

Water Resources Research Institute
Annual Technical Report
FY 2006

Introduction

This program report provides the required information for projects funded with the 2006 base grant and mandatory non-federal matching funds. Please note that there may be some overlap in information with our 2005 report because data collection is based on a July-June fiscal year rather than the March-February USGS Grant Award period.

The New Mexico Water Resources Research Institute (NMWRRI) was established in 1963 by the New Mexico State University Board of Regents, becoming one of the first of the 54 state institutes approved nationwide under the authorization of the 1964 Water Resources Research Act. It is considered to be the statewide nucleus for coordinating water resources research. Using the expertise of researchers in a variety of disciplines at state-supported universities, the institute is able to respond to the critical water needs of New Mexico and the region. It operates under the general advice of a Program Development and Review Board, whose membership includes faculty representatives as well as state and federal agency personnel.

The mission of the NMWRRI is to develop and disseminate knowledge that will assist the state, region, and nation in solving water resources problems. Specifically, the institute encourages university faculty statewide to pursue critical areas of water resources research while providing training opportunities for students who will become our future water resources scientists, technicians, and managers. It provides an outlet for transferring research findings and other related information to keep water managers and the general public informed about new technology and research advances. In addition, the institute maintains a unique infrastructure that links it with many federal, state, regional, and local entities to provide expertise and specialized assistance.

The institute maintains a dynamic program to transfer technical information from the producer to the user and the public. Technical publications, newsletters, conferences, press announcements, and presentations keep practitioners aware of new technology and research advances. The NMWRRI homepage (wri.nmsu.edu) provides on-line information about the institute, newsletters, technical report series, requests for proposals, upcoming conferences and symposia, links to related entities, and the research reference library.

New Mexico is one of the driest states in the nation, averaging no more than 20 inches of precipitation a year, varying from about 6.5 inches in the Four Corners area to more than 30 inches in the high mountains. The relative humidity is low, resulting in a high rate of evaporation. Summer rain accounts for almost half of the annual precipitation other than in the high mountains. Widely varied precipitation contributes as much to a water allocation problem as water scarcity itself. To compound the situation, New Mexico, like much of the West, continues to suffer from the worst drought in 100 years or longer. Although most of New Mexico remained in the drought free category based on above-average precipitation for the 2006 summer and the 2006-2007 winter season, it experienced a drying trend in late winter. Parts of New Mexico remain in mild and moderate drought stages. Reservoir levels range from a low of 6% capacity at Caballo reservoir in southern New Mexico to 94% capacity at Navajo reservoir in the northwest. Storage at New Mexico's largest reservoir, Elephant Butte, is at 30% capacity, a slight increase from last year. Water conservation measures continue to expand in municipalities throughout New Mexico to help ensure adequate public water supplies for residential and industrial use. Drought ordinances are in place in cities across the state, and county and municipal governments are working together to limit water use and reduce demand. The Drought Task Force, established in April 2002 by New Mexico's governor after declaring a state of emergency because of the drought, continues to monitor the situation.

Water problems in New Mexico, like in other western states, continue to revolve around three key issues: quality, quantity, and management. Because water resources are so limited, water quality and water resources management have taken on increasing importance. These concerns are interrelated and sufficiently complex so that the highest quality research is essential to solving them.

Research Program

The primary objective of the New Mexico Water Resources Research Institute is to maintain a balanced program of research that addresses water issues and problems critical to New Mexico, the region, and the nation. In administering this program, the institute relies on financial support from state appropriations, federal and state agencies, and the USGS Water Resources Research Institute Annual Base Program.

To make the best use of limited resources, the institute has targeted four areas as high priority for funding: water conservation, planning, and management; atmospheric, surface, and groundwater relationships; water quality; and utilization of saline and other impaired waters. During the reporting period, five projects received joint funding from state appropriations and the 2006 Annual Base Program. These projects include two that fit into the water conservation, planning, and management category: Development of Geospatial Modeling Tools for Watershed-based Water Resources Management in New Mexico, and Estimating Water Use through Satellite Remote Sensing. Two other projects were funded in the utilization of saline and other impaired waters category: Mitigation of Membrane Biofouling by Harnessing Bacterial Cannibalism, and Sustainable Recovery of Potable Water from Saline Waters. One project, A Physically Based Parsimonious Approach for Spatial Disaggregation and Recovery of NEXRAD Precipitation Data in Mountainous Terrains was funded in the atmospheric, surface, and groundwater relationships category. Funding from the 2006 USGS 104B program supported the institute's GIS laboratory project, Geographic Information Systems for Water Resources Research Planning, a project focusing on conservation, management, and planning.

During the reporting period, the NMWRRI administered a total of 47 projects dealing primarily with water quality and conservation issues. The total value of these projects was just over \$1.14 million, including required cost sharing. Awards were made by various federal and state agencies, a private foundation, and from the institute's annual state appropriations. Dollar amounts per project award ranged from \$1,594 to nearly \$154,000. During the reporting period, projects were conducted at New Mexico State University, New Mexico Tech, University of New Mexico, New Mexico Highlands University, and Eastern New Mexico University. Faculty members were principal investigators on 41 projects and NMWRRI staff managed 6 projects. The institute maintained frequent contact with its researchers through periodic progress updates, site visits, and expenditure tracking.

Research projects administered by the NMWRRI utilized at least 108 students during the year including undergraduates, masters, and Ph.D. candidates in the disciplines of anthropology, aquatic biology, biology, business, chemical engineering, civil engineering, computer science, earth and planetary sciences, ecology, economics, English, environmental geology, environmental engineering, earth sciences, geography, hydrology, life sciences, microbiology, natural resource management, physics, political science, turfgrass management, and watershed management. A water resources summer training program provided a broad understanding of water resources to approximately 15 Native American high school students from across the nation.

Projects administered by the New Mexico Water Resources Research Institute during the reporting period that were funded from sources other than the 2006 USGS Annual Base Program are listed below. Note that total award value is shown and includes both agency and cost sharing when appropriate.

