

# **FINAL REPORT**

## **Water, Drought and Wyoming's Climate**

Workshop held on October 5, 2006  
American Heritage Center, University of Wyoming  
Laramie, Wyoming

Sponsored by  
**Wyoming Water Development Commission, Western Water Assessment,  
University of Wyoming's Ruckelshaus Institute of Environment and  
Natural Resources, UW Department of Geography, UW Department of  
Civil and Architectural Engineering, UW Office of Research and  
Economic Development, UW Office of Water Programs, UW Ecology  
Program, Wyoming Water Resources Data System, and Wyoming  
Geographical Information Science Center**

November 30, 2006

*The views expressed in this report do not necessarily reflect the views  
or positions of the sponsoring organizations.*

## **Introduction**

A workshop on **Water, Drought and Wyoming's Climate** was held on October 5, 2006 at the University of Wyoming (UW). UW faculty members and the Ruckelshaus Institute of Environment and Natural Resources at UW organized the workshop, in consultation with the Wyoming Water Development Commission (WWDC) and the Western Water Assessment (WWA). This workshop built upon a meeting held in Cheyenne in December, 2005, hosted by the WWA, a Regional Integrated Sciences and Assessment program that is part of the NOAA-Climate Program Office dedicated to creating research opportunities and product development to help stakeholders make decisions in the face of climate variability and change, using experts from NOAA and partner institutions like UW. Participants at the December meeting, including state agencies, municipalities, irrigation districts, and UW, agreed that a follow-up workshop was needed to bring together science and water resources experts to focus on the implications of climate variability and climate change in Wyoming, and on issues and resource management needs in Wyoming.

The target audience for the October workshop included county, city, state, and federal water resource managers, climate and water resource scientists, ranchers, land-use and fisheries managers, and non-governmental organizations within the state of Wyoming. The objectives were to:

- Communicate current understanding of climate variability and climate change as it relates to Wyoming's water;
- Discuss needs of water resource managers and other stakeholders in Wyoming in the context of an ever-changing climate and water resource needs; and
- Facilitate discussion between water managers, water users, and researchers to develop future collaborations among participants to find answers, suggest solutions and address anticipated needs within Wyoming.

## **Water, Drought and Wyoming's Climate Workshop Activities**

### **Attendees**

Seventy-seven participants attended the workshop, including representatives from the Wyoming State Engineers Office (SEO), WWDC, WWA, Water Resources Data System (WRDS), City of Cheyenne, Laramie Rivers Conservation District, Green River/Rock Springs/Sweetwater County Joint Powers Water Board, U.S. Geological Survey (USGS), Wyoming State Treasurers Office, Wyoming Game and Fish Department, NOAA, National Weather Service (NWS), The Wilderness Society, Wyoming Stock Growers Association, Wyoming Public Health Lab, Family Farm Alliance, Wyoming Department of Environmental Quality (DEQ), U.S. Senator Craig Thomas' Office, Governor Freudenthal's Office, Weyerhaeuser Company, Wyoming Board of Control, Public Policy

Research Institute, Ruckelshaus Institute Board, and UW departments of Geography, Geology and Geophysics, Civil and Architectural Engineering, Botany, Agricultural and Applied Economics, and Renewable Resources.

### Opening Remarks

Dr. Harold Bergman, Director of UW's Haub School and Ruckelshaus Institute of Environment and Natural Resources, welcomed everyone and noted that this workshop may be part of a multi-step process to connect UW research to needs of the state and region with respect to water management. Where do water users, managers and researchers need to work to prepare Wyoming for future water needs? He noted that the goal of this workshop is not to usurp the Governor's Drought Management Task Force. Rather, it is hoped that this meeting will lead to other workshops and conferences, additional research at UW, and possible management strategies. With many conferences about this particular topic in the West, one goal for this workshop is a list of priorities for Wyoming in regards to water, drought and climate in the state. The outcomes of this workshop also will be a focus of discussion for the Ruckelshaus Institute Board meeting on Friday, October 6, 2006.

