Project Summary

Context: Idaho has benefited markedly from a strong partnership with NSF EPSCoR, resulting in growth in academic R&D expenditures that exceeds the national average and increases its share of total National Science Foundation funding. Idaho's universities, via the ongoing RII Project (V), have built basic research expertise in hydrology and stream ecology. These strengths, combined with Idaho's natural field laboratories, provide a firm foundation on which to build infrastructure to support nationally-competitive research on *understanding the effects of climate change on water resources and the impact of these effects on ecological, human, and economics systems* (RII VI). RII VI—the result of a nine-month planning effort involving the University of Idaho, Boise State University, and Idaho State University—addresses current barriers to competitiveness and targets Ecosystem Health, an area of major significance to Idaho as identified by the Governor's S&T Council. The project is guided by Idaho's EPSCoR Committee (reporting directly to the Office of the Governor) and led by the State Project Director Dr. Jean'ne Shreeve (PI), an internationally recognized chemist. Dr. Von Walden (co-PI), a nationally known climate scientist, will have responsibility for scientific progress and integration of research activities.

This RII strategy has two objectives: **First,** EPSCoR will build a unifying Statewide infrastructure to support research and fill gaps that currently hinder Idaho's and the nation's ability to address vital issues that "improve our ability to live sustainably on Earth." Specifically, this RII plan will: leverage Idaho research activities with a nationally recognized regional center in climate change research; fill a critical niche in hydrology by understanding the nexus between surface flow and groundwater; support complementary field studies on a highly managed river system and a relatively unmanaged system; establish fully-engaged external collaborations; and enhance learning and expertise. **Second,** EPSCoR will support capacity development in three areas: 1) hydroclimatology to improve modeling of water resources affected by climate change; 2) integration of hydrology and economic modeling in the Snake River basin; and 3) integration of hydrology and ecological change in the Salmon River basin. These objectives will be accomplished by new faculty positions, startups, and mentoring; junior faculty support and mentoring; modern instrumentation; improved cyberinfrastructure capabilities; enhanced integrative, interdisciplinary, multi-institutional research; undergraduate and graduate students mentored in research, and summer programs; postdoctoral development; federal funds competitions; interdisciplinary graduate programs; increased STEM diversity; and contributions to economic development.

Intellectual Merit: This RII VI effort will create a cohesive team of researchers in climate change and water resources, and interactions with ecological and human systems. Research on *climate impacts* will focus on: the two-way coupling between hydrology, ecology, and economics and policy; greatly improved modeling of surface and groundwater connections in managed river systems; utilizing long-term datasets of ecological change in pristine river systems; understanding economic ramifications of increased climate variability; collection and management of disparate data types and large datasets from multiple disciplines through cyberinfrastructure. Research in *adaptation strategies* will focus on: understanding how climate change impacts may be buffered through effective utilization of groundwater; and better long-term management of water in an area that serves over half the population of Idaho.

Broader Impacts: Science will be incorporated into learning and outreach activities to achieve broader impacts. Stakeholders (state and federal agencies, irrigation districts, Idaho Power, agriculture, etc.) will benefit from regular interactions with faculty, and ready access to climate and hydrologic forecasts for economic and policy decisions. Integration of research and education will train approximately 20 graduate and 150 undergraduate students, and incorporate water resources and climate change science into educational experiences for hundreds of K-12 students and teachers. Faculty will become more engaged in communities. Outreach and Diversity investments will provide new, sustainable experiential learning programs for 1,750 secondary students/teachers in an outdoor science school; e-Camp for 200 Hispanic students; and research experiences and mentoring for approximately 75 Native American high school students. A more visible "STEM Pipeline" will bridge critical junctures in STEM education. The long-term success of these programs will significantly increase the number and diversity of students pursuing STEM disciplines and careers.

Nevada Infrastructure for Climate Change Science, Education, and Outreach

Project Summary

Nevada seeks to *create a statewide interdisciplinary program that stimulates transformative research, education, and outreach on effects of regional climate change on ecosystem resources and supports use of this knowledge by policy makers.* Six capacity-building components will fill infrastructure gaps in climate modeling; ecological change; water; policy, decision-making, and outreach; cyberinfrastructure; and education. These components will build capacity to model regional climate change, evaluate methods to downscale model output, understand and quantify key ecological and hydrological processes, translate climate change science into formats usable by decision-makers, integrate models and data, and transform how students learn about climate change. In Nevada, a core group of faculty and existing infrastructure are well poised to address regional climate change and its impact on resources, specifically water. Critical existing infrastructure, programs, and faculty include physical and computational resources from past NSF EPSCoR projects; a regional climate center; a community climate and weather monitoring program; graduate programs in hydrology; faculty conducting research in climate; and a history of research into effects of climate change. Diversity strategies are woven throughout the components, and a comprehensive evaluation plan will involve external reviewers. An overarching management structure includes a leadership council, external research and technical advisory board, stakeholder advisory committee, and working groups.

Intellectual merit: Accelerated changes in climate are occurring now in Nevada and will continue into the future, leading to complex changes and feedbacks among climate, biophysical, and human systems. Most efforts to address these issues are directed at the global scale, and understanding of regional impacts and processes is limited. Developing improved understanding of global climate change on a regional scale is imperative since a major scientific challenge is how best to downscale global climate predictions. An integrated approach in which biophysical and human responses to climate change are studied will provide quantitative understanding of feedbacks among water resources, ecosystems, as well as atmospheric and human systems. To achieve an integrated approach, different mechanisms will be pursued to address two broad fundamental scientific questions: *How will climate change affect water resources and linked ecosystem services and human systems?* and *How will climate change affect disturbance regimes and linked systems?* Related questions to be pursued by interdisciplinary teams include identification of forcing factors underlying recent climate changes; feedback mechanisms between climate and vegetation; impact of locally generated aerosols on climate; and effects of change in precipitation type on hydrology. This integrated approach in the unique natural laboratory of the Great Basin has potential to transform climate change studies at regional and sub-regional scales.