The Influence of Larval *Culiseta* sp. (Diptera: Culicidae) on Behavior and Growth Rate of Tadpole Shrimp *Triops longicaudatus* (LeConte) (Notostraca: Triopsidae). WRRRI Student Research Grant 06 (Nicole M. Harings, Eastern New Mexico University) \$1,594

Soil Recovery after Herbicide Treatment of Saltcedar Stands and Management Implications. WRRRI Student Research Grant 05 (Cheryl Rosel, New Mexico State University) \$1,900

Mycorrhizal Colonization in Cottonwood and Salt Cedar Stands along the Middle Rio Grande: Implications for Water Quality and Water Consumption. WRRRI Student Research Grant 05 (Jennifer Follstad Shah, University of New Mexico) \$3,000

Groundwater Quality and Well Water Assessment in Las Vegas, New Mexico Area. WRRRI Student Research Grant 05 (Simone-Camille Yelah Tar, New Mexico Highlands University) \$3,482

Investigation of Transpiration Water Loss from Pinion-Juniper Forests. WRRRI Student Research Grant 05 (Sue White, New Mexico Tech) \$4,586

Rapid Detection of Human Fecal Contamination Using sIgA as an Indicator. WRRRI Student Research Grant 05 (Jessica Hamel, New Mexico State University) \$4,600

The Influence of Predator Detection on Life History Strategies in DAPHNIA. WRRRI Student Research Grant 06 (Irene M. Roselli, Eastern New Mexico University) \$4,696

Uranium and Heavy Metals in Macroinvertebrates in the Santa Fe River on the Cochiti Reservation. WRRRI Student Research Grant 06 (Carlos R. Herrera, New Mexico Highlands University) \$4,899

Determination of Heavy Metal Distribution in the Gallinas River Using Aquatic Macrophytes. WRRRI Student Research Grant 06 (ChemANJI Shu-Nyamboli and Joel Lowry, New Mexico Highlands University) \$4,996

Riparian Evapotranspiration Estimates on the Middle Rio Grande Using Remote Sensing. WRRRI Student Research Grant 05 (Maritza A. Macias-Corral, New Mexico State University) \$5,000

Modeling of Mass and Heat Transport in Membrane Distillation Process for Brackish Water Desalination. WRRRI Student Research Grant 05 (Prajwal Vikram, New Mexico State University) \$5,000

Numerical Modeling Investigation of Fluid Flow Above and Below Sediment-water Interfaces. WRRRI Student Research Grant 05 (Meinhard Bayani R. Cardenas, New Mexico Tech) \$5,000

Hydrometeorological Field Studies During the North American Monsoon in the Valles Caldera National Preserve. WRRRI Student Research Grant 05 (Alex J. Rinehart, New Mexico Tech) \$5,000

Surveying Health Risks Associated with Arsenic in the Gallinas Watershed. WRRRI Student Research Grant 05 (Justin Johns-Kaysing, New Mexico Highlands University) \$5,000

Cattails and Ostracodes: An Investigation of Prehistoric Water Management in the Chupadera Arroyo Basin, Central New Mexico. WRRRI Student Research Grant 05 (Monika Enke, Eastern New Mexico University) \$5,000

Water Quality along the Middle Rio Grande of New Mexico. WRI Student Research Grant 05 (Lydia Zeglin, University of New Mexico) \$5,000

Human Impacts on Nitrate Dynamics in Hypoheic Sediments Using a Stable Isotope Tracer. WRI Student Research Grant 05 (Chelsea Crenshaw, University of New Mexico) \$5,000

Expand and Enhance Effective Partnerships and to Develop and Share Critical, Multi-Jurisdiction Watershed Information with Stakeholders. Texas A&M University \$5,000

Characterization of Heavy Metal Binding by Functional Groups Found in Biomaterials. WRI Student Research Grant 06 (Jesus Q. Cantu, New Mexico State University) \$5,000

Community and Ecosystem Effects of a Nonnative Fish in Refugia in an Intermittent Stream: Implications for Native Fish Restoration. WRI Student Research Grant 06 (Ryan McShane, New Mexico State University) \$5,000

Relating Fish Abundance and Condition to Environmental Factors in Desert Sinkholes. WRI Student Research Grant 06 (Kristin Swaim, New Mexico State University) \$5,000

The Effects of Eutrophication on the Structure and Function of Stream Biofilms. WRI Student Research Grant 06 (David J. VanHorn, University of New Mexico) \$5,000

Experimental and Numerical Modeling Analysis of Arsenic-sulfide Precipitation in Groundwater Environments. WRI Student Research Grant 06 (Matthew F. Kirk, University of New Mexico) \$5,000

Runoff Processes and the Evolution of Water Chemistry in the Saguache Creek Watershed of the Upper Rio Grande. WRI Student Research Grant 06 (Marty D. Frisbee, New Mexico Tech) \$5,000

Use of Remotely Sensed Observations for Improved Distributed Hydrological Modeling in the Jemez River Basin. WRI Student Research Grant 06 (Taufique Mahmood, New Mexico Tech) \$5,000

Multi-disciplinary Analysis of a New Mexico Cold Water Tufa Spring Mound. WRI Student Research Grant 06 (Katrina Koski, New Mexico Tech) \$5,000

Coordinated Database for Water Related Resources in the Rio Grande Watershed. Texas A&M University \$7,062

Predicting Land Use Change and Its Effect on Nonpoint Source Pollution. New Mexico state appropriations \$10,000

Development of RiverWare Model of the Rio Grande Flow between Elephant Butte Dam and Fort Quitman. Texas A&M University \$14,659

Land Application of Industrial Effluent on a Chihuahuan Desert Ecosystem. \$29,240

Sustainable Recovery of Potable Water from Saline Waters. New Mexico state appropriations \$19,960; 104B program \$10,000

Development of Geospatial Modeling Tools for Watershed-based Water Resources Management in New Mexico. New Mexico state appropriations \$19,991; 104B program \$10,000

A Physically Based Parsimonious Approach for Spatial Disaggregation and Recovery of NEXRAD Precipitation Data in Mountainous Terrains. New Mexico state appropriations \$20,000; 104B program \$10,000

Estimating Water Use through Satellite Remote Sensing. New Mexico state appropriations \$20,000; 104B program \$10,000

Solar Desalination of Brackish Water Using Membrane Distillation Process. \$30,000

Utilization of Saline and Other Impaired Waters for Turfgrass Irrigation. \$30,000

New Mexico Pesticide Management Plan 2005-2006. Memorandum of Agreement with the New Mexico Department of Agriculture \$30,000

Mitigation of Membrane Biofouling by Harnessing Bacterial Cannibalism. New Mexico state appropriations \$20,000; 104B program \$10,000

Development of RiverWare Model of the Rio Grande Flow between Elephant Butte Dam and Fort Quitman. Texas A&M, Agricultural Research and Experiment Center at El Paso. \$44,489

State Science Forums for the Gila Basin Act. New Mexico Interstate Stream Commission \$50,000

A Joint Investigation of Evapotranspiration Depletion of Treated and Non-Treated Saltcedar at the Caballo Dam, New Mexico. U.S. Bureau of Reclamation \$53,462

Grand Unified Groundwater Model Development for the Lower Rio Grande. Lower Rio Grande Water Users Association \$63,576

Water Resources Training Program for Native American Students 2006. US Bureau of Indian Affairs \$71,555

Validation, Calibration and Improvement of Remote Sensing ET Algorithms in Mountainous Regions. USGS 104G \$74,795

