Western Water Assessment

Below are descriptions of WWA's current and most recently completed projects, as will be discussed during the Stakeholder Meeting. These and other descriptions can also be found on our website at http://wwa.colorado.edu/projects.

Descriptions of Completed Projects from 2011-2012

Reconciling Projections of Future Flow in the Colorado River Basin

Primary Investigator

Brad Udall (bradley.udall@colorado.edu)

Reconciliation of climate data, scenarios, runoff sensitivities, and other information used by multiple groups projecting future flow in the Colorado River Basin with the intention of providing more useful outputs to water managers in the Southwest.

A number of studies including Seager et al. (2007), Christensen and Lettenmaier (2007), and Milly et al. (2005) suggest that substantial changes in runoff may occur over the next century in the Colorado River Basin. However, the range of estimated impacts on Colorado River discharge (all based on IPCC 2007 model runs) is large – from a low at 2050 of about 6% (Christensen and Lettenmaier 2007) to over 18% (Seager et al. 2007). Not surprisingly, the region's water managers view with great concern the potential for large changes in the flow of the Colorado River. Of even greater concern, though, has been the wide range of projections – as large as 45% in Hoerling and Eischeid (2007) by mid-century. To reduce that range, this multi-RISA, multi-agency effort to reconcile multiple approaches and datasets. This entailed a significant amount of coordination and collaboration usually not found in academic research. Efforts in 2011 and 2012 included evaluating alternative data sets, extending the datasets to the current year and conducting quality control, diagnosing reasons for differences in temperature sensitivities among climate models, reconciling climate scenarios, and evaluating Colorado River discharge sensitivities in regional climate models. A number of papers from this project have been accepted for publication and are either in press or in preparation.

Paleohydrology of the Lower Colorado River Basin

Principal Investigators

Jeff Lukas (lukas@colorado.edu)
Balaji Rajagopalan
Lisa Wade
Connie Woodhouse (U. of Arizona/CLIMAS)

Building on previous efforts to understand the natural long-term variability of the upper Colorado River basin through generation of paleohydrologic reconstructions of annual flows between Lees Ferry and Imperial Dam and the Gila River at its mouth.

This project was initiated at the direction of a WWA stakeholder: Eric Kuhn from the Colorado River Water Conservation District, which has supported the project with District funds and also motivated the Colorado Water Institute's support of the project. In 2011, datasets from 66 tree-ring chronologies were compiled and a naturalized annual flow for the Gila at its mouth was generated based on the chronologies and other sources.

These efforts so far have allowed WWA researchers to identify key hydroclimatic drivers and management influences in the Lower Colorado River Basin. Perhaps the most interesting discovery, part of the untangling of the complex hydrology of the Gila River basin, has been identifying the incredible variation in the historic natural flows at the mouth–some 50-fold from under 0.1 MAF (million acre-feet) to over 5 MAF. The tree-ring reconstructions are largely able to capture this historic-period variation, and they also estimate yet higher extreme annual flows prior to 1900.

Climate Science Support for Vulnerability Assessment of the Gunnison Basin

Principal Investigator

Joe Barsugli (joseph.barsugli@colorado.edu)

Providing climate science support and guidance for a multi-stakeholder effort to assess climate change vulnerability in the Gunnison River Basin.

Throughout 2011, WWA researcher Joe Barsugli provided climate science support and guidance to a landscape-scale climate change vulnerability assessment effort led by The Nature Conservancy. This assessment was developed explicitly for the Gunnison Climate Working Group, a collaboration among public and private stakeholders interested in building ecosystem resilience in the basin. Barsugli's efforts focused in particular on guiding the selection and use of climate models and relevant climate and hydrologic data used to determine the relative future vulnerability of 24 ecosystems in the Gunnison Basin. These efforts were compiled into a report (Neely et al. 2011) that will serve as the basis for future collaborative resilience management efforts and as a pilot for other landscape-scale assessments initiated by The Nature Conservancy.

