New Mexico EPSCoR

New Mexico EPSCoR RII 3 Annual Report Award Year Two

Report Period:
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NM EPSCoR RII3: Climate Change Impacts on New Mexico's Mountain Sources of Water

Climate change is affecting natural environments around the world. NM EPSCoR RII3 addresses a key challenge that is of worldwide significance—understanding and forecasting the effects of climate change on water supply and sources in arid regions, as well as the socioeconomic implications. The overarching vision for the NM EPSCoR Program is to enable:

"An environment in which New Mexico scientists and educators are fully competitive in climate change research and education."

The overarching goal of NM EPSCoR RII3 is to enhance research competitiveness through investment in three strategic areas: *(1) critical Research Infrastructure, (2) Cyberinfrastructure, and (3) Human Infrastructure.* These investments will help establish NM as a laboratory for climate change research and as a model for science-based public policy. The multi-disciplinary, multi-scale effort is envisioned to transform climate change science and policymaking in NM by providing the tools required for quantitative, science-driven discussion of difficult water policy options facing the State in the 21st Century. These goals are articulated in the NM EPSCoR mission:

"Provide the critical gap infrastructure, computational support, and education and outreach opportunities to foster excellence in climate change research and education."

NM EPSCoR Key Accomplishments in Year Two

Intellectual Merit
EPSCoR Year 2 accomplishments (described below) address each of the three strategic areas: Research Infrastructure, Cyberinfrastructure and Human Infrastructure. Research investments supported development of watershed-scale observational networks and climate and hydrology models needed in NM for water supply forecasting and water resources decision support. Significant progress was made in research on the socioeconomic impacts of basin-scale hydrologic changes to *acequias* - the traditional water supply system for agriculture in small NM communities. Cyberinfrastructure activities led to significant progress in the development of the shared data infrastructure for the management, discovery, and delivery of the science data generated by the EPSCoR project. Educational activities for undergraduate students, graduate students, junior faculty and K-12 teachers enhanced NM human infrastructure by improving understanding of climate science, collaborative interdisciplinary research, and diversity issues.

Broader Impacts
Through novel projects and partnerships that are facilitated by NM EPSCoR Research Infrastructure Improvements, scientists and educators contribute to serving the needs of science, education, and the public. Approximately 4,000 members of the general public participated in EPSCoR-supported outreach events in Year 2, increasing their awareness of climate change impacts on natural resources. In addition, integrated education and diversity investments have increased the impact on the critical student population at NM's non-PhD granting institutions. Innovative elements of the outreach, education and diversity programs reach a large and diverse population with an emphasis on involving and supporting the State's population of Native Americans and persons of Hispanic descent.

New Mexico RII3 participants developed strategic and implementation plans which delineate 14 specific strategic objectives that guide the NM EPSCoR program. A summary of efforts and key

accomplishments in research, diversity, workforce development, cyberinfrastructure, outreach and communication, evaluation and assessment and sustainability for Year 2 are presented below as they align with the objectives of the Strategic Plan.

Research Infrastructure Improvements

Objective 1: Enhance climate and hydrology research infrastructure (from data acquisition through modeling).

- Procured equipment to upgrade the climate and hydrology observing networks in New Mexico (including 5 weather stations located on the Navajo Nation) and 2 SNOTEL sites and 6 Enhanced SNOTEL sites to be installed in Summer, 2010.
- Established the Snow Runoff Model (SRM) on each of the 4 intensive important snowmelt sub basins in the Rio Grande drainage.
- Input NDVI data for the 47 Rio Grande basins into the Semi-distributed Land Use and Runoff Process (SLURP) model and calibrated the SLURP model so it runs at 95% accuracy for the 47 basins.
- Investigated the impact of model initial conditions on robust predictions of climate change in the Rio Grande watershed.
- Conducted research into the links between snowpack, surface energy fluxes and seasonal precipitation using a variety of datasets.
- Developed new conceptual and mathematical models that describe how dynamically changing flow conditions influence the distribution of residence times in hydrologic systems.
- Acquired and began deployment of a Distributed Temperature Sensing (DTS) system.

Objective 2: Improve water quality monitoring in high altitude stream environments.

- Developed a laboratory-based iron analyzer as a model to inform the development of an *in situ* analyzer.
- Deployed sondes on the Jemez River; a suite of water quality sensors will be deployed during the summer, 2010.
- Developed interdisciplinary and multi-institution collaborative projects concerned with understanding stream water chemistry dynamics.

Objective 3: Develop interdisciplinary socioeconomics and acequia research capacity.

- Selected the El Rito valley with five different acequias as a final study site.
- Detailed map of hydrological features was created for the Rio Hondo site and similar map is ongoing for El Rito site.
- Purchased additional hydro-meteorology equipment to characterize acequia system flow distribution and surface-groundwater hydrological interactions.
- Collected data on acequia history and customs, climate changes in mountain valley environments, and socio-cultural factors of adaptation in times of drought.
- Held three planning meetings with the new EPSCoR collaborators on the Rio Chama: the El Rito Acequia Association and the El Rito Regional Water and Wastewater Association
- Incorporated residential demand functions into the existing system dynamics (SD) model for the Middle Rio Grande and transformed the functions into PowerSim modules.
- Began programming the linkages and interactions between the demand functions, the population module, and the macroeconomic module.

Objective 4: Provide critical gap infrastructure for New Mexico Highlands University.

- Conducted several workshops for graduate and undergraduate students at New Mexico Highlands University on how to use water quality analysis instrumentation purchased in Year 1.

- Funded a graduate student technician to support and maintain water quality instrumentation.
- In collaboration with water quality researchers at UNM and NM Tech, NMHU students completed studies on the effects of livestock crossings and ungulate grazing on water quality in the Valles Caldera.

Objective 5: Use Innovation Working Groups (IWG) to address key scientific, education, diversity, and workforce development challenges.

- The *Natural and Human Dynamics of Acequia Systems* IWG created the conceptual foundation for a successful proposal submitted to NSF's CNH program; funding is pending.
- An IWG, *Identifying the Most Relevant Spatial and Temporal Scales of Climate Change with Respect to Surface Hydrologic Processes,* grew from collaborations initiated at the All Hands Meeting.
- NM Researchers participated in three Tri-State Consortium funded IWG's.

Objective 6: Provide Critical Infrastructure Gap Seed Awards to increase the impact of NM EPSCoR on the critical student population at New Mexico's non-PhD granting institutions.

- Began development of the RFP incorporating suggestions from the Evaluation report.

Cyberinfrastructure Improvements

Objective 7: Enhance scientific data and model output generation, management, discovery, and use through cyberinfrastructure.

- Developed a base data model that is optimized for the storage of 2d and 3d vector (point, line, and polygon) and raster data in conjunction with consistently encoded temporal data capture for each spatial object in the system.
- Instituted REST web services as the primary means of interacting with the data model and external applications and services that access the contents of the data model.
- Created an initial instance of the GeoNetwork Open Source platform for the creation and management of metadata for science data products managed within the system.
- In summer, 2010 will consult with science and education stakeholders in New Mexico to identify key interface capabilities for development in the data portal that will be built on top of the developed platform.
- Continued collaboration with Tri-State Consortium (Track 2) partners.
- Developed NM EPSCoR list-serv as a communication tool.

Human Infrastructure Improvements

Objective 8: Enhance diversity in all elements of the EPSCoR Program.

- To increase the number of incoming students into STEM disciplines from underrepresented groups, offered a summer UROP program that recruited exclusively from non-PhD granting schools.
- Included a workshop on mentoring and working with diverse students at the Junior Faculty Leadership Institute.
- Expanded the Diversity Leadership team and drafted a *Best Practices Guide for Increasing the Diversity of Faculty at NM Research Institutions of Higher Education*.
- Conducted several meetings with Acequia Associations and local stakeholders to build collaboration and ensure appropriate cultural sensitivity of researchers.

Objective 9: Enhance professional teacher development for STEM areas in northern New Mexico.

- Continued the partnership with The Northern NM Network (NNMN), a non-profit educational cooperative that works to improve education in rural schools of northern New Mexico.

- NNMN provided two follow-up workshops during the academic year for participants in the Year One Teacher Summer Institute; teachers created curricular units based on the summer institute for their classrooms.
- Teachers conducted 10 field trips with students throughout the year implementing lessons based on their summer institute experience.
- NNMN coordinated and offered the second five-day field-based Teacher Summer Institute at the Valles Caldera National Preserve for middle and high school math and science teachers.
- Increased the involvement of EPSCoR scientists in the summer professional development activities.

Objective 10: Develop an Undergraduate Research Opportunity Program that increases the exposure of students at non-PhD granting institutions to high quality, relevant, hypothesis-driven research.

- Successfully engaged 10 undergraduates, recruited from institutions serving large populations of Hispanic and Native American students, in nine weeks of summer research with faculty mentors from NM EPSCoR universities.
- Developed an initial week of workshops and short courses on climate change, hydrology, and water quality, which were taught by EPSCoR-supported faculty, and prepared the new UROP students for their summer research assignment.

Objective 11: Design and develop graduate research training group opportunities.

- Development of a graduate seminar course, *Understanding Climate Change through Modeling and Simulation*, a collaboration of Los Alamos National Laboratories, NMSU, NMT, NMHU and UNM, is on-going.
- Dr. Laurel Saito (UNR) along with 25 faculty from NV, ID, and NM, will teach a graduate level course in summer 2010, entitled *Interdisciplinary Modeling: Water-Related Issues and Climate Change*."
- Graduate students were involved in research-related training in all research component areas.

Objective 12: Inform faculty throughout NM about funding opportunities via NSF Days.

- Date selected for NSF Day in Year 3; event planning has begun.

Objective 13: Enhance leadership skills for faculty via a Faculty Leadership Fellowship Program.

- Offered a week-long training workshop for 19 early-career faculty from 8 higher education institutions in New Mexico, Idaho, and Nevada.
- Offered a series of hands-on activities designed to enhance competitiveness and leadership skills; overall evaluation by participants was very positive and the program was featured in *Nature*.

Objective 14: Create a citizenry that is informed about climate change and its impact on NM's natural resources via public outreach and communication.

- Expanded (from 110 sq.ft. to 825 sq. ft) and revised plans for a new Climate Change Exhibit at the New Mexico Museum of Natural History and Science based on focus group input.
- Climate Change Educator at the Museum offered over 20 public outreach education programs on climate change impacts in New Mexico to approximately 3,000 members of the public.
- Offered joint programming with the Environmental Education Association of NM, NM Environment Department Climate Masters Program, Bosque Ecosystem Monitoring Project and other NM museums and parks.
- EPSCoR researchers participated in public events to showcase EPSCoR research efforts; developed and distributed an informational brochure.

NMEPSCoR Management Structure

The management of the NM EPSCoR program has multiple levels; a diagram is provided in Appendix P. A State Committee acts as the governing body; the Management Team meets regularly to provide input on science and education issues. The Strategic Plan provides guidance for program activities and timelines.

Response to NSF Recommendations from Reverse Site Visit (RSV)

Details of the progress made in implementing plans presented in the RSV response are provided in the body of this report. Key steps taken include:

- Development of a diversity plan for NM research institutions;
- Administration of follow-up surveys to summer teacher institute participants and undergraduate student participants in summer research program;
- Opportunities for scientific synthesis provided at All Hands Meeting, Tri-State Meeting, and regular science meetings by phone of all components;
- Initiation of collaboration among education faculty at two NM Institutions of Higher Education to incorporate climate change education in pre-service teacher education programs;
- Expansion of the Diversity Leadership Committee and increased focus on diversity at the Tri-State Consortium meeting;
- Completed External Advisory Board meeting (response to EAB recommendations are provided below); and
- Strengthened collaboration between water quality researchers across research institutions.

Response to External Advisory Board (EAB) Report

The EAB strongly commended the leadership of the RII3 for their overall 5 year program plan and their progress in year one. Details of the EAB Report and the NM ESPSCoR response are provided in the body of the report and Appendix K. Key components are:

- Institution of virtual "science meetings" to facilitate greater communication and synthesis between research components;
- Review by the Management Team of EAB suggestions related to the science base of the program;
- Continued efforts to leverage lab capabilities across institutions;
- Development of a representation of interactions of EPSCoR with other climate-related programs.

Response to Year One Evaluation Report

As recommended in the evaluation report (Appendix L), a review of the Strategic Plan will be conducted by the Management Team to ensure continued alignment of research components. A new position, Public Information and Outreach, will be added to the State Office staff to address needs identified by the evaluator related to new activities in Years 2 and 3 that will enhance diversity and develop Seed Awards. Evaluation recommendations for specific activities and programmatic changes made in response are provided in the discussion of those activities. Other recommendations are provided in the Evaluation and Assessment section of the report.

Project Changes During Year Two of the Award

The project had no significant changes in scope or priorities since the NSF funding award. Mary Jo Daniel was hired as the Associate Director in January, 2010.

INTRODUCTION

The NM EPSCoR RII 3 Program
Annual Report
Award Year Two: September 1, 2009 – August 31, 2010
The structure of this annual report is based on the guidelines provided by NSF EPSCoR and on the New Mexico EPSCoR RII 3 Strategic Implementation Plan. The Implementation Plan utilizes the NM EPSCoR program's logic model of research infrastructure, cyberinfrastructure and human infrastructure capacity building. Within each of these three areas, the plan specifies objectives to be met throughout the course of program delivery. There are a total of 14 objectives in the plan. The complete Strategic Implementation Plan is included as an Appendix.

The NM EPSCoR RII 3 annual report for Year 2 follows the outline determined by NSF EPSCoR; the report sections and headings follow NSF guidelines. To facilitate reader comprehension, each section begins by listing the Implementation Plan objective(s) that fall under that heading. The objectives are numbered following the scheme established for the Implementation Plan.

Figure 1. The Jemez River flows through the Valles Caldera National Preserve--one of NM EPSCoR's primary study sites.

PARTICIPANTS and PARTICIPATING INSTITUTIONS

NM EPSCoR RII 3, "Climate Change Impacts on Mountain Sources of Water", is a multi-institutional, multi-disciplinary collaboration across the state of New Mexico. The primary research, education and outreach entities active in the award include:

- 3 research universities: New Mexico State University (NMSU) in Las Cruces, New Mexico Tech (NMT) in Socorro, and University of New Mexico (UNM) in Albuquerque.
- 1 regional university: New Mexico Highlands University (NMHU) in Las Vegas
- 1 tribal college: Dine' College (Dine') in Tsaile
- 1 state museum: New Mexico Museum of Natural History and Science (NMMNHS) in Albuquerque
- 2 national laboratories: Sandia National Labs (SNL) in Albuquerque, Los Alamos National Labs (LANL) in Los Alamos
- 1 non-profit educational organization: The Northern New Mexico Network (NNMN or The Network) in Rio Rancho
- 1 national preserve: the Valles Caldera National Preserve (VCNP) in Jemez Springs

Although there are additional partner institutions, and many additional collaborators and participants, the following table (Table 1) lists the core NM EPSCoR scientists, educators and collaborators whose work is detailed in this report.

