

Rural Community Perspectives on Preparedness and Adaptation to Climate-Change and Demographic Pressure

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Abstract: This study investigates local-scale adaptation and long-run capacity building in acequia communities in Northern New Mexico, where there is a long record of resilience and adaptive capacity spanning more than four centuries. These communities may be particularly vulnerable to current stresses from population growth, changing community composition, and projections of water scarcity that are expected to accompany long-run climatic changes. This paper uses a survey approach to explore factors and community characteristics that contribute to community adaptation, the level and extent of community preparedness, and the preferred community actions to cope with stresses and disturbances. Key findings suggest that land ownership and acequias' attachment to water and community have helped these communities cope with environmental and community-based stresses. Results showed divided opinions regarding the degree of "perceived preparedness" and "perceived vulnerability" to disturbances such as population change and growth, aggressive regional development, economic hardships, and droughts.

Keywords: *Adaptation, climate change, acequia, and community irrigation*

Sin agua, la tierra no vale nada
 ("Without water, the land has no value")
 –Anonymous, New Mexico Proverb

New Mexico echoes with the sentiment of this traditional proverb. Water availability often defines and conditions patterns of settlement and economic development. Reservoirs and aquifers, however, have seemingly raised the capacity of these arid environs to attract and support continuously growing populations. Can these trends continue in the face of climatic changes, alterations in streamflow patterns and the hydrographs that will likely result? New Mexico's unique blend of cultures and landscapes, agrarian values and high-tech economies, rare ecosystems, fertile valleys, and expansive desert rangelands is experiencing stress from natural variability and changing environments, and from competition for resources from growing human populations.

With some of North America's oldest known settlements, New Mexico is a place where people have long settled and where growing numbers still long to settle. Migration trends illustrate and highlight growing communities that are praised for their quality of life, climate, and retirement opportunities. What implications lay in wait for various water users and economic interests who have come to rely not only on prevailing stream flows but on the continuing availability and performance of reservoirs and aquifers, particularly if drier and more frequent drought conditions emerge, as our studies tend to suggest?

For centuries peoples of arid- and semi-arid regions have built and sustained community-centered, small-ditch, irrigation systems to provide for both water and food security. These systems often become the basis for forming community identity and social organization. They develop beliefs and rituals that help to bind community

through shared responsibility and commitment, secure economic livelihood in the face of variability and uncertainty, and enhance food and water security.

New Mexico is home to approximately 800 such community-centered irrigation systems many of which were founded by the Spanish in the 17th Century. Their communal traditions towards water and other resources reflect inherited institutions and relationships brought from Spain. These were derived from the influences of Arab, Muslim, and Roman water cultures. As with many Spanish words, the word *acequia* comes from the Arabic term “*saqiya*” which has its root from “*saqa*” meaning “to irrigate.” It refers to both the gravity-based system of diverting and delivering water to fields, as well as to the organizational structure of community-based water management.

One of the distinctive and enduring characteristics of these communities is a communal orientation toward the sharing of water, or *repartimiento*. In contrast to the more individualistic notions of private property which came with English traditions and common law notions of ownership, Spanish and Arab traditions draw from the belief in the “right of thirst” (or more appropriately, the right to quench your thirst and that of your animals). The inherent water-scarce nature of arid and semi-arid lands led to beliefs concerning social organization and efforts to develop needed communal infrastructure to deliver and store water. These communities are the product of centuries of social organization, reflected in defined rules, self-government activities, and community participation (Rivera 1996, 1998; Cox 2010; Klein-Robbenhaar 1996). Rodríguez (2006, 116) describes them as “a moral system, a way of life, a social and cultural identity, and an attachment to place.” According to Rodríguez, water is the element that joins the *acequia* community; water creates disagreements and water solves them.

Acequia systems and communities not only provide social linkages and cultural ties to the past and the present, but the waters flowing through them continue to underwrite local economic activities, primarily agriculture which supplements income and provides employment. In addition, some waters flowing through these systems – principally from agricultural return flows and seepage from

unlined ditches and diversions – nourish riparian environments and wildlife habitat, and replenish subsurface flows that feed both natural springs and sustain late season stream flows (Fernald et al. 2007, 2010). The value and economic benefit flowing from these systems and through the various market and difficult-to-measure non-market products and services they provide is of growing interest and concern particularly in arid- and semi-arid regions where competition for water is steadily rising.

Many new challenges confront many if not all of these communities, not only in New Mexico, but throughout much of the semi-arid world where local agricultural traditions and economies are under stress. Stresses include (1) growing and changing local populations, (2) needs and desires for relief from current economic hardship, (3) internal and external pressure for increased economic development, (4) threats of diminished water deliveries from upstream users, and (5) threats from downstream users to deliver more water. As communities grapple with some or all of these pressures, their awareness of water resources grows. Changing climate could also increase the frequency, intensity, and duration of weather anomalies including droughts and floods, not only altering existing patterns of water supply and demand, but exacerbating many of the internal and external stresses listed above.

