For example, a flexible, personalized, and targeted approach to the adoption of conservation practices. This group of participants also called for the need of trust-based relationships between landowners, conservation groups, and local community leaders. The active role of these three groups of people in the education and the demonstration of the benefits associated with BMP implementation was the bottom line for participants supporting the current approach to BMP adoption.

Networking and Recognition of Community Leaders

One of the most interesting findings in this study was that none of the participants self-identified as a prominent community member. This may be attributed to Kansans' well-known modesty, which would deter them from self-identifying as community leaders. Based on the

qualitative section of this study, it was clear that a number of participants have taken on a leadership role within their communities and continue to do it on a consistent basis. It may be the case that while participants do not self-identify as community leaders, the community itself does not take steps to recognize these individuals for their leadership qualities. Although their work and effort is remarkable, these participants may regard it as insignificant and common. It is often due to their efforts that a number of conservation practices are adopted. It is thanks to individuals like these that critical trust-based relationships among landowners, farmers, conservation groups, and communities occur. Recognition of these community leaders is vital for the long-term success of watershed management efforts.

The work of these community leaders is based on education, innovation, and becoming a medium for communication. These participants do not hesitate to share their own experience-based knowledge on farming law, benefits of conservation practices, processes of cost-share programs, and they are usually happy to use their own projects for demonstration purposes. These participants welcome innovative conservation practices and practices that may be labeled as risky, and they usually encourage other landowners to follow suit. Most importantly, these participants serve as a medium for communication made feasible by their comprehensive understanding of community characteristics and concerns. At the same time, the community knows them, trusts them, and respects their points of view.

While these community leaders may not have all the answers, their deeply rooted connections to the community lead them to be regarded a resource instead of a source of information. They have the capability of connecting the needs of the community to those individuals who can help fill these needs. In case of obstacles to fulfilling these needs, these leaders aim to find a common ground among all parties involved. If those fulfilling the needs of other community farmers are community members themselves, these leaders seem to encourage them to continue taking on leadership roles themselves. Some participants acknowledged other community members' efforts to adopt conservation practices and praised them for taking the initiative to implement these practices when not using cost-share programs. They applaud community members' interest in leading the way and possibly taking

on a leadership role in the conservation community. Most importantly, these participants stand for what they believe in and fight for their ideals and goals often in the name of watershed conservation.

Target Specific

Study participants agreed that those landowners interested in adopting conservation practices have already done so with or without cost-share programs. Participants also agreed that landowners who have not adopted conservation practices might not have done so for a number of reasons. As not all farmers are landowners, it is challenging to communicate with property owners who lack knowledge of the detailed dynamics of their land and who may not be aware of the conservation practices needed. Participants agreed that this is often the case of absentee landowners who may have a different relation with his/her land than a landowner who farms his/her own land. Furthermore, absentee landowners may also have an isolated relationship to the farming community residing in his/her property's vicinity. Therefore, absentee landowners, their friends or family, may not experience the externalities associated with not adopting conservation practices.

Study participants also highlighted the fact that some tenants may also have the same relation to the land as absentee owners, though differing in their lack of decision power over the implementation of conservation practices. While it is not their property, tenants may strongly favor the implementation of conservation practices, however it is ultimately the landowner's decision to adopt these practices. On the other hand, there might be those tenants who do not feel responsible for the externalities that the landowner's property may be causing. An optimal situation may be that both tenant and landowner have a positive three-way relationship with each other and with the land. This way, enforcing the proper maintenance of a conservation practice may be unnecessary. If this relationship is absent, adoption of a conservation practice may be viable, however proper maintenance of it may require additional effort.

According to study participants, residents from urban and suburban areas also need to be considered as part of the target groups in outreach efforts regarding conservation practices.

Participants observed that native water hydrology is drastically changed with urban and suburban sprawl. In addition, participants mentioned that a considerable amount of pollutants that make it to the streams come from urban and suburban practices, instead of rural settings, as it is often believed. Study participants underlined the fact that a number of these urban and suburban residents who contribute to pollution seem to bring their disregard for conservation when moving to the rural areas, often as a result of inheriting the property or wanting a change of lifestyle. According to study participants, many of these new rural residents lack knowledge on how to tend the land; therefore it is challenging to promote conservation practices involving individuals who may not have a comprehensive knowledge of their land's dynamics. On the other hand, there are landowners whose inheritors will move to urban centers and adopting conservation practices on a property that will not be in the family.

Study participants underlined the generational discrepancies that make the adoption of conservation practices challenging. Participants agreed that younger generations might be more enthusiastic about adopting innovative conservation practices in their property compared to older generations. Some participants suggested that approaching older, hesitant landowners through younger relatives seems to lead to the landowner reconsidering his/her decision to implement conservation practices. Study participants suggested techniques to approach hesitant landowners, starting with education about their potential impact on the quantity and quality of water in the watershed. If education fails, phone calls, letters, and ultimately home visits should take place.

Study participants demonstrated considerable concern regarding hesitant landowners. Participants highlighted the fact that for these landowners neither the monetary, technical, and long-term benefits of the cost-share programs, nor the problematic long-term effects of pollution in the watershed, are sufficient incentives to come forward. Participants mentioned that monetary incentives are not an efficient approach when attempting to attract these landowners anymore, and not having a personal incentive seems to be the most significant constraint. Participants observed that if these incentives do not come from within the landowner, an outside incentive such as peer pressure from other community farmers or even

the legal enforcement of conservation practice adoption may be the only way to obtain their participation. This last option might create disruption among the farming community and therefore other options need to be explored.

Consensus Agreement Statements

Other features that the Q methodology offers are the identification of what are called Consensus Agreement and Disagreement Statements. These statements are described as "nonsignificant consensus statements" because there are no significant differences that separate one factor from the next. Therefore, these statements that all stakeholders loading on all factors agreed on can be thought of as being items of the Q set that are perceived by all participants as helping riverbank stability, as well as those items that do not help. This piece of information may be the most important tool that this research project will provide to the Upper Wakarusa WRAPS. These are the key statements that may provide WRAPS leaders with an understanding of what practices resonate most across different groups. It may be that communication with these groups beginning with discussion of such practices may allow for the most successful communication among organization members and hesitant landowners.

Although each factor's stakeholders present distinguishing statements, and acknowledging the different perception groups within the UWWRAPS group, it is imperative to know which aspects participants do agree with and which aspects they do not agree with. Since the consensus agreement and disagreement statements of this study are derived from representatives of the Upper Wakarusa watershed, they likely represent the points of view of other watershed residents, including landowners hesitant to adopt conservation practices. Therefore, this information potentially represents the missing link that the UWWRAPS group has long needed in order to become more successful and obtain an increased participation in the cost-share programs.

Those items that participants loading on Factor 1, 2, and 3 agree will help riverbank stability include wetlands, water and sediment basins, cover crops, vegetative buffers or riparian areas, and grassed waterways (see Table 5). Those items that present a $p>0.01$ are

particularly important as this smaller p value represents a smaller difference among stakeholders loading on all factors. Therefore, wetlands and cover crops have a higher level of agreement among all stakeholders loading on all factors compared to the other items listed in the table below.

CONCENSUS AGREEMENT STATEMENTS							
		FACTOR					
		1 (Hands-On Rural		2 (Detail Oriented Urban		3 (Pro Education and	
No.	Statement	Z score	Rank	Z score	Rank	Z score	Rank
8	Wetlands (**C**, p>**.01**)	1.00	3	**0.29**	1	1.58	4
18	Water and sediment basins (**C**, p>**.05**)	0.78	1	1.02	3	0.79	2
20	Cover crops (**C**, p>**.01**)	0.84	2	0.23	0	0.00	0
21	Riparian areas/buffer zones/grass filter strips (**C**, p>**.05**)	1.71	5	1.90	5	1.18	3
22	Grass waterways (**C**, p>**.05**)	0.79	2	0.70	2	0.00	0

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 6. Consensus Agreement Statements

There were a prevalent number of participants who agreed that riverbank stability would benefit if a number of BMPs that promote native hydrology were put in place (see statements number 8, 18, 20, 21, 22 on Table 5). The UUWRAPS' nine-element plan demonstrates support for wetlands, water and sediment basins, vegetative buffers, and grassed waterways. The plan's support for these practices may be a reason for the stakeholders' agreeing on these BMPs' role in helping riverbank stability. Yet, there seemed to be little mention of cover crops. A significant number of participants showed enthusiasm about the practice, especially in combination with no-till, however, there were some participants not entirely convinced that cover crops was the best BMP to mitigate riverbank instability. This may be due to the recent reintroduction of this practice to the farming community and the fact that many farmers are still only experimenting with the practice. While the practice was used in the past and a number of farmers have had successful increases in their yields today, some participants still need to acquire additional experience with cover crops before it gains wider acceptance. According to this study's participants, some of the benefits associated with cover

crops include the buildup of soil and organic matter, reduction in the use of fertilizers and other agricultural chemicals, runoff water absorption, and decrease in erosion and sedimentation; cover crops work well with no-till and terrace systems.

Participants of this study believe that the items in Table 5 are essential to recuperate the natural hydrology in the watershed. They believe that wetlands are efficient when coupled with terrace systems and that their most important function is to slow down runoff water and filtrate or evaporate it, before it makes it to nearby streams. They also believe that water and sediment basins carry out similar functions as wetlands. These basins, however, have an added benefit: some crops can be planted in the basin as the collected water is drained out slowly over 24-48 hours. Participants believe that basins are efficient when coupled with tile outlet terraces or at the end of a grassed waterway. According to study participants, grassed waterways do not disturb the soil as much as other practices; are successful at controlling erosion; and work well in combination with terraces. They believe that vegetative buffers or riparian areas are necessary for the successful mitigation of riverbank instability. The most common benefit associated with this BMP was the fact that the plants and trees found in the vegetative buffer hold on to the riverbank.

CONSENSUS AGREEMENT STATEMENTS		
	Combination Practice	**Benefits**
Wetlands*	Terraces	• Supported by 9-element plan • Slow down runoff water, filtrates it and evaporates it.
Cover crops*	No-till and terrace systems	• **Not** supported by 9-element plan • Buildup of soil and organic matter • Reduction of Ag. Chemicals • Runoff water absorption • Decrease in erosion and sedimentation
Water and sediment basins	Terraces and grassed waterways	• Supported by 9-element plan • Slow down runoff water, filtrates it and evaporates it. • **Crop can be planted** on basin
Vegetative buffers	-	• Supported by 9-element plan • **Hold on to the riverbank**
Grass waterways	Terraces and water and sediment basins	• Supported by 9-element plan • **Do not disturb** the soil as much as others

Table 7. Consensus Agreement Statements Highlights

Consensus Disagreement Statements

The Q method provides a summary of items that the participants in this study agreed do not help mitigate riverbank stability. Those items with a p>0.01 are items that a significant majority of the study participants agreed are the least helpful items to bank stability, in this case rain gauges. The rest of the items in Table 6 are items considered as being not helpful to bank stability by a number of participants. As most of the participants loading on the factors in this study favored hands-on BMPs, training and awareness and assessments and inventories were part of those items regarded as least helpful. While all BMPs associated with education were listed as not helpful to bank stability, not all assessments and inventories were listed as not helpful. Study participants believed specifically, that data collection of land use and cropland practices were the least helpful data collection items to the mitigation of bank stability. Disapproving of data collection on land use and cropland may be due to the broad and general nature of these categories as most participants associating with all factors favored the data collection of more specific aspects like gullies or riverbanks lacking vegetative buffers. While data collection of natural resources may also be considered as a broad and overarching assessment and inventory, stakeholders loading on Factor 3 ranked it as its main priority, preventing it from being listed as an unhelpful practice.

CONSENSUS DISAGREEMENT STATEMENTS							
		FACTOR					
		1 (Hands-On Rural		2 (Detail Oriented Urban		3 (Pro Education and	
No.	Statement	Z score	Rank	Z score	Rank	Z score	Rank
1	Training and awareness: excess runoff (**C**, p>**.05**)	-0.74	-2	-0.33	-1	0.00	0
5	Assessment and/or inventory: land use (**C**, p>**.05**)	-0.78	-2	-0.75	-2	0.00	0
7	Assessment and/or inventory: cropland (**C**, p>**.05**)	-0.45	0	-1.03	-3	-0.79	-2
12	Rain gauges (**C**, p>**.01**)	-1.50	-4	-1.71	-4	**-0.39**	-1
15	Prescribed burns (**C**, p>**.05**)	-0.46	-1	-0.84	-2	-1.18	-3
16	Training and awareness: TMDLS (**C**, p>**.05**)	-1.24	-3	-0.97	-2	-0.39	-1
	Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.						

Table 8. Concensus Disagreement Statements

Participants believed that individually implemented data collection of land use cover, cropland, or rainfall were of little help to riverbank stability. A number of participants believed that data collection using assessments and inventories should be a requirement prior to BMP implementation in order to better target efforts. Others believed that sufficient data has already been collected and there is no need to collect additional data. These participants believed that it is time to implement hands-on BMPs. Other participants believed that the implementation of hands-on BMPs is the only action needed to help riverbank stability, and they also believed that data collection is unnecessary at this moment. There was no clear consensus among study participants regarding the data collection of land use cover, cropland, or rainfall.

A number of participants in this study agreed that education of watershed stakeholders is unnecessary in efforts towards riverbank stability. However, a number of aspects need to be considered that may have led study participants to rank education lower than other BMPs. According to study participants, landowners who need this education the most are the ones with the least attendance to training sessions. Participants of this study mentioned that some of the reasons for this absence might be the agenda behind the trainings or the instructor, or the complexity of the material, i.e. TMDLs. Other study participants mentioned that most landowners know of the issues in the watershed but decide not to participate in conservation or remediation efforts. According to study participants, education should be the initial step in the mitigation of bank stability and that education programs should target younger, school-age generations.

Prescribed burns seemed to have received low rankings, perhaps because some study participants seemed seeming lack knowledge regarding this BMP. A number of participants were unsure about the benefits or drawbacks of prescribed burns on riverbank stability. Other participants found that the potential sediment input resulting from rainwater runoff after this practice is done would be unfavorable for riverbank stability. Participants added that another drawback to prescribed burns involves complaints from the large number of people who have decided to move to rural areas and who find this practice nuisance. Lastly, participants familiar

with the practice noted that in order to carry out prescribed burns, it is often necessary to request help from friends and neighbors in order for the burn to be safe and successful.

CONSENSUS DISAGREEMENT STATEMENTS	

Rain gauges
Assessments and Inventories: land use
Assessments and Inventories: cropland
	No clear consensus:
	• Too broad and general?
	  o Should be done prior to BMP implementation
	  o Should be done in conjunction with other practices

Prescribed burns	Lack of knowledge about practice? - sediment - disruptive to neighbors - may need help to implement Benefits?

Training and Awareness: excess runoff
Training and Awareness: TMDLS
	Unnecessary?
	• Should be done prior to BMP implementation
	• Should focus on younger generations
	• Those who need it don't participate
	  o No attendance: perceived agenda behind training or instructor
	  o Complex material (i.e. tmdls)

Table 9. Consensus Disagreement Statements Highlights

Factor Q-Sort Values for Each Statement

No.	Statement	No.	Factor Arrays 1	2	3
1	Training and awareness: excess runoff	1	-2	-1	0
2	Assessment and/or inventory: soil types	2	-2	0	1
3	Gradient terraces	3	0	0	-2
4	Assessment and/or inventory: natural resources	4	-1	-1	5
5	Assessment and/or inventory:land use	5	-2	-2	0
6	Erosion control: urban	6	0	3	1
7	Assessment and/or inventory: cropland	7	0	-3	-2
8	Wetlands	8	3	1	4
9	Native grasses and plants	9	1	-3	3
10	Assessment and/or inventory: ephemeral gullies	10	-1	1	2
11	Assessment and/or inventory: stream reaches lacking grass bu	11	0	2	2
12	Rain gauges	12	-4	-4	-1
13	Assessment and/or inventory: animal feeding operations	13	-3	-5	-5
14	Ephemeral gullies\	14	-5	2	-4
15	Prescribed burns	15	-1	-2	-3
16	Training and awareness:TMDLS	16	-3	-2	-1
17	Tile outlet terraces	17	1	0	-2
18	Water and sediment basins	18	1	3	2
19	No till farming	19	3	1	-3
20	Cover crops	20	2	0	0
21	Riparian areas/buffer zones/grass filter strips	21	5	5	3
22	Grass waterways	22	2	2	0
23	Livestock management	23	2	-1	1
24	Revetments	24	4	4	-1

Variance = 6.167 St. Dev. = 2.483

Table 10. The Factor Arrays

CONCLUSION

The agreement and disagreement statements in this chapter serve as a tool for the UUWRAPS to reestablish conversations with landowners who are hesitant to implement water conservation practices in their land. Since the SLT represents watershed stakeholders, the BMPs that the SLT agree help riverbank stability may be overlap with the BMPs welcomed by hesitant landowners. Recognizing that the SLT has differences and commonalities in perceptions may also spark changes in the inner dynamics of the UUWRAPS. Some limitations of this study include the fact that representatives outside of the UUWRAPS were not interviewed. It will be important in the future to carry out a Q method study with a larger number of watershed representatives regarding water conservation practices.

The relevancy of watershed management at an international scale is becoming more obvious with increasing environmental changes that jeopardize water resources for vulnerable and privileged populations. Decisions on water resource management are often in hands of major stakeholders whose perceptions on how to best manage the resource may vary drastically. We have explored the perception groups, agreement, and disagreement areas between the Stakeholder Leadership Team of the UUWRAPS regarding riverbank stability. Now, we turn to water resource management in the Chinchiná watershed located in the Colombian Andes. The proper management of water resources has a significant impact on the quality and quantity of water in the watershed. It also has the capability to prevent significant catastrophes that endangers the human right of access to plentiful clean drinking water. The following chapter presents a case study where water resource mismanagement significantly affected an entire city and surrounding municipalities for over 20 days. The Q methodology is critical in identifying the areas that need to be addressed by Manizales' stakeholders, in order to prevent events like Manizales Sin Agua 2011 in the future.

CH 3: DEFINING PERCEPTIONS OF WATERSHED MANAGEMENT IN AN ANDEAN WATERSHED.

This chapter utilizes the Q method to explore the perceptions of the major stakeholders in the city of Manizales regarding areas that need to be addressed to prevent future catastrophes like Manizales Sin Agua 2011. It provides the perception groups that emerged from the Q methodology qualitative and quantitative analyses. These perception groups provide insights regarding the internal structure and dynamics of major stakeholders in the city. Additionally, perception groups present how major stakeholders approach disaster management through urban water management in the city of Manizales. This chapter also provides the areas of agreement and disagreement between the major stakeholders in the city of Manizales. These areas are composed of areas that contributed or not to the magnitude of Manizales Sin Agua 2011, and that need to be addressed in the near future to prevent such magnitude events. The chapter starts with a literature review regarding the opportunities that Colombia, and the city of Manizales, have for the improvement of urban water management. The literature review ends by connecting proper urban water management to the mitigation of natural disasters. The physical and socioeconomic context of the area is presented, moving into the case study of Manizales Sin Agua 2011. The chapter ends with a detailed explanation of the Q method, results, and discussion.

Abstract

Natural and human processes have threatened human access to sufficient and clean water. In areas prone to natural disasters, governments play a vital role in proactive development of measures prioritizing rights to water at a societal level. This chapter is comprised of a case study of a series of tragic events in 2011 leading to a landslide in the Cervantes neighborhood in Manizales, Colombia. Disaster outcomes were: no water for over 20 days in the city and surrounding municipalities, intermittent gas and electrical utility service,

145 individuals affected, and 48 dead. There is still a debate about whether this disaster was caused by nature or people.

My goal is to determine the views and perceptions of the stakeholders involved in this case study regarding the causes leading to the magnitude of this tragedy. The innovative Q methodology (Q) allows for the identification of consensus groups among stakeholders who serve as respondents to the Q method task. Key informants represent stakeholders in government offices, environmental institutions, main user institutions of the Chinchina watershed, public service institutions, and NGOs. The Q is a valuable tool in the expanding field of quantitative research of subjective human thought in geographical and environmentally focused disciplines. Stakeholders' views and perceptions about the source of this disaster point to natural reasons, citizens' responsibility for electing authority figures, and utility managers and authorities.

Natural forces are more powerful than human, but measures can be taken to mitigate the magnitude of natural disasters. It is important for policy makers to ensure that the interests of all stakeholders are represented in actions to mitigate natural disasters in the city of Manizales.

Literature Review

Consequences of Urban Water Mismanagement

Aqueduct and sewerage networks are poorly distributed in the Latin American Andes. Urban areas currently struggle to provide basic water services, especially in the midst of growing urban sprawl, and they are lagging in preparations for upcoming environmental changes (Fisher, Cook, Tiemann, & Nickum, 2011). Drought, heavy rains, and the increase of temperatures in bodies of water associated with El Niño and La Niña phenomena have significant repercussions in the economy and development of countries located in the Latin American Andes. These phenomena have led to significant loss of cattle, floods, and landslides, and they have shown to significantly impact tourism (Carmona, & Muñoz, 2009). Other

consequences to the current urban water management efforts are environmental pollution, social problems, and increasing health-related issues (White, & Howe, 2004).

In Colombia, social problems, such as discrimination of underrepresented ethnic groups and poverty, are significant issues resulting from, in part, the mismanagement of water resources (Defensoria del Pueblo., n.d.; Johnson, 2009; Sanchez Triana, Ahmed, & Awe, 2007). The Colombian ethnic groups with the least access to aqueduct and sewage networks are the Indigenous communities: the Raizales from San Andres, Providencia and Santa Catalina, and the Afrocolombian communities. It is important to highlight that rural farming communities are also unable to access adequate levels of these basic services (Defensoria del Pueblo., n.d.-b). These communities typically fall below the poverty line, however, increasing access to clean water would instantly assist these communities in rising out of poverty (Sanchez Triana et al., 2007). The lack of access to clean water and inadequate water treatment measures are a direct threat to health, claiming 1.8 million lives each year, most of them children under the age of 5, who succumb to diarrhea (Carmona, & Muñoz, 2009).

The inadequate water use planning in Colombia has led to increasing demands on this resource, compromising water security for a number of communities (Defensoria del Pueblo., n.d.-a). This factor is especially worrisome due to likely changes in environmental conditions, which will likely impact water sources (Defensoria del Pueblo., n.d.-a; Zamudio Rodriguez, 2012). According to the Defensoria del Pueblo (n.d) in Colombia there are 14 million people residing in areas prone to water scarcity that also have increasing populations. A study carried out by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) in 2008, also mentioned that the city of Manizales, for example, ranks high in the probability of water scarcity, holding at the same time high levels of demands on their water resources (Gonzalez, Galeano Moreno, & Cañon Barriga, 2012). Increasing demands for water in this area of Colombia come mainly from agricultural practices, such as cattle and coffee monocultures, and the increasing urban sprawl (Gonzalez et al., 2012).

