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Principal Investigator
Lisa Dilling, University of Colorado-Boulder

Co-Investigators
Kristen Averyt, University of Colorado-Boulder
Nolan Doesken, Colorado State University
Robert Gillies, Utah State University
Douglas Kenney, University of Colorado-Boulder
Jeffrey Lukas, University of Colorado-Boulder
Jason Neff, University of Colorado-Boulder
Thomas Painter, California Institute of Technology
Balaji Rajagopalan, University of Colorado-Boulder
William Travis, University of Colorado-Boulder
Klaus Wolter, University of Colorado-Boulder

**Introduction**

The mission of the Western Water Assessment (WWA) is to identify and characterize regional vulnerabilities to and impacts of climate variability and change, and to develop information, products and processes to assist decision makers throughout the Intermountain West. Using multidisciplinary teams of experts in climate, hydrology, ecology, law, and policy, WWA works with decision makers across the Intermountain West to produce policy-relevant information about climate variability and change. By building relationships and networks of decision makers, our team is able to develop practical research programs and useful information products. WWA is formally part of the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado in Boulder and is physically located in NOAA’s David Skaggs Research Center. Our researchers and partners come from universities and federal institutions in Colorado, Wyoming, and Utah.

**New Areas of Focus**

Within the existing mission described above, WWA shifts its specific research foci from year to year to stay current with stakeholder needs and emerging research frontiers. New areas of focus and new partnerships developed in 2013-2014 are described in Table 1.

<table>
<thead>
<tr>
<th>New Area of Focus</th>
<th>Relevant Projects (see pp. 10-19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State level climate vulnerability assessment</td>
<td>• Colorado Climate Change Vulnerability Study</td>
</tr>
<tr>
<td>External Program Evaluation</td>
<td>• Evaluation of NIDIS Upper Colorado Drought Early Warning System</td>
</tr>
<tr>
<td>New Partnership</td>
<td>Relevant Projects (see pp. 10-19)</td>
</tr>
<tr>
<td>University of Utah Urban Planning</td>
<td>• Adaptation Guidance for Salt Lake City Department of Public Utilities</td>
</tr>
<tr>
<td>Weber Basin Water Conservancy District</td>
<td>• Weber Basin Climate Sensitivity Analysis</td>
</tr>
<tr>
<td>Colorado Energy Office</td>
<td>• Colorado Climate Change Vulnerability Study</td>
</tr>
<tr>
<td>USDA Northern Plains Regional Climate Hub</td>
<td>• Exploring Regional Climate Service Collaborations</td>
</tr>
</tbody>
</table>

**WWA Staff and Research Team**

WWA is comprised of a core staff of four (Table 2) who focus on program management, research development and synthesis, and coordination of stakeholder interactions. In addition to the core staff shown below, WWA shares administrative support (Nancy Filice) and outreach staff (Amy Nacu-Schmidt) with the Center for Science and Technology Policy Research (CSTPR) at CU-Boulder in order to increase efficiency and leverage resources.

<table>
<thead>
<tr>
<th>WWA Core Office Staff</th>
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</thead>
<tbody>
<tr>
<td>Lisa Dilling</td>
<td>Director</td>
</tr>
<tr>
<td>Jeff Lukas</td>
<td>Senior Research Associate</td>
</tr>
<tr>
<td>Eric Gordon</td>
<td>Managing Director</td>
</tr>
<tr>
<td>Tim Bardsley</td>
<td>Utah Liaison</td>
</tr>
</tbody>
</table>

*ldilling@colorado.edu
lukas@colorado.edu
esgordon@colorado.edu
wwa.bardsley@gmail.com
WWA also works with a team of individual researchers at the University of Colorado and other institutions throughout the region. A full list of team members is provided in Table 3.

**Table 3. Western Water Assessment Research Team**

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Title</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andersson, Krister</td>
<td>Assistant Professor, Political Science, Univ. of Colorado</td>
<td>Environmental governance</td>
</tr>
<tr>
<td>Averyt, Kristen</td>
<td>Associate Director for Science, CIRES</td>
<td>Climatology, energy-water, assessment processes</td>
</tr>
<tr>
<td>Barsugli, Joseph</td>
<td>Research Scientist, CIRES, Univ. of Colorado</td>
<td>Climate dynamics</td>
</tr>
<tr>
<td>Berggren, John</td>
<td>Graduate Research Assistant, Univ. of Colorado</td>
<td>Climate adaptation, water policy</td>
</tr>
<tr>
<td>Clifford, Kate</td>
<td>Graduate Research Assistant, Univ. of Colorado</td>
<td>Conservation decisionmaking</td>
</tr>
<tr>
<td>Cozzetto, Karen</td>
<td>Postdoctoral Research Associate, CIRES, Univ. of Colorado</td>
<td>Hydroclimatology, surface water hydrology and ecology, climate adaptation</td>
</tr>
<tr>
<td>Deems, Jeff</td>
<td>Research Scientist, CIRES, Univ. of Colorado</td>
<td>Climate and snow modeling</td>
</tr>
<tr>
<td>Dilling, Lisa</td>
<td>Director, Western Water Assessment</td>
<td>Climate information and decisionmaking</td>
</tr>
<tr>
<td>Gordon, Eric</td>
<td>Managing Director, Western Water Assessment</td>
<td>Climate adaptation</td>
</tr>
<tr>
<td>Huisenga, Mary</td>
<td>Professional Research Assistant, Univ. of Colorado</td>
<td>Limnology, decision modeling</td>
</tr>
<tr>
<td>Kasprzyk, Joseph</td>
<td>Assistant Professor, Civil Engineering, Univ. of Colorado</td>
<td>Multi-objective analysis for water management</td>
</tr>
<tr>
<td>Kenney, Douglas</td>
<td>Director, Western Water Policy Program, Getches-Wilkinson Center for Natural Resources, Energy, and the Environment, Univ. of Colorado School of Law</td>
<td>Western water policy and law</td>
</tr>
<tr>
<td>Klein, Roberta</td>
<td>Managing Director, Center for Science and Technology Policy Research, Univ. of Colorado</td>
<td>Environmental policy</td>
</tr>
<tr>
<td>Livneh, Ben</td>
<td>Visiting Fellow, Western Water Assessment and CIRES, Univ. of Colorado</td>
<td>Hydrologic modeling</td>
</tr>
<tr>
<td>Lukas, Jeffrey</td>
<td>Senior Research Associate, Western Water Assessment</td>
<td>Paleohydrology, forest ecology</td>
</tr>
<tr>
<td>McNie, Elizabeth</td>
<td>Research Associate, CIRES, Univ. of Colorado</td>
<td>Science policy, program evaluation</td>
</tr>
<tr>
<td>Meldrum, James</td>
<td>Research Associate, Institute for Behavioral Studies, Univ. of Colorado</td>
<td>Applied environmental economics</td>
</tr>
<tr>
<td>Molotch, Noah</td>
<td>Assistant Professor, Dept. of Geography, Univ. of Colorado</td>
<td>Snow hydrology</td>
</tr>
<tr>
<td>Nania, Julie</td>
<td>Research Assistant, Getches-Wilkinson Center for Energy, Natural Resources, and the Environment, Univ. of Colorado School of Law</td>
<td>Tribal law</td>
</tr>
<tr>
<td>Rangwala, Imtiaz</td>
<td>Research Associate, CIRES, Univ. of Colorado</td>
<td>Regional climate change, climate of high elevation areas</td>
</tr>
<tr>
<td>Rajagopalan, Balaji</td>
<td>Professor, Civil Engineering, Univ. of Colorado</td>
<td>Water resources engineering</td>
</tr>
<tr>
<td>Ray, Andrea</td>
<td>Scientist, Climate Analysis Branch, NOAA ESRL Physical Sciences Division</td>
<td>Climate-society interactions, water management</td>
</tr>
<tr>
<td>Schneider, Dominik</td>
<td>Graduate Research Assistant, Univ. of Colorado</td>
<td>Snow hydrology</td>
</tr>
<tr>
<td>Team Member</td>
<td>Title</td>
<td>Expertise</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Travis, William</td>
<td>Associate Professor, Geography, Univ. of Colorado</td>
<td>Natural hazards, climate impacts and adaptation</td>
</tr>
<tr>
<td>Udall, Bradley</td>
<td>Senior Fellow, Getches-Wilkinson Center for Natural Resources, Energy, and the Environment, Univ. of Colorado School of Law</td>
<td>Colorado River, hydrology, policy</td>
</tr>
<tr>
<td>Wessman, Carol</td>
<td>Professor, CIRES, Univ. of Colorado</td>
<td>Landscape ecology, remote sensing</td>
</tr>
<tr>
<td>Wolter, Klaus</td>
<td>Research Scientist, CIRES, Univ. of Colorado</td>
<td>Climatology and meteorology</td>
</tr>
</tbody>
</table>

