

SUMMARY REPORT

CLIMATE CHANGE SCIENCE FOR EFFECTIVE RESOURCE MANAGEMENT AND PUBLIC POLICY IN THE WESTERN UNITED STATES

A workshop for scientists and decision makers

March 27-28, 2013 at the University of Nevada, Las Vegas



Summary Report

Climate Change Science for Effective Resource Management and Public Policy in the Western United States

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On the front cover: Climate Change Monitoring, Modeling and Management. Sheep Mojave Desert Shrub monitoring station photo by S. Strachan, model output map from Kelly Redmond's presentation, and Lake Mead photo by L. Fenstermaker.



Breakout session, March 28

EXECUTIVE SUMMARY

Funded by the NSF EPSCoR program, institutions within the Tri-States of Nevada, Idaho and New Mexico have been engaged in collaborative research to build expertise and infrastructure in climate change science, cyberinfrastructure, education and policy. As part of this effort, the Nevada System of Higher Education (NSHE) has created a state- and region-wide interdisciplinary program that stimulates transformative research, education, and outreach on climate change effects to ecosystem services and water resources. This knowledge is being transferred for use by land managers, policy makers and other stakeholders..

This workshop was designed to engage stakeholders and encourage collaborations among scientists and decision makers. The workshop goals included:

- *Engage* key stakeholders and scientists interested in climate change science and/or its translation to resource management and policy.
- *Inform* key stakeholders and scientists about new climate change science efforts and capabilities in Nevada, Idaho and New Mexico.
- *Identify* stakeholder's key climate change questions, data needs, and how to sustain data networks and portals for long-term monitoring use.
- *Build collaborations* among scientists and stakeholders in climate change science utilizing the new capabilities in Nevada, Idaho and New Mexico.
- *Initiate Climate Change Adaptation Information and Strategies:* provide information that can be readily used by land managers and initiate actionable collaborations.

The workshop format optimized opportunities for dialogue about climate change science and its applications. Plenary speakers introduced the topics of: 1- climate change in the southwest by Kelly Redmond, Western Regional Climate Center (WRCC), 2- the impact of climate change on resource management decisions by Pat Mulroy, Southern Nevada Water Authority (SNWA), 3- stakeholder engagement in NSF projects by Henry Gholz, NSF; and 4- how research and modeling can be used to perform climate adaptation planning with community and stakeholder engagement by Vince Tidwell, Sandia National Laboratory. Topical breakout sessions provided a venue for each participant to engage in small group discussions, culminating in opportunities for attendees to network, identify partners, and establish new collaborations. The three topical breakout sessions focused on: 1- climate change effects, moderated by Scott Mensing (UNR), 2- climate change adaptation planning led by Helen Neill (UNLV), and 3- communication on climate change issues moderated by Donica Mensing (UNR). The organizing session themes were identified from a focused stakeholder assessment conducted via telephone interviews with a subset of stakeholders from several land and resource agencies .

A primary goal of the climate change effects session was to identify connections between research and management to inform adaptive strategies. During the workshop the group met three times in break-out sessions to share perspectives at the state level (e.g. New Mexico, Idaho and Nevada)

and professional experiences from alternative sectors (e.g. federal, state and local resource management agencies, nonprofit groups, and academia). Participants discussed experiences in collecting and sharing environmental data, identified gaps in our knowledge, and wrestled with how to better sustain infrastructure and integrate research and management goals.

The climate change adaptation planning session examined the current state of climate change planning in the Western United States. The group shared state-level perspectives and professional experiences from different sectors in planning efforts relating to water conservation, fire management, energy conservation, waste reduction, energy security, and ecological services. The group shared information about planning successes (e.g. ability to respond to drought conditions, ability to increase energy conservation, ability to reduce waste etc.) and challenges (e.g. limited resources available for planning and implementation, ability to communicate risks to different groups, ability to communicate resource needs to decision makers or public etc.).

The climate change communication session focused on information sharing and collaboration between stakeholders and researchers on ways to improve communication about climate change in the West. Participants discussed challenges in communicating climate change and identified specific needs that should be addressed in future communication efforts. The group also shared their own success stories and devoted significant time to making recommendations for how to improve future communication efforts. Participants developed specific suggestions for future collaborations and a number of commitments were made among attendees to continue discussing communication proposals. Graduate students were also active participants, making suggestions and reflecting on the importance of attending to communication as a part of their research efforts.

Key outcomes of the workshop included:

- *Engaging key stakeholders and scientists* – the workshop was attended by 150 people, including 34 representatives of stakeholder organizations.
- Building collaborations among scientists and stakeholders – Seventeen statements of intentions to collaborate were made in the concluding session.
- Informing key stakeholders and scientists about new climate change science efforts and capabilities in Nevada, Idaho and New Mexico – posters provided information on projects, expertise, and capabilities.
- Identifying stakeholder's key climate change questions, data needs, and how to sustain data networks and portals for long-term monitoring use – The climate change effects session recognized the need to learn about different research cultures (academia and resource managers) that share common interests but have different mandates by identifying focused climate change problems that have overlap across different disciplines and organizations. Participants recognized that sustainability of networks for long-term monitoring is critical but with budget cuts occurring everywhere, no one had a solution on how to sustain these networks.



Breakout session, March 28



Gayle Dana

FORWARD

Comments from Nevada NSF EPSCoR State Director, Gayle Dana

With the generous support of the NSF EPSCoR (Experimental Program to Stimulate Competitive Research), scientists and educators of the Nevada System of Higher Education (NSHE), as well as Idaho and New Mexico, have been working hard over the last five years to build a comprehensive program for studying climate change and its impact on the people, water resources, and ecosystems of the Western United States. The project's significant accomplishments for Nevada include: regional climate modeling capabilities; establishing two observational transects in east-central and southern NV (NevCAN) that are collecting data for long-term assessment of climate variability and change and its impact on ecological and hydrological processes and function in Nevada; and creating the Nevada Climate Change Portal that is providing access to real-time and archived environmental data on climate change. A video about the project and its accomplishments may be viewed at:

<http://www.youtube.com/watch?v=AhlA1qdV1NQ>.

An important goal of this project is to significantly enhance the ability of stakeholders – scientists, land managers, policy makers, local officials, and educators – to utilize the new resources and new knowledge on climate change in their work. The workshop held on March 27 and 28, 2013 at the University of Nevada, Las Vegas, was the capstone event of our project that helped realize this goal. Four very excellent plenary speakers provided participants the current state of knowledge on climate change and adaptation strategies, which provided “food for thought” in the ensuing three sets of concurrent breakout sessions.

We designed this workshop to prepare for and foster a conversation among scientists and stakeholders, and a robust conversation we got! This summary report provides a concise report-back along with actionable items resulting from the workshop. Please read the summary, continue the conversations you started at the workshop, and make those actionable items happen. Act Now!



Rick Schumaker

Comments from Idaho NSF EPSCoR Assistant Project Director, Rick Schumaker

It has been very rewarding to collaborate with university faculty and students, as well as agency representatives and other stakeholders during the past several years. Many of the regular interactions throughout the Western Tri-State Consortium were made possible through our states' NSF EPSCoR programs. The importance and value of connecting our research, education, and policy making communities is increasingly recognized by people at all levels. This workshop was an important step toward the goal of connecting the innovation and discoveries from our states' research institutions with the people who influence public policy and make resource management decisions. Research in Idaho, Nevada, New Mexico, and elsewhere will increasingly contribute to improved education, high quality of life, and economic prosperity as we continue to nurture a culture of collaboration and apply the lessons learned from workshops like this.

Comments from New Mexico NSF EPSCoR State Director, William Michener

This exciting workshop served as a capstone event to prior EPSCoR Track 1 and Track 2 collaborations among Idaho, New Mexico, and Nevada. Importantly, much of the EPSCoR work related to promoting research and STEM education associated with western water resources and climate variability and change served as the basis for identifying actionable outcomes and potential future collaborative opportunities. All viewed the workshop as a major success, as evidenced by the highly interactive and engaged participants, the commitment to follow-up activities, and the exceptionally informative plenary talks. Of course, the ultimate measure of success will be the degree to which collaborations continue outside of and as part of EPSCoR. Based on our past tri-state history, I am confident that participants will maintain the momentum.



William Michener



PV Array, Sheep Range

INTRODUCTION

Funded by the NSF EPSCoR program, the institutions within the Tri-States of Nevada, Idaho and New Mexico have been engaged in collaborative research to build expertise and infrastructure in climate change science and cyberinfrastructure. Within Nevada, the Nevada System of Higher Education (NSHE) – namely the Universities of Nevada, Reno (UNR), Las Vegas (UNLV), the Desert Research Institute (DRI), Nevada State College (NSC), and the community colleges – have been engaged since 2008 in the development of science, education, and outreach infrastructure for the study of climate change and its effects on Nevada and adjacent regions. The program has created a state- and region-wide interdisciplinary program that stimulates transformative research, education, and outreach of the effects of regional climate change on ecosystem services (especially water resources). The results and knowledge gained from this program are and will continue to support land managers, policy makers and other stakeholder planning and decision processes.

