Annual Report for Period: 09/2010 - 08/2011
Submitted on: 07/28/2011
Principal Investigator: Fernald, Alexander G.
Award ID: 1010516
Organization: New Mexico St University
Submitted By:
Fernald, Alexander - Principal Investigator
Title:
CNH: Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land-Use Changes

Project Participants

Senior Personnel

Name: Fernald, Alexander
Worked for more than 160 Hours: Yes
Contribution to Project:
PI and overseer of CNH Acequia Project and Team Members.

Name: Wilson, John
Worked for more than 160 Hours: No
Contribution to Project:
Hydrologic data and model construction; also supported by NM EPSCoR.

Name: Rivera, Jose
Worked for more than 160 Hours: Yes
Contribution to Project:
Served as Co-PI of NSF grant to NMSU and as the PI of a subaward from NMSU to UNM at $50,188 for Year One. Supervised work of two graduate students as RAs: GIS mapping and environmental history research. Completed a major review of social science literature and archival sources to include historical maps of the region. Support Source is the Center for Regional Studies at UNM with no NSF grant funding for Rivera.

Name: Tidwell, Vincent
Worked for more than 160 Hours: No
Contribution to Project:
Leading Integrated Modeling Effort. Travel and support of Post-Doc.
Because of employement at Sandia, funding for participation is limited.

Name: Arumi, Jose
Worked for more than 160 Hours: No
Contribution to 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.

Name: Guldan, Steve
Worked for more than 160 Hours: Yes
Contribution to 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.

Name: Boykin, Kenneth
Worked for more than 160 Hours: Yes
Contribution to Project:
Lead personeel overseeing graduate student and participating in project scoping and modeling.

Name: Cibils, Andres

Worked for more than 160 Hours: Yes

Contribution to Project:

Participated in three organizing meetings (Socorro, Albuquerque, and Alcalde) including a visit to El Rito and Alcalde acequias which involved conversations with farmers. Recruited a graduate student (Stephanie Lopez) to conduct interviews and gather background information on the relevance of livestock grazing. Recruited an external collaborator (Dr. Lee Hamilton) to provide necessary expertise in conducting interviews. Completed IRB certification. Collaborated on the preparation of a manuscript that will be submitted for publication to Sustainable Development. Attended a research rally meeting organized by NMSU's VPR office.

Name: Hurd, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Lead personnel regarding Socio-Economic Assessment and Analysis.

Name: Ortiz, Marquita

Worked for more than 160 Hours: No

Contribution to Project:

Provides acequia expert input and survey involvement with Dr. Hurd and Dr. Rivera.

Name: Rodriguez, Sylvia

Worked for more than 160 Hours: No

Contribution to Project:

Consultant with UNM.

Name: Link, Timothy

Worked for more than 160 Hours: No

Contribution to Project:

Project Participant-will be assisting with an interdisciplinary modeling course that will be held in 2012.

Name: Saito, Laurel

Worked for more than 160 Hours: No

Contribution to Project:

Project Participant-will be assisting with an interdisciplinary modeling course that will be held in 2012.

Name: Rango, Al

Worked for more than 160 Hours: No

Contribution to Project:

Related through EPSCoR Project.

Name: Michener, William

Worked for more than 160 Hours: No

Contribution to Project:

Related through EPSCoR Project.

Name: Klein, Kathryn

Worked for more than 160 Hours: No

Contribution to Project:

Project Participant association with the Maxwell Museum.

Name: Fleming, William

Worked for more than 160 Hours: No

Contribution to Project:

Related through EPSCoR Project.

Name: Pullin, Michael

Worked for more than 160 Hours: No

Contribution to Project:
Project Participant-UROP Coordinator.

Name: White, Amanda
Worked for more than 160 Hours: No
Contribution to Project:
Collaborator-left project in 2011.

Name: Garcia, Paula
Worked for more than 160 Hours: No
Contribution to Project:
Related through New Mexico Acequia Association.

Name: Shukla, Manoj
Worked for more than 160 Hours: No
Contribution to Project:
Worked with Dr. Ochoa in creating poster presentation titled 'Field Studies and Modeling of Water Movement through the Vadose Zone'.

Post-doc

Name: Steele, Caitriana
Worked for more than 160 Hours: No
Contribution to Project:
Spatial data creation, compilation and GIS support.

Name: Ochoa, Carlos
Worked for more than 160 Hours: Yes
Contribution to Project:
Collects and provides research information dealing with New Mexico Acequias.

Graduate Student

Name: Mayagoitia, Laura
Worked for more than 160 Hours: Yes
Contribution to Project:
Assistance with survey design and implementation.

Name: Samson, Elizabeth
Worked for more than 160 Hours: Yes
Contribution to Project:
Graduate Student focusing thesis and GRA time on wildlife and ecosystems.

Name: Garcia, Jarrett
Worked for more than 160 Hours: Yes
Contribution to Project:
Lead responsibility for the creation of GIS maps for the Rio Chama Basin in Rio Arriba County of New Mexico. Received NSF/RA salary of $1800 monthly for approximately seven months.

Name: Markwell, Sam
Worked for more than 160 Hours: Yes
Contribution to Project:
Co-author responsibility for environmental history research, Rio Chama Basin. Received NSF/RA salary of $1800 for approximately five months.

Name: Lopez, Stephanie

Worked for more than 160 Hours: Yes

Contribution to Project:
Conducted a literature review and a guided study on Rural Sociology in preparation for survey design. Worked on the design of interview questions for planned focus group sessions.

Name: Cozzens, Brian
Worked for more than 160 Hours: No
Contribution to Project:
Hydrologic data and model construction; also supported by NM EPSCoR.

Name: Harding, Jevon
Worked for more than 160 Hours: No
Contribution to Project:
Hydrologic data and model construction; also supported by NM EPSCoR.

Undergraduate Student

Technician, Programmer

Name: Fossberg, Bobbie Jo
Worked for more than 160 Hours: No
Contribution to Project:
Program Coordinator-provides project support for CNH Acequia Team Members.

Name: Haas, Laua
Worked for more than 160 Hours: No
Contribution to Project:
Assisted with research-OSI.

Name: Rad, Hamid
Worked for more than 160 Hours: No
Contribution to Project:
Assisted with research-OSI.

Name: Murthy, Sudha
Worked for more than 160 Hours: No
Contribution to Project:
Assisted with research-OSI

Name: Courtney, Mark
Worked for more than 160 Hours: No
Contribution to Project:
Part of review team that evaluated draft proposal.

Name: Richards, Beth
Worked for more than 160 Hours: No
Contribution to Project:
Part of review team that evaluated draft proposal.

Name: Bencala, Kenneth
Worked for more than 160 Hours: No
Contribution to Project:
Associated with IWG at USGS.