**WWA 2013-2014 Program Highlights**

**Major Research Findings**

- With colleagues from the Salt Lake City Department of Public Utilities, the NOAA Colorado Basin River Forecast Center, and University of Utah, **Tim Bardsley** led the co-production of a study that found Salt Lake City’s water supply could drop 1.8 to 6.5 percent for every degree Fahrenheit of warming in the region.

- While the September 2013 extreme rain and flood event along Colorado’s Front Range was widely believed to be unprecedented, especially for the fall season, analysis by **Jeff Lukas**, **Joe Barsugli**, and **Klaus Wolter**, with colleagues at NOAA Earth Systems Research Laboratory showed that a September 1938 event had an eerily similar synoptic pattern, and similar results in terms of precipitation totals and flooding impacts on the Front Range.

- Winter temperatures in the Rocky Mountains are projected to warm more in the future than lower-elevation regions at the same latitude, according to an analysis of CMIP5 global climate model runs by **Imtiaz Rangwala** and colleagues at Rutgers University.

- The worst watershed stresses seen across the country between 1999 and 2007 could become the new normal under a warming climate, according to research by **Kristen Averyt** and **James Meldrum**, along with colleagues from the USDA, Tufts University, and the Union of Concerned Scientists.

- Future projected changes in temperature and precipitation could exacerbate the effects of dust deposition on snowpack in the Upper Colorado River Basin, inducing additional losses of 10 to 20% of flow and earlier runoff timing shifts of 10-20 days relative to current climate and moderate dust conditions, according to research by **Jeff Deems** and **Joe Barsugli**.
Select Outreach Activities

Rapid Response to Colorado Front Range Flooding

In the wake of historic flooding across Colorado’s Front Range, Jeff Lukas led the development of a four-page assessment report and a widely attended public briefing (Figure 1) discussing the meteorological, climatic, and hydrologic context of this extreme event. Nearly 100 people in-person and over 200 online attended the briefing, which also featured Klaus Wolter along with Martin Hoerling and Kelly Mahoney of the NOAA Earth Systems Research Laboratory’s Physical Sciences Division and Nolan Doesken of the Colorado Climate Center at Colorado State University.

![Figure 1](image)

Figure 1. WWA’s Jeff Lukas and Klaus Wolter join other colleagues in presenting meteorological, climatic, and hydrologic information about the Colorado Front Range Flooding of 2013 to a public audience.

Informing Water Managers About New Climate Projections

Imtiaz Rangwala has done extensive analysis of the differences between the projected climate in the Coupled Model Intercomparison Project, Phase 3 (CMIP3) and the newer set of model runs (CMIP5) for the Upper Colorado River Basin and the state of Colorado. Selected results of this analysis were presented at a variety of stakeholder forums, including the Upper Colorado River Basin Water Conference in November 2013, during a webinar held by the Carpe Diem West Academy, and at a WWA-organized meeting of the Front Range Climate Change Group (see below). Of particular interest to water management stakeholders were changes in projections of future precipitation in basins in western Colorado that feed into the Colorado River.

Media and Stakeholder Outreach on the Energy-Water Nexus

In addition to publishing several academic papers on the topic, Kristen Averyt engaged both decision makers and the public in numerous efforts intended to promote understanding of the effects of energy...
production on water supplies. These efforts included filming a video with the University of Colorado Boulder’s Office for University Outreach, being interviewed on Colorado Public Radio, and co-presenting a webinar hosted by the Association of Metropolitan Water Agencies.

**Describing Research Results to Utility CFOs**

In March 2014, Doug Kenney co-hosted a workshop of water utility Chief Financial Officers (and related staff) examining water utility revenue volatility associated with climate events and other stressors affecting water demand and deliveries. This “CFO Connect Water Utilities” was held in cooperation with Ceres and the Water Efficiency Foundation and incorporated information from Kenney’s 2014 paper in the *Journal of the American Water Works Association* entitled “Understanding Utility Disincentives to Water Conservation as a Means of Adapting to Climate Change Pressures.”

**Promoting Literacy Across Climate Topics**

Eric Gordon, Jeff Lukas, Imtiaz Rangwala, Joe Barsugli, Lisa Dilling, and Kristen Averyt convened a series of climate literacy workshops for the Front Range Climate Change Group, an informal gathering of municipal water utility managers from Colorado’s Front Range. Topics covered included updated (CMIP5) projections of precipitation in the Upper Colorado River Basin and relevant uncertainties, the effects of wildfire on soils and erosion into reservoirs, and communication of climate change information to the public.

**Narrative Examples of Decisions Relevant to WWA Work**

**Salt Lake City: Using Climate Sensitivity Results in Operations and Planning**

Salt Lake City Public Utilities (SLCDPU) worked with Tim Bardsley and other research partners to develop a study of the climate sensitivity of their water supplies. Rather than informing a specific decision, SLCDPU has used the study to inform all of their operations and planning—in other words, they have “mainstreamed” the information into their work, to use a term from climate adaptation practice. For more information on how SLCDPU’s Laura Briefer is using the climate sensitivity study in her decision making and looking towards future collaborations with WWA, see the “Decision Maker Take 5” at [http://www.climate.gov/news-features/decision-makers-take-5/laura-briefer-talks-about-preparing-salt-lake-city’s-water](http://www.climate.gov/news-features/decision-makers-take-5/laura-briefer-talks-about-preparing-salt-lake-city’s-water).