This workshop was conceived in response to the need to sustain the human and other infrastructure developed by these programs beyond the duration of the current NSF EPSCoR funding cycle by engaging stakeholders and initiating partnerships and collaborations among scientists and decision makers. The workshop was designed as a project “capstone” to demonstrate the value and maximize the scientific return on the research, education, and outreach infrastructure that was developed to stakeholders such as federal, state, and local agencies. In addition, Nevada developed climate change infrastructure that will enhance other existing regional and national networks to strengthen national climate science initiatives.

The workshop format was designed to be a conversation or dialogue about climate change science and its applications. Keynote presentations were an important component of the workshop. Speakers were selected to provide information that would in turn stimulate discussion during topical break-out sessions that focused on climate change adaptation, planning and communication. Our goal was to challenge participants and to create interactions between “producers” of climate change science and those in a variety of areas who “consume” and apply scientific information on climate change--whether for education at all levels, or to inform decisions about management of natural resources. Important outcomes for the workshop included: enhanced dialogue between stakeholders and researchers, articulation of newly-developed resources that could potentially be used by other scientists and stakeholders, and most importantly, identify potential collaborations to address the key climate change issues identified during the workshop.

Workshop Background and Organization

As the concept for the Tri-State Workshop was taking shape, the Nevada co-Principal Investigators (co-PIs; i.e., Lynn Fenstermaker and Nick Lancaster) conferred with a twelve-member Organizing Committee representing the three NSHE institutions, the three EPSCoR states (ID, NM and NV) and stakeholders. The committee reviewed a workshop concept plan developed by the Nevada co-PI team and from that review developed a list of topical themes, questions and outcomes for the workshop. The organizing committee members are listed in Table 1 below.

Table 1. Organizing Committee members are listed with their respective institution.

Name	Institution
Shawn Benner	Boise State, ID
Bill Michener	New Mexico NSF EPSCoR
Doug Boyle	NV State Climatologist/UNR
Todd Hopkins	Great Basin LCC
Helen Neill	University of Nevada, Las Vegas
Nick Lancaster	Desert Research Institute
Keely Brooks	Southern Nevada Water Authority
Lynn Fenstermaker	Desert Research Institute
Mary Jo Daniel	New Mexico NSF EPSCoR
Rick Schumaker	Idaho NSF EPSCoR
Marcie Jackson	Nevada NSF EPSCoR
Martha Delgado	Nevada NSF EPSCoR

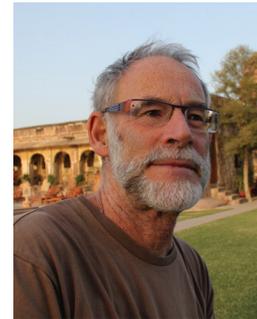
Early in the planning process for the workshop, Scott McCreary and Megan Vinett of CONCUR Inc., a San Francisco Bay Area-based firm specializing in environmental policy and dispute resolution, was recruited to help plan and facilitate the workshop.

The Tri-State Workshop “*Climate Change Science for Effective Resource Management and Public Policy in the Western U.S.*” was broadly organized around a central theme of adapting to climate change by scientists and decision-makers working together to accommodate climate change in their planning and research efforts and a series of specific goals, as listed below.

- Engage key stakeholders and scientists interested in climate change science and/or its translation to resource management and policy.
- Inform key stakeholders and scientists about new climate change science efforts and capabilities in Nevada, Idaho and New Mexico.
- Identify stakeholder’s key climate change questions, data needs, and how to sustain data networks and portals for long-term monitoring use.
- Build collaborations among scientists and stakeholders in climate change science utilizing the new capabilities in Nevada, Idaho and New Mexico.



Lynn Fenstermaker



Nick Lancaster



Scott McCreary



Megan Vinett



Breakout session, March 28

- Initiate Climate Change Adaptation Information and Strategies: provide information that can be readily used by land managers and initiate actionable collaborations.

The NSF EPSCoR co-PIs worked with CONCUR Inc. to devise a meeting format that provided information for topical discussions based on a series of plenary presentations. The topical sessions were formatted to create opportunities for each participant to engage in small group discussions, culminating in opportunities for attendees to network, identify partners, and establish new collaborations.

The plenary sessions introduced the topics of climate change in the southwest (Kelly Redmond, WRCC), impact of climate change on resource management decisions (Pat Mulroy, SNWA/LVVWD), stakeholder engagement in NSF projects (Henry Gholz, NSF) and a culminating plenary talk on how research and modeling can be used to perform climate adaptation planning with community and stakeholder engagement (Vince Tidwell, Sandia National Laboratory). Following the plenary presentations, the topical area conveners briefly discussed the framework for the three topical sessions and encouraged participants to select a topic session of interest.

Three topical sessions were developed to focus on – (1) climate change effects, moderated by Scott Mensing (UNR), (2) climate change adaptation planning led by Helen Neill (UNLV), and (3) communication on climate change issues moderated by Donica Mensing (UNR). The organizing themes for these sessions were identified based on guidance from a focused stakeholder assessment conducted via telephone interviews of a sample of stakeholders by CONCUR Inc. (Appendix A).

The co-PIs, CONCUR, and the topic area conveners structured the flow and organization of the break-out sessions. To give participants an idea of what to expect for these discussions, a set of questions was developed for each topical session and incorporated in the final workshop agenda and workshop website (see Table 2 on page 15).

Framing questions were drafted in advance for the first and second breakout sessions, but they were not prescribed for the third session. The questions for the third session were developed as a result of the discussions held during day one of the workshop. The role of the focus questions was to encourage participants to reflect on their own experience. For example for the session on the status of climate adaptation planning, the first question was “Have you identified climate change impacts for your organization or community? What are they? Do these impacts affect your core mission?”

The workshop design limited the number of participants at each topical session round table to approximately 10 people, to ensure that each participant would have an opportunity to contribute to the discussion. Prior to the workshop, the co-PIs recruited a set of volunteer facilitators to moderate, guide, and help summarize break-out discussions at each table.

The day before the Workshop, the PIs and CONCUR convened a briefing session for the volunteer facilitators to walk through the meeting structure, discuss the roles of facilitators, and give table-level facilitators a chance to meet the Topic Area Conveners. We also devised and provided the facilitators with a template (hardcopy and file on a flash drive) that incorporated the questions for each session and provided space below each question to write responses. A tour of one of the NevCAN Sheep Range monitoring stations was also provided the day before the workshop.

After the breakout sessions were launched, CONCUR helped track and guide their work, and conferred with the topic area conveners to troubleshoot, track progress, and encourage the solid collaborative work.

Topic area conveners assembled their break out groups, and ensured that members were distributed around break out tables.

For each topic area, there were 4 to 7 round-table groups. As each round table worked through the first set of organizing questions, facilitators were asked to summarize the most important 3 to 4 responses for each question, and convey these responses to the topic area conveners either by writing on hard copy or using the digital templates to develop summaries. Then, the topic area conveners worked to develop an initial synthesis across all round tables for their respective area, and reported that synthesis back to the full Plenary group of attendees.

Following the poster session on day one, the topic area conveners met with Lynn Fenstermaker and CONCUR to devise a final set of questions to guide the third breakout session on day two. In addition, on the evening of day one, topic area conveners each developed a one-page summary of their group's deliberations, which were printed and distributed prior to the day two round table discussions.

The final break out discussion included these steps:

1. Summaries from Day 1 were presented to all participants to read before beginning the discussion. Then participants were asked to brainstorm any potential collaborations, partnerships or action steps they thought might help address the issues identified by yesterday's participants. (The advice to participants was to record as many of these as they could.)
2. Then, building on the prior day's discussion and the Day 1 summaries, each group considered the following questions as a catalyst for the final Plenary Session.
 - (i) What actionable next steps do people in this group intend to take as a result of participating in this conference? (Take names and identify the proposed steps.)
 - (ii) What general actionable steps does this group recommend be taken to address the issues identified in this workshop?

Going into the final plenary session, the co-PIs and CONCUR reminded attendees that they would have a chance to present voluntary statements of intent to collaborate. Topical area conveners each presented a brief summary of the two days of discussion. Then, the floor was opened for voluntary statements of intentions to collaborate. We took care to emphasize that there was not a requirement to develop such a statement, and we emphasized the term "intent", to distinguish from a harder, more rigid commitment. Scott Mensing and Lynn Fenstermaker initiated this effort by stating their own intentions to collaborate. A total of 17 statements of intent were shared with the attendees (Table 3).