Water security for future generations is compromised as a result of increasing pressures and the lack of engagement in water use planning by the region's managing institutions. Land use changes that affect forests and wetlands, critical elements for the recharging water

sources, impact the quantity of water for future use (Chavarriaga Montoya, Jimenez Carmona, & Toro Betancur, 2012). According to Gonzales, et al. (2012), when the volume of water decreases to a certain point, the expansion of aqueduct networks is severely hindered. In addition, when the water resources are mismanaged, households are harmed by increasing price and decreasing availability of water (Briscoe, 1993). According to the Defensoria del Pueblo (n.d), in approximately 2007, each Colombian could enjoy 40,000 cubic meters of water per year. If no steps were taken to better manage the resource, in 2020 this amount would decrease to 1,890 cubic meters of water per year.

Suggestions for Reforms in Urban Water Management

Cardona Lopez (n.d.), suggests that water is used in Colombia in the following main ways: water to live, water for general activities, water for development, and water for illegal or illegitimate uses. The author explains that water to live refers to the basic human right to access to water in order to survive; water for general activities refers to water used for health, wellbeing, and social cohesion activities; water for development refers to water used for business development that allows individuals to better their quality of life, and this water use most significantly impacts the quantity and quality of water; lastly water for illegal or illegitimate activities involves the extraction of the resource and point-source pollution into water sources (Cardona Lopez, n.d.).

Management of demand is becoming an important idea in water management (Ben Lamoree, García, Perez, & Castro, 2005). According to Ben Lamoree et al. (2005), increasing water demands should not be addressed with the mindset that water is unlimited; instead the demands themselves should be managed, decreasing them wherever possible. Lamoree et al. (2005) proposed an integrated approach where all users' water demands are considered and balanced to prevent future scarcity of water. An integrated approach includes a clear understanding of the hydrologic cycle of water in order to guarantee sufficient water supply for all residents, including those residing in rural areas (Contraloria General de la Republica, n.d.). According to the Contraloria an integrated approach seeks to include all the sectors of society in decision-making processes to prevent the discrimination of certain groups in the distribution

of access to clean water. Stakeholders from all levels should be taken into account in management decisions regarding water resources, including policy makers, planners, and users (Gadgil, 1998). The coordination of stakeholders associated with institutional efforts is also imperative in the effective and efficient improvement of water resource management (Ben Lamoree et al., 2005).

An improvement in land use and water use planning as part of an integrated approach to water resource management in the city of Manizales, is a must in order to prevent future natural disasters like landslides (Chavarriaga Montoya et al., 2012). The researchers propose that an environmental inventory or natural resource inventory of the watershed should aid in decision-making processes regarding land use that may potentially affect the water sources used for watershed residents. Chavarriaga et al. (2012) add that it should be of special interest, the land use in areas surrounding springs and main bodies of water that water utility companies utilize to supply significant numbers of watershed residents.

Data Collection

Other aspects that should be part of an integrated approach to water management include education, adoption of new technologies, and an efficient use of water resources in national development endeavors (Wade, 2012). According to Sanches (2007), new technologies are necessary in the collection of data in order to develop a clear and efficient water management scheme. However, as Cardona Lopez (n.d) suggest, these data should be available not only to institutions and organizations, but also to all water users. Cardona (n.d) makes it clear that up to date information regarding pertinent laws and regulations, assessments, and water monitoring should be in the public domain. In order to move forward in the conservation and management of watersheds, it is necessary to determine the gaps in data availability, as well as consolidating the existing data to fill in missing information and add new research (Chavarriaga Montoya et al., 2012). The Contraloria General de la Republica (n.d) acknowledges that the lack of information has created inconsistencies in water resource management, making it difficult to launch new projects and programs.

Sanches (2007) suggest that data collection should start with the proper creation of a user registry to have more transparent water resource management. In Manizales for example, there are a number of watershed residents who use surface water illegally and lack the permits that would allow for the tracking of the quality and quantity of water that the community should use (CORPOCALDAS, 2013). In addition to health benefits, this information would ease management of the resource (Chavarro Velandia, 2011) as its real demand can be determined as well as the best areas to place new technologies and gather more accurate information (Contraloria General de la Republica, n.d.). The Contraloria acknowledges that in Colombia, there are additional challenges. These challenges include the illegal use of aquifers and the improper monitoring of water volume in the watershed. In addition, inequality in water resource distribution is brought about when permits for water use are granted without current information on the state of water scarcity (Contraloria General de la Republica, n.d.).

Information regarding water users in the watershed is especially applicable to entities who have agreed to be active in water resource management as they need to monitor the quantity and quality of water they use in order to secure the future water supply that they will need for their internal manufacturing and processing activities (Bernal Pedraza, 2010). The city of Manizales is in the Chinchina watershed, which has been proposed as a priority watershed for the implementation of hydrometeorologic monitoring networks to provide high-accuracy real time information (Corporación Autonoma Regional de Caldas, n.d.). According to the Defensoria del Pueblo (n.d), a number of environmental organizations have proposed to define standards for water quality, assess and regulate the volume on bodies of water, and carry out censuses of water users. Data collection is an imperative tool in the truly integrative management of water in the Chinchina watershed (Instituto de Estudios Ambientales IDEA. Grupo de Trabajo Academico en Ingenieria Hidraulica y Ambiental., 2012).

Integrated Water Resource Management (IWRM)

Data collection, water monitoring, and reduction of water demand are supported under an integrated water resource management approach (Dominguez Calle, Rivera, Vanegas Sarmiento, & Moreno, 2008). The Contraloria General de la Republica (n.d) suggests that the

IWRM should allow for the long-term preservation, recuperation, and management of water resources. According to Chavarriaga Montoya (2012), the IWRM approach should include four main categories: knowledge and research; land use planning; water pollution prevention and control; and education and participation to change the way water is perceived by the population. In order to dive into the details about IWRM, it is first necessary to understand the fundamental differences between water governance and water management.

In general, water management can be seen as a subcategory of water governance. According to Zamudio Rodríguez (2012), water governance is understood as a group of administrative, social, economic, and political systems, which are responsible for the development, management, and distribution of water resources. Therefore, water governance has three main pillars as its foundation: norms and legislations to protect water resources and its development; institutions and organizations responsible for water management who act as facilitators for all stakeholders' participation; and the mechanisms and regulations for decision-making processes, allowing for the responsible use of political power, use of the water resources, and its sustainable development (Zamudio Rodriguez, 2012). In sum, water governance is a group of systems that promote stakeholder participation in decision-making processes regarding water management (Agencia de Noticias UNAL, 2013). According to Zamudio Rodríguez (2012), water governance determines who gets what, when, and how.

The main challenges to water governance are the lack of clarity regarding the division of institutional responsibilities and the confusion regarding what IWRM means and entails (Grigg, 2008). Grigg (2008) adds that clear designations about individual institutional leadership responsibilities and financial roles in water resource management are critical for success. Confusion regarding IWRM is evident when comparing international definitions and area specific definitions. In the international arena, the author explains that IWRM is seen as a framework to plan, organize, and operate water systems in order to unite and stabilize the perceptions and objectives of watershed stakeholders. Scaling the IWRM definition to Latin America, there are clear indicators of economic development as a priority, and IWRM seems to become an important tool for economic growth.

The 1900's definition of IWRM for Latin America promotes the coordinated management and development of land use and water resources in order to have a significant impact on the economy and the equality based social welfare while promoting ecosystem conservation (Betancur Vargas, Campillo Pérez, & García Leoz, 2011). Wade (2012) provides a detailed definition of IWRM and highlights its applicability to 21st century Latin America. The author explains that IWRM should include cohesive and transparent institutional collaborations and partnerships at the individual citizen, national, and international levels. Wade (2012) suggests that the planning and management of water and land should include traditional and non-traditional approaches, and that it should be based on social, economic, and environmental factors. For Wade (2012), IWRM includes surface water and groundwater, in addition to the ecosystems where these bodies of water flow. The author highlights the need for political commitment and public awareness on the importance of water quality and water security through sustainable management practices (Wade, 2012).

The IWRM definition for specific Latin American countries underlines the impact that successful IWRM will have on economic development. Paraguay's definition is clear on its priorities when mentioning not only an improvement in efficiency and environmental conservation, but the profits that development and IWRM would bring to the country (Ward, 2013). In Colombia IWRM is divided into three elements: national policy and law, organization, and operation, which should involve water users (Carmona, & Muñoz, 2009). Zamudio Rodríguez (2012) provides a detailed definition of IWRM for Colombia, which is based on the equilibrium among social, economic, political, and environmental dimensions. According to Zamudio, the IWRM seeks to integrate not only water in all its hydrologic cycle phases, but also land, other natural resources and ecosystems. Water management should aim to fulfill all watershed residents' use of water and interestingly, Zamudio adds that it should prevent conflicts stemming from competition over possible scarcity of the water resource in Colombia (Zamudio Rodriguez, 2012).

The Corporación Autonoma Regional de Caldas (CORPOCALDAS), which is the environmental authority of the department of Caldas, where the capital city of Manizales is located, uses the national definition of IWRM as basis for its decision-making processes. For

CORPOCALDAS, successful management of water resources should be based on knowledge regarding the state of water supply and demand, its performance, its distribution, its quantity, and its quality (Corporación Autonoma Regional de Caldas, n.d.). CORPOCALDAS' (n.d) main water resource management goals are: to efficiently and effectively use water resources to secure sustainability; to connect land use planning to water use planning and the conservation of ecosystems that serve in the regulation of water resources; to acknowledge water resources as an important foundation for economic development and social wellbeing; and to implement equality and inclusive opportunities for participation in decision-making processes regarding water resources in the watershed. CORPOCALDAS plays a critical role in the proper management of the water resource in the department of Caldas.

An important focus of CORPOCALDAS is the Chinchina watershed due to the fact that this watershed contains the city of Manizales, and the most important industries for the development of the region. According to (personal communication 21 July 2013) the Assistant Director at CHEC (the largest energy provider for the region) the revitalization and protection of the Chinchina watershed has become of major interest to a number of significant stakeholders in the region, including the water and energy utility companies. For the city of Manizales, IWRM places an emphasis on planning the water resources used at a watershed level, disregarding political boundaries. The city understands the need to promote and re-establish forests and other ecosystems that maintain the quality and quantity of water supplies for the watershed (Chavarriaga Montoya et al., 2012).

The concept of IWRM presents a number of variations, from its applicability at certain scales, to particular incentives included in the definition, which aim to increase the implementation of water conservation practices. Most definitions agree that water is indispensable for the wellbeing of societies worldwide and for the development of a community or a nation. Wade (2012) points out that the success of urban water services in Latin America depends on the refining of the IWRM definition, and to the development of policies and techniques for the proper application of the IWRM concept. Grigg (2008) suggests that the application of this concept should be done using a watershed-wide focus and the definition may have to be amplified or broadened to moderate confusions regarding the

complexity of the term, especially for the public at large. Wade (2012) also suggests that it is necessary to have watershed stakeholder participation, governmental involvement, and the acknowledgement of human and environmental requirements to obtain optimal future access, quality, and quantity of water.

Though the concept of IWRM has met international appeal, a number of critics have emerged. Ward (2013) explains that in Paraguay for example, the mere introduction of the concept of IWRM is insufficient when attempting to improve water resource management. Instead, the author explains, it is when individuals reject, and go around these complex concepts that new and successful ways of governing materialize. Ward (2013) found it problematic that the IWRM approach attempts to take on the large task of completely changing historical ways of governing through changing attitudes and behaviors. Wade (2012) observes that although the basis of IWRM is to create sustainable ways of water management, it still utilizes industrialized techniques that are costly, rely heavily on water resources, and unfortunately produce negative unintended consequences (Wade, 2012).

Alternatives for Urban Water Management

Wade (2012) introduces a model based on soft path and hard path techniques for water resource management. Wade mentioned that the soft path has a significant potential for long term positive results with low monetary, environmental, and social costs (Wade, 2012). The hard path on the other hand, tries to use canals, wells, water treatment plants, dams and reservoirs, and desalination systems to solve the problem of increasing water demands from increasing populations and compromised water resources (Wade, 2012). The soft path instead addresses the problem of how best to fulfill the services that water currently provides with ways that acknowledge economic, social, and environmental aspects. Wade (2012) explains that the soft path is based on ideas of “use and reuse, innovation, conservation, and reallocation.” S/he highlighted the fact that the soft path aims to include local communities in decision-making processes of water management and utilization, operating under systems that often require little technology and are decentralized (Wade, 2012).

Community-based Natural Resource Management (CBNRM) bases its model on different types of capital: social, economic, human, and natural (Gruber, 2011). Social capital refers to community partnerships; economic capital refers to alternative environmentally friendly ways for a community to gain profits; and human capital refers to the enhancement of local knowledge and understanding. According to Gruber (2011), social, economic, and human capital should become stable and should be followed by the reversal of natural capital deterioration, in order to obtain a long-lasting and sustainable management of natural resources. The goal of CBNRM is to create equilibrium between the exploitation and the conservation of ecosystems while attending to socio-economic and environmental goals (Gruber, 2011). The author explains that this model aims to empower communities to manage their natural resources, building the natural capital of the community. Gruber adds that CBNRM promotes the inclusion of watershed stakeholders in decision-making processes, welcoming the input of "local institutions, customary practices, and knowledge systems" for managing, regulating, and enforcing procedures (Gruber, 2011, p. 162).

A number of alternatives to urban water management depart from conventional Latin American models based on the market and privatization, which are traditionally promoted by international financial and economic institutions (Wade, 2012). Some of these alternatives include payment for environmental services (PES) (Johnson, 2009), and the introduction of new environmentally friendly technologies (Chavarro Velandia, 2011). PES has been adopted as pilot projects in Colombia, Costa Rica, and Guatemala. Johnson (2009) explains that hydroelectric and water utility companies are required to re-invest in water conservation projects, benefiting residents downstream. Residents, governmental organizations, or non-governmental organizations repay these companies for their commitment to water conservation in the watershed. However, this approach is still under a trial period and may not work for all countries (Johnson, 2009).

Chavarro (2011) recommends a number of techniques to be included in alternative models for water resource management. S/he acknowledges that current models have disregarded the need for new technologies that have created tremendous pollution. According to the author, these two aspects should be merged to create environmentally friendly

technologies in current water resource management approaches. The author suggests techniques like water recapturing methods and/or the control of irrigation systems (Chavarro Velandia, 2011). According to Dominguez et al. (2008), Germany has gained significant water reduction demands in the outskirt areas of the country through increases in the use of rainwater for toilets, sinks, and gardens.

Chavarro (2011) mentions adaptive management techniques necessary for communities to thrive through environmental changes using the "learning to manage by managing to learn" approach. S/he explains that learning should be a life-long community-wide task as environmental changes are constant and continuous. Chavarro (2011) also introduces the systemic perspectives technique, which utilizes simulation models for water resource management in order to address land use and water use planning, urban water, floods, and irrigation systems. This technique is composed of five stages: defining the problem, conceptualizing the system, formulating and evaluating the model, and analyzing the implementation (Chavarro Velandia, 2011).

Watershed Stakeholder Participation

Communities

The active participation of institutions and stakeholder groups is imperative in order to bring about positive and sustainable management of water resources (Ben Lamoree et al., 2005). According to Johnson (2009), starting in the year 2000 new approaches for participation and inclusion in decision-making processes regarding water resource management emerged. The focus changed from local community inclusion to different types of stakeholders and stakeholder groups. The emphasis also changed to work on conflict resolution and linking social, institutional and hydrological scales instead of only focusing on natural resource management (Johnson, 2009). A number of studies have shown the importance of community and watershed stakeholder inclusion in decisions regarding water resource management.

A comparative study by Ben-Lamoree et al. (2005) that took place in Costa Rica and the Dominican Republic demonstrated the importance for all watershed stakeholder parties, including governmental institutions and local community members in decision-making

processes. Ben-Lamoree observes that in situations regarding water resource management in Costa Rica, the political decision-making processes lagged behind, while the rest of the watershed stakeholders agreed with decisions about the next steps to follow. In the Dominican Republic, the opposite occurred. However, in both countries these miscommunications significantly delayed progress towards the implementation of water resource management changes (Ben Lamoree et al., 2005).

In Colombia, watershed stakeholder participation is seen as an indicator of the thorough understanding of relationships among social, economic, and biophysical dynamics in the watershed (Johnson, 2009). Most importantly, Johnson (2009) indicates that this participation might provide insights about stakeholder success in identifying common goals and appropriate allies to work with to reach these goals. Therefore, Johnson believes that stakeholder decision-making processes can overcome traditional Andean watershed social divisions. According to Zamudio (2012), the lines between the governing and the rest of society in Colombia are becoming increasingly faint.

Johnson (2009) goes on to point out that in a Colombian watershed, lack of stakeholder participation in decision-making processes regarding water resource management can indicate that a community is experiencing suboptimal conditions and sees itself as “poor”. The author explains that it is critical that community members that define themselves as “poor” interact with other stakeholder groups in decision-making processes for watershed management. S/he explains that those who identify themselves as poor often share perceptions and points of view with individuals from other stakeholder groups and this common ground might ease conversations regarding watershed management. It is important to promote the participation and inclusion of the poor as it may improve the equity and welfare of decisions made regarding water resource management (Johnson, 2009).

Institutions and Organizations

Competing institutions and organizations can significantly affect water resource management efforts (Briscoe, 1993). In Colombia, the lack of enforcement and collaboration between environmental authorities has allowed individuals with sufficient power, funds, and experience, to exploit water resources indiscriminately (Defensoria del Pueblo, n.d.-b). Ward

(2013) suggests that the IWRM (explained above) could allow for watershed-wide effort coordination, instead of an administratively divided management, thus mitigating the effects of unforeseen political changes in water resource management. The merging of legal, economic, financial, and administrative tools in the watershed should allow for a sustainable framework for watershed management (Defensoria del Pueblo, n.d.-a). According to Grigg (2008), in Colombia the specific elements to merge are:

> *"policy sectors, water sectors, government units (In Colombia, water policy requires coordination between the Ministry of Environment, Housing, and Territorial Development, and a set of autonomous regional corporations), organizational levels, functions of management (management functions are universal and the same in all countries), geographic units, phases of management, and disciplines and professions."* (Pg 291)

Unity among institutions, organizations, and the rest of watershed stakeholders is imperative in order to improve water resource management in Colombia.

There are a number of clear indicators leading to the success or failure of water resource management (Fisher et al., 2011). They explain that it is a requirement for institutions and organizations to adapt to changes coming from development, for example changes in population demographics or unsustainable demands for water resources. Fisher et al. (2011) add that it is also necessary for institutions and organizations to understand their dynamics with the biophysical aspects of the population with which they are working; for example, soils, rainfall patterns, as well as probabilities of flood and drought. Seven characteristics that significantly affect the success of water resource management are uncertainty, short-term, local interests, organizational compartmentalization, corruption, power inequalities, and lack of capacity (Fisher et al., 2011).

Fisher et al. (2011) explain that when the consequences of actions are not quantified, it is difficult for stakeholders to make informed decisions and possibly change future negative outcomes. Long-term impacts are often the priority of local communities, but not of political institutions and organizations. Local concerns however, tend to disregard offsite impacts creating problems in other areas of the watershed. Furthermore, competition and the lack of

communication among institutions and organizations make water resource management challenging, especially since the legitimacy of institutions and organizations is threatened by suspicions of corruption. Power inequalities often override long-term agreements over sharing water resources leading to political violence witnessed in the Latin American Andes. In countries where agriculture is central to the national economy, investments in human and physical capital are limited. These are therefore insufficient incentives for institutions and organizations to improve the management of water resources (Fisher et al., 2011).

In Latin American countries it is the role of the national government to serve as a facilitator in the coordination of institutional and organizational efforts to achieve the efficient use of natural resources and implementation of an integrated approach to solve current problems (Araya Obando, n.d.). According to Fisher et al. (2011), institutions provide rules and norms, legal frameworks, official language, trust-building tools, social capital, and a regulatory culture. Institutions can also help in the creation and maintenance of partnerships among stakeholders (Abers, 2007). In terms of water resource management, institutions have a significant role, as positive upstream and downstream relationships are critical, despite political and administrative borders. The role of institutions in this situation includes resolving disagreements among organizations carrying out conflicting activities in different areas of the watershed (Fisher et al., 2011). Institutional efforts should also address vulnerable populations in the watershed, while acknowledging traditional ways of living.

Organizations overlook and coordinate the way in which institutions interact with each other, and therefore play a key role, in the successful management of natural resources (Fisher et al., 2011). Examples of organizations such as non-governmental and autonomous regulatory bodies, like CORPOCALDAS, as well as governmental departments. Examples of institutions include the Red Cross, the Manizales fire department, and the regional committee of prevention and attention of disasters. Both institutions and organizations must work together to determine the specifics related to the rights and responsibilities associated with access to natural resources, spatial allocation of rights, and water resource dynamics. Institutions and organizations in the Latin American Andes have failed in a number of important areas: there is great inequality in the distribution of land and water resources; political violence prevails; there

is a rising gap between rich and poor; corruption is endemic; overall there is extremely low administrative legitimacy. Fisher et al. (2011) add that partial success in Latin America has been achieved, where the benefits of rural ecosystem services are seen as an important factor.

In Colombia, the Ministry of Environment defines the policies associated with water resource management (Sanchez Triana et al., 2007). The Ministry of Environment, Housing and Regional Development (Ministerio de Ambiente, Vivienda y Desarrollo Territorial, MAVDT), the Autonomous Regional Corporations (Corporaciónes Autónomas Regionales, CARs), and the Urban Environmental Authorities (Autoridades Ambientales Urbanas, AAUs) are expected to design and implement environmental policy. According to Sanchez et al. (2007), the Ministry of Environment, Housing and Regional Development (MAVDT) is the major regulatory authority of water pollution control, and it sets policies and programs related to water. However, the most important entities in regional water resource management are the CARs and the AAUs; these entities create regulations that are stricter than those under national law, however, they cannot be less strict than national law (Sanchez Triana et al., 2007).