**The Nature Conservancy: Using WWA’s Climate Guidance to Select Restoration Targets**

Imtiaz Rangwala has been working directly with The Nature Conservancy (TNC) on conservation projects in Colorado’s Gunnison River Basin. As part of these efforts, he has provided guidance derived from climate projections regarding the future viability of wet meadows critical to sage grouse habitat in the basin. Using this information, TNC and its partners have made decisions regarding the specific location of wet meadow restoration projects (Figure 2).
Navajo Nation: Considering WWA Climate Report in Adaptation Planning

In consultation with the Navajo Nation and in conjunction with the National Integrated Drought Information System (NIDIS) and the Getches-Wilkinson Center for Natural Resources, Energy, and the Environment, Julie Nania and Karen Cozzetto developed a report entitled “Considerations for Climate Change and Variability Adaptation on the Navajo Nation.” This report provides a synthesis of climate-related information intended to be used for adaptation planning by the Navajo Nation. Along with information on potential impacts across a variety of sectors, Cozzetto and Nania’s report includes guidance on developing and implementing adaptation planning processes. The Navajo Nation is currently reviewing this information as it determines how to proceed with climate adaptation efforts.

Figure 2. WWA’s Imtiaz Rangwala (far left) joins others from The Nature Conservancy-led restoration efforts. Rangwala’s climate projection guidance aided in the selection of restoration projects.
WWA 2013-2014 Publication Highlights


WWA Metrics of Success

WWA is in the process of developing a new strategic plan. As part of this effort, we are revising the metrics used by the program to evaluate outputs and outcomes. Generally speaking, however, our new metrics of success will fall into three broad categories: knowledge production, learning and engagement, and knowledge networks. Likely outcomes to be assessed include changes in understanding, expansion of the knowledge network, resources conserved/saved, resources lost, money saved or lost, decisions or policies made, and new relationships forged.

Knowledge Production: Metrics in this category will be used to quantify and characterize the kinds of outputs we produce, their salience and credibility, the impacts our outputs have according to standard bibliometric measures, the degree to which the outputs reflect interdisciplinary scholarship, and the degree to which they integrate physical/social/natural sciences. Metrics will also characterize the spatial and temporal scale of the problem researched and how the outputs are intended to contribute in the decision process (e.g. from problem identification to policy implementation).
Learning and Engagement: Metrics in this category will be used to evaluate the ways in which knowledge outputs are produced, such as the degree to which intended users help to shape the research agenda, as well as how effectively WWA responds to users’ expressed needs. Metrics will also capture the different ways that WWA conducts outreach and education to the public and other researchers. Other metrics will attempt to characterize WWA’s role as a trusted source of information and its role in creating and leveraging social capital.

Knowledge Networks: Metrics in this category will characterize the scope of and change in WWA’s knowledge network, which includes WWA researchers, other RISA researchers, external researchers, decision makers, and other stakeholders.
New Projects

Weber Basin Climate Sensitivity Analysis

Primary Investigator(s): T. Bardsley
Stakeholders: Weber Basin Water Conservancy District, Utah Division of Water Resources
Partners: D. Rosenberg (Utah State University), M. Bekker (Brigham Young University), A. Wood (NCAR), M. Hobbins (NOAA ESRL PSD), D. Cole (Utah Div. of Water Resources), T. Adams (Utah Div. of Water Resources), C. Hasenyager (Utah Div. of Water Resources), J. Lhotak (NOAA NWS CBRFC), C. Peterson (NOAA NWS CBRFC)

Exploring climate change impacts on water supplies from the Weber River Basin.
This project came from a request by Weber Basin Water Conservancy district to explore climate change impacts to the Weber River water supply in collaboration with the Utah Division of Water Resources (UTDWR). UTDWR has developed a water supply model for the Weber River, which has been re-coded from the original Fortran to integrate into the Water Evaluation And Planning (WEAP) model by Utah State University (USU). The goal of the project is to develop relevant and defensible climate change scenarios and climate perturbed hydrologies, using the CBRFC model and evaluate impacts to the current operations of the Weber River system. Recently published tree-ring reconstructed streamflows may also be evaluated to explore extreme drought conditions beyond those in the observed record. The model will facilitate the exploration of a variety of new management, infrastructure, or demand changes to retain a resilient system. Initial work has focused on evaluating climate change sensitivities across multiple flow points on the Weber river and addressing evapotranspiration and model calibration.

Deliverables: Presentation and report to Weber Basin Water Conservancy District forthcoming
Leveraged Funding: In-kind staff efforts from NOAA Colorado Basin River Forecast Center, Utah State University, Brigham Young University, National Center for Atmospheric Research, and NOAA Earth Systems Research Laboratory Physical Sciences Division

Climate Support for Wasatch Mountain Accord

Primary Investigator(s): T. Bardsley
Stakeholders: Wasatch Mountain Accord group (http://www.mountainaccord.com)
Partners: Utah State University, Brigham Young University, US Forest Service

Synthesis and provision of credible climate information to inform the future consensus-based efforts of the Wasatch Mountain Accord.
The Mountain Accord is a long-range planning effort focused on the future of the central Wasatch Mountains and canyons. The Accord will use a systems approach to collaboratively optimize future scenarios across four areas – transportation, environment, economy, and recreation. WWA has participated in the environment systems group as well as smaller working groups on climate and water to coordinate relevant and credible climate information to inform the planning process. Anticipated deliverables are a white paper on observed and projected climate conditions to provide background for the each systems working group. Additional relevant climate information will be provided on request.

Deliverables: White paper on climate conditions delivered to group

Update of Climate Change in Colorado

Primary Investigator(s): J. Lukas
Stakeholders: Colorado Water Conservation Board; water managers and planners across the state of Colorado
Partners: Colorado Water Conservation Board

Comprehensive synthesis of observed and projected climate co-produced directly with the Colorado Water Conservation Board.
WWA is comprehensively updating and expanding their well-received 2008 Climate Change in Colorado report, also co-produced by WWA and the CWCB. The report synthesizes the best available climate science relevant to the state’s water resources. Like the original, the updated report covers the observed climate patterns and trends in Colorado, a primer on climate models, linking observed state trends with global changes, projections of future climate and hydrology, and guidance on using this information in planning and management. Several dozen stakeholders at the local, state, and federal levels reviewed or contributed to the updated report. One key area of updating was using the new CMIP5 global climate model output; for Colorado, CMIP5 shows a modest shift towards wetter projected precipitation outcomes compared to
the previous CMIP3 models. This presented a challenge: acknowledging the resulting shift in ensemble-average modeled runoff, while reaffirming the need to prepare for a broad range of hydrologic outcomes.

**Deliverables:** Final report expected to be released in summer 2014  
**Leveraged Funding:** $45,000 from Colorado Water Conservation Board

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**Rapid Response to the 2013 Colorado Front Range Flooding**

**Primary Investigator(s):** J. Lukas, K. Wolter  
**Partners:** M. Hoerling (NOAA ESRL PSD), K. Mahoney (NOAA ESRL PSD), N. Doesken (Colorado Climate Center)

Rapid analysis and synthesis of meteorological and hydrological conditions that led to the September 2013 flooding along Colorado’s Front Range.

The September 2013 flooding along Colorado’s Front Range demonstrated the capacity of WWA to respond rapidly to science information needs about an extreme climate event—one that personally impacted many on its team. The core deliverable was a four-page preliminary assessment that explained the large-scale weather patterns responsible for the rains, compared the precipitation and flooding to historic events, and discussed potential linkages to climate change. Just ten days after the rains ended, WWA released the assessment at a public briefing and panel discussion in the CIRES Auditorium, attended by 100 people onsite, including local and national media, and another 200 online. Feedback from water resource managers and other decision makers confirmed that the assessment provided useful and relevant information on this destructive event. The report was later reprinted in a slightly different form in Colorado Water, the magazine of the CSU Colorado Water Institute, which has a circulation of over 4,000 people. To follow up, WWA is planning a “one year later” briefing and panel discussion to highlight new research on the meteorology, hydrology, and climate attribution of the floods, to be convened in fall 2014.