Framework for Colorado River Water Availability Assessment

Primary Investigators

Balaji Rajagopalan (balajir@colorado.edu)
Andrew Verdin

Investigation of storage reliability in the Colorado River Basin under multiple scenarios of flow reduction due to climate change.

Rajagopalan et al. (2009) found that under a climate change scenario of 20% reduced annual flow in the Colorado River by 2057 there is a nearly ten-fold increase in the probability of reservoirs being depleted annually by 2057. That study also suggested that flexibility in current management practices could mitigate some of the increased risk from climate change-induced reductions in flows. To further investigate this possibility, current work is examining the amount of water available in the basin and the associated reliability for a given amount of storage. Preliminary research findings in 2011 show that reliability of the Colorado River Basin water management system drops dramatically with even small increases in the amount of water yield needed. For example, under natural variability of streamflow, the reliability is quite high (~97%) for a yield of 12.67 million acre-free (MAF) but it drops to 80-85% for 13.5 MAF and substantially lower for 15MAF. In addition, storage in the upper reservoir (Lake Powell) appears to be higher than the lower reservoir (Lake Mead) when the equalization condition is relaxed, which is especially striking for flow scenarios under climate change. Furthermore, total yield is higher when equalization is relaxed, indicating the benefits of storing more water in Lake Powell due to a lower evaporation rate. Doing so, however, is not permitted under the current policy of equalization.

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

Primary Investigator

Doug Kenney (douglas.kenney@colorado.edu)

Assessment of outdoor water conservation through an investigation of whether 1) outdoor conservation could be incentivized through the application of alternative revenue models from other industries, including the electricity sector; and 2) hardening demand by reducing "slack" in residential water systems is a threat to supply reliability.

For both halves of this project (i.e., the revenue model and the demand hardening focus areas), literature has been compiled and reviewed. Informal interviews on these subjects have occurred in several settings, but given the lack of tangible data or experience on either issue, most water managers have had relatively little to say to augment the findings already documented in the literature. The most interesting finding is that the electricity sector has roughly 30 years of experimentation and research on alternative revenue models, yet these models remain completely foreign to most individuals in the water sector. Thus, there is a tremendous opportunity for transferring lessons.

Assessing the Utility of Regional Climate-Driven Water Quality Modeling in the Intermountain West

Primary Investigator

Jimmy McCutchan (james.mccutchan@colorado.edu)

Other Research Personnel

Mary Huisenga

Understanding stakeholders' needs for climate-drive water quality modeling at regional and other scales and assessing the utility of existing regional water quality and climate models.

Due to the complex interactions among factors affecting many aspects of water quality, the effects of climate change on water quality can sometimes be counterintuitive and are best evaluated through modeling. Before beginning modeling work, however, PIs focused on understanding what dischargers, government agencies, and other groups would find most useful in water quality modeling. A survey of 105 stakeholders working in water supply, water treatment and water quality regulation showed that respondents were most interested in nutrients, algae, pH, and temperature. Respondents also expressed general interest in water quality and in some specific water-quality variables that may be affected by climate, but many respondents also requested information on expectations for climate variability and hydrologic responses to climate change (e.g., how much change in timing or amount of discharge can be expected). Thus, enhanced climate literacy will likely make it easier to explain and understand the potential effects of climate variation on water quality. Aside from site-specific interests, there was considerable interest in headwaters (i.e., source areas) and transitional streams (i.e., foothills-plains transition). Ongoing work involves assembling a database of variables including discharge, temperature, nutrients, chlorophyll, dissolved oxygen, pH, conductivity to support modeling the effects of climate on water-quality in Colorado, Utah, and Wyoming. Efforts to date indicate that complex, mechanistic and semi-mechanistic models are well suited to some purposes, but that stakeholders prefer site-specific mass balance models when model results will be used to support regulatory decisions.

A Socioeconomic Impacts and Adaptation Strategies Clearinghouse

Principal Investigators

Bobbie Klein (roberta.klein@colorado.edu)
Bill Travis

Development of an online, searchable database to provide stakeholders with resources regarding socioeconomic impacts of climate change in the Western Water Assessment region.