Sanchez et al. (2007) explains that the CARs enforces and sanctions violators of the environmental law; additionally, these corporations also authorize water use through concessions. CARs are expected to offer resolutions to geographic disagreements (Grigg, 2008) and to evaluate, follow up, control, and monitor the permits and management plans to secure the proper use of water resources in the department of Caldas (Corporación Autonoma Regional de Caldas, n.d.). According to the CARs, they are responsible for maintaining an adequate balance between the supply and demand of water, in order to sustain normal socio-economic activities in Caldas (Corporación Autonoma Regional de Caldas, n.d.). Departmental and municipal governments are expected to support and help CARs in supervising and implementing water pollution regulations, in addition to expanding waste-water treatment and sanitation infrastructure (Sanchez Triana et al., 2007).

There are tremendous inconsistencies regarding water use fees in Colombia because CARs lacks specific criteria concerning how fees are set and who is charged (Sanchez Triana et al., 2007). Some water treatment plants that have been provided by CARs are still in operation to this day and are still under their management, allowing municipalities to avoid compliance

with a number of regulations. According to Sanchez et al. (2007), a number of studies have suggested that the responsibilities regarding water resource management should be distributed among different entities like the AAUs, CARs, IDEAM, MAVDT, and the Ministry of Agriculture. These entities would be able to address a number of issues in a more efficient manner, issues such as "drinking water quality standards, control of nonpoint sources of water pollution, management of water runoff and urban drainage, reduction of vulnerability to natural disasters associated with flooding and landslides, management of marine and coastal resources, and conservation of important water ecosystems" (Sanchez Triana et al., 2007, p. 384).

The Public Services Companies or utility companies (Empresas de Servicios Públicos, ESPs) are the other main entities responsible for water resource management in the department of Caldas (Gonzales Plazas, 2012). An ESP is considered a mixed, public, or private entity whose function is to manage, administer, and provide the water supply distribution network in urban and rural areas (Gonzales Plazas, 2012). ESPs are seen as an agent that controls the access and quality of water; therefore, these entities are a medium of interaction between society and water. In Manizales, the capital of Caldas, the main ESP company is Waters of Manizales (Aguas de Manizales). The company has had to confront a number of difficult situations in recent years, however, such constant problems with the extremely large volume of water that the company has available for use. Environmental authorities have granted Waters of Manizales a higher volume of water than the minimal volume required to be in a given body of water during drought season. Especially during these drought seasons this situation significantly increases the vulnerability for the population and surrounding ecosystems (Gonzales Plazas, 2012).

Waters of Manizales is not the only ESP having questionable compliance status; there are multiple ESPs in the country who provide management reports to the Public Services Superintendent. The Superintendent utilizes reports provided by health authorities to supervise and control the quality of water that ESPs supply. The national government lacks information about the finances, administration, and technical status of the rest of the ESPs in the country. In the context of urban water distribution, these data provide information about potential budget

and financial projections, subsidies, and technologies that will be needed to supply water to a growing population and the expansion of industries and businesses (Gonzales Plazas, 2012).

POMCAs/PORH

In Colombia, the main tools to control the degradation of bodies of water are the Watershed Administration and Management Plans (Planes de Ordenamientos y Manejos de Cuencas Hidrográficas , POMCAs) (Sanchez Triana et al., 2007). The POMCAs aim to secure enough quantity and quality of water for social and economic activities in the watershed (Contraloria General de la Republica, n.d.). The CARs are required to create the POMCAs and these plans should include mentions of the requirements for: "land use planning, development of water resources infrastructure, allocation of water resources, water pollution control, and conservation of bodies of water" (Sanchez Triana et al., 2007, p. 362). Although the POMCAs are required by law, the compliance is variable and enforcement of these plans in nation-wide watersheds have proven challenging. According to the Contraloria (n.d), the POMCAs are also viewed as a watershed-planning tool. The POMCAs not only include water but also include all other natural resources like land, its uses, and its effects on the environment (Betancur Vargas et al., 2011).

The specific planning for water resources is presented in the Plan for the Administration of Water Resources (Plan de Ordenamiento del Recurso Hídrico , PORH). The main objective of the PORH is to acknowledge, classify, and monitor bodies of water whose quality and quantity are threatened by polluted tributaries or by water distribution suppliers (Betancur Vargas et al., 2011). Betancur et al. (2011) adds that PORH should not only aim for the long-term preservation of national bodies of water, but it should also provide a framework for the implementation of conservation practices with active public participation. More specifically, the PORH dictate water use and its destination; define quality goals for short, medium, and long-term; establish water quality norms to ensure the conservation of water biological cycles and the normal development of species; determine when and where certain activities should be prohibited either in one section of the water body or in the entire source of water; identify the

areas where polluters should be prohibited or restricted in superficial, aquifers, or ocean; and it is also responsible for self-evaluation verifying its efficiency and effectiveness.

The national decree to implement PORHs was created in 2010, but the execution of these plans have taken more time than anticipated (Betancur Vargas et al., 2011). In the city of Manizales, for example, it was not until 2012 that the technical and legal aspects of the PORH were discussed, as well as the regulations for uses of water and point source pollution of the Chinchina watershed (CORPOCALDAS, 2013). Betancur et al. (2011) suggests that it is the environmental authority's responsibility to inform the community about the PORH and to provide social interactions and discussion spaces for the community and all stakeholders to become involved in the execution of PORH.

Dense vegetative cover reduces run-off and therefore increases water absorption into the soil, which will eventually refill aquifers or surface bodies of water. The amount of water refilling bodies of water and aquifers, and water scarcity values determine the Index of vulnerability (Defensoria del Pueblo, n.d.-a). The vulnerability index measures the degree of fragility that a hydrologic system presents when attempting to maintain sufficient water supply to satisfy the demand. Forty-eight percent of the national population are at high levels of vulnerability, Caldas being among those departments with the highest levels, and only 17% are not at risk of suffering due to water scarcity (Defensoria del Pueblo, n.d.-a).

The inadequate land-use planning in Colombia are deeply affecting the natural ecosystem's ability to regulate water quality and quantity, therefore jeopardizing water security for future generations (Contraloria General de la Republica, n.d.). CORPOCALDAS acknowledged that the gradual but severe changes in the departmental land use patterns, where forests and vegetative stubble have become cattle grazing grounds, have created hydrological imbalances in the department's watersheds and micro-watersheds (Corporación Autonoma Regional de Caldas, n.d.). The urban sprawl has disrupted ecological corridors at a regional scale, affecting the Andean and sub-Andean Paramos and the dry tropical forests (Gonzales Plazas, 2012).

Proper land-use planning is often negatively influenced by pressures from municipal governments to urbanize areas that are designated by the CARs for rural use (Gonzales Plazas, 2012). According to Gonzales (2012), in the Caldas region, it is common to see land-use plans on

paper subject to future change, disregarding population growth projections and also a need for the development of water distribution systems. Some of the consequences resulting from inconsistencies in urban land-use planning include inadequate infrastructure for growing populations, reduced environmental quality, and increased road congestion and deterioration (Sanchez Triana et al., 2007). Sanchez (2007) observed that while land-use planning currently provides a wide array of guidelines, even minimal guidelines are often evaded, resulting in the development of 'informal settlements', which do not provide residents with adequate access to safe drinking water supplies. Problems with urban management and high vulnerability to risk are often the result of inconsistent urbanization of rural areas in the Caldas region (Gonzales Plazas, 2012).

Urban Sprawl: Aqueducts and Natural Disasters

The new settlements resulting from the encroaching urban sprawl in the mountainous areas of the Caldas department are often located in highly vulnerable areas and have created the fragmentation of water distribution systems (Gonzales Plazas, 2012). Due to this fragmentation, most of the families residing in these settlements lack potable water and other basic utilities. Providing utility services to these communities is often costly and difficult, due to the extreme topography where they are located (Sanchez Triana et al., 2007). A study carried out by Sanchez et al. (2007) showed that the concerns of communities residing in these settlements include their lack of access to potable water and their vulnerability to become victims of a natural disaster. According to CORPOCALDAS (n.d), all settlements in the department of Caldas face a real threat from landslides due to the geologic, geomorphologic, hydrogeologic, geotechnical, and hydrological characteristics of the region.

Environmental impacts of urban sprawl in the Caldas department exasperate the problems that lead to decreasing water availability for future residents (Gonzales Plazas, 2012). According to Sanchez et al. (2007), the areas where urban sprawl settlements occur are often environmentally sensitive with vague property rights, weak enforcement of environmental preservation law, and they are often of little value to other users. Places like riverbanks, mountain slopes, or wetlands are not only prone to landslides, but they also have an important

role in the regulation of the quality and quantity of water of the watershed (Sanchez Triana et al., 2007). According to Gonzales (2012), the changes in land use in the Caldas region is problematic as the capacity of the Andean Forests to replenish and regulate water in the area are significantly endangered. The author suggests that authorities should acknowledge this situation especially as El Niño and La Niña phenomena become increasingly drastic. Chavarriaga et al. (2012) mention that according to a 2011 law, Manizales should allocate at least 1% of its income to the purchase of areas that directly affect the regulation and provision of water for the watershed. The author added that this law has not effectively protected these areas.

The geophysical propensity for landslides characteristic of this area poses incredible challenges not only for the expansion of water distribution systems, but also for maintenance and upkeep. Water distribution systems in municipalities are the most vulnerable to landslides (Contraloria General de la Republica, n.d). According to the Contraloria during the year 2007, approximately 20,000 inhabitants had their service suspended due to landslide damages on infrastructure of the distribution system. In 2007, there was no national plan to mitigate the effects of this vulnerability, and there were no studies, assessments nor inventories regarding the impact of landslides to water infrastructure. The frequent landslides often either create minor fissures in or severely damage distribution systems, impacting the quality of water that residents receive and increasing the amount of water leaking from the system (Carmona, & Muñoz, 2009).

Carmona et al. (2009) suggest that water utilities should be prepared for natural disasters as the distribution system may become disrupted, and there may be severe contamination of the water in the system, spreading water-borne illnesses. The World Health Organization and the Pan-American Health Organization agree on the many illnesses related to the consumption of untreated water: anemia, arsenicosis, ascariasis, cholera, dengue, hemorrhagic dengue, fluorosis, hepatitis, and malaria (Carmona, & Muñoz, 2009). Carmona et al. (2009) suggested that after a landslide, which often damages water infrastructure, it is imperative that authorities also think of other consequences using a more integrated approach. The author draws attention to the fact that medium-term damages to the residents may be more important than those immediate damages after a landslide.

The maintenance of water distribution systems is a worldwide problem, and has to be expected; industrialized countries need fewer repairs in their systems compared to developing nations. This is evident in the number of employees needed per 1000 connections in the distribution system (Gadgil, 1998). In industrialized countries, 3-4 employees are needed; in Latin America, 10-20 employees are needed per connection (Gadgil, 1998). According to Briscoe (1993), in Latin America, the levels of leakage are 4 times higher than industrialized countries, and pipe breakages are 20 times higher. In large Latin American cities, over 50% of their water supply is lost to leakages or stolen (Barlow, & Clarke, 2004), equaling approximately $1 billion to $1.5 billion a year in losses (Briscoe, 1993).

In Colombia, the Non Revenue Water Index (Índice de Agua no Contabilizada) is an indicator of the water utilities performance on urban water resource management. This index measures the amount of water lost in the water distribution system due to technical failures or other factors (Defensoria del Pueblo, n.d.-b). This measurement is done by using the amount of water that is distributed to homes and the amount of water that leaves the water treatment plants. The Defensoria (n.d.) acknowledges that in Colombia, 70% of the water that is introduced into the distribution system is lost; these losses are due to technical failures, commercial conditions, or fraud. Because of myriad factors, 17,736,687 Colombians did not receive water apt for human consumption during the first trimester of 2007: watershed deterioration and decreasing water quality, the unequal water distribution, the low maintenance to water treatment plants and the distribution system, and the lack of control and monitoring of water quality.

PERCEPTIONS

A water resource management approach involving stakeholder participation on decision-making processes should be able to acknowledge the number of different perceptions and points of view within a group. Some stakeholders agree on certain points of view regarding a topic and others disagree; however, taking all points of view into account during decision-making creates a balanced and improved management approach (Grigg, 2008). According to

Chavarro (2011), water resource management should be addressed using an interdisciplinary lens, because management presents economic, social, political, and environmental challenges.

In Colombia, the points of view and perceptions of citizens are attributed to culture (Zamudio Rodriguez, 2012). Therefore, the approach to bettering the watersheds nationwide is to change the "Water Culture " or the way people perceive the resource in the department of Caldas. The water supply vulnerability that the country faces has been socially constructed and reproduced through cultural means, because people interact with nature according to their cultural background (Zamudio Rodriguez, 2012). The author explains

> *"Through culture, from its political, economic, scientific, technological, social, ethical, and even aesthetic elements, the level of pressure on ecosystems is determined. Moreover, considering that in culture, images and concepts are recreated, this is the biggest challenge to implement a comprehensive water resource management and a common sense associated with the sustainable use of water in the country."* (Pg 107, own translation)

The Water Culture should create equilibrium between people and the environment where each component—economic progress, nature, and social equality—should take responsibility for maintaining a harmonious coexistence (Carmona, & Muñoz, 2009). The objective of the Water Culture movement is to use water resources efficiently and carefully and to reach water quality standards (Diaz-Pulido et al., n.d.). Based on the four Water Culture themes—to know, to protect, to save, and to enjoy—a number of educational and social activities involving different sectors of the population have been implemented. These activities work with communication tools and educational materials provided by CORPOCALDAS and include youth ecology groups, environmental school fairs, rural community organizations that administer their own aqueduct and who are composed of community leaders, plumbers, and others. (Corporación Autonoma Regional de Caldas, n.d.).

A real value has been identified in the shared perceptions that originate among stakeholders in a watershed. According to Grigg (2008), approaches to water resource management that promote the finding shared values are vital. In the researcher's study for example, s/he found that conservation and alleviation of poverty were shared values. In a Q

methodology study on natural resource conservation, Gruber (2011) found that it is necessary to identify a shared value system that surpasses societal divides to obtain the successful and sustainable management of natural resources. The researcher found that the values shared within his study group were local participation and ownership. Further application of the Q methodology in the context of developing countries has been encouraged, for which this Q method study has made a contribution (Dasgupta, & Vira, 2005).

Physical and Case Study Context

Chinchina Watershed, Land Use, and Health Effects

Figure 10. Departmental Map of Colombia (Mapa de Colombia por Departamentos., 2013, April 29) .

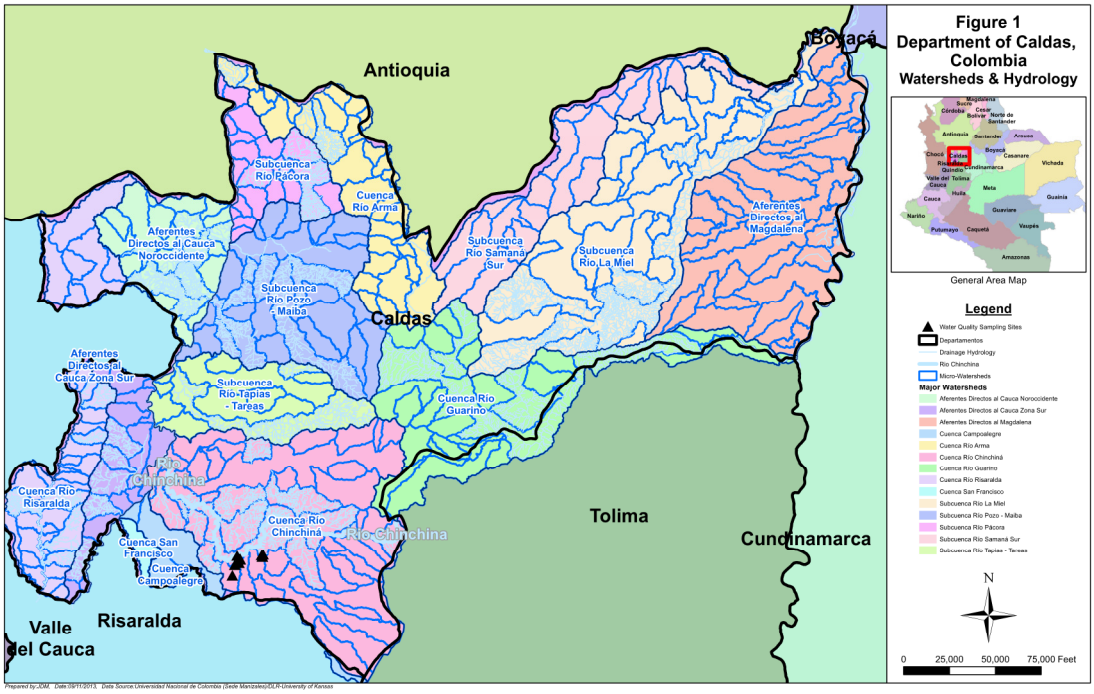

Figure 11. Department of Caldas: Watersheds and Hydrology (Prepared by Maher, J.D. Data Source: Universidad de Colombia sede Manizales).

The Chinchina watershed is located in the southern region of the department of Caldas, Colombia. (Departments are the rough equivalent of states in the USA.) It encompasses the municipalities of Manizales, Villamaria, Neira, Chinchina and Palestina, and it is the most populated zone of the department, making up approximately 15% of its area. The Centre for Information and Statistics reported that in the year 2012, the City of Manizales had a population of 391,640 inhabitants. Manizales has a population density of approximately 0.89 inhabitants per square kilometer, due to the topographic limitation of suitable space to build. Males comprise 47.59% of the population, and 52.39% are females (Alcaldia de Manizales, n.d.).

The Claro, Guacaica and Chinchina rivers originate in the Central Andes Mountain Range at one of the largest sources of freshwater in Colombia, Los Nevados Natural National Park. There, the Nevado del Ruiz and Santa Isabel Tropical Glaciers serve as the water source for nearly 35% of the city of Manizales residents. Most importantly, this park is one of the main contributors to important streams and rivers that drain the east and west sides of the Central Mountain Range supplying several departments (UNFCCC/CCNUCC, 2007).

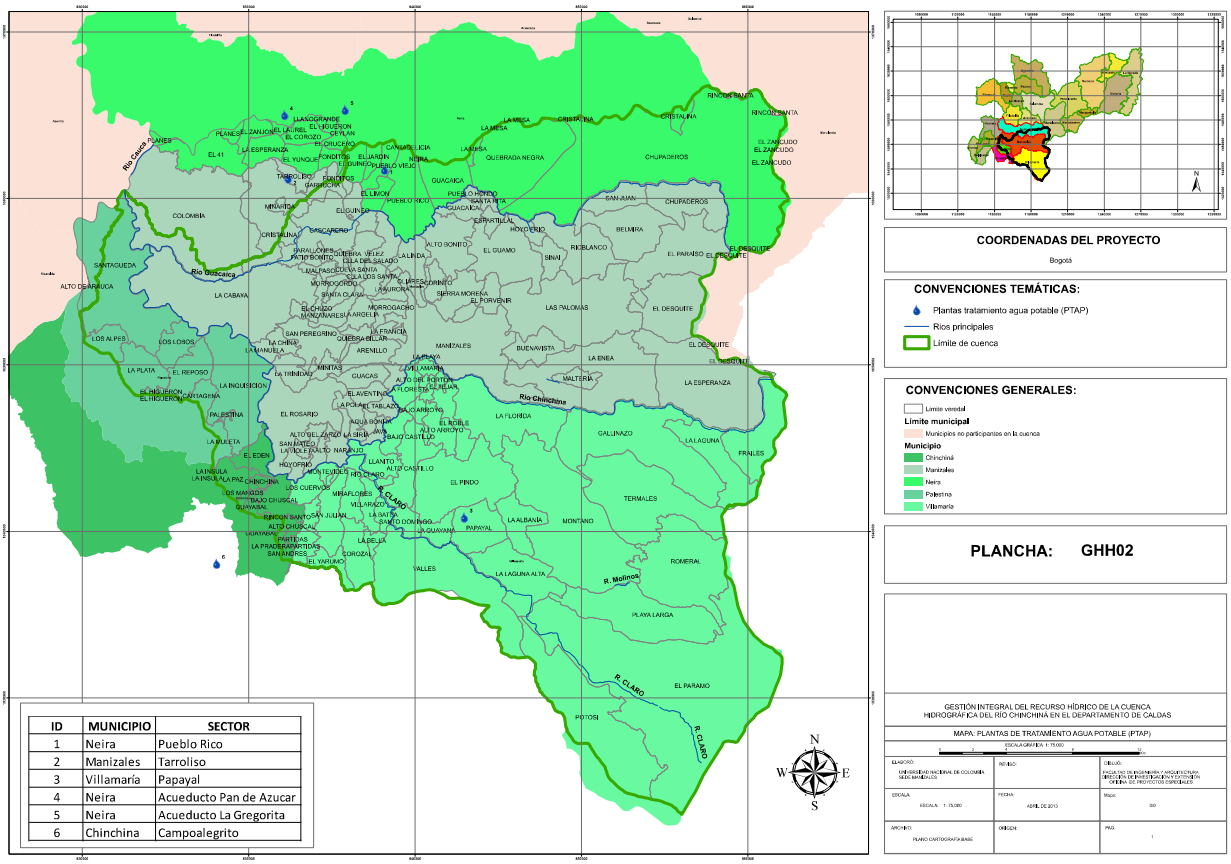

Figure 12. Chinchina Watershed (Facultad de Ingenieria y Arquitectura Direccion de Investigacion y Extension Oficina de Proyectos Especiales, 2013)

Two periods of abundant precipitation occur during the winter months of March to June and July to August, with a yearly range of 2000 to 2200 mm. Although precipitation and melting of the mentioned glaciers may serve as a water supply, two centuries of poor farming practices and inadequate land-use planning have significantly compromised the watershed's soil and water resources. Due to the steep topography of this mountainous area, intense and extended rain events increase the effects of inadequate land-use practices leading to damaging and fatal landslides.

In addition to coffee monocultures, 40% of the watershed land is used for cattle grazing. This practice is common among residents for meat and milk. In addition, "Cattle is considered to supply immediate consumption as well as being part of the capital stock" (UNFCCC/CCNUCC 2007). Cattle also produce large amounts of manure high in nutrients, which is likely to be transported to bodies of water during runoff events. Most importantly, manure contains

significant amounts of fecal coliform bacteria, which include *Escherichia coli* (*E. coli*), known for its dramatic effects on the health of individuals residing in rural and urban areas who consume products contaminated by it.

The proper maintenance of water distribution systems may diminish the pervasive cases of gastrointestinal diseases and deaths related to the consumption of contaminated water. These illnesses and the poorly maintained water systems have been present since the 1960's (DANE, 1973). Young children are the most vulnerable to these issues related to water; nevertheless, records indicate that these conditions continue through adulthood. These problems are prevalent in rural areas due to the consumption of untreated water from nearby streams and rivers (Marsh, 1983). Cases are also commonly reported in urban areas where drinking water is treated by the local water treatment plant (Lopez Herrera, 2006).

