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Preview of Award 1010516 - Annual Project Report

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Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1010516
Project Title:	CNH: Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land-Use Changes
PD/PI Name:	Alexander G Fernald, Principal Investigator Jose A Rivera, Co-Principal Investigator Vincent Tidwell, Co-Principal Investigator John L Wilson, Co-Principal Investigator
Recipient Organization:	New Mexico State University
Project/Grant Period:	09/15/2010 - 02/29/2016
Reporting Period:	09/01/2013 - 08/31/2014
Submitting Official (if other than PD\PI):	Alexander G Fernald Principal Investigator
Submission Date:	06/20/2014
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Alexander G Fernald

Accomplishments

*** What are the major goals of the project?**

The goals of this project are to understand acequia-moderated linkages between culture and nature and to quantify community survival tipping points. The objective is to quantify the role of acequias in hydrologic buffering, community resilience, and ecosystem health. The **central hypothesis** is that traditional acequias create and sustain intrinsic linkages between human and natural systems that increase community and ecosystem resilience to climatic and socioeconomic stresses. Two sets of linkages are explored: 1) socioeconomic and cultural acequia linkages within and between communities and uplands; and 2) hydrologic acequia linkages between surface water and groundwater in river valleys and contributing watersheds. The working null hypothesis is that stresses from climate change and population growth will have no appreciable effect on the function, performance resilience, and longevity of agro-enviro-social systems of acequia communities.

The following list highlights major anticipated outcomes of the project. The cited years represent the expected initiation and completion dates. The ambitious proposed outcomes are realistically obtainable due to ongoing successful team cooperation and infrastructure foundations established by NM EPSCoR. The NM EPSCoR project that ended in 2013 treated the topic of NM sources of mountain runoff. The physical infrastructure developed under NM EPSCoR allows this proposed project to address complex questions at multiple spatial scales without a large investment in equipment and materials. This leveraging of a complementary project enables budget allocation for participants with all expertise needed to complete the major outcomes listed below and described in more detail in the proposal text. The NM EPSCoR project that began in 2013, titled *Energize New Mexico*, treats the topic of regional water budgets and continues to complement this study.

a) A system dynamics decision support system, the Rio Grande Water and Society Simulation Model (RGWSSIM), that will allow simulations of changes in human and natural systems linked by acequia communities. RGWSSIM will operate on a computer and be accessible to community users. Scenarios will consider climate and economic changes as well as stakeholder-defined impacts such as climate and land use on river/riparian function, trade-offs among competing agricultural practices, and associated economic/environmental consequences of alternative resource management strategies. Years 1-4. **Ongoing**

b) A model of acequia community economic adaptability and resilience that will provide cutting-edge analysis of community economics and resource use. The project will yield entirely new analyses of sociocultural and economic relationships in acequia communities. It will characterize dynamics of changing natural resource use in a multi-cultural setting across multiple temporal and spatial scales. The analysis will address significant recent pressures on acequia communities and provide quantified estimates of community resilience tipping points. The model and analysis will inform the RGWSSIM with functions developed to describe equitable resource sharing and sustainable land use. Years 1-4. **Ongoing**

c) An integrated multi-model and multi-scale approach to studying hydrologic connections between managed agricultural valleys and associated unmanaged forested watersheds. Applied to this unique setting, the suite of models will provide state-of-the-art advances in two areas of hydrologic research: 1) multiple flow path and residence time analysis of surface - subsurface exchange over small to large spatial scales, and 2) ecohydrologic connectivity analysis of managed and unmanaged human and natural landscapes. Water budget and flow- path analyses will also be used to parameterize and inform the RGWSSIM. Years 1-4. **Ongoing**

d) Educational programs for K-12, undergraduates, graduate students, teachers, stakeholders and the general public. K-12 student efforts will tap into NM EPSCoR programs. This proposed project will support undergraduate and graduate college students, importantly at multiple minority-serving institutions. Extension service-directed programs and local community group programming will reach community members as will the New Mexico Acequia Association. The general public will be reached by a museum exhibit about multiple human and natural aspects of acequia communities. Years 1-4. **Ongoing/Completed museum exhibit is open to the public until April 30, 2015**

e) Integrated online atlas with maps of human and natural interactions in the upland to irrigated valley continuum and at multiple scales, including the local, valley, and regional scales. These maps will identify communities, water works, wildlife habitat, biodiversity, wildlife corridors, upland vegetation, grazing areas, and hydrology source and sink areas. For policy development, the maps will also show scenarios of these resources due to

different impacts mentioned above based on the system dynamics model outputs and the mapping spatial analysis. Years 3-4. **Ongoing**

f) Peer reviewed articles (at least 14 total with two per senior personnel) addressing the different topics investigated in this research effort and participation in local, national, and international meetings for project results dissemination. Years 2-5. **Ongoing**

Study the Rio Chama basin in Rio Arriba County as a region to test ideas about the coupling of natural and human systems dynamics.