This project entailed the creation of an online, searchable database of research on socioeconomic impacts of climate change in the Intermountain West. It has been populated with more than 160 items, including peer- and non-peer-reviewed articles, reports, websites, presentations, etc. addressing the socioeconomic impacts of various climate phenomena. The items can be sorted by sector (e.g., agriculture, outdoor recreation–which can further be broken down by type of activity–and water), phenomenon (climate variability, climate change, drought, floods, fire, heat waves, extreme events), and any geographical location the item focuses on. In general, there is more literature about the socioeconomic impacts of climate variability and change on outdoor recreation than initially expected. In addition, researchers have crafted two separate white papers to capture the state of existing knowledge on socioeconomic impacts of drought in the West.

Tools for Assessing Urban Landscape Water Use Efficiency

Primary Investigator

Joanna Endter-Wada (joanna.endter-wada@usu.edu)

Spatial and temporal analyses of urban landscape water use patterns to provide municipalities and water suppliers with a better understanding of how landscape water use and conservation fit into the management of urban water supplies.

This project developed a tool to demonstrate a seasonal site-specific landscape irrigation ratio that compares estimated landscape water use (total metered use minus estimated indoor use over an irrigation season) with estimated landscape water need. This ratio is derived from the classification of remotely sensed airborne multispectral imagery and localized reference evapotranspiration rates modified by relevant landscape factors. Work conducted in 2011 and 2012 focused on refining software that automates this analysis and graphically displays ratios by locations (color coded by ranges the user can define) across an entire city or service area. In addition, the system is being tested with the Weber Basin Water Conservancy District. As water use data has been better incorporated into the software, assumptions (indoor water use, inclusion of parking strip) used in calculating the landscape irrigation ratio (LIR) have improved. The availability of monthly and/or hourly water consumption data enables more accurate definition of indoor water use utilizing winter consumption as a basis instead of an assumption based on average occupancy and water use. Inclusion of the parking strips in calculating landscape irrigation ratios has provided more accurate assessments of landscape water use, particularly in relation to small and/or corner lots. Current methodology for calculating water budgets is generally based upon landscaped area within a site's parcel boundaries, excluding the landscaped area in the parking strip, which residents nevertheless are required to maintain.

Building a Monitoring Network for the North Platte Headwaters at the Little Laramie River (Formerly Green River Headwaters Network)

Primary Investigator

Scott Miller (snmiller@uwyo.edu)

Design and installation of a monitoring network that will monitor a number of critical variables to understand the conversion of snow and rain to soil water, groundwater, and runoff.

In 2011, PI began the process of instrumenting the Little Laramie River from its headwaters to its confluence with

the Laramie River below the town of Laramie. The headwaters has been instrumented off and on over the past several decades by several scientists from University of Wyoming, the USFS in Fort Collins and others, making it an ideal location to carry out longer term research. The new network is an extension of on ongoing collaborative hydrologic monitoring and modeling effort in the Snowy Range facilitated by the PI. Sites were identified in fall 2011 and equipment has been ordered for installation in Fall 2012. An MS-level Graduate Research Assistant has been leveraged from state funds for this grant, and the student will assist in data management, database development and outreach / data dissemination. Continuing work entails setting up observation stations longitudinally down the river to continuously monitor stream discharge and temperature and partnering with other scientists collecting rainfall and climate data in order to better understand the fate and timing of snowmelt and rainfall with respect to its conversion to soil water, groundwater and ultimately runoff.

A Drought Impact and Vulnerability Indicator Suite

Primary Investigators

Bill Travis (wtravis@colorado.edu)
Bobbie Klein
Kristin Gangwer

Development of a visualization platform to examine a suite of key indicators of drought and other climate-related vulnerability at appropriate scales using both physical and social data.