U.S.-Latin American Relations Program Mapping Project. Hewlett Foundation \$101,376

Development of a RiverWare Model of the Rio Grande Flow and a Coordinated Database for Water Related Resources in the Rio Grande Watershed. Texas A&M University \$110,070

U.S.-Latin American Relations Program. Hewlett Foundation \$153,925

A Physically Based Parsimonious Approach for Spatial Disaggregation and Recovery of NEXRAD Precipitation Data in Mountainous Terrains (Wilson)

Basic Information

Title:	A Physically Based Parsimonious Approach for Spatial Disaggregation and Recovery of NEXRAD Precipitation Data in Mountainous Terrains (Wilson)
Project Number:	2006NM38B
Start Date:	3/1/2006
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	Three
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Hydrology, Models
Descriptors:	
Principal Investigators:	John L Wilson

Publication

1. Guan, H., J.L. Wilson, and O. Makhnin. 2005. Geostatistical Mapping of Mountain Precipitation Incorporating Autosearched Effects of Terrain and Climatic Characteristics. *Journal of Hydrometeorology*. 6:6:10181031.

Problem and Research Objectives

The temporal and spatial variability of precipitation controls many terrestrial hydrologic processes and states. Common remotely sensed precipitation products used to estimate precipitation have a spatial resolution that is often too coarse to reveal hydrologically important spatial variability. NEXRAD precipitation fields are one such product. This study is aimed at further developing and testing a physically-based statistical approach to spatial disaggregation using NEXRAD precipitation data.

Methodology

A parsimonious physically based multivariate-regression algorithm, referred to as multi-level cluster-optimizing ASOAdEK regression, is developed for downscaling low-resolution spatial precipitation fields. This algorithm auto-searches precipitation spatial structures (e.g., rain cells), and atmospheric and orographic effects to estimate precipitation distribution without prior knowledge of the atmospheric setting. The only required input data for the downscaling algorithm are a large-pixel precipitation map and the DEM map of the area of interest.

If the proposed algorithm performs well in tests, it will provide a tool to significantly improve existing NEXRAD precipitation estimates in mountains. The spatial disaggregation approach is also applicable to other low resolution remote sensing precipitation products (e.g., TRMM) and modeling precipitation products (e.g., PERSIANN). Based on this, we can generate high-resolution precipitation maps from current remote sensing products. This will significantly improve the atmospheric boundary conditions for near-surface hydrologic modeling, better test the hydrologic models, and improve their predictive capability. The algorithm can also be embedded into hydrologic modeling codes using NEXRAD precipitation an input, or in climate modeling codes to improve the spatial resolution of the output precipitation estimates.

Mitigation of Membrane Biofouling by Harnessing Bacterial Cannibalism (Huang)

Basic Information

Title:	Mitigation of Membrane Biofouling by Harnessing Bacterial Cannibalism (Huang)
Project Number:	2006NM41B
Start Date:	3/1/2006
End Date:	2/14/2007
Funding Source:	104B
Congressional District:	Three
Research Category:	Biological Sciences
Focus Category:	Treatment, Water Quality, Conservation
Descriptors:	
Principal Investigators:	Frank Huang

Publication

1. Huang, F. and S. Rogelj. Mitigation of Membrane Biofouling by Harnessing Bacterial Cannibalism. New Mexico Water Resources Research Institute, Technical Completion Report, New Mexico State University, Las Cruces, New Mexico. In Review.

Problem and Research Objectives

In 2002, about 113 million barrels (bbls) of produced water were generated in New Mexico during crude oil and natural gas production. The majority of the produced water is re-injected back into the same geological formation to enhance recovery of fuel reserves while the remainder is disposed of via deep injection wells. The amount of water disposed of through the injection wells is vast. Even partial desalination of water for use in industry, agriculture, and recreation would dramatically decrease pressures on freshwater aquifers and provide more water for beneficial needs. Membrane desalinization, being a well-established and effective separation process, is used routinely to reclaim small quantities of produced water. Large-scale implementation of the membrane processes for desalinating produced water, however, is hampered by the recurring biofouling of the membranes and the associated high operating costs. Acid and alkaline/detergent cleaning of biofouling are generally found to be ineffective.

Methodology

In this research, the applicability of bacterial cannibalism on biofouling control was studied. *Bacilli* and *Bdellovibrio bacteriovorus* have been shown to degrade biofilms and thus were chosen as the candidates to induce cannibalism. Evaluation of the protease and DNase activities showed that the 36-hour conditioned media (CM) by *B. subtilis* and *Bdellovibrio bacteriovorus* exhibited a significant proteolytic and DNA-degrading activity, respectively. Consequently, the 36-hour CM could potentially be used to control biofouling. In order to assess the degree of degradation on preformed biofilms, *Pseudomonas fluorescens* biofilms were cultivated at the air/growth media interface and characterized using Scanning Electron Microscopy with a special sample preparation process. The preformed *Pseudomonas fluorescens* biofilms were then immersed either in control saline, or *B. subtilis* conditioned media either in the absence or the presence of the living *B. subtilis* cells or *E. coli*-*Bdellovibrio* conditioned medium. The effectiveness of biofilm removal was gauged by staining the remaining biomass after treatment with crystal violet.

Principal Findings

From the results, the treatment of the preformed *P. fluorescens* biofilm with the *B. subtilis* or *Bdellovibrio* conditioned medium appeared to have reduced the *P. fluorescens* biofilm accumulation over time.

Development of Geospatial Modeling Tools for Watershed-based Water Resources Management in New Mexico (Vivoni)

Basic Information

Title:	Development of Geospatial Modeling Tools for Watershed-based Water Resources Management in New Mexico (Vivoni)
Project Number:	2006NM44B
Start Date:	3/1/2006
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	Three
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Hydrology, Management and Planning
Descriptors:	
Principal Investigators:	Enrique Vivoni

Publication

1. Aragon, C.A., E.R. Vivoni, L.A. Malczynski, and V.C. Tidwell. 2006. Ungauged tributary contributions in large ephemeral river basins through dynamical simulation. *Hydrological Processes*. In preparation.

Problem and Research Objectives

The project is developing new geospatial modeling tools for managing water resources in New Mexico using scientific knowledge on climate, surface, and groundwater relations. The new technology will be designed to provide decision makers with probabilistic forecasts of water supply using ensemble techniques and address the potential for climate and land cover changes on hydrological quantities. While sophisticated, the modeling results will be made amenable to water managers through monthly web products in a similar fashion to existing drought maps. The specific objectives of the project during the first year are to:

- Identify the hydrologic processes and feedbacks to be simulated in a system dynamics framework,
- Design and implement a watershed model in PowerSim (a system dynamics framework) with the linkages to a GIS and mathematical software (MATLAB),
- Develop ensemble forcing and parameter estimation code in MATLAB to generate alternative climate and land-use scenarios, and
- Utilize existing data for Rio Grande (topography, land/soils, rainfall, atmospheric observations) to obtain retrospective model simulations as a proof-of-concept.

