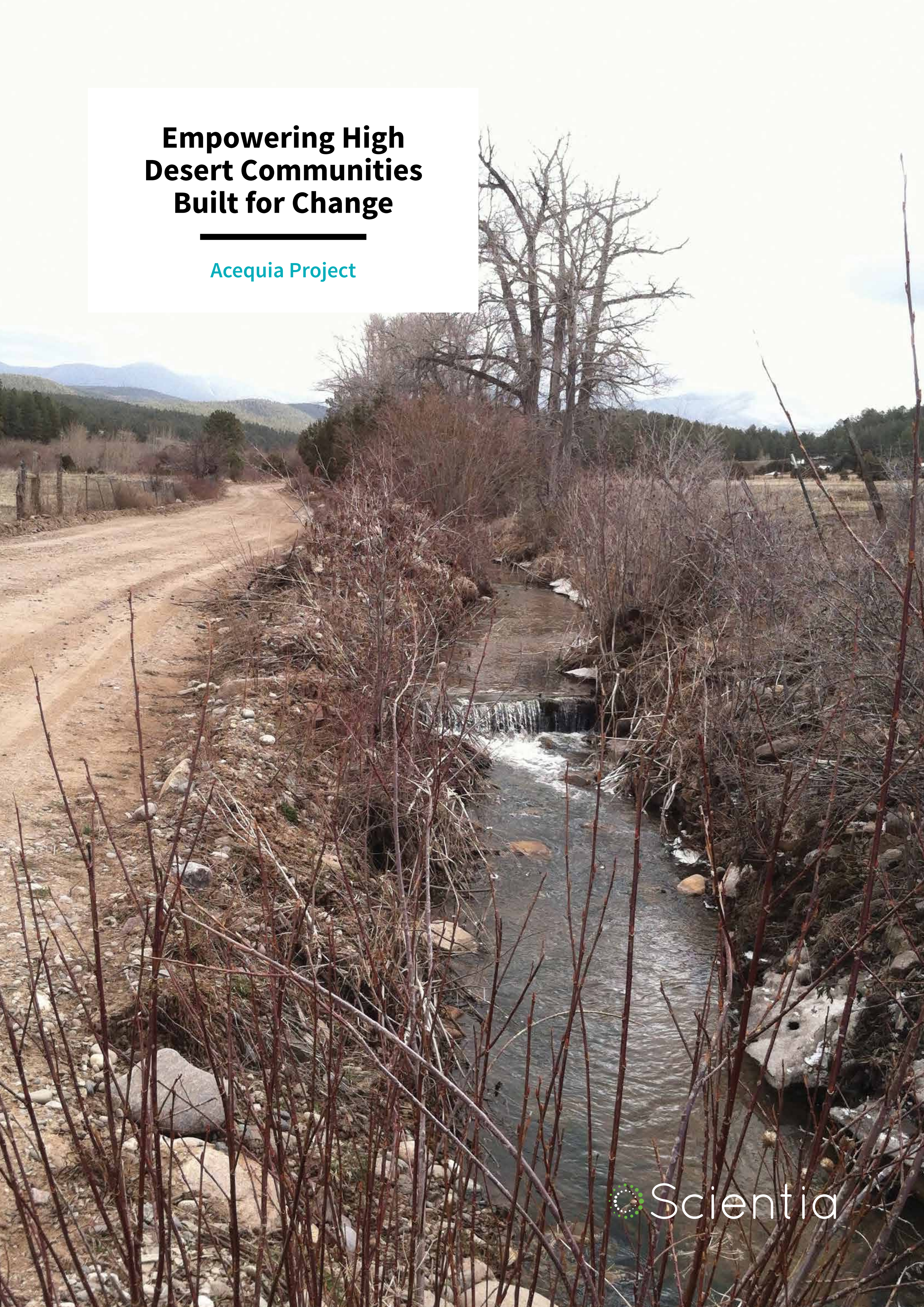
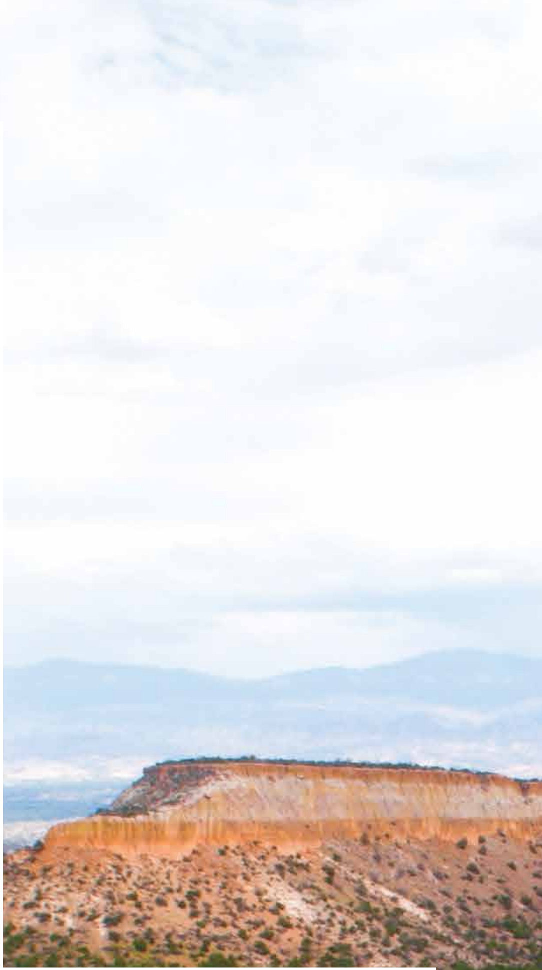
Empowering High Desert Communities Built for Change

