WRITTEN TESTIMONY OF
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HEARING ON IMPACTS OF CLIMATE CHANGE ON WATER SUPPLY AND AVAILABILITY IN THE UNITED STATES

BEFORE THE
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COMMITTEE ON ENERGY AND NATURAL RESOURCES
U.S. SENATE

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Chairwoman Cantwell, Ranking Member Corker, my cousin Senator Smith, and other Members of the Committee, thank you for the opportunity to speak with you today on the impacts of climate change on water supply and availability in the United States.

My name is Brad Udall. I am the Director of the Western Water Assessment, an interdisciplinary Regional Integrated Science and Assessment (RISA) project funded by the NOAA Climate Program Office and a joint effort of the NOAA Earth System Research Laboratory and the University of Colorado. The eight RISAs around the country are innovative programs designed to connect climate science with decision makers. There are no other programs anywhere like these, and we are on the front line of dealing with requests for regional information on all aspects of climate variability and change.

Although I was invited to sit on a panel with scientists, I am not a scientist. I am an engineer by training and I have an MBA. During the last four years of my life I have been embedded with scientists at the largest NOAA laboratory in the country where I have had the opportunity to learn about climate from scientists while providing them with a real world view of water management. It has been a fabulous and life changing experience. Formerly, I was a principal at a consulting engineer firm. In preparing this testimony I talked to scientists, water managers, and consulting engineers. Many were eager to share their thoughts on this important topic.

All water planning is based on the idea of a static climate. Normal engineering practice for designing water supply and flood control projects is to plan as if the future will look like the past. However, we now know that our future climate will not look like the past, and that in addition to warmer temperatures the normal patterns of water movement around the globe will change. This is because the water cycle redistributes heat from the equator to the poles-- and it is this movement of heat and water that determines our weather and climate. As the planet warms, these relationships will change, and the water cycle will adjust with potentially large impacts on humans.

This fundamental fact has profound implications for water management. The novelist T. Morris Longstreth once wrote, “Of course we weren’t lost. We were merely where we shouldn’t have been without knowing where that was.” This is the position water managers find

themselves in today. As we move forward, all water management actions based on "normal" as defined by the twentieth century will increasingly turn out to be bad bets.

I would like to discuss three issues concerning adaptation to climate variability and change today. The first is the serious situation due to drought and increasing demands that has developed on the Colorado River which climate change threatens to make far worse. The second is my concern about how our national climate change scientific enterprise is being managed, and the third is the need to devote more scientific resources to meeting the needs of decision makers, almost all of whom have a regional or local focus.

The Situation on the Colorado River

Please indulge me in a small bit of family history. My great-great grandfather John D. Lee was asked by Brigham Young to found what is now called Lee's Ferry, the all-important dividing line on the Colorado River between the Upper Basin and the Lower Basin in the 1922 Colorado River Compact. My great-grandfather and my grandfather farmed on the banks of the Little Colorado River in northeastern Arizona. My father, Morris Udall, was part of the Arizona delegation that passed the Central Arizona Project Act in 1968 which now moves large quantities of Colorado River water over 300 miles and 3000 vertical feet to Phoenix and Tucson. And during the course of my life I have been both a Grand Canyon River Guide and a water engineer.

I care deeply about this river which affects 30 million people in seven states and faces an uncertain future even without climate change. The population of the American Southwest is the fastest growing of anywhere in the nation. The recent drought, which has featured extended low flows not seen in the 100-year gauged record, has resulted in the loss 30 million acre-feet of water, the equivalent of two years of annual flow and half of the maximum total storage. The two largest reservoirs, Lakes Mead and Powell, are now approximately half full. Lake Mead is currently losing 1.4 million acre-feet per year, and contains only 10 years of water at this rate of loss[1] because the Lower Basin states have grown accustomed to using excess water from the Upper Basin, water that may not be there in the future under either climate variability or under climate change. According to Reclamation modeling, even under average historical hydrology Lake Mead never refills and Lake Powell takes decades to refill.

