

Water Resources Research Institute

Annual Technical Report

FY 2001

Introduction

This program report provides the required information for projects funded with the 2001 base grant and mandatory non-federal matching funds. Please note that there may be some overlap in information with our 2000 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 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 vigorous 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. NMWRRI homepage (<http://wrrri.nmsu.edu>) provides on-line information about the institute, newsletters, technical report series, requests for proposals, upcoming conferences, and the research reference library.

One of the driest states in the nation, New Mexico's average annual precipitation is no more than 20 inches, varying from about 8 inches in the desert valleys 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 the annual precipitation other than in the high mountains. Such widely varied precipitation is as much a water allocation problem as water scarcity itself.

Like other western states, New Mexico's water problems 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 as well as federal and state agencies, and the USGS Water Resources Research Institute Annual Base Program. Projects funded in the 2001 Annual Base Program included "Genetic Techniques for the Verification and Monitoring of Dahaloethane Biodegradation in New Mexico Aquifers," which focused on an important water quality issue, and "Information Management Program and Geographic Information Systems for Water Resources Research Planning" which focused on conservation, management and planning.

During the reporting period, the NMWRRI administered a total of 17 projects dealing primarily with water quality and conservation issues. The total value of these projects was just under \$2 million, including required cost sharing. Awards were made by various federal and state agencies, as well as from the institute's annual state appropriations. Dollar amounts per project award ranged from under \$25,000 to more than \$950,000. Research on two projects was conducted at New Mexico Tech and one at the University of New Mexico, while NMSU faculty members were principal investigators on eight projects and NMWRRI staff managed six 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 50 students during the year including undergraduates, master's and Ph.D. candidates. A water resources training program provided a broad understanding of water resources to a number of Native American high school students from across the nation.

Projects administered by the NM Water Resources Research Institute during the reporting period that were funded from sources other than the 2001 USGS Annual Base Program are listed below. Note that total award value is shown and includes both agency and cost sharing when appropriate.

Mapping Services - Regional Water Plan Task Orders. Professional Services Agreement with the NM Interstate Stream Commission. \$20,000

New Mexico Pesticide Management Plan. Memorandum of Agreement with the New Mexico Department of Agriculture - US Environmental Protection Agency. \$70,000

Creating a Single Map: Combining Databases to Form a Single Regional GIS System (with University of Texas at El Paso and Universidad Autonoma de Ciudad Juarez faculty). The William and Flora Hewlett Foundation. \$75,000

Organizational Review of Transfers of Surface Water from Irrigation to Domestic Use. US Environmental Protection Agency through the Lower Rio Grande Water Users Organization. \$39,400

A Flash Flood Prediction Model for Rural and Urban Basins in New Mexico. NM Water Resources Research Institute seed money. \$24,753

Salinity Sources of the Hueco Bolson. Subcontract with California State University - Los Angeles. \$36,002

Riparian Evapotranspiration Study of the Middle Rio Grande. US Bureau of Reclamation, NMWRI and New Mexico State University. \$939,096

Evaporation Estimation at Elephant Butte Reservoir. Office of the State Engineer. \$64,010

Evaporation Study of Dona Ana County. US Environmental Protection Agency through the Lower Rio Grande Water Users Organization. \$59,543

Water Resources Training Program. US Bureau of Indian Affairs. \$45,392

Arsenic and Arsenic Species in the Rio Grande, and the Effect of Irrigated Lands. NM Water Resources Research Institute seed money. \$24,680

Water Valuation: Types, Procedures and Policy Application. Texas A&M, Texas Agricultural Experiment Station, El Paso. \$37,584

Economic Feasibility and Value of Water Saved with Alternative Irrigation Technologies on the Lower Rio Grande. Texas A&M, Texas Agricultural Experiment Station, El Paso. \$23,639

Sources of Salinity in Rio Grande and Mesilla Basin Aquifers. Joint Powers Agreement with the NM Interstate Stream Commission. \$150,000

Monitoring Network of the Groundwater Flow System in the Mesilla Basin. New Mexico State University. \$12,900

Basic Information

| | |
|---------------------------------|--|
| Title: | Geographic Information System for Water Resources Research Planning |
| Project Number: | 2001NM1421B |
| Start Date: | 3/1/2000 |
| End Date: | 2/28/2003 |
| Research Category: | Not Applicable |
| Focus Category: | Management and Planning, Conservation, Water Quality |
| Descriptors: | geographic information systems, water resources information, data development, education |
| Principal Investigators: | Bobby J. Creel , John F. Kennedy |

Publication

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 assure no duplication of effort and 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.