Methodology

The project will integrate various technologies for the purpose of hydrological forecasting in regional basins. The hydrological simulation code is being developed in a system dynamics (SD) modeling environment known as PowerSim; the geospatial products are stored, queried, displayed, and archived in a geographical information system (ArcGIS); the ensemble generator and uncertainty estimator for climate/land-use changes will be developed in a mathematical software (MATLAB). We will spend considerable effort in integrating the three components to provide the user with seamless operation. The project will result in a semi-distributed hydrologic model to address the spatial and temporal dynamics of watershed processes, applied initially to the Rio Grande from headwaters to the NM/TX state line. Through coupling to a GIS, the model will incorporate remote sensing observations of rainfall, topography, vegetation cover, and soils to provide maps of hydrologic states (e.g., soil moisture, water table depth) and fluxes (e.g., evapotranspiration, runoff, recharge).

Principal Findings

Over the course of the past year, the system dynamics-based watershed model in Powersim has been completed. The model development has been carried out using both Powersim coding and Visual Basic. In addition, tools have been developed in Excel, GIS, and MATLAB to visualize model input and output. In addition to the model development efforts, we have also focused on collecting watershed data necessary to run the model for the Rio Grande over the time period of interest. We have selected the Rio Salado as our prototype case study and focused on the relevant data sets for this model application. Model testing is currently being completed with a short-term goal of producing an M.S. thesis (Carlos A. Aragón) on the project results. The goals for this summer include:

- Completion of M.S. thesis and preparation of publication on model development and testing for the Rio Salado,
- Retrospective model runs (1995-2005) for entire Rio Grande region, and
- Web site completion and dissemination of model results.

Estimating Water Use through Satellite Remote Sensing (Bleiweiss)

Basic Information

Title:	Estimating Water Use through Satellite Remote Sensing (Bleiweiss)
Project Number:	2006NM50B
Start Date:	3/1/2006
End Date:	2/14/2007
Funding Source:	104B
Congressional District:	Second
Research Category:	Engineering
Focus Category:	Water Use, Management and Planning, Water Supply
Descriptors:	
Principal Investigators:	Max P. Bleiweiss

Publication

1. Z. Samani, Salim Bawazir, M. Bleiweiss, R. Skaggs and V. Tran. Estimating Net Radiation over Vegetation Canopy. Scheduled for publication in ASCE Journal of Irrigation and Drainage, 2007. In press.

Problem and Research Objectives

A recent evaluation of the water budget at Lower Rio Grande has shown that 56% of water is unaccounted for (Magallanez and Samani, 2001). The 56% likely includes domestic water use, riparian vegetation use, supplementary farm irrigation pumping, and off-season runoff. In order to better account for the various uses of water and sources of beneficial and non-beneficial use and ultimately to optimize the use of water resources, a realistic evaluation of the amount and spatial and temporal variation of ET is needed.

For the purposes of the effort, the primary goal is to use the spatial and temporal variation of ET information to assess and map economic return from agricultural activities. Once ET is determined, then biomass can be calculated and linked to crop yield. This could provide an excellent opportunity to evaluate the impact of various parameters such as crop type, field size, and soil on the economic return from irrigated agriculture.

Methodology

Recent innovations in satellite technology have made it possible to process satellite data to estimate evapotranspiration (ET) with high spatial and temporal resolution. This technology (so named REEM), utilizes remote sensing parameters (land surface temperature (LST), normalized difference vegetation index (NDVI), and short wave albedo along with climate station data to arrive at an estimate of ET. These ET maps will be processed by overlaying agricultural field boundaries (initially, pecan orchards) to arrive at a field by field estimate of total ET. This is then linked to biomass and crop yield for a determination of economic return.

Principal Findings

Due to the many “false starts” in the creation of vector files that delineate the pecan orchards, there has been considerable delay in arriving at the necessary information to complete the task. However, we now have established procedures for the determination of two parameters of special interest: tree count/density and percent canopy cover, which will be compared to NDVI (normalized difference vegetation index) and then to ET – this is the “link” between biomass and ET. This will be the major topic of Aldo Piñon’s M.S. thesis.

Sustainable Recovery of Potable Water from Saline Waters (Khandan)

Basic Information

Title:	Sustainable Recovery of Potable Water from Saline Waters (Khandan)
Project Number:	2006NM51B
Start Date:	3/1/2006
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	Second
Research Category:	Engineering
Focus Category:	Treatment, Water Quality, Conservation
Descriptors:	
Principal Investigators:	Nirmala Khandan

Publication

1. Veera Gnaneswar Gude and NirmalaKhandan. Desalination Using Low Grade Heat Sources. Submitted to ASCE Journal of Energy Engineering.

Problem and Research Objectives

Due to increasing energy costs and declining energy sources, interest in the use of low grade heat sources and recovery of waste heat is growing. The goal of this study is to evaluate the feasibility of utilizing low grade heat to run a new desalination process. Traditional desalination processes such as reverse osmosis, electrodialysis, mechanical vapor compression, and multi-effect flash distillation require electrical energy derived from nonrenewable sources the cost of which has increased by 10 times over the past 20 years. Recently, a new desalination process has been proposed by Al-Kharabsheh & Goswami (2004) that has the potential to run solely on low grade heat at around 50°C. We propose a modification to that process, whereby it can be run round the clock, using a thermal energy storage (TES) system. The TES system can be maintained at the desired temperature using waste heat from any available source. In this study, we evaluated the feasibility of utilizing the heat rejected by a solar-powered absorption refrigeration system (ARS) to provide the energy for the TES.

Methodology

An integrated process model has been developed using Extend® and EES® software to simulate the desalination-absorption refrigeration system (ARS) process. Process parameters have been established to evaluate process performance and economical feasibility of the combined desalination/air conditioning system. Operating parameters have been identified. Design values of solar panels and TES volumes have been calculated for different desalination/air-conditioning rates.

Principal Findings

The integrated process model has been completed. Complete analysis of the process and design specifications have been completed. We have utilized other resources to build a near-full scale prototype system. This system is fully operational now and is being readied for experiments. It is planned to conduct a range of experiments over the summer to generate experimental data to validate the model developed during the first year.

Validation, Calibration, and Improvement of Remote Sensing ET Algorithms in Mountainous Regions

Basic Information

Title:	Validation, Calibration, and Improvement of Remote Sensing ET Algorithms in Mountainous Regions
Project Number:	2006NM63G
Start Date:	9/1/2006
End Date:	8/31/2008
Funding Source:	104G
Congressional District:	Second
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Water Quantity, Models
Descriptors:	
Principal Investigators:	Jan M.H. Hendrickx, Jan Kleissl

Publication

1. Hendrickx, J.M.H., J. Kleissl, et al. Scintillometer Networks for Calibration and Validation of Energy Balance and Soil Moisture Remote Sensing Algorithms. International Society for Optical Engineering (SPIE). In press.