Table 1. Primary NM EPSCoR scientists, educators and collaborators active in Year 2 of the award

NM EPSCoR Role	Name	Institution	Department
Cyberinfrastructure	Karl Benedict	UNM	Earth Data Analysis Center
Remote Sensing	Max Bleiweiss	NMSU	Environmental and Plans Science
Education	Marnie Carroll	Dine	Executive Director Center Environment
Economics	Janie Chermak	UNM	Economics
Aquatic Chemistry	Laura Crossey	UNM	Earth & Planetary Sciences
Aquatic Ecology	Clifford Dahm	UNM	Biology
Education	Anya Dozier-Enos	St of NM	New Mexico Public Education Dept.
Water Resources	Leeann De Mouche	NMSU	Extension Plant Sciences
Education	Anna Espinosa	NNet	K-12 Math Education Coordinator
Outreach	Eileen Everett	NMMNHS	Climate Change Educator
Hydrology	Alexander (Sam) Fernald	NMSU	Range Science
Water Resources	William Fleming	UNM	Community and Regional Planning
Climatology	Joe Galewsky	UNM	Earth and Planetary Sciences
Education	Lisa Majkowski	NMT	Earth & Environmental Science
Aquatic Chemistry	Edward Martinez	NMHU	Natural Resources
Ecology	Robert Parmenter	VCNP	Preserve Director
Education	Dick Powell	NNet	K-12 Science Education Coordinator
Aquatic Chemistry	Michael Pullin	NMT	Chemistry
Remote Sensing	Albert Rango	NMSU	USDA ARS Jornada Experimental Stations
Climatology	Todd Ringler	LANL	Climate, Ocean, and Sea Ice Modeling Group
Sociology	Jose Rivera	UNM	Community and Regional Planning
Cyberinfrastructure	Renzo Sanchez-Silva	UNM	Earth Data Analysis Center
Outreach	Jessica Sapunar-Jursich	NMMNHS	Director of Education
Remote Sensing	Caiti Steele	NMSU	USDA ARS Jornada Experimental Stations
Hydrology	Vince Tidwell	SNL	Geo-Hydrology
Hydrology	John Wilson	NMT	Earth & Environmental Science

Demographics for the primary NM EPSCoR scientists, educators and collaborators active in Year 2 of the award are shown in Table 2.

Table 2. 2010 NM EPSCoR primary scientists, educators and collaborators

Demographic	Number	Percent
Female	10	38%
Male	16	62%
Underrepresented Minority Ethnic/Race	6	23%

Appendix B: RII Participants details complete participant demographics in aggregate for the entire project and for each institution. These data include all participants, for example faculty, staff, students, K-12 teachers, external advisory board members, etc. and are not restricted to the core project personnel shown above in Table 1. Demographics for all project participants in Years 1 and 2 of the award are shown in Table 3.

Table 3. 2009 and 2010 NM EPSCoR Participants

Demographic	2009 Number	2009 Percent	2010 Number	2010 Percent	Change
Female	36	36%	57	40%	4%
Male	61	61%	86	60%	-1%
Underrepresented Minority Ethnic/Race	5	18%	38	27%	9%
Totals	102		143		41

As is evident from the table above, the total number of participants has increased as program activities have advanced. Additionally, *the percent of participants from underrepresented minority groups has increased significantly--from 18% to 27%. The percent of female participants has also increased, from 36% to 40%*. These demographic changes are a direct result of the RII 3 project's focus on diversity and implementation of strategic activities aimed at broadening participation by underrepresented groups.

Appendix A: Faculty Support is also attached as Appendix A showing NM EPSCoR support in terms of months and amount of salary on the RII project. The total dollar support columns include salary of each faculty member and the faculty member's support for students and postdocs, including fringe benefits and overhead. It *does not indicate* the time expended since most core project participants do not receive salary from the RII 3. The appendix shows faculty financial support from other grant sources.

PROJECT DESCRIPTION

1. Research Accomplishments and Plans

Significant progress was made in each of the objectives for research infrastructure improvement. These research efforts have also led to new collaborations within and between institutions in NM and beyond. The investments made in supporting undergraduate students, graduate students and post-doctoral scholars have produced noteworthy dividends as these junior scholars have contributed significantly to the research effort and gained valuable experience in research and scholarship.

Strategic Plan Objective 1: Enhance climate and hydrology research infrastructure.

Climate and Hydrology

The central research challenge of NM EPSCoR RII 3 is to understand how future changes in seasonal temperature and precipitation regimes will impact snowpack, snowmelt and spring runoff in the mountainous region of north central New Mexico. This region, the southernmost extent of the Rocky Mountain range, serves as the headwaters for river systems of crucial importance to NM, including the Rio Grande. Year 2 of the award focused on upgrading and expanding climate and hydrology observing networks and improving climate models to better investigate questions in the study region. Expansion of the observing networks has led to numerous collaborations with agencies and organizations both within and beyond the NM RII 3 jurisdiction. Two new EPSCoR-supported hires, the State Climatologist and the Hydro-meteorological Instrument Coordinator, have been key contributors to this work.

Instrumentation

Equipment was procured by New Mexico State University (NMSU) to significantly upgrade climate and hydrology observing networks in New Mexico, including sites on the Navajo Nation. Necessary materials, instruments and computers for the fabrication and on-site installation of observing stations measuring precipitation including snowfall, temperature and soil hydrology were purchased. There are now three weather stations operating: two in the Middle Rio Grande (MRG) on agricultural land and one at the Acequia Hydrology site in El Rito as part of the New Mexico State University Climate Ce nter (NMSUCC). One additional weather station will be installed in summer, 2010 on agricultural land in the MRG. In consultation with the Water Resources Department of the Navajo Nation, five weather stations will be installed on the Navajo Nation during summer, 2010.

Figure 2. Installing a NMSU weather station

Researchers from NMSU are working with the U.S. Forest Service, the Bureau of Land Management, and National Park Service to procure permits and upgrades for weather stations in the Remote Automatic Weather Stations (RAWS) network for winter operation. Additionally, NMSU will be working with NRCS-NWCC to adapt the NMSUCC weather stations into their meteorburst program and are working with NRCS-NWCC to establish a Memorandum of Agreement (MOA) on the telemetry applications and terms.

During this period the Hydrology Project began to assemble, train on, and apply/deploy equipment to be used in future research. This includes a laser and fiber-optic based Distributed Temperature Sensing (DTS) system. Distributed temperature sensing is a powerful tool that can provide monitoring data necessary for validating climate and other environmental models. In fact, it is often the only feasible method for getting high-resolution (meter-scale) temperature data over large spatial areas (up to several kilometers), since other methods are either prohibitively expensive or simply not logistically feasible. The DTS system will be deployed in both the Valles Caldera and Rio Hondo study areas during the summer of 2010 to study groundwater-surface water interaction, especially the upwelling of hyporheic zone discharge. The new equipment also includes a laser based water isotope analyzer, which is being used to analyze water samples from the same study areas in order to, for example, help determine the role of snow and snow melt, and the summer monsoon, in supplying water to plants, groundwater recharge, and stream flow. The isotope analyzer can simultaneously test for both isotopes of water, do so very quickly, and in the future could be deployed in the field in a campaign style for high resolution measurements. Finally, a series of field instruments including weather stations, flumes, and well transects are being deployed during the summer of 2010 to study streamflow generation at the plot, hillslope, and catchment scales, and to study hyporheic exchange in streams, a collaborative effort with the Water Quality Project.

Modeling
NMSU researchers and post-docs have established the Snow Runoff Model (SRM) on each of the 4 intensive important snowmelt sub basins in the Rio Grande drainage in order to provide snow cover mapping procedures as well as simulated and forecast flows and hydrologic scenarios in response to future climate scenarios. The methods developed on the 4 intensive basins will be transferred to 25 major snowmelt sub basins in the Rio Grande.

NMSU researchers collaborated with the developer of the Semi-distributed Land Use and Runoff Process (SLURP) model, to input NDVI data for the 47 Rio Grande basins in the model. After working on calibrations for the SLURP model, the model runs at 95% accuracy for the 47 basins. Unimpaired flows for the Rio Grande basin were simulated to assist in running different trial runs, especially for climate change. For climate change scenario runs with SLURP, the unimpaired or natural flow will be a better representation of how climate change will affect New Mexico and allow us to examine the bigger picture; how much water loss there will be due to climate change in the Rio Grande. In the coming year, the SLURP output will be used as input into a hydro-economic model. Results will be used to assess the consequences of climate change on the competing uses of water including agriculture, urban supplies, recreation, endangered species, and power.

The overall thrust of University of New Mexico (UNM) EPSCoR-related research into climate modeling is to better understand the large-scale controls on climate variability in arid, semi-arid, and hyper-arid regions. Research field areas include, but are not restricted to, the Southwestern United States. Other sites include the Big Island of Hawaii, which is uniquely situated in the arid mid-troposphere of the Pacific Basin, and the Atacama Desert of Northern Chile, the driest desert in the world and a site where the processes governing aridity are especially strong. These sites provide unique natural laboratories and offer important incentives to attract top-tier graduate students and postdoctoral scientists to the University of New Mexico. A particular focus of the UNM program is the use of idealized climate and weather models to understand the underlying processes that govern climate variability globally and especially in arid regions. The UNM team includes EPSCoR-supported researchers at the undergraduate, graduate, post-doc and faculty levels.

Modeling research at UNM during Year 2 of the RII 3 project focused on a variety of observational studies of climate variability in the southwestern United States. First, an EPSCoR supported graduate student continued her research into the links between snowpack, surface energy fluxes and seasonal precipitation using a variety of datasets. An unfortunate (if useful) outcome has been the identification of a major flaw in the surface energy flux fields in the North American Reanalysis dataset. She has communicated these problems to NOAA and has identified some more reliable datasets to be used in her ongoing research. Second, an undergraduate student completed an undergraduate thesis in which he used ensemble climate model output generated by the National Center for Atmospheric Research (NCAR) to determine the impact of model initial conditions on robust predictions of climate change in the Rio Grande watershed. His results suggested that initial atmospheric conditions do not impact robust prediction of temperature variations, but precipitation predictions do appear to be impacted by initial atmospheric conditions. Third, a postdoctoral scholar began a new project with UNM faculty researchers to investigate the use of oxygen isotopic ratios in ponderosa pine tree rings as a proxy for tropical cyclone activity in the Southwestern United States (SWUS). The most intense rainfall in the SWUS is delivered in the remnants of tropical cyclones (hurricanes), but the frequency of such events prior to the early 1960s is unknown. The rainfall from tropical cyclones is isotopically light and studies from the southeastern US have suggested that tree rings may faithfully record the passage of such weather systems. In November 2009, we conducted a field-sampling program in Arizona to collect cores from sites affected by Hurricane Nora in 1997, and initial isotopic analysis of those samples is now beginning. The goal is to initially see if we can identify the presence of Nora's rainfall in sites that are known to have received rain from the storm, and to confirm that we do not see an isotopic anomaly in those sites we know did not receive rainfall from Nora. A new graduate student will join the team in Year 3; she is interested in using water vapor stable isotopes to improve our understanding of the processes that control the aridity of subtropical deserts and will use a variety of modeling and field-based approaches to meet her research goals.

Researchers at NM Tech developed new conceptual and mathematical models that describe how dynamically changing flow conditions influence the distribution of residence times in hydrologic systems. This work is motivated by the use of natural and manmade tracers (e.g., isotopes) to understand the circulation of water in hydrologic systems and its sensitivity to climate variability and change, and to understand biogeochemical processes. This data is now invariably interpreted by assuming that water circulation is steady (not changing in time), a clearly limiting assumption. Models were developed for small-scale (1-100 m) hyporheic exchange and larger scale (1-100 km) basin flows, and tested with dynamic flows ranging from individual storm events up to seasonal, decadal, and longer time scales. Among the findings is the common presence of multimodal residence time distributions, with profound implications for data interpretation. Preliminary results were presented in nine talks/posters at regional and national professional meetings, including the 2009 annual meetings of the Geological Society of America and the American Geophysical Union (AGU), and the summer 2010 meeting the American Society of Limnology and Oceanography. The results have implications for atmospheric science and oceanography, not just hydrology. Manuscripts are being prepared for three journal papers to be submitted during the summer of 2010.

NM Tech researchers also initiated the development of watershed models for the Valles Caldera and the Rio Hondo using the GS Flow approach (http://water.usgs.gov/nrp/gwsoftware/gsflow/gsflow.html) developed by the US Geological Survey. Most watershed models give little attention to groundwater, treating it simply, if at all. The GS Flow approach combines PRMS, a surface water and land surface model, together with MODFLOW, a groundwater model, to develop an integrated model of the entire system. With our

emphasis on the role of groundwater in mountain hydrology such an approach is essential, and GS Flow approach provides software and partners (at the U.S. Geology Survey in Carson City, NV, and collaborators in the Nevada EPSCoR project) to pursue this with minimal new software development.

Strategic Plan Objective 2: Improve water quality monitoring in high altitude streams

Water Quality

Climate change impacts on mountain sources of water are not restricted to hydrologic elements such as timing and flow amounts, but also affect water chemistry. There is a particular need to understand the chemical constituents of streams in snowmelt-dominated watersheds that are important for both ecosystem and human health. Research efforts focused on water quality have led to substantive collaborations between faculty, students and post-doctoral scholars both within and across three of the NM EPSCoR RII 3 institutions: New Mexico Tech, the University of NM, and NM Highlands University.

NM EPSCoR RII 3 is deploying state-of-the-art, near-real-time, autonomous water quality in-stream sensors for monitoring the quality of surface water in three watersheds in New Mexico fed by snowmelt. Year 1 meetings among investigators determined that the watersheds selected should coincide with the *acequia* research project described below and with the snow hydrology research and SNOTEL stations. The selected watersheds are the Rio Hondo, Jemez River and Rio Chama.

Iron Analyzer Development
In Year 2 of this award, researchers at New Mexico Tech (NMT) developed a laboratory-based iron analyzer as a model to inform the development of an *in situ* analyzer. The results of this work are in press in *Analytica Chimica et Acta* and formed the basis for a master's thesis written by a NMT chemistry graduate student who graduated and secured employment as an analytical chemist.

The laboratory-based system serves as the model for development of an iron analyzer that will measure iron(II) and total iron at the nanomolar level and can be deployed in a stream to collect data unassisted for up to 30 days. In collaboration with Electrical Engineering faculty at NMT, design of the analyzer was completed and construction has begun. In summer, 2010, an EPSCoR-supported graduate student in electrical engineering will assist in the development of the electronics for the device, including microprocessor programming, data collection and logging, and power consumption. The design, construction, and deployment of the iron sensor will contribute to the dissertation study of an EPSCoR-supported graduate student in chemistry, making this an interdisciplinary project at both the graduate student and faculty levels.

Water Quality Monitoring
The water quality team has used areas of the Jemez river watershed located within the Valles Caldera National Preserve (VCNP) for much of their fieldwork in Year 2. The sites are readily accessible and provide adequate security for expensive field equipment. Researchers from UNM deployed sondes in the VCNP from November through February, and reinstalled them in the spring. An additional sonde was installed in April in the Jemez River downstream from the main monitoring site to allow site data to be connected to larger scale systems such as the Rio Grande. In early summer, 2010 UNM and NMT water quality researchers will install a well network to combine water quality and hydrologic efforts at the VCNP.