This paper explores some of the factors and issues related to community preparedness, adaptation and perceived needs. It reports the findings from a survey of *acequia* *parciantes* (irrigators) regarding their views and experiences. Specific aims are to: (1) Assess community perceptions of current preparedness and adaptation capacity; (2) Identify key factors that influence the *acequia* communities’ capacity to adapt to changes in climate, population, and community change; and (3) Identify actions and activities that can support and enhance *acequia* community preparedness and resilience.

The next section describes the context and study area in Northern New Mexico. It then discusses some of the important stresses confronting these communities. The paper then describes the survey design and approach, followed by some of the key findings from initial data analyses. Finally, the paper concludes with some insights, implications and a discussion of some possible next steps.

Acequia Community Study Area

Acequias are defined both by their territorial extent and by their community-based organization. Acequias are regarded as among the oldest water institutions in the United States. In addition to the ditch itself (the acequia madre), they generally consist of a chief administrator (the mayordomo) who supervises water distribution and an acequia commission that oversees the administration and serves as the legal body for enforcing the by-laws and adjudicating disputes (Rivera 1998; Peña 2005).

Water allocation and use within the acequia is based on common property principles that are aimed at ensuring equitable and fair water allocations while trying to reinforce shared community responsibility and participation. Peña (2005) explains five basic principles that generally underlie acequia customs. First, the communitarian value of water recognizes the close association between water, land, and the community, and the mutual nature of water and its shared benefits and costs. Second, acequia waters are an asset in place. This is the principle that ties the right to use water to the acequia community, or appurtenant to the acequia lands. Water and water rights, except through mutual water-sharing agreements, are for use within the community and are not considered as tradable outside of the acequia. The water is “not for sale.” This view is upheld by the New Mexico State Engineer as consistent with the State’s provisions against water trades that are contrary to the public welfare. The third principle emerges from the right of thirst. In Islam, this is the universal right of humankind to quench their thirst and thirst of their animals. The fourth principle is water sharing. Community waters are equitably distributed among parciantes during water shortages. The fifth principle is cooperative labor and mutual aid where the responsibility for maintenance is shared across each parciante. For example, members contribute to ditch cleaning activities.

The study area included the acequia communities of Alcalde-Velarde, El Rito and Rio Hondo as shown in Figure 1. They are selected to reflect a range of traditional activities including farming and ranching. These communities highlight both upland and lowland systems along the Rio Grande,

important distinctions for other aspects of the broader research project.

Alfalfa and irrigated pasture have the greatest productive extent. Each supports livestock production and supplements public land grazing (Eastman et al. 1997). In addition, there are a number of other important crops, including native varieties of maize, beans, squash and chiles. Though not all are included in acequia communities, the 2007 Census of Agriculture indicates that there are 1,312 farms in Rio Arriba County, of which 84.6 percent are irrigated farms. There are 637 farms in Taos County, of which 84.6 percent are irrigated farms.

Agents of Change: Population, Demography, and Climate Change

Concerns for New Mexico’s water situation stem not only from its semi-arid climate, high climate variability and dependence on upstream

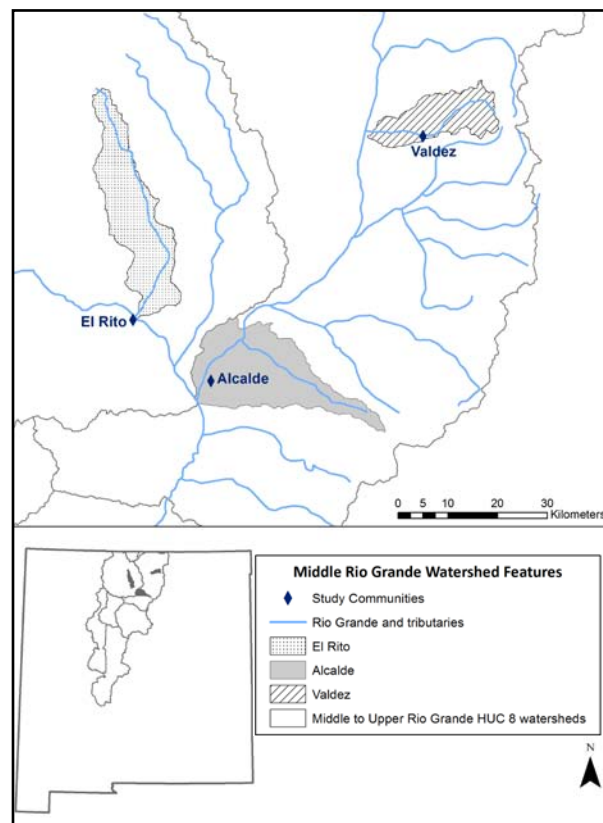


Figure 1. Study Area: Three Selected Acequia Communities along New Mexico’s Rio Grande Watershed.

sources of water, but from its rising population and economic growth. These bring greater competition for available water. For example, population growth in New Mexico cities (and throughout the cities of the southwestern U.S.) has been significant. Studies suggest that this growth amplifies the exposure and vulnerability of these communities to climate risks including severe droughts and flash floods (Hurd et al. 1999, 2006).