Problem and Research Objectives

Accounting of key reservoirs and fluxes associated with the global water cycle, including their spatial and temporal variability, are crucial goals of water resource managers. Advancements in satellite optical remote sensing have resulted in the development of several operational remote sensing evapotranspiration (ET) algorithms. While these algorithms typically give accurate ET predictions over flat terrain, significant difficulties have been encountered in mountainous regions which are characterized by heterogeneous soil and topography and high elevation changes. However, mountain runoff represents more than 90% of the total runoff in the semi-arid basins of the Rio Grande, Oranje, Colorado, and Rio Negro rivers. Thus improving ET estimates in the mountains is crucial for determining the regional water balance in the southwestern U.S. and in many mountainous regions worldwide.

Methodology

Most remote sensing algorithms obtain ET as the residual of the energy balance after measuring and/or modeling net radiation, ground heat flux, and sensible heat flux H . Among these fluxes, H is the most complex to estimate and its value is associated with the greatest uncertainty. We will use novel measurement techniques, such as scintillometers, together with spatially dense meteorological measurements and archived ETA numerical weather model data to measure H and determine how it is related to temperature lapse rate, wind speed, water vapor deficit, and boundary layer height. Two protected sites with idealized topographical shape will be considered in the field study: the Magdalena Ridge and the Valles Caldera National Park in New Mexico. First, the measured H will be used to validate estimates derived from the Surface Energy Balance over Land (SEBAL) algorithm applied on data from synchronous ASTER and MODIS satellite overpasses. Second, techniques for calibration of the SEBAL algorithm in near-real time using surface measurements of H will be developed. Third, parameterizations in the SEBAL algorithm for mountain lapse rates, wind speeds, and surface roughnesses will be critically reviewed and improved by considering meteorological measurements and archived numerical weather model data. Through this work we will make a lasting contribution to ET estimation from SEBAL and other remote sensing algorithms for current and future satellite missions.

Principal Findings

The first major research episode will take place during the summer of 2007.

Information Transfer Program

The New Mexico Water Resources Research Institute maintains an active program to transfer technical information from the producer to the user and the public. Technical publications, newsletters, conferences, symposia, press announcements, and presentations keep practitioners aware of new technology and research advances. The WRRRI homepage (wrrri.nmsu.edu) provides online information about the institute's newsletters, technical report series, requests for proposals, upcoming conferences and symposia, and the research reference library. All 51 past annual water conference proceedings have full-text viewing via the institute's homepage. Other federal and state servers, such as the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, USGS, and National Weather Service are linked to the WRRRI homepage.

Geographic Information System for Water Resources Research Planning

Basic Information

Title:	Geographic Information System for Water Resources Research Planning
Project Number:	2002NM1B
Start Date:	3/1/2006
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	Second
Research Category:	Not Applicable
Focus Category:	Management and Planning, Conservation, Water Quality
Descriptors:	
Principal Investigators:	Bobby J. Creel

Publication

1. Creel, B.J., J.W. Hawley, J.F. Kennedy, and A. Granados-Olivas. 2006. Groundwater resources of the New Mexico-Texas-Chihuahua border region. *New Mexico Journal of Science*. 46:11-29.
2. Granados-Olivas, A., C. Brown, J. Greenlee, B. Creel, J.W. Hawley, J.F. Kennedy, O. Dena-Ornelas, and B. Hurd. 2006. Geographic information systems at the Paso del Norte region: The academic accomplishments and challenges for a transboundary water resources GIS cooperation. *New Mexico Journal of Science*. 46:45-56.
3. Kennedy, J.F., R.P. Langford, and J.W. Hawley. 2006. Using GIS and Remote Sensing to Reconstruct Late Quaternary and Early Holocene Paleo-Hydrography Using Climate Data and Modern Topography: An example from the Southwestern US. *Computers and Geosciences*. In press.
4. Kennedy, J.F., R.P. Langford, and J.W. Hawley. 2006. Estimating a Water-Balance Equation for a Playa in the Tularosa Basin of Southern New Mexico. *Computers and Geosciences*. In press.
5. King, J.P., J.W. Hawley, J.W. Hernandez, J.F. Kennedy, and E.L. Martinez. 2006. Study of Potential Water Salvage on the Tucumcari Project, Arch Hurley Conservancy District: Phase I. A pre-appraisal-level study of the potential amount of water that may be saved, and the costs of alternative methods of reducing carriage losses from district canals. *New Mexico Water Resources Research Institute Technical Completion Report 335*, with plates and appendices on CD ROM, New Mexico State University, Las Cruces, New Mexico.
6. Ortiz, Marquita. 2007. The Impacts of Land Use Change on Water Resources and Traditional Acequia Culture in Northcentral New Mexico. Master's thesis, Department of Geography, New Mexico State University, Las Cruces, NM.

GIS Project

Problem and Research Objectives

The New Mexico Water Resources Research Institute has become the focal point for geographic information system (GIS) data and information concerning water resources in New Mexico. It combines database management with digital mapping into spatial-tabular data models. These models are powerful tools for representing and manipulating earth-science information.

As use of geographic information systems has grown and presented new opportunities, it also has raised a number of new issues and problems. Of increasing concern is the management of a growing collection of spatial data sets and applications programs. These data sets and programs are very expensive to produce but relatively easy to share, so there is a great incentive to avoid duplicating production efforts. The trend clearly is toward managing these elements in distributed spatial libraries.

The primary objective of the project is to increase availability and accessibility of water resource information to support water resource planning and management in the state. The first task provides spatial data library accessibility. This task maintains arrangements and establishes those necessary to provide access to spatial data maintained by other agencies and organizations. The second task, spatial data development, evaluates needs, establishes priorities, and undertakes development of spatial data that is otherwise unavailable. These efforts will be coordinated with cooperating agencies and organizations to ensure no duplication of effort and to establish guidelines for coverages and priorities. The principal investigators maintain, update as necessary, and make the data available to cooperating agencies and organizations through both formal and informal arrangements to facilitate water resource planning activities.

Bobby J. Creel, Associate Director of the WRRI, oversees the GIS laboratory and its programs. Currently six students are being trained in the lab, three undergraduates and three graduate students.

Methodology

A number of cooperative data sharing agreements have been entered into with state, federal, and local agencies and organizations to facilitate access and to develop spatial data. Others will be pursued as necessary. Research funded by the NMWRRI in many cases results in the development of data that can be represented in a spatial form and thus can contribute to the state data pool. Projects that have such a potential are adjusted as necessary to meet this secondary purpose.