Mike Besson, Director of the WWDC, pointed out that whatever is happening in terms of climate (e.g., global warming), we need to be prepared. In particular, 85 percent of water used in Wyoming is for agricultural irrigation, however, over the last 20 years, Wyoming has spent \$70 million on drinking water for cities, towns and rural areas. One issue for agriculture is reservoirs. The biggest reservoir of all, snowpack, is now running off 30 to 45 days sooner than in the past. Agricultural producers are impacted the most by this, especially if they do not have upstream storage. He identified three challenges for workshop participants:

1. the change in timing of snowpack runoff;
2. reducing water consumption related to energy production; and
3. the impact of population growth with respect to groundwater resources.

First, there is a need to discuss how we address the change in timing of snowpack runoff and its impacts on upstream storage. The WWDC has increased their grant package through the legislature to be able to spread out water use, spread out return flows, and create more water to go downstream. Additional storage is needed to hold more water to be regulated for multiple uses as well as efficient sprinklers to maximize irrigation return flow. Aquifer storage and retrieval needs to be considered, as some are doing in Arizona, which can provide additional benefit for times when water is scarce. The second challenge was to identify ways to save water. With regards to energy consumption and use, coal fired power plants use a lot of water, where wind generation does not. We in Wyoming need to look at all of our energy resources, not just carbon fuels. UW needs to help with the transition between fossil fuels and fuels of the future. The third challenge was the additional demand on Wyoming's water that comes with population growth. The WWDC is attempting to quantify where good groundwater resources are. There is a need for good groundwater modeling and determining areas of recharge. UW can help with that as well as measurement of consumptive use in order to assist managers with allocating resources.

## What We Know and Wish We Knew About Wyoming's Changing Climate

Dr. Stephen Gray, Wyoming State Climatologist and Director of WRDS, presented the current state of understanding on climate change and climate variability and the future of water management in Wyoming. Wyoming is in the 7<sup>th</sup> to 8<sup>th</sup> year of a severe drought, much like in the 1950's, highlighting our vulnerability to our dependence on water. There are some items where there is a scientific consensus that we need to pay attention to and focus on for management of water that could make us less vulnerable regardless of the source of climate change. Below is a summary of Dr. Gray's presentation. The full presentation is available online:

<http://www.uwyo.edu/enr/WaterClimateConfFall2006/SteveGrayWyoClimateOverview.pdf>

### **1. Multiple factors make water resources in Wyoming highly sensitive to climate change (natural or otherwise).**

Wyoming has a desert climate. While precipitation ranges from 6 inches/year in the low basins to 70-90 inches/year in some of the high mountains, 75 percent of the state receives less than 16 inches/year, making Wyoming the 5<sup>th</sup> driest state in the U.S. behind Nevada, Arizona, Utah, and New Mexico (compared to the national average of 37 inches/year).

### **2. The majority of WY surface water comes from a single source – snowpack.**

The wettest areas of Wyoming are usually above 10,000 feet, and these snow-dominated areas comprise only 7 percent of the land area. Thus a very small percentage of Wyoming land area is responsible for the majority of surface run off.

### **3. Wyoming is a headwaters state.**

Droughts in Wyoming's Upper Green River watershed, for example, affect the entire watershed. Impacts vary with the size of the watershed. Needless to say, we are subject to the needs of downstream, out of state users, setting the stage for difficult challenges in the future.

### **4. The Earth as a whole is getting warmer with an increase in mean average global temperatures.**

At least some of this increase is caused by human activities. There is very little agreement about what to do about this. What are the contributions of different human activities? Sources include burning of fossil fuels, land cover change, and urbanization. There is much uncertainty related to regional-scale effects of global climate change.

There is no scientific consensus on what will happen with precipitation as a result of continued warming. Using historical data, projections vary from wetter to drier than present.

Regardless of whether we know what is going to happen with precipitation as a result of continued warming, we do know it will get warmer. We will have to consider what that warming will mean for water resources. A slight change in growing season temperatures, for example, could have tremendous impacts in Wyoming.

Trends in the timing of spring snowmelt in western North America from 1948-2000 show a shift in runoff of 20-30 days (later in a few locations but mainly earlier). In Wyoming, we see less change than in other areas over the 50-year period, but in recent decades, peak runoff has moved considerably, occurring earlier in the spring. This trend is expected to continue into the future.