**Deliverables:** Four-page assessment, seminar and webinar for public audience, multiple invited presentations  
**Leveraged Funding:** In-kind contributions from NOAA ESRL PSD, Colorado Climate Center

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**Regional 2013 Drought Briefing**

**Primary Investigator(s):** J. Lukas, L. Darby (NIDIS)  
**Stakeholders:** Regional decision makers (water, agriculture, others) and policy makers  
**Partners:** National Integrated Drought Information System

Real-time assessment of the development and use of stakeholder-oriented tree-ring paleohydrology research for water resource planning on the Wasatch Front.

The purpose of this project was to produce a concise, high-level briefing on rapidly expanding and intensifying drought conditions in June 2013 in the Upper Colorado River Basin and New Mexico. The briefing used text and graphics to convey recent precipitation and current drought conditions, agricultural impacts, runoff conditions and reservoir levels, and wildfire impacts. The briefing was similar to one co-produced by WWA and NIDIS in July 2012, and was disseminated through the WWA website and mail list, and through the NIDIS website (drought.gov). With a now well-established model, a new briefing could be quickly developed as future drought conditions call for it.

**Deliverables:** Two-page drought synthesis distributed to regional stakeholders

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**High-Resolution Meteorological and Hydrologic Data Extension to Trans-Boundary Basins in the Conterminous U.S., Southern Canada and Northern Mexico**

**Primary Investigator(s):** B. Livneh  
**Partners:** U.S. Bureau of Reclamation

Using hydrologic modeling to examine the influence of dust deposition and climate change on snowmelt, runoff timing, and volume in the Colorado River Basin.

The purpose of this project is to address questions related to Reclamation’s needs to improve existing methods of extreme precipitation estimation, as well as improved understanding of appropriate applications of model and reanalysis-based extreme precipitation data. This will involve extending the data development and model application methods featured in Livneh et al. (2013) to expand geographic coverage from contiguous U.S. to the North American Land Data Assimilation (NLDAS) domain. PI will document data and model development and demonstrate utility through evaluation of spatiotemporal statistics for temperature and precipitation, i.e. exceedance probabilities, frequency of extremes, and a comparison of drought characteristics relative to other dataset(s).
Deliverables: 1/16 degree gridded fields of daily precipitation, wind, and minimum and maximum temperatures over the NLDAS domain for the period 1950 – 2011; a daily hydrologically consistent dataset over NLDAS domain; documentation of data and model extensions
Leveraged Funding: $40,000 from U.S. Bureau of Reclamation

Colorado Climate Change Vulnerability Study

Primary Investigator(s): E. Gordon
Partners: D. Ojima (Colorado State University)

Overview of key climate-related vulnerabilities facing several sectors in the State of Colorado.

During its 2013 session, the Colorado Legislature passed HB 13-1293, which declared that "climate change presents serious, diverse, and ongoing issues for the state’s people, economy, and environment.” Among other provisions, the bill required a person appointed by the Governor to submit an annual report to a number of committees within the legislature “on climate change issues generally, the current climate action plan...and the specific ways in which climate change affects the state.” Multiple state agencies, including the Colorado Energy Office, the Colorado Department of Public Health and the Environment, and the Colorado Water Conservation Board are leading efforts to respond to this legislation and to meet the challenges of climate change in the state. To help meet this requirement, the Colorado Energy Office commissioned the University of Colorado Boulder (through the Western Water Assessment) and Colorado State University to complete a study providing an overview of the key vulnerabilities that climate change and climate vulnerability will pose for Colorado’s economy and resources.

Deliverables: Final Colorado Climate Change Vulnerability Study report expected in Summer 2014
Leveraged Funding: $73,500 from Colorado Energy Office

Evaluation of NIDIS Upper Colorado River Basin Drought Early Warning System

Primary Investigator(s): E. McNie
Stakeholder: National Integrated Drought Information System

Evaluation of utility of NIDIS’s first drought early warning system (DEWS) to provide lessons for other regional DEWS efforts.

This project entailed the development a comprehensive evaluation for the National Integrated Drought Information System Upper Colorado River Basin Drought Early Warning System (UCRB DEWS). PI completed scoping interviews with UCRB DEWS personnel, semi-structured interviews with sample of UCRB DEWS stakeholders, archival research, collection of analytics of webinar and web page use, and development of a comprehensive online survey of DEWS services and products. The survey was designed to be transferrable to other DEWS locations and programs. In process of finalizing first draft of evaluation report. PI also used this project for ongoing consultation on the development of a ‘Mid-Level Climate Services Evaluation Tool’ with the International Research Institute’s Climate and Society Program at Columbia University. Beta-tested this ‘mid-level tool’ with the evaluation project conducted for the National Integrated Drought Information System Upper Colorado River Drought Early Warning System. Feedback has been provided to IRI and collaboration continues with group to revise the tool.

Deliverables: Report on evaluation of UCRB DEWS expected in 2014

Evaluation of Western Water Assessment’s “Utah Model”

Primary Investigator(s): E. McNie
Stakeholders: WWA, NOAA RISA Program

Assessment of the preliminary results of WWA’s effort to expand its presence in Utah.

This project examines what WWA calls the ‘Utah Model’ (directly hiring a boundary professional to expand WWA’s geographic reach) and how this alternative approach to the traditional university-based model expanded WWA’s network and provided climate-related decision-support activities in novel ways. As with many RISA activities, the Utah Model is a work in progress, so findings are rather limited at this time. Furthermore, our sample size of stakeholders is very small so this case study should be viewed as the starting point for discussions about the role of RISAs within a broader decision-support community. Furthermore, our sample size of stakeholders is very small so this case study should be viewed as the starting point for discussions about the role of RISAs within a broader decision-support community, and not be construed as conclusive.

Deliverables: Report on “WWA’s The Utah Model” completed, to be posted on WWA website

Typology of Useful Science Approaches
**Primary Investigator(s):** E. McNie, D. Sarewitz (Arizona State University)

**Stakeholder:** Science policy community

**Development of a typology of research approaches related to user-inspired science.**

In collaboration with the Center for Science and Policy Outcomes at Arizona State University, PI is developing a typology of research approaches of user-inspired research in order to help shape research agendas to lead to the production of useful information for decision makers. The typology currently under development uses over 20 different variables in four categories to characterize knowledge, learning and engagement, power and politics, and organization design of research approaches to achieve different goals. This effort is supported financially by the Packard Foundation.

*Deliverables:* Final report expected in 2014  
*Leveraged Funding:* $5,000 from Packard Foundation

<table>
<thead>
<tr>
<th>Media Treatment of “Climate Change” in Shaping Colorado River Problems and Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Investigator(s):</strong> D. Kenney</td>
</tr>
</tbody>
</table>

**Analysis of media coverage of Colorado River issues shows relatively little discussion of climate change since 2000.**

The project reviewed newspaper coverage of Colorado River issues from 2000 to 2013 in order to identify the extent to which climate change is identified as a contributing factor to ongoing water shortages and, similarly, is a challenge to be addressed going forward. Two clear themes emerged from the analysis: (1) climate change is largely absent from the media coverage (mentioned in less than 10% of articles), although there was a slight uptick in the last few years of the study period; (2) to the extent that climate issues are mentioned, “acute drought” or “persistent drought” dominate, reflecting an ongoing preference amongst water managers and the media to view current issues as a temporary phenomenon rather than as a fundamental shift in regional hydroclimatology. These findings suggest an ongoing need for education about the existence and significance of climate change in the basin.