The major goal of this specific component of the CNH Acequia project is to understand the role that small-scale raising of livestock plays in conferring resilience to acequia communities of Northern New Mexico. We seek to assess the conditions and characteristics of small-scale livestock operations and identify livestock-related factors that could trigger future community tipping points.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Development and guest curation of an exhibit entitled, "El Agua es Vida: Acequias in New Mexico," at the Maxwell Museum of Anthropology at UNM (Albuquerque campus). Drawing on the the full scope of the CNH acequia research project, the exhibit integrates the science, history, economics, and anthropology of New Mexico's acequias into accessible visual, artistic, and material form. Organized in terms of a threefold of Watershed, Water Regime, and Waterscape, the exhibit brings together information about watershed hydrology, acequia governance, customary irrigation practice and agro-pastoralism, as well as spirituality, sense of place, social change, contemporary challenges to acequia systems, and an emergent acequia social movement. It combines modern and archival photographs, artwork, traditional and modern objects and artifacts, texts, and audiovisual materials to tell the story of acequias. The exhibit opened on May 3, 2014, and will remain in place in the Maxwell main gallery until April 30, 2015. The opening, attended by approximately 275 people, featured brief presentations, music, poetry, food, and a seed demonstration. The museum plans public and educational programs related to the exhibit throughout the coming year and anticipates a high rate of visitation by the general public, including local school children. Collaborators: Sylvia Rodriguez, UNM; Guest Curator, Jose Rivera; UNM, Co-Curator, Quita Ortiz, New Mexico Acequia Association; Devorah Romanek, curator of Exhibits, Maxwell Museum, in addition to Maxwell Museum staff in public programs, graphics, and production, Moises Gonzales, School of Architecture and Planning, UNM. Two graduate students, Elise Trott (Anthropology) and David Castello (Architecture and Planning), were employed to assist with production of the exhibit, funded by fellowships from the UNM Center for Regional Studies.

Specific Objectives: The intent of the museum exhibit was to show the general public the interconnected futures of upstream and downstream rural and urban populations as linked by acequias. The exhibit was developed to integrate some facets only touched on in other project components such as spirituality, sense of place, social movement, governance, and customs of community irrigation systems. The exhibit does a superb job of connecting art with research.

Significant Results:

This is the first time an entire year-long exhibit has been dedicated to the topic of linked community irrigation systems and natural hydro-ecosystems. It has received attention from common resource researchers around the world.

A children and parents' event at the Maxwell Museum with the Acequias as the theme to celebrate land and water, a family program day organized by the staff of the Ortiz Center and the Maxwell Museum which houses the "El Agua es Vida: Acequias in New Mexico" exhibit.

Key outcomes or Other achievements: The "El Agua es Vida: Acequias in New Mexico" exhibit was featured in the June 2014 issue, Vol.6 No.6, pg. 26 of *Green Fire Times*. The article written by Alejandra Lopez describes the intent of the exhibit and provides pictures that were taken on the opening day of May 3, 2014.

The *Albuquerque Journal* ran a two-page (above the fold) article in their Sunday Journal Arts Section on May 25, 2014. The article titled "Exhibit reflects value of acequias" was written by Kathaleen Roberts.

The exhibit is expected to reach tens of thousands of people during the one year that it will be open.

*** What opportunities for training and professional development has the project provided?**

The project has trained and will continue to train undergraduate college, Masters, and PhD students. It has provided professional development for field hydrologists, museum curators, and community hydrologists.

*** How have the results been disseminated to communities of interest?**

Steve Guldán, representing the NMSU Agricultural Science Center at Alcalde, has completed many presentations to various groups such as university students, extension advisory groups, international visitors, ranchers, farmers, beekeepers, and to the NM Acequia Commission. The audience size of these presentations has ranged from 6-50 people. The presentations include walking tours, oral presentations, and slideshows.

Elizabeth Tysor and Noah Stewart-Maddox both students at New Mexico Tech in Socorro, NM gave a public outreach presentation in El Rito, NM in the Summer of 2014. The purpose of their presentation was to provide information about their research to date as well as to answer any questions that the public may have.

There will be a Hydrology Research field day hosted at the New Mexico State University: Sustainable Agriculture Science Center at Alcalde. This field day event will be held on Wednesday, August 13, 2014 and is expected to attract approximately 200-300 people.

*** What do you plan to do during the next reporting period to accomplish the goals?**

We will continue our ongoing activities and augment them with the following:

We will continue working with the current graduate students and will be adding approximately five more students to help complete the project. We are in the process of hiring a postdoc to bring together all of the system dynamics modeling. We have field crews who will provide detailed data collection in the final year. We also plan to compile a book that brings together all of the topics for dissemination to the interested public and to scholars.

A faculty led international course is planned for the later part of 2014 or early 2015. This course will expose New Mexico State University students to irrigation agriculture in the northern Chilean Patagonia (Concepcion) and to rangeland-based ranching systems of southern Chilean and Argentinian Patagonian steppes. This course will be geared toward undergraduate juniors or seniors with an interest in international natural resource and agricultural issues.