Population Growth

There is a clear need to balance water availability among users. Due to their proximity to larger and economically diverse cities and towns, acequia communities are attracting growth and change. If the climate conditions were relatively stable, the increase in population by itself would create water deficits (Agency Technical Work Group State of New Mexico 2005; D'Antonio 2006). During the last six decades, the population in Rio Arriba County increased 61 percent and the population in Taos County increased 92 percent (see Figure 2). The most significant population change occurred in the decades 1990 and 2000.

Population increases not only bring an increase in water demand, but also a change in population

characteristics. Rio Arriba and Taos economies are no longer largely agricultural based. In 2006, Rio Arriba County statistics show that 50 percent of the county's employed population worked in the service sector, mostly in education, health, transportation, and utilities; 32 percent of the county's employed population was in local government; and only one percent of the county's employed population worked in the agriculture, forestry, fishing, and hunting service (Economic Profile System 2009a). The 2006 Taos County statistics show that 66 percent of the employed population worked in the service sector mainly in leisure, hospitality, education, health, trade, transportation, and utilities; 14 percent of the county's employed population worked in local government, and zero percent of the county's employed population was reported for the agricultural, forestry, fishing, or hunting sector (Economic Profile System 2009b). Gentrification is observed throughout this region as an attractive landscape and quality of life bring in higher income residents. For example, Rodríguez (2006) describes that from 1990 to 1999 13,000 people moved to Taos County and 11,000 people moved out. The majority of out-migrants were younger, Hispanic, and moderately

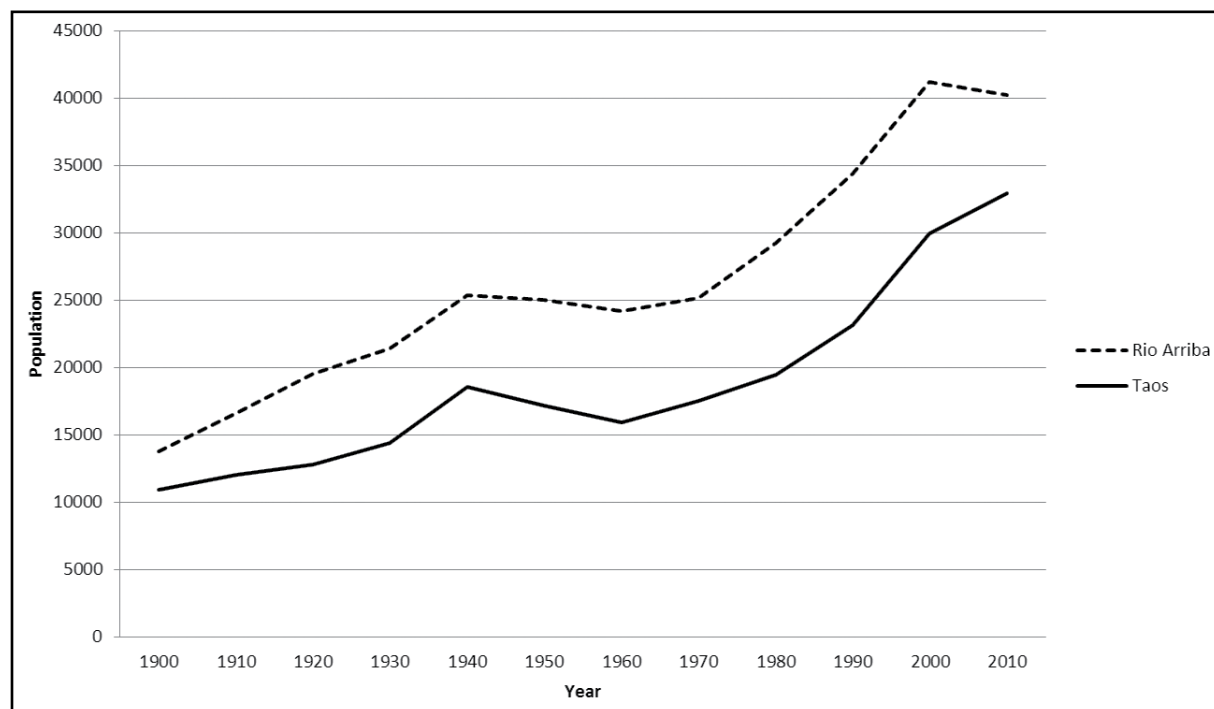


Figure 2. Population Growth Trends of Two New Mexican Counties within the Rio Grande Watershed.

poor people, and the majority of in-migrants were older, Anglo, and wealthy people looking for “lifestyle amenities.” Some acequia communities perceive the in-migrants as an element that alters local relationships because in-migrants do not necessarily understand and share the native acequia residents’ attachment to water and land.

New Mexico and Climate Change

In New Mexico water is a crucial resource; several regions of the state already face water challenges while trying to meet growing population needs (Agency Technical Group State of New Mexico 2005). Researchers have documented that the pressure on water resources could be aggravated significantly by climate change (Agency Technical Group State of New Mexico 2005; Gutzler 2007; Hurd and Coonrod 2007). The Agency Technical Group State of New Mexico (2005) reports that projections of New Mexico average air temperature could increase by 6 to 12 °F; more episodes of extreme heat and fewer episodes of extreme cold could result; and a longer frost-free period could be expected.