The NMWRRI maintains a GIS laboratory consisting of computer workstations; data storage devices; input/output devices (color plotter, digitizer, etc.); software for mapping and analysis (ARC/Info); database development and visualization; and network systems. The laboratory is connected via fiber to the New Mexico State University computer network and thereby to the Internet. The NMWRRI also maintains an Internet web server site through which both spatial and tabular water resource data can be provided.

Principal Findings and Significance

Various research activities are supported by the system for water resources planning in the state. The New Mexico Interstate Stream Commission provides grants to regional groups to support water resources planning. NMWRRI continues to be utilized by the NM Interstate Stream Commission to provide GIS mapping products for use in their plans and in public outreach. NMWRRI has helped many regional groups with GIS mapping products for use in their plans and in public outreach efforts.

Additionally, support has been given to the New Mexico/Texas Water Commission and various public entities of southern New Mexico for their planning activities. GIS mapping support is also provided to the Lower Rio Grande Water Users Organization.

Several presentations utilizing the products of the database management system were made: A presentation on the NM/TX/CH border groundwater mapping system project, which is supported by the Hewlett Foundation and the New Mexico Environment Department, was given at the Southwest Environmental Research and Policy (SCERP) annual meeting in Rio Rico, AZ, in May 2006 and at the SCERP sponsored GIS Summit in El Paso, TX, in April 2006. A similar presentation was made to the Paso del Norte Water Task Force meeting in August 2006.

Marquita Ortiz, a graduate student at New Mexico State University and WRRI's GIS Technician received an NMSU Cluster Mini-Grant award for her project entitled, *The Impacts of Land Use Change on Water Resources and Traditional Acequia Culture in North Central New Mexico*. She worked with co-investigators from several departments to examine and interpret land use changes in the Black Mesa Reach of the Rio Grande in northern New Mexico. Marquita employed GIS, remote sensing, and aerial photography to study the land use changes. She presented her project at the UCOWR annual meeting in Santa Fe, New Mexico, in July 2006. The presentation will appear as an article in UCOWR's journal, "Journal of Contemporary Water Research and Education." Marquita also presented a poster at the 2007 New Mexico Water Research Symposium in August 2006 for her project entitled, U.S.-Mexico Geospatial Database Based on Aquifer Boundaries. Marquita's co-authors on the poster included Casey Gomez, an undergraduate student in the GIS lab, and Hugo Rojas, a collaborator from Centro de Información Geográfica Instituto de Ingeniería y Tecnología Universidad Autónoma de Ciudad Juárez.

Another student in the GIS lab, Susanna Glaze, an undergraduate geography/GIS student received a GREG Award from the Office of the Vice President for Research at New Mexico State University. She has worked for the past year in the WRRI GIS lab.

Several presentations were made during the reporting period including the following:

1. John W. Hawley: Neogene basin-fill aquifer systems of the bi-national Paso del Norte Region—Advances in characterization of their depositional history and hydrogeologic framework. New Mexico Tech Hydrology Colloquium, October 16, 2006, Socorro, NM
2. John W. Hawley: Neogene basin-fill aquifer systems of the bi-national Paso del Norte Region—Advances in characterization of their depositional history and hydrogeologic framework. Geological Society of America, October 23, 2006, Philadelphia, PA
3. John W. Hawley: Neogene basin-fill aquifer systems of the bi-national Paso del Norte Region—Advances in characterization of their depositional history and hydrogeologic

framework. University of Illinois Geoscience Colloquium, November 10, 2006, Urbana, IL (with John Kennedy and Marquita Ortiz)

This sophisticated mapping and geo-spatial database management system, originally designed to support WRRI-funded research activities, is now being used for external research grants (e.g., Creation of a Digital Hydrogeologic Framework Model of the Mesilla Basin and Southern Jornada del Muerto Basin; creation of maps for the purpose of water planning funded by the New Mexico Interstate Stream Commission; and pesticide management planning in the state funded by the New Mexico Department of Agriculture) by water resources management and planning agencies in the state. A research grant resulted in the creation of a regional geographic information system to support water planning in the Paso del Norte borderland area of the southwestern United States.

This is an ongoing project with new data continually being added to the database and assistance being given to produce specific GIS products upon request. Continued funding is anticipated from annual state appropriations as well as pending agency awards.

Information Transfer Program

Basic Information

Title:	Information Transfer Program
Project Number:	2002NM3B
Start Date:	3/1/2002
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	Second
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	
Principal Investigators:	Bobby J. Creel, Cathy T. Ortega Klett

Publication

1. Tillery, S., Z. Sheng, J.P. King, B. Creel, C. Brown, A. Michelsen, R. Srinivasan, and A. Granados. 2006. The Development of a Coordinated Database for Water Resources and Flow Model in the Paso del Norte Watershed. New Mexico Water Resources Research Institute, Technical Completion Report No. 337, New Mexico State University, Las Cruces, New Mexico.
2. King, J.P., J.W. Hawley, J.W. Hernandez, J.F. Kennedy, and E.L. Martinez. 2006. Study of Potential Water Salvage on the Tucumcari Project Arch Hurley Conservancy District: Phase I. A pre-appraisal-level study of the potential amount of saved-water and the costs of alternative methods of reducing carriage losses from district canals. New Mexico Water Resources Research Institute, Technical Completion Report No. 335, with plates and appendices on CD ROM, New Mexico State University, Las Cruces, New Mexico.
3. Bawazir, A.S., J.P. King, S. Kidambi, B. Tanzy, F. Nibling, N.H. Troxel Stowe, and M.J. Fahl. 2006. A Joint Investigation of Evapotranspiration Depletion of Treated and Non-Treated Saltcedar at the Elephant Butte Delta, New Mexico. New Mexico Water Resources Research Institute, Technical Completion Report No. 328, New Mexico State University, Las Cruces, New Mexico.
4. Ortega Klett, C.T. 2006. Proceedings of the 50th Annual New Mexico Water Conference, New Mexico Water: Past, Present, and Future or Guns, Lawyers, and Money. New Mexico Water Resources Research Institute, Conference Proceedings Report No. 339, New Mexico State University, Las Cruces, New Mexico.
5. Ortega Klett, C.T. 2006. Proceedings of the 51st Annual New Mexico Water Conference, Water Quality for the 21st Century. New Mexico Water Resources Research Institute, Conference Proceedings Report No. 340, New Mexico State University, Las Cruces, New Mexico.

Statement of Critical Water Problem:

The New Mexico Water Resources Research Institute's Information Transfer Program is designed to bring the results of its research projects to the public and to educate New Mexicans on the critical water issues of the state, region, and nation. Different sectors of the public are targeted for each of its activities.