Each of the NSF EPSCoR leaders from Nevada, Idaho and New Mexico provided a closing statement about the opportunities and successful achievements of the workshop. Future meetings were mentioned where attendees could meet to continue discussions on climate change collaborations. The Nevada NSF EPSCoR Director, Gayle Dana, reminded everyone to "Act Now" and to build upon the knowledge and new contacts gained from this workshop.



Breakout session, March 28



Lisa Kohne

Immediately following the workshop, Lisa Kohne with SmartStart Educational Consulting Services asked participants to take a survey to identify the strengths and weaknesses of the workshop. A subset of the data (pie charts and bar graphs) and comments from the survey are provided throughout this report. The graphs depict the percentage of survey respondents selecting each question response.

PLENARY SPEAKER ABSTRACTS

The following sections contain abstracts provided by each of the workshop plenary speakers. The abstracts highlight the information provided in each talk. Short biographies and all plenary PowerPoint presentations are available at: <http://epscorspo.nevada.edu/nsf/2013-Tri-State/speakers.html>. Short biographies for each of the topical session moderators may also be found on that webpage. Video of each plenary speaker presentation is available at: <http://epscorspo.nevada.edu/nsf/2013-Tri-State/index.html> (click in center box) or http://www.youtube.com/user/nevadaepscor?feature=results_main.



Kelly Redmond

What is Climate Change? How is it Manifested in the Western United States?

Kelly Redmond

Western Regional Climate Center, DRI, Reno

The basic physical mechanisms by which humans can affect the planetary energy budget are reviewed. Climate models driven by estimated time histories of these forcings project irregular warming over the 11 western-most contiguous states for the rest of the 21st century, starting approximately in the mid-1970s. These models also indicate slightly wetter conditions near the Canada border and somewhat drier conditions near the Mexico border, with wetter winter and somewhat drier spring and summer. Characteristics of observed temperature and precipitation histories for Nevada, the West, North America, and the globe (temperature only) are discussed. Warming rates have accelerated since about the middle 1970s. Temporal properties of freezing levels and high elevation hydrology affecting water supplies and ecological communities are presented.

The West has seen a marked increase in area burned over the past 15 years, with 7 states recording their largest fire on record, and two of those twice in this period. The US Drought Monitor has shown drought to be constantly present somewhere in the West since 1999. Warmth can cause more drought-like conditions even in the absence of precipitation change. Reconstructed flow on the Colorado River shows major natural droughts 1-2 times per century since around 800, complicating the interpretation of the 1997-201x Southwest drought. The expected effects on extremes of temperature and precipitation are discussed, with illustrative time series from Las Vegas as examples. The West, and Southwest in particular, show little increase in heavy precipitation events, in contrast to the eastern United States. Temporal trajectories in climate will be expressed in the form of weather, and thus in the moments and other statistics of weather elements. Any rise in temperature is expected to be highly irregular, with numerous

plateaus and downturns that might last up to a decade or two.

For the West over the past 110 years, about one-seventh of the temperature behavior can be associated with a projection onto the global mean temperature, about a fifth results from decade to decade variations, and about two-thirds of the variance is associated with year-to-year changes. Thus, even as the temperature rise becomes more prominent, the ongoing “pre-existing condition” of climate variability will remain a major source of concern as society copes with adaptation to a slowly differing climate. Greenhouse gases already added to the atmosphere, and time lags in system response, constitute a modest commitment to warming that cannot be undone even with no further emissions. As an aside, carbon dioxide contributes significantly to three major concerns: climate warming, differential vegetative growth, and ocean acidification. In combination, these and other global trends are thus very likely to be a source of emergent (and thus unprecedented) phenomena.



Frameworks for Decision-Making: How Does Climate Change Fit into the Equation?

Patricia Mulroy

General Manager, Southern Nevada Water Authority

Water managers are increasingly acknowledging the reality of climate change. No longer relegated to the status of an ideological debate, climate change will affect water supplies in many different ways. While the impacts will be diverse and geographically focused—precipitation quantities, timing of snowmelt, salt water intrusion, flood-induced reservoir contamination, and a host of other implications—few water agencies will be left unscathed.

While the implications of climate change will vary dramatically by region, there are commonalities that will allow water managers to factor it into their long-horizon planning efforts. For instance, as recent years’ violent storms in the United States have demonstrated, weather patterns will be marked by increased variability and severity. Whether a region’s extremes take the form of prolonged drought or unprecedented flooding, managers must expand their bracket of possibilities and prepare appropriate contingency plans. Similarly, developing or reconfiguring resource plans to place increased emphasis on flexibility will be critical in allowing water agencies to adapt quickly as conditions change.

This presentation considered some of the more likely climate change scenarios and conveyed key adaptation and mitigation strategies that can assist water managers in navigating these turbulent waters.



“The information was understandable for all, even those who aren’t familiar with complicated climatology and modeling.

The talk was connected to my research in a lot of ways. ... excellent job conveying climate change in the intermountain west.”

--Anonymous comment from Workshop Survey responses



Patricia Mulroy

“I learned a lot about how a water agency has effectively dealt with and is planning for climate change.”

--Anonymous comment from Workshop Survey response



Henry Gholz

“Very easy to understand and made relevant even though I didn’t think it would be.”

--Anonymous comment from Workshop Survey response

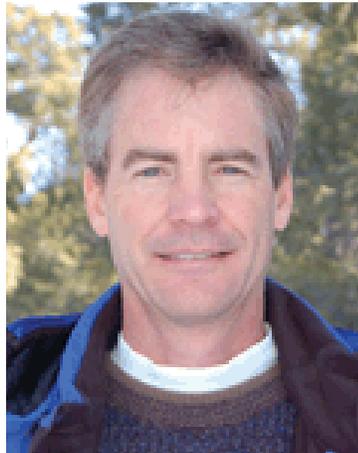
Stakeholder Engagement in NSF Research

Henry Gholz

Program Director, Divisions of Ecosystem Biology and Macro-systems Biology, National Science Foundation

The National Science Foundation supports about two-thirds of the non-defense and human health research carried out by academic institutions in the U.S. The major stakeholders in NSF research are those institutions and the PIs that actually carry out the research. Limits on who may also be involved, including scientists from federal agencies, are primarily determined by the parent institution, subject to some financial limitations imposed by NSF. NSF is a “non-mission” agency, which means that proposals to it must focus first and foremost on ideas for moving forward the frontiers of fundamental science, with all other considerations (such as techniques, applications, study sites) secondary.

Nevertheless, programs across NSF are not static or uniform. For this reason institutions and PIs need to be aware of, if not involved in, NSF supported workshops, committees, panels and programs to stay up to date. Despite the overall decline in federal (as well as state, in most cases) support for research, opportunities for involvement in NSF research in the general area of environmental science are considerable, presuming that PIs are creative and think broadly.



Vince Tidwell

Climate Adaptation through Collaborative Modeling: Examples from the Rio Grande and Western Inter-connection

Vince Tidwell

Sandia National Laboratories

Equitable allocation of resources is a growing challenge due both to the increasing demand for natural resources and an uncertain and variable climate. While scientists can contribute to a technically defensible basis for water resource planning, this framework must be cast in a broader societal and environmental context. Given the complexity and often contentious nature of resource allocation, success requires a process for inclusive and transparent sharing of ideas complimented by tools to structure, quantify, and visualize the collective understanding and data, providing an informed basis of dialogue, exploration and decision making. Although modeling tools have long been used by scientists and management agencies, they have often been relatively inaccessible to policy makers and the public, and therefore limited in their exposure and use.

Cooperative modeling is an approach in which resource stakeholders are drawn from all sectors and special interests of a community to work with modelers and scientists in the development of a model aimed at assisting difficult and contentious resource management decisions. The collaborative

community effort is intended to build transparency into the modeling process, and to assure that all important issues and viewpoints are represented in the model. Hallmarks of this process include integrated/interdisciplinary modeling; an open and collaborative environment; an interactive and visual analysis framework; and a shared sense of urgency. Applications are drawn from the Rio Grande and Western Electric Interconnection.

“Tidwell was a great speaker and the subject matter was fascinating, the application of climate science to the “real world.”

--Anonymous comment from Workshop Survey response



POSTER SESSIONS

A total of 59 posters were presented in an evening session on day 1 of the workshop, encompassing many innovative research projects from all project themes. Presenters came from all Tri-State partners and included stakeholders as well as scientists. Graduate student presenters were able to enter a competition for best poster. The winners from first to third place were:

Benjamin Hatchett (DRI/UNR)

for his poster entitled *“The Heartbeat of the Boreal Heat Engine: Planetary Wave Breaking, Cold Air Outbreaks and Coupled Atmosphere-Ocean Responses – Relevance to the Hemispheric Climate”*

Heather Skaza (UNLV)

for her poster entitled: *“Taking Scientists to School: Using Nevada’s Climate Research for K-12 Science Curriculum”*

Brittany Johnson (DRI/UNR)

for her poster entitled *“Soil and Climate along Two Elevational Transects in the Eastern Great Basin and Northern Mojave Desert of Nevada”*

The poster session abstracts may be viewed at:

<http://epscorspo.nevada.edu/nsf/2013-Tri-State/poster-abstracts.html>.