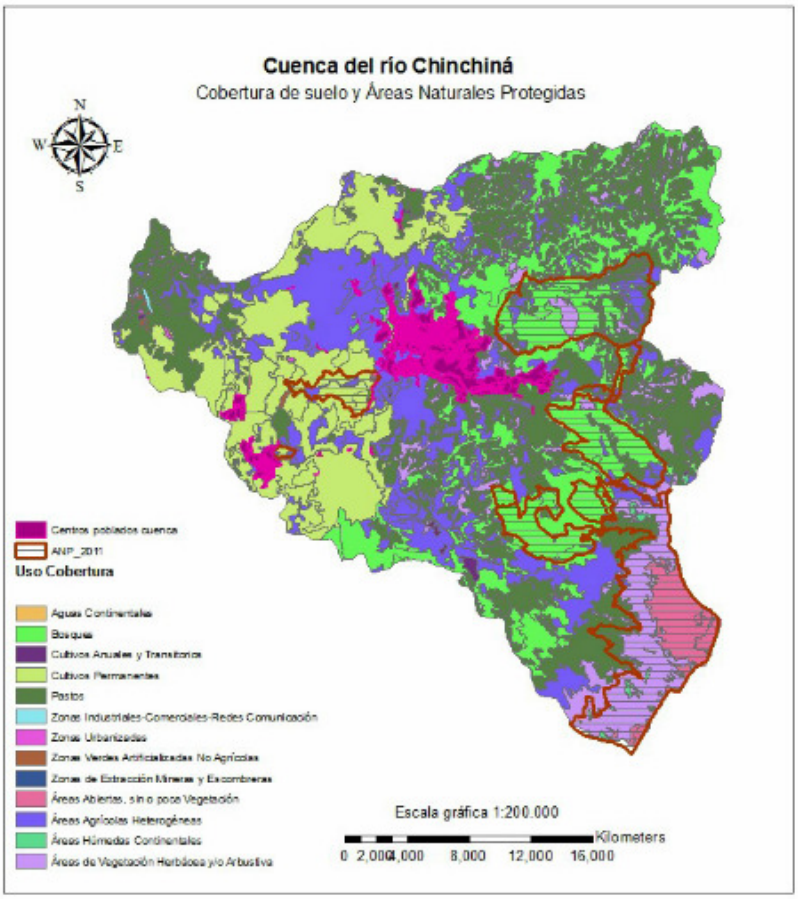

Figure 13. Land use Chinchina Watershed (FESCO-Sociedad de Mejoras Publicas de Manizales, n.d.).

FIGURE 13. LEGEND	FIGURE 13. LEGEND TRANSLATION
centros poblados de la cuenca, ANP_2011 Areas Naturales Protegidas, aguas continentales, bosque, cultivos anuales y transitorios, cultivos permanentes, pastos, zonas industriales-comerciales-redes de comunicacion, zonas urbanizadas, zonas verdes no agricolas, zonas de extraccion minera y escombreras, areas abiertas sin o poca vegetacion, areas agricolas heterogeneas, areas humedas continentales, areas de vegetacion herbacea y/o arbustiva.	populated areas of the basin, ANP_2011 Protected Areas, inland /continental waters, forest, annual and seasonal crops, permanent crops, grasses, commercial-industrial areas-communication networks, urbanized areas, nonagricultural green areas, areas of mining extraction and tailings, open areas with no or little vegetation, heterogeneous agricultural areas, humid continental areas, areas of herbaceous vegetation and / or shrub.

Socioeconomic Context

In the department of Caldas, the main socioeconomic challenges seem to derive from a recent shift moving away from an agricultural based development to service based development. This means, for example, that there are fewer farmers producing agricultural products and selling them in the farmers market, and instead, there are more individuals who have found jobs in the city providing services, such as super market clerks. Departmental economic growth based on the tradition of coffee growing and processing has dwindled during recent decades (Programa de las Naciones Unidas para el Desarrollo, n.d.). Subsidies for coffee growers and other farmers have been redirected to other government priorities, including military aid (O'Connor, 2013). The lack of these agricultural monetary aids has pushed farmers into more prosperous and often illegal options (O'Connor, 2013). As a result, farmers unable to support their families frequently migrate to the city in search of better opportunities. In this case, Manizales, the capital of Caldas, receives a significant amount of immigrants compared to the number of emigrants that leave the city.

In the period of 2000 to 2005 for example, Manizales received a total of 17,163 immigrants, most of them in the age groups 18 to 24 years of age, and 31 to 59 years of age. On

the other hand, of the 12,031 individuals who emigrated during 2000 and 2005, the majority was between 25 to 30, and 31 to 59 years of age (Alcaldia de Manizales: Gobierno en la Calle, n.d.). While the number of immigrants is higher than the number of emigrants in Manizales, when compared to the surrounding municipalities of Anserma, Chinchiná, and Villamaría, the city of Manizales presented the highest levels of emigrants from 2001 to 2005. Those who emigrate tend to travel outside of the country, in descending order to Spain, United States, Venezuela, Ecuador, Canada, and Panamá (Programa de las Naciones Unidas para el Desarrollo, n.d.). Those who stay in the city of Manizales often contribute to the increasing number of unemployed individuals.

According to the United Nations' Development Program, compared to the national average, Caldas has the highest number of unemployed individuals in the 20 to 34 years of age group, which is considered as the most productive age to work. Due to the lack of job opportunities, this group therefore displays the highest rates of emigration in the department. Of those who stay to work, it is males who enter the workforce more often than females. In the year 2000, Caldas presented 32% of females who entered the workforce, compared to 68% of males. The reason for this significant difference seem to be based on male chauvinism, typical of this region, which often leads to male preference over females when hiring for certain jobs (Programa de las Naciones Unidas para el Desarrollo, n.d.).

The Index of Human Development (Índice de Desarrollo Humano, IDH) measures the impact of the productive and social activities in the department, on the human development of Caldas. The IDH is based on three indicators: longevity, educational level, and income. From 1993 to 2005, Caldas' IDH decreased significantly compared to the national average. The United Nations' Development Program speculates that the Law 50 of 1990 could have had a significant effect on the IDH, as this law increased the number of individuals receiving minimum wage in the department. In order to increase the levels of IDH in Caldas, the department has set up a number of goals for which progress will be evaluated in the year 2015. These goals are 1) eradicate extreme poverty and hunger, 2) achieve basic education for all children in the department, 3) promote gender equality and empower women, 4) reduce child mortality, 5)

improve sexual and reproductive health, 6) fight HIV/AIDS, malaria, and dengue, 7) ensure environmental sustainability, and 8) develop global partnerships for development (Programa de las Naciones Unidas para el Desarrollo, n.d.). The United Nations' Development Program made a number of recommendations in order to focus departmental efforts and have greater probabilities of achieving these goals.

An important overarching recommendation was to work towards the eradication of the "Adam Syndrome" in public management. The Adam Syndrome refers to managers or governors who come into office, believing they are the first ones there, and who completely disregard current plans, programs and projects that may be having a positive impact in the community (Programa de las Naciones Unidas para el Desarrollo, n.d.). Recommendations more specific to the eight goals mentioned above seem to be based on the fact that in the 2005 census, 60% of the population in Caldas was under the poverty line. The United Nations' Development Program suggests that in order to improve the Index of Human Development in Caldas, the aspect of longevity needs to be addressed first. This implies investing in health, sanitation, specifically access to potable water, reducing crime, and managing areas with public order problems. Other suggestions include increasing the index of educational levels, reducing illiteracy, and improving levels of secondary school and university studies. According to the United Nations' Development Program, these actions will eventually lead to an increase in the GDP, which will eventually benefit the population under the poverty line (Programa de las Naciones Unidas para el Desarrollo, n.d.).

The program also made recommendations to decrease unemployment rates and promote inclusion of the rural areas in land use planning efforts. According to the United Nations' Development Program, promoting and fortifying jobs in the primary and secondary sectors should prevent the loss of qualified and unqualified residents. The main function of the primary sector is to transform natural resources into raw products for industrial processes. Primary sector activities include agriculture, mining, cattle rising, and others. The secondary sector's main function is the industrial manufacturing of the primary sector products. Although most municipalities in Caldas are rural in nature, most of the population resides in the urban

centers like Manizales (40%), followed by Dorada, Riosucio, Chinchiná, and Villamaria. The Program encourages that land use planning be reinforced in the urban areas of the department for more organized growth. However, rural area planning should serve as a complement to urban land use planning. Rural planning is especially important as a significant number of residents reside in rural areas.

Case Study Context: Manizales Sin Agua 2011

Figure 14. Cervantes Landslide. Photograph by Carlos Antonio Botero.

The title Manizales Sin Agua 2011 (Manizales Without Water) refers to the events that occurred from October to the end of November of 2011 in the city of Manizales. These events include the lack of water for approximately 20 days and the Cervantes neighborhood landslide. However, there were two additional events that occurred prior to Manizales Sin Agua 2011, which although significant, did not prepare the city for the after events. In September 21st of 2011, an explosion occurred in an underground electrical station managed by the major

electricity provider, the Hydroelectric Power Station of Caldas (Central Hidroeléctrica de Caldas, CHEC). The CHEC had workers painting the inside of a large pipe when the accumulation of chemical gases accumulated creating an explosion. The explosion killed six workers and wounded 17. Eight days later on September 29th, a fire almost destroyed the iconic Industry of Liquors of Caldas (Industria de Licores de Caldas, ILC). This factory produces rum and an anise-based liquor called Aguardiante, roughly translated "flaming water". This drink has made the department of Caldas known nationally and internationally. The fire destroyed two storage rooms, which had 35 million pesos worth of merchandise (~ 18,410 US) fortunately there were no casualties.

Manizales Sin Agua 2011 started on October 20th with the landslide affecting the Luis Prieto water treatment plant, followed by the November 5th Cervantes landslide. The Cervantes landslide left 48 dead and 111 families displaced. It could be said that it is still going on today as a number of disaster victims have yet to be compensated for their losses. The following is a general view of Manizales Sin Agua 2011 as told by the research participants in this study, and as it is best understood by most Manizales residents. During the course of these events, Manizales was electing a new mayor and it was one of the two rainy seasons typical of the region.

According to a number of participants, the series of events started with a landslide that significantly affected the Luis Prieto water treatment plant. This treatment plant is one of two water treatment plants that the city of Manizales utilizes to distribute the water resources to the Manizales citizens and some surrounding municipalities. The other water treatment plant, Niza, had been out of service for approximately a year, and the water utility, Waters of Manizales, did not seem to have plans to fix it in the near future. When Luis Prieto was affected, the city was left with no water supply, as the utility company did not have a contingency plan in case of an emergency. The gas and electricity infrastructure was also affected; therefore, during a period of this disaster Manizales residents were lacking water, gas, and electricity. There were multiple attempts to reconnect an important water pipe that connected the treatment plan to the rest of the city. However, the effects of the inclement weather on a river close to the pipe, led to the new pipe being damaged more than once.

Waters of Manizales attempted to supply water using water tankers. There were water tankers brought from outside the city to help with water distribution, however, poor areas often received water late and in smaller rations. Those who could afford to leave the city stayed with friends or family members who lived in nearby cities. Those who stayed had to spend several hours of their day in line with their own bucket to receive water. The elderly were the most affected with this process, as carrying heavy water in the hills of Manizales is extremely physically demanding. Social instability was evident in the lines to get water, with fights and arguments often breaking out. Wealthy individuals, who had to stay in the city, often hired their own water tankers and paid for water to be delivered to their front door.

As Election Day was fast approaching, the reactivation of the water distribution system was critical to the campaign of candidates who could benefit from additional votes. The proper procedures to reactivate the aged water distribution system that had been dry for more than 18 days were not followed. This led to pressure buildup in the system, which would eventually explode in the Cervantes neighborhood. However, prior to the rupture of the Cervantes pipe, a number of community reports were called in to Waters of Manizales who seem to have ignored them due to their preoccupations with the Luis Prieto treatment plant. Community members indicated that a slope was seeping water and that unusual sounds were coming from under ground. In the morning hours of the following day, the pipe ruptured leaving tremendous devastation to the surviving families.

What followed were a number of debates trying to determine those responsible for this disaster. The water utilities (Aguas de Manizales) manager and the mayor of the city were forced to leave their positions after massive protests and demonstrations by citizens. The cause of the disaster in Cervantes is still being debated; it seems unclear if the pipe ruptured and saturated the soil to create the landslide, or if the landslide ruptured the pipe while it was moving down the slope. If it was the pipe that ruptured causing the landslide, Waters of Manizales is responsible for compensating all victims of this disaster. If the landslide ruptured the pipe, Waters of Manizales is free of responsibility. To this day, the conclusion of Manizales Sin Agua 2011 is still unclear. What is clear is the tremendous humiliation and national shame that Manizales residents faced during and after the disaster. Manizales' world-renowned

reputation for having an excellent water quality resulting from optimal water resource management was destroyed by Manizales Sin Agua 2011.

Methodology

All Q methodology studies present two main features:

iii. Data is collected through Q sorts. A Q sort is an arrangement of items or a model, (also known as the Q set), that each participant produces according to the subjective measurement that each participant attaches to each item i.e. agree/disagree. The researcher prepares in advance the Q set utilized in each Q method study (Watts, & Stenner, 2012c).

iv. Subsequently, the Q sorts of each participant are compared and contrasted with each other using factor analysis, which in turn finds commonalities and differences in the perceptions and view points of the participants (Watts, & Stenner, 2012c).

Materials: Q Set Design and Content

The items that were sorted by study participants (called the Q set) was created using personal interviews, and supplemented with information from La Patria newspaper articles, local news stations, local radio stations, legal documents, and technical reports. La Patria is the most widely read newspaper in the city of Manizales. The selection of items was revised, reduced, and confirmed during an informal interview with undergraduate students from the National University of Colombia in Manizales. The final Q set was composed of 28 items that can be found on Appendix 2. The Q set was presented in the form of 4”x 6” photo paper cards, which presented a descriptive statement in a ~70-point font (See Fig. 3).

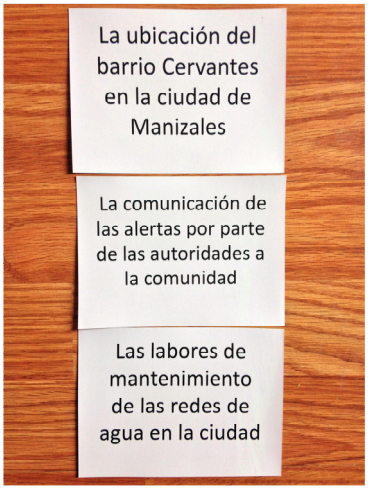

Figure 15. Q Set Sample

Participants

The Q methodology does not require a large participant pool in order to reach its objective of establishing commonalities and differences in viewpoints among participants, to then understand, interpret, and compare them (Watts, & Stenner, 2012). Twelve individuals participated in the study. Key informant recruitment of stakeholders of the Chinchina Watershed presented the majority of the sample with a few cases of participants resulting from snowball sampling. One key informant participant refused to participate and another participant resulting from snowball sampling refused to be recorded. However, the rest of the participants resulting from snowball sampling were very interested in participating. The group of participants displayed a variety of gender, age, levels of schooling, title or profession, years lived in current residency, and ethnicity. Only one participant identified his/her self as being Black, Mulatto, Afro-Colombian or Afro- descendent. The rest of the participants identified themselves as not belonging to any of the ethnic groups listed in the demographic survey—Indigenous, Rom, Raizal, Palenquero. There were six females and six males whose ages ranged from 20 to older than 61 years of age. The highest level of schooling among participants was university, equivalent to receiving a bachelor's degree, and three participants had received a master's degree.

Five participants did not load significantly or did not share points of view with any of the perception groups (factors), making them ineligible to participate in this study (see Table 1).

According to the Q methodology, loading non-significantly in any of the factors disqualifies a participant from a Q study because of the methodology's underlying function of finding a common ground among groups of people differing on points of view about a topic. A participant who is labeled as a non-significant participant and not being included in this study is not necessarily negative. It may mean that these participants are impartial to a number of the statements presented in the Q set.

Some individuals identified with more than one profession or title; consequently, the sum of the individuals who identified with a particular profession or title is greater than the number of total participants (12). In total, there were three participants identifying themselves as governmental employees, three identifying as working in public service institutions, two identifying as working in an environmental institution, two identifying as government officials, one identifying as self employed, one identifying as contractor, one identifying as working for a non governmental organization (NGO), and one identifying as working at a private business. All participants currently reside in urban areas of the Chinchina Watershed. Two participants have resided in their current residency for 20 to 29 years; one participant has resided for 10 to 19 years; and three participants have resided for less than 9 years. See Appendix 1 for this study's demographics.

Procedure: Administering the Q sort

The Q sort was administered in the participant's place of choice, which included the table or the floor in their houses' living room, a room that was quiet and away from other family members, bakeries, coffee shops, a church, and their work offices or conference rooms. Participants were provided with 28 4" x 6" cards of the Q set that needed to be ranked and a *Lona* or canvas with a hand drawn quasi-normal distribution of 28 4" x 6" boxes. A Likert scale ranging from -5 to +5 was written across the bottom of the quasi-normal distribution where each number, or ranking value, corresponded to a column of the distribution. In the quasi-normal distribution, a set number of items could be assigned to each ranking value in a forced-choice manner. Below the ranking scale, the word menos (less) was written in the left extreme,

neutral was written in the central area, and mas (more) was written in the right extreme of the distribution. These labels visually guided the participant during the sorting process. See Fig. 4 for an actual picture of the canvas used for this study.

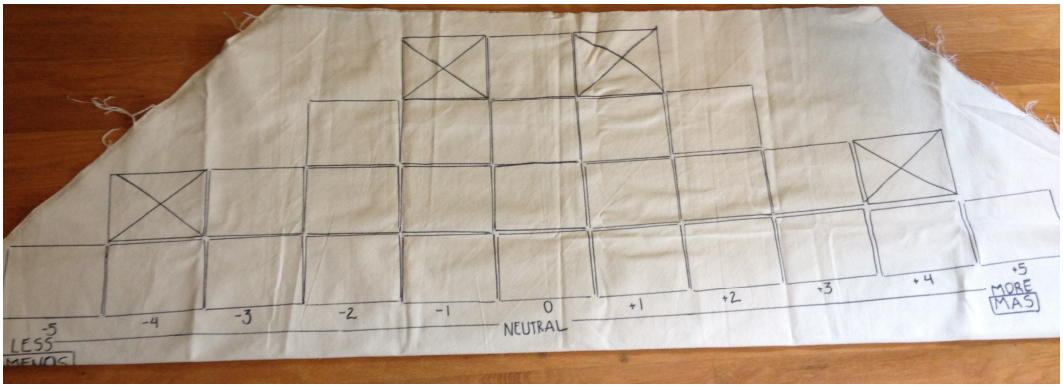

Figure 16. Lona or Canvas with Quasi-Normal Distribution

Participants were asked to answer the question, ¿En qué medida cree usted que los siguientes factores contribuyeron a la magnitud y efectos posteriores de Manizales sin Agua en el año 2011? (To what extent do you think the following factors contributed to the magnitude and aftereffects of Manizales without water in the year 2011?). Participants' responses were based on the Likert scale of -5 to +5 and were instructed to place only one card per box in the distribution. Participants were advised to take as much time as needed in placing the Q set in the order they thought best represented their points of view on the subject of Manizales sin Agua 2011 (Manizales without Water 2011). Participants were reminded that there was no right or wrong answer and that their next task was to explain their rationale for putting the cards where they did. Most individuals took approximately 30 minutes to sort the cards and to place them in the distribution. See Fig. 5 for an example of a completed Q sort.

The post-sort interview varied in length depending on the participants' willingness to elaborate on their Q sort choices. Some interviews were as short as 15 minutes and some were as long as two hours. Results were recorded in the backside of the demographic survey using a random number assigned to each item in the Q set. The task ended with an open-ended question about the participant's opinion on how this disaster could have been prevented and how their daily lives were affected by this event.

FACTOR ARRAY FOR FACTOR 1										
				26 La cantidad de tiempo que llovio	28 El tipo de suelo de los lugares donde ocurrieron derru	21 Preparacion de la ciudad para hacer frente a deslizami				
			27 La saturacion del suelo al absorber la enorme cantidad	25 La intensidad de las lluvias de invierno	8 El desacato de las instrucciones que las autoridades d	20 La recursividad de la empresa Aguas de Manizales para	22 La ubicacion de la planta de tratamiento de agua afect			
	15 La carretera que se encuentra encima de la tuberia de	24 La ubicacion del barrio Cervantes en la ciudad de Mani	18 La inclinacion de la pendiente donde se ubica el barri	17 El papel que las Guardianas de la Ladera ejercio duran	7 La creacion de falsas expectativas en la poblacion de	14 La atencion y rigurosidad por parte de las autoridades	19 Las labores de mantenimiento de las redes de agua en l	9 La comunicacion de las alertas por parte de las autori	13 Que solo una de las dos plantas de tratamiento de agua	
5 Atribucion de castigo divino a la emergencia que se pr	11 La eleccion popular de determinadas personas para ocup	23 La utilizacion del suelo en el barrio Cervantes	3 La eficiencia en las labores de los organismos de soco	4 La disponibilidad de refugios en la ciudad en caso de	6 La emergencia sanitaria	12 La camaraderia entre el gerente de Aguas de Manizales	16 Las condiciones de la tuberia que se rompio	1 La utilizacion y planificacion del suelo en la ciudad	2 La priorizacion del arreglo de la planta de tratamient	10 La eficiencia de las autoridades para abordar las adve
Rank -5	-4	-3	-2	-1	0	1	2	3	4	5
Less	←----------				Neutral	----------→				More

Figure 17. Example of Completed Q sort

Statistical Data Analysis

Q method is a tool to investigate subjective questions about "personal experiences, matters of taste, values and beliefs" through qualitative and quantitative techniques (Watts, & Stenner, 2012c). The Q method uses three unique transitions in its statistical data analysis: 1) from Q sorts to factors, 2) from factors to factor arrays, and 3) from factor arrays to factor interpretations.

1) From Q sorts to Factors

A total of 12 Q sorts were intercorrelated and factor-analyzed using the computer package PQMethod 2.33 (Schmolck, 2012). This analysis resulted in three factors, which were extracted and rotated by Varimax and then by hand (Brown, n.d.), explaining 42% of the study responses' variability or variance. Four of the seven Q sorts loaded significantly on one of the three factors.

Factor loadings of ± .49 or above were significant at the p<0.01 levels. The Unrotated Factor Matrix presented three factors with Eigenvalues higher than 1.00; however, it presented a confounded Q sort. See Table 1 for Q sorts loadings and associations with their respective factors.