Statement of Results and Benefits:

The program goal is to provide people with water information appropriate to their level of training and interest. Information transfer activities are funded primarily from non-federal sources. Responsibilities for different segments of the program have been assigned to various professional and support staff at the institute.

Nature, Scope, and Objectives:

The primary methods for information transfer are conferences, publications, audio/visual presentations, and available information on the institute's website. For the past 51 years, the NMWRRI has sponsored the Annual New Mexico Water Conference focusing on a topic of importance to the New Mexico water community. The annual conference is held in different locations around the state, usually in the fall. Most of the conference participants are water resources practitioners working for state, federal, or local agencies, although some members of the general public and of academia also attend. Average attendance ranges between 200 and 350 people, depending on the location and topic of the conference.

Publications include technical completion reports resulting from NMWRRI-sponsored projects, special in-house publications, and conference proceedings. The institute has published more than 360 technical and miscellaneous reports. The peer reviewed technical completion reports are directed toward water professionals working in disciplines related to the research projects. Technical reports published since about 1980 are available via the NMWRRI website in full text. Those interested in a particular report are able to print off the Internet instead of ordering a hard copy of the report. All WRRRI water conference proceedings for the past 51 years are now available online in full text.

The institute averages over 500 requests online each month for its publications and 8 requests for hard copies of specific publications each month. As reports have become available on-line in the past few years, the institute has been receiving fewer requests for hard copies. Requests online have more than doubled in the past three years.

A quarterly newsletter, *The Divining Rod*, focuses on research and current water issues. It is distributed to approximately 2,300 readers and is available on the WRRRI homepage.

A reference room, housed at the institute, contains over 11,000 documents and is used frequently by faculty, students, and others. A complete catalog of holdings can be searched through the NMWRRI home page on the Internet, along with an extensive water resources and information system database and other information about the institute. Several hundred inquiries per month are recorded on the web page. During the reporting period, approximately 30 publications were checked out of the library.

The institute director and associate director are invited frequently to speak at local, regional, and national conferences and workshops in addition to serving on a number of committees that focus on water resources. The institute director is currently the past-president of the national organization, Universities Council of Water Resources, and is an active member of the National Institute of Water Resources. The NMWRRI staff also regularly provides expertise for solving specific problems and general concerns. They play a central role in planning for the water future of the region by cooperating with a host of water resources entities throughout the state and region, particularly in the Paso del Norte area.

Accomplishments:

The 51st Annual New Mexico Water Conference was held in October in Albuquerque, New Mexico. The conference focused on water quality issues. A tour of Albuquerque's water treatment plant, currently under construction, took place on the afternoon before the conference began. The highlight of the conference was the 2006 Utton Memorial Water Lecture, "The 1907 Water Code at 100 Years Old." University of New Mexico School of Law Professor Em Hall presented the lecture. A full proceedings of the conference was produced and is available on the WRRI website. All conference participants received a copy on CD.

The NMWRRI coordinated the 2006 Water Research Symposium held on the campus of New Mexico Tech, in Socorro, New Mexico. The one-day "2006 New Mexico Water Research Symposium" was co-sponsored by Sandia National Laboratories, Los Alamos National Laboratory, New Mexico's three state universities, the Office of the State Engineer, New Mexico Interstate Stream Commission, and the AWRA-New Mexico section. Thirty presentations were given and 33 posters displayed. Over 180 participants from throughout New Mexico, Arizona, and west Texas attended.

As past-president of the Universities Council on Water Resources (UCOWR), institute Director Karl Wood along with his staff helped organize the UCOWR/NIWR 2006 Annual Conference: Increasing Freshwater Supplies. The annual meeting took place in Santa Fe in July and drew one of its largest audiences ever with 243 in attendance. At the meeting, New Mexico WRRI received the "Friends of UCOWR" award. The WRRI staff was touted for "...the energy and skill they have provided in the development of this year's annual UCOWR/NIWR conference, and especially its Director, Karl Wood, for the service he has given to UCOWR as a member of the Board of Directors and President."

The WRRI co-sponsored the Spring 2006 New Mexico State University Water Lecture Series, a monthly seminar with attendance averaging about 100.

Institute staff judged water-related projects at the New Mexico Science and Engineering Fair for high school and middle school students. The NMWRRI also took part in the annual Project Wet Fair for elementary and middle school students in the fall of 2006. The institute also participated in New Mexico State University's Research Fair by displaying a poster.

The institute maintains an active program to transfer technical information from the producer to the user and the public. Technical publications, newsletters, conferences, press announcements, and presentations keep practitioners aware of new technology and research advances. The NMWRRI's homepage (wrrri.nmsu.edu) provides online information about the institute's newsletters, technical report series, student grants, requests for proposals, upcoming conferences, and the research reference library. All annual New Mexico water conference proceedings have full-text viewing on the institute's homepage.

The institute's publications for the period included three technical reports: "The Development of a Coordinated Database for Water Resources and Flow Model in the Paso del Norte Watershed"; "Study of Potential Water Salvage on the Tukumcari Project Arch Hurley Conservancy District Phase I: A Pre-appraisal-level Study of the Potential Amount of Water That May Be Saved and the Costs of Alternative Methods of Reducing Carriage Losses from District Canals"; and "A Joint Investigation of Evapotranspiration Depletion of Treated and Non-Treated Salt Cedar at the Elephant Butte Delta, New Mexico." The 50th and 51st Annual New Mexico Water Conference proceedings were produced in hardcopy and on CD. NMWRRI technical completion reports are available at no charge while supplies last. A copy charge is assessed if the report is out of print or has been reprinted. An average of eight hard-copy technical reports was requested each month during the reporting period. Because technical reports are now available in full-text via the WRRRI homepage, the number of requests for hard-copies of reports has dropped through the years. Water conference proceedings and miscellaneous reports can be purchased for a small charge. Publications may be ordered at wrrri.nmsu.edu.

The institute's quarterly newsletter, *The Divining Rod*, is an eight- to sixteen-page newsletter that focuses on research projects administered by the NMWRRI and on current water issues in New Mexico. It provides information on upcoming conferences, seminars, and workshops; describes new grants and newly released publications; and provides general information on new developments in water resources research and management. Each issue is available on the NMWRRI's homepage. Hard copies of the newsletter are distributed to approximately 2,300 readers. During the reporting period, the institute published one 8-page issue and two 12-page issues of *The Divining Rod*.

The Information Transfer Program is an ongoing program with no particular timelines.

Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	5	0	0	0	5
Masters	4	0	0	0	4
Ph.D.	4	0	0	0	4
Post-Doc.	1	0	0	0	1
Total	14	0	0	0	14

Notable Awards and Achievements

John W. Hawley, WRI senior hydrogeologist, received the Geological Society of America's 2006 Quaternary Geology & Geomorphology Division Distinguished Career Award in recognition of excellence in science, given on the occasion of the 118th Annual Meeting. Dr. Hawley also received The University of Illinois at Urbana-Champaign's 2006 Alumni Achievement Award in recognition of a distinguished career in geoscience, presented by the Department of Geology.