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 NMWRRRI 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 NMWRRRI 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, and visualization; as well as network systems. The laboratory is connected via fiber to the New Mexico State University computer network, and thereby to the Internet. The NMWRRRI 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. NMWRRRI has been utilized by the NM Interstate Stream Commission to provide GIS mapping products for use in their plans and in public outreach. NMWRRRI 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.

This sophisticated mapping and geo-spatial database management system, originally designed to support WRRRI-funded research activities, is now being used for external research grants (e.g., sources of salinity in the Mesilla Valley and creation of maps for the purpose of water planning funded by the New Mexico Interstate Stream Commission, and the New Mexico Department of Agriculture for pesticide management planning in the state) by water resources management and planning agencies in the state. A recent research grant resulted in the creation of a regional geographic information system to support regional water planning in the Paso del Norte borderland area of the southwestern United States. The system also has widespread applicability for water rights administration and stream adjudications.

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.

Basic Information

| | |
|---------------------------------|--|
| Title: | Genetic Techniques for the Verification and Monitoring of Dihaloethane Biodegradation in New Mexico Aquifers |
| Project Number: | 2001NM1661B |
| Start Date: | 3/1/2000 |
| End Date: | 2/28/2002 |
| Research Category: | Biological Sciences |
| Focus Category: | Groundwater, Methods, Toxic Substances |
| Descriptors: | horizontal gene transfer, carcinogen, natural attenuation, biodegradation, xenobiotic, PCR, EDC,EDB |
| Principal Investigators: | Rebecca Reiss |

Publication

1. Reiss, R. 2002. Genetic Techniques for the Verification and Monitoring of Dihaloethane Biodegradation in New Mexico Aquifers. NM Water Resources Research Institute, Technical Completion Report, #324. New Mexico State University, Las Cruces, NM. 63pp.

Research Project Objectives and Accomplishments

This research project had two objectives: 1) determine the route of the gene (*dhlA*) in aquifers, and 2) determine which microbes may harbor the *dhlA* gene. The hypothesis was that the gene is present at very low levels until selection pressure is increased. Dihaloethanes can provide a rich carbon source for those microbes that harbor the genes to metabolize these compounds, so there is a strong selective advantage for those microbes that contain the *dhlA* gene in contaminated environments. Since the preliminary experiments involved isolating total DNA from water and sediment samples as a template for PCR, it is not known which microbes harbor this gene, or whether it is chromosomal or extrachromosomal. The hypothesis was that the gene will be found in a variety of naturally occurring microbes due to their ability to transfer genetic information laterally.

The first step for Objective 1 was to design a DNA isolation procedure that eliminates all inhibitors of DNA *Taq* polymerase. This enzyme amplifies DNA in the process of polymerase chain reaction (PCR). Modifications to the previously developed DNA isolation protocol include a microfiltration step. Next, the conditions to amplify the *dhlA* gene were established using DNA from *Xanthobacter autotrophicus* strain GJ10 as a positive control. A nested PCR strategy was designed in which two consecutive rounds of PCR are performed.

The method suggested to meet the second objective was to clone and sequence the 16SrRNA gene from all the microbes in the aquifer. A different approach is being developed to determine the microbial community of each aquifer. Rather than cloning and sequencing each individual 16S amplification product, the 16S region is labeled with fluorescent primers, digested with restriction enzymes and electrophoresed on the Prism 310 Genetic Analyzer. The data are compared to the ribosomal database to determine the species.