*Deliverables:* Final white paper completed in spring 2014

<table>
<thead>
<tr>
<th>Exploring Regional Climate Service Collaborations</th>
</tr>
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<tbody>
<tr>
<td><strong>Primary Investigator(s):</strong> K. Averyt</td>
</tr>
</tbody>
</table>

**Stakeholders:** Climate services community

**Partners:** J. Morisette (NC CSC), D. Ojima (NC CSC), L. Joyce (USDA Northern Plains Regional Hub), J. Derner (USDA Northern Plains Regional Hub)

**Analyzing and reporting on collaborations among three regional climate service entities to provide lessons learned.**

One challenge, and opportunity, facing WWA and the RISA program is the increasing interest in delivering climate services by Federal agencies other than NOAA. While the increased investment is encouraging, it creates some challenges, and questions emerging from leadership in the Executive Branch seeking definition of these different entities. Thus far, there has been difficulty addressing this question because of the highly adaptive nature of regional climate services. WWA, and others, are faced with navigating the field of federal authorizations, regional priorities, scientific expertise, budgets, and scientific expertise on the teams leading separate Federally funded climate service efforts. However, these challenging circumstances have given rise to success stories that highlight why climate services should be conceived, developed and focused on regional priorities. WWA is collaborating with the leaders of the North Central Climate Science Center and the new Northern Plains USDA Hub to craft a paper outlining how collaboration among these entities has worked in the past, how it is working now, and how future partnerships will work. The paper will demonstrate how the allowance of an adaptive framework is an important mechanism for ensuring the most efficient synergies among these entities as they strive to collaborate with decisionmakers.

*Deliverables:* Publication in prep

<table>
<thead>
<tr>
<th>Climate Science Support for the North Central Climate Science Center</th>
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</thead>
<tbody>
<tr>
<td><strong>Primary Investigator(s):</strong> K. Averyt, J. Barsugli</td>
</tr>
</tbody>
</table>

**Stakeholders:** Various in NC CSC stakeholder community

**Partners:** J. Morisette (NC CSC), D. Ojima (NC CSC),

**Providing climate science support for the DOI North Central Climate Science Center.**

Western Water Assessment is a partner with the North Central Climate Science Center (NCCSC), based at Colorado State University. Averyt serves as the CU Boulder representative to the University Consortia Team. The NCCSC is framing its research agenda and strategic in a framework termed ReVAMP (Resource for Vulnerability Assessment, Adaptation and Mitigation Planning). The implementation plan has three
parts: Climate Science, Impacts, and Vulnerability/Adaptation. Each has a science lead, and PI Barsugli serves as the lead for the Climate Science part of this effort. The NCCSC is leveraging the climate, hydrology and communication expertise within the WWA team to collaborate with their socio-ecological experts. WWA has funding from the NCCSC for a 2-year post doc who will focus on evapotranspiration questions relevant to both WWA and NCCSC interests.

Deliverables: Postdoc hire completed; direct climate science support for NC CSC projects; other deliverables to be determined.

### Ongoing and Completed Projects

#### Climate Adaptation Guidance for Salt Lake City Public Utilities

*Primary Investigator(s):* T. Bardsley  
*Stakeholder:* Salt Lake City Department of Public Utilities  
*Partners:* A. Wood (NCAR), L. Briefer (SLCPUD), J. Niermeyer (SLCPUD), M. Hobbins (NOAA ESRL PSD), S. Burian (University of Utah), E. Goharian (University of Utah), C. Strong (University of Utah), P. Stoker (University of Utah), J. Lhotak (NOAA CBRFC), C. Peterson (NOAA CBRFC)

**Working with the Salt Lake City Department of Public Utilities (SLCPUD) to help them assess the challenges that climate change presents to their water supply system.**

WWA’s Tim Bardsley has spearheaded a climate change assessment and adaptation planning effort for the Salt Lake City Department of Public Utilities. The results of this first phase of work, consisting of a water supply climate sensitivity analysis, was published as “Planning for an Uncertain Future: Climate Change Sensitivity Assessment towards Adaptation Planning for Public Water Supply” in a special edition of *Earth Interactions*. This paper produced numerous media hits and was cited as a prime example of local-level adaptation work by the White House Office of Science and Technology Policy. Ongoing efforts in this project include a pilot study on one of Salt Lake City’s watershed creeks, where a reservoir systems planning model has been developed. The model has recently been expanded to include the full water supply system. This systems model is currently being incorporated into an integrated water planning model. The planning model will facilitate more comprehensive assessments of changes in system reliability are being evaluated in combination with future water demand, supply, infrastructure, and management scenarios. To add to available information on climate impacts to water supplies, Bardsley will work with colleagues to integrate soon-to-be-available high-resolution dynamically downscaled climate projections, test an expanded integrated water planning model, and develop more advanced water supply and demand scenarios to evaluate a range of possible future impacts to water supply to assist in defining low-regrets management strategies.

*Deliverables:* 2013 publication of article in *Earth Interactions*; multiple stakeholder presentations; information directly transferred to SLCPUD  
*Leveraged Funding:* In-kind staff efforts from NOAA Colorado Basin River Forecast Center, University of Utah, National Center for Atmospheric Research, and NOAA Earth Systems Research Laboratory Physical Sciences Division

#### Project Evaluation for Stakeholder-Oriented Paleohydrology

*Primary Investigator(s):* T. Bardsley, J. Lukas  
*Stakeholders:* Water managers across the Wasatch Front urban corridor

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*Drought Dashboards*

*Primary Investigator(s):* W. Travis  
*Stakeholder:* National Integrated Drought Information System

 Prototyping new methods for visualizing socioeconomic indicators of drought.

Building on previous WWA work to identify appropriate socioeconomic indicators of drought, PIs sought in this project to explore visualization methods. The idea of creating “drought dashboards” is a prototyping effort aimed at developing the concepts, data, skills, tools, and prototypes for drought impact assessment via rapid analytics and dashboards. The development has been recorded in a white paper and the dashboard made available online at [http://public.tableausoftware.com/views/DroughtDashboard/AffectedPopulation](http://public.tableausoftware.com/views/DroughtDashboard/AffectedPopulation). Ongoing discussions will explore the utility of this approach for NIDIS.

This project examined hydrologic impacts of climate change and dust deposition on water resources in the Colorado River Basin.

Primary Investigator(s): J. Deems

Stakeholders: Water managers and planners throughout the Upper Colorado River Basin

Using hydrologic modeling to examine the influence of dust deposition and climate change on snowmelt, runoff timing, and volume in the Colorado River Basin.

This project examined hydrologic impacts of dust radiative forcing on snowmelt and climate change in the Upper Colorado River Basin (UCRB).
Deliverables: how such information can help stakeholders make better decisions. PIs are preparing a summary and analysis of the interviews and could play. We also will analyze the potential for the WWA snowpack physical science research to be usable in the CBFRC context and how such information can help stakeholders make better decisions. PIs are preparing a summary and analysis of the interviews which will be integrated with the survey results into a final white paper that will be shared with CBFRC and posted on the CBFRC website.