Name: Parra, Rita
Worked for more than 160 Hours: No

Contribution to Project:
Provided proposal accounting assistance.

Name: Villa, Alma
Worked for more than 160 Hours: No
Contribution to Project:
Provided proposal accounting assistance.

Name: Haynes, Misty
Worked for more than 160 Hours: No
Contribution to Project:
Provided proposal accounting assistance.

Name: Blackburn, Anne
Worked for more than 160 Hours: No
Contribution to Project:
Provided proposal accounting assistance.

Name: Smith, Amy
Worked for more than 160 Hours: No
Contribution to Project:
Edited original grant proposal

Name: Rapp, Dustin
Worked for more than 160 Hours: No
Contribution to Project:
Assisted with proposal editing.

Other Participant

Research Experience for Undergraduates

Organizational Partners

University of New Mexico

Sandia National Laboratories

New Mexico Institute of Mining and Technology

Universidad de Concepcion

New Mexico Acequia Association
Rivera - Marquita Ortiz assisted with input to the Acequia Socio-Economic Survey headed by NMSU Professor, Brian Hurd.

University of Idaho
Assisting with an interdisciplinary modeling course that will be held in 2012.

University of Nevada, Reno
Assisting with an interdisciplinary modeling course that will be held in 2012.

Long Term Ecological Research Network

US Geological Survey

New Mexico EPSCoR
Extreme integration with infrastructure from NM EPSCoR.

Taos Valley Acequia Association
Ochoa - Palemon Martinez allowed us to install a weather station on his property.

Rivera - Palemon Martinez convened a meeting of the Rio Hondo Valley Acequia Association to discuss the Flow Sharing Agreement with presentation by NMSU Carlos Ochoa.

Acequia de los Prandos
Ochoa - Sandra Varos and Nora Olst collaborated with acequia flow measurement.

Acequia de la Atalaya
Ochoa - Solomon Kaplan and Allen Kaplan collaborated on acequia flow measurement and allowed installation of a water level monitoring device on Allen Kaplan's domestic well.

Acequia de la Plaza
Ochoa - Peter Merscher collaborated on acequia flow measurement.

Acequia de Des Montes
Ochoa - Herbert Martinez, Ernie Martinez and Jim Sanborn collaborated on acequia flow measurement, allowed installation of a water level monitoring device on Ernie Martinez's domestic well, and discussed project activities to be performed.

Acequia Madre del Llano
Ochoa - Allen Kaplan and Moises Lacombe allowed installation of a water level monitoring device on Allen Kaplan's domestic well and discussed project activities to be performed.

APSensing
Ochoa - Greg McElyea and Doug Yates ran distributed temperature sensing (DTS) trial in a 300 m transect of the Rio Hondo.

Canoncitos North Ditch
Ochoa - Collaborated with Herbert Garcia to install a new flume in the Canoncitos ditch.

Canoncitos South Ditch
Ochoa - Collaborated with Cloro Garcia on discussion of project activities to be performed.

Acequia de San Antonio
Ochoa - Collaborated with Elias Espinoza on discussions for project activities to be performed.

Valdez, NM
Ochoa - Collaborated with Eric Patterson on data collection from installed water level monitoring device on his domestic well.

Alcalde, NM
Ochoa - Collaborated with Horace Valdez on data collection from installed water level monitoring device on his domestic well.

Velarde, NM
Ochoa - Collaborated with Richard Garcia, Mike Martinez, Gene Lopez, Joe Garcia, Archie Velarde, and Mel Medina on data collection from installed water level monitoring device on each of their domestic wells.

El Guique, NM
Ochoa - Collaborated with Benito Chavez on data collection from installed water level monitoring device on his domestic well.

UNM Maxwell Museum
Dr. Rodriquez will work with UNM Maxwell Museum staff to curate the Acequia exhibit, utilizing materials, such as museum historical photographs.

Environmental Protection Agency

UNM Resource Center for Raza Planning
Rivera - Moises Gonzales served as a faculty mentor for the GIS mapping, Rio Chama Basin in Rio Arriba County.

UNM Community & Regional Planning Prgm.
Rivera - William Flemming served as faculty mentor for the Natural Resources Inventory.

Other Collaborators or Contacts

Amanda Beth White from New Mexico Institute of Mining and Technology left the project during the first year.

Cibils - Lee Hamilton from NMSU-Sociology is collaborating in training a graduate student (Stephanie Lopez) to conduct field interviews. He is participating in formulating the questionaire for the focus group sessions, and will help lead the focus group sessions.

Activities and Findings

Research and Education Activities:
Ochoa - Training Apr-11 on Acequia Flow Measurement as a Community Education Event at the Rio Hondo site for 2-4 hours to 1-25 local stakeholders/specific resource users. Purpose was to train acequia water masters (mayordomos) on how to measure acequia flow.

Ochoa with Fernald, Guldan, and Tidwell - Training May-11 on Acequia Hydrology as a Research Event for 1-25 regional students.

Ochoa - Training June-11 on Well Installation as a Research Event at the Alcalde site for 8 hours to 1-25 local student to provide content knowledge.

Hurd - Ongoing training on Socio-economic Survey Sample and Survey Design as a Research Event for a 2 year duration to provide content knowledge.

Rodriguez - Ongoing preparation and collaboration with the Acequia and EPSCoR teams, New Mexico Acequia Association, and the UNM Maxwell Museum to establish an Acequia exhibit and assist in the coordination and hosting of the Global Communities Workshop.

Guldan - Guided tours June-11 of Alcalde Science Center as a Community Education Event at ACS Alcalde to 1-25 UNM and Northern NM College faculty and students.

Rivera - Rio Hondo Meeting Apr-11 at the Community Center at Arroyo Seco as a 2 hour community event for content knowledge. Given to 22 officers and members of acequia associations in the Rio Hondo Valley for local farmers who irrigate from the Rio Hondo Stream.

Rivera - El Rito Meeting Apr-11 at the La Clinica del Norte at El Rito as a 2 hour community event for content knowledge. Given to 38 officers and members of acequia associations in the El Rito Valley for local farmers who irrigate from the El Rito Stream.

Cibils - Organizational Meetings Aug-10, Oct-10, and Dec-10 in Socorro, Albuquerque, and Alcalde full day for the purpose to plan project execution strategies and refine overall conceptual model.

Arumi - Project startup 'Water availability in a stressed Andean watershed in Central Chile: Vulnerability under climate variability'

Arumi - Creation of a new Water Center by the Chilean partners, which is inspirited in the research and extension centers that exist in the USA, like Alcalde. The center has the participation of the Irrigation Water Organization of Central Chile.