Application of Research Results

Attempts to detect specific genes for dihaloethane biodegradation using polymerase chain reaction (PCR) in New Mexico aquifers proved unreliable. However, it was discovered that the enzyme activity was detectable in crude protein extracts made from groundwater samples. Direct enzyme assays for monitoring biodegradation potential has three major advantages over PCR. First, it is a direct measure of the activity, not just the potential. Just because a gene is present, it does not mean it is expressed. Second, it provides an accurate estimate even if more than one gene can be involved. Third, it is not prone to contamination because there is no amplification of product.

First-order biodegradation rate constants were calculated from rate constants determined from direct enzyme assays on crude protein extracts. This is a distinct improvement over current batch-reactor methods because it is a rapid method that does not require culturing so there is no loss of species from the consortium. These rate constants can be incorporated into existing models for natural attenuation.

The application of direct enzyme assays to monitoring of biodegradation does not require information regarding the microbial consortium of an aquifer. However, combining enzyme data with information regarding species diversity will advance the understanding of biodegradation. By comparing the enzyme data to the microbial consortium of numerous wells, a better understanding of the bacterial species responsible for biodegradation will result.

Information Transfer Program

Basic Information

| | |
|---------------------------------|--|
| Title: | Information Transfer Program |
| Start Date: | 3/1/2000 |
| End Date: | 2/28/2003 |
| Descriptors: | information transfer, information dissemination, education |
| Principal Investigators: | Bobby J. Creel, Catherine T. Ortega Klett |

Publication

1. Proceedings of the 45th Annual New Mexico Water Conference, "Water, Growth and Sustainability: Planning for the 21st Century. 2001. C.T. Ortega Klett, Ed. NM Water Resources Research Institute, Report #319. New Mexico State University, Las Cruces, NM 145 pp.
2. Norman, David I. and Lorie M. Dilley. 2002. Arsenic and Arsenic Species in the Rio Grande, and the Effect on Irrigated Lands. New Mexico Water Resources Research Institute, Technical Completion Report #320. New Mexico State University, Las Cruces, NM. 55pp.
3. Wood, M. Karl and Nasim Javed. 2001. Hydrologic and Vegetal Responses to Fuelwood Harvest and Slash Disposal in a Pinyon Pine and Juniper Dominated Grassland. New Mexico Water Resources Research Institute, Miscellaneous Report #M27. New Mexico State University, Las Cruces, NM. 29pp.
4. Harris, L.G., L. Blair and C.T. Ortega Klett. 2002. New Mexico Water Rights. New Mexico Water Resources Research Institute, Miscellaneous Report #M15. New Mexico State University, Las Cruces, NM. 49pp.

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 46 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 late 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, 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. More than 300 technical and miscellaneous reports have been published by the institute. The peer reviewed technical completion reports are directed toward water professionals working in disciplines related to the research projects.

A quarterly newsletter, *The Divining Rod* focuses on research and current water issues. It is distributed to approximately 2,000 readers.

The institute averages about 125 requests for general information and more than 60 requests for specific publications each month. A reference room, housed at the institute, contains almost 10,000 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.

The institute director and associate director are frequently invited 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 NMWRRI staff also regularly provide 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.

Accomplishments:

The 46th Annual New Mexico Water Conference was held in early November 2001 in Santa Fe. The conference theme, "New Mexico Watershed Management: Restoration, Utilization and Protection" drew over 200 participants. Tours included a visit to the Bernalillo Watershed study site and the Cerro Grande Fire site near Los Alamos. Internationally renowned water law expert, Professor Dan Tarlock, gave the Albert E. Utton Memorial Water Lecture.

The institute maintains a vigorous 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 (<http://wrri.nmsu.edu>) provides on-line information about the institute's newsletters, technical report series, requests for proposals, upcoming conferences, and the research reference library. Starting with the 44th Annual New Mexico Water Conference Proceedings, all conference papers have full-text viewing on 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 NMWRRI homepage.