A shift in the peak runoff means quicker and earlier snowmelt, leading to diminished late season flows. In addition, a warmer climate means increased evaporation in reservoirs. Even a temperature increase of just 2 degrees during the growing season would enhance evaporation enough to negate even a 15-20 percent increase in precipitation.

Also, a small temperature increase would imply a shift in the ratio of snow versus rain as precipitation. If more precipitation comes as rain, this has major consequences for the snowpack and our hydrologic cycle.

## **5. Climate changes significantly over decadal time scales.**

Tree-ring studies of historical precipitation showing an 1100 year reconstruction of flow in the Upper Colorado River basin reveal conditions ranging from very dry to very wet (compared to the long-term mean). Historically, conditions were much dryer at times than what we see today and there wasn't the huge combustion of fossil fuels. Climate does vary naturally but whatever the cause, we need to be better prepared.

Clearly, Wyoming water resources are highly vulnerable to all types of climatic change. Even the most conservative scenarios for future climatic change could bring major impacts on Wyoming's water, and inherent natural variability can amplify (or dampen) the effects of future change. Three things to focus on for this workshop:

1. How do current management practices and policies make us more or less vulnerable to climatic change?
2. How will changing land use, land cover, and climate interact to impact regional hydrology?
3. A better understanding of current and potential future uses of water. Most of our water in Wyoming goes to agriculture. Is this expected to change much in the future?

## Needs Within Wyoming (Panel)

A panel representing federal, state, city, and agricultural viewpoints discussed needs within Wyoming with respect to understanding water, drought and climate change.

Kirk Miller, USGS Chief of Hydrologic Studies identified several key needs within Wyoming in terms of monitoring and investigation of water resources to address how and why water is being used within the state.

- Long-term, consistent, statewide monitoring networks.
  - Streamflow.
  - Groundwater levels.
  - Water quality.
  - The purpose of monitoring.
    - Establish “baseline.”
    - Identify trends.
    - Improve statistics.
    - Create databases.
- Multiple-process, multiple-scale water resource investigations.
  - Local (ground water/surface water interactions) and diffuse (regional) recharge.
  - Refined statistics and estimators for streamflow.
  - Use of water resources for energy development.
  - The purpose of these investigations.
    - Prioritize efforts.
    - Determine cause and effect.
    - Plan (or not?) for development.
    - Guide future monitoring.

Kirk Miller’s presentation is available online:

<http://www.uwyo.edu/enr/WaterClimateConfFall2006/KirkMillerUSGS.pdf>

Clint Bassett, City of Cheyenne Board of Public Utilities, identified strengths and weaknesses in using long-term outlooks in demand-side management. Snotel sites provide information on snow accumulation. We spend about a month of the year receiving water and the remainder of the year using that water. How can we better anticipate the annual demand considering that Cheyenne is completely dependent on snowpack for their water? Some of Cheyenne’s water comes from reservoirs in the Laramie Range, but a majority comes from snowpack quite a ways west of Cheyenne in the Snowy Range and Sierra Madre Range and is piped to Cheyenne.

- Water collection is a short term event, while consumption lasts all year round.
- Water collection relies heavily on snow for water, going multiple years on below average to little runoff.
- We can control collection structures and where water goes, but only if water is available.

- We have to plan ahead to be proactive to drought instead of reactive.
- Cheyenne models anticipate consumption and try to project where reservoir amounts will be in the coming year. When temperature increases, and/or precipitation decreases, water demand increases.
- There is a need for demand-side tools to be able to better predict demand with respect to supply.

Clint Bassett's presentation is available online:

<http://www.uwyo.edu/enr/WaterClimateConfFall2006/ClintBassettCheyenne.pdf>

Pat O'Toole, Rancher and President of the Family Farm Alliance, provided some key issues regarding water resources and drought from a users perspective. The Family Farm Alliance represents irrigators in 17 western states and participates in the policy side of water resources. They look to bring solutions to the policy discussion and get new management on the ground.