Acequia Project



EMPOWERING HIGH DESERT COMMUNITIES BUILT FOR CHANGE

The acequia communities of the southwestern United States build on traditional practices and knowledge to sustain community-managed irrigation systems. Interdisciplinary researchers from New Mexico State University, the University of New Mexico, Sandia National Laboratories, and the New Mexico Institute of Mining and Technology worked closely with these communities to understand their resilience and adaptive capacity and to promote wellbeing in the face of emerging threats.



In the arid southwestern United States, communities center on a valuable resource: water. In the late 16th century, Spanish colonists transformed the desert landscape by installing a network of irrigation canals and ditches, known as acequias (pronounced *ah-say-key-uh*). These channels are typically unlined with water naturally fed to them by gravity from adjacent streams and rivers. Local communities, using traditional knowledge passed down through generations, manage the acequias together and collectively share the resources.

Typically, acequias are spread throughout the narrow alluvial floodplains adjacent to rivers and streams. When acequias thrive, so do other ecological and hydrological functions including an enhanced habitat to support multiple aquatic and terrestrial species typical of riparian areas. In that sense, acequia irrigation systems mimic seasonal streams and pools of water characteristic of natural floodplain systems.

Acequias provide communities and associated regions with valuable ecosystem services (benefits individuals and communities gain from well-functioning ecosystems). Such ecosystem services include diluting contaminants in the groundwater supply, including nitrates, and contributing to riparian habitat. However, changes to the region are imminent, and various threats to these historic landscapes have recently emerged.

Many threats that scientists have identified as menaces to other ecosystems around the globe are also shifting the resources available within acequia communities. Worldwide, shifts in land usage such as the urbanization occurring in some rural communities are threatening traditional agricultural systems. The acequia communities' land use is also changing from growing crops and fruit trees to constructing homes and commercial buildings. These changes threaten the sustainability of these traditional irrigation communities and some of the ecological and hydrological function benefits provided.

To address these concerns, a team of interdisciplinary researchers

from universities and national labs worked with the New Mexico Acequia Association and several acequia communities in the state's northern region. They employed complex mathematical models to understand and generate resilience within these long-standing communities.