Based on equipment and site evaluation activities conducted throughout the year, a suite of water quality sensors will be deployed on the Jemez River in the VCNP during the summer, 2010. The sensors will be installed in a 6' x 10' enclosed cargo trailer that will be connected to an existing power line. Electric space heaters will be used to heat the inside of the trailer to prevent damage to the equipment due to freezing winter temperatures. All of the equipment described below will be fed by a common water source pumped from the stream to the trailer. The pumps and valves used to control the water flow and the collection of data from the various sensors will be controlled by a Labview software package recently purchased from National Instruments (NI). NMT researchers are working with NI to develop a system of I/O devices and drivers to control devices, collect data, and transmit data back to our laboratory.

Figure 3. Sonde at VCNP

Several water quality sensors will be installed in the trailer, including an online carbon analyzer that was purchased from O.I. in late 2009. This instrument uses new electrochemical oxidation technology to measure organic carbon in water, which eliminates the need for a heated combustion chamber or corrosive chemical oxidants. The O.I. instrument was determined to be the most suitable for this installation as it measures both organic carbon and inorganic carbon and can measure carbon in water unattended for up to 60 days without recalibration. In addition, the quality of the organic carbon will be monitored using spectroscopic methods. Evaluation of available technology for measuring the absorbance and fluorescence of the organic carbon is underway and will be completed in summer, 2010 after which the equipment will be tested and installed in the trailer. A NMT graduate student in Geochemistry will conduct the carbon analysis work. Other sensors to be installed in the trailer include a nutrient analyzer to measure nitrate, phosphate, and silica and a water quality sonde to measure dissolved oxygen, pH, conductivity, and temperature. An EPSCoR-funded post-doctoral scholar at UNM will be in charge of this equipment; the installation will be completed by the end of Year 2 funding.

Several additional NM EPSCoR RII 3 water quality research projects are scheduled at the VCNP during summer, 2010 including:

- a study of the transfer of organic carbon from soils to streams by a NMT graduate student;
- a study of the movement of organic carbon through the hyporheic zone by NMT graduate students;
- an investigation of decomposition rates and nutrient contribution of plants to streams by NMHU graduate students

Collaboration between the UNM water quality team and the NMSU acequia research group began in Year 2. Study sites were identified, and preliminary sampling occurred in March. The selected sites will be monitored several times throughout the spring and summer, 2010 and results compared to streams of similar order.

Stategic Plan Objective 3: Develop interdisciplinary socioeconomic and hydrologic research capacity in *acequia* systems research.

Acequia Interdisciplinary Research

Acequias are the traditional water management system of rural northern New Mexico. Their communal governance and 'ditch irrigation' management systems provide unique physiographic and cultural elements to help understand the effects of changing mountain hydrology on land and water use, ecosystem change, and stream flow. A collaborative interdisciplinary team integrates social, economic, ecological and hydrological research to understand climate change impacts on *acequias*, and *acequi*a management responses to climate variability.

In Year 2, the El Rito valley (Rio Chama) that encompasses an irrigated valley with five different acequias was chosen as the third major study site for the RII 3 project. Researchers made multiple visits to the Rio Hondo and El Rito study sites for ongoing hydrological and meteorological instrumentation. They created a detailed map of hydrological features for the Rio Hondo site and a similar map is ongoing for the El Rito site. Throughout Year 2, researchers from UNM and NMSU broadened the cooperative relationship with the Rio Hondo community, in particular with the Taos Valley Acequia Association. They contacted and established similar cooperative relationships with the El Rito Ditch Association and the El Rito Regional Water and Waste Water Association for equipment installation. UNM researchers surveyed the riparian health of acequias in collaboration with members of Rio Hondo and El Rito acequia associations. Together, the researchers and acequia members are collaborating to adapt the riparian health survey technique developed for streams to apply to acequia systems. An Exploratory Research Focus Group Session for the Rio Hondo Valley is tentatively scheduled for implementation the first week of August 2010. The focus group session will facilitate discussion about possible climate change impacts on traditional irrigation practices, cropping patterns and land use, water sharing agreements, storage facilities, and water conservation, and also on techniques to develop a long term riparian monitoring program driven by the acequia stakeholders.

Figure 4. Dr. Jose Rivera (UNM) and students at an *acequia* study site

Graduate students from UNM began collecting data on acequia history and custo ms, climate changes in mountain valley environments, and socio-cultural factors of adaptation in times of drought. Of specific interest were the hydrographic surveys and regional water plans for the Rio Chama in Rio Arriba County and the Rio Hondo Valley in Taos County as well as maps, population projections, water use categories, and climate change reports for New Mexico. The students collected and shared qualitative data on historical irrigation practices, cultural components, ditch rules and water sharing agreements, the hydrology of acequias, climate change projections, water supply and demand projections, USGS and NRCS reports, crop types and agricultural conservation, riparian and acequia health survey material, and Western state water planning reports. The students also documented and saved images of field site locations in a database for common access by EPSCoR students and faculty. The socio-cultural data collected will be incorporated into the master's thesis of an EPSCoR-supported graduate student.

Socioeconomics and System Dynamics Model

A primary goal of this research is to support the expansion of the System Dynamics (SD) economic-behavioral-physical model to include more robust residential demand models for Albuquerque, as well as a population model tied to both natural growth and economic growth. The incorporation of the demand functions allows a more robust representation of consumer response to substantially increased water prices. Incorporating both natural growth and economic growth into the population module will allow investigation into the trade-offs between resource use and economic development. This expansion of the SD model will provide one of the most extensive interactive models of a watershed system with equal attention to the physical and behavioral worlds.

To this end, year two work has focused on the incorporation of residential demand functions into the existing SD model for the Middle Rio Grande. Research began with a focus on initial estimations of residential water demand functions and review of the components of the SD modules. The Year 2 research plan was:

1) refine the residential water demand functions,
2) program the functions into modules consistent with the Toolbox PowerSim frame,
3) refine the existing population model module to allow for net migration into the study area that is, in part, driven by economic activity,
4) develop and complete the connections between the residential demand functions, the population model, and the existing macro-economic input-output model,
5) connect these economic modules to the larger systems dynamics model,
6) test the model,
7) refine as necessary,
8) run a series of basic scenarios, and
9) time permitting, begin developing the modeling plan for the Acequia.

The preliminary residential demand functions have been econometrically estimated, refined, and checked for robustness. The functions are currently being transformed into PowerSim modules. The plan (roadmap) for the linkages and interactions between the demand functions, the population module, and the macroeconomic module has been developed and the programming of these modules will be programmed by early summer, 2010.

The work plan for June 1, 2010 through August 30, 2010 is to complete the population module, the link between the population and residential demand module, as well as the link between these and the macroeconomic component. Working with Sandia National Laboratories researchers, these modules will be linked to the larger Toolbox model by the end of the reporting period. Scenarios will be developed for the simulations and we will begin the process of running the scenarios with sensitivity analyses. In addition to these activities, preliminary analysis of developing socio-economic components for a similar dynamic simulation model for an Acequia will be conducted. This includes relevant background research, as well as collaboration with other EPSCOR researchers (e.g., Rivera and Fleming) to develop appropriate behavioral components.

Strategic Plan Objective 4: Provide critical gap infrastructure for New Mexico Highlands University.

Aquatic Chemistry Laboratory at New Mexico Highlands University (NMHU)

In Year 1, NM EPSCoR funded the establishment of an aquatic chemistry laboratory at NMHU for state-of-the-art water quality analysis that enhanced the institution's ability to perform research on climate change and water resources. A primary incentive for the laboratory upgrade was to improve the quality of graduate student research at NMHU, and to provide training in the use of analytical instruments for graduate and undergraduate students.

In Year 2, Dr. Edward Martinez (NMHU) provided several training sessions for undergraduate and graduate students in the use of the aquatic chemistry equipment. A graduate student was employed to provide technical assistance in the use and maintenance of the water analysis equipment. The NMHU aquatic chemistry lab will analyze water samples that are collected by NMT and UNM researchers and that are also analyzed by the field-deployed water sensor equipment, to check the sensors for accuracy. During Summer and Fall 2010, Dr. Pullin (NMT) will travel to NMHU to work with Dr. Martinez and his students on developing and validating water testing methodology.

Researchers from NMHU have worked in collaboration with researchers from UNM, NMT and the VCNP on several water quality projects:

- *Effects of Livestock Crossings on Water Quality in the Valles Caldera Streams.*
- *The Effects of Ungulate Grazing on Nutrient and Geomorphology of Streams in the Valles Caldera National Preserve.*
- *Seasonal Variation Influences on the Bioavailability of Dissolved Organic Carbon (BDOC) in High Mountain Meadow Streams, Valles Caldera, NM.*

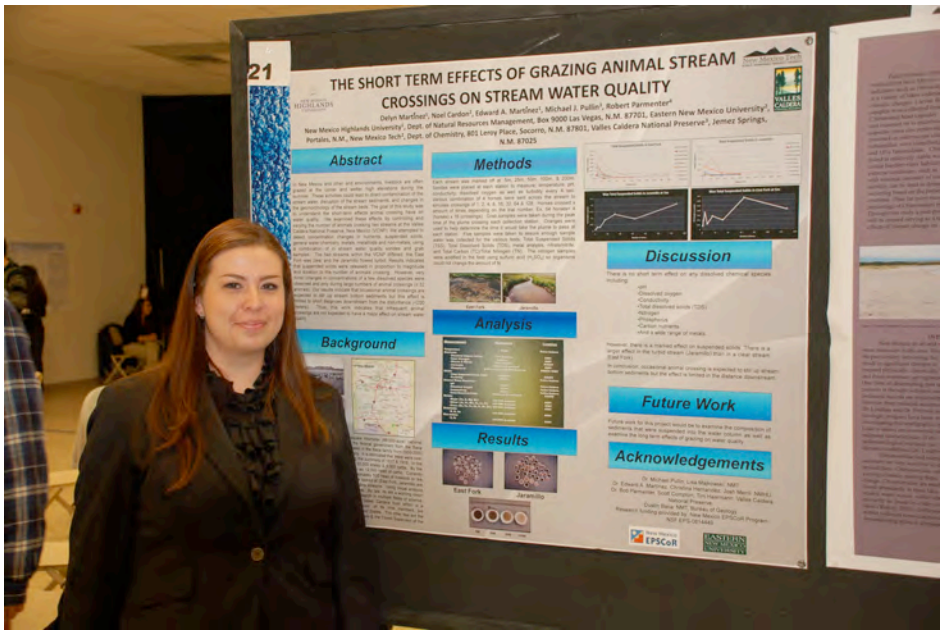


Figure 5. NMHU student, Delyn Martinez, reports on her research at VCNP—a collaborative project between NMHU and UNM researchers.

2. Diversity of People and Institutions

As required by NSF following the Reverse Site Visit, a revised diversity plan is include in the NM EPSCoR Implementation Plan (see pp. 33-35 in Appendix N) to include a strategic objective to encourage and support leadership by women and underrepresented groups on EPSCoR-supported projects. In program solicitations, such as Innovation Working Groups and SEED Awards, preference will be given to proposals that provide leadership opportunities for women and underrepresented groups. Diverse faculty and post-docs will be invited and encouraged to lead presentations and discussions at science meetings, including the annual All Hands Meeting and Tri-State Consortium Annual Meeting. Leadership training will continue to be provided through the annual Junior Faculty Leadership Workshop; diverse EPSCoR faculty will be recruited to attend.

Progress:
The Diversity Leadership Team was expanded to provide additional opportunities for involvement of junior faculty, post-docs and graduate students in shaping the EPSCoR program as well as providing broader perspectives on diversity issues. The RFP for IWG's includes criteria encouraging the leadership of diverse faculty; the upcoming SEED Awards will as well. A female post-doc took the lead in presenting the research agenda and progress of the RII program to the External Advisory Board and was supported in her presentation by another female post-doc. The Year 2 Tri-State meeting provided an opportunity for future faculty (graduate students) to present posters; 8 NM students from underrepresented groups and women participated.

Table 4. Diversity Leadership Team

First	Last Name	Institution	Role
Laura	Arguelles	UNM	Prof. Staff
Karl	Benedict	UNM	Faculty
Marnie	Carroll	Dine College	Faculty
Asitha	Coorey	NM Tech	Grad Student
Laura	Crossey	UNM	Faculty
Mary Jo	Daniel	NM EPSCoR Office	Assoc. Director
Li	Dong	UNM	Post-Doc
Yaika	Echevarria-Roman	NM Tech	Grad Student
Eileen	Everitt	NMMNHS	Climate Educator
Edward	Martinez	NM Highlands Univ	Faculty
Robert	Parmenter	VCNP	Science Dir.
Michael	Pullin	NM Tech	Faculty
Jessica	Sapunar-Jursich	NMMNHS	Educ. Director
Caiti	Steele	NMSU	Faculty
Amanda	White	NM Tech	Post-Doc

The Diversity Leadership Team is itself 67% women and 20% members of underrepresented minorities. In Year 2, the Team reviewed the *Best Practices Guide for Increasing Faculty Diversity at New Mexico Higher Education Institutions*. Members of the team also provided leadership for the Tri-State Consortium Annual Meeting's diversity session.

2a. Broadening Participation

Strategic Plan Objective 10: Develop an Undergraduate Research Opportunity Program that increases the exposure of students at non-PhD granting institutions to high quality, relevant, hypothesis-driven research.

The NM EPSCoR Undergraduate Research Opportunities Program (UROP)

The NM EPSCoR UROP is a summer undergraduate research program specifically designed to broaden participation from under-represented groups in science and technology. Application is available to students attending two-year, tribal, or four-year non-Ph.D.-granting colleges in New Mexico. The program PI, Michael Pullin, NMT and the program manager Lisa Majkowski, NMT conducted campus visits to science and engineering departments--biology, chemistry, earth sciences, natural sciences, computer science and engineering--at eight campuses (see Table 4).

Visits generally consisted of a research seminar and/or PowerPoint presentation on the UROP program plus distribution of application materials. The visit to Eastern New Mexico University involved participation in their Career Fair. A large recruitment display was developed for use during the campus visits. The display features photos of the students from last year's program working in the laboratory, conducting field work, and presenting their results at the UROP Conference. Applications were received from six of the seven schools as a direct result of these visits. The PI and Program Manager also direct an NSF-REU funded summer program at New Mexico Tech. Recruitment for both programs was conducted during the campus visits..

Table 5. 2010 UROP Recruitment Visits

Recruiter	School	Minority Serving	# Students Contacted
Michael Pullin	Diné College (Shiprock Campus)	Yes	30
Michael Pullin	Diné College (Tsalie Campus)	Yes	35
Lisa Majkowski	Eastern New Mexico University	No	15
Lisa Majkowski	New Mexico Highlands University	Yes	10
Lisa Majkowski	Northern New Mexico College	Yes	1
Michael Pullin	San Juan College	Yes	25
Lisa Majkowski	Southwestern Indian Polytechnic Institute	Yes	40
Lisa Majkowski	Navajo Technical College (Field Trip)	Yes	4

Program announcement posters were also utilized as a recruitment method. A full color 8.5"×14" poster (see end of report) and letter describing our program was mailed to the Chemistry, Biology, Earth Science, Environmental Science, Natural Sciences, Computer Sciences and Engineering department chairs and faculty at all of the non-Ph.D. granting two and four year colleges in New Mexico. A total of 216 separate recruitment packages were sent out this year. This method also yielded applications to the UROP program, including from Western New Mexico University, one of the few campuses we did not visit.