Factor 3 presents only one significant loader; however, it was critical to include this participant as this individual has major weight over decisions involving the economic development of the city and works closely with the local government. Therefore, this individual's decisions and perceptions may override those of other participants due to his/her position of power. It was imperative to gauge the effect that this individual's decisions, evidently based on his/her perceptions and beliefs, would have on urbanization and land use in the watershed. In addition, the three factors used in this study explain a significant percentage of the variance. In order for a study to have promising results, the explicatory variance should be 35-40%, which this study surpasses (Watts, & Stenner, 2012a).

Table 11. The Rotated Factor Matrix

	Loadings		
QSORT	1	2	3
1 jv002	0.8062X	0.1664	0.1291
2 bv003	0.2769	0.1768	0.2768
3 dc005	0.6677X	0.0797	0.2148
4 ja014	0.6298X	-0.2772	-0.3199
5 sl016	0.0147	0.9207X	0.1551
6 ab017	0.1486	0.1860	0.0146
7 sv019	0.3441	0.5092X	-0.0515
8 lr025	-0.0044	0.1374	0.9017X
9 ly026	0.2284	-0.0468	0.0928
10 yg029	0.2028	-0.0263	0.0866
11 ot030	0.2539	0.0585	0.2693
12 oc031	0.8239X	0.0369	-0.0870
Eigenvalues	2.52	1.32	1.20
% expl.Var.	21	11	10

Factor Matrix with an **X** Indicating a Defining Sort.

*Q Sorts 2, 6, 9, 10, and 11 are non-significant, or did not load significantly in any of the factors. These Q sorts were not included in the statistical analysis.

The Q sorts that loaded significantly on a particular factor shared similar sorting patterns in the quasi-normal distribution. This indicates that these Q sorts may have similar viewpoints about the role that the Q set had in the magnitude of the 2011 events. Therefore Q sorts 1, 3, 4, and 12, which loaded in Factor 1, sorted the Q set in a similar pattern, and it may assumed that these Q sorts share a distinct viewpoint on Manizales without Water 2011. Q sorts 5 and 7 on Factor 2 share a viewpoint on this event, which is distinct from those on Factor 1 and Factor 3. Q sort 8 significantly loaded on Factor 3 and has its individual viewpoint regarding the 2011 event.

2) From Factors to Factor Arrays

A factor array is "a single Q sort configured to represent the viewpoint of a particular factor" (Watts, & Stenner, 2012b). Q sorts that loaded significantly in a factor are merged together to form a Q sort or an array that represents the factor. The factor arrays are the main piece of information used to interpret and report the results of the study. The factor arrays for Factor 1, Factor 2, and Factor 3 are found in Figures 6, 7, and 8.

3) From Factor Arrays to Factor Interpretations

The unique sorting pattern of each factor array is the basis for a careful and holistic interpretation of each factor (Watts, & Stenner, 2012c). Participants' comments and observations were quoted in order to create a comprehensive view of each factor and complement the factor array interpretations. The direct reporting of the points of view of the particular individuals that loaded significantly in each factor attempts to reflect the holistic foundations of the Q methodology.

The main goal of the factor interpretations is to uncover the views and perceptions that each one of the 3 factors has regarding the level at which the aspects presented in the Q set contributed to the magnitude and aftereffects of Manizales without water in 2011. It is important for the major stakeholders of the watershed to understand the perceptions of their

peers regarding what aspects need to be addressed in order to prevent future disasters like the one in 2011. Their influential positions should help in mitigating and addressing these aspects. It is also critical for these participants to acknowledge that there are other individuals who share their perceptions and at the same time, that there are other individuals who differ in perspectives. The Q methodology provides an interpretation of the perspectives associated with each factor or perception group. Most importantly, it identifies aspects in the Q set that all participants agree with, and aspects that all participants disagree with. These characteristics provide a common ground where different stakeholders can meet and start a conversation regarding steps to follow in order to prevent further catastrophes.

The factor array interpretations present a demographic summary of the heavy loaders on each factor. Rankings of relevant items are provided by the item number followed by its ranking in a particular factor. For example, "(26: -1)" indicates that for this specific factor, item number 26, the amount of time that rained, it was given a ranking of -1 by those who loaded significantly on this factor. The participants' comments used to clarify factor array interpretations are properly cited and denoted in italics (Watts, & Stenner, 2012c)

Results

Factor 1: Manizales Needs Proactive Measures to Prepare for Future Landslide Events.

FACTOR ARRAY FOR FACTOR 1										
				26 La cantidad de tiempo que llovio	28 El tipo de suelo de los lugares donde ocurrieron derru	21 Preparacion de la ciudad para hacer frente a deslizami				
			27 La saturacion del suelo al absorber la enorme cantidad	25 La intensidad de las lluvias de invierno	8 El desacato de las instrucciones que las autoridades d	20 La recursividad de la empresa Aguas de Manizales para	22 La ubicacion de la planta de tratamiento de agua afect			
	15 La carretera que se encuentra encima de la tuberia de	24 La ubicacion del barrio Cervantes en la ciudad de Mani	18 La inclinacion de la pendiente donde se ubica el barri	17 El papel que las Guardianas de la Ladera ejercio duran	7 La creacion de falsas expectativas en la poblacion de	14 La atencion y rigurosidad por parte de las autoridades	19 Las labores de mantenimiento de las redes de agua en l	9 La comunicacion de las alertas por parte de las autori	13 Que solo una de las dos plantas de tratamiento de agua	
5 Atribucion de castigo divino a la emergencia que se pr	11 La eleccion popular de determinadas personas para ocup	23 La utilizacion del suelo en el barrio Cervantes	3 La eficiencia en las labores de los organismos de soco	4 La disponibilidad de refugios en la ciudad en caso de	6 La emergencia sanitaria	12 La camaraderia entre el gerente de Aguas de Manizales	16 Las condiciones de la tuberia que se rompio	1 La utilizacion y planificacion del suelo en la ciudad	2 La priorizacion del arreglo de la planta de tratamient	10 La eficiencia de las autoridades para abordar las adve
Rank -5	-4	-3	-2	-1	0	1	2	3	4	5
Less	←----------				Neutral	----------→				More

Figure 18. Factor Array for Factor 1

		FACTOR 1	
No.	**Statement**	**Z score**	**Rank**
9	La comunicacion de las alertas por parte de las autori	**1.06**	5
10	La eficiencia de las autoridades para abordar las adve	**1.75**	1
21	Preparacion de la ciudad para hacer frente a deslizami	**0.66**	9
25	La intensidad de las lluvias de invierno	**-0.56**	19
26	La cantidad de tiempo que llovio	**-0.5**	17
27	La saturacion del suelo al absorber la enorme cantidad	**-0.63**	21

Note: Bold indicates significance at $p<0.05$; bold underline identifies significance at $p<0.01$. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 12. Distinguishing Statements for Factor 1

Participants loading on Factor 1 emphasize the need to pay attention to landslide warnings, and it highlights the need for improving the preparation of the city for future events. Factor 1 loaders acknowledge that the city has suffered tremendously in the past due to landslide warnings that were ignored (10; $z=1.75$, $p< 0.01$) and it is imperative to learn from past experiences. According to participant 12, the water treatment plant Luis Prieto was damaged by a landslide that occurred around the year 1985, leaving it out of service for approximately a year. Based on this event, it should be clear that a second fully functioning water treatment plant was needed to provide water to the city and surrounding municipalities. As witnessed in Manizales Sin Agua 2011, the back-up water treatment plant Niza had been out of service for over a year, and therefore it was unusable during the landslide event. Fixing the water treatment plant Niza did not seem to be a priority for the utility company, leaving the city without a contingency plan for catastrophic events like Manizales Sin Agua 2011 (2: 4). Having the Niza water treatment plant properly working could have allowed the city to endure this event without inconveniences (4). Participant 4 added that there would be only 10% of the population affected if Niza was working. Unfortunately for the people of Manizales having one water treatment plant working was only a part of a number of unfortunate events that occurred in the city in a short period of time (13: 4, 3).

The participants of Factor 1 indicate that Waters of Manizales inadequately executed the reactivation of the distribution system, and it scarcely conducted maintenance to the water distribution system of the city (19: 2). The participants suggest that stronger management, and the presence of trained technical personnel in Waters of Manizales, could have diminished the devastating effects of the Cervantes landslide. The incident at the Luis Prieto water treatment plant took place shortly before the election of a new Manizales mayor in 2011. Attributing the reactivation of the water distribution system to an election candidate was sure to gain a significant amount of votes and maybe the victory. Procedures associated with the reactivation of the system were not properly executed, leading to the collapse of the system and the eventual deadly rupture of a large pipe in the Cervantes neighborhood (4). Some pipes are approximately 50 years old and need to be replaced, however, there does not seem to be a clear plan regarding the update of the distribution system (12). Factor 1 participants added that

these changes might not be a priority for Waters of Manizales. A few months before the disaster, the company invested in its own expansion into foreign countries instead of investing in the maintenance and renovation of the local distribution system. According to participant 12, "*the company is investing in the sustainability of their business but not on the sustainability of their service to the city, and these are two very different things".*

Stakeholders loading on this factor believe that maintenance and updating of the distribution system is needed in the city, however, they attribute the magnitude of the catastrophe in the Cervantes neighborhood to other causes. According to Factor 1 participants, the management of Waters of Manizales, which is composed of the city mayor as the president of the company and the utility manager, are perceived as being responsible for the magnitude of Manizales Sin Agua 2011 (16: 2). The manager of Waters of Manizales evaded any liability related to the event, saying that he was responsible for the administrative aspect of the utilities, not the technical aspect (4). Participants believe that the condition and the vulnerability of the pipe that ruptured in Cervantes was a direct responsibility of Waters of Manizales (12). Though it is still uncertain if the landslide caused the pipe to break, or if it was the other way around, stakeholders loading on this factor gave strong indications that they believed the pipe caused the landslide that killed 48 individuals in Cervantes.

Loaders on this factor also believe that the city's inadequate disaster preparedness contributed to the magnitude of Manizales Sin Agua 2011 (21; $z= .66$, $p< 0.01$). Among Factor 1 loaders, there was a sense of pride regarding all the progress that the city has had throughout the years in order to prepare itself for landslides typical of rainy seasons. However, participants eventually accepted the fact that this disaster uncovered aspects that need to be improved (1). The city of Manizales does not possess assigned refuges for landslide-related victims. Refuges, usually schools, seem only to be used for victims of earthquakes or volcanic activity (4: -1; 3). While there were numerous reports of gastrointestinal disease associated with consumption of untreated water, an official health emergency was not announced (6: 0). Participants agreed that if a health emergency had happened, it could have been the most worrisome aspect of the disaster (1,3).

Stakeholders loading on Factor 1 strongly believe that the lack of warnings (9; $z=1.06$, $p< 0.05$) and instructions of evacuation to the residents of the Cervantes neighborhood (8: 0) significantly increased the magnitude of the disaster. According to participant 3, there were no warnings and therefore the residents of Cervantes did not leave their homes (8: 0). The communication during the event was poor. The manager of Waters of Manizales refused to report the true status of the water treatment plant and the distribution system. This created an immeasurable sense of disbelief and pessimism in the city. A number of participants praised the calm and patient reactions of citizens, as desperation increased, however, so did the social unrest. As expected, a number of protests and manifestations of social unrest took over the city (1, 3).

The community of Cervantes was unsure about where to report a community alert regarding seepage from a slope, where the pipe was ultimately going to break (12). The report went to Waters of Manizales, which was unable to pay attention to this alert due to their preoccupations with the Luis Prieto water treatment plant (3). The firefighting group in Manizales is an efficient relief agency responsible for rescue efforts during catastrophes. If the alert had been called in to the firefighters, more lives could have been saved (1, 3). Factor 1 participants believed that their work did not influence negatively the magnitude of the event. Instead, they saved as many lives as possible though they were not notified about the emergency on time (3).

The Municipal Office of Disaster Prevention and Care (OMPAD) needs to take on a leadership role and develop institutional coordination and public awareness throughout the year, not only during disasters (3). Carlos Alberto Garcia Montes, the chief officer of the OMPAD, seemed to be the only individual knowledgeable and capable of executing the disaster protocol in the city of Manizales. Garcia Montes had stepped down from his position a few months prior to Manizales Sin Agua 2011 and the provisional officer was simply not prepared to face such a tremendous disaster (3, 4). Manizales Sin Agua 2011 was truly a series of unfortunate events for the city of Manizales.

Participants believe that early alerts are the most accurate when coming from community members. They have more detailed knowledge of their surroundings and can

readily identify abnormalities like the leakage in the Cervantes neighborhood slope (12). Participant 12 suggested that these community alerts should be acknowledged and be rerouted to expert geotechnicians, instead of pipeline technicians. These experts could determine if there is truly a threat and possibly create evacuation routes to prevent large numbers of casualties. In the city of Manizales there is no protocol to manage community alerts at a more serious level by individuals holding a higher level of training (12).

Loaders on Factor 1 believe that Waters of Manizales' lack of resourcefulness to continue providing water to Manizales residents increased the magnitude of the disaster (20: 1). The utility company gathered a number of water tankers for citywide water distribution. Some tankers were brought from other cities in order to fulfill the water demands. While these efforts were seen as positive, they were not enough. There was clear inequality of water distribution and access during Manizales Sin Agua 2011. Lower socioeconomic status neighborhoods often lacked access to water for longer periods of time, and the quantity of water designated to these communities was less. Community members of all ages often had to walk long distances and wait for long periods of time for their water ration. Wealthier communities either had special access to aquifers or clean surface waters, or they were able to afford their own water tankers, purchasing water to be delivered to their particular homes or apartment complexes (3).

Waters of Manizales was determined to prove their autonomy and their resourcefulness by rejecting help from other institutions. While the water tankers were an acceptable temporary solution, the lack of water for Manizales and surrounding municipalities lasted longer than anticipated and other options should have been explored sooner. There were offers to use water treatment plants from neighboring municipalities, like Chinchina or Neira, but these offers were declined (20). The utility company accepted help only when they had lost control over the emergency. Inputs from those who helped seemed to have fallen on deaf ears as the distribution system was reactivated while violating all protocols to prevent problems with pipes that had been dry for approximately 18 days (1, 20). The result was the deadly rupturing of the Cervantes pipeline. To this day it is still unclear if the pipeline ruptured before or after the landslide.

Stakeholders loading on Factor 1 believe that the camaraderie between the mayor of the city and the manager of Waters of Manizales somewhat affected the magnitude and the aftereffects of Manizales Sin Agua 2011 (12: 1). Participants reproached the mayor of the city for treating the situation lightly and not requiring Waters of Manizales to activate the Niza water plant sooner. After all, the utility company belongs to the municipality of Manizales, and the mayor, as the president of this company, could have ordered the repair and activation of Niza. There had been warnings in the area where the Luis Prieto water treatment plant is located, and repercussions of a possible landslide in Luis Prieto were acknowledged. This under-prioritization left Waters of Manizales without a contingency plan for disasters (12). Factor 1 participants did not believe that candidate elections to governing positions contributed to the magnitude and aftereffects of Manizales Sin Agua 2011 (11: -4). Participants considered this a separate problem that needs to be addressed but that did not directly influence the events of November 2011 (1). It was uncomfortable that the candidates used water as political campaign to increase votes, but this was not the direct cause of the catastrophe (3).

Stakeholders loading on this factor believe that natural and physical characteristics of the areas where the landslides happened contributed the least to the magnitude and aftereffects of Manizales Sin Agua 2011. Compared to Factor 2 and Factor 3, loaders on Factor 1 particularly believed that the intensity of the rainfall (25; $z=-.56$, $p< 0.01$), amount of time that rained (26; $z=-.5$, $p< 0.01$), and the soil saturation (27; $z=-.63$, $p< 0.01$) did not affect the magnitude of the event. Participants disregarded the intensity and the amount of time that it rained as a contributing factor because they are used to experiencing these types of rains often and are usually not associated with such disasters (1, 2, 12). Participants believe that the soil saturation in Cervantes could have been increased by the early stages of the pipe rupturing and this could have caused the landslide to happen. Due to vague details regarding the cause for the landslide in Cervantes, participants were not sure if the saturation affected the magnitude of the event (1, 3, 12).

Factor 1 loaders ranked neither the type of soil where the landslides happened (28: 0) or the inclination where the neighborhood of Cervantes is located (18: -2) as aspects that affected the magnitude of Manizales Sin Agua 2011. Participants stated that the volcanic ash soil type

typical of this area was not a determinant cause for the landslides. The Cervantes neighborhood has been in the same location for approximately half a century and catastrophes like the one in 2011 had not occurred before (1). The inclination of the slope where the Cervantes neighborhood is located was also disregarded as a potential cause for the landslide. Participants indicated that Cervantes is not located in a high-risk area and that this inclination is typical of the rest of the city (1, 3, 4).

Stakeholders loading on Factor 1 rated planning and land use as an aspect that influenced the magnitude of Manizales Sin Agua 2011 (1: 3). Land use (23: -3), including the road on top of the pipe that ruptured (15: -4), and the location in Cervantes (24: -3) were ranked as not being significant aspects influencing the magnitude of the disaster. On the other hand, the location of the Luis Prieto water treatment plant (22: 2) was ranked as having an impact on the magnitude of the event. One participant claimed that the 2011 emergency was rooted in the improper land use of the property located on the slope that eventually covered the Luis Prieto water treatment plant (12). The property was located on a 40-degree slope and all protective forest had been removed to accommodate a few head of cattle. Participant 12 pointed out that in such slope, having cattle for commercial production is unfeasible and these were only subsistence cattle for the family owning the property. The Luis Prieto water treatment plant is located at the foot of the slope and close to the river; therefore, land use around the treatment plant should be under close monitoring and under a strict conservation program (12).

The acquisitions of properties surrounding water treatment plants, or a monetary incentive for landowners to implement conservation practices, are options that may be included in the Land-use Plan (Plan de Ordenamiento Territorial). After the 2011 disaster, the city of Manizales seems to have prioritized the improvement of the Chinchina watershed, executing plans that were long overdue, such as the POT. The POT is in its early planning stages, and it is a current watershed-wide project. Major stakeholders have acknowledged that the root cause of many problems in the watershed lie in the inadequate land-use planning of the city (1, 3, 12). Stakeholder participation is imperative and numerous collaborations have

emerged among important institutions (3). Concrete actions include a more stringent policy regarding permits and licenses for new construction (3).

Factor 1 participants commented that the current urban sprawl seems to be independent of the water distribution system's potential to expand (3). According to a Factor 1 participant, homes for families of low socioeconomic status continue to be built in the northern part of the city. This northern community has been flagged as a high-risk area for landslides, a characteristic that deters the utilities from extending their networks there (1, 3). It is often very expensive, challenging, and dangerous to work in these areas. Therefore, these homes are built disregarding the capabilities of the water utility to extend their network to these hard to reach places. Participants believe that this is a very poor and retrograde approach to land use in the city (3, 12).

Participants loading on Factor 1 believed that divine punishment had no influence on the magnitude and after effects of Manizales Sin Agua 2011 (5: -5). The participants added that volcanic activity is sometimes attributed to divine punishment. The landslides related to this disaster were understood to be of a technical and administrative nature (3). Another observation was the fact that those individuals responsible for the causes of the disaster may attribute the eventuality to divine punishment in order to evade being liable for the damages.

Factor 2: It was not Waters of Manizales, It was Nature.

FACTOR ARRAY FOR FACTOR 2										
				21 Preparacion de la ciudad para hacer frente a deslizami	22 La ubicacion de la planta de tratamiento de agua afect	20 La recursividad de la empresa Aguas de Manizales para				
			24 La ubicacion del barrio Cervantes en la ciudad de Mani	17 El papel que las Guardianas de la Ladera ejercio duran	10 La eficiencia de las autoridades para abordar las adve	14 La atencion y rigurosidad por parte de las autoridades	26 La cantidad de tiempo que llovio			
	8 El desacato de las instrucciones que las autoridades d	19 Las labores de mantenimiento de las redes de agua en l	23 La utilizacion del suelo en el barrio Cervantes	6 La emergencia sanitaria	9 La comunicacion de las alertas por parte de las autori	7 La creacion de falsas expectativas en la poblacion de	18 La inclinacion de la pendiente donde se ubica el barri	28 El tipo de suelo de los lugares donde ocurrieron derru	27 La saturacion del suelo al absorber la enorme cantidad	
12 La camaraderia entre el gerente de Aguas de Manizales	5 Atribucion de castigo divino a la emergencia que se pr	16 Las condiciones de la tuberia que se rompio	11 La eleccion popular de determinadas personas para ocup	4 La disponibilidad de refugios en la ciudad en caso de	3 La eficiencia en las labores de los organismos de soco	2 La priorizacion del arreglo de la planta de tratamient	13 Que solo una de las dos plantas de tratamiento de agua	15 La carretera que se encuentra encima de la tuberia de	1 La utilizacion y planificacion del suelo en la ciudad	25 La intensidad de las lluvias de invierno
Rank -5	-4	-3	-2	-1	0	1	2	3	4	5
Less	←----------				Neutral	----------→				More

Figure 19. Factor Array for Factor 2

		FACTOR 2	
No.	**Statement**	**Z score**	**Rank**
9	La comunicacion de las alertas por parte de las autori	**0**	14
10	La eficiencia de las autoridades para abordar las adve	**0.04**	13
12	La camaraderia entre el gerente de Aguas de Manizales	**-1.9**	28
15	La carretera que se encuentra encima de la tuberia de	**0.97**	5
16	Las condiciones de la tuberia que se rompio	**-1.09**	25
18	La inclinacion de la pendiente donde se ubica el barri	**0.73**	7
19	Las labores de mantenimiento de las redes de agua en l	**-1.05**	24
21	Preparacion de la ciudad para hacer frente a deslizami	**-0.41**	18
22	La ubicacion de la planta de tratamiento de agua afect	**-0.04**	15
28	El tipo de suelo de los lugares donde ocurrieron derru	**1.17**	4

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 13. Distinguishing Statements for Factor 2

Stakeholders loading on Factor 2 focus on the role of the natural and physical aspects as the main contributors to the magnitude and the aftereffects of Manizales Sin Agua 2011. Those aspects include the intensity of the rain (25: 5), the soil type (28: 3), the saturation of the soil (27:4), and the steepness of the slope (18: 2). While rain intensity received the highest ranking in the distribution, both participants loading on this factor differed significantly on their point of view regarding this statement. Participant 5 believed that November of 2011 presented rain levels that had not been witnessed in a significant amount of time. Participant 7, on the other hand, believed that November of 2011 was not a particularly rainy month compared to previous Novembers. For this participant, the rains were not a determining aspect for the magnitude of the disaster. While participant 7 reported these perceptions, his/her ranking of this aspect on the distribution shows that rain intensity affected the magnitude of the event slightly. To a degree, both participants believe that the intensity of rains had an effect on the 2011 disasters. However, participant 5 believed it to be the most influential aspect on the disaster's magnitude.