Poster Topical Areas

The list below provides the topical areas and percentage of posters within each topical area.

Climate (15%)

Cyberinfrastructure (8%)

Ecology (25%)

Education (17%)

Policy and Outreach (10%)

Water (24%)



Benjamin Hatchett



Heather Skaza



Brittany Johnson



Breakout session, March 28

TOPICAL SESSIONS

The topical sessions were organized around three themes:

- Assessing the effects of climate change: informing adaptation strategies
- Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities
- Communicating climate change science for education, management, and policy

The topical session themes were identified by the workshop organizing committee with guidance from the stakeholder telephone surveys conducted by CONCUR Inc. The summary of the stakeholder interviews are provided in the Appendix A. For each of the topical sessions, the moderators prepared a series of questions to guide the first two rounds of discussions during Day 1. While synthesizing the results from Day 1, the session moderators developed the last set of questions for table discussions during Day 2. The questions for rounds 1 and 2 of each topical session discussion are provided in Table 2 below. The topic area moderators devised a single set of questions for round 3 of discussions. The final break out discussion included these steps:

First, Summaries from Day 1 were presented to all participants to read before beginning the discussion. Then, the first question is to brainstorm any potential collaborations, partnerships or action steps you think might help address the issues identified by yesterday's participants. (The advice to participants was to record as many of these as they could.)

Then, building on the prior day's discussion and the Day 1 summaries, each group considered the following questions as a catalyst for the final Plenary Session.

What actionable next steps do people in this group intend to take as a result of participating in this conference? (Take names and identify the proposed steps.)

What general actionable steps does this group recommend be taken to address the issues identified in this conference?

How appropriate were the questions for the topic?

Source: Workshop Survey performed by L. Kohne, SmartStart Educational Consulting Services

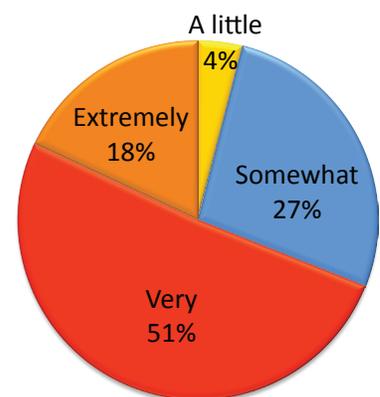


Table 2. Topical questions used to structure the first two rounds of workshop table discussions.

<p>Topical Area Session A: 1st Round of Questions Assessing the effects of climate change: informing adaptation strategies</p>	<ol style="list-style-type: none"> 1. Are you developing strategies for adaptation? 2. Given the uncertainty of the direction and magnitude of potential future climate change, what is important to be doing now? 3. What information (data, instrumentation) do you most need to reduce uncertainty in planning for potential future climate change?
<p>Topical Area Session B: 1st Round of Questions Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities</p>	<ol style="list-style-type: none"> 1. Have you identified climate change impacts for your organization or community? What are they? Do these impacts affect your core mission? 2. What are your plans for adaptation to climate change in your business, government agency or community? 3. What are the benefits and disadvantages of making plans? What are the challenges for maintaining a plan for your organization? 4. What info would help you make or revise plans to promote future resilience (aka, ability to adapt to change) for your business, government agency or community?
<p>Topical Area Session C: 1st Round of Questions Communicating climate change science for education, management, and policy</p>	<ol style="list-style-type: none"> 1. What are you doing to communicate the effects of climate change? Who are your audiences? 2. What messages about climate change do you hear from others? 3. What strategies for communicating climate change are most effective?
<p>Topical Area Session A: 2nd Round of Questions Assessing the effects of climate change: informing adaptation strategies</p>	<ol style="list-style-type: none"> 1. What is your highest priority in planning for potential future climate change? 2. What are the barriers that prevent you from fully planning for potential future climate change? (money/information/data/intellectual capital/public support)? 3. How can these barriers be overcome? 4. Who are your collaborative colleagues in working on/thinking about/ planning for potential future climate change? Who could be potential collaborators?
<p>Topical Area Session B: 2nd Round of Questions Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities</p>	<ol style="list-style-type: none"> 1. What are the different audiences for climate science? 2. How can we make climate science findings more accessible to alternative audiences? 3. What are ways to improve potential collaborations between scientists and decision makers? 4. What are potential collaborations that would help your business, government agency or community to become more resilient to climate change effects?
<p>Topical Area Session C: 2nd Round of Questions Communicating climate change science for education, management, and policy</p>	<ol style="list-style-type: none"> 1. What barriers are preventing you from communicating effectively about future climate change? 2. What do you need to reduce these barriers? 3. What collaborations might help you improve your communications about climate change?



Scott Mensing

TOPICAL SESSION SYNTHESSES

Assessing the effects of climate change: informing adaptation strategies

Session Moderator: Scott Mensing (UNR)

The purpose of this session was to assess the effects of climate change on the environment, including water resources, biota, and soils and to identify connections between research and management, and in turn to inform adaptive strategies. During the two-day workshop the group met three times in break-out sessions to share perspectives at the state level (e.g. New Mexico, Idaho and Nevada) and professional experiences from alternative sectors (e.g. federal, state and local resource management agencies, nonprofit groups, and academia). Participants from a variety of the groups were involved in each round of discussions, and participants were encouraged to change tables between sessions to broaden the level of interactions. Participants discussed experiences in collecting and sharing environmental data, identified gaps in our knowledge, and wrestled with how to better sustain infrastructure and integrate research and management goals. Each group's answers to session questions were then summarized before the end of the session, and then collated into the summary presented below. The summary incorporates the key challenges, opportunities, and observations identified from each of the tables for all questions discussed each day of the workshop.

"It was helpful to see others working toward their agencies' goals. It gave me a better idea where our agency might fit in the overall area's preparedness activities."

--Anonymous comment from Workshop Survey response

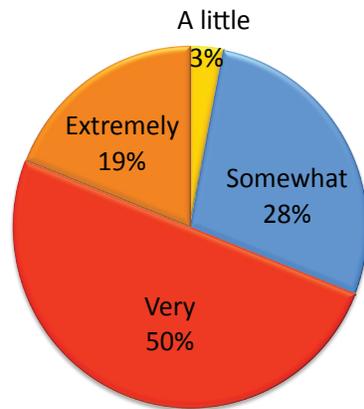
Summary Day 1 Break-out Sessions

Research strategies are mostly geared towards better understanding the system, such as developing better models, developing baseline datasets and/or better data sets, and geographically specific data.

- Develop stakeholder strategies that will help reduce the uncertainty of future impacts by developing a range of scenarios and response plans, and testing these plans.
- It is necessary to identify common goals/areas of overlap in areas of research to facilitate collaboration between academics and stakeholders that can turn data/information into action plans.
- Initiate collaborations at the proposal stage to integrate both academic and resource manager's vision/interests when designing research plans and hypotheses.
- Recognize/identify areas of institutional mismatch/conflict/priority of missions between academics and resource managers to improve communication and reduce disconnects.
- Build, maintain and 'mine' high quality datasets to better understand processes, make more robust predictions and quantify uncertainty.
- Design more accurate metrics to validate data.
- Fill knowledge gaps that can be used to address management/policy problems and reduce uncertainty in predictions.

How useful were the sessions to engage stakeholders in dialogue?

Source: Workshop Survey performed by L. Kohne, SmartStart Educational Consulting Services



Presentation, Sheep Range Tour

- Develop data portals with quality control, metadata, process description, assumptions described to improve data sharing and storage.
- Funding is a challenge for maintaining monitoring stations, small local projects, monitoring projects, replacing equipment. Science funds new ideas and initiatives but part of the problem is maintaining long-term data streams. Work together to develop strategies for supporting this type of research in Nevada.
- Increase public awareness (of climate change) by communicating information of climate related problems (drought, flood safety, fire, and habitat loss) that directly affect people.
- Improve communication of basic climate change information by simplifying the message about the underlying science.
- Include stakeholders and social scientists in discussions about setting research priorities and how to apply the results.
- Develop agreements that reduce the time/red tape associated with obtaining permits to conduct projects.
- Share information and quality control responsibility by jointly reviewing reports/products before release.

Summary Day 2 Break-out Sessions

There was a strong consensus that the meeting was a good step towards learning about our different research cultures (academia and resource managers) that share common interests but have different mandates. Organizing meetings where different groups talk face-to-face is critical and we should continue this dialogue process.