Travis, Gangwer, and Klein assembled a set of agricultural, water supply, and ecological indicators of drought effects that go beyond precipitation, snowpack and runoff measures. Included in the initial roster are indicators such as inter-annual crop yield variation, abandoned cropland, agricultural disaster declarations, number of declared water shortages among a sample of small to medium size municipal supply systems, and wildfire area. This effort has been aimed at enhancing drought vulnerability analyses, similar to the study that fed into an update of Colorado's state drought response plan. PIs have used the Tableau data visualization software to develop a pilot "drought dashboard" capable of reflecting impacts of drought in real-time.

Boulder County Climate Change Preparedness Plan

Principal Investigators

Eric Gordon (esgordon@colorado.edu)
Joe Barsugli

Development of policy-oriented climate change adaptation plan for Boulder County and the City of Boulder, Colorado.

Climate change has the potential to exacerbate many of the challenges faced by Boulder County and its municipalities. These challenges include droughts, flash flooding, West Nile virus, heat waves, fire mitigation and fire protection, and increased road maintenance, among others. In light of this, WWA, together with Stratus Consulting and AMEC Earth & Environmental, was awarded a contract to develop an adaptation plan for the County of Boulder, Colorado and the municipalities contained within its borders. In addition to providing a needed service to the city and county where WWA is physically located, this project provides an opportunity for WWA to engage in on-the-ground adaptation planning efforts, which will feed back into WWA efforts to understand and improve adaptation practices across the Intermountain West region. WWA's specific contributions included drafting of a review of relevant science on climate projections and hydrologic impacts (Barsugli), drafting of a chapter on adaptation options for the water sector (Gordon) and co-authoring of the report's introduction and conclusion (Gordon). The draft report was completed in December 2011 and a final version will be considered by Boulder County Commissioners in October 2012.

Descriptions of Current Projects for 2012-2013

Drivers of Adaptation: A Comparative Analysis of Local Decision-Making in the American West

Principal Investigators

Lisa Dilling (ldilling@colorado.edu)
Krister Andersson

Other Research Personnel

John Berggren

Multi-year effort to systematically investigate the conditions under which local decision-makers in cities and large towns in Colorado, Utah, and Wyoming decide to adapt (or not) to increased climate-related risk and hazards, such as blizzards, tornadoes, and floods.

In 2011, the PIs developed and administered a semi-formal survey to over 140 individuals at the municipal level in 60 cities in Colorado, Utah and Wyoming. Interviews included three individuals for each city covering both elected and appointed positions. Survey questions asked about top priority areas, what natural hazards were seen as important, how municipalities have allocated resources to a given hazard, what types of plans exist and how they relate to implementation, impressions of memorable extreme events, where communities obtain information, how collaborations occur, how citizen groups are involved, and beliefs about climate change. In addition, researchers collected city policy documents and reviewed city websites for additional information. Preliminary findings indicate that while the acceptance of anthropogenic climate change widely varies among respondents, it does not appear to influence adaptation in any obvious way. In addition, results appear to show that municipalities that have experienced more disasters of greater magnitude tend to show greater adaptation. Work in 2012-2013 will entail in-depth case studies of three municipalities in each of the WWA states, with an emphasis on examining those that have done the most preparation and those that have done the least.

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

Principal Investigators

Lisa Dilling (ldilling@colorado.edu)

Other Research Personnel

Bobbie Klein

Assessment of the use of quantitative streamflow forecast information by Colorado Basin River Forecast Center stakeholders.

This project is aimed at developing a comprehensive understanding of the use of information by stakeholders of the NOAA/NWS Colorado Basin River Forecast Center (CBRFC). Through surveys and interviews, the researchers will assess the climate information needs of CBRFC stakeholders and how they do or do not use quantitative streamflow forecasts. This will provide 1) a better understanding of how water managers and others who use CBRFC forecasts deal with variability and 2) a context through which to view and understand the potential utility of the results of the "Snowmelt Perturbations in the Upper Colorado River Basin" project.