Steele - The three Geo-databases containing relevant spatial data for acequia study sites have been created. Although nearly complete, the data is of variable quality and require topological and accuracy checking. The data also requires metadata to be complete. Dr. Steele is coordinating with Dr. Ochoa and the current undergraduate student employee to create a 'master' copy of the data and to make corrections where necessary.

Steele - Maps of acequia valleys have been created, but will need to be updated as data is corrected.

Steele - Maps of the snowmelt dominated basins above the acequias are underway.

Findings:

Ochoa - Collaboration with community.

Ochoa - Collaboration with regional student community.

Ochoa - Driven-point well installation.

Hurd - Collaboration with community.

Rodriguez - Acequia exhibit will be based on results from the integrated analysis accomplished by the project. The Global Communities Workshop will be an international participatory workshop designed to put study findings from NM and Chile into a comparative global perspective with respect to community irrigation systems located in semi-arid settings.

Guldan - Tours covered ASC-Alcalde Research including acequia hydrology and new phases.

Rivera - Irrigators concluded that they need to implement a water sharing agreement and evaluate the headgates and flumes to better measure the flows.

Rivera - Irrigators provided information regarding crop patterns, dryland agricultural practices historically, water conservation, water allocation in dry years, and other key points.

Arumi - The research project focus is on obtaining answers for the river stakeholders. They need to improve their understanding of the hydrological process with potential to assist the decision-making process regarding the water management of the Diguillin watershed and assess the vulnerability of the river water resources against the land use change at the headwater and/or climate change.

Arumi - The Water Center will provide the basis of future collaboration between the Acequia Team, the Chilean partners and the Chilean canal users.

Training and Development:

Ochoa - Provided basic training on how to read/collect acequia flow data.

Ochoa - Provided research knowledge on Acequia Hydrology.

Ochoa - Hands on experience on installing monitoring wells.

Hurd - During the coming year, expectations are that the socio-economic survey will begin to be implemented and data assembled.

Rodriguez - The exhibit will show the interconnected futures of upstream and downstream rural and urban populations as linked by acequias. It will also draw on the global communities' workshop perspectives.

Guldan - Tours provided understanding of ASC-Alcalde Research including acequia hydrology and new phases.

Rivera - Took notes to document the meeting for use later at Focus Group Sessions.

Rivera - Took notes to document the meeting for use later at Focus Group Sessions.

Arumi - Will provide answers and future collaborations between the Acequia Team, the Chilean partners, and the Chilean canal users.

Steele - Outline and introductory content in place for an article describing object-based image processing approach for mapping forest cover in snowmelt dominated basins.

Fernald - Outline and introductory content in place regarding a paper on sustainability.

Outreach Activities:

Ochoa with Fernald, Guldan, and Tidwell - Invited talk Apr-11 titled 'Acequia Hydrology Research in the Rio Hondo' given to the local general public with 1-25 participants.

Ochoa with Fernald, Guldan, and Tidwell - Invited talk May-11 titled 'Acequia Hydrology: Surface Water and Groundwater Interactions' given to the Local General Public with 51-100 participants.

Rodriguez - The materials from the exhibit will be available for various venues and educational programs located at the museum. Additionally, a smaller, traveling component of the exhibit will be developed by the museum for display in venues in northern and southern parts of New Mexico.

Guldan - Guided tour June-11 of Alcalde Science Center as a Community Event at the Alcalde site for three NMSU Media Personnel/Reporters.

Guldan with Fernald, Tidwell, and Ochoa - Invited talk: Lecture and Powerpoint June-11 titled 'Hydrologic Connection between Traditional Acequia Communities and their Watersheds: Three Cases from Northern New Mexcio' given to irrigators, college students, university faculty, and a general audience with 50-100 total participants. Given at 4th Annual Celebrando las Acequias - Water and Resilience.

Rivera - Invited talk: Lecture and Powerpoint Jun-11 titled 'The Culture of Ayuda Mutua in the Rio Arriba' given to local, regional, and national researchers, students, government employees, and the general public with 80 total participants. Given at 4th Annual Celebrando las Acequias - Water and Resilience.

Fernald - Invited talk Jan-11 titled 'Climate Changes and Forest Management for Water' given to staff of Carson and Santa Fe National Forests with 50 total participants. Given in Abiquiu, NM during a Forest Service Meeting.

Fernald with NMSU Researchers - Informational meeting and answer session Jan-11 titled 'Acequia Water Systems Linking Culture and Nature' given to NMSU Administrators (VPR, Provost, President), students, faculty and staff as well as New Mexico legislators, local government officials, the general public and the media. Held at NMSU's Second Research Rally.

Journal Publications

Books or Other One-time Publications

Hurd, Brian; Rivera, Jose; Mayagoitia, Laura, "Adapting Water, Economy, and Values in Small Community Irrigation (Acequia) Systems to the Challenges of Regional Economic Growth and Climate Change", (2011). Conference, Published
Bibliography: Universities Council on Water Resources, PLANNING FOR TOMORROW'S WATER: SNOW PACK, AQUIFERS, AND RESERVOIRS. Boulder, CO. July 11-14, 2011

Samson, Elizabeth; Boykin, Kenneth, "Coupled Natural and Human Systems: Changes In Biodiversity Metrics Based On Climate And Land Use Changes At Watershed And Basin Landscape Scales", (2011). Conference and Paper, Published
Bibliography: Universities Council on Water Resources, PLANNING FOR TOMORROW'S WATER: SNOW PACK, AQUIFERS, AND RESERVOIRS. Boulder, CO. July 11-14, 2011

Boykin, Kenneth, "Research within the Center for Applied Spatial Ecology", (2011). Paper, Published
Bibliography: Boykin, Kenneth. April 2011

Rivera, Jose; Garcia, Jarrett RA, "Acequia Systems Linking Culture and Nature: The Rio Chama Basin Case Study", (2011). Conference, Published
Bibliography: EPSCoR Western Consortium Tri-State Meeting. Santa Ana Pueblo, NM. April 8, 2011

Guldan, Steven; Fernald, Alexander; Ochoa, Carlos, "Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land Use Changes", (2011). Conference, Published
Bibliography: Universities Council on Water Resources, PLANNING FOR TOMORROW'S WATER: SNOW PACK, AQUIFERS, AND RESERVOIRS. Boulder, CO. July 11-14, 2011

Tidwell, Vince; Ochoa, Carlos; Mayagoitia, Laura, "Modeling the Physical/Social/Cultural Dynamics of Small Scale Community Irrigation Systems (Acequias)", (2011). Conference, Published
Bibliography: Universities Council on Water Resources, PLANNING FOR TOMORROW'S WATER: SNOW PACK, AQUIFERS, AND RESERVOIRS. Boulder, CO. July 11-14, 2011

Fernald, Alexander, "Treating Juniper with Herbicide: Where Does the Water Go?", (2011). Convention, Published
Bibliography: IX International Rangeland Congress-IRC 2011, "Diverse Rangelands for a Sustainable Society" , Rosario, Argentina - April 2nd to April 8th, 2011

Web/Internet Site

URL(s):
https://sites.google.com/site/cnhacequia/
Description:
Boykin - This is an internal website for the project.