The University of New Mexico will be hosting two different sessions (one in the Spring semester and the other in the Fall semester of 2015) regarding the El Agua Es Vida, The Acequia of New Mexico museum exhibit housed the Maxwell Museum of Anthropology at The University of New Mexico. These two sessions will involve a panel of speakers and discussion will be in regards to acequia activism.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
AcequiaOpenFL (3).pdf	A flyer announcing speakers, chefs, musicians, and poets that presented at the opening of the Acequia exhibition on May 3, 2014.	Alexander Fernald	06/05/2014
PassportJune2014 NMkids AD1ab.pdf	Kid's and parents' event at the Maxwell Museum with the Acequias as the theme to celebrate land and water, a family program day organized by the staff of the Ortiz Center and the Maxwell Museum.	Alexander Fernald	06/05/2014
RioArribaMeetingFlyer.pdf	A flyer announcing the Rio Arriba workshop. The workshop included two presentations by UNM urban planning students who have focused some of their work on the Rio Chama/Rio Grande confluence area.	Alexander Fernald	06/20/2014
EL AGUA ES VIDA, THE ACEQUIAS OF NEW MEXICO.pdf	An article that was featured in the "Green Fire Times" about "El Agua Es Vida, The Acequias of New Mexico" museum exhibit.	Alexander Fernald	06/20/2014

Products

Books

Book Chapters

Conference Papers and Presentations

Moises Gonzales (2013). *Climate Connections, Resurfacing Cities of the American Southwest*. Climate Change Town Hall Meeting, New Mexico Sierra Club. Albuquerque, New Mexico. Status = OTHER; Acknowledgement of Federal Support = Yes

Alexander Fernald, Jose Rivera, Sylvia Rodriguez, Vince Tidwell, Andres Cibils, Ken Boykin, Brian Hurd, Carlos Ochoa, and Steve Guldán (). *Connectivity of Coupled Hydrologic and Human Systems as the Basis of Resilience in Traditional Irrigation Communities in New Mexico*. Universidad Politecnica D Valencia. Valencia, Spain. Status = UNDER_REVIEW; Acknowledgement of Federal Support = Yes

Stewart-Maddox, N., V. Ward, K. Coker, E. Tysor, J. Wilson, M. Frisbee and T. Schlossnagle (2013). *Groundwater/Surface-Water Interaction in a Losing Reach of the El Rito Watershed*.

Geological Society of America Ann. Mtg.. Denver, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Tolley, D., M.D. Frisbee, J.J. Harding and J.L. Wilson (2013). *High Elevation Streamflow Generation*. Geological Society of America Ann. Mtg.. Denver, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Moises Gonzales, Jose A. Rivera, J. Jarrett Garcia, and Sam Markwell (2013). *Qualitative and Visualization Methodologies for Regional Water Planning in the Rio Chama Basin*. UCOWR/NIWR Conference. Lake Tahoe, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Caitriana Steele, Emile Elias, Albert Rango, John Mejia, and Alexander Fernald (). *Simulating Streamflow Under a Warming Climate Implications For Acequia Communities In The Upper Rio Grande*. Western Snow Conference 2014. Durango, Colorado. Status = SUBMITTED; Acknowledgement of Federal Support = Yes

Ochoa, C., S. Guldán, A. Fernald, V. Tidwell, E. Elias, K. Gutierrez, and M. Borman (2014). *Surface water and shallow groundwater interactions in semiarid agro-ecosystems of the western USA*. European Geosciences Union, General Assembly. Vienna, Austria. Status = OTHER; Acknowledgement of Federal Support = Yes

Tsinajinnie, L., M. Frisbee and J.L. Wilson (2013). *The Relationship between streamflow in the El Rito watershed, New Mexico, and recharge variability, residence times, and springflow*. American Geophysical Union, Fall Ann. Mtg.. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes

Tolley, D. G., M.D. Frisbee, J. Harding and J.L. Wilson (2013). *The Significance of Deep Groundwater Contributions to Streamflow in a Crystalline Bedrock Mountain Watershed*. American Geophysical Union, Fall Ann. Mtg.. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes

Inventions

Journals

A. Fernald, S. Guldán, K. Boykin, A. Cibils, M. Gonzales, B.Hurd, S. Lopez, C. Ochoa, M. Ortiz, J. Rivera, S. Rodriguez, and C.M. Steele (2013). Hydrological, ecological, land use, economic, and sociocultural, evidence for resilience of traditional irrigation communities in New Mexico, USA.. *Hydrology and Earth System Sciences*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = No

Boykin, K.G., W.G. Kepner, D.F. Bradford, R.K. Guy, D.A. Kopp, A.K. Leimer, E.A. Samson, N.F. East, A.C. Neale, and K.J. Gergely (2013). A National Approach for Mapping and Quantifying Habitat-based Biodiversity Metrics across Multiple Spatial Scales. *Ecological Indicators*. 33 (NA), 139-147. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 11.005.

Moises Gonzales, Jose A. Rivera, J. Jarrett Garcia, and Sam Markwell (2013). Qualitative and Visualization Methodologies for Modeling Social-Ecological Dimensions of Regional Water Planning on the Rio Chama. *Journal of Contemporary Water Research and Education (JCWRE)*. 152 (1), 55-68. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: NA

Ochoa, C.G., A.G. Fernald, S.J. Guldán, V.C. Tidwell, and M.K. Shukla (2013). Shallow aquifer recharge from irrigation in a semi-arid agricultural valley in New Mexico. *Journal of Hydrologic Engineering*. 18 (10), 1219-1230. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: NA

Ochoa, C.G., S.J. Guldán, A. Cibils, S. Lopez, K. Boykin, V.C. Tidwell, and A.G Fernald (2013). Hydrologic connectivity of head waters and floodplains in a semiarid watershed. *Journal of Contemporary Water Research and Education*. 152 (1), 69-78. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: N/A

Rango, A., Fernald, A., Steele, C. M., Hurd, B. H., Ochoa, C (2013). Acequias and the effects of climate change.. *Journal of Contemporary Water Research and Education*. 151 (1), 84-94. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: NA

Steven J. Guldán¹, Alexander “Sam” G. Fernald¹, Carlos G. Ochoa¹, and Vincent C. Tidwell² (2013). Collaborative Community Hydrology Research in Northern New Mexico. *Journal of Contemporary Water Research and Education*. 152 (1), 49-54. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI:

Licenses

Other Products

Databases.