Gutzler (2007) shows that the temperature in New Mexico since 1960 has increased by nearly 2°F in the cold season and around 3°F in the warm season – double the annual global average trend of 1.5 °F. Precipitation patterns and trends are much more uncertain, although it is possible that there will be more extreme events such as torrential rain, severe droughts and multi-year droughts. D’Antonio (2006) discusses that from the existing scenarios the most expected patterns of climate change in New Mexico are warmer conditions and

an irregular change in total precipitation. Table 1 illustrates some of the climate change effects projected for New Mexico.

Adaptation and Adaptive Capacity

Adaptive capacity in a system is the ability to create, develop, and execute adaptive strategies to reduce the impact of disturbances (Brooks and Adger 2005). Scholars who study adaptation agree that adaptive capacity can be formed and strengthened by (1) investing in information and knowledge, (2) promoting proper institutions that enhance change and learning processes, and (3) increasing the degree of access to resources such as education and income (Lemos et al. 2007). In addition, significant components of adaptive capacity include enhancing individual, community, and society involvement, and community decision-making (especially with regard to vulnerability and adaptation), then identifying and developing pathways that change mal-adaptive behaviors (Jones et al. 2010).

Learning about the acequia’s adaptation capacity will help identify strategies to encourage communities to benefit from potential opportunities and to reduce potential hazards. In addition, it could be a step to promote the participation of all the stakeholders while incorporating flexible plans to cope with climate change or population growth. Adaptation is defined by Brooks (2003, 8) as “the adjustment in a system’s behavior and characteristics that enhance its ability to cope with external stresses.” It is also defined as an “adjustment in natural or human systems in response to actual or expected climatic stimuli or

Table 1. Selected Projections of Climate Change for New Mexico. Source: New Mexico Office of the State Engineer/Interstate Stream Commission, 2006.

	1971-2000	2001-2030 (change)	2031-2060 (change)	2061-2090 (change)
Temperature (°C)				
October-September	12.2	13.1 (+0.9)	14.3 (+2.1)	15.5 (+3.3)
December-February	0.6	1.4 (+0.8)	2.3 (+1.7)	3.4 (+2.8)
June-August	24.1	25.2 (+1.1)	25.2 (+1.1)	27.8 (+3.7)
Precipitation (mm)				
October-September	601.0	590.0 (-11.0)	590.0 (-11.0)	571.7 (-29.3)
December-February	127.9	127.9 (-0.9)	155.8 (-2.1)	122.5 (-5.5)
June-August	191.4	189.6 (-1.8)	195.5(+4.1)	193.0 (+1.6)

their effects, which moderates harm or exploits beneficial opportunities” (Levina and Tirpak 2006).

The State of New Mexico has taken a proactive position to reduce the potential impacts of climate change on water resources. The state recognizes that proactive adaptation strategies should be flexible under an ample range of climate conditions, be economically justifiable, and encourage the development of adaptive capacity (D’Antonio 2006). However, adaptation strategies should come not only from government initiatives, but from the local context. Compared to more centralized government institutions, rural or small communities are historically more familiar with change and often have developed more effective strategies and adaptation practices (IPCC 2007). The local level is where most adaptation actions take place (as cited in Jones et al. 2010). In addition, Agrawal and Perrin (2008) suggest it is more successful to focus on improvements in adaptive capacity than on how rural populations will be affected by climate change. For the authors, it is valuable to investigate how those populations have confronted climate hazards historically and culturally, and which local institutions have assisted individual or collective adaptation.

Jones et al. (2010) recognize that traditional indicators analyze adaptation characteristics at the national level (e.g., economic wealth or infrastructure). However, little research has been done to understand the adaptation characteristics at community or household levels. The challenge of an analysis at the local level is to include and explore aspects such as decision-making, governance, encouragement of innovation, opportunity exploitation, structural institutions and entitlements that underlie the drivers of adaptation capacity and vulnerability (Jones et al. 2010). A survey was conducted to explore and understand the factors and community characteristics that contribute to the acequia’s adaptation capacity and community preparedness at the local level. The following section discusses the survey methodology and then summarizes the main results.

Acequia Community Perspectives

Here we report on findings from a survey of acequia members conducted in the late summer months of 2011. One of the central challenges in conducting a survey in these communities was

developing a sampling plan and ensuring a sufficient response rate. Although the survey instrument was initially designed for administration through standard mail survey protocols, based on pre-testing and prior experience, the importance of a direct, person-to-person approach was determined to be essential for successful participation and an adequate response rate. Further complicating the process was a need for the interviewer to be welcomed into the community. This is particularly true when “outsiders” are often viewed with suspicion, and there is a reluctance to respond to questions, especially those concerning water. To overcome these obstacles, a non-standard approach was identified and deemed the most promising method of gaining access, trust, and useable responses.