- Act on the collaborations established in this meeting.
 - Create a working list of individuals active in climate change in the three states.
 - Circulate information about the groups interested in climate change that have regular meetings (LCC forums, Climate Forum, Great Basin Consortium).
 - Recognize the essential value of focused discussions with managers about their needs. Policy decisions may necessitate internal data development.



Breakout session, March 28

- Recognize that stakeholders may be interested in collaborating in terms of intellectual participation, data sharing.
- Work to overcome the apparent mismatch in effort and focus between academia and agencies.
 - Begin to articulate targeted/focused climate change problems that have overlap across different disciplines/organizations (including both members of academia and land use managers).
 - Interact with policymakers and educators and match their needs, make research applicable to policy to be most effective.
- Find avenues to better inform political decision makers. Some politicians are “out of the loop” in terms of their understanding of climate science and its implications, but they are making decisions, the information needs to be disseminated to them. We need to be better at addressing personal connections between issues like climate change to their own personal geographic/connection.
- Improve the precision of our predictions. Ways to possibly do this include more creativity, improved coordination of data collection, better ways to communicate uncertainty, and improvements in our modeling. Agencies in particular need more site specific information, downscaling from global/regional/state to improve predictive modeling
- Improve and simplify our message to the public. Seek ways to make connections at the local level. Create more press releases to alert general public about all the work that is being and has been done.
- Address the reality that all units of government (local, state and federal) and academia (public and private) are money-stressed. When applying for funding, seek out agency collaborators early in the proposal development process, name an agency scientist in the proposal and look for applied benefits that can be funded as part of the project. This is particularly important for research that is on public land, or impacts agency management.
- Collaborate more fully on data dissemination – possibly through creation of a Nevada Data Center. Data need to be easily accessible and quality controlled, following a consistent standard.
- Support existing infrastructure that is collecting climate change data and leverage/share infrastructure where appropriate to extend resources further.
- Physical scientists should seek more collaboration with social scientists since the effects of climate change will impact society and this is where the public greatest concern lies.
- Agencies have seminar series similar to those at universities. When practical, researchers in academia should present results through these forums, particularly when they relate to work done on agency land or that is related to agency management.

Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities

Session Moderator: Helen Neill (UNLV)

The purpose of this session was to evaluate the current state of climate change planning in the Western United States. During the two-day workshop the group met three times in break-out sessions to share state perspectives (e.g. New Mexico, Idaho and Nevada) and professional experiences from alternative sectors of the economy (e.g. business, federal government, local government, nonprofit agencies, and academia). Participants shared experiences in planning efforts relating to water conservation, fire management, energy conservation, waste reduction, energy security, and ecological services. A mix of representatives from each of these groups sat at separate tables on the first day to share information about planning successes (e.g. ability to respond to drought conditions, ability to increase energy conservation, ability to reduce waste etc.) and challenges (e.g. limited resources available for planning and implementation, ability to communicate risks to different groups, ability to communicate resource needs to decision makers or public etc.).



Helen Neill

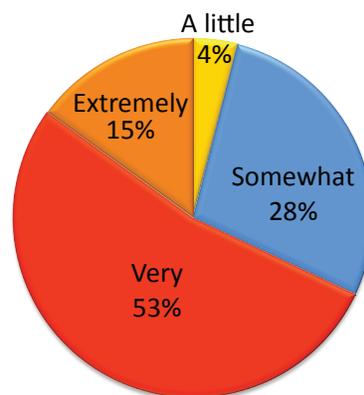
Day 1 outline

Plans for adapting to climate change include:

- managing ecosystem services
- business investing in technologies and human capital
- reducing waste and use of alternative energy in universities
- farmers conserving water
- research on new technologies
- collaboration across sectors, disciplines and agencies

How useful were the sessions to enable participants to identify key questions and needs?

Source: Workshop Survey performed by L. Kohne, SmartStart Educational Consulting Services



Advantages of planning are:

- improved communication networks
- saving money

“It was a good opportunity to talk to others who need to communicate or receive climate data and information and see if they face the same challenges and share ideas.”

--Anonymous comment from Workshop Survey

Challenges include:

- diverting scarce resources in unit or agency
- planning horizons differ across sectors
- complicated internal procedures leading to higher costs
- few incentives to conserve or use resources differently given some policies (e.g. water)
- data access or availability

Ways to promote resilience are:

- generating accurate information for modeling and decision making
- crafting policies to incentivize conservation
- improving communication between policy makers and scientists
- conducting economic analyses of policy options

Ways to improve stakeholder understanding of climate science:

- presenting audiences with results that matter to them (price, employment opportunities)
- provide summaries along with reports/journal article
- senior level internships across agencies to promote collaborations

Integrated themes across both days

Planning

- Planning efforts help support regional management of drought, fire and other ecological services.
- Trading information and analyses can help participants from different sectors meet goals.
- Participants recognize resource constraints (time, money etc., short term outlook) and challenges associated with changing conditions, but recognize the value of networking and information sharing.
- Participants want access to accurate and understandable climate science information and models
- Participants recognize importance of incentives and behaviors.

Science communication

- Unit goals and efforts should be accessible and understandable to other groups.
- Complex information and recommendations in academic journals or reports needs to be summarized in language that multiple stakeholders can evaluate quickly.
- Climate science communication is not a one way transfer of knowledge but a dialogue that involves understanding motivations of stakeholders as well as climate science data.

Collaboration

- There are multiple practical ways of promoting collaboration.
- Academic, private and government agencies providing information to stakeholders and each other, student projects (e.g. Internships, independent studies, capstone course, applied courses)
- Seminars on impacts and efforts designed for a specific audience (businesses, nonprofits, academic and government agencies)
- And academic projects linking environmental science with the socio economic sciences
- Senior level internships across agencies

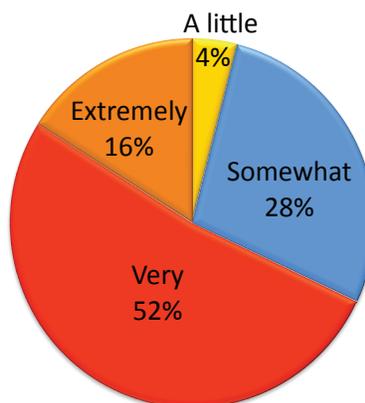
On the second day participants chose to work together as one plenary group instead of several smaller groups at individual tables. At this point in the workshop, the unified format proved productive and resulted in the identification of approximately ten potential future collaborations. The Climate Change Planning Group adopted this simple protocol: Each time a participant identified an area where he or she could use some help in achieving a goal, other participants responded with supportive suggestions on how his or her unit or agency could help make a goal a reality.



Breakout session, March 28

How useful were these sessions to develop collaborations?

Source: Workshop Survey performed by L. Kohne, SmartStart Educational Consulting Services



In summary, several themes emerged with respect to potential collaborations.

- climate impacts and recommendations can be summarized using language and other formats (e.g. seminars, summaries, briefs, service announcements) that professionals from other sectors can understand. This is an opportunity for professionals, students and faculty to gain a better understanding by working together with stakeholders to improve communication and understanding of impacts.
- trading information (e.g. data and knowledge) and analyses (e.g. models and results) can help participants from different sectors meet goals. This may require communication and data sharing among participants while also recognizing that some data is sensitive and would require additional protocols.

- climate science communication is not a one-way transfer of knowledge but a dialogue that involves stakeholders. This may require gathering information about areas of concern for stakeholders (e.g. water availability, price of food, price of energy, employment opportunities, investment opportunities, health effects, job opportunities, poverty levels, industry impacts, policy impacts etc.) and presenting information from these areas to stakeholders in an accessible format.
- participants across sectors recognized the need for tri-state collaboration and analyses (e.g. climate impact models and agent-based models) that could be shared.



Donica Mensing

Communicating climate change science for education, management, and policy

Session Moderator: Donica Mensing (UNR)

The purpose of this session was to stimulate information sharing and collaboration between stakeholders and researchers on ways to improve communication about climate change in the West. Five groups of seven to ten participants each met three times during the workshop to discuss challenges in communicating climate change and to identify specific needs that should be addressed in future communication efforts. The groups also shared their own success stories and devoted significant time to making recommendations for how to improve future communication efforts. At the last session participants made specific suggestions for future collaborations and a number of commitments were made between attendees to continue discussing communication proposals. Graduate students were also active participants, making suggestions and reflecting on the importance of attending to communication as a part of their research efforts.