Deliverables: Peer-reviewed publication to be submitted in 2014

Analysis of Use of Information by Stakeholders of the Colorado Basin River Forecast Center

Primary Investigator(s): L. Dilling, R. Klein

Stakeholder: NOAA NWS Colorado Basin River Forecast Center

Effort to understand the flow of forecast information to stakeholders of the NOAA Colorado Basin River Forecast Center.

The Colorado Basin River Forecast Center (CBRFC) generates forecasts across the Colorado Basin and Utah including daily streamflow forecasts, long lead peak flow forecasts and water supply forecasts. Decision makers such as Denver Water, the Bureau of Reclamation, the Central Arizona Project, and the Colorado River District are some of the CBRFC stakeholders who use or potentially might use these forecasts. Previous research has found, however, that unless reliability and/or quality are threatened, water management agencies have little incentive to use forecasts (especially ensemble forecasts), and that forecast use correlates more with perceived risk than with forecast skill and reliability. A series of workshops with CBRFC stakeholders (facilitated through a previous WWA-CLIMAS project) assessed individual decision-making processes in order to see how stakeholders processed visual representations of streamflow data and forecasts and then used this information in decision making. One of the conclusions from the workshops was that a better understanding of the decision making process was needed (Werner et al. 2011). The Deems et al. “Snowmelt Perturbations” project falls within the research and operations part of the framework in that it is working to improve tools such as CBRFC forecasts. This project will augment the snowmelt research by obtaining a better understanding of both the CBRFC stakeholder decision making process as well as how WWA research can feed into this process. We will provide basic data on the stakeholders of the CBFRC, their climate-related decision making contexts, and the role that information does and could play. We also will analyze the potential for the WWA snowpack physical science research to be usable in the CBFRC context and how such information can help stakeholders make better decisions. PIs are preparing a summary and analysis of the interviews which will be integrated with the survey results into a final white paper that will be shared with CBFRC and posted on the WWA website.

Deliverables: Initial survey results presented to CBRFC; White paper to be completed in 2014
Understanding the impacts of electricity generation on freshwater resources in a warming world.

Pls have been actively publishing research exploring critical questions at the nexus between energy and water. Particular attention has been paid to the impacts of shifts in water resources on national and regional electricity generation. The research completed in 2012-13, and published through 2013 explores this issue on the national scale, in the ACT Basin, and in the greater Colorado River Basin. Further work showed that although power plants, on average, are not contributing to water stress, building a single thermoelectric plant can directly impact local water availability for other uses in a way that establishing a single farm cannot. Therefore, it is important to consider sensitivity of water resources when siting power plants. Currently, WWA is engaged in a project through the Joint Institute for Strategic Energy Analysis (JISEA), where Pls are mapping future electricity demands, future water demands, onto water availability as defined by 3 different climate scenarios derived from CMIP5 output. A paper is forthcoming and will be submitted in Summer/Fall 2014.


**Assessment of Climate Change in the Southwestern United States**


**Stakeholders:** Many potential climate-sensitive decision makers across NCA Southwest region

**Participating in the development of the Southwest Region Technical Input and other portions of the National Climate Assessment.**

After several years of effort, the National Climate Assessment was released in early May 2014. WWA made significant contributions to the process. K. Averyt was a lead author for the energy-water-land chapter, and K. Cozetto was a contributing author for the tribal regions chapter in the National document. But prior to publication of the final document, WWA supported the inception, development, and publication of the Technical Input to the Southwest Region. Over a dozen authors from the WWA Team were coordinating lead authors and lead authors for the document. Others on the WWA Team also contributed to additional technical inputs. For future work, WWA plans to engage in the ongoing assessment concept. The team expects to dovetail efforts at the federal level with state-based assessments. In coordination with the RISA Program Office, and other RISAs, WWA expects to learn more about the future of ongoing assessment.


**Understanding Utility Disincentives to Urban Outdoor Water Conservation as a Means of Adapting to Climate Change Pressures**

**Primary Investigator(s):** D. Kenney

**Stakeholders:** Municipal water managers and government officials responsible for establishing the administrative and financial framework within which municipal water management takes place

**Partners:** Ceres, Water Education Foundation

Investigation of how institutional incentives may affect the use of outdoor water conservation by water utilities as a climate adaptation strategy.

The project examined two constraints, or “disincentives,” that can preclude a municipal water agency from embracing demand management strategies as part of long-term climate change adaptation. The first, often described as “demand hardening,” is the concern that ongoing improvements in conservation remove the “slack” from a water system, thereby making it difficult to reduce further demand in the response to climate pressures or other stressors. Our research suggests this problem is more speculative than real at this time, and is a problem that can be addressed by ensuring that conserved water is primarily allocated to storage rather than as a baseline supply for new development.
The second issue is the water utility revenue instability that is associated with conservation, as reduced demands typically result in declining revenue streams for utilities. “Selling every drop” of water is good business for a utility, but is maladaptive from a climate standpoint. Removing this disincentive can require modifying the revenue model under which utilities operate, which is challenging in part because it involves changing rules that are beyond the control of the utilities themselves. In addition to a publication in a stakeholder-oriented journal, this project resulted in a March 2014 workshop with water utility Chief Financial Officers to explore and discuss these issues.


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Building Climate Science into Land and Water Conservation Planning and Decisionmaking in the American Southwest

Primary Investigator(s): W. Travis, I. Rangwala, J. Barsugli, G. Garfin (CLIMAS), E. Gordon
Stakeholders: The Nature Conservancy, others participating in Gunnison Basin conservation efforts
Partners: The Nature Conservancy, DOI/USGS North Central Climate Science Center, CLIMAS RISA

Project funded by intra-RISA competition will provide an opportunity to pilot new efforts to integrate climate science into conservation adaptation efforts developed by The Nature Conservancy in the Southwest.

Collaboration with Leveraged Project: Southwest Colorado Social Ecological Climate Resilience: The experience of the project personnel in the core effort helped Travis and Rangwala become part of a separate but linked DOI North Central CSC-funded project. Rangwala has been the lead climatologist on this project, which entails a collaboration among the Nature Conservancy (TNC) and its partners in the Gunnison Basin, San Juan Mountains and the Four Corners regions. He has developed landscape-scale climate scenarios from the CMIP5 global climate models for the region. These will be used by an ecologist and a social scientist, in conjunction with Rangwala, to develop narrative scenarios of future climate and its impacts. Next, the project scientists, in a collaborative process with land managers, will use these narrative scenarios to develop robust adaptation strategies that could work across these climate futures for a particular time horizon. Rangwala is developing “target-specific” climate scenarios for different systems targets selected in the project. This information will be collaboratively produced by integrating the expert and local knowledge of a specific target with the larger scale climate projections. It is expected that development of such information would be more actionable for the user community. Evaluate and improve methodologies for developing “actionable climate scenarios”:

- Rangwala has been working with Barsugli, Travis, Clifford, Betsy Neely (TNC), Renee Rondeau (Colorado Natural Heritage), Erin Towler (NCAR), Teresa Chapman (TNC), Laurie Young and Carina Wyborn (U. Montana), among others, to evaluate and improve the approach for developing more effective and actionable climate scenarios for resource management and conservation. Understanding local climate knowledge and its influence on decision making: Clifford designed a survey to probe local knowledge of climate and stakeholder climate information needs for application during a summer 2013 fieldwork season. The survey was approved by the university’s IRB for human subjects, and administered by Clifford in the field during July-August, 2013. Twenty-six of the 28 interviews were transcribed in their entirety using “intelligent verbatim” protocol to maintain the rich quality of each interview and correctly capture participants’ opinions and insights, while dispensing with non-essential words. These documents ranged from 1297 to 4310 words per interview transcript. Transcribed interviews were entered into the qualitative coding software, NVivo, and coded according hypotheses, interview topics and assumed themes. The a priori codes were built around the hypothesized structure of climate features, benchmarks and processes, that we expected interviewees to use when explaining experienced climate.