- Last year was the first time U.S. food imports exceeded U.S. food exports, and this trend likely will continue.
- Colorado projects 450,000 acres of irrigated land going out of production in the next 10 to 20 years. This land-use change has implications for water supply.
- Storage is extremely important. The Family Farm Alliance is looking at areas where water storage could be increased and have created a database of potential locations. Water must be retained in the upper basins to continue food production.
- Growth will impact our water in the west. City planners throughout the west see agriculture as a future reservoir for development.
- Some of Cheyenne's water comes from the Little Snake River. Ranchers thought they could give water to Cheyenne and get a reservoir out of the deal. It was a contentious issue and they feel like they have lost water.
- As a headwaters state, Wyoming can make decisions that will impact other states. We have the opportunity to be a leader in the future vision and right now we are a reservoir of growth for municipalities in other states.

Harry LaBonde, SEO, explained that the SEO mission is to provide for proper regulation, administration, management, and protection of Wyoming's waters. He discussed drought impacts in Wyoming, interstate impacts, reservoirs, and needs of the SEO.

- Drought impacts in Wyoming.
  - High drainages are going dry sooner and more drainages are being regulated as a result.
  - Drainages are being regulated sooner.
  - In some cases Territorial (pre-1890) water rights have been regulated off and there is not enough water to satisfy very senior rights.
- Interstate compacts.
  - Wyoming is party to seven interstate compacts and three interstate court decrees.

- Montana called for interstate regulations in 2004 and 2006 on the Tongue and Powder Rivers.
- North Platte River – Allocation years declared in 2002-2006 and 2007 is anticipated to be the same, depends on snowfall.
- Colorado River – a compact call from the lower states (never been done before) was narrowly avoided due to heavy precipitation in the lower basin in 2005.
- Reservoirs.
  - Reservoirs have functioned as designed and have mitigated the recent drought impacts.
  - Lake Powell percent of capacity has dropped over the last seven years from 94 percent (October 1999) to 49 percent (October 2006).
    - Lake Powell is important to upper basin states because we have obligations to provide a certain amount of water to Lake Powell.
    - Wyoming is studying uses of water in the Green River Basin in anticipation of being forced to curtail consumption to be able to meet compact obligations to lower basin states.
- Needs of the SEO.
  - Additional flow measurement of diversions.
  - Additional stream flow measurements.
  - Real-time data.
    - Radio.
    - Satellite.
  - Data serving via the web or auto attendant telephone systems.

Harry LaBonde's presentation is available online:

<http://www.uwyo.edu/enr/WaterClimateConfFall2006/HarryLaBondeSEO.pdf>

### Morning Break-out Groups

Workshop participants were divided into six facilitated break-out groups. The objective of the morning break-out session was to begin a conversation about climate and water related issues and concerns. Participants discussed:

- Concerns about water supply and how it is affected by climate.
- What types of data or forecasts would help them more effectively manage their water supply (e.g., snowpack monitoring, streamflow forecasts, understanding how snowpack is translated into streamflow)?
- What are some perceived drought risks and current responses?
- What could be done to reduce the impact of drought at home, work, or within the region?

Several major themes emerged from the morning break-out groups:

- 1) Tracking consumptive use.
  - Need to tie together land use and water planning in the face of uncertainties and inevitable conflicts.



- How much water is actually consumed in Wyoming?
  - How to measure consumptive use from agriculture?
- 2) Climate modeling and monitoring.
- Improvement of climate forecast models.
  - Need more data collection on climate in Wyoming.
  - Improvement of radar coverage beyond the two collection points of Cheyenne and Riverton.
- 3) The need to link surface water and groundwater monitoring.
- Drilling more groundwater wells during a drought and then continuing to rely on these new wells extends the impact of groundwater drawdown beyond the current dry period.
  - Data collection needs to be integrated among all state agencies.
- 4) Headwaters issues.
- Issues for Wyoming as an upper basin state in the face of drought that extends beyond the region.
  - Basic assumption has been that upper basin would be fine, but reality shows that there is much less water in the basin than anticipated.
  - Upper basin states bear the risk associated with the Colorado River Compact.
  - Wyoming needs to proceed by planning for developing what water we have.
  - Should or will western law and management concepts change?
- 5) Education and conservation.
- Need to educate people about issues and consequences of information presented in today's workshop (similar to Ruckelshaus Institute [Open Spaces Initiative publications](#)).
  - Public education needed from K-12 through the general populace and needs to address why we should use less water.
  - Conservation has to be part of the equation, from impacts on fisheries and wildlife to increased demand.
  - Conservation may be easier in municipal setting than in agricultural setting.
  - Municipal incentive programs (such as Cheyenne using wastewater in city parks).
  - Need forums where people doing work on water/climate/drought issues can share with each other.
  - Use of metering – if using a lot of water and are forced to pay, water use will likely fall.
  - Possibly increase permit fees to get added revenue.
  - Replace ditches with closed pipes.