The UROP program hosts a website at New Mexico Tech (http://www.nmt.edu/~climate/). The website was created by the PI and contains general information about the program, research projects and application materials. The posters refer students to the web site for more information and application materials.

Required application materials included an application form that assessed the student's motivation for applying, expectations of the program, future education and career goals, ranking of preferred research projects and how the student learned about the program. Two optional questions, race/ethnicity and gender, were included on the application. Other required application materials included two letters of reference and official transcripts.

UROP Applicants.
Application materials were submitted by 30 students, double the number of applications received for Year 1 of the program. The program also received applications for the first time from Navajo Technical College, Santa Fe Community College and Western New Mexico University. The program saw a dramatic increase in applications received from Native American students, going from 20% in Year 1 to 40% in Year 2. The overall number of URM applicants increased from 47% in Year 1 to 67% in Year 2. The demographics for the pool of applicants are listed in Table 5.

The faculty leading the undergraduate research projects selected the participants from within the applicant pool. Once the application deadline had passed, each application was scanned and the applications were pooled into groups based on the applicant's ranking of the projects by interest. Packets of applications were mailed to the faculty/scientists who will be leading UROP projects. Each packet contained all of the applications from applicants who ranked their project as their first or second choice. The faculty and scientists reported back with a ranked list of the applicants they chose for their program. The PI and program manager made the final decision on the applicants for each program. The decision was heavily influenced by the faculty/scientist ranking, but also influenced by demographics. In particular, a strong effort was made to choose participants from a variety of schools.

Table 6. 2010 UROP Application Demographics

Demographic	Number	Percent
Gender		
Female	12	40%
Male	16	53%
Unknown	2	7%
Race/Ethnicity		
African American	2	7%
Asian	0	0%
Caucasian	6	20%
Hispanic	6	20%
Native American	12	40%
Pacific Islander	0	0%
Unknown	4	13%
Total Underrepresented Minorities	20	67%
Educational Level		
Freshmen	8	27%
Sophomore	11	37%
Junior	4	13%
Senior (non-graduating)	6	20%
Unknown	1	3%
Educational Major		
Anthropology	2	7%
Biology	5	17%
Chemistry	2	7%
Computer Science	0	0%
Earth Science	2	7%
Engineering	8	27%
Natural Sciences	7	22%
Other	4	13%
Colleges		
Diné College	6	20%
Eastern New Mexico University	3	10%
Navajo Technical College	1	3%
New Mexico Highlands University	4	13%
Northern New Mexico College	1	3%
San Juan College	11	37%
Santa Fe Community College	2	7%
Southwestern Indian Polytechnic Institute	0	0%
Western New Mexico University	2	7%
Information on UROP Program		
Recruiting Visit	9	30%
Faculty/School	11	37%
Poster	8	26%
Unknown	2	7%

2010 UROP Participants

Student participants and their demographics for Summer 2010 are listed in Table 6. The program has achieved 60% female participation. Underrepresented minority participation is also very high at 60%. Participants come to the program from six different schools. A student from New Mexico Highlands University who applied to the UROP program was chosen to participate in the New Mexico Tech Interdisciplinary Science for the Environment REU, operated in collaboration with the NM-EPSCoR UROP.

Table 7. 2010 UROP Participant Demographics

Demographic	Number	Percent
Female	6	60%
Male	4	40%
Underrepresented Minority	6	60%
Colleges		
Diné College (DC)	2	
Eastern New Mexico University (ENMU)	2	
Navajo Technical College (NTC)	1	
San Juan College (SJC)	1	
Santa Fe Community College (SFCC)	2	
Western New Mexico University (WNMU)	2	

Program Activities

Year 2 of the NM-EPSCoR UROP program runs from May 30 through July 31, 2010. Ten UROP students will participate in five research projects hosted at various NM-EPSCoR research institutes across the state. As part of the program, the students are enrolled in a graded, four-credit, upper division interdisciplinary science course of their choice (Biology, Chemistry, Earth Science) at New Mexico Tech. Students will receive their tuition, housing, travel expenses, food allowance ($700), and stipend ($4,000) through the program.

UROP students will spend the first week of the program at New Mexico Tech attending mini-courses focused on climate change and the environment. The UROP participants will join the participants in the New Mexico Tech REU program during the mini-courses. Additionally, UROP students are invited to participate in the REU Saturday science field trips throughout the program.

UROP students will be housed at their project research institutions for weeks 2-9. During this time, the UROP students will formulate a research question, conduct field and laboratory research, collect data and prepare a formal research report/presentation. The program will culminate in a research conference, to be held at the Valles Caldera National Preserve Science and Education Center on Friday, July 30, 2010. Student participants from the NM-EPSCoR UROP program and the New Mexico Tech REU program will present their research results to an audience of faculty, graduate students, peers and the public.

2010 UROP Week 1 Mini-Courses

The UROP program begins with a week of mini-courses to cover a range of topics focused on climate change (Table 7). The mini-courses are designed to provide students from different disciplines with basic knowledge on the relationship between climate change, water, and people in New Mexico. Additionally, the mini-courses provide a mechanism to address the potential lack of junior and senior-level coursework faced by the freshmen, sophomore, and/or 2-year college

participants. The mini-courses are typically four hours long and consist of a variety of classroom lectures, hands-on laboratory work and field trips. The courses and the instructors are under development.

Table 8. 2010 UROP Mini-Courses

Course	**Faculty**
Laboratory Safety	Verploegh
Water Quality	Pullin
Climate Change	TBD
Maps and GPS	Majkowski
Acequia Hydrology	Fernald
Stream Ecology	TBD
Hydrology	Wilson/Gutierrez/Gomez
Soils and Local Geology	Majkowski
Geologic History of New Mexico	TBD
Climate Change Impacts of Society	TBD
Climate Change and Archaeoagriculture	TBD

2010 UROP Projects

The 2010 UROP program is sponsoring five research projects, listed in Table 8; descriptions of the projects are provided in Appendix Q.

Table 9. 2010 UROP Research Projects

Institution	Project Lead	Project Title	UROP Participants
NM State University	S. Fernald	Hydrology and Water Quality of Ancient Acequia Irrigation Systems and Their Contributing Forested Watersheds	1: Dine 1: SFCC
NM Tech	J. Wilson	The Deployment Of Hydrology Sensors In High Altitude Northern New Mexico Watersheds	1: NTC 1: SFCC
Univ. of NM	L. Crossey, L. Sherson	Hyporheic Zone Effects on Water Quality	1: SJC 1: WNMU
Valles Caldera Nat'l Preserve	R. Parmenter, S. Compton, D. VanHorn	Stream Hydrology and Geomophology Response to Elk and Livestock Activities in the Valles Caldera National Preserve	1: Dine 1:WNMU
Valles Caldera Nat'l Preserve	A. Steffan	Climate (Temperature And Precipitation) Influence On Pueblo Agriculture In The Southern Jemez Mountains Of New Mexico	2: ENMU

Program Year 1 Evaluation and Follow-Up

An external evaluation was conducted for the Year 1 UROP and results were shared with the Program PI and Program Managers. Program participants found little fault with the program, other than a slight lack of organization, which they attributed to it being the first year of the program. Some of this was at the UROP level, while sometimes it was at the project level or in the lab in which the student worked. The design and content of the program appears to be meeting the needs of

students. Mentors in most situations were well liked and supportive. They were rated well in explaining expectations, presenting information and being available to ask questions. One area of mentorship that might be improved is providing opportunities for the students to talk about graduate school, careers and being a research scientist.

As part of the long-term follow up for the UROP program, surveys will be sent out annually to prior participants to ascertain their educational progress and how the program has influenced their future in graduate school and science careers. The survey is under development and will be sent out during the summer 2010.

Strategic Plan Objective 8: Enhance diversity in all elements of the NM EPSCoR Program. A) Increase the number of incoming students into STEM disciplines from underrepresented groups.

The NSF Geosciences - AIHEC program in climate change science education

In Year 1, NM EPSCoR participated in the development of an undergraduate course entitled, "An Introduction to Climate Change from an Indigenous Perspective: a collaborative curriculum development project of the Tribal Colleges". In Year 2, the course was offered by ITV at Diné College in northwestern NM; 20 Native American students enrolled from Diné College. The semester-long course targets sophomore-level Native American students enrolled in Tribal Colleges and Universities and focuses on climate science, climate change, and climate change impacts. Importantly, the curriculum is taught from the perspective of the traditional ecological knowledge held by native peoples of North America. Participating students rated the course very highly and several students changed their academic major to a science field.

2b. Institutional Collaborations

Western Tri-State Consortium

New Mexico has joined the Nevada and Idaho NSF EPSCoR programs in forming a consortium of EPSCoR states with similar research agendas related to climate change and water resources. The consortium model significantly increases opportunities for scientific collaboration and enhances each state's ability to secure competitive funding and tackle complex climate change research agendas.

Tri-State Meeting

Each year the Western Tri-State Consortium of Idaho, Nevada and New Mexico (#0814387, #0814372, and #0814449) conduct an annual meeting of current NSF EPSCoR participants. The primary purpose for this meeting is to foster collaborations among the NSF EPSCoR RII projects and participants in our respective states and to identify common challenges and solutions related to the themes of our states' RII programs. The meeting agendas and presentation formats, facilitated sessions, working group breakouts, etc., are specifically and carefully developed to spur collaboration among program directors, cyberinfrastructure scientists, research scientists, education professionals, and outreach and diversity program coordinators. The meeting rotates among the three EPSCoR jurisdictions.

Nevada EPSCoR hosted the second annual meeting of the Western Consortium on April 6-8, 2010 in Incline Village, NV. Approximately 165 people attended this event; a 50% increase in participation from the first tri-state meeting. Forty participants were from New Mexico. The three-day meeting included keynote speakers and sessions on cyberinfrastructure, diversity, climate change science and education, and collaborative and interdisciplinary science. In addition there was a half-day workshop on Hydrologic Information Systems. A highlight of meeting was an evening graduate student poster session where 33 students presented research posters to judges and meeting participants. The final agenda for the meeting is attached as Appendix R.

Figure 6. NM Diversity Team leaders, Mike Pullin and Marnie Carroll participated in the Tri-State Diversity session.

Cyberinfrastructure is a major focus area of the Tri-State meeting and of the overall tri-state collaboration and is being further developed through an EPSCoR Track 2 proposal, *Collaborative Research: Cyberinfrastructure Development for the Western Consortium of Idaho, Nevada, and New Mexico* (EPS-0918635). The collaborative tri-state activities to support cyberinfrastructure development are described in Section 4 (pp. 25-26) of this report.

Tri-State IWGs

Another mechanism for facilitating collaborations is the Tri-State's Innovation Working Group (IWG) Program, which supports collaborative, trans-disciplinary work by the three member states. The IWG provides a venue for engaging scientists and educators, along with key nationally and internationally recognized experts, to address the grand challenges that can transform science and education. This program supports week-long working group activities that are modeled after those hosted by the highly successful NSF-supported National Center for Ecological Analysis and Synthesis (NCEAS). The Tri-State Consortium awarded three IWGs in 2009: 1) *The effects of climate change on ecosystems and societies: A Focus on Native American and Hispanic Communities*; 2) *Paleo-Rainfall and Groundwater Recharge in Southern Nevada over the past 11000 Years from Cave Calcite Deposits*; and 3) *Integrated Environmental Modeling Software Systems*. IWG funding is discussed in the Sustainability and Outcomes section under, pp. 33-34.

Tri-State Training

The Tri-State Consortium is also collaborating to provide additional graduate training through the development of a new interdisciplinary modeling course to be offered in summer 2010. The course will be taught by a host of instructors representing various disciplines and universities. The course is open to graduate students from all institutions in Idaho, New Mexico, and Nevada and is further described in section 7b (p. 37) of this report.

The Junior Faculty Leadership Workshop, an activity designed to address one of NM EPSCoR's RII 3 strategic objectives, was opened in Year 2 to Nevada and Idaho post-doctoral scholars and junior faculty, making it another component of tri-state collaboration. In the 2010 workshop there were 2 participants from Idaho and 5 from Nevada. This activity is more fully described in section 7b (pp. 35-37) below.

Institutional Collaborations within and beyond New Mexico

Collaborations on research and education projects have been plentiful in the second year of the project among New Mexico institutions of higher education, education and outreach organizations, and state and federal agencies. Many of these collaborations are described within the report sections on research, broadening participation, cyberinfrastructure, and workforce development. The following activities briefly highlight some of the collaborative undertakings not discussed in other sections of the report:

The water quality research is collaborative effort between UNM, NMT and NMHU. and will be sharing aquatic chemistry equipment and facilities. Graduate students at these three institutions have developed joint activities are planned. In addition, the water quality team from UNM has begun working with acequia researchers from NMSU.

In addition to collaborative work between the three tri-state collaborating institutions, EDAC has also begun work with researchers at NM Tech and NMSU to identify initial data products that will be integrated into the project data portal as an early demonstration of the entire workflow from instruments to data services. Thus far these discussions have focused on general concepts for data flow, but by the end of the year we will have developed an end-to-end workflow for at least two science data products that will result in the availability of those products as downloadable products suitable for use in both research and education contexts.

As an extension of the work on the data portal platform, EDAC at UNM has begun a collaboration with the University of Texas at El Paso (a designated HSI), resulting in the development of an NSF CI-TEAM proposal, and is also working with their faculty and graduate students in the experimental development of semantic provenance generation as an integral part of science data product generation and processing.

NMSU has established a working relationship with USDA/NRCS/NWCC in Oregon and Colorado for the procurement of SCAN and SNOTEL site equipment and for technical assistance. Additionally, the New Mexico NRCS office has offered to help identify and evaluate the SCAN & SNOTEL site selections.

NMSU also contacted and established a cooperative relationship with the Navajo Nation for siting and installing 5 weather stations on tribal lands. Researchers from NMSU are working with the U.S. Forest Service, the Bureau of Land Management, and National Park Service to procure permits and upgrades for weather stations in the Remote Automatic Weather Stations (RAWS) network for winter operation. Additionally, NMSU will be working with NRCS-NWCC to adapt the NMSUCC weather stations into their meteorburst program and are working with NRCS-NWCC to establish a Memorandum of Agreement (MOA) on the telemetry applications and terms.

3. Workforce Development

Strategic Plan Objective 9: Enhance teacher professional development for STEM areas in northern New Mexico.

NM EPSCoR Teacher Summer Institute

NM EPSCoR has selected The Northern New Mexico Network for Rural Education (NNMN), an educational cooperative of 29 school districts in northern New Mexico, to serve as our partner for the RII 3 teacher professional development component. The NNMN is a 36-year collaborative of small, rural, predominately minority districts in North Central and Northeastern New Mexico, an area serving approximately 30,000 students. The NNMN's mission is to work with school districts to improve the quality of life in rural northern New Mexico by being an advocate and catalyst for the improvement of education for all children. The Network forges partnerships, develops funding avenues, and delivers programs that promote K-12 professional development in science and mathematics.