This alternative, termed the “snowball” approach, was selected to enhance the response rate and interviewer acceptance into close-knit acequia communities. The snowball method is a non-probabilistic method founded on the principle that members of a special or uncommon population are familiar with other members in that population (Penrod et al. 2003). It consists of finding and contacting an initial person conducting the survey interview, and then asking him or her to help identify and make the introduction to other persons with similar characteristics or from the same subgroup of the population. In the case of this study, the total acequia population is unknown and some possible limitations exist, such as exclusion of smaller subgroups of the acequia population. Consequently, the sample cannot be assumed to conform to the standard statistical population. However, with as much data and insights drawn from similarly selected samples (e.g., focus groups), we believe the potential for bias is minimal given the general nature of the survey and the lack of an identifiable agenda.

In total, 149 surveys were distributed in the three regions. Of those surveys, 119 were delivered in person and 30 were mailed, covering the acequia communities of Alcalde, Arroyo Hondo, Arroyo Seco, El Rito, Valdez, and Velarde. Of the 50 survey responses returned, 48 were conducted in-person and 2 by mail. After adjusting for undeliverable addresses, the response rate was 33.6 percent.

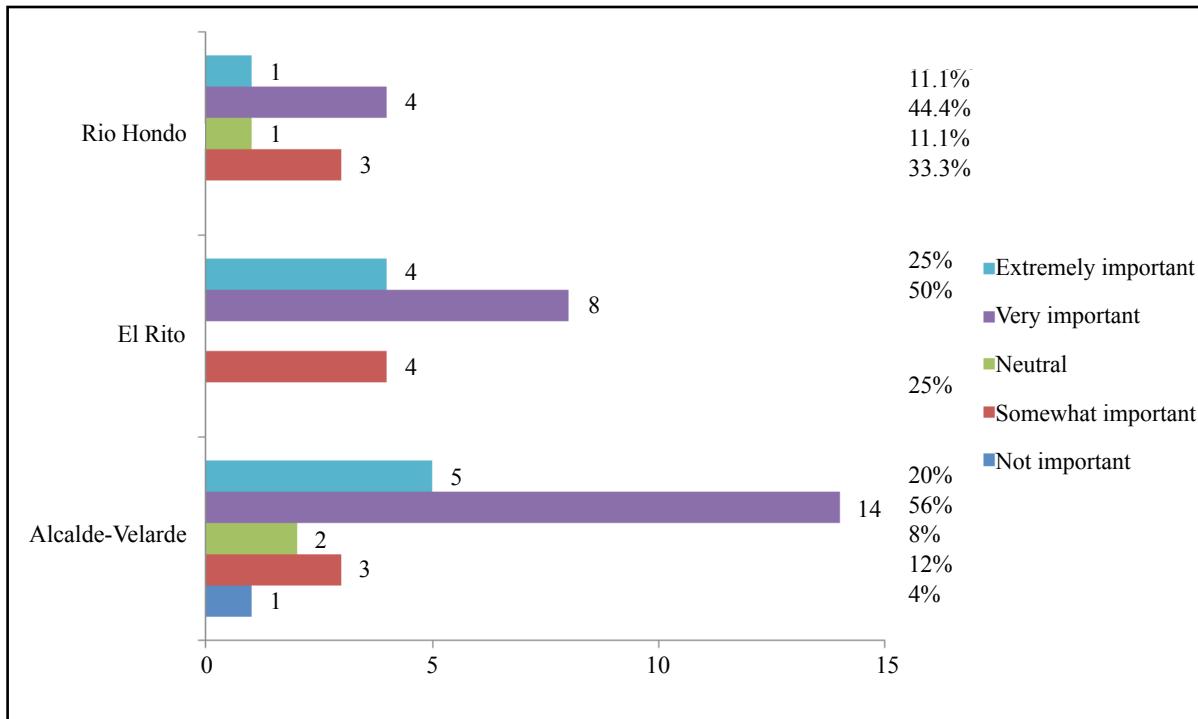


Figure 3. Perceived Importance of Acequias to the Local and Regional Economy.

Perceptions and Lifestyles in Acequias

Longevity and family connectivity to the area appears strong in spite of recent demographic changes by the influx of new residents. Of the total parciantes that answered about their family’s history, 66 percent said their family has lived in their acequia, or nearby acequia communities, for more than four generations, whereas 16 percent responded stated that they do not have a previous generation living in the acequia community.

The perceived importance of the acequia’s various roles and functions showed relative strength and little variation between communities. Eighty-four percent of the respondents indicate that maintenance of the ditches and infrastructure is very important. Eighty-one percent indicated that it is important to protect the community waters from outside influences and diversions. Seventy-five percent indicated that the acequia is important for building community spirit and cooperation. In addition, 75 percent responded that the acequia is important because it is the foundation for many of the community traditions and customs. Finally, 77 percent indicated that the acequia is important for maintaining an independent and self-governing organization.

In addition to the institutional function of the acequia, the economic function is also important and regionally significant. Agriculture generates incomes and employment throughout the region and has a significant role in the local economy, as indicated by 72 percent of the respondents (Figure 3). On average, acequia agricultural activities contributed about 27 percent to total family income, including income from sales, bartering, and self-consumption of the acequia products (Figure 4). Even though a significant number of the acequia’s population has non-farm employment, Ortiz et al. (2007) clarifies that off-farm employment does not diminish the parciantes’ attachment to land and sense of place.