Raw data is currently being collected in an internal excel spreadsheet. Once this data is verified and converted to a uniform unit of measure, it is then uploaded to an internal access database. This data is used by project researchers for their project work. As some of this data is sensitive to the project, not all is currently available to our project stakeholders or the general public.

CNH Acequia DropBox.

A secure web-based external repository that allows invited project participants efficient access to all data and information relevant to the CNH project

Other Publications

Lopez, S.C., A.F. Cibils, U. Smedly, S. Guldán, S. Fernald, C. Ochoa. (2014). *Linkages between livestock -raising and Acequia irrigation farming in traditional agropastoral communities of northern New Mexico*. Planned submission date is July 2014. Status = OTHER; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

Stephanie Lopez, Steve Guldán, Sam Fernald, Carlos Ochoa. Lopez, SC. 2014 *The role of livestock in suppressing rangeland weeds and sustaining traditional agropastoral communities in northern New Mexico*. MS Thesis. 124;. Las Cruces, NM. (2014). New Mexico State University. Acknowledgement of Federal Support = Yes

Websites

CNH: Acequia Water Systems Linking Culture and Nature

<http://aces.nmsu.edu/cnhacequia/>

In arable valleys of water-limited regions worldwide, community water management systems have evolved to sustain communities in the face of unreliable precipitation. The acequias of the southwestern United States are community irrigation systems that are based largely on ancient technology introduced to the region by 16th-century settlers. Acequias consist of gravity-fed earthen canals that divert stream flow for distribution to fields. They lie at the center of a set of complex self-maintaining interactions between culture and nature that appear to enable drought survival and maintain other sociocultural and ecosystem benefits. Local water management groups inherent in acequias ensure equitable distribution of water to each community, allocating less water for all users in dry years and more in wet years. Acequias help maintain community identity and cohesion, economic sustainability, enhanced floodplain hydrologic function, and wildlife habitat. Contemporary acequia-based communities face new socioeconomic and natural resource pressures that threaten their existence, however. Population growth is accelerating the change from agricultural to residential land and water uses, while climate change threatens to bring warmer winters with less precipitation and earlier spring snowmelt. Traditional acequias

create and sustain intrinsic linkages between human and natural systems that increase community and ecosystem resilience to climatic and socioeconomic stresses. Greater knowledge about these interconnections and what can cause them to change or fail will be essential to determine how the communities relying on acequias can adapt to changing conditions. This interdisciplinary research project will explore socioeconomic and cultural linkages within and between acequia communities and associated landscapes; hydrologic linkages between surface water and groundwater in irrigated river valleys and contributing watersheds; and wildlife habitat and grazing distribution connections between valley riparian areas and upland forests and grasslands. The investigators will quantify the role of acequias in hydrologic function, community resilience, and ecosystem health, and they will identify potential tipping points for acequia community survival. Integrative tools informed by examinations of socioeconomic, cultural, and ecohydrological factors will indicate the resilience level of acequia-centered systems. A system dynamics model will simulate effects of climate and land-use stressors on relationships between economic, social, cultural, climatic, hydrologic, vegetation, and wildlife components. The model will quantify the magnitude of stressors needed to undermine community and ecosystem resilience. Mapping will capture spatial linkages and help communicate the findings to a larger audience.

This project will provide new insights into the relationships between traditional water management systems, communities, and landscapes. It will broaden participation of minorities by conducting research in rural Hispanic communities. Community members will be active participants in the project and help determine keys to their own community survival. Project results will be made available to researchers, policy makers, local stakeholders, and the general public through scientific publications, presentations, extension documents, and workshops. Teachers from the region will be involved in participatory training in order to reach K-12 students. Undergraduate students will be directly involved in the research, as will graduate students who will be trained as future scientists and community leaders. A major museum exhibit will integrate spirituality and sense of place into presentation of community resource governance. Cross-pollination of ideas with international experts will take place through a global comparative workshop and a comparative study in Chile. Policy guidance resulting from this study should help maintain acequia communities and similar common-pool resource systems worldwide.

Surface Water- Groundwater Interactions in Irrigated Floodplains in Northern New Mexico

<http://aces.nmsu.edu/academics/waterresearch/index.html>

Along irrigated cropland corridors between irrigation ditches and rivers, potential water quantity and water quality benefits of ditch seepage and irrigation deep percolation may derive from the close interaction between surface water and shallow groundwater.

Insufficient data exist to fully characterize the hydrological effects of ditch seepage and irrigation deep percolation in these irrigated corridors.

In order to advance scientific understanding and improve water resources management, our research integrates study of surface water and shallow groundwater to characterize hydrological processes in irrigated cropland corridors along the Rio Grande in northern New Mexico.