Partnership with NNMN is a key step in achieving NM EPSCoR objectives. The school districts it serves are located in northern New Mexico in the mountainous central part of the State in which our climate change research is focused. These school districts are small, rural, and poorly funded. They are predominantly Hispanic and almost 75% of the population speaks Spanish as the primary language in their homes. Three of the school districts have a majority of Native American students, (Apache, Navajo, and Taos pueblo). The longtime working relationship established by NNet with these school districts provides the access and cultural understanding that are necessary to solicit successful participation by their teachers and administrators. In addition, NNet has extensive experience in improving STEM education. They currently have in place a program of 'circuit riders' - math and science pedagogy professionals who travel from school to school and assist teachers on-site in the implementation of NNet programs. Consistent and ongoing on-site attention is crucial to the adoption of climate change curriculum that the NM EPSCoR educational plan seeks to develop.

The Northern Network provides a one-week inquiry-based curriculum development summer institute for secondary science teachers and teams of science/math teachers at the Valles Caldera National Preserve (VCNP), another NM EPSCoR partner and field research site. The Valles Caldera Summer Teacher Institute program, "Rim to River," engages teachers in the development of curricula on climate change in New Mexico, using field studies in water, soils, botany, and sampling methods. Teachers receive a stipend for their week of attendance, and all housing and food costs are paid.

Figure 7. Teacher Summer Institute participants working on field projects at the Valles Caldera.

The NNMN, in collaboration with NM ESPCoR, the Valles Caldera, and the NM PED Math and Science Bureau, sponsored a one-week science institute for fourteen high school science teachers and math/science teams of teachers in June, 2009. Sixty-four

percent (64%) of the teachers were members of under-represented minority groups (Hispanic and Native American).

Table 10. Teacher Summer Institute and Follow up (2009-10) Demographics

Demographic	Number	Percent
Female	10	71%
Male	4	28%
Underrepresented Minority	9	64%

A follow-up professional development session was held at the start of the 2009-10 school year; focus was on providing place-based site alternatives for field experiences and collaboration in reviewing, revising and planning implementation of curriculum units. A second follow-up professional development session was held in spring, 2010 at a school site computer lab and focused on using NWEA MAP (short-cycle) science data to drive instruction, collaboration, and assessing current implementation of curriculum units. The teacher-developed curriculum materials will be made available to other teachers through the NM ESPCoR website.

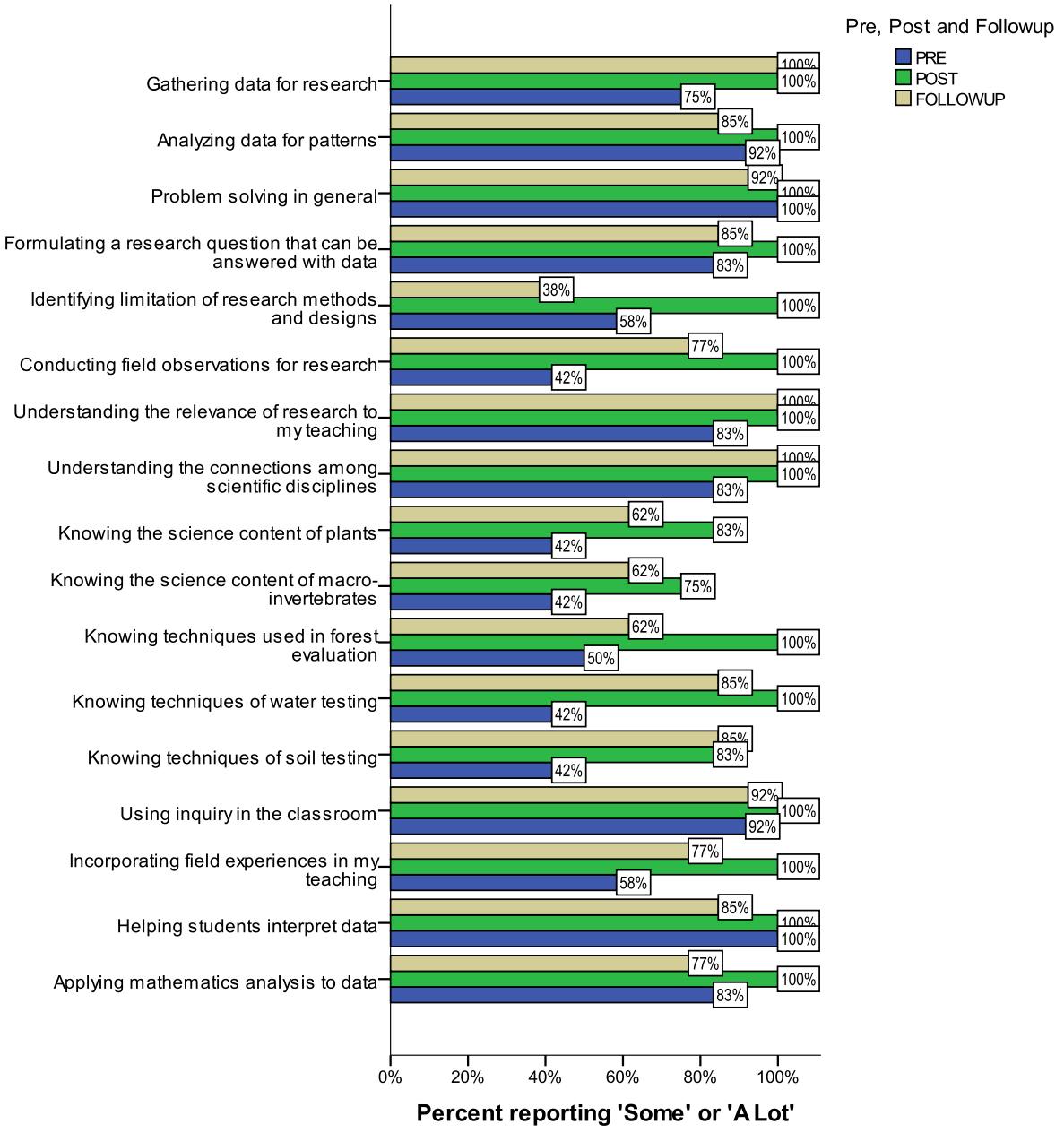
Year One Evaluation Results

During the first day of the program a pre-survey was administered to the teachers; the same survey was administered at the end of the institute. In addition, a nine-month follow-up survey was developed to assess longer-term impacts and receive feedback from participants on the institute. The results of the three assessments are presented in the graph below.

In general, those skills/knowledge areas where teachers rated themselves highly on both pre and post surveys, were also rated highly on the teaching success question, suggesting these were areas in which the teachers felt competent before participating in the institute. However, there were different response patterns on those skill/knowledge areas that showed the most change from pre to post survey. In some of these areas teachers reported considerably less success in teaching the skill/knowledge to their students than they reported their skill level on the post survey. This suggests teachers may not have learned the knowledge or skills at adequate depth for teaching these concepts to their students.

Figure 8. Teacher Summer Institute participants at the Valles Caldera National Preserve.

Graph 1. Self-Reported Ratings of Skill/Knowledge on Pre-Post Surveys and Six-Month Follow-up Rating of Success in Teaching Skills/Knowledge in Classroom
(Number responding: Pre/Post=14, FUP=16)



Program participants found little fault with the program. The design and content of the program appeared meet the needs of teachers. However, some participants questioned the usefulness of the curriculum development component. There was a lack of EPSCoR scientist involvement in the Institute and this should be rectified in coming years. Although the scientists that were involved were well respected and taught the teachers similar content and equipment use, NM EPSCoR

scientists should be able to expand the linkage between the equipment use and its relationship with climate change research.

The proposed concept of identifying teams of teachers to participate was not implemented during the first year. It may be that this was found to be too difficult to implement, but it should be explicitly addressed . NM EPSCoR has multiple research components, some of which address the economic and cultural impacts of climate change. The expansion of this program to include these other research areas could excite students from Northern NM communities.

Overall, the program had a very successful first year with EPSCoR funding.

Year Two Summer Teacher Institute

The Network has actively recruited high school teachers and coordinated course content for the summer 2010 (Year 2) teacher institute, using formative evaluation data to improve the program. In keeping with the NM EPSCoR research emphasis on climate change impacts on mountain sources of water, this summer's teacher institute offers field techniques, data collection, and data analysis centered on hydrology and water quality in high-altitude stream basins. As recommended in our external evaluation report, there is an *increased emphasis on involving EPSCoR researchers* in the summer institute for teachers. EPSCoR faculty and graduate students working on water quality and hydrology who are using the Valles Caldera as a study site will participate as instructors for the teachers. Appendix S shows the daily program activities.

Table 11. Year 2 Teacher Summer Institute Demographics

Demographic	Number	Percent
Female	9	64%
Male	5	36%
Underrepresented Minority	3	21%

Half of the teachers in the Year 2 summer institute will be attending as part of a *team of teachers* from the same school. The Year 2 evaluation will investigate whether there is a significant difference in participant satisfaction or classroom implementation between those teachers who attend as a team and those who are the only participants from their school. Recruiting teams of teachers from very small schools is challenging; the evaluation can help to determine if the outcomes justify the effort required.

4. Cyberinfrastructure

Strategic Plan Objective 7: Enhance scientific data and model output generation, management, discovery, and use through cyberinfrastructure.

NM Cyberinfrastructure Activities

During Year 2 of the award, the Earth Data Analysis Center (EDAC) at UNM made significant progress in the development of the shared (with New Mexico's Resource Geographic Information System) data infrastructure for the management, discovery, and delivery of the science data generated by the EPSCoR project. This work has resulted in the following capabilities:

- A base data model that is optimized for the storage of 2d and 3d vector (point, line, and polygon) and raster data in conjunction with consistently encoded temporal data capture for each spatial object in the system. This data model is generalized for storage of observations/measurements taken in 4-dimensions, with uniform representation of spatial and temporal values for cross-observation discovery by location and time.
- REST web services as the primary means of interacting with the data model and external applications and services that access the contents of the data model. These services provide the following interfaces:
    - Create, Read, Update, Delete functions for managing data objects in the system
    - Metadata request and reformatting functions
    - Data generation request functions
    - Automatically generated Open Geospatial Consortium Web Map, Web Feature, and Web Feature services for delivery of data system content through a wide variety of interfaces: web, desktop Geographic Information Systems, or as "mashups" with external products that implement the OGC services.
- An initial instance of the GeoNetwork Open Source platform for the creation and management of metadata for science data products managed within the system. This platform supports a variety of distributed search standards, including the Open Geospatial Consortium Catalog Services for Web (CSW), the library community's z39.50, and the OAI PMH standards.

Planned accomplishments in the final quarter of the project year include the following:

- Consultation with science and education stakeholders in New Mexico to identify key interface capabilities for development in the data portal that will be built on top of the developed platform.
- Development of a round-trip synchronization between the GeoNetwork platform and the developed data portal platform for standards-based discovery through the GeoNetwork interfaces and data service and client interfaces hosted by the project's data portal.

Tri-State Coordination of Cyberinfrastructure Activities

The Tri-state Consortium Cyberinfrastructure (CI) Working Group was formed in 2008 to leverage existing CI resources and expertise both nationally and in the tri-state region, to support climate change research, and to identify and evaluate interoperability standards and solutions that can be deployed regionally. The CI Consortium was further solidified with the three year, NSF EPSCoR Track 2 collaborative award issued to the three states in September 2009. The three CI sessions convened at the 2010 Tri-State meeting, Data Policy, Architecture, and Data Formats and Instrumentation Systems Connectivity, were identified as the three top priority topics at the 2009 Tri-state CI Working Group meeting in Boise, ID.

Session A1: CI Data Policy
This session focused on data policies being developed by the individual EPSCoR states, which includes the sharing of data and final products between the scientists and research projects.
Key Session Outcomes

- Challenges include resistance by researchers to the application of emerging CI tools and to data sharing models that do not have an obvious and immediate "payoff" for their research.
- There is a need for integrating into existing scientific workflows to streamline data publication and sharing both by individual researchers and by distributed research teams.
- There are many needs surrounding metadata including:
    - The need for both "use" metadata documenting appropriate or recommended uses for data products for non-domain experts and more detailed processing metadata for scientific users.
    - The need to capture and encode access limitation data (i.e. social science data), and build data access models that reflect those limitations.
    - The need for both the ISO and FGDC geospatial metadata standards providing the foundation capabilities for capturing and documenting the above types of metadata for project science products.
    - The need to provide access both to "Raw" data, and higher level products based upon those data, with metadata providing the needed contextual and processing data needed for effective use of both.

Session A2: CI Architecture
This session focused on guidance and reference documentation on CI architecture issues related to the tri-state collaboration projects. Presentations included architecture development for Nevada's climate data, portal, and software frameworks, CUAHSHI HIS, and New Mexico's standards-based interoperability architecture for science data sharing.
Key Session Outcomes

- A diverse set of approaches are being used by each state - ID and NM are building on existing activities and capabilities, whereas NV is developing a new system.
- The importance of interoperability standards for connecting the systems used by each state was reinforced, along with the importance of providing data and metadata exchange.
- A diverse software implementations is fine as long as they can be connected using interoperability standards.
- CUASHI
    - There is a need for 2D, 3D, and 4D data and support for service standards, diverse but interoperable provider technologies, and clients
    - One size doesn't fit all - different user communities approach their analysis/visualization processes in different ways

Session A3: CI Data Formats and Instrumentation Systems Connectivity
This session focused on coordinating common data ingest formats and how instrumentation data should be compiled and organized in order to enable shared observation system data processing models across states. Presentations included design, data acquisition, data transport, and ingest workflows for Nevada's and New Mexico's environmental monitoring and instrumentation systems and an introduction of the HydroDesktop as an element of the HIS system.
Key Session Outcomes

- There is a challenge posed by higher bandwidth requiring sensors; may need a diverse collection of connection models for solving "first mile" problem
- There is a need to understand specifics of particular sensor systems and understand the "one off" nature of some data flow problems

5. Outreach and Communication

Strategic Plan Objective 14: Create a citizenry that is informed about climate change and its impact on NM's natural resources via public outreach and communication.

Climate Change Exhibit and Outreach at the New Mexico Museum

The New Mexico Museum of Natural History & Science (NMMHS, or Museum) receives NM EPSCoR funding to design, fabricate and install a new Climate Change in New Mexico exhibit at the Museum. Jessica Sapunar-Jursich, Director of Education at the Museum, spearheads the project with Dave Gutzler as the guest curator for the project. Dr. Gutzler is a climatologist on faculty at UNM in Earth and Planetary Sciences. He is active not only in climate change research but multiple statewide task force and outreach initiatives. Dr. Gutzler's guest curator position is funded through NM EPSCoR and commits approximately one and a half months of his time to the museum exhibit.

Planning meetings have honed the exhibit 'grand message' and have led to an expansion of the original exhibit from 110 sq.ft. to 825 sq.ft. A central feature of the exhibit will be a global representation of climate data using a Magic Science "Science on a Sphere". A portion of the exhibit will also address regional climate change impacts from the perspectives of local land users using videos of different stakeholders.