Snowmelt Perturbations in the Upper Colorado River Basin

Principal Investigators

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Noah Molotch
Carol Wessman
Joe Barsugli
Klaus Wolter

Other Research Personnel

Ben Livneh
Brian Buma
Dominik Schneider

A collaborative effort among snow hydrologists, an ecologist, weather and climate experts, and hydrologists at the NOAA Colorado Basin River Forecast Center (CBRFC) to better understand drivers of snow accumulation and melt in the Upper Colorado River Basin with the ultimate goal of improving CBRFC streamflow forecasts.

Over the past decade, the Upper Colorado River Basin has experienced unusual runoff patterns resulting in anomalously high errors in peak and daily streamflow forecasts. Water managers and hydrologic forecasters suspect that bark beetle infestations and/or increased dust deposition on snowpack might be causing these runoff anomalies, but to date there has been no concerted effort to understand the contributions of various snowmelt perturbations. A multidisciplinary team of WWA researchers with expertise in climatology, meteorology, snow hydrology, and landscape ecology is bringing a novel combination of methodologies to bear on this question. The team has assembled streamflow data, vegetation change maps, and snow-water equivalent reconstructions in preparation for running a comprehensive land-and-snow-hydrology model. Four test basins were selected based on dust and beetle impacts: low dust/high beetle (Fish Creek, Snake), intermediate dust/incipient beetle (Boulder) and high dust/very low beetle (Uncompahgre). Spatial inputs for a hydrology model (DHVSM) are being prepped, with one of the four basins complete and two others nearing completion. Compilation and analysis of metorologic data and streamflow records for each basin have begun. Daily USGS streamgage and NRCS SNOTEL data are being processed and analyzed for all four watersheds. Phenologic maps have been created for Colorado and parts of WY, NM, and AZ (250,000km^2) for input into DHVSM. MODIS NDVI-based growing season metrics include the observed start-of -season, end-of-season, and length-of-season since 2000 at 250m resolution. PIs are currently analyzing and mapping changes in these metrics through the record. MODIS-based Leaf Area Index (LAI) has been compiled for years 2002-2010 and processed for both mean and max summer LAI values. All of these metrics, representing vegetative water usage related to growth/death and evapotranspiration, will improve modeling of the influence of vegetation and the impact of disturbances such as the MPB on the hydrology of the region. The ultimate goal of this multi-year effort is to provide usable information to improve streamflow forecasting at the NOAA Colorado River Basin Forecast Center (CBRFC).

Building Climate Science into Land and Water Conservation Planning and Decision-Making in the American Southwest

Principal Investigator

Bill Travis (wtravis@colorado.edu)

Other Research Personnel

Joe Barsugli
Eric Gordon

Multi-year effort to provide WWA-based expertise in climate science to help advance conservation efforts by The Nature Conservancy in moving beyond vulnerability assessments and into adaptation planning.
This project will entail connecting the climate expertise of two RISA programs, the Western Water Assessment (WWA) and Climate Assessment for the Southwest (CLIMAS), with regional conservation planners and decision-makers through collaboration with The Nature Conservancy's (TNC) Southwest Climate Change Initiative (SWCCI) in order to improve climate adaptation planning and implementation by land managers in the American Southwest. A key challenge in this effort will be bringing climate knowledge to bear on the many habitat and species conservation efforts underway in the region and moving conservation projects beyond vulnerability assessments to adaptation planning and implementation. This project is intended to advance four goals: 1) expand translational science capacity in the region to support adaptation; 2) improve regional climate-sensitive conservation decision-making; 3) disseminate climate knowledge through conservation networks in the region; and 4) develop both a comprehensive evaluation of the project and a training curriculum for future personnel intending to engage in this type of work. The project as a whole is intended to prototype and develop a model for expanding the translational climate science capacity needed to move ecosystem management beyond vulnerability assessments and into on-the-ground decision-making for adaptation to climate variability and change.