Participants loading on Factor 2 ranked soil types as being important contributors to the magnitude of the disaster (28:3). Both participants agreed that the region typically has volcanic ash soils and they suggested that land-use planning should take into account the type of soil of the area, as these may be prone to landslides. As illustrated by the statement regarding soil saturation (27: 4), Factor 2 participants believe that the capacity of certain types of soil to retain moisture may influence landslide risk. The saturation of soils during Manizales Sin Agua 2011 triggered a citywide red alert. Factor 2 participants, however, added that there was no information for the citizens regarding the steps to follow after the alert was announced. There were no instructions providing guidelines for signs of a possible landslide or how best to prepare for an emergency (7). Participants loading on Factor 2 observed that the soils became saturated both in the rural area where the Luis Prieto water treatment plant was located, and in the urban area where the neighborhood of Cervantes was located (5). It would be interesting to see if there are differing soil types in both areas or if the external anthropic activities (condition of the pipe that ruptured, and land use of slope) could have played an important role in the landslides. Stakeholders loading on Factor 2 ranked the steepness of the slope as having

some importance in the magnitude of the event (18: 2). However, Factor 2 participants acknowledged that this steepness is a citywide characteristic and it is a feature that increases the vulnerability to landslides (7).

Both participants loading on Factor 2 agree that the inadequate land-use planning in the city was a major contributor to the landslides of Manizales Sin Agua 2011 (1: 4). Like Factor 1 participants, Factor 2 participants believe that the subsistence cattle raising property above the Luis Prieto water treatment plant was a catalyst for the landslide that affected the treatment plant (5,7). Participants loading on Factor 2, like Factor 1 participants, suggest that the property should be purchased for conservation purposes or that the landowners should receive a monetary incentive to implement intensive reforestation on the property (5). Participant 7 suggested that land-use management and risk management should work hand-in-hand in order to prepare the city for future disasters.

The land use in Cervantes was ranked by participants loading on Factor 2 as not having significant effects in the magnitude of the November 2011 events (23: -2). While this ranking is negative, or not having significant effects on the events, -2 is in fact higher than the ranking assigned by participants loading on Factor 1 and Factor 3 to the land use in Cervantes. Factor 2 participants explained that the land use in Cervantes is characteristic of the majority of areas in the city, so this aspect could not have contributed significantly to the magnitude of the events (5, 7). For Factor 2 participants, the road on top of the pipe that ruptured in Cervantes significantly affected the magnitude of this landslide (15: 3). While the ranking for this road was positive, participants loading on Factor 2 seem to be in disagreement regarding this road in Cervantes. Participant 5 explained that there was inadequate management of the road that led to multiple infiltration events, which in turn saturated the soil leading to the landslide that ruptured the pipe. On the other hand, participant 7 explained that this road had been there since the foundation of the city of Manizales and it was used in the past as a railroad that had never shown instability. Factor 2 participants compared to Factor 1 and 3 participants ranked this aspect higher. In addition, participant 7 does not seem to think of this road as significantly affecting the magnitude of the event. This may hint at Participant 5's perception putting

particular weight on the ranking that participants loading on Factor 2 assigned to the Cervantes road.

For Factor 2 participants, land-use planning in the city, land use in Cervantes, and the road in Cervantes are all aspects that contributed to the magnitude of Manizales Sin Agua 2011. However, the location of Waters of Manizales' Luis Prieto water treatment plant was not a contributor. In fact, Factor 2 participants compared to Factor 1 and 3 participants ranked the location of this treatment plant the lowest. According to participant 5, the plant has been in the same location for many years and it had not been affected by natural disasters since the early 1980's, when there was a landslide caused by one of the tropical glaciers in the area. Participant 7 agreed with participant 5, but also acknowledged that Waters of Manizales could have recognized the vulnerability of the plant associated with the slope above the water treatment plant. This participant added that the location of the treatment plant makes it vulnerable and that there is a lack of risk management by Waters of Manizales. Participant 7 believed that this disaster could have been prevented if Waters of Manizales mitigated the risk that the Luis Prieto water treatment was under.

In terms of disaster preparedness, Factor 2 participants believe that relief agencies (3: 0), shelter availability (4: -1), and the resourcefulness of Waters of Manizales to continue providing the service (20: 1) increased the magnitude of Manizales Sin Agua 2011. On the other hand, the health emergency (6: -1), the residents' disregard about the instructions that the authorities gave them about leaving their properties (8: -4), the warnings provided by the authorities to the community (9: 0), and the efficiency of the authorities to address the technical warnings of previous years (10; $z= .04$, $p< 0.01$), did not have a major role in the magnitude of the disaster.

According to participant 7, Manizales has relief agencies with sufficient technical capacity and qualifications to handle emergencies in the city, however there is always room for improvement (7). Participants of Factor 2 believe that the lack of shelters for disaster victims was not a significant contributor to the magnitude of the disaster. Participants explain that the number of citizens that were affected by these disasters was 'not significant', therefore not providing shelters did not have a significant impact on the magnitude of the event. While Factor

2 participants ranked this aspect as -1, this ranking was higher than the ranking of Factor 1 and 3 participants.

Stakeholders loading on Factor 2 ranked the resourcefulness of Waters of Manizales to continue providing the service as having an impact on the magnitude and aftereffects of Manizales Sin Agua 2011 (20: 1). Participant 5 praised the resourcefulness of Waters of Manizales to continue providing the water service as the utility company paid for 180 water tankers to distribute water in urban and rural Manizales. The company created a plan to reconstruct the infrastructure damaged by the landslide in Luis Prieto. Contractors worked day and night to finish the work that was unfortunately damaged again two days later by another landslide (5). Participant 5 added that Waters of Manizales collaborated with the police, the relief agencies, and other water treatment companies within the city to fill and distribute water-using tankers. According to participant 5 there were no deaths attributed to the lack of water and there was no health emergency due to gastrointestinal diseases.

Participant 7 evaluated the resourcefulness of Waters of Manizales from a more comprehensive perspective. The participant claimed that the provision of water was successful due to national solidarity with the city of Manizales, instead of the resourcefulness from the utility company. Participant 7 added that the company's resourcefulness to manage water distribution before and after the disasters is less than optimal. The participant added that Waters of Manizales should in general improve its resourcefulness to manage, evaluate, verify, and adjust their procedures to secure water for the city at all times. The ranking that Factor 2 participants assigned to the resourcefulness of Waters of Manizales (20: 1) was higher than the ranking assigned by Factor 1 and 3 participants. While participant 5 praised Waters of Manizales's resourcefulness, when compared with other factors, Factor 2 shows that this aspect contributed to the magnitude of the event, although not at significant levels.

Factor 2 participants ranked the health emergency as not having significant effects on the magnitude of Manizales Sin Agua 2011 (6: -1), and the residents' disregard about the instructions that the authorities gave them about leaving their properties as having less of an effect (8: -4). According to participants loading on Factor 2, there was not a significant spread of illnesses, deaths, or infections among the population; therefore, this aspect did not have

significant effect on the magnitude of the event. According to Factor 2 participants, instructions were given to Cervantes residents after the landslide occurred. Participant 7 pointed out that if these instructions had been given prior to the event, casualties could have been prevented. This is also the case of the warnings by the authorities to the community (9:0). Participant 7 mentioned that the disinformation coming from Waters of Manizales did not allow citizens to take actions regarding their wellbeing and that of their families. This participant suggested that in emergencies such as Manizales Sin Agua 2011, the communication should be clear and honest so that citizens know exactly what is happening. Although the red alert was general, and there were no clear instructions for the citizens, having accurate and timely information about the emergency may trigger community action and life-saving mobilization.

Stakeholders loading on Factor 2 ranked the false expectations that miscommunication created among Manizales citizens as having some impact on the magnitude of the disaster (5). Participant 7 explained that the false expectations about the re-activation of the water distribution system were problematic due to the social unrest. However, participant 7 highlighted the fact that the false expectations attached to risk management in the city may be an important root cause to the 2011 disasters. The participant described past events when foreigners have come to the city of Manizales to complement the risk management work that has been done in the city. Although the people of Manizales see that additional work needs to be done in this area, they seem to become satisfied with the complements and believe that the work done in the past will suffice for the future (7). Participant 7 explains that this attitude could be attributed to the people of Manizales' culture, which does not value self-evaluation and self-critique.

Factor 2 participants ranked the camaraderie between the manager of Waters of Manizales and the mayor of the city as having the least contribution on the magnitude and aftereffects of Manizales Sin Agua 2011 (12: -5, $z= -1.90$, $p< 0.01$). According to participant 7 the camaraderie has little influence on the magnitude of the disaster. The participant added that what became evident was the lack of technical capacity of both the manager of Waters of Manizales and the city major to handle these emergencies. According to participant 5, the city mayor receives significant funding for his city management works from Waters of Manizales. As

mentioned before, the mayor chooses the manager of the utility company, therefore the mayor chooses an individual who he trusts (5). Participant 5 explains that is not camaraderie, but more of a trust relationship between the mayor and the manager of the utility company.

Participant 5 explained that Waters of Manizales is a mixed utility company, which has as its major investor a large public company, and as smaller investor, a private company. Because of this, Waters of Manizales is mostly regarded as a public company, meaning that it has large political bureaucratic influences in its administration. For example, as the city mayor chooses the utility company manager, every four years when the mayor changes, the manager of the company's manager also changes. There have been periods of time when the city has changed mayor multiple times during a four-year period, meaning that the administration at Waters of Manizales has also changed that many times (5). Participant 5 added that there have only been a few managers who have actually stayed the full term (four years). During the 18 years that the Waters of Manizales has been functioning, the company has had 12 different managers who come determined to leave their personal seal (5). While all the assistant directors and all positions below the often-changing management stay the same through these changes, it is disruptive to the company's functioning (5).

When management changes, the first year is often spent revising all progress that was made with the previous manager and new projects seem to take on a second priority (5). The mission and vision of Waters of Manizales changes with changing managers as the company is run based on the new manager's expertise (5). After the 2011 disasters, all management and assistant directors were changed, forcing the company to completely re-define itself (5). The most problematic aspect of this shifting management is that it leads to short management terms, and therefore no interest in establishing long-term projects or a long-term vision for the company (5). Participant 5 acknowledges that long-term goals should be the basis for a public water utility company (5). This volatile management situation seems to only be a characteristic of Waters of Manizales as the other utility companies in the city are either private or significant investors are of private nature (5). The magnitude of Manizales Sin Agua 2011 seems to have been worsened by this unstable and shortsighted management scheme.

Stakeholders loading on Factor 2 ranked the efficiency of the authorities to address the technical warnings of previous years as having a significant impact on the magnitude of the 2011 disasters (10: 0, z= .04, p< 0.01). Factor 2 participants ranked this aspect higher than Factor 1 or 3 participants. The indifference for past landslide event warnings, especially in the Luis Prieto water treatment plant area, reflects the consequences of the inadequate management system of Waters of Manizales. If these events occurred under a specific manager, it may not necessarily mean that the upcoming manager would improve risk and prevention management for the future. Factor 2 participants ranking these warnings higher than participants loading on other factors indicates a particularly strong view regarding the need for improvement in the administration and management of the utility company.

For Factor 2 participants, the conditions of the pipe that broke in the Cervantes neighborhood did not have a significant effect on the magnitude and aftereffects of Manizales Sin Agua 2011 (16: 2, z= -1.09, p < 0.01). According to participant 5, the pipe did not have a particular problem, the pipe could not hold the pressure exerted by the landslide and ruptured. Although Factor 2 participants' ranking was +2 for the conditions of the Cervantes pipe, it was the most negative ranking if compared to Factor 1 and Factor 3 participants' ranking.

Compared to Factor 1 and 3 participants, Factor 2 participants ranked the prioritization to fix the water treatment plant that was out of order (2:1), and that only one of two water treatment plants was operational when the landslide happened (13: 2), as not having significant impact on the magnitude of Manizales Sin Agua 2011. Participant 7 commented that having the Niza water treatment plant out of service for so long demonstrates irresponsibility and inadequate risk management from Waters of Manizales. On the other hand, participant 5 explained that media sources in the city of Manizales reported that the utility company had made substantial investments in the utility company of Peru, Waters of Tumbes. This news sparked anger among Manizales' citizens who questioned why these funds were used on foreign water treatment plants, instead of on local investment for repairs needed for Niza. According to Participant 5, Waters of Manizales applied for federal funding to repair the Niza water treatment plant; since these funds were delayed, they started purchasing materials needed for the repair ahead of time when the Luis Prieto treatment plant landslide occurred.

Participant 5 explained that the application for funding had been submitted long before the 2011 disaster occurred; therefore fixing Niza was a priority to the utility company.

Factor 2 participants ranked the maintenance of water distribution networks in the city of Manizales as not having significant effects on the magnitude of the 2011 events (19: -3). Participant 7 mentioned that there were no official reports regarding either past due scheduled maintenances or questionable pipe conditions. Participant 5 agreed that neither the Cervantes landslide nor the Luis Prieto water treatment plant landslide were due to the lack of maintenance to the distribution network. However, Waters of Manizales should have recognized the old state of the pipes in the distribution network and should have been cautious when re-activating the system.

Factor 3: Preventing the Incrimination of Specific Institutions

FACTOR ARRAY FOR FACTOR 3										
				24 La ubicacion del barrio Cervantes en la ciudad de Mani	28 El tipo de suelo de los lugares donde ocurrieron derru	19 Las labores de mantenimiento de las redes de agua en l				
			23 La utilizacion del suelo en el barrio Cervantes	20 La recursividad de la empresa Aguas de Manizales para	6 La emergencia sanitaria	14 La atencion y rigurosidad por parte de las autoridades	27 La saturacion del suelo al absorber la enorme cantidad			
	21 Preparacion de la ciudad para hacer frente a deslizami	9 La comunicacion de las alertas por parte de las autori	17 El papel que las Guardianas de la Ladera ejercio duran	18 La inclinacion de la pendiente donde se ubica el barri	5 Atribucion de castigo divino a la emergencia que se pr	12 La camaraderia entre el gerente de Aguas de Manizales	16 Las condiciones de la tuberia que se rompio	26 La cantidad de tiempo que llovio	25 La intensidad de las lluvias de invierno	
10 La eficiencia de las autoridades para abordar las adve	7 La creacion de falsas expectativas en la poblacion de	8 El desacato de las instrucciones que las autoridades d	4 La disponibilidad de refugios en la ciudad en caso de	15 La carretera que se encuentra encima de la tuberia de	3 La eficiencia en las labores de los organismos de soco	11 La eleccion popular de determinadas personas para ocup	1 La utilizacion y planificacion del suelo en la ciudad	2 La priorizacion del arreglo de la planta de tratamient	22 La ubicacion de la planta de tratamiento de agua afect	13 Que solo una de las dos plantas de tratamiento de agua
Rank -5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Less	←----------				**Neutral**	----------→				**More**

Figure 20. Factor Array for Factor 3

		FACTOR 3	
No.	Statement	Z score	Rank
5	Atribucion de castigo divino a la emergencia que se pr	**0**	16
7	La creacion de falsas expectativas en la poblacion de	**-1.54**	27
9	La comunicacion de las alertas por parte de las autori	**-1.16**	25
10	La eficiencia de las autoridades para abordar las adve	**-1.93**	28
21	Preparacion de la ciudad para hacer frente a deslizami	**-1.54**	27

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 14. Distinguishing Statements for Factor 3

The participant loading on Factor 3 ranked the fact that only one of two water treatment plants was operational when the landslide happened as having the most influence on the magnitude and after effects of Manizales Sin Agua 2011 (13: +5). According to this participant, having the Luis Prieto water treatment plant affected by a landslide left the city unprotected. The participant added that the 2011 disaster in Luis Prieto had been forewarned and that it was a well-known risk.

The stakeholer loading on Factor 3 ranked the condition of the pipe that broke in Cervantes (16: 2) and the maintenance of the water distribution system in the city (19: 1) as having somewhat of an effect on the magnitude of the 2011 events. The resourcefulness of Waters of Manizales to continue providing the water distribution service, however, was ranked as not having a significant impact on the magnitude of the events (20: -1). For participant 8 loading on Factor 3, the condition of the pipe that ruptured in Cervantes was critical to the disaster in Cervantes. Although the participant did not directly mention that it was the pipe that ruptured causing the landslide, s/he mentioned that it is well known that the pipes in the water distribution network need replacement due to their age. Regarding the resourcefulness of Waters of Manizales to continue providing the service, the participant loading on Factor 3 believed that it was the least that the company could do for Manizales citizens. The participant however found it hard to witness community members waiting in line for their ration of water being dispensed from the water tankers.

Participant 8 ranked the popular election of certain individuals to hold public office (11: 1) and the camaraderie between the manager of Aguas de Manizales and the Manizales mayor

(12: 1) as having some influence on the magnitude of the 2011 events. According to this participant, the main role of those in public office was to have the Niza water treatment plant available for use in case of an emergency. Participant 8 acknowledged that the risk was well known and that their role was to protect the citizens. Regarding the camaraderie between the manager at Waters of Manizales and the city mayor, participant 8 believed that they should have reported with honesty and clarity about the state of the Luis Prieto treatment plant. The participant was concerned about a health emergency therefore offering to help with the evacuation of the city, however Waters of Manizales declined the need for evacuation.

Creating false expectations among the population of the city (7: -4, $z= -1.54$, $p < 0.01$) and the efficiency of the authorities to address the technical warnings of previous years (10: -5, $z= -1.93$, $p < 0.01$) were ranked as having little to no impact on the magnitude of Manizales Sin Agua 2011. Participant 8 relates the false expectations created in the population to the camaraderie between the mayor and the manager of the utility company. However, contrary to the camaraderie ranked as having some impacts on the magnitude of the events, false expectations are ranked as not having significant impact. Participant 8 ranked the efficiency of authorities to address previous warnings as the aspect that had the least influence on the magnitude and aftereffects of Manizales Sin Agua 2011. According to the participant these warnings were not new and when the Colombian president visited Manizales in April of 2011, he asked the mayor to make water security a priority for Manizales citizens (8). In October of that year, Manizales and surrounding municipalities suffered almost 20 days without water. This participant's rankings for these aspects seem to somehow contradict his/her opinion on these aspects. Perhaps these contradictions reveal the intention to prevent the direct incrimination of the utility company or the local government.

Participant 8 believes that the city should improve its disaster preparedness and management. According to the participant, the relief agencies (3:0) arrived at the Cervantes neighborhood when the landslide had already occurred and they performed as expected in the rescue of victims. Participant 8, as other participants, acknowledged that there was no official health emergency (6:0) although the water tankers were not always clean. This participant was not aware of existing shelters for Manizales citizens in case of an emergency (4: -2); schools

have been used as shelters in the past (8). Participant 8 ranked the lack of city shelters as not having a significant impact on the magnitude of late 2011 events. Participant 8 ranked the warnings provided by the authorities as not having an impact on the magnitude of events (9: -3). According to the participant there were no warnings given to Cervantes citizens regarding a potential landslide. The residents' disregard about the instructions to evacuate their properties was also ranked as not having impact on the magnitude of the event (8: -3) as there were no instructions steps to follow after the citywide alert was released.

According to participant 8, land-use planning in the city of Manizales had some impact on the magnitude on the 2011 events (1: 2). Participant 8 believes that to this day, the land use planning approach in the city of Manizales is questionable and current efforts need to be evaluated. While participant 8 ranked land use planning as +2 having some impact on the magnitude of the event, Factor 1 and Factor 2 ranked this aspect as having a more significant impact. For Participant 8 the location of the Luis Prieto water treatment plant (22: 4) had a significant effect on the magnitude of the 2011 events. The participant added that more than the location of Luis Prieto, the land use of the area for cattle rising made the slope susceptible to the landslide that affected the treatment plant. Participant 8 does not believe that land use in Cervantes had a significant influence on the magnitude of the landslide in this neighborhood (23: -2). The participant added that the land in the neighborhoods nearby Cervantes is used in the same manner and had never displayed propensity for landslides. Participant 8 did not consider the location of the Cervantes neighborhood as having a significant influence on the magnitude of the event; the neighborhood had been for a significant amount of time (24: -1).

For participant 8, the amount of time it rained (26: 3), the intensity of the rains (25: 4), and the saturation of the soil (27: 2) were important contributors to the magnitude of Manizales Sin Agua 2011. Participant 8 believed that a number of situations happened at the right time and at the right place to create a catastrophe. It rained a significant amount of time with significant intensity and the city was not prepared for the events that followed (8). Participant 8 mentioned that with climate change, the intensity of the rains has increased and this aspect contributed significantly to the magnitude of the 2011 events. The participant

observed that if the soil had not saturated so severely, both landslides, in Cervantes and in Luis Prieto would have less probability of occurring.

Interestingly participant 8 on Factor 3 ranked the attribution of divine punishment to the emergency that happened in the city higher than Factor 1 and 2 (5: 0). Factor 1 and Factor 2 participants clearly discarded the relationship between divine punishment and the 2011 events. Participant 8 did not elaborate on the rationale used for placing this aspect as a neutral, however, it may be a reflection of her/his personal religious beliefs or that the participant did not identify a clear role for divine punishment in the 2011 events.

DISCUSSION

Consensus Agreement Statements

			FACTOR					
			1		2		3	
No.	Statement		Z score	Rank	Z score	Rank	Z score	Rank
1	La utilizacion y planificacion del suelo en la ciudad	**(C, p>.05)**	1.31	4	1.66	2	0.77	8
2	La priorizacion del arreglo de la planta de tratamient	**(C, p>.05)**	1.31	3	0.53	10	1.16	5
13	Que solo una de las dos plantas de tratamiento de agua	**(C, p>.01)**	1.75	2	0.85	6	1.93	1
14	La atencion y rigurosidad por parte de las autoridades	**(C, p>.05)**	0.46	10	0.45	12	0.39	12
20	La recursividad de la empresa Aguas de Manizales para	**(C, p>.05)**	0.43	11	0.53	10	-0.39	20

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 15. Consensus Agreement Statements

These Consensus Agreement Statements provide insights on watershed stakeholder's perceptions regarding aspects that significantly affected the magnitude and aftereffects of Manizales Sin Agua 2011. The Consensus Agreement Statements are aspects that all stakeholders agree impacted the 2011 events and therefore need to be addressed. Despite stakeholder loading on a particular factor, this segment of the Q methodology provides common perceptions among all participants that loaded significantly in one out of the three factors. Data from participants that loaded in a confounded or non-significant fashion were not included further in any further analysis.