Water Connections

<http://www.waterconnections.org/>

A website dedicated to water research connecting human and natural landscapes.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
HomesteadPost1.pdf	Roberto Valdez- Santa Fe Homestead poster	Alexander Fernald	06/19/2014

Filename	Description	Uploaded By	Uploaded On
Landuse Change in Rio Arriba.pdf	First two slides of a presentation that was too large to upload in its entirety. Operating on funding from the National Science Foundation, this project is part of a greater research initiative, Dynamics of Coupled Natural and Human Systems.	Alexander Fernald	06/19/2014

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Fernald, Alexander	PD/PI	2
Rivera, Jose	Co PD/PI	2
Tidwell, Vincent	Co PD/PI	1
Wilson, John	Co PD/PI	4
Guldan, Steve	Co-Investigator	2
Arumi, Jose	Faculty	1
Boykin, Kenneth	Faculty	2
Cibils, Andres	Faculty	2
Gonzales, Moises	Faculty	1
Hurd, Brian	Faculty	2
Phillips, Fred	Faculty	1
Rango, Al	Faculty	0
Rodriguez, Sylvia	Faculty	2
Cruz, Jose Juan	Postdoctoral (scholar, fellow or other postdoctoral position)	8
Elias, Emile	Postdoctoral (scholar, fellow or other postdoctoral position)	2

Name	Most Senior Project Role	Nearest Person Month Worked
Frisbee, Marty	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Ochoa, Carlos	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Steele, Caitriana	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Garcia, Paula	Other Professional	0
Howard, Clifford	Other Professional	1
Ortiz, Marquita	Other Professional	1
Romanek, Devorah	Other Professional	4
Gutierrez, Karina	Graduate Student (research assistant)	8
Lopez, Stephanie	Graduate Student (research assistant)	1
Lopez, Alejandro	Graduate Student (research assistant)	7
Samson, Elizabeth	Graduate Student (research assistant)	0
Thompson, Sophia	Graduate Student (research assistant)	6
Tolley, Douglas	Graduate Student (research assistant)	1
Tsinnajinnie, Lani	Graduate Student (research assistant)	1
Valdez, Roberto	Graduate Student (research assistant)	4
Williams, Tristan	Graduate Student (research assistant)	3
Ratliff, Jesslyn	Non-Student Research Assistant	3
Boyko, Kevin	Undergraduate Student	1
Degon, Amber	Undergraduate Student	4
Howard, Jordan	Undergraduate Student	4
Stewart-Maddox, Noah	Undergraduate Student	2

Name	Most Senior Project Role	Nearest Person Month Worked
Swanson, Jake	Undergraduate Student	4
Tysor, Elizabeth	Undergraduate Student	2

Full details of individuals who have worked on the project:

Alexander G Fernald**Email:** afernald@ad.nmsu.edu**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 2**Contribution to the Project:** PI and overseer of CNH Acequia Project and Team Members.**Funding Support:** NM EPSCoR**International Collaboration:** Yes, Chile**International Travel:** No

Jose A Rivera**Email:** jrivera@unm.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 2**Contribution to the Project:** Project: Rio Chama Research Monograph. Developed work plans for two graduate students and monitored progress, both supported with CNH funds as research assistants.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Vincent Tidwell**Email:** vctidwe@sandia.gov**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** Vince is leading the integrated modeling effort.**Funding Support:** NM EPSCoR**International Collaboration:** No**International Travel:** No

John L Wilson**Email:** jwilson@nmt.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 4

Contribution to the Project: John is leading the hydrologic studies of mountain watersheds.

Funding Support: NSF

International Collaboration: No

International Travel: No

Steve Guldán

Email: sguldán@nmsu.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Takes lead on AES and CES outreach publications. Coordinates assistance of Alcalde staff on some aspects of field work. Presents project objectives and results as needed at meetings and when giving tours at the Alcalde Science Center.

Funding Support: none

International Collaboration: Yes, Chile

International Travel: No

Jose Arumi

Email: jarumi@udec.cl

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Dr. Jose Luis Arumi is currently starting the project 'Water availability in a stressed Andean watershed in Central Chile: Vulnerability under climate variability', funded by the Chilean Sciences Council (Fondecyt) that can be used as a parallel Chilean research project. The creation of a new Water Center will provide the basis of future collaboration between the Acequia Team, the Chilean partners and the Chilean canal users.

Funding Support: Support from his home university

International Collaboration: Yes, Chile

International Travel: No

Kenneth Boykin

Email: kboykin@nmsu.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 2

Contribution to the Project: Ken is the lead personnel overseeing graduate student and participating in project scoping and modeling.

Funding Support: none

International Collaboration: No

International Travel: No

Andres Cibils**Email:** aciblis@nmsu.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 2**Contribution to the Project:** Studies the role of livestock in acequia community resilience.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Moises Gonzales**Email:** mgonzo1@unm.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 1**Contribution to the Project:** Project: Rio Arriba/Chama Land Use Change and Acequia Farms. Guided student work with GIS and other visualization tools as well as collection of farm parcel data from county records.**Funding Support:** Tri-State EPSCoR, NM EPSCoR**International Collaboration:** No**International Travel:** No

Brian Hurd**Email:** bhurd@nmsu.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 2**Contribution to the Project:** Brian is the lead personnel regarding Socio-Economic Assessment and Analysis.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Fred Phillips**Email:** phillips@nmt.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 1**Contribution to the Project:** Advised on field methods and results synthesis**Funding Support:** NSF**International Collaboration:** No**International Travel:** No