Deliverables: Direct guidance to TNC and its partners; AGU poster; K. Clifford Master’s Thesis
Leveraged Funding: $10,000 in travel and other support from TNC

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Climate Change Preparedness Among Tribal Communities in the American West

Primary Investigator(s): K. Cozzetto, J. Nania
Stakeholders: Navajo Nation
Partners: NIDIS, CLIMAS

Delivering climate guidance for the Navajo Nation as part of an effort to build stakeholder relationships with native communities and understanding tribes’ needs for relevant climate information to prepare for climate change.

In consultation with the Navajo Nation and in conjunction with the National Integrated Drought Information System (NIDIS) and the Getches-Wilkinson Center for Natural Resources, Energy, and the Environment, WWAs team members Julie Nania and Karen Cozzetto recently completed a report entitled “Considerations for Climate Change and Variability Adaptation on the Navajo Nation.” This report provides a synthesis of climate-related information intended to be used for adaptation planning by the Navajo Nation. Along with information on potential impacts across a variety of sectors, Cozzetto and Nania’s report includes an example adaptation planning and implementation process. The Navajo Nation is currently reviewing this information as it determines how to proceed with climate adaptation efforts.

Decisionmaking Under Hydro-Climatic Uncertainty

Primary Investigator(s): W. Travis, M. Huisenga

Development of models and other tools capable of understanding how decision deal with hydro-climatic uncertainty in climate adaptation, including response to droughts.

This project seeks to develop and apply decision analysis to adaptation of climate-sensitive activities in the WWA region. It fits in between vulnerability assessments and empirical studies of adaptation, providing a modeling “test bed” to develop hypothesis and test hypotheses about how decision makers might respond to climate variation and change in specific resource management systems. Particular attention is given to adaptation decisions in response to extreme climate events. The project effort is guided by attention to decision analysis and decision support in the latest National Climate Assessment. A proposal to increase effort on the climate risk and adaptation decisions modeling work focused on the role of extreme events in climate decision-making was submitted to the Risk and Decision, Risk and Management Sciences (DRMS) division of NSF in January, 2013.


Intermountain West Climate Dashboard

Primary Investigator(s): J. Lukas, E. Gordon, T. Bardsley, K. Wolter

Stakeholders: Water resources managers; anyone needing to monitor evolving weather, climate, and hydrologic conditions

Development of a new web resource providing updated regional climate information as soon as it is produced.

The Intermountain West Climate Dashboard made its debut in October 2012 as a prototype/replacement for the more staff-intensive yet less timely Intermountain West Climate Summary digest produced by WWA since 2005. It is a grid of 30 weather, climate and water information graphics that are automatically updated on the Dashboard as their providers update them. In the past year and a half, feedback from WWA stakeholders has indicated that the Dashboard is a very useful ‘one-stop shop’ for up-to-date climate and water information. And the creation of similar dashboards by other climate-service entities (e.g., Great Basin Climate Dashboard by WRCC and DRI/CNAP) is further confirmation of the effectiveness of this format. In the coming year, WWA plans to evaluate the Dashboard in the context of the increasingly similar product of the NIDIS Upper Colorado River Basin Drought Early Warning System (produced by the CSU Colorado Climate Center). The Intermountain West Climate Dashboard is at: http://wwa.colorado.edu/climate/dashboard.html

Deliverables: Intermountain West Climate Dashboard web resource (http://wwa.colorado.edu/climate/dashboard.html)
APPENDIX A: List of 2013-2014 WWA Publications


APPENDIX B: WWA Appearances in Media

May 13, 2014
"National Climate Assessment"
KGNU Radio - Boulder
Kristen Averyt

May 8, 2014
"How climate change is affecting Utah"
Salt Lake Tribune
Tim Bardsley

May 6, 2014
"Boulder scientists play key role in documenting climate change in U.S."
Daily Camera
Kristen Averyt

May 5, 2014
"New Report Aims to Help Navajo Nation Cope With Climate Change"
Indian Country
Karen Cozzetto

May 1, 2014
"Grass: American Obsession, Environmental Disaster"
Huffington Post
Kristen Averyt

April 27, 2014
"Dust on snow presents problems in runoff"
Daily Camera

April 10, 2014
"Sprawling Navajo Nation confronts climate change and 20-year drought"
ClimateWire

April 10, 2014
"New report summarizes climate considerations on Navajo Nation lands"
Phys.org
Karen Cozzetto
March 1, 2014
"Young preservationists get firsthand look at flood aftermath"
Daily Camera
Klaus Wolter

February 18, 2014
"Despite Fall Floods, Drought Persists in Southeastern Colorado"
NOAA’s Climate.gov
Western Water Assessment Study

February 6, 2014
"Lasers Help Scientists Get a Detailed Picture of the West's Snowpack"
Aspen Public Radio
Jeffrey Deems

February 5, 2014
"Scientists get a grip on snowpack"
Aspen Times
Jeffrey Deems

January 29, 2014
"Uncertainty a Big Hurdle in Colorado Climate Planning"
Climate Central
Eric Gordon

January 29, 2014
"Connecting the Drops: Water and Power"
KVNF News
James Meldrum

January 24, 2014
"Rising temperatures challenge Salt Lake City’s water supply"
YottaFire
Tim Bardsley

January 22, 2014
"WWA researchers discuss study at climate change roundtable"
NOAA’s Climate Program Office
WWA Researchers
January 5, 2014
"Colorado River Drought Forces a Painful Reckoning for States"
New York Times
Brad Udall

December 24, 2013
"Rising temperatures challenge Salt Lake City’s water supply"
The Almagest
Tim Bardsley

December 15, 2013
"Water Lines: Dust, higher temps may advance spring snowmelt"
Glenwood Springs Post Independent
Western Water Assessment

December 12, 2013
"10 Cities That Could Run Out Of Water"
The Weather Channel
Western Water Assessment

December 5, 2013
"These 11 Cities May Completely Run Out Of Water Sooner Than You Think"
The Huffington Post
Kristen Averyt

December 3, 2013
"New report seeks early warning system of abrupt climate change events"
Daily Camera
Kristen Averyt

December 2, 2013
"As Temperatures Rise, Salt Lake City Faces An Increasingly Dry Future"
The Weather Channel
Tim Bardsley

December 2, 2013
"DWR: forecast is for mostly dry California winter"
Western Farm Press
Klaus Wolter
November 29, 2013
"Warming and extreme dust could advance spring thaw in Colorado basin by 6 weeks"
NOAA’s Climate.gov
Jeffrey Deems

November 28, 2013
"Another Dry Winter?"
Mother Lode
Klaus Wolter

November 27, 2013
"Dust threatens Colorado’s water supply"
Colorado Public Radio
Jeffrey Deems