Decision-Making Under Hydrologic Uncertainty

Principal Investigator
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Other Research Personnel
Mary Huisenga

Developing multiple computer models usable for exploring climate-related decision-making in the face of uncertainty.
This project builds on completed WWA work in order to explore decision-making in the face of hydrologic uncertainty. It will entail two separate efforts: 1) completing a prototype "drought indicators dashboard" the provides rich information on socioeconomic impacts of drought; 2) building on an existing farm decision model to develop additional decision-making models, potentially including wastewater and natural flows, urban stormwater, or ranchers and drought.

Assessment of Documented Needs for Climate Information in the Missouri River Basin

Principal Investigators
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Kristen Averyt

Other Research Personnel
John Berggren

Initial assessment of Missouri Basin stakeholder needs for information on impacts of climate variability and change.
By providing a broad overview of needs in the Missouri Basin, this effort can help guide federal investments in climate services for the basin by providing a blueprint for where services are needed the most. The examination of stakeholder needs involves developing a comprehensive list of documents where stakeholders have expressed the need for climate information within the Missouri River Basin, followed by a set of key stakeholder interviews aimed at filling in the gaps from the initial document review. Rather than beginning an assessment with the more

traditional formal interview process, this project began with a systematic examination of stakeholder needs for climate information as demonstrated in existing documentation. (This method was used effectively in a previous project cataloging needs throughout the Western Water Assessment RISA region.) Reviewing previously published documents allows for the development of an understanding of baseline climate related needs over an extended time period. Conducting this type of needs analysis prior to interviewing stakeholders also helps avoid fatigue among stakeholders, a recognized informal and formal impediment to engaging relevant stakeholders in developing necessary and applicable research portfolios. The output of this project is intended to inform future work by Doug Kluck, the NOAA Central Region Climate Services Director, in coordinating regional climate services.

Climate Change Preparedness Among Tribal Communities in the American West

Principal Investigator
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Affiliated Personnel
Julie Nania
Julie Teel Simmonds

Building new stakeholder relationships with native communities and understanding tribes' needs for relevant climate information and assistance to prepare for climate change.

Many tribes in the Southwest face pressing challenges that would be exacerbated by a warming climate, including persistent drought and land-cover change, while socioeconomic and historical factors may limit their adaptive capacity. This project seeks to understand tribal efforts towards climate adaptation while bringing university-based resources to bear on those efforts. Completed work includes the "Native Communities and Climate Change" database available at http://www.tribesandclimatechange.org and a culturally appropriate Tribal Energy Action and Climate Change Adaptation Reports in consultation with the Southern Ute Tribe and Navajo Nation in the Southwest. Ongoing work includes the development of relationships with tribal managers interested in drought mitigation, water conservation planning, or climate change information. The project will be completed in 2012 with a report on 1) how to transition knowledge and lessons learned to service partners and 2) the appropriate role of RISAs in addressing tribal issues within the region.

Water, Energy, and Climate Change: Freshwater Use by Power Plants in the United States

Principal Investigator
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Other Research Personnel
James Meldrum

Outlining the national water footprint of electricity generation and addressing regional vulnerabilities to climatically driven changes in water and energy resources both in the present and in the near future.

In November 2011, the first of two major reports on water and energy produced by the Union of Concerned Scientists in collaboration with WWA researcher Averyt, was released. ("Freshwater Use by US Power Plants: Electricity's Thirst for a Precious Resource," available at http://www.ucsusa.org/assets/documents/clean_energy/ew3/ew3-freshwater-use-by-us-power-plants.pdf). Initial work to assess water use by power plants across the US resulted in two major insights: 1) Data collected and

disseminated by the Energy Information Administration about water withdrawals and consumption is significantly flawed, and given that 41% of national water withdrawals are by power plants, these data gaps can create significant problems for those managing and planning for water resources; 2) Stress imposed on water systems by power plants is both a water quality and quantity issue. Additional work includes water stress analyses for multiple regions. Current work includes modeling efforts that consider water consumption under scenarios of different energy production and/or higher future temperatures.