Redefining Disciplines

The project, which was funded by a $1.4 million National Science Foundation grant beginning in 2010, aimed to understand how the socioeconomics, culture, hydrology and ecosystems associated with acequias are linked and to characterize their sensitivity to

possible 'tipping points' that may affect the survival of these systems in northern New Mexico.

The collaborative team included researchers from New Mexico State University, the University of New Mexico, Sandia National Laboratories and the New Mexico Institute of Mining and Technology, with diverse expertise across disciplines. The team collaborated extensively with local educators and acequia leaders, as well as Chilean researchers who were conducting a comparative study on similar community-managed irrigation systems in their region.

Using long-term historical datasets, future scenarios, surveys completed by local acequia community members and hydrology data collected by their team, the researchers aimed to understand the complex relationships that allow acequia systems to remain resilient in the face of change. In particular, they studied how acequias affect surface water and groundwater. They also analyzed how wildlife habitats and cattle grazing areas connect with local wetlands, forests and grasslands to maintain healthy ecosystems. Most importantly, they identified potential 'tipping points' using mathematical models that simulate the effects of different future scenarios. These insights can help the communities to remain resilient, as they have for centuries, under various pressures.

The team prioritized the dissemination of their research goals by reaching a broad audience of educators, policy makers and community members through hands-on involvement. The project actively recruited rural acequia community members and asked them to define resilience in their community and prioritize their needs.

Working with the University of New Mexico Maxwell Museum of Anthropology, the team also helped to create an exhibit entitled 'El Agua es Vida: Acequias in New Mexico' to educate the public on these communities. In addition, the researchers engaged with a scientific audience by hosting a Global Perspectives Workshop in 2013 on 'Acequias and the Future of Resilience in Global Perspective'. They have also published multiple scientific papers on this work and are currently working to publish a book summarizing their findings. Information has been made available to policy makers with the aim to guide policy toward decisions that help to maintain flourishing acequia communities.

A Water Savings Account

Acequias may help to counteract the negative effects of a changing climate on regional hydrology. One major effect of a warming planet in the southwestern United States appears to be less snowpack. This snowpack is also melting earlier in the year than before.

By measuring water balance components and using hydrologic models, the research team found that acequia irrigation systems can help recharge the shallow aquifer for temporary storage underground. This stored water is released into the river later in the year, helping to maintain stream flow for downstream users and to maintain environmental flows for stream and riparian species habitat. Seepage from acequia systems during the irrigation season also helps to improve groundwater quality by diluting nutrient concentrations from residential leaching.

Overall, it seems that acequia systems in northern New Mexico may help to save water in the Rio Grande Basin by reducing direct evaporative losses through storing water underground during the summer. This is in contrast to open water bodies such as reservoirs or lakes, which are known to lose large amounts of water to evaporation every year.

Traditions May Be the Solution

The close-knit, rural acequia communities of northern New Mexico are particularly vulnerable to stress from a growing population. As the population increases, the composition of the community shifts, economic hardship persists, and pressure to develop increases. In addition, projections for climate change in the region forecast water scarcity in an area where water is already a strained resource and an increase in the intensity and frequency of severe weather events, such as droughts and floods.

Team members adopted a unique method to understand how these acequia communities will adapt to change – using a 'snowball' approach to survey the local population. By working with local leaders, introductions were facilitated between interviewers and community members. This engendered a greater level of comfort and acceptance, allowing the team to survey a larger portion of the population and to elicit their underlying sentiments toward change. The researchers aimed to understand the community perception of current preparedness and the capacity to adapt to change. They also identified several steps that the community can take to enhance their preparedness and overall resilience.

Over 800 acequia communities exist in New Mexico, which are built upon the idea of 'repartimiento' – the sharing of water and the sharing of the responsibility for the management of this resource. As these communities grow with the influx of newcomers from other areas, their new neighbors do not necessarily share native acequia residents' attachment to water.