Matthew Fletcher Kirk, a doctoral student at The University of New Mexico and a recipient of a 2006-2007 WRI Water Research Student Grant, received the UNM Earth and Planetary Sciences Kelly Doctoral Candidate Scholarship for his research project entitled, Experimental and Numerical Modeling Analysis of Arsenic-Sulfide precipitation in Groundwater Environments.

Michelle Estrada-Lopez, a graduating civil engineering student, is the 2007 valedictorian at New Mexico State University. She participated in several WRI supported projects throughout her undergraduate years.

Susanna H. Glaze, an undergraduate geography/GIS student received a GREG Award from the Office of the Vice President for Research at New Mexico State University. She has worked for the past year in the WRI GIS lab.

Sri H. Valluri made a poster presentation entitled, Direct Contact Membrane Distillation for Brackish Water Desalination: Comparison of Flat-Sheet Membrane and Hollow Fiber Membrane Modules at the 2006 New Mexico Water Research Symposium, in Socorro, NM, Aug. 2006 and the 2006 New Mexico State University Research Council Fair, in Las Cruces, NM, Oct. 2006. Sri's presentation was selected by NMSU VPR's Office as the best poster presentation.

Yoshiaki Ikemura, doctoral candidate, received the first prize for his student poster presentation at the 2005 ASA (American Society of Agronomy) meeting in Salt Lake City for his work on remote sensing of drought and salinity stressed turfgrasses. Thirty-six students from universities across the U.S. displayed posters in the competition.

Kristin Swaim, a graduate student working on a master's degree in Fish and Wildlife Sciences, has received research funding from Sigma Xi and T&E, Inc, and the New Mexico Department of Game and Fish in addition to her WRRRI student research grant.

Ryan McShane received Best Oral Presentation at New Mexico State University's Graduate Research and Arts Symposium in April 2007. He is a graduate student in Fish and Wildlife Sciences and a WRRRI student research grant recipient.

Marty Frisbee of New Mexico Tech received 1st Place for his poster presentation at the 6th Annual SAHRA Conference. Marty has passed his oral Ph.D. candidacy exam in the Department of Earth and Environmental Sciences and is a recipient of a WRRRI student research grant.

Carlos Herrera, a graduate student at New Mexico Highlands University, is conducting research on uranium and heavy metals in macroinvertebrates in the Santa Fe River on the Cochiti Reservation. He received special permission from the governor of Cochiti Pueblo to take samples on Pueblo land and has worked closely with the Cochiti Pueblo Environment Department in the sampling and transportation of the sampling team. Carlos is a recipient of a WRRRI student research grant.

Brad Kirksey, A. Salim Bawazir, Zohrab A. Samani, Max Bleiweiss, and Rhonda Skaggs. Crop Evapotranspiration Study for Doña Ana County, New Mexico. 19th annual EPSCoR National Conference at Lexington, Kentucky, November 7-10, 2006. Poster presented received Second Place Award of Excellence for outstanding research among 27 states participating. The same poster received First Place at the NSF/EPSCoR 2nd Annual State conference, New Mexico State University, Wooten Hall, Las Cruces, NM.

Publications from Prior Projects

1. 2000NM3B ("Genetic Techniques for the Verification and Monitoring of Dihalothane Biodegradation in New Mexico Aquifers") - Articles in Refereed Scientific Journals - Reiss, R.A., 2006. Ancient DNA from ice age insects: proceed with caution. *Quaternary Science Reviews*. 25:15-16:1877-1893.
2. 2000NM10B ("Soil Moisture-Rainfall Feedbacks in New Mexico") - Articles in Refereed Scientific Journals - Assessing Interannual Variation in MODIS-Based Estimates of Gross Primary Production. *IEEE Transactions on Geoscience and Remote Sensing*. 44:7.
3. 2000NM10B ("Soil Moisture-Rainfall Feedbacks in New Mexico") - Articles in Refereed Scientific Journals - Turner, D.P., W.D. Ritts, M. Zhao, S.A. Kurc, A.L. Dunn, S.C. Wofsy, E.E. Small, and S.W. Running. 2006. Assessing Interannual Variation in MODIS-Based Estimates of Gross Primary Production. *IEEE Transactions on Geoscience and Remote Sensing*. 44:7.
4. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples") - Articles in Refereed Scientific Journals - Oshima, K.H., A.K. Highsmith, and E.W. Ades. 2006. Removal of influenza A virus, phage T1, and PP7 from fluids with a nylon 0.04- μ m membrane filter. *Environmental Toxicology and Water Quality*. 9:3:165-170.
5. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples") - Articles in Refereed Scientific Journals - Removal of influenza A virus, phage T1, and PP7 from fluids with a nylon 0.04- μ m membrane filter. *Environmental Toxicology and Water Quality*. 9:3:165-170.

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8. 2000NM7G ("Institutional Adjustments to Coping with Prolonged and Severe Drought in the Rio Grande") - Other Publications - F.A. Ward. 2006. *Environmental and Natural Resource Economics*. Prentice Hall.
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11. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Articles in Refereed Scientific Journals - Derrington, D., M. Hart, and T.M. Whitworth. 2006. Low head sodium phosphate and nitrate hyperfiltration through thin kaolinite and smectite layers: Application to engineered systems. *Applied Clay Science*. 33:1:52-58.
12. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Articles in Refereed Scientific Journals - Saindon, R. and T.M. Whitworth. 2006. Membrane effects during filtering investigation of membrane effects during filtering of natural surface waters in Missouri. *Journal Aquatic Geochemistry*. 12:4:365-374. DOI: 10.1007/s10498-006-9002-8
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14. 1999NM102B ("Detection of Groundwater through Ultra-Sensitive Magnetic Measurements with Ultra-short Pulse Lasers") - Articles in Refereed Scientific Journals - Smith, D.D., L. Arissian, and J-C. Diels. 2007. Dispersive elements for enhanced-laser gyroscopy and cavity stabilization. *Laser Resonators and Beam Control IX*. A.V. Kudryashov, A.H. Paxton, V.S. Ilchenko (eds). *Proceedings of SPIE*, Vol. 645204 (Feb. 14, 2007).
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Hirsl, and V. Skoda. 2006. Measuring of intracavity phase changes by use of bidirectional ring diode-pumped mode-locked Nd:YVO₄ laser. Solid State Lasers and Amplifiers II. A. Sennaroglu (ed). Proceedings of SPIE, Vol. 61901C (Apr. 17, 2006).