Identification of Key Factors that Influenced the Acequia’s Capacity to Adapt

Many acequia communities have endured through four centuries, a longevity that has included many periods of adversity and hardship. Are there lessons to be drawn from such longevity, for example, within the type and role of institutions and social arrangements concerning access and control to natural resources such as water, grazing, and forests? To identify the factors that

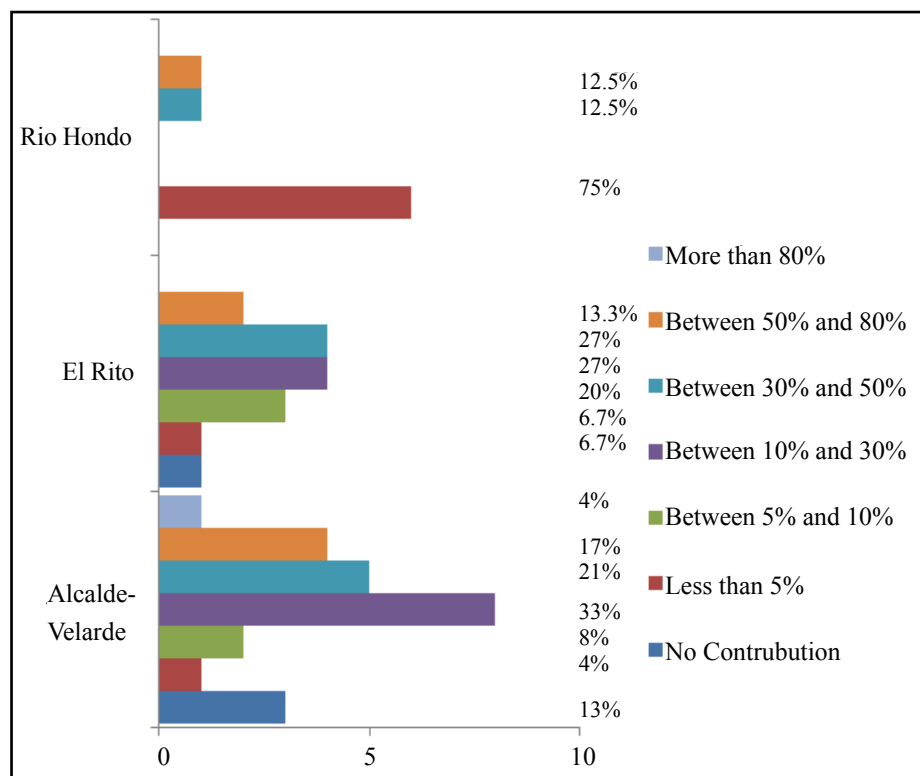


Figure 4. Perceived economic contribution of acequia-related activities to family income.

influenced the acequia communities' capacity to adapt, the *parciantes* were asked to identify which characteristics they believed helped them to adjust to economic downturns, population growth, increasing development, and droughts.

Responses generally indicated that land ownership was a principal characteristic that had helped address these challenges. As shown in Figure 5, 79 percent of Alcalde-Velarde respondents indicated the importance of land ownership, followed by family connection to the land, water, and community. All the possible options were preferred by more than 50 percent of the respondents.

Community Perception of Preparedness, Vulnerability, and Adaptation

Parciantes were asked about their level of perceived preparedness and vulnerability to external stresses. Across all three communities, there appears to be a balance between those who feel at least somewhat prepared and those who perceive at least some vulnerability. This balance of perceived preparedness and perceived

vulnerability is an interesting outcome, especially in view of the attention given to each of these stressors in the media. Although there is some variation across the three sub-sampled regions, which could indicate particular community situations, there remains a close balance in those seeing the glass as “half full” and those seeing it as “half empty.” Taking a slightly closer look, however, the two stressors perceived with the greatest vulnerability to families and communities are significant drought and economic downturn. Each stressor received more than 1 in 5 responses as very vulnerable (Table 2). With respect to population growth and change, it is interesting to note that no one indicated a belief that they were very vulnerable. The most common response for this stressor was neutral, indicated by 1 in 3, followed closely by somewhat vulnerable and somewhat prepared, respectively. This might be a promising finding at least in terms of the potential for successful integration of in-migrants in the long-run and an adaptation to changing community composition.

Usefulness of Selected Drought-Coping Strategies

One of the principle aims of the survey was to learn about possible climate-change coping strategies that acequia users might find desirable to use and deploy as conditions arise or in their anticipation. However, within the current media and political context, the terms “climate change” and to a lesser degree “climate variability” can introduce unnecessary and undesirable attitudinal responses among survey respondents. Instead our approach was to draw particular attention to one of the impacts of climate change and variability that is prominent within the regional projections, that of significant drought. We asked parciantes to assess and describe the potential for various selected drought-coping activities to positively or negatively affect their ability to effectively cope with drought and water shortage.

The drought-coping strategy with the greatest positive response was “improve soil to reduce evaporation,” with 78 percent of the respondents selecting this option. “Considering an alternative irrigation system” was the second most preferred practice with a positive impact, with 67 percent

of the respondents indicated that using this option may be helpful during water scarcity or drought periods. In addition, 56 percent of the respondents selected the “use of cold frames” as a possible positive change on practices to cope with water scarcity and droughts. Table 3 shows the potential for various changes in practices in order to adapt and to cope with droughts and water scarcity.