Other Specific Products

Product Type:
Poster
Product Description:
Visual Poster Presentation
Sharing Information:
Fernald with Arumi, Boykin, Cibils, Guldan, Hurd, Klein, Link, Ochoa, Ortiz, Pullin, Rivera, Rodriguez, Saito, Steele, Tidwell, White, and Wilson - Visual presentation to a large widespread audience representing "Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land Use Changes". (PDF Attached)

Ochoa with Fernald, Guldan, and Tidwell - Visual presentation for an audience of more than 100 International Researchers representing "Temporal and Spatial Variability of Surface Water and Ground Water Interactions in a Semi-Arid Agricultural Valley". (PDF Attached)

Ochoa with Fernald, Guldan, and Shukla - Visual presentation for an audience of more than 100 International Researchers representing "Field Studies and Modeling of Water Movement through the Shallow Vadose Zone in a Floodplain Irrigated Valley. (PDF Attached)

Product Type:
Powerpoint
Product Description:
Powerpoint Presentation
Sharing Information:
Guldan - Powerpoint demonstration to accompany presentation titled "Hydrologic Connections between Traditional Acequia Communities and

their Watersheds: Three cases from Northern New Mexico".

Rivera - Powerpoint demonstration to accompany presentation titled "The Culture of Ayuda Mutua in the Rio Arriba".

Product Type:
Map
Product Description:
Study Area Boundary Map
Sharing Information:
Boykin - Mapping showing regional study area boundary shared through internal website: http://sites.google.com/site/cnhacequia/

Boykin - Mapping showing three fine scaled study area boundaries shared through internal website: http://sites.google.com/site/cnhacequia/

Product Type:
Table
Product Description:
Land Cover Table
Sharing Information:
Boykin - Tables of land cover for region and 3 sites shared through internal website: https://sites.google.com/site/cnhacequia/

Product Type:
Model
Product Description:
Integrated Decision Model
Sharing Information:
Tidwell - Model will evaluate stress and mitigation options for acequia operation and will be available from website on completion.

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Journal
Contributions: To Any within Discipline

Contributions: To Any Other Disciplines
Contributions: To Any Human Resource Development
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering
Any Conference

Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land Use Changes

Fernald, A[1]., J.L. Arumi[2], K. Boykin[1], A.Cibils[1], S. Guldan[1], B. Hurd[1], K.Klein[3], T. Link[4], C. Ochoa, M. Ortiz[5], M. Pullin[6], J. Rivera[7], S. Rodriguez[8], L. Saito[9], C. Steele[1], V. Tidwell[10], A. White[6], and J. Wilson[6]

[1]New Mexico State University; [2]University of Concepcion, Chile; [3]Maxwell Museum; [4]University of Idaho; [5]New Mexico Acequia Association; [6]New Mexico Institute of Mining and Technology; [7]University of New Mexico; [8]University of New Mexico *ret*.; [9]University of Nevada-Reno; [10]Sandia National Laboratories

PURPOSE

This poster describes a newly funded project about acequia resilience in the face of changing land use and climate

The project will study linkages between acequias, communities, water, and ecosystems

If successful, the study will provide new clues for sustainability of acequia communities

ACEQUIAS

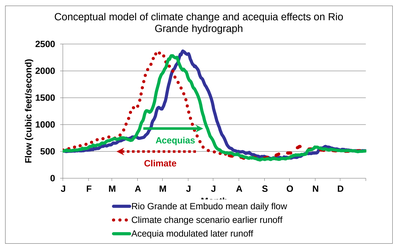
Acequia physical structures divert water from river for:
- -irrigation
- -animals
- -domestic use
- -groundwater recharge

Community acequia associations allocate water:
- -more for all in wet years
- -less for all in dry years

HYDROLOGY

Acequia systems have high seepage to groundwater that returns to the river as subsurface return flow after storage underground

Delayed hydrograph due to acequia seepage could mitigate predicted future earlier snowmelt runoff



COMMUNITIES

Water is critical for acequia community survival

Acequia organizations are important for maintaining community culture

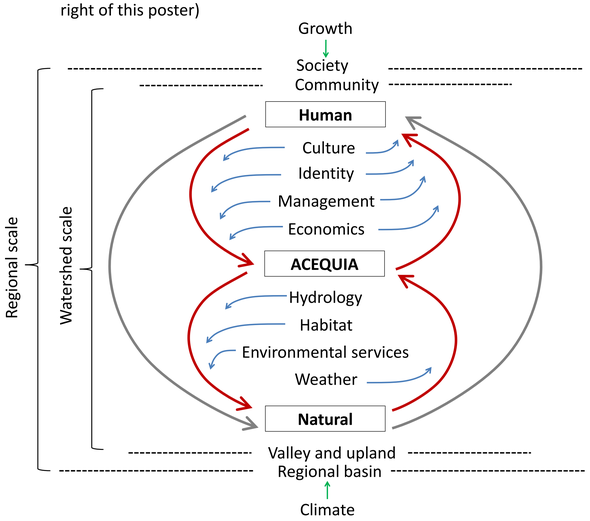
Mural located in Espanola, NM painted by Alejandro Lopez of Santa Cruz, NM

PROJECT PROPOSAL: COUPLED NATURAL AND HUMAN SYSTEMS

Proposal to National Science Foundation program in Dynamics of Coupled Natural and Human Systems

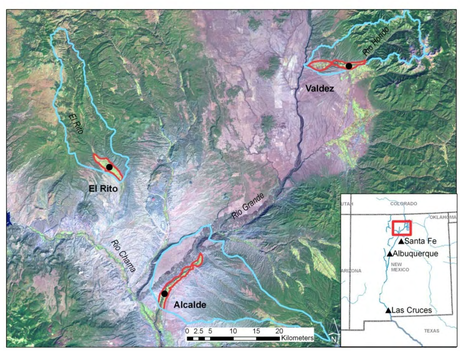
Hypothesis - *"Traditional acequias create and sustain intrinsic linkages between human and natural systems that increase community and ecosystem resilience to climatic and socioeconomic stresses."*

Proposal funded in September 2010 (See newspaper article at the right of this poster)