## Available Climate Products

Dr. Andrea Ray, Research Scientist with the Physical Science Division of NOAA gave a brief presentation on available climate products and resources for understanding climate and how these resources can be utilized.

- The Intermountain West Climate Summary is a product designed to provide the latest climate information in a simple compact document aimed at water managers.
  - Provides climate information in the form of graphics, current conditions, forecasts, verifications, and articles.
  - [http://wwa.colorado.edu/products/forecasts\\_and\\_outlooks/intermountain\\_west\\_climate\\_summary/](http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary/).
- NOAA National Integrated Drought Information System is an education and outreach program aimed at engaging preparedness in communities.
- U.S. Drought Monitor – a synthesis of multiple indices, outlooks and news accounts, which represents a consensus of federal and academic scientists. Products include maps of U.S. regions with drought intensity and impact types. <http://drought.unl.edu/dm/monitor.html>.

Andrea Ray's presentation is available online:

<http://www.uwyo.edu/enr/WaterClimateConfFall2006/AndreaRayWWAOct06.pdf>

## Afternoon Break-out Groups

Participants returned to their initial six facilitated break-out groups. The objective of the afternoon break-out session was to narrow the focus to specific priorities, needs and opportunities. Participants identified short-term and long-term priorities as well as identifying individuals or agencies that may be able to contribute.

### *Short-term priorities*

- Assessment of current tools within the state (e.g. monitoring) – what's working and what's not (Governor's Drought Management Task Force).
- Baseline assessment of water consumption – a function of population and climate.
  - Better understanding of the link between climate and consumption.
    - Outreach/education.
    - Develop consistent framework for measurement.
    - Implement framework.
- Linking interagency information.
- Involving the public.
  - Rain gauge data collection, possibly expand to stream gauge.
- Need to enable market transfers.
- Involving the public.
  - Provide information resources for watershed planning groups (Ruckelshaus Institute).

### *Long-term priorities*

- Better understanding of groundwater/surface-water climate connections. (collaborative projects – SEO, DEQ, USGS, UW).
  - Use of groundwater in times of need.
  - Monitoring – what groundwater do we have.
- Education to improve public understanding of climate and drought (Governor’s Drought Task Force, Ruckelshaus Institute, UW Math and Science Teaching Center, Conservation Districts, NWS/NOAA, possible funding through National Science Foundation or US Department of Agriculture).
  - Emphasize the effects of drought.
  - Use economic examples to inform about drought impacts.
- Projecting consumptive use (WRDS, Ruckelshaus Institute).
- Improved interagency communication (Governor’s Drought Management Task Force, Ruckelshaus Institute, Conservation Districts).

### Possible Next Steps

Many participants pointed out the need to assess consumptive water use in light of the challenges faced in Wyoming with variable precipitation, snowfall, and timing of snow melt as a consequence of climate variability and climate change. In addition, as a headwaters state, Wyoming is bound by certain agreements to provide water to downstream states while also planning for the future needs within the state. These concerns potentially could be addressed with follow-up meetings that focus on some of the topics identified above. The Ruckelshaus Institute, in conjunction with federal, state, and local agencies, may be able to play a role in providing an information clearinghouse for climate, water, and drought related topics. Additional comments and suggestions from the participants are welcome.

This report, the workshop agenda, and presentations from the October 5, 2006 **Water, Drought, and Wyoming’s Climate Workshop** are available online: <http://www.uwyo.edu/enr/WyomingWater.asp>