November 16, 2013
"Environment: ‘Extreme’ dust-on-snow events can speed runoff in Colorado River Basin by six weeks"
Summit County Citizens Voice
Jeffrey Deems

November 15, 2013
"Dust, warming portend dry future for Colorado River"
Aspen Business Journal
Jeffrey Deems

November 15, 2013
"Snowpack Dust Creates Problems for Colorado River"
Environmental News Network
Jeffrey Deems

November 14, 2013
"New study: Dust, warming portend dry future for the Colorado River"
University of Colorado News
Jeffrey Deems

November 6, 2013
"Salt Lake City water managers troubleshoot climate change with local data"
High Country News
Tim Bardsley
November 6, 2013
"Oklahoma vs. Texas (Water, Not Football)"
*National Geographic*
Western Water Assessment

November 6, 2013
"The Rundown: Examining the Effects of Rising Temperatures on Local Watersheds"
*KCPW Radio*
Tim Bardlsey

November 5, 2013
"Utah must prepare for impact of climate change"
*Salt Lake Tribune*
Tim Bardsley

November 5, 2013
"Episode 6: The Changing Face of Water Management"
*Utah Public Radio*
Tim Bardsley

November 5, 2013
"Climate change likely to affect streams that quench Salt Lake City's thirst"
*Environmental News Network*
Tim Bardsley

November 4, 2013
"Rising Temperatures Challenge Salt Lake City's Water Supply"
*Red Orbit*
Tim Bardsley

November 4, 2013
"Salt Lake City lays plans for dwindling water supply"
*E&E*
Tim Bardsley

November 2, 2013
"Warmer Temperature May Reduce Water Supply in Salt Lake City"
*Headlines & Global News*
Tim Bardsley
November 2, 2013
"Boulder climate change experts encouraged by Obama's actions"
Daily Camera
Tim Bardsley and Kristen Averyt

November 2, 2013
"Climate Change Will Significantly Deplete Salt Lake City's Water Supply for Every Degree Fahrenheit Risen"
University Herald
Tim Bardsley

November 2, 2013
"Rising temperatures may threaten Salt Lake City's water supply"
Science Recorder
Tim Bardsley

November 1, 2013
"Rising temps challenge Salt Lake City's water supply"
Boulder i Journal
Tim Bardsley

November 1, 2013
"Salt Lake City water managers prepare for a challenging future"
Salt Lake City Tribune
Tim Bardsley

November 1, 2013
"New study: Rising temperatures challenge Salt Lake City's water supply"
American Geophysical Union Press Release
Tim Bardsley

November 1, 2013
"Salt Lake City Mayor Appointed to White House Task Force on Climate Change"
KUER Radio
Tim Bardsley

November 1, 2013
"New study: Rising temperatures challenge Salt Lake City's water supply"
e! Science News
Tim Bardsley

**October 30, 2013**
"Two perspectives take on drought, water in West"
*Durango Herald*
Kristen Averyt and Imtiaz Rangwala

**October 28, 2013**
"How does the Colorado River drought stack up?"
*High Country News*
Jeff Lukas

**October 21, 2013**
"Caterpillar moth aside, when predicting winter weather, most left out in cold"
*The Grand Junction Daily Sentinel*
Klaus Wolter

**October 11, 2013**
"Colorado No Stranger To Flooding, Extreme Conditions"
*CBS News*
Kelly Mahoney

**October 9, 2013**
"More Water Stress than Meets the Eye"
*National Geographic*
Kristen Averyt

**October 8, 2013**
"Flood Forensics: Why Colorado's Floods Were So Destructive"
*Utah Public Radio*
Klaus Wolter

**October 8, 2013**
"What Trees Know about Drought"
*Utah Public Radio*
Western Water Assessment

**September 30, 2013**
"Warning: Many watersheds in US failing 'stress test'"
CNBC
Kristen Averyt

September 26, 2013
"Report: Colorado flooding was 'unprecedented'"
USA Today
Jeff Lukas

September 26, 2013
"Could the 'biblical' northern Colo. floods have been predicted?"
Climate Wire
Jeff Lukas and Klaus Wolter

September 25, 2013
"Were Colorado floods result of global warming? Probably not"
Christian Science Monitor
Jeff Lukas and Klaus Wolter

September 25, 2013
"Boulder storm summit: Questions linger among experts"
Daily Camera
Jeff Lukas and Klaus Wolter

September 25, 2013
"Almost One in 10 Watersheds 'Stressed,' Challenges Ahead for Utilities, Agriculture"
Bloomberg BNA
Kristen Averyt and James Meldrum

September 24, 2013
"Nearly One In 10 U.S. Watersheds Is 'Stressed'; Demand For Water Outpacing Supply: CIRES Study"
Huffington Post
Kristen Averyt

September 24, 2013
"Extreme weather: How unusual were September's floods?"
Denver iJournal
Jeff Lukas
September 23, 2013
"Climate change to pose new challenges for already-stressed Western watersheds"
*Climate Wire*
James Meldrum

September 20, 2013
"What Is the Climate Change Context behind the Colorado Floods?"
*Scientific American*
Joe Barsugli

September 19, 2013
"1 in 10 Watersheds in the Continental US Stressed with Number Likely to Grow"
*Nature World News*
Kristen Averyt and James Meldrum

September 18, 2013
"Today's worst watershed stresses may become the new normal, study finds"
*University of Colorado Boulder Press Release*
Also appeared in *Aspen Business Journal* and *Earth Sky*
Kristen Averyt and James Meldrum

September 17, 2013
"WATER LINES: The silver lining — flood ends drought in northern Colorado"
*Grand Junction Post Independent*
WWA's Climate Dashboard

August 19, 2013
"Are reduced Colorado River releases a sign of things to come?"
*Environment & Energy Daily*
Balaji Rajagopalan and Jeff Lukas

August 13, 2013
"WATER LINES: Do recent rains mean the end of the drought?"
*Glenwood Springs Post Independent*
Western Water Assessment

August 13, 2013
"RMBL hosts panel discussion on future of the Gunnison Valley"
*Crested Butte News*
Imtiaz Rangwala
August 13, 2013
"Climate change talks hot, heavy"
_Gunnison Country Times_
Imtiaz Rangwala

August 12, 2013
"Meeting Energy Demands with Less Water"
_Colorado Matters_, Colorado Public Radio
Kristen Averyt

August 6, 2013
"Speakers Discuss Science Policy Challenges in the Water-Energy Nexus"
_Eos, Transactions American Geophysical Union_
Kristen Averyt

August 5, 2013
"What will happen when the cheap water and power run out in Arizona?"
_Phoenix Business Journal_
Kristen Averyt

July 28, 2013
"Is it time to panic over lack of water?"
_Durango Herald_
Jeff Lukas

July 16, 2013
"Power plants that need water might be at risk"
_Toledo Blade_
Kristen Averyt

July 9, 2013
"Water worries: Climate change in the desert Southwest"
_USA Today_
Various WWA members

June 26, 2013
"Study: Colorado River vulnerable to 'megadrought'"
_The Coloradoan_
Brad Udall
April 19, 2013
"Southwestern dust found in snow across Colo. mtns"
The Denver Post
Jeffrey Deems

March 20, 2013
"Expert to talk 'strange bedfellows"
The Durango Herald
Imtiaz Rangwala

January 30, 2013
"Water Demand for Energy to Double by 2035"
National Geographic Daily News
Kristen Averyt