In a related question, parciantes were asked to indicate how well certain activities could contribute and strengthen their ability to withstand challenges such as economic hardships, population growth, development, and significant droughts. The aim of this question was to identify possible programs, policies, and investments that the community perceives could help strengthen adaptive capacity throughout the community and their families. More than 75 percent of the respondents indicated that at least one of the listed activities could help to strengthen the acequia capacity to withstand challenges. The activity most commonly identified as helpful was “increasing public awareness concerning the importance of acequia knowledge and traditions”; with an average of 2.65 (on a scale of 1=Not at all helpful and 3=Very helpful) (Table 4). This was

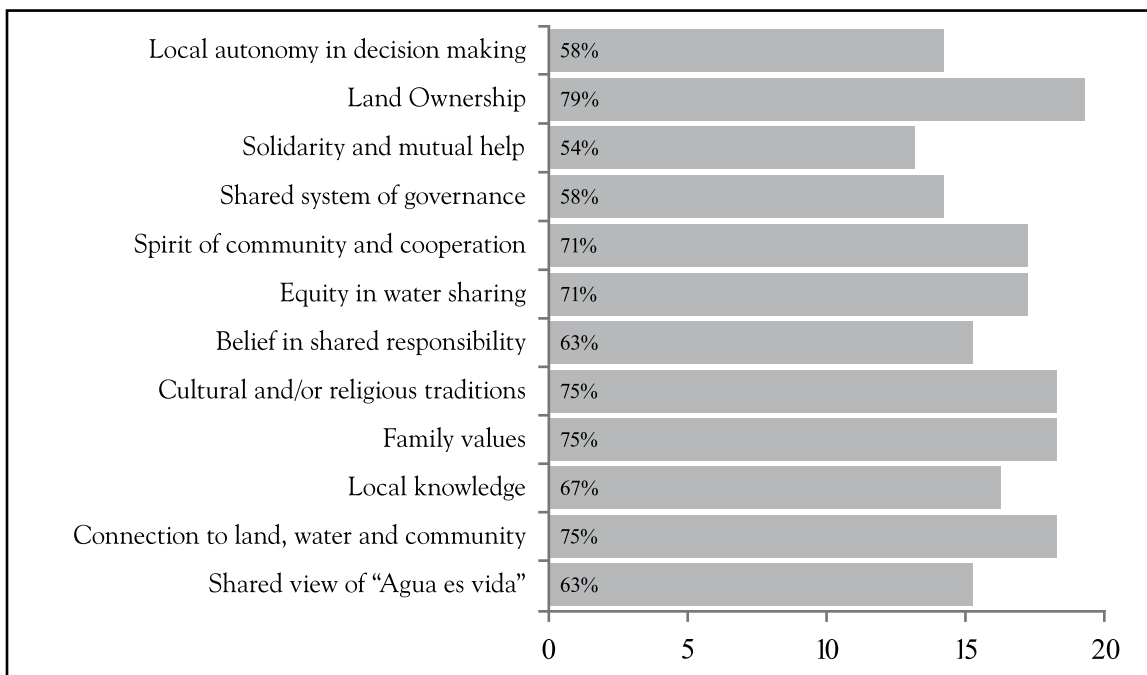


Figure 5. Acequia characteristics perceived to best contribute to acequia adaptive capacity, past adaptation, and resilience: Alcalde-Velarde region.

Table 2. Share of acequia respondents indicating perceived preparedness versus vulnerability to selected stressors and challenges.

	Acequia Regions			
	Alcalde-Velarde	El Rito	Rio Hondo	Overall
Significant Drought				
Very prepared	17%	7.1%	11.1%	13.0%
Somewhat prepared	21%	35.7%	55.6%	32.0%
Neutral	17%	7.1%	11.1%	13.0%
Somewhat vulnerable	29%	7.1%	22.2%	21.0%
Very vulnerable	17%	42.9%		21.0%
Regional and Local Economic Downturn				
Very prepared	21%		33.3%	17.0%
Somewhat prepared	25%	28.6%	44.4%	29.8%
Neutral	21%	14.3%	22.2%	19.1%
Somewhat vulnerable	25%	28.6%		21.3%
Very vulnerable	8%	28.6%		21.8%
Population Change and Growth				
Very prepared	8%	7.1%	11.1%	9.0%
Somewhat prepared	25%	21.4%	44.4%	28.0%
Neutral	29%	29.0%	44.4%	32.0%
Somewhat vulnerable	38%	42.9%		32.0%
Very vulnerable				
Regional Economic Development Pressure				
Very prepared	21%		12.5%	13.0%
Somewhat prepared	21%	53.8%	37.5%	33.0%
Neutral	13%	15.4%		11.0%
Somewhat vulnerable	38%	30.8%	37.5%	36.0%
Very vulnerable	8%		12.5%	7.0%

followed by “maintaining traditional knowledge and providing hands-on-training, education, and practical demonstrations”; with an average of 2.57 and 2.50, respectively. “Having access to data information such as climate impact or meteorological data”; “adopting alternative irrigation practices”; and “creating local insurances or relief funds” were the options with a lower average response with an average of 2.32. From these results we conclude that maintenance and strengthening of the internal mechanisms and institutions within the acequias is viewed as quite valuable and an important role for organizations

that support acequia communities (e.g., the NMSU Cooperative Extension and the New Mexico Acequia Association). Hands-on training and education also received considerable support; continued investment in these areas and activities is also recommended.