Broader impacts: Outreach to diverse stakeholders will be accomplished by identifying important needs in climate change research as well as informing and involving the public in climate change science. Policy makers who need to make prompt and prudent decisions on how to act in the face of these impacts will be supported by scientific findings. A key strategy is to make results available from this enhanced capacity via an accessible, on-line data portal. Nevada has a strong history of involvement in K–12 outreach as well as undergraduate and graduate research. This will continue with summer research programs, academic year scholarships, mentorship programs for graduate students, and a "whole school" approach to broaden participation in K–12 education in which teachers will be trained on climate change science. Recruitment of new faculty and graduate students will target underrepresented groups. Communication of climate change science will be enhanced by use of cyberinfrastructure and involvement of a broad range of students and faculty. A statewide virtual information center for climate change will be created to focus on outreach, and visualization strategies will be employed to communicate findings to the public and policy makers. Partnership with the Nevada Small Business Development Center will assist businesses to address state and federal science and technology needs related to climate change and increase their competitiveness for federal SBIR and STTR grants.

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

Intellectual Merit. Climate changes are affecting natural environments around the world. In NM, climate changes are altering processes associated with the water supply, which sustains the state's economy and determines to a great extent the quality of life. The overarching goal for NM EPSCoR RII3 is to enhance research competitiveness through the acquisition of critical climate change research infrastructure and cyberinfrastructure, and through strategic investment in human infrastructure. A second goal is to address a critical state problem of worldwide significance—understanding and forecasting the effects of climate change on water supply and sources in arid regions.

Specific research infrastructure programs are designed to: (1) expand and upgrade research infrastructure that fills key gaps in monitoring climate and hydrological conditions in northern NM high elevation watersheds; (2) install integrated hydrometeorological station networks and innovative water quality sensor systems capable of continuous, real-time in-stream measurements of chemical constituents important for ecosystem and human health; (3) acquire research and teaching equipment for NM's non-PhD granting institutions; (4) support research training for graduate students engaged in climate, hydrological, or socioeconomic modeling; and (5) develop innovation working groups that will address important education and research challenges, and will bridge connections across disciplines (e.g. climate science, hydrology, economics) and broad spatial and temporal scales.

NM EPSCoR will stimulate innovative use of cyberinfrastructure for scientific data delivery including: (1) development of efficient data acquisition, processing, and storage models; (2) high performance computing; (3) interoperable data discovery and delivery through interfaces based upon open standards; (4) deployment of collaboration tools that facilitate knowledge exchange; and (5) development of a project portal that provides a single point of access for project products, services, and information.

Enhancing the human infrastructure in NM's academic and scientific research enterprise is central to NM EPSCoR. Three inter-related programs are tightly integrated with the Climate Change focus. First, *Education* includes: a Summer Institute focusing on middle school teacher professional development in northern NM; providing Undergraduate Research Opportunities for students at NM's regional non-PhD granting institutions; creating a Research Training Group Program that provides interdisciplinary training and develops modeling skills for MS/PhD students; developing a new class of academic leaders via Junior Faculty Leadership Training; and informing faculty throughout NM about funding opportunities via NSF Days and other NSF outreach activities. *Outreach and Communication* includes: a new 3-D Climate Change Exhibit that will reach 230,000 annual visitors; a Climate Change Seminar Series to bring nationally recognized experts to the large municipalities throughout the state; Science Cafés to communicate climate change science to citizens in rural northern NM; a New Mexico First Town Hall meeting to provide a forum for scientists, business leaders, and concerned citizens to build consensus and develop practical, actionable solutions; and a Climate Change Web Portal to provide easy access to news, project information, documents and publications, data and services. *Diversity* is integrated throughout NM EPSCoR and includes: place-based, locally relevant science education; strategic recruitment of students for research opportunities, emphasizing Hispanic and Native American students; providing self-study programs for faculty, staff, and students, as well as strategies for faculty on the inclusion of women, underrepresented groups and persons with disabilities in teaching, learning and research; and networking with other state and national programs that promote diversity.

Broader Impacts. The investment in NM EPSCoR RII3 research, cyberinfrastructure, and human infrastructure will establish NM as a laboratory for climate change research and a model for science-based public policy that can serve science and society in NM and more broadly. Proposed infrastructure supports the watershed-scale observational database and the coupled atmosphere-land surface-hydrology modeling capability needed for meaningful forecasting and decision support. RII3 also supports creation of the data and models necessary to understand the socioeconomic impacts of basin-scale hydrologic changes to acequias (i.e., the traditional water supply systems that have been an integral cultural feature of NM for centuries). These research foci are of global scientific and societal importance. New cyberinfrastructure supports multi-scale modeling and rapid delivery of climate change data and information to scientists, educators, decision-makers, and the public. Education, outreach and communication, and diversity programs will create a citizenry that is informed about climate change and its impact on natural resources. Innovative elements of these programs are designed to optimally and cost-effectively reach a large and diverse range of the NM population in both rural and urban areas and, when successful, will serve as a national model.