Al Rango**Email:** alrango@nmsu.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 0**Contribution to the Project:** Related through snowmelt runoff modeling of upper Rio Grande**Funding Support:** none**International Collaboration:** No**International Travel:** No

Sylvia Rodriguez**Email:** sylrodri@unm.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 2**Contribution to the Project:** Consultant with UNM. Development and guest curation of an exhibit, entitled "El Agua es Vida: Acequias in New Mexico," at the Maxwell Museum of Anthropology at UNM (Albuquerque campus). The exhibit was showcased on May 3, 2014.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Jose Juan Cruz**Email:** cruzjuan@nmsu.edu**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 8**Contribution to the Project:** Irrigation system recharge of valley aquifers**Funding Support:** Government of Conicyt of Mexico.**International Collaboration:** No**International Travel:** No

Emile Elias**Email:** eliaseh@nmsu.edu**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 2**Contribution to the Project:** Assisted with database management and modeling effort.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Marty Frisbee**Email:** mfrisbee@alumni.nmt.edu**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 1**Contribution to the Project:** Post-Doc with NM Tech on Hydrology Modeling.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Carlos Ochoa**Email:** carlos.ochoa@oregonstate.edu**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 1**Contribution to the Project:** Conducts research dealing with New Mexico Acequia hydrology by analyzing hydrology data.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Caitriana Steele**Email:** caiti@nmsu.edu**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 1**Contribution to the Project:** Spatial data creation, compilation and GIS support.**Funding Support:** NM EPSCoR**International Collaboration:** No**International Travel:** No

Paula Garcia**Email:** lamorena@lasacequias.org**Most Senior Project Role:** Other Professional**Nearest Person Month Worked:** 0**Contribution to the Project:** Related through New Mexico Acequia Association.**Funding Support:** NMAA**International Collaboration:** No**International Travel:** No

Clifford Howard**Email:** clhowar@sandia.gov

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 1

Contribution to the Project: Assisting with the integrated modeling effort.

Funding Support: none

International Collaboration: No

International Travel: No

Marquita Ortiz

Email: quita@lasacequias.org

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 1

Contribution to the Project: Provides acequia expert input and survey involvement with Dr. Hurd and Dr. Rivera. Works with Dr. Rivera on Socio-cultural data collection and analysis. Collaborated on the "El Agua es Vida: Acequias in New Mexico" exhibit housed at the Maxwell Museum in Albuquerque, NM. Assisted in curation of the museum exhibit and conducted outreach for exhibit.

Funding Support: NMAA

International Collaboration: No

International Travel: No

Devorah Romanek

Email: dromanek@unm.edu

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 4

Contribution to the Project: Ethnology Curator for the Maxwell Museum at UNM in Albuquerque, NM. Prepared the museum exhibit that was showcased on May 3, 2014.

Funding Support: UNM

International Collaboration: No

International Travel: No

Karina Gutierrez

Email: kgutier@nmsu.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 8

Contribution to the Project: Assisting Dr. Fernald with data research in Northern New Mexico for CNH project and graduate work.

Funding Support: none

International Collaboration: No

International Travel: No

Stephanie Lopez**Email:** lopez@nmsu.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 1**Contribution to the Project:** Conducting a literature review and a guided study on Rural Sociology in preparation for survey design.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Alejandro Lopez**Email:** arlopez@nmsu.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 7**Contribution to the Project:** Assisting Dr. Fernald and Dr. Guldán with data research in Northern New Mexico.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Elizabeth Samson**Email:** easamson@nmsu.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 0**Contribution to the Project:** Graduate Student that focused thesis and GRA time on wildlife and ecosystems. Graduated with MS late Summer of 2013**Funding Support:** none**International Collaboration:** No**International Travel:** No

Sophia Thompson**Email:** sophiat4@unm.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 6**Contribution to the Project:** Project: Landscape Morphology and Adaptation: Landuse Change in Rio Arriba. Developed a report on land use change and agriculture economic history of Rio Arriba and Rio Chama acequia farms 1935-2012.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Douglas Tolley**Email:** gustolley@gmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 1**Contribution to the Project:** Research assistant that conducted field measurement; results synthesis**Funding Support:** EPSCoR**International Collaboration:** No**International Travel:** No

Lani Tsinnajinnie**Email:** lani.tsinnajinnie@gmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 1**Contribution to the Project:** Research assistant conducted field measurements; results synthesis**Funding Support:** EPSCoR**International Collaboration:** No**International Travel:** No

Roberto Valdez**Email:** presidio@unm.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 4**Contribution to the Project:** Project: Santa Fe National Forest Service homesteads. Compiled database and archive for research use in climate change, settlement history, economic and social life, and crop production during early homestead period following federal act of 1906.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Tristan Williams**Email:** tristanw@nmsu.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 3**Contribution to the Project:** Responsible for data base entry and raw data collected in the field.**Funding Support:** none**International Collaboration:** No**International Travel:** No

Jesslyn Ratliff**Email:** jesslynr@nmsu.edu**Most Senior Project Role:** Non-Student Research Assistant**Nearest Person Month Worked:** 3

Contribution to the Project: Program Coordinator that provides project support for all of the CNH Acequia Team Members.

Funding Support: NM EPSCoR

International Collaboration: No

International Travel: No

Kevin Boyko**Email:** kboyko@nmsu.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1

Contribution to the Project: Intern student hired to assist with field and data research for Spring and Summer 2013. Finished in the Fall of 2013.