- Find ways to communicate climate change in much simpler terms. Recognize that a lot of conflicting and misleading narratives are crowding out the accurate, but more difficult to understand, stories. There is a real need to simplify the message. Develop an “elevator pitch” to describe climate change in the West. Or, create a simple message for ‘Climate Change in the West’ in three to four bullet points that would fit on the back of a business card, and give them to everyone.
- As one track of communication, consider finding ways to communicate about climate change without ever using the terms “climate change” or “global warming.” We can talk instead about water, air, drought, fire, food – issues that people understand more intuitively. Look to the issues people DO care about and connect climate change to those issues. Deal with climate change but don’t use the phrase; use incentives to get people engaged with dealing with drought planning, for example.
- Find ways to improve scientific literacy. Illiteracy is a significant barrier preventing people from understanding climate change or and it allows them to believe misinformation. We need better science education in K-12, focusing specifically on the kinds of learning that would be useful in understanding

these processes. We also need more creative ways to improve the scientific literacy of adults.

- Learn from the communication research that has been done on effective ways to communicate about climate change. We need ways to distribute or share this research to make it more accessible to people who are communicating about these issues.
- Recognize that providing information and changing behavior are two very different things. We need to be clear about when we are communicating information and when we intend to inspire some behavioral changes.
- Work with scientists to describe specific impacts of climate change. Many people in the public are more interested in understanding possible effects than the science behind them. How can we do a better job of connecting scientific data to the issues people are interested in learning about?
- Create better visualizations of potential impacts of climate change. These need to be simple, easy to understand and scientifically accurate. How might we develop ways to find funding and time to create these kinds of useful visual messages?
- Develop communication strategies for climate change through informal, as well as formal channels of communication. Consider using social media and other tools to engage people in these informal networks as well as more formal ways. How might we help scientists improve their one-to-one communication of climate change issues?
- Find ways to share effective analogies and powerful “stories” that communicate well about climate change. We need a way to share these stories to help each other improve the ways we communicate. Effective use of multimedia and other new forms of communication could potentially reach younger audiences.
- Develop ways to communicate credibly about *uncertainty* using language people are familiar with in other domains. Help people understand how to react to and respond to decision making when not all facts are in (ie uncertainty) and relate daily decisions by ordinary people based on patchy information to climate change and other science. Contribute to a sense of what science is all about—i.e., learning, not knowing; a process of coming to new knowledge.

“I wish we had used a roundtable format at one of the earlier meetings because it gave everyone a better chance to hear and understand each other, which may have improved collaboration between disciplines. I am planning to graduate soon and looking for the next step, and I enjoyed the opportunity to talk to people across disciplines and agencies to better understand my options. I also learned a lot about the benefits and difficulties of the collaborative process.”

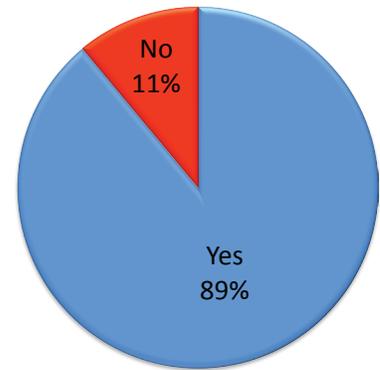
--Anonymous comment from Workshop Survey response

Summary Day 2 – Collaboration Ideas

- Create a list of top five things people should know about climate change in the West. Aim the list to a general audience and make it available in English and Spanish. Get everyone – water managers, land managers, researchers, foresters, etc. to refer to these points when talking with people. Create alternative lists of top five messages for specific audiences (K-8, high school, tradesmen, etc.) for a particular outcome.

Were the Topical Area discussions that you attended and the round table format of the breakout sessions of value to you and your work goals?

Source: Workshop Survey performed by L. Kohne, SmartStart Educational Consulting Services



- Invite faculty from marketing and business fields to coach and train scientists and graduate students in better messaging on climate change and uncertainty. Provide more instruction to EPSCoR participants on communicating about climate change (building on events like the NSF Workshop with Chris Mooney).
- Create a workshop specifically on what it means to collaborate, and tools and approaches to achieve effective collaboration. It means different things to different people – the currency of collaboration changes between academics, land managers, community colleges, educators, business people and the general public.
- Send out a press release for every paper that's published on climate change. Work to provide research results in layman's terms.
- Develop a series of science 'cafes' in the community, where scientists and citizens can interact around specific questions and impacts of climate change. Create a tool kit of climate change materials that would illustrate basic scientific processes. Gear them to different age groups and knowledge levels --- and then share them online and let people freely use them in their own materials.
- Create climate change 'story' production teams—combining the perspectives of scientist, educator, journalist, computer scientist.
- Work with scientists to develop sound mitigation strategies—what an individual can do – and then communicate those strategies. Reach out to state climatologists and others doing the research to add more data.
- Bring together Web developers, designers and cognitive psychologists, especially for accessibility/usability of climate change data portals.
- Create a collection center for freely available materials for communicating climate change, and include information about

audiences and impacts. Or, if such a clearinghouse already exists, publicize it as widely as possible to participants in this workshop.

- Create a series of visual representations that show the effects of climate change already – before and after shots, etc. Provide information on what people can do to mitigate secondary effects of climate change, such as drought.
- Identify funding opportunities for collaborations/interdisciplinary work and share those opportunities.

STATEMENTS OF INTENT TO COLLABORATE

As the culmination of the workshop, participants were invited to volunteer statements of intent to collaborate. Providing time, information and motivation to develop new collaborations was one of the critical goals for this workshop. This workshop goal was successful as demonstrated in table 3, which summarizes these statements. To date, several of the participants who made statements have proceeded and at least one draft proposal has been completed. We encourage anyone interested in the collaboration topics to contact the lead individual, or to continue dialogues to build other new collaborative efforts.



Group picture, Sheep Range

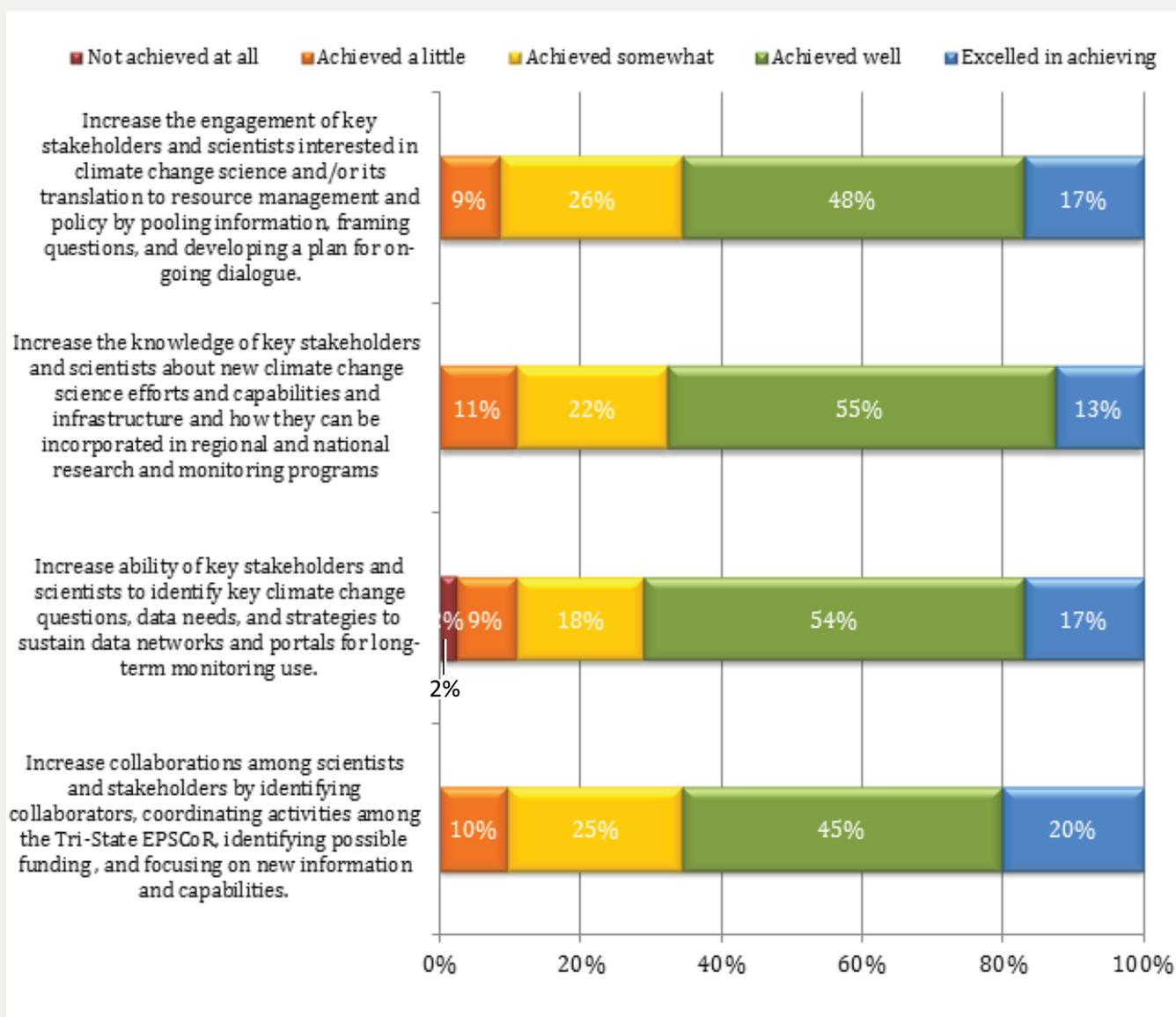
Table 3. Voluntary statements of intent to collaborate are summarized in this table.