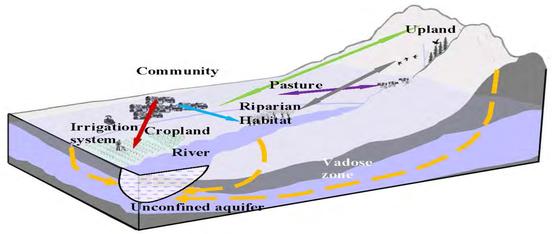


STUDY SITES

Three study valleys - El Rito, Rio Hondo, and Rio Grande with contributing watersheds and associated local communities (El Rito, Valdez/Arroyo Hondo, and Alcalde/Velarde)



CONNECTIONS



Connections between valley irrigation communities and contributing upland watersheds will be explored from multiple perspectives

PROJECT APPROACH

Acequia Resilience model
Socio-cultural and agro-economic characterizations and models of acequia community resilience

Multi-scale hydrology models
Surface water-groundwater studies and models of acequia effects on hydrology at watershed and basin scales

Integrated mapping
Spatial representations of land cover, wildlife habitat, and ecosystem services

System Dynamics model
System scale model that brings together project components to test acequia human and natural sustainability with changing climate and land use

Interdisciplinary modeling workshop
Multi-state effort to seamlessly integrate multiple disciplines with coordinated modeling of acequia hydrology and communities

Comparative global perspectives workshop
Gathering of international experts on community irrigation systems to explore new perspectives of science added to previous cultural analyses

Educational programs
Inclusion of K-12, undergraduate, and graduate students and the general public through research activities and museum exhibits

Outreach
Acequia community involvement through the New Mexico Acequia Association; general stakeholder outreach through the NM Cooperative Extension Service

Peer-reviewed articles
Dissemination of findings through published articles for scientific advancement and policy guidance

FUNDING

NSF Coupled Natural and Human Systems #1010516
NSF NM EPSCoR RII #0814449
New Mexico Agricultural Experiment Station

New Mexico EPSCoR

NSF

Las Cruces Sun News - Oct. 11, 2010

NMSU receives NSF grant to study link between acequia hydrology, culture, ecosystem

LAS CRUCES, N.M. – Water is the life blood of a community. Through the centuries, northern New Mexico communities along traditional acequia irrigation canals have managed the limited water resource provided by nature in ways that modern society can learn and benefit from.

New Mexico State University's College of Agricultural, Consumer and Environmental Sciences has received a $1.4 million grant from the National Science Foundation to provide new insights into the relationships between traditional water management systems, communities and landscapes.

"We think there are clues for future water sustainability within these acequia systems," said NMSU's Sam Fernald, associate professor of watershed management, who is principal investigator of the five-year study. "We want to quantify how these inter-relationships benefit local communities and downstream water users."

The study will involve hydrologists, sociologists, economists, anthropologists, remote sensing specialists, and rangeland and ecosystem scientists from NMSU, the University of New Mexico, Sandia Labs, New Mexico Tech University, Maxwell Museum at UNM, the University of Idaho, the University of Nevada at Reno and the University of Concepcion in Chile, as well as the New Mexico Acequia Association and community members from El Rito, Arroyo Hondo and Valdez, Velarde and Alcalde and surrounding areas.

Acequias consist of gravity-fed earthen canals that divert stream water flow for distribution in fields. These systems 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 socio-cultural and ecosystem benefits.

"Acequia systems help maintain community identity and cohesion, economic sustainability, enhanced floodplain hydrologic functions, and wildlife habitat," Fernald said. "Contemporary acequia-based communities face new socio-economic and natural resource pressures that threaten their existence."

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," Fernald said. "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 along three rivers, El Rito, Rio Hondo and Rio Grande, will explore socio-economic 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 livestock grazing distribution connections between valley riparian areas and upland forests and grasslands.

A computerized system dynamics model will be used to quantify the role of acequias in hydrologic functions, socioeconomic structures and ecosystem processes, and simulate effects of climate and land-use stressors.

"We want to identify potential tipping points for acequia community survival," Fernald said of the integrative model. "Mapping will capture spatial linkages and help communicate the findings to a larger audience."

Once the study is completed, results will be made available to researchers, policymakers, local stakeholders and the general public through publications, presentations, Cooperative Extension Service documents and workshops.

Activities planned to communicate the study findings include participatory training for K-12 teachers of the region in order to educate their students of the inter-relationship of hydrology, communities and landscape, and a museum exhibit that will integrate spirituality and sense of place into presentations of community resource governance done through acequia associations.

"We are also planning to share information and ideas with international experts during a global comparative workshop and a sister study in Chile," said Fernald of the project that is being supported by the NSF Dynamics of Coupled Natural and Human Systems Program. "Policy guidance resulting from this study should help maintain acequia communities and similar common-pool resource systems worldwide."

"EYE ON RESEARCH" is provided by New Mexico State University. This week's feature was written by Jane Moorman of University Communications.

Temporal and Spatial Variability of Surface Water and Groundwater Interactions in a Semi-Arid Agricultural Valley

Carlos Ochoa[1]; Alexander Fernald[1]; Steve Guldan[2]; Vince Tidwell[3]

Introduction:

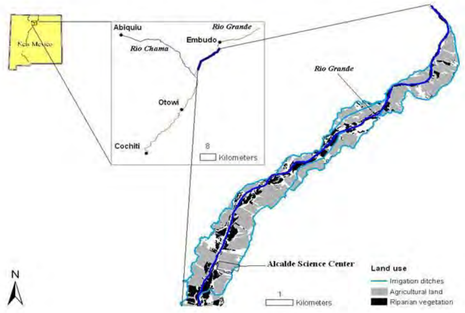
In arid and semi-arid landscape settings, an important source of groundwater supply may come from shallow aquifers. In agricultural valleys of northern New Mexico, the use of traditional surface-irrigation systems may contribute to shallow aquifer recharge. Over the last eight years, we have studied surface water and groundwater interactions occurring at different spatial and temporal scales in a 20-km agricultural valley along the Rio Grande in northern New Mexico. At the Alcalde-Velarde valley, we have conducted research trials and modeling efforts for characterizing hydrological interactions in the surface-vadose zone-aquifer continuum for representative crops and soils.

Objective:

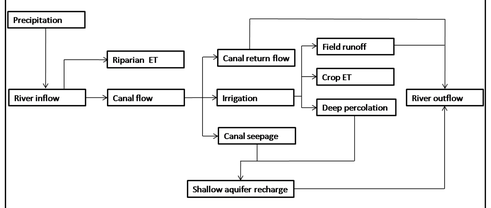
To characterize surface water and groundwater interactions of an irrigated valley occurring at different temporal and spatial scales.

Study site:

The Alcalde – Velarde agricultural valley in northern New Mexico.