Funding Support: none

International Collaboration: No

International Travel: No

Amber Degon**Email:** ad03613@georgiasouthern.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 4

Contribution to the Project: REU student to conduct field measurements in El Rito

Funding Support: NSF (related grant)

International Collaboration: No

International Travel: No

Jordan Howard**Email:** jh10467@georgiasouthern.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 4

Contribution to the Project: REU student to conduct field measurements in El Rito

Funding Support: NSF (related grant)

International Collaboration: No

International Travel: No

Noah Stewart-Maddox**Email:** noah.fencer@gmail.com**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 2**Contribution to the Project:** Conducted field measurements and related laboratory analyses**Funding Support:** none**International Collaboration:** No**International Travel:** No**Jake Swanson****Email:** jpsalfa11@yahoo.com**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 4**Contribution to the Project:** REU student to conduct field measurements in El Rito**Funding Support:** NSF (related grant)**International Collaboration:** No**International Travel:** No**Elizabeth Tysor****Email:** etysor@gmail.com**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 2**Contribution to the Project:** Conducted field measurements and related laboratory analyses.**Funding Support:** none**International Collaboration:** No**International Travel:** No**What other organizations have been involved as partners?**

Name	Type of Partner Organization	Location
Acequias of El Rito	Other Nonprofits	El Rito area of Northern New Mexico
Acequias of the Rio Hondo	Other Nonprofits	Rio Hondo area of Northern New Mexico
Natural Resources Conservation Service	State or Local Government	United States
New Mexico Acequia Association	Other Nonprofits	Santa Fe, NM

Name	Type of Partner Organization	Location
New Mexico EPSCoR	State or Local Government	Albuquerque, NM
New Mexico Institute of Mining and Technology	Academic Institution	Socorro, NM
Northern New Mexico Stockman's Association	Other Nonprofits	Taos, NM
Rio Hondo Valley Acequia Association	Other Nonprofits	Taos, NM
Sandia National Laboratories	State or Local Government	Albuquerque, NM
Taos Valley Acequia Association	Other Nonprofits	Taos, NM
UNM Center for Regional Studies	Academic Institution	Albuquerque, NM
UNM Community & Reginal Planning Program	Academic Institution	Albuquerque, NM
Alcalde Acequia Association	Other Nonprofits	Alcalde, NM
UNM Maxwell Museum	Academic Institution	Albuquerque, NM
UNM Resource Center for Raza Planning	Academic Institution	Albuquerque, NM
US Geological Survey	Other Organizations (foreign or domestic)	United States
USDA Forest Service; Carson National Forest	State or Local Government	Carson, NM
USDI BLM Taos Field Office	State or Local Government	Taos, NM
Universidad de Concepcion	Academic Institution	Chile, South America
University of New Mexico	Academic Institution	Albuquerque, NM
County Assessor's Office	State or Local Government	Rio Arriba County
El Rito Acequia Association	Other Nonprofits	El Rito, NM
El Rito Regional Water and Wastewater Association	Other Nonprofits	El Rito, NM
Environmental Protection Agency	State or Local Government	United States

Name	Type of Partner Organization	Location
La Nueve Acequias en el Rio Grande	Other Nonprofits	Northern New Mexico
Long Term Ecological Research Network	Other Organizations (foreign or domestic)	North America
NMSU Alcalde Science Center	Academic Institution	Alcalde, NM

Full details of organizations that have been involved as partners:
Acequias of El Rito

Organization Type: Other Nonprofits

Organization Location: El Rito area of Northern New Mexico

Partner's Contribution to the Project:

Facilities

Collaborative Research

More Detail on Partner and Contribution: A. de la Otra Vanda, A. Madre, A. Alire. A, del Monte, A. del Jaral

Acequias of the Rio Hondo

Organization Type: Other Nonprofits

Organization Location: Rio Hondo area of Northern New Mexico

Partner's Contribution to the Project:

Facilities

Collaborative Research

More Detail on Partner and Contribution: La Cuchilla ditch, A. de Los Prando, A. de San Antonio, Canoncitos ditch north, Canonictos ditch south, A. de Atalaya, A. Madre del Llano, A. de La Plaza

Alcalde Acequia Association

Organization Type: Other Nonprofits

Organization Location: Alcalde, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

County Assessor's Office

Organization Type: State or Local Government

Organization Location: Rio Arriba County

Partner's Contribution to the Project:

In-Kind Support

More Detail on Partner and Contribution: Levi Valdez provided land parcel data to Graduate Student for use in the study of Rio Arriba County land use change 1935-2012

El Rito Acequia Association

Organization Type: Other Nonprofits

Organization Location: El Rito, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

El Rito Regional Water and Wastewater Association

Organization Type: Other Nonprofits

Organization Location: El Rito, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution: Juan Garcia provided interview to Graduate Student regarding El Rito farm and ranch economy, and also attended the Rio Arriba Land Use Workshop in December 2013.

Environmental Protection Agency

Organization Type: State or Local Government

Organization Location: United States

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution: William Kepner and Anne Neale helped to develop biodiversity metrics.