The NMMNHS has offered numerous Climate Change Education program events. The NM EPSCoR supported Museum Climate Change Educator, Eileen M. Everett, coordinated numerous public outreach events. NMMNHS partners with the National Association of Science and Technology Centers (ASTC) as a sub-award recipient on their NSF grant "Communicating Climate Change". By leveraging ASTC funds as well as building collaborations with educational organizations and agencies, the NMMNS was able to present events that reached nearly 3,000 members of the general public. Public outreach events for Year 2 included:

- Science and Technology Day at the NM State Fair: hands-on climate change activities engaged state fair visitors all day.

- "Hot Topic: Dialoging About Climate Change" statewide seminars on climate change were held in Albuquerque, Socorro, Las Cruces, and Los Alamos. David Herring from NOAA discussed background information on past climate, current climate trends, evidence for man-made contributions to climate change, and scientists' progress toward modeling future climate scenarios on a global, regional, and local level. After each presentation, the public was invited for informal dialoging over refreshments.

- Hispanic Heritage Month Celebration: Celebra la Ciencia coalition of 8 museums and community partners offered hands-on, bilingual family activities at the NMMNHS. Museum visitors explored several climate change related activities.

- Curator's Coffee: Searching for Answers About Climate Change, an informal science café. The NMMNHS's climate change educator discussed how climate has impacted New Mexico's past and present landscape and how climate projections may impact our planet in the future.

- Presentation on climate change to upper level UNM students at Tiguex Park.

- "Educating About Our Changing Climate" – presentation in partnership with the Environmental Education Association of New Mexico and the Year of Planet Earth to informal educators and the public on educating the public on climate change.

- Presentation on an introduction to climate change to the Climate Masters program participants through the NM Environment Department.

- Tour and presentation to visiting delegation of water resource managers from Turkmenistan.

- BioBlitz 2010: Discover Your Bosque at the Rio Grande Nature Center State Park. Bilingual family activities from 11:00 AM–3:00 PM. The New Mexico Museum of Natural History and Science, The Nature Conservancy, Rio Grande Nature Center State Park, Los Griegos and Taylor Ranch Public Libraries have created a day of natural discovery and citizen science. Throughout the day, scientific experts led walks to explore the middle Rio Grande ecosystem and find different groups of living organisms. An emphasis was placed on linking current and predicted climate change impacts on species and ecosystems.

- Lecture at NMMNHS by Eric Blinman on connecting archeology and climate change – "The Rear View Mirror: 2000 Years of People and Climate Change in the Southwest"

- Curators Coffee on educating about climate change presented to NMMNHS volunteers.

- Extreme Ice Science Café in partnership with KNME. Showing of a video clip from Nova's "Extreme Ice" with a presentation and discussion by William Lipscomb, land ice specialist, from LANL.

- Between June 1 and August 31, 2010, planning has begun to offer a series of book-signings and family events of *The Tree Rings Tale: Understanding Our Changing Climate* by John Fleck. These events will be geared towards upper elementary and middle school students and will occur in Socorro and Santa Fe.

Public Events

EPSCoR researchers have contributed to public education and outreach efforts at public events at using hands-on demonstrations for a wide variety of audiences. UNM graduate student Lauren Sherson represented NM EPSCoR at Math and Science Day at the NM Legislature. Lauren used a water chemistry probe and sonde to explain to visitors some of the water quality research EPSCoR supports in the Valles Caldera. Amanda White, a postdoctoral scholar at NM Tech, talked to visitors at the Taos Earth Day celebration about EPSCoR's research into climate change impacts on Northern NM water. In

Figure 9. EPSCoR post-doctoral scholar, Amanda White (NMT), does public outreach at Earth Day celebration.

addition, members of the Hydrology Research Team participated in a one day Science Crawl for 45 7th graders from Rio Rancho, NM, exposing them to how scientists make measurements in the field.

NM EPSCoR Web Portal

The NM EPSCoR web portal (www.nmepscor.org) offers important capabilities for communicating NM EPSCoR program information to the public as well as to educational and governmental entities in the State. Project scientists currently have access to NM EPSCoR news, calls for proposals, award announcements, and publications. Photos and brief news stories about EPSCoR activities are posted regularly and links are being added to related climate science news services. There is a link to join the NM EPSCoR list-serv that allows members to share information with each other. The portal also includes a web page interface for conference and workshop registration that allows online completion of registration forms and travel and logistics arrangements.

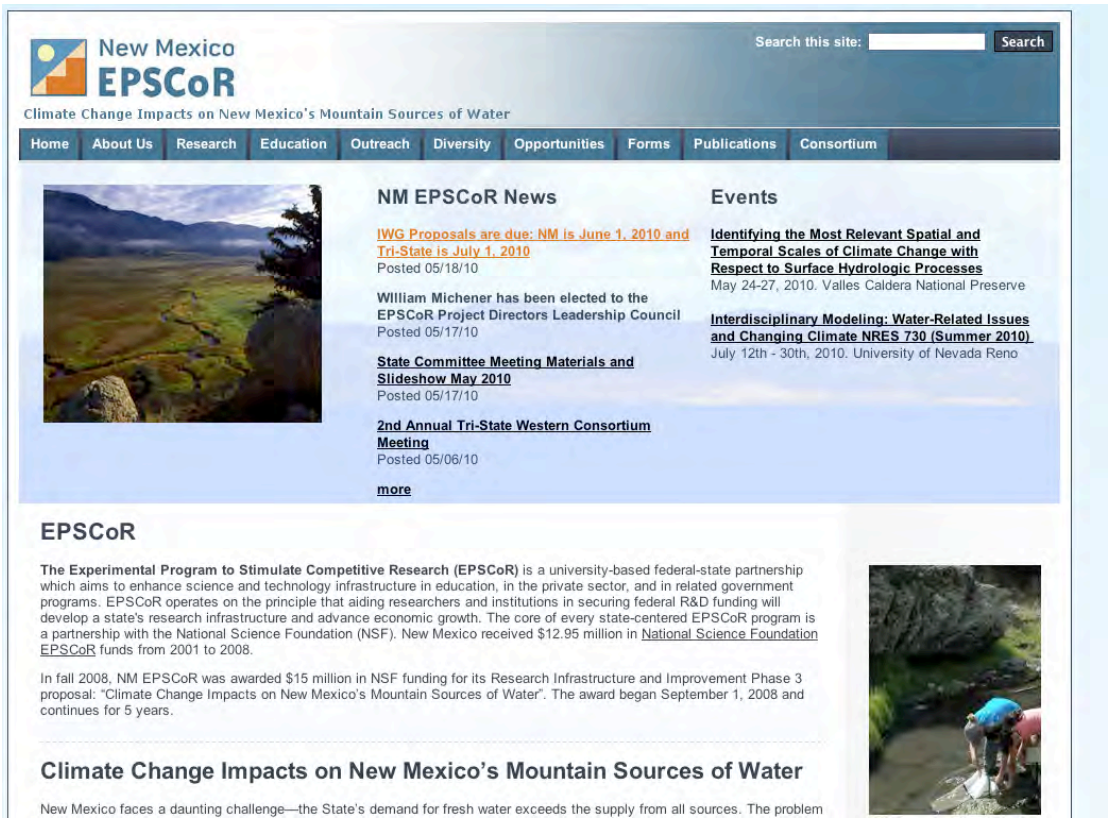


Figure 10. NMEPSCoR web portal provides information for EPSCoR participants as well as the general public.

6. Evaluation and Assessment

NM EPSCoR has three external evaluation mechanisms: 1) a 7-person External Advisory Board of science, education and outreach scientists and professionals providing expert guidance in their field, 2) a contracted sub-award with the American Association for the Advancement of Science for site visit and overall program review, and 3) an external consultant evaluator, Kirk Minnick and Associates, for data collection and assessment assistance to the NM EPSCoR Management Team.

External Advisory Board (EAB)
The External Advisory Committee met in January, 2010 in Albuquerque, NM. The EAB's summary statement commended NM EPSCoR's progress to date:

> The EAB is very impressed with the year one progress of RII3. Much of the necessary baseline work in both physical and human infrastructure have been put in place and positions New Mexico EPSCoR well in both Climate Change adaptation and broadening STEM education and career opportunities for their diverse population.

The EAB recommendations and the NM ESPSCoR response are provided below; the complete EAB report is provided in Appendix K.

Increase communications both within the academic network and with the public. Internally, work with faculty to articulate the key science questions to be addressed by the EPSCoR sponsored scientific infrastructure. This will dramatically enhance faculty participation and buy-in, facilitate program integration and more clearly define future grant opportunities. Externally, clear articulation of the changing water dynamics on New Mexico and the impact on the entire population creates a compelling buy-in and support for the program (i.e., brand the program). Year one efforts lay the foundation for this effort.

Communication between project components is already occurring through quarterly Management Team meetings, the annual All Hands Meeting and participation in the annual Tri-State Consortium meeting. An electronic list-serv has also been established for all members of the NM EPSCoR community. Internal communication between scientists will be enhanced through regularly scheduled virtual "science meetings" during which scientists can discuss their work, the questions they are focusing on and data being collected. These science meetings will be explicitly for the purpose of fostering program integration and synergies.

The climate change exhibit planned for the NM Museum of Natural History and Science will provide an important mechanism for communicating with the public about climate change impacts on NM water. Once the exhibit is installed, programming for the public—lectures, seminars, science cafes, will address these issues as well. Already, the Museum's climate educator, funded by NM EPSCoR, is providing numerous activities for the public related to climate change. NM EPSCoR has also participated in public events such as Math and Science Day at the NM Legislature and Earth Day festivities in Taos. At these events, NM EPSCoR researchers provide engaging experiences for members of the public to learn more about climate research and NM EPSCoR. We will continue to take advantage of public events to increase the public's awareness of and appreciation for our efforts.

Consider addressing several of the EAB members' input on the science base of the program. These include: more closely link the data collection to the modeling analyses; consider including groundwater in the modeling studies (e.g. consider age dating ground water to provide an integrated

estimate of recharge); clarify the fit of the proposed study to the statewide water plan in terms of current and future water supply and demand and investigate expanding the study boundaries to include Northeast New Mexico and beyond state boundaries.

The EAB members' suggestions related to the science base of the program will be raised with members of the Management Team and discussed through the science meetings mentioned in the previous response. Scientists will be encouraged to propose Innovation Working Groups to further develop these areas as appropriate.

The diversity driven undergraduate research program and the Native American place based outreach program has tremendous potential. The programs would benefit from better leveraging of science lab capabilities across institutions, from more involvement with tribal college leadership, and resource partnerships with other Native American/Minority based Federal Government programs.

An assessment of each institution's lab capabilities as well as existing minority based federal programs will be conducted and shared with all researchers. As the researchers discuss their work through Management Team meetings and science meetings, opportunities for leveraging different lab capabilities will be highlighted. The outcomes of the undergraduate research program will be shared with leaders at each of the tribal colleges in NM and their input will be sought on possible program improvements.

The RII3 is a very complex program that overlays a number of existing programs funded from a number of sources. As part of the evaluation of RII3, it will be important for the RII3 leadership to be able to articulate the contribution of EPSCoR versus the existing programs. EPSCoR has the opportunity to be a very significant integrating force on this collection of programs and by doing so can make a major contribution to understanding and adapting to Climate change in New Mexico.

The NM EPSCoR state office will develop a representation of the various programs related to climate change in the state that indicates funding sources and inter-relationships.

AAAS Program Review
The NM EPSCoR Director and Associate Director are working with Ed Derrick, AAAS, to identify members of the AAAS Review Board and to schedule a meeting date. It is anticipated the review will take place in early fall, 2010.

External Evaluation Report

The external evaluator, Kirk Minnick of Minnick and Associates, worked closely with the EPSCoR state office to develop processes and procedures for documenting project activities and outcomes. Activity Evaluation Reports were prepared for the Junior Faculty Leadership Training (JFLP) program, K-12 Teacher Summer Institute, and the Undergraduate Research Opportunity Program (UROP). These reports were used to make program improvements in Year 2 and are described in other sections of this report.

Minnick also prepared an overall Year 1 Evaluation Report, which is included as Appendix L. The report encourages NM EPSCoR to review the Strategic Plan and Implementation Plan to ensure continued alignment of activities with these strategic plans. The Management Team will conduct a review during summer 2010 in preparation for the fall 2011 All Hands Meeting. Many of the key recommendations in the evaluation report related to the research components of the NM EPSCoR RII project focused on increasing the documentation of collaborations and project outputs through

publications and presentations. A significant number of scientific presentations were made in Year 2 as seen in Table 12.

Table 12. Year 2 NM EPSCoR Science Presentations

Invited Talk	20
Panel	3
Conference Presentations	12
Poster	19

Additional information about these presentations is in Appendix U.

Overall, the Evaluation Report indicated that appropriate progress was made in Year One on project activities.

7. Sustainability and Outcomes

7a. Seed Funding / Emerging Areas

Strategic Plan Objective 5: Use Innovation Working Groups (IWGs) to address key scientific, education, diversity, and workforce development challenges.

Innovation Working Groups

Innovation Working Groups support week-long working group activities that are modeled after those held at the highly successful NSF-funded National Center for Ecological Analysis and Synthesis (NCEAS). An IWG supports a small group of scientists or educators to work together on challenges in the climatological, hydrological and socioeconomic sciences, as well as education, outreach and diversity. Anticipated outcomes of the IWGs include synthesis papers and proposals that target NSF cross-cutting programs.

The IWG Request for Proposals (RFP) was designed to solicit succinct proposals that emphasize:
- Topic aligned with EPSCoR Track 1 (or Track 2) research and education agenda
- Diversity of Institutions (minimum of two NM institutions represented)
- Significant participation by women and members of underrepresented groups
- Multi-and trans-disciplinary participation
- Intellectual merit and transformative nature of the project

In Year 2, Tri-State Innovation Working Groups were also solicited, using mostly the same criteria as the NM-specific RFP. Tri-State IWGs have a higher budget limit ($15,000) and require participation from at least two of the three Consortium States.

The RFPs for both types of IWG proposals are available at http://www.nmepscor.org/node/29.

The Year 2 IWG's are listed below; complete reports are available at the website above.

Natural and Human Dynamics of Acequia Systems. Lead Investigator: Dr. Alexander (Sam) Fernald, New Mexico State University.

This Innovation Working Group (IWG) was designed to bring together a group of local, national, and international experts to explore the interactions between ecosystem functions and human cultures of traditional acequia irrigation systems. The IWG was convened to address the following questions:

1) What are the hydrologic and ecosystem functions of acequia-irrigated valleys?
2) How are these functions dependent on socio-cultural traditions of these systems;
3) How can understanding of these natural and human elements be integrated into a single multi-spatial and multi-temporal analysis of response to climate change?

Outcome: Following the IWG, a proposal was submitted to NSF's Dynamics of Coupled Natural and Human Systems (CNH) program, *Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land Use Changes*. Funding is pending.

Identifying the Most Relevant Spatial and Temporal Scales of Climate Change with Respect to Surface Hydrologic Processes. Lead Investigator: Dr. Amanda White, New Mexico Tech (post-doc)

Figure 11. An Innovation Working Group provides an opportunity for creative collaboration among researchers from different institutions.