The institute's publications for the period included 7 technical reports, the 45th Annual New Mexico Water Conference proceedings and an update to the popular report "New Mexico Water Rights." 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. Water conference proceedings and miscellaneous reports can be purchased for a small charge. All technical report abstracts can be viewed via the NMWRRI homepage and publications may be ordered at <http://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.

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

Student Support

| Student Support | | | | | |
|-----------------|------------------------|------------------------|----------------------|---------------------|-------|
| Category | Section 104 Base Grant | Section 104 RCGP Award | NIWR-USGS Internship | Supplemental Awards | Total |
| Undergraduate | 11 | 0 | 0 | 0 | 11 |
| Masters | 4 | 0 | 0 | 0 | 4 |
| Ph.D. | 1 | 0 | 0 | 0 | 1 |
| Post-Doc. | 0 | 0 | 0 | 0 | 0 |
| Total | 16 | 0 | 0 | 0 | 16 |

Notable Awards and Achievements

Project 2000 B-02 Kevin H. Oshima, principal investigator. Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples. Graduate students of Dr. Oshima received best poster presentation award at the Water Quality Technology Conference, Nashville, TN. November 2001.

Project 2000 B-03, 2001 NM1661 Rebecca Reiss, principal investigator. Genetic Techniques for the Verification and Monitoring of Dihalothane Biodegradation in New Mexico Aquifers Three graduate students of Dr. Reiss received first place in the Student Poster Competition at the NM Environmental Health Conference. October 2000. Ann Harper, a graduate student of Dr. Reiss, won third place in the Student Presentation Competition at the Tri-Beta Student Conference. Spring 2000.

Dr. Joseph Wang, principal investigator on several previous USGS/NMWRRI research projects, received the distinction of the most cited scientist in the world of engineering during the period, 1991-2001, by the Institute for Scientific Information.

Project 1999 B-03 T. Michael Whitworth, principal investigator. Hyperfiltration-Induced Precipitation of Sodium Chloride. Dr. Whitworth, New Mexico Tech, developed a hyperfiltration system as a result of research partially funded through two Water Resources Research Institute/USGS seed money awards. The system could help the states water conservation effort by enabling recovery of drinking water from deep into the groundwater aquifer where water becomes more salty from prolonged contact with rocks and minerals. A patent (No. 6,241,892) was secured for the system in 2001 through the NM Tech Research Foundation. A three-year, \$1.2 million award from the U.S. Department of Energy was received by the Petroleum Recovery Research Center at NM Tech as a result of Dr. Whitworths USGS seed money grant. The project is entitled Modified Reverse Osmosis System for Treatment of Produced Water. The U.S. Department of Agriculture awarded \$135,000 to Dr. Whitworth for a three-year project entitled The Role of Hyperfiltration in Fate and Transport of Fertilizers in Shallow Perched Aquifers as a result of his seed money grant

Publications from Prior Projects

1. Kuhn, R.C. and K.H. Oshima. 2001. Hollow fiber ultrafiltration of *Cryptosporidium parvum* oocysts from 10L of surface water. In Proceedings of the Water Quality Technology Conference. American Water Works Association. Nashville, TN.
2. Kuhn, R.C. and K.H. Oshima. 2001. Evaluation and optimization of reusable hollow fiber ultrafilter as a first step in concentrating *Cryptosporidium parvum* oocysts from water. *Water Research*. 35:11:2770-2783.
3. Kuhn, R.C., C.M. Rock, K.H. Oshima and A. Campbell. 2001. The interaction of matrix and IMS recovery of *Cryptosporidium* oocysts from environment samples. In Proceedings of the Water Quality Technology Conference. American Water Works Association. Nashville, TN.
4. Olszewski, J. and K.H. Oshima. 2001. Small scale tangential flow ultrafiltration of viruses from environmental waters. In Proceedings of the Water Quality Technology Conference. American Water Works Association. Nashville, TN.
5. Winona, L.J., A.W. Ommani, J. Olszewski, J.B. Nuzzo and K.H. Oshima. 2001. Efficient and predictable recovery of viruses from water by small-scale ultrafiltration systems. *Can.J. Microbio.* 47:1033-1041.