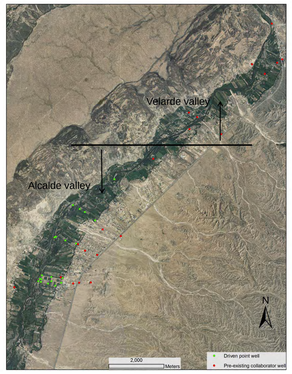
Conceptual model:



Methods:

The water balance and the water level fluctuation methods were combined to characterize surface water and groundwater interactions at the valley and plot scales.

VALLEY SCALE INTERACTIONS

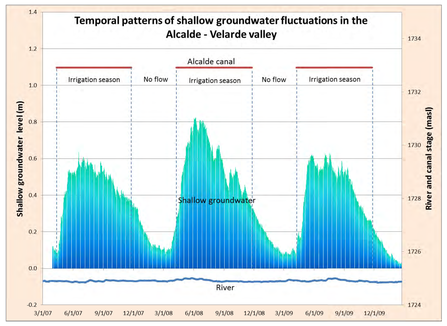


- Installed driven point wells and collaborator domestic wells were monitored for water level fluctuations in the entire valley.
- Water level data were collected hourly.

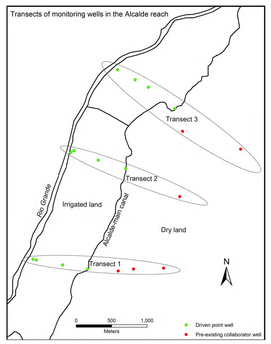
Alcalde main canal - water balance for year 2007.

Component		Amount from canal diversion + total precipitation (%)	Range (%)
Surface water - return flow	Flow control diversion	9.4	0 to 14
	Crop field runoff	8.8	5 to 12
	Canal outflow	44.0	28 to 67
Shallow groundwater	Canal seepage	11.3	5 to 17
	Deep percolation	19.2	9 to 32
Crop evapotranspiration		7.3	1 to 12
	Total	100.0	

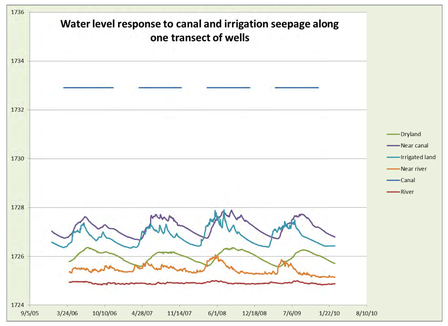
- Of water diverted from the Rio Grande into the Alcalde valley - main irrigation canal, 33.3 % reached shallow groundwater during the irrigation season of 2007.



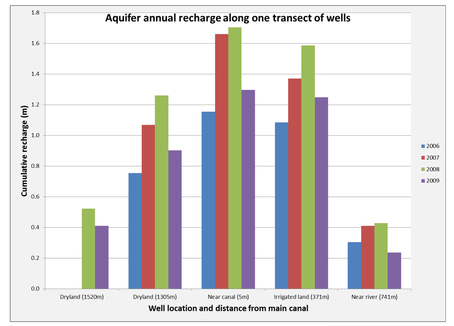
- Canal seepage and irrigation deep percolation contributed to water table rise up to 0.8 m during irrigation season.



- Depth to water table at its lowest level ranged from 1.5 m (near-river), to 8 m (near-canal), to 4 m (mid-irrigated land), to 30 m (dry land).



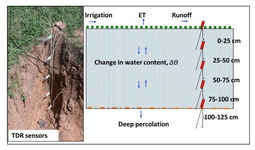
- Transects of wells were selected for studying aquifer recharge at different well locations
- Water levels in transect 1 responded seasonally to inputs from irrigation.



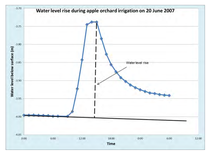
- A monthly step water level fluctuation method was used to calculate cumulative annual recharge at different well locations.
- Higher shallow aquifer recharge in transect 1 occurred in the well located near the main canal.

PLOT SCALE INTERACTIONS

- Studies of irrigation and groundwater interactions were conducted in valley representative crop and soil types at the NMSU-Alcalde Science Center.



- A daily water balance method was used for determining deep percolation below the top 1-m soil.

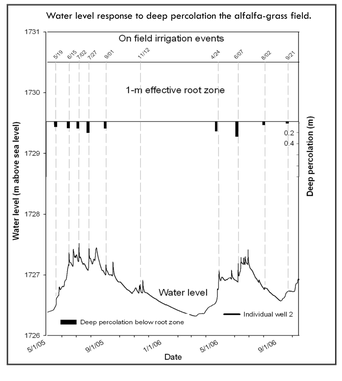


- The water level fluctuation method was used to estimate aquifer recharge from irrigation.

- Measurements of field irrigation and runoff were used in calculating the water balance.

- Flood and furrow are the most common irrigation methods in the valley.

- Weather data collected on-site was used for calculating crop ET.

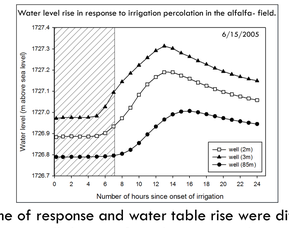


- A transient water level rise was observed in response to deep percolation from irrigation.

Deep percolation by the daily water balance method and aquifer recharge by the water level fluctuation method at different well locations for different crop and soil types.

Date	IRR rate	IRR	ΔS	RO	ET	DP	Well distance from irrigation line (m) 2	3	20	50	85	120
	mm/h					mm	Aquifer Recharge					
Alfalfa-grass with sandy loam soil												
5/19/05	31	216	156	0	8	52	26	NA	-	-	NA	-
6/15/05	31	246	138	0	9	99	87	53	-	-	23	-
7/6/05	32	219	87	0	8	124	88	72	-	-	NA	-
7/27/05	34	298	112	0	4	182	93	74	-	-	51	-
9/1/05	24	175	91	0	8	76	55	39	-	-	31	-
4/24/06	29	317	159	0	8	150	36	112	-	-	19	-
6/7/06	33	390	146	0	8	236	76	83	-	-	53	-
8/2/06	26	154	85	0	4	65	12	8	-	-	17	-
9/21/06	19	125	93	0	7	25	1	1	-	-	4	-
Apple orchard with sandy clay soil												
5/24/06	55	385	35	0	6	344	-	-	205	-	-	72
6/22/06	58	462	84	0	9	369	-	-	165	-	-	62
6/20/07	31	213	161	0	8	44	-	-	65	-	-	5
7/17/07	23	204	128	0	9	67	-	-	190	-	-	8
10/26/07	39	284	329	0	5	-	-	-	110	-	-	-
Oat-grass with clay loam soil												
6/10/08	8	211	31	14	9	157	-	-	1	4	-	0.3
6/24/08	8	187	34	17	7	129	-	-	61	44	-	28
7/7/08	7	85	24	9	4	48	-	-	3	-	-	0.3
8/12/08	8	59	44	0	4	10	-	-	-	-	-	-
9/9/08	11	81	94	11	5	-	-	-	-	-	-	-
10/28/08	6	42	50	0	4	-	-	-	-	-	-	-
4/29/09	13	122	34	2	8	79	-	-	4	8	-	7
5/21/09	12	97	63	5	4	26	-	-	3	4	-	6
6/15/09	12	93	62	7	8	17	-	-	5	8	-	5
7/13/09	12	88	111	1	1	-	-	-	-	-	-	-
7/27/09	12	85	109	16	9	-	-	-	-	-	-	-
9/2/09	14	103	140	6	4	-	-	-	-	-	-	-