Insights, Implications, and Next Steps

There are many challenges to conducting research and to identifying effective approaches to crossing cultural barriers in these communities. This study is believed to be among the few,

Table 3. Assessment by acequia parciantes of the effects of possible drought-coping strategies.

Activity	Alcalde-Velarde	El Rito	Rio Hondo	Overall
Decrease planted area and fallow				
Not applicable	20.8%	28.6%	37.5%	26.1%
Positive	62.5%	35.7%	50.0%	52.2%
Neutral	12.5%	14.3%		10.9%
Negative	4.2%	21.4%	12.5%	10.9%
Switch some acres or parcels to dry land farming				
Not applicable	56.0%	35.7%	11.1%	41.7%
Positive	24.0%	35.7%	44.4%	31.3%
Neutral	12.0%	7.1%	44.4%	16.7%
Negative	8.0%	21.4%		10.4%
Plant higher yield cash crops on fewer acres				
Not applicable	36.0%	35.7%	12.5%	31.9%
Positive	52.0%	50.0%	37.5%	48.9%
Neutral	12.0%	14.3%	12.5%	12.8%
Negative			37.5%	6.4%
Plant native or heirloom crops on some acres				
Not applicable	32.0%	28.6%	12.5%	27.7%
Positive	56.0%	50.0%	50.0%	53.2%
Neutral	12.0%	14.3%	25.0%	14.9%
Negative		7.1%	12.5%	4.3%
Reduce livestock numbers				
Not applicable	52.0%	35.7%	25.0%	42.6%
Positive	32.0%	42.9%	50.0%	38.3%
Neutral	16.0%		25.0%	12.8%
Negative		21.4%		6.4%
Consider alternative irrigation technology				
Not applicable	16.7%	30.8%	11.1%	19.6%
Positive	62.5%	61.5%	100.0%	67.4%
Neutral	12.5%	7.7%		8.7%
Negative	8.3%			4.3%
Improve soil to reduce evaporation				
Not applicable	8.3%	30.8%		13.3%
Positive	83.3%	61.5%	87.5%	77.8%
Neutral	8.3%	7.7%		6.7%
Negative			12.5%	2.2%
Use cold frames to start seedlings or plants				
Not applicable	32.0%	54.0%	14.0%	36.0%
Positive	60.0%	31.0%	86.0%	56.0%
Neutral	8.0%	15.0%		9.0%
Negative				

Table 4. Perceived level of helpfulness of various possible coping activities and adaptation strategies to the challenges of climate change, economic hardship and population growth.

Activities to Withstand Challenges	Acequia Regions			
	Alcalde-Velarde	El Rito	Rio Hondo	Overall
Reported Mean Values Based on the following 3-Point Scale (1=Not at all helpful, 2=Somewhat Helpful, and 3=Very helpful)				
Having access to data information such as climate impacts or meteorological data	2.40	2.00	2.56	2.32
Maintaining traditional knowledge, such as water sharing	2.54	2.47	2.88	2.57
Increasing public awareness regarding the importance of the acequia knowledge and traditions	2.68	2.47	2.88	2.65
Providing acequia water users with hands-on training, education, and practical demonstrations including information on crop selection, irrigation scheduling and water-conservation techniques	2.56	2.35	2.56	2.50
Adopting alternative irrigation practices such as drip irrigation or sprinklers	2.44	2.00	2.50	2.32
Becoming familiar with legal aspects such as water laws in New Mexico	2.48	2.21	2.78	2.46
Encouraging the gathering of streamflow data	2.40	2.13	2.67	2.37
Developing small scale water storage facilities	2.44	2.21	2.76	2.44
Creating local insurances or relief funds	2.43	2.00	2.50	2.32

including Cox (2010), that have focused on efforts to explore and understand the factors and community characteristics that contribute to adaptation to disturbances driven by factors such as climate change and population growth. Further studies that analyze adaptation capacity at the local level are recommended. Rural communities are often key when attempting to better understand the linkages between society and land-based resources. The capacity for these communities to leverage local customs, institutions and knowledge with the potential of new techniques and methods could harness truly effective coping strategies and adaptation.

Our findings provide support for continued efforts to examine adaptation and adaptive

capacity building at local scales and within rural communities. Findings also provide preliminary support for activities aimed at community strengthening, and building cooperation within and between communities. In particular, we find support for maintaining and strengthening rural extension programs and activities aimed at integrating innovative and new techniques and methods within existing community cultural systems. Demonstration projects, hands-on workshops and individualized training are also supported by our findings. These are important conduits for communication, information dissemination, and eventual adoption by local resource users.

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