Name:	Institution:	Name of Collaborators:	Collaborator Institutions, respectively:	Collaboration Topic:
Leigh Bernacchi	University of Idaho	Lynn Fenstermaker	DRI	Create a database/wiki of best practices for climate change communication strategies
Nick Lancaster	DRI	As many as possible	DRI, UNLV, UNR	Develop database of climate change expertise
Helen Neill	UNLV	Lewis Wallenmeyer, Keely Brooks, Marco Velotta	Clark County, SNWA, City of Las Vegas	Estimate economic benefits of better air quality; develop student research projects linking economic, social, environmental and water issues
John Mejia	Desert Research Institute	Keely Brooks	SNWA	Share data and/or infrastructure; Continue to meet and brainstorm future plans and projects
Gayle Dana	NSHE NSF EPSCoR	Susan Moore	Lt. Governor's Office	Promote Nevada's NSF EPSCoR programs to gain support by Lt. Governor's office
Marco Velotta	City of Las Vegas	Helen Neill, Tom Piechota	UNLV	Develop adaptation plans
Dave Makings	College of Southern Idaho	(In progress)	Not known	Develop climate change K-12 course materials
Lynn Fenstermaker	DRI	Marcy Litvak	UNM	Compare NV and NM ET data
Lynn Fenstermaker	DRI	Doug Merkler, Britt Johnson	NRCS, DRI	Publish NevCAN soils data
Dale Devitt	UNLV	Lewis Wallenmeyer	Clark County	Add ozone sensors on the existing NevCAN Sheep Range towers
Venkat Sridhar	Boise State University	Darko Koracin, John Mejia, Laurel Saito	DRI, UNR	Prepare proposals and manuscripts focusing on hydrological modeling using downscaled regional climate projections
Thomas Piechota	UNLV	Keely Brooks, Marco Velotta	SNWA, City of Las Vegas	Develop water vulnerability project; develop work plan for climate assessment studies
Derek Kauneckis	University of Nevada Reno	Keely Brooks, Todd Hopkins, Melinda Bensen	SNWA, Great Basin LCC, UNM	Develop joint proposals/research on climate and water issues in NV, ID and NM, curriculum, and course-based student projects
Nina Oakley	DRI	(In progress)		Develop web interfaces for climate data
Kelly Redmond	DRI	(In progress)		Distillation of climate data
Guoping Tang	DRI	(In progress)		Collaborate on ecosystem model enhancement for the SW, NASA proposal development
Tom Albright	UNR	Scott Nowicki and others to be determined	UNLV	Develop proposals to improve characterization of land surface temperature regimes using remote sensing and NevCAN data

WORKSHOP CONCLUSION

On March 27 and 28, 2013, approximately 150 stakeholders and members of the NSF EPSCoR Western Tri-State Consortium of Nevada, Idaho and New Mexico met to discuss and exchange information about climate change research, infrastructure, planning and adaptation. The goals of the workshop were to ENGAGE key stakeholders and scientists, INFORM participants about climate change science and capabilities, IDENTIFY stakeholder's key climate change questions, BUILD COLLABORATIONS, and INITIATE climate change adaptation strategies. As summarized in graphs (above and below) from the workshop survey, participants felt the plenary speakers provided valuable information to help guide and summarize the workshop topical sessions. Participants reported that the round table discussions helped them understand each other better and helped them identify and develop future collaborative effort of mutual benefit. The organizers of the workshop are hopeful that the dialogue will continue at future meetings to ensure that the knowledge and infrastructure gained through the NSF EPSCoR climate change project will provide continuing and enhanced benefit to as many stakeholders, scientists and educators within the western states as possible.

How well did we achieve our goals?



Percentage of survey respondents selecting each rating is depicted.

ACKNOWLEDGEMENTS

Organizing and convening a workshop of this scale requires the capable assistance of many key people. We would first like to thank the dedicated Nevada NSF EPSCoR Office staff who worked many long hours to make the workshop a success. This team marketed the workshop, efficiently and diligently organized and managed the logistics of the workshop, and ensured that all participants had a productive time engaging in the set of workshop activities. Special thanks are due to Martha Delgado for the workshop website and keeping track of registrations; Michele Casella for the poster session; and Marcie Jackson for overall supervision and budgetary oversight.

We also wish to gratefully acknowledge the topical input from the workshop committee. The list of these individuals was provided in the section on the workshop background. Although all of the organizing committee members provided significant input, we would like to highlight the special efforts of a few individuals. Keely Brooks (SNWA) worked tirelessly to identify and help invite stakeholders to attend the workshop. Todd Hopkins (FWS and Great Basin LCC Science Coordinator) provided significant input on key issues for stakeholders as well as a number of reference documents pertinent to the workshop. The NM and ID State NSF EPSCoR Directors (William Michener and Rick Schumaker) provided several great plenary speaker suggestions, for which we are truly grateful.

CONCUR, Inc. provided unlimited guidance and leadership throughout the workshop process. We sincerely thank them for their assistance in organizing the workshop, conducting stakeholder interviews, providing training for the table facilitators and keeping the process moving. Thanks Scott and Megan.

We sincerely thank SmartStart Educational Consulting Services for preparing and summarizing the two workshop surveys; one to evaluate the workshop as a whole and the other provided a format for people to list their intentions to collaborate. Both of these provide valuable input for future workshops and continuing the collaborative dialogue.

The report graphics and publication were made possible by the talented skills of Lisa Wable, DRI. We are truly grateful for her aesthetic eye, patience and efficient assembly of the final report.

Most importantly we thank all the participants in the workshop, who engaged fully in the discussions and provided many insights into climate change science and its applications.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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APPENDIX A: Stakeholder Surveys

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Date: January 11, 2013

To: Nevada NSF EPSCoR Climate Change Science Stakeholder Workshop Organizing Committee

From: Scott McCreary and Megan Vinett, CONCUR, Inc.

Subject: Interview Synthesis and Recommended Outreach

As part of CONCUR's efforts to support the Climate Change Science for Effective Resource Management and Public Policy in the Western United States Workshop, we are transmitting a summary of our findings from the stakeholder interviews CONCUR conducted in December 2012 and early January 2013. We were able to schedule and conduct a dozen interviews with federal agencies (USGS, USDA Forest Service, BLM, etc.), state agencies and local government officials, and conservation organizations.

Our interviews were structured around five organizing questions. As we heard many recurring themes, we have chosen to structure our summary around those major ideas rather than iterating a response from each respondent. We have structured our summary in a table format. The columns in the table list the organizing question. The rows simply divide separate ideas.

Stakeholder Interview Synthesis - NV NSF EPSCoR Climate Change Science Stakeholder Workshop

Question 1: What is your interest in the discussion about climate change science?	Question 2: What topics would you like to see addressed in this workshop?	Question 3: What are the key climate change issues facing your organization?	Question 4: How can the academic community help you address these issues?	Question 5: What are your suggestions of colleague organizations or individuals who may have a strong interest in our workshop?
Understanding prospects for adaptation was cited repeatedly as a key interest in climate change - the need for both research and resource management adaptation.	Respondents expressed an interest in forecasts, data sets and information on how climate change is affecting precipitation, runoff, soil stability and other managed resources, and information on how new disturbances can arise.	Resource managers and conservationists and other workshop participants wrestle with changing precipitation and variability in forecasts. Healthy, sustainable ecosystems and how to protect and manage them are important issues.	It would be helpful if the academic community could address specific uncertainties - warmer or wetter or drier or colder climate trends - and how they could affect resources.	**See contact list spreadsheet. General suggestions included
Respondents recognized that inter-agency discussions have already started on regional levels but more progress is needed.	It was noted that management culture is difference research culture and how decisions are made - which decisions are brought by climate change and which by budget?	Relating climate trends to specific resource issues is important, such as impacts on vegetation communities, wildlife and water resources.	Finding common ground between academics and managers could help how data is collected and used. If researchers can look at the specific goals and objectives for each management unit and what it is trying to accomplish, they can better meet data needs. Relevant information and data that speaks to a specific plan can help overcome management constraints and help form doable actions within budget targets.	
Many participants work in resource management: - land/habitat - water (availability) - inventory of resource(s). Participants are interested in climate change impacts on resources and seeing data.	In recognizing the difficulty for regulatory agencies to adapt to changes in weather and resource availability trends, respondents often pose this question: how do we adapt current budget and decision-making structures to better take into account changing climate?	Disaster response and management, risk management and mitigation, risk/benefit analyses, and using actionable information that is legally defensible are more difficult to develop with uncertainties of a changing climate.	It would be very helpful for the academic community could develop a fast, geospatially-robust data set that allows users to see where changes are.	
Interest in sustainable development, carbon sequestration/ pollution control, and economic impacts were also discussed in their relationship to science and climate change.	Participants would like to see, at a high level, an overview of various efforts going on around the region and the West, especially around water resources, wildfires, erosion and soil stability.	Organizations and agencies in the West have realized the need to link economic realities to climate change issues. Drastic weather or wildfire events can devastate an economy.	It was also discussed that reasonable overhead rates charged by universities and a fast turnaround of data could lend to greater support for addressing climate change issues and mobilizing political will.	