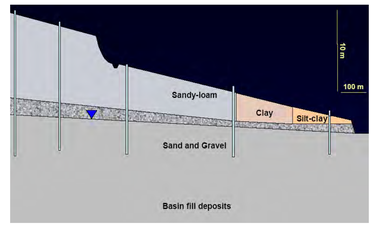
- Irrigation amount and rate of application played an important role in deep percolation and aquifer recharge.



- Time of response and water table rise were different at different well distance from the irrigation line.

Modeling:

- HYDRUS is being used for simulating water transport through the vadose zone in cross sections of this irrigated valley.

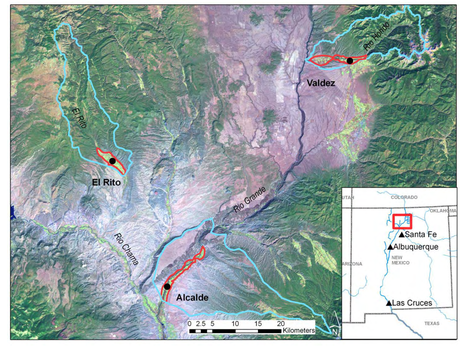


- A Collaborative System Dynamics Model is being used for integrating water interactions with socio-economic parameters at the regional scale.

Conclusions:

- Shallow aquifer recharge in this irrigated valley is mostly driven by irrigation percolation.
- Temporal scales of aquifer recharge range from few hours in irrigated lands to several weeks in wells located in dry lands.
- Water table rise in wells located in dry land as far as 1500 m from the irrigated portion of the valley can be attributed to irrigation water inputs.
- Ongoing modeling efforts will allow expanding local results to larger spatial scales, especially to other irrigated valleys with similar physiographic and water management settings.

Future Research:



Based on research findings at the Alcalde – Velarde valley study, we are expanding our research scope to investigate the hydrological connectivity of irrigated valleys and their head waters. For that, we have selected three different watersheds (Alcalde, El Rito, and Rio Hondo) in northern New Mexico, which provide important discharge to the Rio Grande, one of the most important river systems in the southwestern United States.

Funding acknowledgments: NSF-EPSCoR, NSF-CNH, USDA CSREES NRI, USDA Rio Grande Basin Initiative, USDOI Bureau of Reclamation, New Mexico Agricultural Experiment Station.

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Field Studies and Modeling of Water Movement through the Vadose Zone

Carlos Ochoa[1], Alexander Fernald[1], Steve Guldan[2], Manoj K. Shukla[3]

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Introduction:

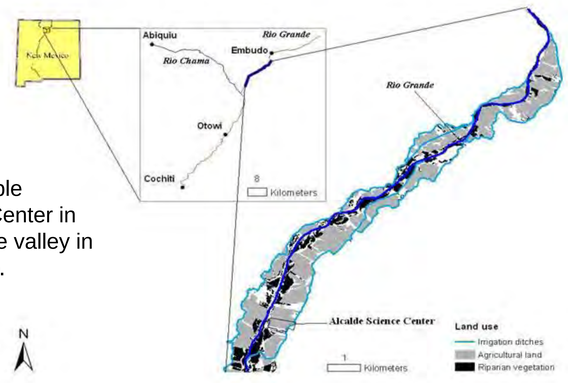
In the arid southwestern United States, deep percolation from irrigation contributes a significant amount to the recharge of local aquifers. This can be particularly observed in alluvial agriculture valleys of northern New Mexico, where large applications of surface irrigation often exceed plant consumptive use and percolate below the root zone and into the aquifer. At one of these alluvial valleys, we conducted several percolation studies in three crop fields (alfalfa, apple, and oat-grass) with different soil types and variable depth to water table.

Objective:

Determine deep percolation rates and aquifer response to variable irrigation amounts.

Study site:

The NMSU-Sustainable Agriculture Science Center in the Alcalde agriculture valley in northern New Mexico.



Methods:

A daily water balance method and the Root Zone Water Quality Model were used for calculating deep percolation below the top 1-m soil using field-measured parameters.

Soils:

• Different soil type: Alfalfa = Sandy loam, Orchard = Clay, Oat-grass = Sandy loam, Oat-grass = Clay loam.

Irrigation:

• Border irrigation on alfalfa and apple fields and furrow irrigation on oat-grass.

Soil water content:

• Vertical nests of soil water content sensors in the top 1-m soil.

Water table fluctuation:

• Driven point wells instrumented with water level loggers

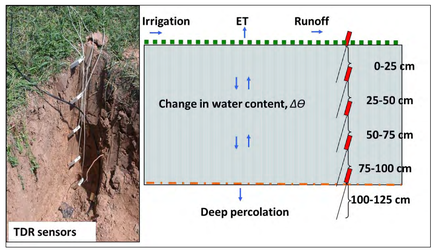
• Variable depth to water table: Alfalfa = 5 m, Apple orchard = 4 m, Oat-grass = 2.5 m (clay loam soil), and 4 m (sandy loam soil).

Weather:

• A weather station was installed on-site for measuring weather parameters used in ET calculations.

Deep percolation by the Daily Water Balance Method (DWBM)

Deep Percolation = Irrigation - ΔΘ - Runoff – ET



Date	Time of irrigation	Irrigation	ΔΘ	Runoff	ET	Deep percolation	
m/d/y	h	cm					%
5/19/05	7.0	21.6	15.6	-	0.5	5.5	25.4
6/15/05	7.9	24.6	14.0	-	0.8	9.8	39.7
7/6/05	6.9	21.9	8.7	-	0.9	12.3	56.3
7/27/05	8.7	29.8	10.9	-	0.7	18.2	61.2
9/1/05	7.3	17.5	9.3	-	0.8	7.4	42.5
4/24/06	11.0	31.7	16.0	-	0.6	15.1	47.6
6/7/06	12.0	39.0	15.0	-	0.7	23.3	59.7
2/8/06	6.0	15.4	9.0	-	0.6	5.8	37.8
9/21/06	6.5	12.5	10.0	-	0.6	1.9	14.9

• Significant deep percolation rates were observed during most irrigations in the alfalfa field.