There are five Consensus Agreement Statements of which one is at the p> 0.01 value, meaning that there is a smaller difference in opinion among stakeholders of this study regarding this statement compared to the other four statements. Therefore, participants of this study agree that having only one of two water treatment plants in operation when the disasters occurred was the main contributor to the magnitude of the 2011 events. This aspect is closely linked to the prioritization of Waters of Manizales to fix the Niza treatment plant that had not been working for a number of years. Therefore, the prioritization of Niza is also a consensus statement of this Q study. While it presents a p> 0.05, both of these statements are related as Niza had been out of service for a considerable period of time and the city faced a tremendous disaster with one functioning water treatment plant that was eventually damaged by a landslide. If Niza had been working properly, the magnitude of the event could have been minimized.

Participants loading on Factor 3 (z=1.93) and Factor 1 (z=1.75) strongly agree on the most significant contributor to the magnitude of the 2011 events. That is the fact that the Luis Prieto water treatment plant was the only functioning plant in Manizales. The participant loading on Factor 3 believes that the landslide affecting Luis Prieto made the city of Manizales extremely vulnerable, and the landslide in Cervantes showcased this vulnerability. The participant believes that the landslide in Cervantes was a consequence of the damages caused by the landslide that affected the Luis Prieto water treatment plant (8). Participants loading on Factor 1 believe that the city still needs to work on disaster management and preparedness for future landslide events. These participants believe that Manizales needs to mitigate social vulnerability to natural disasters through proactive measures, such as having contingency plans in case of emergencies. They promote the active participation of institutions and organizations as being imperative for the execution of these tasks.

Participants loading on Factor 2 agree that the land-use planning in the city of Manizales was the most influential aspect on the magnitude of the 2011 events. Factor 2 loaders tend to minimize the role of Waters of Manizales in the magnitude of the 2011 events. Apart from the consensus statements, participants loading on Factor 2 believe that natural and physical aspects like rain intensity, soil type, and soil saturation were the primary aspects that

influenced the magnitude of the 2011 events. Participants loading on other factors do not share this point of view with Factor 2 participants, preventing natural and physical aspects from becoming consensus statements in the Q methodology process. Participants loading on Factor 2 strongly agreed (z= 1.66) with Factor 1 (z=1.31) and Factor 3 (z= .77) participants that land-use planning was a significant contributor to the magnitude of events. Out of the five consensus statements, land-use planning seems to be the only statement involving an institution different from Waters of Manizales, CORPOCALDAS. This may seem as a confirmation of the perceptions portrayed by Factor 2 participants as avoiding involvement of the utility company in these events.

The most explicit example of the characteristics associated with the factors in this study is presented in the consensus statement regarding the attention and thoroughness by the authorities regarding the concern of the community. Although participants loading on all factors agreed that this aspect affected the magnitude of the 2011 events, they all agreed at different levels. Participants loading on Factor 1 agreed at a z= .46, participants loading on Factor 2 agreed at a z= .45, and participants loading on Factor 3 agreed at a z=. 39. The levels of agreement seem to decrease from Factor 1 participants to the participant loading on Factor 3. It appears, therefore, that the level of institutional incrimination decreases as we go from Factor 1 participants to Factor 3 participants.

Factor 1 participants openly call for an active role of authorities and institutions in the mitigation of risk and city preparedness. These participants acknowledged past events that were potential causes of the 2011 events, and they tried to encourage authorities in actively preventing these mistakes from happening again. Factor 1 participants therefore may perceive as more significant the authorities' inadequate attention to community reports regarding a leaky slope in Cervantes, compared to participants loading on other factors. Factor 2 participants steer away from the specific incrimination of Waters of Manizales. Therefore, the role of authorities, in this case Waters of Manizales, in addressing community concerns is lower in its impact on the magnitude of the 2011 events. Lastly, the participant loading on Factor 3 seemed to make a conscious effort not to incriminate any institution or office in this Q study. This is reflected on his/her lower ranking of authority's response to community concerns. This

participant's critical role as a mediator of industries, also critical for the economic development of the city, may have influenced the responses provided.

The consensus statement regarding the resourcefulness that the company Waters of Manizales had in order to continue providing the service seems to confirm the pattern above. The participant loading on Factor 3 disagrees that Waters of Manizales's resourcefulness had a significant impact on the magnitude of the 2011 events (z= -.39). The participants loading on Factor 2 believe that Waters of Manizales's resourcefulness did have an impact on the magnitude of the event. According to these participants' post interviews however, this was a positive impact, hence z= .53. Participants loading on Factor 1 believe that the utility company's resourcefulness to continue providing the service did have a significant impact on the magnitude of the events. According to these participants' post interviews, this impact increased the magnitude of the events.

Consensus Disagreement Statements

			FACTOR					
			1		2		3	
No.	Statement		Z score	Rank	Z score	Rank	Z score	Rank
3	La eficiencia en las labores de los organismos de soco	**(C, p>.05)**	-0.68	23	-0.08	16	0	16
4	La disponibilidad de refugios en la ciudad en caso de	**(C, p>.05)**	-0.57	20	-0.53	20	-0.77	23
6	La emergencia sanitaria	**(C, p>.05)**	0.1	13	-0.28	17	0	16
17	El papel que las Guardianas de la Ladera ejercio duran	**(C, p>.05)**	-0.5	18	-0.53	20	-0.77	23
23	La utilizacion del suelo en el barrio Cervantes	**(C, p>.05)**	-0.82	24	-0.85	23	-0.77	23
24	La ubicacion del barrio Cervantes en la ciudad de Mani	**(C, p>.05)**	-1.17	25	-0.77	22	-0.39	20

Note: Bold indicates significance at p<0.05; bold underline identifies significance at p<0.01. Nonsignificant "consensus" statements are indicated by C and associated p values.

Table 16. Concensus Disagreement Statements

Consensus Disagreement Statements are aspects that all participants, regardless of what factor they load on, agree did not contribute to the magnitude and aftereffects of Manizales Sin Agua 2011. All Consensus Disagreement Statements present a p> 0.05, meaning there is no difference in opinion among stakeholders of this study regarding these statements. The Z scores provide the level of agreement that participants of a factor have regarding the role of a specific statement in the magnitude of the 2011 events. Therefore, the more negative Z

scores hint at a higher level of agreement that a statement did not contribute to the magnitude of the 2011 events, and more positive Z scores hint at a lower level of agreement that a statement did not contribute to the magnitude of the events. The double negative of the more positive Z scores, therefore, may mean that the statement did contribute to the magnitude of the event according to participants loading on a factor that display more positive Z scores.

+Z=Lower level of agreement that X statement did NOT contribute to the magnitude.
-Z=Higher level of agreement that X statement did NOT contribute to the magnitude.

According to participants' post interviews, relief agencies were alerted about the situation in the Cervantes neighborhood after the landslide had occurred. Unfortunately, residents of Cervantes alerted Waters of Manizales who was preoccupied with the Luis Prieto landslide instead of the relief agencies who could have prevented more casualties. According to participants' accounts, when they arrived at the scene, they did everything they could to recue disaster victims. Participants loading on Factor 1 agree that the role of relief agencies did not contribute to the magnitude of the events (z=-.68). Based on Factor 1 participants' characteristic call for improvement in all aspects of disaster and risk management in the city, this may mean that relief agencies had an acceptable performance during the Cervantes landslide according to Factor 1 participants' point of view. This does not discount the fact that Factor 1 participants believe that there is room for improvement in Manizales's relief agencies.

Participants loading on Factor 2 (z=-.08) and Factor 3 (z=0) closely agreed that relief agencies had a slight influence on the magnitude of the 2011 events. The characteristics associated with Factor 2 participants show a propensity to draw attention away from Waters of Manizales. Agreeing that relief agencies contributed to the magnitude of the 2011 events effectively attains this goal. The characteristics associated with the participant loading on Factor 3 of preventing the incrimination of any governmental office or institution seems to be overridden in this statement. Agreeing that the relief agencies had an impact on the magnitude of 2011 events may incriminate the office for prevention of disasters. While this is a governmental office, it is not Waters of Manizales or the mayor's office, which are the main authorities in this case study.

According to post interviews, the availability of shelters in the city in case of disaster were not needed, because the number of families displaced by the Cervantes landslide was not significant. Participants loading on Factor 1 (z=-.57) and Factor 2 (z=-.53) were close in the level of agreement regarding the influence that shelter availability had on the magnitude of the 2011 events. Factor 1 participants were more neutral regarding this statement, and this may be due to the fact that there have never been official disaster shelters in Manizales. There does not seem to be a particular institution in charge shelter provision; one might assume that the office of disaster prevention is the institution responsible for shelters, but it has no role in this aspect of disaster management. There is a cultural explanation for the lack of a specific shelter provisioning institution; families in this region have close, extended familial connections and network of friends and neighbors who serve, in effect, as shelters for a period of time. Participants loading on Factor 2 agree that shelters could have had influence on the magnitude of the event, once again holding other parties responsible. The participant loading on Factor 3 (z=-.77) agreed that shelter availability did not contribute to the magnitude of the events. Although there is no specific institution to avoid incriminating, it follows the characteristic impartiality associated with the participant loading on Factor 3.

While there were some cases of gastrointestinal disease caused by the consumption of untreated water, there was no official health emergency during Manizales Sin Agua 2011, as not enough people in the population presented these or more grave symptoms. According to post interviews, participants believed that if a large portion of the population had been affected by a health emergency, an official health emergency would have been declared. Having the population under a health emergency and without water could have tremendously increased the magnitude of the 2011 events. Participants loading on Factor 1 (z= .1) agree that if an official health emergency had been announced, the magnitude of the event would have been significantly impacted. Participants loading on Factor 2 (z=-.28) naturally believe that the health emergency did not have a significant influence on the magnitude of the 2011 events. The importance of a health emergency is evident, as is the role that Waters of Manizales had on these events. Hinting at a link between both aspects would make the utility company

responsible for overwhelming consequences to the people of Manizales. The participant loading on Factor 3 (z=0) is logically neutral to this aspect.

Guardians of the Slope is a group of heads of family, unemployed women, who are hired to remove debris and cut the grass off the stability infrastructure built on a number of slopes, which have been identified as being vulnerable to landslides. Interviews revealed that the role of the Guardians of the Slope during the event was not clear. While it was mentioned that the Guardians had reported the seepage coming out of the Cervantes slope, authorities disregarded their concerns, like the concerns of the community. Participants loading on Factors 1 (z=-.5) and 2 (z=-.53) were in close agreement regarding the Guardians' effects on the magnitude of the 2011 events. Factor 1 participants' agreement with this group having an impact on the 2011 events may originate from the authority's disregard for the Guardian's report of the seeping slope. It may be that if the Guardians and the community had been heard and acknowledged, the number of casualties could have been reduced.

According to interviews, some participants believed that the Guardians of the Slope program needs to be re-evaluated. Participants mentioned that having older aged women leading this group, often lacking proper training and the physical strength to carry out this job properly, seems to be unsustainable. Factor 2 participants' agreement that the Guardians increased the magnitude of the Cervantes landslide may be rooted in this belief. In addition, turning responsibilities to other organizations beside Waters of Manizales also matches the characteristics associated with Factor 2 participants. The participant loading on Factor 3 (z=-.77) believes that Guardians of the slope did not contribute to the magnitude of the 2011 events. Unsurprisingly this point of view avoids the incrimination of Guardians of the slope and the entities funding this program.

Post interviews indicated that the location and land use of the Cervantes neighborhood was often regarded as having little effect on the magnitude of the Cervantes landslide. Participants observed that the location and land use in Cervantes is the same as a number of neighborhoods around it, which have not demonstrated a propensity for landslides. At the same time, there is a real concern among participants regarding the inadequate land-use planning in the City of Manizales. Some participants believed that this was the root of

Manizales Sin Agua 2011. Participants loading on Factor 1 (z=-1.17) and Factor 2 (z=-.77), the land use and location in Cervantes, did not contribute to the magnitude of the event. This opinion may be based on the fact that land use in that area has not changed since the neighborhood was created long ago, and the fact that the land use in neighborhoods around Cervantes is similar and has not shown a propensity for landslides.

Although the difference in agreement among all participants was minimal, the participant loading on Factor 3 seems to believe that the land use in Cervantes may have contributed somewhat to the magnitude of the event. The topic of land-use planning in the city of Manizales is currently in its beginning stages, assessing specific stakeholders and their responsibilities in the watershed. The participant loading on Factor 3 may believe that improving the land-use planning in the city, not specifically Cervantes is important to prevent future disasters. This point of view seems also to be reflected in the participant loading on Factor 3, who believes that the location of Cervantes could have also affected the magnitude of the event in this neighborhood (z= -.39).

CONCLUSION

This chapter illuminated a number of aspects that major watershed stakeholders believed need to be addressed in order to prevent future disasters like Manizales Sin Agua 2011. This chapter also provided a reflection about the dynamics among stakeholders who have significant influence in the way the water resource management is carried out. As witnessed in the factor interpretations, it appears that the most neutral points of view regarding the contributors to the magnitude of the 2011 events were those among participants with a higher level of responsibility in water management in Manizales. A study participant's comment regarding the challenges associated with self evaluation in the Manizales culture may be involved in this pattern. While the Q method provides a safe and private environment for participant's to share their points of view, there still seems to be a level of distrust among study participants. The distrust may be related to other stakeholders being exposed to participant's criticisms and incriminations that were conveyed during the Q method.

Some limitations of this study include the fact that not all major stakeholders of the watershed were included in this study and the fact that no clear information is available regarding the victim's remuneration. It would have been helpful to include the perceptions of the victims and more members of the community. Due to time constraints, a comprehensive analysis including all stakeholders was not achieved in this chapter. However, future analysis should include the analysis of community members, including disaster victims, and major stakeholders in the watershed.

The consensus statements in this chapter may potentially provide a common ground for major watershed stakeholders to start evaluating future efforts to improve the water resource management in the city of Manizales and mitigate future disasters. This information is especially relevant at this moment in the city's establishment of land-use planning and water resource use planning schemes in the Chinchina watershed.

Factor Q-Sort Values for Each Statement

No.	Statement	No.	Factor Arrays 1	2	3
1	La utilizacion y planificacion del suelo en la ciudad	1	3	4	2
2	La priorizacion del arreglo de la planta de tratamiento que	2	4	1	3
3	La eficiencia en las labores de los organismos de socorro	3	-2	0	0
4	La disponibilidad de refugios en la ciudad en caso de desast	4	-1	-1	-2
5	Atribucion de castigo divino a la emergencia que se presento	5	-5	-4	0
6	La emergencia sanitaria	6	0	-1	0
7	La creacion de falsas expectativas en la poblacion de la ciu	7	0	1	-4
8	El desacato de las instrucciones que las autoridades dieron	8	0	-4	-3
9	La comunicacion de las alertas por parte de las autoridades	9	3	0	-3
10	La eficiencia de las autoridades para abordar las advertenci	10	5	0	-5
11	La eleccion popular de determinadas personas para ocupar car	11	-4	-2	1
12	La camaraderia entre el gerente de Aguas de Manizales y el a	12	1	-5	1
13	Que solo una de las dos plantas de tratamiento de agua estab	13	4	2	5
14	La atencion y rigurosidad por parte de las autoridades respe	14	1	1	1
15	La carretera que se encuentra encima de la tuberia de agua e	15	-4	3	-1
16	Las condiciones de la tuberia que se rompio	16	2	-3	2
17	El papel que las Guardianas de la Ladera ejercio durante la	17	-1	-1	-2
18	La inclinacion de la pendiente donde se ubica el barrio Cerv	18	-2	2	-1
19	Las labores de mantenimiento de las redes de agua en la ciud	19	2	-3	1
20	La recursividad de la empresa Aguas de Manizales para contin	20	1	1	-1
21	Preparacion de la ciudad para hacer frente a deslizamientos	21	1	-1	-4
22	La ubicacion de la planta de tratamiento de agua afectada	22	2	0	4
23	La utilizacion del suelo en el barrio Cervantes	23	-3	-2	-2
24	La ubicacion del barrio Cervantes en la ciudad de Manizales	24	-3	-2	-1
25	La intensidad de las lluvias de invierno	25	-1	5	4
26	La cantidad de tiempo que llovio	26	-1	2	3
27	La saturacion del suelo al absorber la enorme cantidad de ag	27	-2	4	2
28	El tipo de suelo de los lugares donde ocurrieron derrumbes	28	0	3	0

Variance = 6.500 St. Dev. = 2.550

Figure 21. The Factor Arrays (For complete and translated statements see Appendix 2)

Table 17 Factor Scores with Corresponding Ranks, Distinguishing Statements per Factor, Consensus Statements

			FACTOR 1		FACTOR 2		FACTOR 3	
No.	**Statement***	**Consensus**	**Z Score**	**Rank**	**Z Score**	**Rank**	**Z Score**	**Rank**
1	La utilizacion y planificacion del suelo en la ciudad	**(C, p>.05)**	1.31	4	1.66	2	0.77	8
2	La priorizacion del arreglo de la planta de tratamient	**(C, p>.05)**	1.31	3	0.53	10	1.16	5
3	La eficiencia en las labores de los organismos de soco	**(C, p>.05)**	-0.68	23	-0.08	16	0	16
4	La disponibilidad de refugios en la ciudad en caso de	**(C, p>.05)**	-0.57	20	-0.53	20	-0.77	23
5	Atribucion de castigo divino a la emergencia que se pr		-2.14	28	-1.66	27	**0**	16
6	La emergencia sanitaria	**(C, p>.05)**	0.1	13	-0.28	17	0	16
7	La creacion de falsas expectativas en la poblacion de		-0.18	14	0.49	11	**-1.54**	27
8	El desacato de las instrucciones que las autoridades d		-0.37	15	-1.54	26	-1.16	25
9	La comunicacion de las alertas por parte de las autori		**1.06**	5	**0**	14	**-1.16**	25
10	La eficiencia de las autoridades para abordar las adve		**1.75**	1	**0.04**	13	**-1.93**	28
11	La eleccion popular de determinadas personas para ocup		-1.28	26	-0.69	21	0.39	12
12	La camaraderia entre el gerente de Aguas de Manizales		0.21	12	**-1.9**	28	0.39	12
13	Que solo una de las dos plantas de tratamiento de agua	**(C, p>.01)**	1.75	2	0.85	6	1.93	1
14	La atencion y rigurosidad por parte de las autoridades	**(C, p>.05)**	0.46	10	0.45	12	0.39	12
15	La carretera que se encuentra encima de la tuberia de		-1.34	27	**0.97**	5	-0.39	20
16	Las condiciones de la tuberia que se rompio		0.87	8	**-1.09**	25	0.77	8
17	El papel que las Guardianas de la Ladera ejercio duran	**(C, p>.05)**	-0.5	18	-0.53	20	-0.77	23
18	La inclinacion de la pendiente donde se ubica el barri		-0.66	22	**0.73**	7	-0.39	20
19	Las labores de mantenimiento de las redes de agua en l		1.02	6	**-1.05**	24	0.39	12
20	La recursividad de la empresa Aguas de Manizales para	**(C, p>.05)**	0.43	11	0.53	10	-0.39	20
21	Preparacion de la ciudad para hacer frente a deslizami		**0.66**	9	**-0.41**	18	**-1.54**	27
22	La ubicacion de la planta de tratamiento de agua afect		0.88	7	**-0.04**	15	1.54	3
23	La utilizacion del suelo en el barrio Cervantes	**(C, p>.05)**	-0.82	24	-0.85	23	-0.77	23
24	La ubicacion del barrio Cervantes en la ciudad de Mani	**(C, p>.05)**	-1.17	25	-0.77	22	-0.39	20
25	La intensidad de las lluvias de invierno		**-0.56**	19	1.86	1	1.54	3
26	La cantidad de tiempo que llovio		**-0.5**	17	0.69	8	1.16	5
27	La saturacion del suelo al absorber la enorme cantidad		**-0.63**	21	1.45	3	0.77	8
28	El tipo de suelo de los lugares donde ocurrieron derru		-0.42	16	**1.17**	4	0	16

Note: Bold indicates significance at p<.05; bold underline identifies significance at p<.01. Non-significant "consensus" statements are indicated by C and associated p values. For complete and translated statements see Apendix 2.*

CH 4: THESIS CONCLUSION

Personal Lessons and Q Method Procedures

The steepest learning curve in writing this thesis was learning how to carry out a Q method study. The Q method is an intricate and holistic approach to human perception, and there is always a new learning experience to tackle with each new Q study. Throughout the steps of the Q method I became aware of a number of skills that I have acquired during my educational and professional career in order to conduct a successful Q study. The combination and proper use of these skills allowed me to have a deeper understanding of my study participants and their points of view than if I had not used the Q method. I believe that the Q method served as a tool to put research participants at ease when confronted with topics of a sensitive or controversial nature. While I consider myself as tactful, sensitive, and a good listener, the Q method and the Q sort that everyone completed served as space where participants were empowered to reflect on their own points of view. I simply served as an observer and facilitator interested in understanding their particular stories and points of view.

Due to the nature of the Q methodology, interviews are atypical and participants are often surprised by the fact that there are no real questions coming from the researcher. The exploration of the Q study's topic often starts as a personal reflection, which can sometimes change the point of view of a participant. However, this exploration often becomes a mutual sharing of ideas and points of view. Most of the time the Q method gives way to a more interpersonal connection between interviewer and the participant. After the dynamic Q sorting process, where the participant places the cards on a canvas, the participant verbalizes his/her rationale for placing the cards where they did. The process of rationalizing out loud seemed to have made a number of participants feel vulnerable, especially those who encountered difficulties explaining their choices or those who changed their points of view about the topic at hand. Sharing this moment of vulnerability with the participant often opened a door to an interesting sharing of ideas and experience.

It was also very instructive for me to carry out the Q method in two different cultures. The two case studies allowed me to consider the adaptability of the method for future use. There are a number of important adjustments required for making the study culturally

sensitive. While a number of these modifications were done prior to the study, there were a number of additional changes that were only evident during fieldwork. The demographic survey was adjusted for ethnicity or race, and the titles describing the participants, and the survey, in itself, had educational value for the participants themselves regarding race and ethnicity in the Colombian case. Participants were often surprised to know of the variety of underrepresented ethnic groups in the country, including Native Indigenous populations, Rom, Raizal from the San Andres and Providence archipelago, Palenquero from San Basilio, or Afrocolombian.