Cross-Jurisdictional Water Marketing

Principal Investigator
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Other Researchers
Julie Nania

Synthesis of lessons learned about interstate water marketing in the American West.
Discussions about the possibility of cross-jurisdictional water marketing in the Colorado River Basin have resumed after breaking off in the 1990s. This project will examine what was learned during previous discussions and what is known about water markets to assess how this policy mechanism could improve adaptability. It will also involve the development of a centralized database of federally reserved water rights for tribes, including compilation of information on whether tribes in the Colorado River basin have quantified rights and whether those rights can be marketed or leased.

Adaptation Guidance for Salt Lake City Department of Public Utilities

Principal Investigator
Tim Bardsley (wwa.bardsley@gmail.com)

Continued work aimed at advancing climate change assessment and adaptation work conducted in conjunction with the Salt Lake City Department of Public Utilities.
In 2011, WWA, the Colorado Basin River Forecast Center (CBRFC), and the Salt Lake Department of Public Utilities (SLCDPU) began a collaborative effort to assess potential impacts of climate change to the Salt Lake City water supply and develop no-regrets adaptation strategies in advance of such impacts. Preliminary discussions and analyses have evaluated the sensitivity of water supply volume, timing, and water demand to changes in temperature and precipitation. Recently, the group has expanded to include collaborations with the University of Utah as well as a proposal funded through University of Massachusetts and the National Weather Service. Ongoing work will entail the development of climate sensitivity analyses for Salt Lake City's water supplies, including the development of future scenarios and an assessment of likely drivers of changes in water demand.

Experimental Climate Extension Services in Utah

Principal Investigator
Rob Gillies (robert.gillies@usu.edu)

Continuing effort by WWA researchers located at the Utah Climate Center to pilot small-scale climate services relevant to various stakeholders in Utah.

In 2011, PI Gillies and others at the Utah Climate Center developed multiple small-scale pilot climate services efforts. These included forecasts of first freezes intended to help orchard growers and better atmospheric inversion predictions intended to assist in air quality protection efforts. Continuing work will look for and address new small-scale, targeted needs for climate services and continue to build a foundation for more permanent climate extension capacity in Utah.

Project Evaluation for Stakeholder-Oriented Paleohydrology

Principal Investigators

Tim Bardsley (wwa.bardsley@gmail.com)
Jeff Lukas

Real-time longitudinal investigation of the process by which new dendochronological information is incorporated into water management across the Wasatch Front.
A research team led by the Wasatch Dendroclimatology Research Group (WADR) at Utah State University are in the process of developing proxy hydrology records from tree rings for Wasatch Front creeks in order to provide water managers with a longer period of record to aid in planning. The WADR group is carrying out their technical work and stakeholder interactions following an earlier model developed by Connie Woodhouse and Jeff Lukas in Colorado. WWA intends to follow this effort through a real-time, longitudinal tracking of the process and interactions between the WADR research team and water managers to gain insights into the challenges, capabilities, and limitations in the incorporation of tree-ring data into planning processes. PIs will also compare the research-stakeholder interactions on the Wasatch Front with those that were documented in Colorado in Rice et al. (2009) to see if any cross-regional differences can be observed and then examined. Ultimately, this project is intended to improve the co-production of knowledge between researchers and decision-makers in water resources.

Climate Training for Water Managers

Primary Investigators

Eric Gordon (esgordon@colorado.edu)
Brad Udall
Joe Barsugli

Work in conjunction with the Bureau of Reclamation to engage the UCAR COMET program in establishing a training curriculum that will increase the ability of technical practitioners to incorporate climate change information in the studies they conduct that inform water and water related resource management decisions.
Based on the multi-agency report "Addressing Climate Change in Long-Term Water Resources Planning and Management – User Needs for Improving Tools and Information," WWA, the Bureau of Reclamation, and others identified the need to develop rigorous technical training aimed at helping water resource managers use climate information to study future water availability issues. After the creation a core team including experts from the Bureau of Reclamation, WWA, US Army Corps of Engineers, EPA, and Denver Water, the UCAR COMET program was engaged to develop online curriculum modules and training workshops as part of overall professional curriculum units. Online training modules are nearly complete, with two in-residence workshops planned for early 2013.