• High deep percolation rates observed during first two irrigations were associated to sprinkler irrigation applied within one week prior to border irrigation

Date	Time of irrigation	Irrigation	ΔΘ	Runoff	ET	Deep percolation	
m/d/y	h	cm					%
5/24/06	10.4	38.5	3.5	-	0.6	34.4	89.3
6/22/06	7.7	46.2	8.4	-	0.9	36.9	79.9
6/20/07	4.5	21.3	16.1	-	0.8	4.4	20.7
7/17/07	4.0	20.4	12.8	-	0.9	6.8	33.2
10/26/07	5.6	28.4	32.9	-	0.5	–	–

Date	Time of irrigation	Irrigation	ΔΘ	Runoff	ET	Deep percolation	
m/d/y	h	cm					%
6/10/08	26.5	21.1	3.1	1.4	0.9	15.7	74.4
6/24/08	23.0	18.7	3.4	1.7	0.7	12.9	69.0
7/7/08	11.5	8.5	2.4	0.9	0.4	4.8	56.5
8/12/08	7.0	5.9	4.4	0.0	0.4	1.1	18.6
9/9/08	7.6	8.1	9.4	1.1	0.5	–	–
10/28/08	7.6	4.2	5.0	0.0	0.4	–	–
4/29/09	9.4	12.2	3.4	0.2	0.8	7.8	63.9
5/21/09	8.0	9.7	6.3	0.5	0.4	2.5	25.8
6/15/09	7.7	9.3	6.2	0.7	0.8	1.6	17.2
7/13/09	7.2	8.8	11.1	0.1	0.1	–	–
7/27/09	7.0	8.5	10.9	1.6	0.9	–	–
9/2/09	7.3	10.3	14.0	0.6	0.4	–	–

• High deep percolation rates were observed following the first three irrigations in the oat-grass field with clay loam soil.

Date	Time of irrigation	Irrigation	ΔΘ	Runoff	ET	Deep percolation	
m/d/y	h	cm					%
6/16/08	27.0	26.7	10.4	4.2	0.9	11.2	41.9
7/1/08	8.8	9.6	6.0	2.2	0.5	0.9	9.4
7/14/08	11.5	12.5	4.1	4.0	0.4	4.0	32.0
8/7/08	8.0	8.7	9.5	3.9	0.4	–	–
9/11/08	7.5	7.4	5.2	1.6	0.4	0.2	2.7
10/20/08	7.5	4.1	8.4	0.0	0.3	–	–
5/6/09	7.1	8.4	6.9	0.8	0.9	–	–
6/4/09	8.8	11.7	17.3	2.4	0.8	–	–
6/25/09	7.2	8.5	8.6	0.8	0.7	–	–
7/20/09	6.8	8.5	7.3	0.2	0.8	0.2	–
8/10/09	7.0	8.5	6.7	0.9	0.9	–	–
9/1/09	6.7	10.1	14.9	3.5	0.4	–	–

• Few irrigation events yielded deep percolation in the oat-grass field with sandy loam soil.

Deep percolation by the Root Zone Water Quality Model (RZWQM)

• RZWQM was used to simulate deep percolation in the alfalfa and oat-grass fields.

Irrigation	RZWQM-DP	DWBM-DP	Difference
cm			
21.1	13.4	15.7	2.3
18.7	13.6	12.9	-0.7
8.5	2.2	4.8	2.6
5.9	-	1	1
8.1	0.2	-	-0.2
4.2	-	-	-
12.2	1.4	7.9	6.5
9.7	1.8	2.6	0.8
9.3	1.7	1.7	0
8.8	1.3	-	-1.3
8.5	1.6	-	-1.6
10.3	1.9	-	-1.9

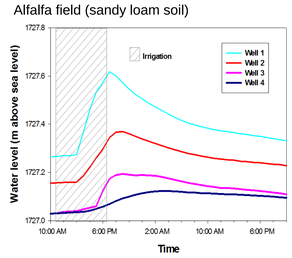
Irrigation	RZWQM-DP	DWBM-DP	Difference
cm			
21.6	6.8	5.2	-1.6
24.6	11.4	10	-1.4
21.9	9.5	12.4	2.9
29.8	17	18.2	1.2
17.5	5.5	7.7	2.2
31.7	14.8	15	0.2
39.0	24.4	23.5	-0.9
15.4	3.1	6.5	3.4
12.5	1.2	2.5	1.3

Irrigation	RZWQM-DP	DWBM-DP	Difference
cm			
26.7	11.2	11.2	0
9.6	3.5	0.9	-2.6
12.5	5.7	4.0	-1.7
8.7	1.9	-	-1.9
7.4	0.6	0.2	-0.4
4.1	-	-	-
8.4	0.2	-	-0.2
11.7	1.6	-	-1.6
8.5	0.8	-	-0.8
8.5	0.8	0.2	-0.6
8.5	0.8	-	-0.8
10.1	1.1	-	-1.1

• Reasonable agreement between DWBM deep percolation and RZWQM deep percolation was observed.

Water level response

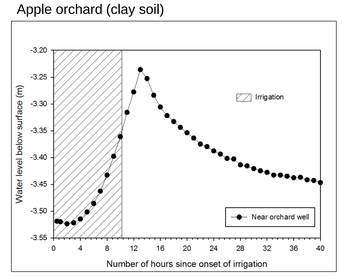
Alfalfa field (sandy loam soil)



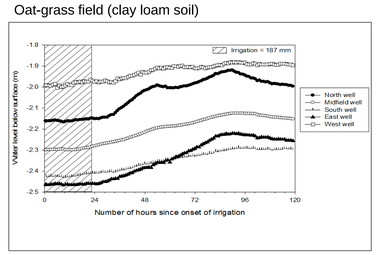
• Rapid response and peak water level of up to 38 cm were observed during the 6/15/05 irrigation on the alfalfa field

• A water level rise of up to 28 cm was observed during the 5/24/06 irrigation in a well 50 m south of the apple orchard

Apple orchard (clay soil)



Oat-grass field (clay loam soil)



• Longer time of response and smaller rise in water level were observed in the oat-grass fields when compared to results from the alfalfa and apple fields.

Conclusions:

• Antecedent soil water content played an important role on determining deep percolation.

• The RZWQM can be used for adequately simulating deep percolation on fields with crop and soil conditions similar to the ones evaluated in these studies.

•The greater water table rise observed in the alfalfa and apple fields was attributed to macropore flow from these two crops deep-rooting system.

Funding: USDA CSREES NRI CGP; New Mexico Agriculture Experiment Station.

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