Peculiarities regarding the demographic survey include the time a participant has lived in their current place of residency and the description of the area where participants reside. I am native of Manizales and I was under the impression that families in this area of the country resided in the same home most of their lives. Families in this region of the country are large, and it is not uncommon to find multiple generations residing under the same roof. To my surprise most participants have resided in their current residency for less than 9 years, making this region more fluid than I anticipated. It might be interesting to explore migration patterns in this region of the country, or within the city of Manizales, and understand their influence on perceptions. The description of the participants' area of residency provided insights regarding the differences in land-use planning in Kansas compared to Manizales. All participants in Manizales reside in the urban area, where participants in Kansas are distributed in urban, suburban, and rural areas. Urban sprawl in the Manizales area is a real threat to the health of the watershed. It would be interesting to explore if perceptions of the role that an individual has on watershed preservation changes depending on the participant's place of residency.

It became evident during fieldwork that adjustments needed to be made in the materials used during the Q sorting process. The materials needed during the Q sorting process are the Q set cards and the canvas, with a drawn or printed quasi-normal distribution for the placement of the cards. Having the canvas made traveling abroad very simple, as it could be folded and packed. However, considering that 4 x 6 cards were used for the Q set meant that a very large area was needed to spread out all the materials; it was challenging to find an adequate space or a table to hold everything.

It is also important to consider the Q set cards themselves in the study and consider whether using statements or pictures and descriptions is more helpful or useful. For the Q study in Kansas, I used a photograph and a description of the practice, and in Manizales, I used statements only. In Manizales, I believe it would have been better for participants to sort pictures and short descriptions, rather than statements. Considering the relatively low socio economic and education status in Manizales, and the elderly age of community members, it was often difficult for participants to understand and read the statements. Font size and font type in the Q set cards could have influenced participant responses.

Conversely, the Kansas Q study could have benefited from using statement only cards. Due to the fact that there were a number of experts among the participant pool, the photo on the card seemed to invite unwarranted inspection of what exactly was occurring in the photos, beyond what was really required for the purposes of the study. A number of participants examined the picture conspicuously to determine the precise state of the best management practice pictured on the card as part of their decision to place it where they did in the distribution. Q set cards with only statements would have eliminated this unnecessary deliberation. In sum, this research emphasized for me the importance of preparing the Q set cards to obtain a clean participant response, based on the participants' ethnic and socio economic background.

Watershed Management

In both Q method studies the topography and geology of the area was critical for watershed management efforts. In Kansas, for example rocky areas of Shawnee County present challenges in agriculture and in implementing substantial best management practices (BMPs). According to a study participant, as agriculture seems to be difficult to maintain in these areas, the BMPs applicable to this land are limited. Therefore the watershed protective functions of the BMPs are limited as well, potentially increasing the amount of pollution entering water bodies. In Manizales, the topography makes water resource management challenging due to the propensity for landslides and the high cost of building and maintaining distribution networks. Expanding water distribution networks, to keep up with the often-unplanned urban

sprawl in Manizales, is extremely expensive for the city's utility company. The expense is mostly derived from the difficult work required by the area's topography for the building of the distribution network. This results in homes lacking basic services including water and electricity.

Twice per year, rains affect water security of Manizales due as well to topography. Slopes of approximately 40 degrees, in combination with increasing torrential rains, and inadequate land-use planning, often give way to catastrophic landslides. These landslides often leave a number of casualties and also affect important infrastructure, including water pipes and electrical towers.

It is in the major stakeholders' best interest to participate actively in the management of the watershed. In Kansas, for example, it ends up costing more to dredge rivers and build water treatment plans than it does to prioritize watershed management practices. A number of BMPs serve as filters for nutrients and sediment that pollute the water used as a drinking water source for watershed residents. The implementation of BMPs may reduce the treatment needed to make water available for residential use. BMPs also aid in the prevention of sediment input in a body of water; not implementing these practices may lead to an increase in erosion and therefore sedimentation of reservoirs. Dredging significantly disturbs aquatic ecosystems and also stirs up dangerous minerals that often settle on the bottom of reservoirs. Additionally, preventing the consumption of contaminated water would potentially require extraordinarily expensive measures.

In both Kansas and in Manizales, management practices for raising cattle and for watershed data collection are required in order to secure an appropriate quantity and quality of water for watershed residents. In Kansas, the implementation of BMPs for cattle management may be partially subsidized with cost-share programs. In order to continue receiving this subsidy, the landowner needs to follow prescribed guidelines regarding the stocking rate. If the stocking rate is violated, the landowner changes their status to overgrazing, losing the financial incentive from the cost-share program.

In the Manizales area, cattle rising create a number of problems that not only affect the quality and quantity of water but also ultimately serve as a catalyst for deadly landslides. In order to raise cattle, the slopes are cleared of native vegetation to plant grasses for forage.

These new grasses do not hold the soil as well as the native vegetation does, increasing the vulnerability for landslides. This land-cover change, soil compaction caused by cattle, and torrential rains often lead to landslides like the one affecting the Luis Prieto water treatment plant. The implementation of conservation practices to mitigate land-use damage on water sources is just beginning in this area of the country. Cost-share programs in Colombia, if existent, must be rare. Major watershed stakeholders are in the process of improving land-use planning (POT) and water resource planning (PORH) in the watershed. As with BMP implementation, the foundations of the POT and the PORH call for data collection in the form of an "environmental inventory or natural resource inventory of the watershed" (Chavarriaga Montoya et al., 2012).

The lack of maintenance for water distribution systems, as part of water resource management, showed itself to be critical during the Cervantes landslide in the city of Manizales. As the pipes in water distribution network age, more maintenance and care are required. The disregard for this aspect while reactivating the water distribution network in Manizales seemed to have been the cause of the deadly pipe rupture in Cervantes. While these types of situations are not common in Kansas, the deterioration of the pipes is a common challenge in both regions. In developed nations as in developing nations, utility companies require employees to carry out maintenance routines on the water distribution networks. However, distribution networks in developed nations require only 3-4 employees per 1000 connections compared to 10-20 employees required n Latin America (Gadgil, 1998). The deteriorating condition of Latin American pipes has resulted in over 50% of their water supply being lost to leakages or theft (Barlow, & Clarke, 2004). According to a participant of this Q method study, in Shawnee County rural utility companies consider 15% loss of water due to leakage as acceptable. The participant shared his concern about the 20% loss of network under his supervision.

To conclude, watershed management in both regions is imperative as environmental changes can potentially threaten water security for the Wakarusa and the Chinchina watershed. Major stakeholders and watershed residents need to work together to create comprehensive approaches to watershed management. Education was mentioned in both Q method studies as one of the most efficient ways to obtain the participation of watershed stakeholders. As a

Manizales native and as a decade-long resident of the state of Kansas, I hope that this thesis serves as an initial step to understand the importance of acknowledging the perceptions of all residents in the watershed in order to secure water for our future generations.

APPENDIX 1:
Grant List

SOURCE: THE KANSAS ALLIANCE FOR WETLANDS AND STREAMS

www.kaws.org/grant-list

AGENCY	PROGRAM	CONTACT	PURPOSE
Kansas Dept. of Ag	Permits for dams, stream obstructions, floodplain fills, and levees	Water Structures Program	Enforce regulations for water structures, stream alterations, water rights/assurance, and flood protections
Kansas Dept. of Commerce and Housing	Small Cities Community Development Block Grant	Thomas Dow 785-296-3485	Provide assistance to counties and cities for human development projects or natural disaster protection projects
Kansas Dept. of Health and Environment	Nonpoint Source Pollution Program	Watershed Management Section 785-296-4195	Provide funds for projects that will reduce nonpoint source pollution. Also provides funds for Watershed Restoration and Protection Strategies (WRAPS)
Kansas Dept. of Wildlife, Parks and Tourism	Land and Water Conservation Funds	Program coordinator 620-672-0742	Provide funds to preserve, develop and assure access to outdoor recreation
	Conservation Easements for Riparian and Wetland Areas	Wildlife Section 620-672-5911	Provide easements to permanently secure and enhance quality areas in the state.
	Wildlife Habitat Improvement Program	Wildlife Section 620-672-5911	Assist landowners with food plot seed, grass and forb planting or interseeding including seed and providing the grass drill, tree and shrub plantings, and water developments or enhancements.
	North American Waterfowl Conservation Act	Wildlife Section 620-672-5911	Provide up to 50% cost-share for purchase and/or development of wetlands and wildlife habitat
	Wildtrust	Wildtrust Administrator 620-672-5911	Accepts donated money, property and real estate which includes wetlands and riparian areas. Donated funds may be used for enhancemnet

	MARSH Program	620-672-5911	May provide up to 100% of funding for small wetland projects. Projects need to provide waterfowl benefits and be open to the public.
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program	State Supervisor 785-539-3474	Mainly supports field operations which includes technical assistance on protecting, restoring or maintaining native habitats
	Private Lands Program	State Private Lands Coordinator 785-539-3474 Ext 107	Contracts to restore, enhance or create wetlands or native grasslands. Partial payment for construction is provided.
	Riparian and Wetland Protection Program	Rural Forestry Coordinator 785-532-3310	To work closely with other agencies to promote and assist with establishment of riparian forest land
K-State Research and Extension	Water Quality Programs	KCARE Director 785-532-7103	To provide programs, expertise and educational materials that relate to minimizing the impact of agriculture on water quality.
	Pollution Prevention Institute	Contact 800-578-8898	PPI provides free, non-regulatory technical assistance and training in pollution prevention and environmental compliance
Kansas Rural Center	Rural Water Quality Protection Technical Assistance	Contact 785-873-3431	Assists farmers with questions about water quality and agriculture
KS Department of Ag. Division of Conservation	Water Resources Cost-share Program	Assistant Director 785-296-3600	Provide cost-share assistance to landowners for establishment of water conservation practices
	Nonpoint Source Pollution Control Fund	NPS Program Manager 785-296-3600	Provides financial assistance for nonpoint pollution control projects which help restore water quality
	Riparian and Wetland Protection Program	Riparian and Wetland Coordinator 785-296-3600	Funds to assist with wetland development and enhancement as well as stabilization of streams
	Kansas Water Quality Buffer Initiative	Riparian and Wetland Coordinator 785-296-3600	Compliments the Federal Conservation Reserve Program by offering additional financial incentives for grass filter strips and riparian forest buffers in high priority TMDL areas
Kansas Water Office	Public Information and Education	785-296-3185	Provide information and education to the public on Kansas Water Resources
US Army Corps of	Planning Assistance to	KC District 816-983-	Assistance in development of plans for

Engineers	States	3157 or Tulsa District 913-669-7185	development, utilization and conservation of water and related land resources of drainage basins
	Environmental Restoration	KC District 816-983-3157 or Tulsa District 913-669-7196	Funding assistance for aquatic ecosystem restoration.
US Dept. of Ag - Natural Resources Conservation Service	Conservation Compliance	State Conservationist 785-823-4565	Requires specific treatment of highly erodible cropland and wetlands in order to participate in most USDA programs
	Conservation Operations	State Conservationist 785-823-4565	Provides technical assistance on private lands for development and application of Resource Management Plans
	Emergency Watershed Protection	State Conservationist 785-823-4565	Provides assistance to reduce threats to life and property in the wake of a natural disaster
	Environmental Quality Incentives Program (EQIP)	State Conservationist 785-823-4565	Provides technical and financial assistance to install structural and management practices
	Inventory and Monitoring	State Conservationist 785-823-4565	Provides information on soils, water and related resources.
	Plant Materials Program	State Conservationist 785-823-4565	Assists with development of plant materials and techniques for their use in environmental improvement programs
	Watershed Planning and Operations	State Conservationist 785-823-4565	Provides assist to watershed or conservation districts to install land treatment and structural practices
	Wetlands Reserve Program	State Conservationist 785-823-4565	Cost-share and easements to restore wetlands
	Wildlife Habitat Incentives Program	State Conservationist 785-823-4565	Cost-share to establish wildlife habitat which includes wetlands and riparian areas.
	Grassland Reserve Program	State Conservationist 785-823-4565	Cost-share and easements to protect, restore, and enhance native rangeland
	Conservation Security Program	State Conservationist 785-823-4565	Contract payments for utilizing good conservation practices

	Farm and Ranchlands Protection Program	State Conservationist 785-823-4565	Provides funding to keep farm and ranchlands in agricultural uses
Farm Services Agency	Conservation Reserve Program	FSA State Director 785-539-3531	Cost-share and rental agreements to restore native grasses and wetlands
Environmental Protection Agency	Clean Water State Revolving Fund Program	Clean and Safe Water Branch 913-551-7030	Provide low cost loans to communities for water pollution control activities
	Watershed Protection	Watershed Planning and Implementation Branch 913-551-7447	To conduct holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries.
Kansas Alliance for Wetlands and Streams	Wetland and Riparian Program	State Coordinator 785-620-1619	Provides technical and financial assistance on creating, protecting or restoring wetland or riparian areas.
Kansas Association for Conservation and Environmental Education	WET	Laura Downer 785-532-3322	

APPENDIX 2:
Great Plains Demographics

KEY

FACTOR	*COLOR*
1	
2	
3	

**Confounded Q sort not included on statistical analysis*

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
1	Female	41-60	College +	Landowner, Business Owner, Ecosystems Consultant	20-29	Rural	White
2	Male	61-older	Some high school, Trade/technical/vocational training	Landowner	More than 40 years	Rural	White
3	Male	61-older	College	Government official, Landowner, Ecosystems Consultant	10-19	Rural	White
4	Female	41-60	College +	Landowner, Utilities Employee, Public Official	10-19	Urban	White
5	Male	41-60	College	Government Official	20-29	Urban	White

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
6	Female	41-60	Some college	Landowner, Government Official	All my life	Rural	White
7	Female	20-40	College +	Government Official	10-19	Suburban	White
8	Male	61-older	College +	Business Owner, Landowner, Ecosystems Consultant	20-29	Rural	White
9	Male	20-40	College	Government official	All my life	Rural	White
10	Male	41-60	College	Ecosystems consultant	10--19	Rural	White

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
11	Male	41-60	College	Landowner	All my life	Rural	White
12	Male	61-older	College	Utilities employee	All my life	Urban	White
13	Female	41-60	College +	Government official	20-29	Urban	White
14	Male	41-60	College +	Government official	10--19	Suburban	White
15*	Female	41-60	College	Government official	years	Urban	White

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
16	Female	41-60	Some college	Business owner, Landowner	20-29	Rural	White
17	Male	41-60	College +	Public official	20-29	Suburban	White
18	Male	20-40	College +	Government official	Less than 9 years	Urban	White
19	Male	61older	College +	Ecosystems consultant	20-29	Urban	White

Table 18. Great Plains Watershed Study Demographics

APPENDIX 3:
Andean Watershed Demographics

KEY

FACTOR	*COLOR*
1	
2	
3	

**Confounded Q sort not included on statistical analysis*

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
1	Male	41-60	University	Governmental Employee	<9	Urban	None of the above
2*	Female	41-60	University	Environmental Institution	<9	Urban	None of the above
3	Female	20-40	University, Masters	Environmental Institution, Self employed, Contractor	<9	Urban	None of the above
4	Male	41-60	University	Public Services Institution	20-29	Urban	None of the above
5	Female	20-40	University	Public Services Employee	<9	Urban	None of the above

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
6*	Male	20-40	University	Non Governmental Organization	<9	Urban	None of the above
7	Male	41-60	University	Public Services Employee	<9	Urban	Black, Mulatto, Afro-Colombian or Afro-descendent
8	Female	20-40	Masters	Private Business	<9	Urban	None of the above
9*	Female	>61	University	Government official	20-29	Urban	None of the above
10*	Female	41-60	University	Government official	10--19	Urban	None of the above

Participant	Gender	Age	Highest Level of School	Title/Profession	Years in Current Residency	Area of Residency	Ethnicity origin (or Race)
11*	Male	20-40	University	Governmental Employee	20-29	Urban	None of the above
12	Male	41-60	Masters	Governmental Employee	>40	Urban	None of the above

FACTOR	*COLOR*
1	
2	
3	

**Non-significant Q sort not included on statistical analysis*

Table 19. Andean Watershed Study Demographics

APPENDIX 4:
Q Set Statements

GREAT PLAINS WATERSHED

1. Training and awareness: excess runoff
2. Assessment and/or inventory: soil types
3. Gradient terraces
4. Assessment and/or inventory: natural resources
5. Assessment and/or inventory: land use
6. Erosion control: urban
7. Assessment and/or inventory: cropland
8. Wetlands
9. Native grasses and plants
10. Assessment and/or inventory: ephemeral gullies
11. Assessment and/or inventory: stream reaches w/o grass buffer
12. Rain gauges
13. Assessment and/or inventory: animal feeding operations
14. Ephemeral gullies
15. Prescribed burns
16. Training and awareness: TMDLS
17. Tile outlet terraces
18. Water and sediment basins
19. No till farming
20. Cover crops
21. Riparian areas/buffer zones/grass filter strips
22. Grass waterways
23. Livestock management
24. Revetments

ANDEAN WATERSHED

Q SET STATEMENTS	TRANSLATION OF Q SET STATEMENTS BY AUTHOR
1 La utilizacion y planificacion del suelo en la ciudad	1 Land utilization and planning in the city
2 La priorizacion del arreglo de la planta de tratamiento que no estaba funcionando	2 Prioritization to fix the treatment plant that was not working
3 La eficiencia en las labores de los organismos de socorro	3 The efficiency in the work of relief agencies
4 La disponibilidad de refugios en la ciudad en caso de desastre o calamidad	4 Availability of shelters in the city in case of disaster or calamity
5 Atribucion de castigo divino a la emergencia que se presento en la ciudad	5 Attribution of divine punishment to the emergency that happened in the city
6 La emergencia sanitaria	6 The health emergency
7 La creacion de falsas expectativas en la poblacion de la ciudad	7 Creating false expectations among the population of the city
8 El desacato de las instrucciones que las autoridades dieron a los residentes que deberian desalojar sus propiedades	8 The resident's disregard about the instructions that the authorities gave them about leaving their properties
9 La comunicacion de las alertas por parte de las autoridades a la comunidad	9 The warnings provided by the authorities to the community
10 La eficiencia de las autoridades para abordar las advertencias tecnicas de años previos	10 The efficiency of the authorities to address the technical warnings of previous years
11 La eleccion popular de determinadas personas para ocupar cargos públicos	11 The popular election of certain people to hold public office
12 La camaraderia entre el gerente de Aguas de Manizales y el alcalde de la ciudad	12 The camaraderie between the manager of Aguas de Manizales and the Manizales mayor
13 Que solo una de las dos plantas de tratamiento de agua estaba en funcionamiento cuando el derrumbe sucedio	13 That only one of two water treatment plants was operational when the landslide happened
14 La atencion y rigurosidad por parte de las autoridades respecto a la preocupacion de la comunidad	14 The attention and thoroughness by the authorities regarding the concern of the community
15 La carretera que se encuentra encima de la tuberia	15 The road above the water line in the neighborhood

	de agua en el barrio Cervantes	of Cervantes
16	Las condiciones de la tuberia que se rompio	16 The conditions of the pipe that broke
17	El papel que las Guardianas de la Ladera ejercio durante la eventualidad	17 The role of the Guardians of the Slope during the event
18	La inclinacion de la pendiente donde se ubica el barrio Cervantes	18 The inclination of the slope where the neighborhood of Cervantes is located
19	Las labores de mantenimiento de las redes de agua en la ciudad	19 The maintenance of water distribution networks in the city
20	La recursividad de la empresa Aguas de Manizales para continuar prestando el servicio	20 Resourcefulness that the company Waters of Manizales used to continue providing the service
21	Preparacion de la ciudad para hacer frente a deslizamientos de tierra tipicos de la temporada de lluvias	21 The preparation of the city to deal with landslides typical of the rainy season
22	La ubicacion de la planta de tratamiento de agua afectada	22 The location of the affected water treatment plant
23	La utilizacion del suelo en el barrio Cervantes	23 The land use in the neighborhood Cervantes
24	La ubicacion del barrio Cervantes en la ciudad de Manizales	24 The location of the Cervantes neighborhood in the city of Manizales
25	La intensidad de las lluvias de invierno	25 The intensity of the winter rains
26	La cantidad de tiempo que llovio	26 The amount of time it rained
27	La saturacion del suelo al absorber la enorme cantidad de agua lluvia en distintos lugares de la ciudad	27 The saturation of the soil when it absorbed the large amount of rain in different places of the city
28	El tipo de suelo de los lugares donde ocurrieron derrumbes	28 The soil type of the places where landslides occurred

APPENDIX 5:
Q Sort Questions

GREAT PLAINS WATERSHED

Does the practice presented in the cards help or not help riverbank stability?

ANDEAN WATERSHED

To what extent do you think the following factors contributed to the magnitude and aftereffects of Manizales Without Water 2011?

En qué medida cree usted que los siguientes factores contribuyeron a la magnitud y efectos posteriores de Manizales Sin Agua 2011?

APPENDIX 6:
List of Acronyms

AAUs	Urban Environmental Authorities (Autoridades Ambientales Urbanas)
BMPs	Best Management Practices
CARs	Autonomous Regional Corporations (Corporaciónes Autónomas Regionales)
CBNRM	Community-based Natural Resource Management
CHEC	Hydroelectric Power Station of Caldas (Central Hidroeléctrica de Caldas)
CORPOCALDAS	Corporación Autonoma Regional de Caldas
CRP	Conservation Reserve Program
CWA	Clean Water Act
EPA	Environmental Protection Agency
ESPs	Public Services Companies or utility companies (Empresas de Servicios Públicos)
IDEAM	Institute of Hydrology, Environmental Meteorology and Studies (Instituto de Hidrología, Meteorología y Estudios Ambientales)
IDH	Index of Human Development (Índice de Desarrollo Humano)
ILC	Industry of Liquors of Caldas (Industria Licorera de Caldas)
IWRM	Integrated Water Resource Management
MAVDT	Ministry of Environment, Housing and Regional Development (Ministerio de Ambiente, Vivienda y Desarrollo Territorial)
NGO	Non-Governmental Organization

NRCS	Natural Resources Conservation Service
OMPAD	Municipal Office of Disaster Prevention and Care (Oficina Municipal para la Prevención y Atención de Desastres)
PES	Payment for Environmental Services
PORH	Plan for the Administration of Water Resources (Plan de Ordenamiento del Recurso Hídrico)
POMCAs	Watershed Administration and Management Plans (Planes de Ordenación y Manejos de Cuencas Hidrográficas)
POT	Land-use Plan (Plan de Ordenamiento Territorial)
SLT	Stakeholder Leadership Team
TMDL	Total Maximum Daily Load
UWWRAPS	Upper Wakarusa Watershed Restoration and Protection Strategy

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