La Nueve Acequias en el Rio Grande

Organization Type: Other Nonprofits

Organization Location: Northern New Mexico

Partner's Contribution to the Project:

Facilities

Collaborative Research

More Detail on Partner and Contribution: A. de Alcalde, A. de la Canova, A. Ancon, A. San Rafael del Guique, A. Madre del Bosque, A. de Los Chicos, A. Garcia, A. del Medio, A. Rinconada Isla

Long Term Ecological Research Network

Organization Type: Other Organizations (foreign or domestic)

Organization Location: North America

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

NMSU Alcalde Science Center

Organization Type: Academic Institution

Organization Location: Alcalde, NM

Partner's Contribution to the Project:

In-Kind Support

Facilities

Collaborative Research

More Detail on Partner and Contribution:

Natural Resources Conservation Service

Organization Type: State or Local Government

Organization Location: United States

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution: Rewa Charles serves as a end user for biodiversity metrics.

New Mexico Acequia Association

Organization Type: Other Nonprofits

Organization Location: Santa Fe, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

New Mexico EPSCoR

Organization Type: State or Local Government

Organization Location: Albuquerque, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

New Mexico Institute of Mining and Technology

Organization Type: Academic Institution

Organization Location: Socorro, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

Northern New Mexico Stockman's Association

Organization Type: Other Nonprofits

Organization Location: Taos, NM

Partner's Contribution to the Project:

Facilities

More Detail on Partner and Contribution:

Rio Hondo Valley Acequia Association

Organization Type: Other Nonprofits

Organization Location: Taos, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

Sandia National Laboratories

Organization Type: State or Local Government

Organization Location: Albuquerque, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

Taos Valley Acequia Association

Organization Type: Other Nonprofits

Organization Location: Taos, NM

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

UNM Center for Regional Studies

Organization Type: Academic Institution
Organization Location: Albuquerque, NM

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

UNM Community & Reginal Planning Program

Organization Type: Academic Institution
Organization Location: Albuquerque, NM

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

UNM Maxwell Museum

Organization Type: Academic Institution
Organization Location: Albuquerque, NM

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution: UNM Maxwell Museum Staff to curate the Acequia Exhibit, utilizing materials, such as museum historical photographs.

UNM Resource Center for Raza Planning

Organization Type: Academic Institution
Organization Location: Albuquerque, NM

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: RCRP (Moises Gonzales) provided graduate students to develop a companion project in economic development for the communities of the lower Rio Chama, the Santa Cruz Basin, and Alcalde on the Rio Grande. RCRP also designed and built two physical terrain models for installation at the Maxwell Museum of Anthropology for display as part of the Acequia Exhibit.

US Geological Survey

Organization Type: Other Organizations (foreign or domestic)
Organization Location: United States

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

USDA Forest Service; Carson National Forest**Organization Type:** State or Local Government**Organization Location:** Carson, NM**Partner's Contribution to the Project:**

Facilities

Collaborative Research

More Detail on Partner and Contribution: Allowed access to grazing allotment livestock records.

USDI BLM Taos Field Office**Organization Type:** State or Local Government**Organization Location:** Taos, NM**Partner's Contribution to the Project:**

Facilities

More Detail on Partner and Contribution: Allowed access to grazing allotment livestock records.

Universidad de Concepcion**Organization Type:** Academic Institution**Organization Location:** Chile, South America**Partner's Contribution to the Project:**

Collaborative Research

Personnel Exchanges

More Detail on Partner and Contribution:

University of New Mexico**Organization Type:** Academic Institution**Organization Location:** Albuquerque, NM**Partner's Contribution to the Project:**

Collaborative Research

More Detail on Partner and Contribution:

What other collaborators or contacts have been involved?

YES

Impacts

What is the impact on the development of the principal discipline(s) of the project?

We have made major strides in connecting community sociocultural structures with hydro-ecological systems. In particular the museum exhibit has brought together these different disciplines.

An important theoretical development has been the demonstration that hydrologic connectivity and community connectivity are interlinked and each supports the resilience and health of the other. These relationships will be presented in peer reviewed papers at national and international conferences.

What is the impact on other disciplines?

Other disciplines impacted include hydrology, ecology, and community economics in terms of utilizing a multidisciplinary framework for modeling natural and human system dynamics of resilience. This approach is potentially transformative to other world regions in high desert environments.

In addition, this study will provide insights on the interactions between two common pool resources (CPRs), surface irrigation water and grazing land. Both CPRs are critical to acequia communities yet have contrasting regulation and oversight. The first CPR, which is perhaps the most crucial, is almost entirely under irrigator control, while the second is subject to fairly stringent government regulation and control. Livestock raising appears to be agricultural activity that links both these CPRs.

What is the impact on the development of human resources?

The museum exhibit is providing information about the research to young people, underrepresented groups, professionals, academics, and members of the public.

Graduate and undergraduate student opportunities are being taken advantage of by underrepresented groups.

Graduate students have received graduate-level training at three research universities in New Mexico in six different disciplines.

Steve Guldán conducted tours throughout the year at NMSU Alcalde Science Center on acequia research to many individuals including those from the New Mexico Acequia Association.

What is the impact on physical resources that form infrastructure?

Nothing to report.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

Beyond science and technology, policy makers can also be impacted when study results are more widely disseminated. This component will provide important contributions to modeling the resilience of acequia farming communities in northern NM and how they enhance hydro-ecosystem sustainability.

Changes/Problems

Changes in approach and reason for change

Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.