The team's survey was able to capture the communities' ideals and highlighted the respondents' prioritization in maintaining the ditch infrastructure, protecting the community waters from outside diversions, building community spirit of cooperation, and maintaining a self-governing organization. In addition, land ownership and family connections to the land, water and community were shared sentiments when asked which characteristics helped the participants to adjust to threats in the past. To combat drought, the communities identified soil improvement to reduce evaporation as a potentially promising strategy in the future.

There is also a growing sentiment that public awareness of acequia knowledge and traditions is essential to the survival of this community in the future. By providing hands-on training, education, and practical demonstrations of traditional knowledge, local communities may be able to protect the community waters in the face of change.

Farming for the Future

Using historical datasets of livestock numbers, drought and hay production, coupled with surveys of farmers and ranchers, the research team was able to understand how water allocation influences the economics of livestock in acequia agriculture. Many acequia farmers raise livestock and the majority of these farmers believe that livestock provide better financial security than crops. However, the researchers found that county hay production directly relates to yearly livestock numbers, which is highly dependent on water reserves. In particular, the ability to acquire winter hay appears to limit the size of herds and therefore the farmer's yearly profit.

To make matters more complicated, acequia communities historically grazed their livestock on common lands, until the

early 20th century, when their lands were placed under the jurisdiction of the United States Forest Service and Department of the Interior. This change in land policy fragmented the traditional land management connections of the entire upland-valley continuum.

Therefore, today many who still practice acequia farming must lease public grazing lands in the uplands and controversy over land tenure rights still persists. Livestock feed practices changed to rely more on irrigated hay that is now grown in the valleys. Even though the upland-valley connections were affected by changes in land usage and policy, the physical connections between the irrigated valley and contributing watershed still exist due to the role that acequias play in redistributing snowmelt runoff through the agricultural system. Data derived from this study was used in simulation models to test if these traditional farming practices are resilient to expected changes in climate and social factors.

Simulating Success

Using cutting-edge mathematical models, the research team was able to ask a question critical to the health of this community: what will happen in the future? The project aimed to understand whether acequias will be resilient with future changes and what they can do to promote a sustainable future. These mathematical models bring together four main disciplines in search of answers: hydrology, ecology, economics, and sociology.

The team found that when water supplies decrease, the community must rely on local knowledge of the water system, a deep-rooted ethic of water sharing and other forms of social capital, while also being willing to modify traditional water management practices. Among livestock producers, some were not able to stay in the sheep ranching business when labor became less available, wool and lamb prices dropped in the late 1950s and early 1960s, and sheep grazing permits were no longer issued. Many shifted to cattle and/or continued producing hay on their irrigated land for winter cattle feed or for sale.

By continuing to irrigate using traditional methods, water recharges the groundwater supply for use later in the year, supports biodiversity in local ecosystems, and ameliorates the effects of climate change by prolonging stream flow. The team used their models to evaluate the impact of the acequia community's social structure in governing its responses to water availability stresses posed by climate change. Although stream flows were found to decrease on average and shift to earlier in the season, adaptive measures of adjusting crop selection allowed for greater production of higher value crops and fewer people leaving the acequia. However, the team found that economic benefits were lost if downstream water pressures increased.

Even with significant reductions in agricultural profitability, feedbacks associated with community cohesion buffered the community's population and land parcel sizes from more detrimental impacts, indicating the community's resilience under natural and social stresses. Overall, the team's studies highlighted the importance of mutualism within the community as a key feature of resilience, and customary practices of sharing both the water resource and management responsibility, as the acequia community has done for generations.

The acequias project demonstrates the ability for a multi-disciplinary team to work together with local communities to prioritize future health in a changing climate. By detailing concrete solutions and actively working to disseminate research results to the community and policy makers, the team continues to educate stakeholders on the importance of acequia systems for future use.

Meet the researchers

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PROJECT WEBSITE

http://wcrg.nmsu.edu/cnhacequia/

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