This IWG was designed to bring together a multi-disciplinary group of atmospheric scientists, hydrologists, and ecohydrologists to tackle a critical issue: identifying the most relevant spatial and temporal scales of climate change with respect to surface hydrologic processes. The IWG enabled the team to formulate innovative ideas centered on a broad theme and facilitated interactions among trans-disciplinary scientists, opening the door to future research activities. Two strands of future research emerged and have anticipated outcomes: a proposal to NSF's Decadal and Regional Climate Prediction using Earth System Models focused on groundwater storage and a conference session on complementary indicators of climate change related to water.

The effects of climate change on ecosystems and societies: A Focus on Native American and Hispanic communities. Lead: Dr. Karletta Chief, DRI (post-doc)

The purpose of this Innovation Working Group (IWG) was to develop research ideas that will couple the effects of climate change on ecosystems and societies while focusing on potential impacts to Native American and Hispanic communities. The objective of the IWG was to host a workshop where hydrologists, ecologists, and social scientists convene to (1) invite stakeholders and experts to offer their perspectives and concerns on potential impacts, and how potential impacts and mitigation can be incorporated into long-term planning related to climate change; and (2) discuss how climate and hydrological models can be improved to identify and mitigate risks to these vulnerable populations. The group intends to develop a cross-cutting proposal to NSF that takes a holistic approach to addressing complex interactions of socio-political and biophysical systems affected by climate change.

Paleo-rainfall and Groundwater Recharge in Southern Nevada over the Past 11000 Years from Cave Calcite Deposits. Lead: Matthew Lachniet, University of Nevada

The purpose of this IWG was to initiate inter-state collaboration to review and discuss the paleoclimatic scientific literature for southern Nevada and the Mojave Desert. IWG participants met at the Walking Box Ranch and held a day-long meeting on scientific objectives, priorities, possible field sites, and discussions of climate records in southern Nevada. This established a conceptual foundation for development of a full proposal to the National Science Foundation's (NSF) Paleo Perspectives on Climate Change Program (P2C2) for an October, 2010 submission.

Integrated Environmental Modeling Software Systems. Lead: Dr. Dan Ames, Idaho State University

The purpose of this IWG is to develop a unique integrated modeling software system that builds on the concept of web processing services in such a way as to support integrated execution of disparate computational models of environmental systems. The group will be working towards the development of a proposal to NSF Software Development for Cyberinfrastructure (SDCI) program.

7b. Education / Human Resources Development

Strategic Plan Objective 13: Enhance leadership skills for faculty via a Faculty Leadership Fellowship Program.

Junior Faculty Leadership Workshop

The Faculty Leadership program is designed to provide training for early-career faculty that enhances their leadership skills and increases their competitiveness for national-level funding opportunities. Nineteen faculty members, graduate students, and post-doctoral scholars from eight different institutions spent three days in the foothills of the Sangre de Cristo mountains at this year's Faculty Leadership Institute. The Santa Fe Institute hosted the event that provided participants with skills to better communicate their research, write successful research grants, manage research projects, and promote diversity. The 2010 Faculty Leadership Institute incorporated evaluation data from last year's Institute to create an interactive structure that included lectures, small group discussions, role-playing, and informal networking opportunities. Highlights of the 2010 Institute include:

Figure 12. Participants at the 2010 Junior Faculty Leadership Workshop in Santa Fe, NM.

- Sandra Blakeslee, former science reporter for the New York Times presented tips for communicating effectively with the media. Participants then engaged in mock interviews with invited newspaper and television reporters using information about their research they had provided to Ms. Blakeslee. The interviews were observed and discussed by the entire group.

- Carl Moore, from The Community Store, modeled several effective facilitation strategies and processes while providing a context for participants to think carefully about their own leadership styles, priorities, and professional goals. The session provided hands-on experience with each of the facilitation tools presented by Dr. Moore.

- Bill Michener, NM EPSCoR Project Director, shared productivity tools and strategies and a logic model for organizing an effective proposal.

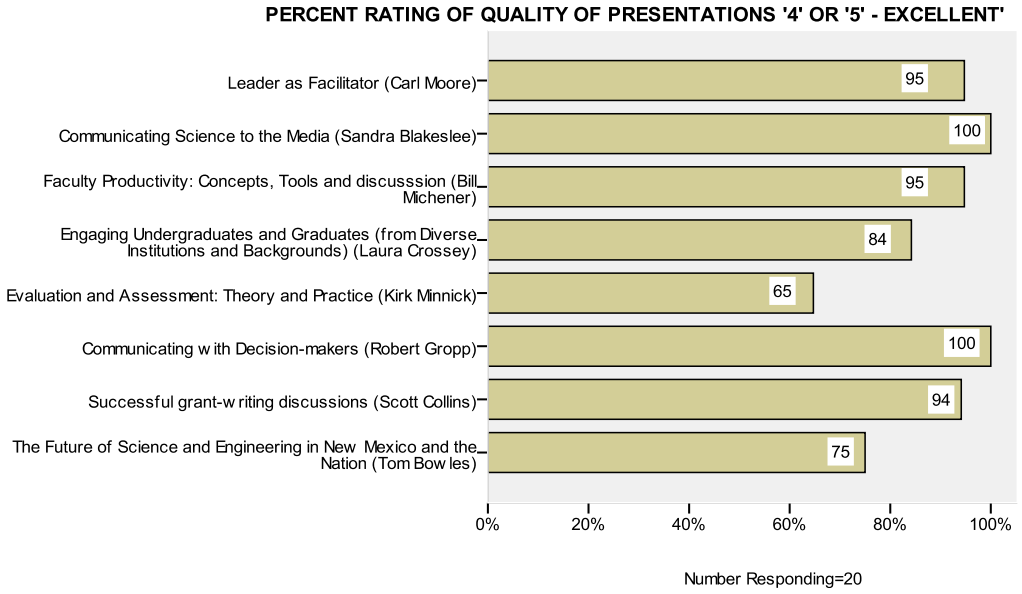
- In small groups, participants used the ideas presented by Robert Gropp, Director of Public Policy at the American Institute of Biological Sciences, to develop a brief "pitch" to a legislator about the importance of funding basic scientific research. Participants demonstrated flexibility as they responded to the "legislator"—whether he was supportive or not.

- Participants also appreciated hearing Scott Collins, Director of the Sevilleta LTER Program at UNM and former NSF Program Officer, provide insights into successful proposal writing.

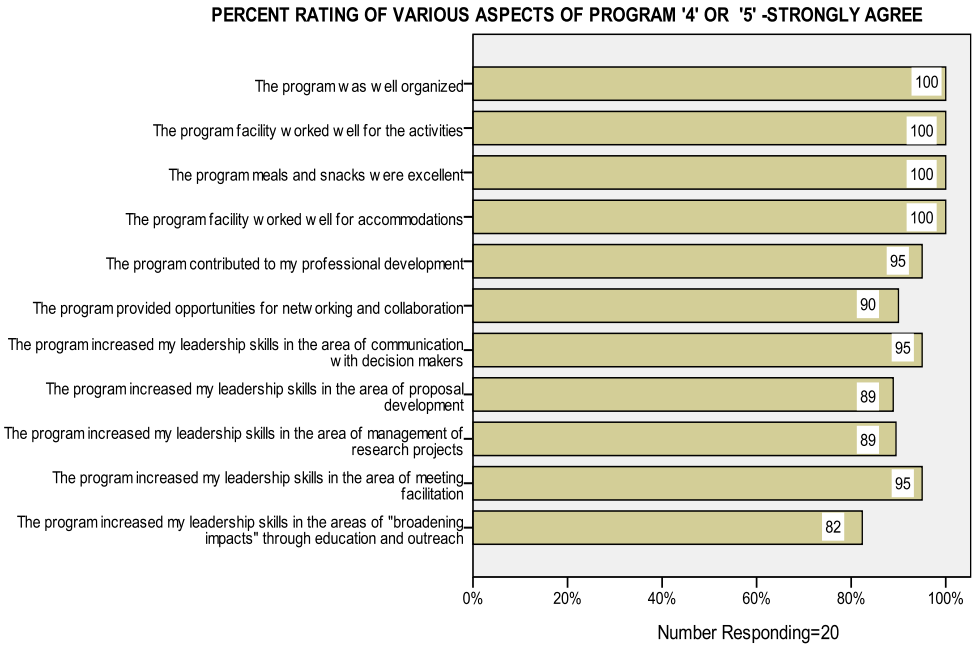
- Engaging undergraduates and graduate students from diverse backgrounds was the focus of Laura Crossey's presentation. A member of UNM's Earth & Planetary Sciences Department, Dr. Crossey shared her perspective on integrating research, teaching, and outreach to increase participation of underrepresented minority students in science.

A post workshop survey was distributed to participants immediately after the end of the workshop. Overall, the participants rated the program very highly, with almost 90% agreement on all aspects of the program. Participant responses to the question of whether the January workshop had "increased my leadership skills in the area of communication with decision makers" were 95% 'strongly agree'. To the broader question of whether the workshop had " improved my professional development" responses were also 95% 'agree' or 'strongly agree'. Graphs below provide results for some of the survey data; all survey results are attached as an Appendix T.

Graph 1. Faculty Leadership Workshop, January 2010. Faculty participant ratings of Quality of Content



Graph 2. Faculty Leadership Workshop, January 2010. Faculty participant ratings of Workshop Overall



Evaluation results will be used to modify the Junior Faculty Leadership Workshop in Year Three.

Strategic Plan Objective 11: Design and develop graduate research training group opportunities.

New Interdisciplinary Modeling Course

The Western Tri-State Consortium of Idaho, Nevada, and New Mexico EPSCoR programs funded the development of a new interdisciplinary modeling course to be offered in summer 2010 (Water-Related Issues and Changing Climate (NRES 730) University of Nevada Reno). Students will be introduced to models that are available in different disciplines and how such models might be applied together to address water-related issues regarding climate change, address issues of variability and uncertainty in implementing interdisciplinary approaches, and gain experience in working in teams to apply interdisciplinary modeling approaches to increase knowledge about water-related issues regarding climate change. Students also will use common software to do an interdisciplinary project. The course will be taught by a host of instructors representing various disciplines and universities. The course is open to graduate students from all institutions in Idaho, New Mexico, and Nevada who work in any discipline related to water including, but not limited to: hydrology, engineering, political science, law, economics, geology, atmospheric science, geochemistry, environmental science, chemistry, and water resources. Students should have some experience with modeling and/or at least one course in modeling or consent of the coordinating instructors. The application process is competitive. Support for travel and lodging will be provided by the Idaho, New Mexico, and Nevada EPSCoR offices.

Graduate Research Training

Faculty from NMSU, NMT, NMHU and UNM are collaborating with Todd Ringler and other researchers from Los Alamos National Laboratory on the development of a graduate seminar course, *Understanding Climate Change through Modeling and Simulation*. The course will be offered in the spring 2011 semester through distance education, allowing students from higher education institutions across the states to participate.

7c. Leveraging NSF funded programs

Several NM EPSCoR faculty have NSF support that is detailed in *Appendix A: Faculty Support.* Because few NM EPSCoR research scientists receive salary from the EPSCoR grant, other grant sources are intrinsically key to achieving the EPSCoR RII 3 goals.

A brief listing follows for the more significant NSF funding and programs that have been leveraged in the past year.

- Funding has been recommended for a proposal submitted by Sam Fernald (NMSU) to NSF's Dynamics of Coupled Natural and Human Systems (CNH) program, *Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land Use Changes*.
- NSF has designated the Jemez River Basin Critical Zone Observatory (JRB CZO) for funding. The Jemez River Basin lies within the NM EPSCoR study area. The CZO is led by a group of Earth Scientists at the University of Arzona. This group has worked closely in the past with several NM EPSCoR researchers on the SAHRA project in the Valles Caldera National Preserve. Discussions are already underway to facilitate interactions among the Arizona and NM EPSCoR research projects, to include: a joint field technician for hydro-meteorology stations, shared baseline data, an annual science meeting for all participants on the CZO, and joint purchasing of equipment and instrumentation.
- The Western Tri-State Consortium represents a significant leveraging of NSF funds. Three tri-state IWG proposals have been funded in Year 2.
- The NMMNHS is recipient of an NSF award to ASTC that was combined with the NM EPSCoR funds to hire a full time Climate Change Educator for the Museum.
- The climatology group at UNM, working under Joseph Galewsky, has very close ties with the NSF-funded National Center for Atmospheric Research. In particular there is a close working relationship with the Mesoscale and Microscale Climate Modeling group. These ties extend not only to meetings and intellectual support but include crucial access to supercomputing time for model runs of the CCSM model. In addition, NCAR is assisting UNM with graduate student training on-site at NCAR in the WRF model.
- A proposal to NSF's Informal Science Education Communicating Research to Public Audiences (CRPA) program has been submitted to fund development of a movie focused on the Valles Caldera National Preserve. This project will assist in the broader dissemination of important research findings and promote STEM learning by the general public. The overarching goals of this project are to increase public understanding of research and increase knowledge about climate change and its impact on New Mexico's natural resources, particularly water. This multidisciplinary project involves hydrology, meteorology, geology and ecology.

8. Management Structure

The management of the NM EPSCoR program has multiple levels and is diagrammed on the NM EPSCoR web site (http://www.nmepscor.org/node/4). The NM EPSCoR office leadership staff is Dr. William Michener, Executive Director, Dr. Mary Jo Daniel, Associate Director, and Anna Morrato, Program Administrator. Mary Jo Daniel was hired in January, 2010 and assists the Director in program management and oversees project database development and data collection per NSF requested standards. Fiscal and contract management is performed by Anna Morrato. Part-time support staff include: Accounting - Megan Gallegos, Data Management – Laura Arguelles, and Information Technology - David Danzilio; Administrative Support—Melissa Coverdale.

NM EPSCoR Management Team

The RII 3 project has a 17 member Management Team which has convened by conference call at least quarterly over the past year, responded to relevant problems, and made determinations on science and education issues of importance to the project. The Management Team is listed in Table 11; membership is currently 47% female and 29% members of underrepresented minority groups.

Table 13. NM EPSCoR Management Team 2009 - 2010

	Name	Organization
1	Karl Benedict	University of NM
2	Marnie Carroll	Dine College
3	Janie Chermak	University of NM
4	Laura Crossey	University of NM
5	Anya Dozier-Enos	NM Public Education Dept.
6	Anna Espinoza	Northern NM Network
7	Sam Fernald	NM State University
8	Joe Galewsky	University of NM
9	Rhea Graham	U.S. Bureau of Reclamation
10	Edward Martinez	NM Highlands University
11	Al Rango	NM State University
12	Todd Ringler	Los Alamos National Lab
13	Bob Parmenter	Valles Caldera Nat'l Preserve
14	Mike Pullin	NM Tech
15	Jessica Sapunar-Jursich	NM Museum of Natural History and Science
16	Anne Watkins	Biophilia
17	John Wilson	NM Tech

NM EPSCoR State Committee

The NM EPSCoR governing body is the State Committee, composed of Vice Presidents and Deans from every institution of higher education in the State, along with key individuals from the National Laboratories, State Government, and private industry; a complete list of members is in Appendix O. The State Committee has met twice during Year 2 of the award. An October, 2009 meeting centered on the following: the Reverse Site Visit to NSF; discussion of a Diversity Plan; review of Project progress and milestones; and a presentation on the climate change research and education efforts at the Valles Caldera National Preserve.