Question 1: What is your interest in the discussion about climate change science?	Question 2: What topics would you like to see addressed in this workshop?	Question 3: What are the key climate change issues facing your organization?	Question 4: How can the academic community help you address these issues?	Question 5: What are your suggestions of colleague organizations or individuals who may have a strong interest in our workshop?
Calling it "Climate Change" - hard data versus perception is still an obstacle for many regulatory and conservation agencies and groups. There is a strong interest in exploring ways to engage the public into discussing and engaging in the reality of climate change.	By the time differences/changes are seen in water, soil, vegetation, etc., it can be too late to react and prevent damage. What specific things should participants look at to detect, anticipate and respond to changes?	More specifically, there is concern about changing average rainfall and annual aquifer replenishment. These changes affect freshwater and groundwater management - appropriation and allocation so as to use the available resource without depleting it.	Solid science and conclusions from climate change studies could bring the whole conversation to the forefront in a very political environment. It would provide real data, not just perceived opinions or information from the east coast or California.	**See contact list spreadsheet.
Climate status and climate change are typically not listed as enforceable triggering events in regulations; changes need to start with management	Monitoring stations to detect changes could be linked into a regional monitoring effort, using both ground sensing and remote sensing. To expand on this, similar databases used by region- wide users could lend to a network. Networking with each other could address a critical need. What are other states doing?	Addressing "climate change skepticism" head-on was mentioned as an issue during multiple interviews. Specifically, there is an interest in the workshop "making real" what is happening.	Participants also expressed interest in not limiting academic/organization partnerships to science.	
Climate change needs more attention so everyone can become more comfortable with the reality of changing ecosystems.	There is an interest in the conversation about the apparent conflict between the push for renewable energy, and the necessary infrastructure that comes with it, and land trust and conservation efforts to protect sensitive species and communities. Uncertainties on how climate changes effect habitat makes this planning difficult.	Many organizations hold an interest in education and outreach and developing ways to teach people (not just academics or scientists) about climate change and engaging them in efforts.		

APPENDIX B: Workshop Agenda

Climate Change Science for Effective Resource Management and Public Policy in the Western United States

MARCH 27-28, 2013		UNIVERSITY OF NEVADA LAS VEGAS
Day 1 – March 27, 2013		
8:00 am - 4 pm	Poster installation	
7:30 – 8:30 am	Registration	
8:30 - 9:00 am	<p>Welcome</p> <p>Gayle Dana – Nevada NSF EPSCoR Project Director</p> <p>Thomas Piechota – NSF EPSCoR Co-PI; Interim Vice President for Research and Dean of the Graduate College, University of Nevada, Las Vegas</p>	
9:00 – 9:45 am	<p>Plenary Session #1</p> <p>What is climate change and how is it manifested in the western USA?</p> <p>Kelly Redmond, Deputy Director and Regional Climatologist, Western Regional Climate Center</p>	
9:45 - 10:15 am	Break	
10:15 – 11:00 am	<p>Plenary Session #2</p> <p>Frameworks for decision making - how does climate change fit into the equation?</p> <p>Patricia Mulroy, General Manager, Southern Nevada Water Authority and Las Vegas Valley Water District</p>	
11:00 – 11:45 am	<p>Plenary Session #3</p> <p>Engaging Stakeholders in Research</p> <p>Henry Gholz, Program Director, National Science Foundation Division of Environmental Biology</p>	
11:45 am - Noon	<p>Plenary Session #4</p> <p>Introduction to Topical Areas and Goals for Discussion Groups</p> <p>Participants – Topical Area Conveners (Scott Mensing, Helen Neill, Donica Mensing)</p>	
Noon – 1:00 pm	Lunch	
1:00 – 2:30 pm Concurrent Session Room 205 <u>Topical Area Session A: 1st Round of Questions</u> Assessing the effects of climate change: informing adaptation strategies	<ol style="list-style-type: none"> 1) Are you developing strategies for adaptation? 2) Given the uncertainty of the direction and magnitude of potential future climate change, what is important to be doing now? 3) What information (data, instrumentation) do you most need to reduce uncertainty in planning for potential future climate change? 	
1:00 – 2:30 pm Concurrent Session Room 209 <u>Topical Area Session B: 1st Round of Questions</u> Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities	<ol style="list-style-type: none"> 1) Have you identified climate change impacts for your organization or community? What are they? Do these impacts affect your core mission? 2) What are your plans for adaptation to climate change in your business, government agency or community? 3) What are the benefits and disadvantages of making plans? What are the challenges for maintaining a plan for your organization? 4) What info would help you make or revise plans to promote future resilience (aka, ability to adapt to change) for your business, government agency or community? 	

1:00 – 2:30 pm Concurrent Session Room 213 <u>Topical Area Session C: 1st Round of Questions</u> Communicating climate change science for education, management, and policy	<ol style="list-style-type: none"> 1) What are you doing to communicate the effects of climate change? Who are your audiences? 2) What messages about climate change do you hear from others? 3) What strategies for communicating climate change are most effective?
2:30 – 2:45 pm	Break
2:45 – 4:15 pm Concurrent Session Room 205 <u>Topical Area Session A: 2nd Round of Questions</u> Assessing the effects of climate change: informing adaptation strategies	<ol style="list-style-type: none"> 1) What is your highest priority in planning for potential future climate change? 2) What are the barriers that prevent you from fully planning for potential future climate change? (money/information/data/intellectual capital/public support)? 3) How can these barriers be overcome? 4) Who are your collaborative colleagues in working on/thinking about/ planning for potential future climate change? Who could be potential collaborators?
2:45 – 4:15 pm Concurrent Session Room 209 <u>Topical Area Session B: 2nd Round of Questions</u> Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities	<ol style="list-style-type: none"> 1) What are the different audiences for climate science? 2) How can we make climate science findings more accessible to alternative audiences? 3) What are ways to improve potential collaborations between scientists and decision makers? 4) What are potential collaborations that would help your business, government agency or community to become more resilient to climate change effects?
2:45 – 4:15 pm Concurrent Session Room 213 <u>Topical Area Session C: 2nd Round of Questions</u> Communicating climate change science for education, management, and policy	<ol style="list-style-type: none"> 1) What barriers are preventing you from communicating effectively about future climate change? 2) What do you need to reduce these barriers? 3) What collaborations might help you improve your communications about climate change?
4:15 – 4:40 pm	Break
4:40 – 5:15 pm	Plenary Session #5 Report back from Topical Area discussions General discussion
5:15 – 5:30 pm	Break
5:30 – 7:00 pm	Poster Session

Day 2 – March 28, 2013

8:30 - 9:30 am	<p>Plenary Session #6 Convene workshop for day 2</p> <p>Plenary Speaker: Climate adaptation through collaborative modeling: Examples from acequia communities, Rio Grande and the Western Interconnection Vincent Tidwell, Distinguished Member of the Technical Staff, Sandia National Laboratories</p>
9:30 – 9:45 am	Session Breakout Instructions
9:45 – 10:30 am	Break
10:30 am – noon Concurrent Session Room 205 <u>Topical Area Session A: Final Round of Questions</u> Assessing the effects of climate change: informing adaptation strategies	(Questions developed during Day 1)
10:30 am – noon Concurrent Session Room 209 <u>Topical Area Session B: Final Round of Questions</u> Evaluating the Current State of Climate Change Planning: Identifying Opportunities and Challenges for Businesses, Government Agencies, and Communities	(Questions developed during Day 1)
10:30 am – noon Concurrent Session Room 213 <u>Topical Area Session C: Final Round of Questions</u> Communicating climate change science for education, management, and policy	(Questions developed during Day 1)
12:00 pm – 1:15 pm	Lunch
1:15 – 3:15 pm	<p>Plenary Session #7 Student poster session awards Panel Discussion to review all topical area discussions and develop action items Voluntary statements of collaboration commitments by participants</p>
3:15 – 3:30 pm	Closing

APPENDIX C: Workshop Attendees

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