In May, 2010 the State Committee met at the Valles Caldera Science and Education Center in Jemez Springs. The Committee reviewed the draft *Best Practices Guide for Increasing Faculty Diversity at New Mexico Higher Education Institutions* document and provided recommendations for how to prepare it for final approval by the Council of University Presidents. The State Committee also provided suggestions for participants in a CI for Industry Day planning workshop and held a discussion about New Mexico's workforce development needs. The State Committee also approved plans to use the AAAS Review as an opportunity to get input on future needs and opportunities for research in NM that can inform future RII proposals.

On the day preceding the State Committee Meeting, committee members and EPSCoR researchers participated in a field trip to several of the study areas within the Valles Caldera National Preserve. Researchers showed some of the instrumentation that has been installed and described their research agendas.

Figure 13. State Committee members and researchers at the Valles Caldera National Preserve, an NM EPSCoR study site.

External Advisory Board (EAB)

The External Advisory Board met in January, 2010 in Albuquerque, NM; Table 11 lists the members of the EAB. Two members of the EAB were able to participate in a voluntary field trip to the Valles Caldera National Preserve, one of NM EPSCoR's study sites, on the day preceding the meeting. The field trip allowed EAB members to better understand the scientific goals and methodologies employed by EPSCoR scientists. The EAB meeting was used as a leadership development opportunity; 2 female post-doctoral scholars were invited to present the EPSCoR research agenda to the EAB.

Table 14. NM EPSCoR External Advisory Board 2009 – 2010

Advisor	**Institution/Organization**
Elsa Bailey	Elsa Bailey Consulting
Stephen G. Borleske	Director, Delaware EPSCoR
L. Ruby Leung	Pacific Northwest National Laboratory
Bridget R. Scanlon	University of Texas, Austin
Steven Semken	Arizona State University
Amy Ward	University of Alabama
Mark W. Williams	University of Colorado

The EAB provided a report to NM EPSCoR Management that contained a synopsis of program strengths and challenges and detailed four specific recommendations. In summary, the report states:

> The EAB is very impressed with the year one progress of RII3. Much of the necessary baseline work in both physical and human infrastructure have been put in place and positions New Mexico EPSCoR well in both Climate Change adaptation and broadening STEM education and career opportunities for their diverse population.

The EAB's recommendations address four areas: improved communication internally and with the public, suggestions for modifications of the science basis of the project, increased laboratory and resource leveraging across institutions, and better articulation of EPSCoR's contribution to the mosaic of climate change programs in the state. In response, the State Office has:

- Created a list-serv to facilitate communication between EPSCoR participants;
- Encouraged greater participation in public outreach events related to STEM and climate change;
- Initiated regular "virtual science meetings" using phone and video conference capabilities to address the science-related suggestions of the EAB as well as foster greater synergies across project components and find opportunities to share resources and facilities;
- Committed to develop a representation of the various programs related to climate change in the state that indicates funding sources and inter-relationships.

The full EAB Report and the NM EPSCoR response to its recommendations are provided in Appendix K.

9. Unobligated Funds

This summary provides the salient features of Year 2 financial status for NM EPSCoR.

NM EPSCoR RII 3 Year Two Funds

Awarded	Obligated	Unobligated	% Unobligated
$3,042,809	$2,989,068	$53,741	2%

Year 2 funding for the NM EPSCoR award totaled $3,042,809. A balance of $53,741 or 2% of the awarded budget, remains as unobligated funds derived from actual expenditures, and projected expenditures through August 31, 2010.

Amount awarded is $42,809 greater then the original budget of $3 million due to funds being transferred from Year 1 to Year 2 funding. Please see FastLane Approved notifications and requests.

Requested carry-over funds applied to Year 3 will automatically be applied to the corresponding line-items as budgeted in Year 2 and will continue to follow the original Scope of Work.

JURISDICTION SPECIFIC TERMS and CONDITIONS

The General Programmatic Terms and Conditions (PTCs) for the New Mexico EPSCoR Research Infrastructure Grant Program (RII) Cooperative Agreement were met and discussed in the Year 1 annual report. Following are the recommendations and requirements from the Reverse Site Visit (RSV) that took place in Year 2.

Response to NSF Recommendations from Reverse Site Visit

Recommendation 1 – Faculty diversity:
Efforts to support the development of a diversity plan for New Mexico's research universities are admirable. A revised diversity plan that includes strategies and initiatives to increase the diversity of the faculty engaged in the EPSCoR project must be included with the Year 2 annual report.

A plan for recruiting and retaining diverse faculty, *Best Practices Guide for Increasing Faculty Diversity at New Mexico Higher Education Institutions,* has been developed and reviewed by the Diversity Leadership Team. The plan has been presented to the EPSCoR State Committee; their comments will be incorporated into a final draft that will be submitted to the Council of University Presidents at their next meeting. The plan is provided in Appendix M.

In addition, a revised diversity plan is included in the NM EPSCoR Implementation Plan (see Appendix N pp.33-35) to include a strategic objective to encourage and support leadership by women and underrepresented groups on EPSCoR-supported projects. The plan and progress to date is reported in section 2 of this report, p. 12.

Recommendation 2 – Workshop participant follow-up:
Mechanisms appear to be in place to follow-up with the summer workshop participants. Brief reports on the tracking of the long-term outcome of student engagement and success of curriculum implementation by teachers should be included as part of the annual reports.

Follow-up surveys were administered to the participants of the Teacher Summer Institute that addressed success of curriculum implementation; those results are described in this report (see p. 21-24). Additional follow-up with UROP student participants is planned for summer, 2010.

Recommendation 3 – Succession plan:
The response demonstrates that a suitable succession plan has been developed. Changes and updates to the succession plan should be described in Year 2 and subsequent annual reports.

As described in the NM EPSCoR Response to the RSV, the Management Team does include a mix of senior and more junior faculty. In combination with the "virtual" science meetings, regular phone conferences ensure that program knowledge is appropriately distributed among many participants so that any future transitions in program leadership can be reasonably and smoothly managed. Participants in the Junior Faculty Leadership Workshop have reported using the skills developed in the workshop throughout the year and have taken leadership roles in IWG's and science presentations. Finally, the formal Career Ladder process at the University is on hold due to hiring and promotion freezes implemented in response to the current economic situation in the state. Working within those constraints, however, we are finding ways for staff in the State Office to enhance their skills and position themselves for promotion when that becomes an option. Three staff members (Gallegos, Danzillio, and Arguelles) are involved in advanced training programs,

appropriate for their job classifications. The accountant (Gallegos) will be given supervisory responsibility—mentored by the Business Manager (Morrato)—of a junior fiscal technician. This is the final competency she will need for promotion. Arguelles is also learning about and contributing to program operations through participation on the Diversity Leadership Team.

Recommendation 4 – Scientific synthesis:
The response describes numerous activities in the NM EPSCoR program that support greater integration of interdisciplinary research and scientific synthesis. It is expected that the scientific integration among interdisciplinary fields would be highlighted in the annual reports.

Innovation Working Groups (IWG's) have been key activities that support integration of science across science disciplines and have been described in this report. Of note, the IWG led by Sam Fernald (NMSU) led to a successful proposal to NSF's CNH program that has been recommended for funding. Amanda White, a post-doc from NMT, led an IWG that was a direct outcome of activities at the last All Hands Meeting that were intended to foster cross-discipline and cross-institution collaboration. As described in Section 1, the hydrology and water quality teams have continued to develop their cross-institution, interdisciplinary efforts. The continued development of a data portal will also lead to additional synthesis as researchers discuss their data generation and needs. Collaborations will be fostered through on-going science meetings as well as through the annual All Hands Meeting.

Recommendation 5 – Pre-service teachers:
The plan to collaborate with education faculty to incorporate material into courses for pre-service teachers is highly appropriate. NSF EPSCoR is pleased with the plan and looks forward to reviewing the results of the collaboration through descriptions in annual reports.

The Associate Director has begun discussions with education faculty from NMSU and UNM to incorporate climate change science and EPSCoR project results in pre-service education programs. Faculty members have expressed interest in submitting an IWG proposal that will address resources and appropriate strategies for on-going dissemination of EPSCoR science products to pre-service teachers.

Recommendation 6 – Multilingual dissemination:
Plans for consideration of multilingual dissemination are well-described. Original budget plans for the EPSCoR project should not be considered an impediment to bi-lingual production of educational materials. Cooperative agreements encourage active management of the budget in response to critical needs, and a request for budget reallocation to meet this need would be highly appropriate. Reports *on multi-lingual availability of educational materials should be included as part of every annual report.*

The climate change exhibit at the Museum of Natural History and Science will be bi-lingual in English and in Spanish. As the Museum develops instructional materials in support of the exhibit, the planning team will assess which are appropriate for multilingual dissemination; EPSCoR funds will be reallocated if necessary to support this activity. Few high school science and math classes in NM are taught in Spanish; teacher participants are assessing which educational materials they have developed should be translated into Spanish as supplemental materials to support student achievement.

Recommendation 7 – Leadership diversity:
Plans to increase the leadership diversity and include senior faculty in the working group on diversity appear to be well underway. The list of members of the working group should be provided by email to the cognizant Program Officer by March 1, 2010. The activities of the group should be described briefly in the Year 2 and subsequent annual reports.

The November All Hands Meeting did include a session on how to advance diversity goals, as planned. The diversity committee was expanded; the list of members was sent to the cognizant program officer and is included in this report with a description of their activities (see p. 12).

Recommendation 8 – Advisory Committee:
The EPSCoR office is pleased to note that the External Advisory Committee (EAC) is scheduled to meet January 11-13, 2010. When available, submit a copy of the EAC report to the cognizant Program Officer and note any program modifications that result from the EAC report in the Year 2 annual report.

The External Advisory Board report has been submitted to the cognizant Program Officer, is provided here as Appendix K, and resulting program modifications are described in this report (see pp. 40-41).

Recommendation 9 – Evaluation plan:
The updated evaluation plan provided is appropriate. Reports of change in evaluation metrics, and evidence of the use of the evaluation results to guide program improvement are expected in the Year 2 and subsequent annual reports.

Descriptions of program responses to evaluation results are provided in this report; see pp. 30-32 as well as throughout in activity descriptions.

Recommendation 10 – Meteorological station sustainability:
Sustained support for the meteorological stations by the NMSU Climate Center addresses this recommendation.

Additional recommendation – Plan for water quality researcher collaboration

Cross-calibration of instrumentation and the addition of a break-out session at the state-wide meeting are excellent steps to building collaboration between the New Mexico Highlands University and New Mexico Tech researchers. Collaborations initiated through the state-wide meeting should be described in annual reports.

As noted in the report of the water quality research for year 2, the collaborations between NMT and NMHU have flourished following the state-wide meeting. This collaboration will continue in Year 3 as NMT researcher, Dr. Pullin, will use a portion of his sabbatical year to work further with Dr. Martinez at NMHU on using the new water analysis equipment to support research at the VCNP. Furthermore, collaborations initiated through the state-wide meeting have led to an Innovation Working Group, "*Identifying the Most Relevant Spatial and Temporal Scales of Climate Change with Respect to Surface Hydrologic Processes,"* which was described above.

Year 2 Publication Outputs

Climate and Hydrology Research	Smith, A.M.S., Falkowski, M.J., Hudak, A.T., Evans, J.S., Robinson, A.P. and **Steele, C.M.**(2009). Comparing field and remote estimates of forest canopy cover, *Canadian Journal of Remote Sensing,* 35 (5), 447-459.	Journal Article	Published	2009
Climate and Hydrology Research	**Gomez, J.D**. and **J.L. Wilson**, 2009. Residence Time Distributions and Dynamically Changing Hydrologic Systems: Exploring Transient Hyporheic Flow Systems, Abstract 164889, *Geological Society of America, Abstracts with Programs*, 41(7), 348.	Abstract	Published	Oct-09
Climate and Hydrology Research	**Gomez, J.D.**, **J.L. Wilson**, and M.B. Cardenas, 2009. Dynamic residence time distributions of sinuosity-driven hyporheic zones. American Geophysical Union. Abstract H51G-0848, Fall Meet. Suppl., *Eos Trans. AGU*, 90(52).	Abstract	Published	Dec-09
Climate and Hydrology Research	Cardenas, M B; Cook, P L; Gerecht, K E; Jiang, H S; Markowski, M S; Nowinski, J D; Sawyer, A H; Swanson, T E; and **Wilson, J L.** 2010. Fluid dynamic interactions near sediment-water interfaces in aquatic and coastal environments, 2010 Summer Meeting, *Aquatic Sciences: Global Changes from the Center to the Edge*, Joint Meeting with ASLO & NABS, Abstract 6544.	Abstract	Published	May-10
Climate and Hydrology Research	**Gomez, J D**; **Wilson, J L**; and Cardenas, M B. 2010. Exploring the dynamics of sinuosity-driven hyporheic zones, 2010 Summer Meeting, *Aquatic Sciences: Global Changes from the Center to the Edge*, Joint Meeting with ASLO & NABS, Abstract 7321.	Abstract	Published	May-10
K-12 Professional Teacher Development	"Rim to River": The Valles Caldera Field Experience Manual for High School Teachers	Technical Report	Published	Jun-09

Water Quality Research	**Michael J. Pullin**, Andrea M. Higdon, Eric S. Osantowski, and Patrick E. Sims. Colorimetric Flow Injection Analysis of Iron(II) and Total Iron in Natural Waters at the Nanomolar Level, In press in *Analytica Chimica Acta*	Journal Article	Accepted Awaiting Publication	Sep-09
Climate and Hydrology Research	Ashraf N El-Sadek, **M. Bleiweiss**, M. Shukla, **A. Fernald**, and S. Guldan. 2009. Hydrology Modeling of the Mimbres Watershed Using Precipitation Data from Several Different Sources. *New Mexico Water Research Symposium* held in New Mexico Tech Campus, Socorro, NM. August 11, 2009.	Journal Article	Submitted-under review	Feb-10
Climate and Hydrology Research	**Gomez, J**. and **J.L. Wilson**, 2010. On residence time distributions in dynamically changing hydrologic flow systems, *Water Resources Research*, in submission	Journal Article	Submitted-under review	Jun-10
Climate and Hydrology Research	**Gomez, J.D**., M.B. Cardenas, and **J.L. Wilson**, 2010, Hyporheic exchange and residence time distributions in sinuous streams, *Water Resources Research*, in submission.	Journal Article	Submitted-under review	Jun-10
Climate and Hydrology Research	**Gomez, J.D**. and **J.L. Wilson**, 2010, Exploring the dynamics of sinuosity-driven hyporheic zones, *Geophysical Research Letters*, in submission.	Journal Article	Submitted-under review	Jul-10

Note: Publications listed in Appendix E are those that appeared in peer-reviewed journals; the list above includes those still under-review, accepted awaiting publication, and other project outputs.

Posters are included in Appendix U: Year 2 Science Presentations.