With climate change the picture is even more troubling. The West in general is experiencing warmer springs, reduced snowpack, and earlier runoff[2]. The Colorado River basin has warmed approximately 2ºF since 1976[3]. Recent studies on the Colorado River indicate that the basin is

[1] With Lake Powell at about 50% of capacity, current operating practice is to release 8.23 million acre-feet (maf) to Lake Mead which combines with approximately 750,000 acre-feet of tributary inflow to make total annual inflow to Mead of 9.0 maf. Annual releases from Lake Mead total 10.4 maf: 7.5 maf total to Arizona, California and Nevada, 1.5 maf to Mexico to meet our treaty requirements and an additional 1.4 maf in evaporation and other losses.

[2] For an overview of climate related impacts see: "Climatic and Hydrologic Trends in the Western U.S.: A Review of Recent Peer-Reviewed Research" available at: http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary/articles/wwa_jan_2007_feature.pdf

[3] National Research Council (NRC) 2007. Colorado River basin Water Management – Evaluating and Adjusting to Hydroclimatic Variability. The National Academies Press, Page 61.

likely to have less streamflow in the future[4]. In fact, all climate change studies on the river, some dating back to 1979, have found that less runoff will occur in the future under warmer conditions with either the same or less precipitation, the most likely future according to climate models. A variety of new studies[5] based on the most recent Intergovernmental Panel of Climate Change (IPCC) modeling also paint a future with less water in the basin. Two other second order effects of rising temperatures associated with climate change potentially influence water supply. Insect pests such as the pine beetle are projected to increase, which will affect forest health and the potential for fire[6]. Large forest fires have increased in recent years[7] which may lead to increased reservoir sedimentation and water quality degradation. While these studies and projections may be wrong, the collective picture is troubling and it would be foolish to ignore them.

While the Lower Basin states of California, Arizona, and Nevada have over-consumption and growth problems, the Upper Basin states have another set of problems relating to the uncertainty of their compact entitlements. In the state of Colorado, for example, there is no unappropriated water in any basin other than the Colorado River, but use of Colorado River water is constrained by a 1922 Colorado River Compact downstream delivery requirement at Lee's Ferry. Developing additional water to meet Colorado's needs is now highly uncertain – there could be anywhere from 0 to 800,000 acre-feet, enough to supply anticipated new growth for the next twenty years. Ever more problematic is the concern that climate change induced drought might lead to drastic curtailment of all 'Post-Compact' water rights. Such curtailment could include shutting off half of the water which is now used by the major municipalities of the Front Range of Colorado where 75% of the state lives.

There is at least one bright spot on the river. For the last two years Reclamation has been working on an Environmental Impact Statement on how to share shortages and operate Powell and Mead during drought. This effort has lead to a noteworthy and imaginative agreement among the seven Colorado River states and Reclamation should issue a Record of Decision later this year. However, given climate change projections, I fear that this agreement will not be enough and the states will soon have to deal again with the delicate issue of not enough water for too many people.

Better Federal Management of Climate Change Science

We need a better way to manage the nation's overall climate change science enterprise. This is a critically important national problem yet the existing management structure seems ill-suited to

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[4] For an overview, see http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary/wwa_may_2007.pdf

[5] See for example: N. Christensen, D. P. Lettenmaier. 2006. A multimodel ensemble approach to assessment of climate change impacts on the hydrology and water resources of the Colorado River basin. Hydrology and Earth System Sciences Discussions, 3, 3727-3770. Hoerling, M. and J. Eischeid. 2006. Past Peak Water in the Southwest. Southwest Hydrology, 6(1). Milly, P. C. D., K. A. Dunne, et al. (2005). "Global pattern of trends in streamflow and water availability in a changing climate." Nature 438(7066): 347-350. Seager, R., M. Ting, et al. (2007). "Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America." Science: 1139601.

[6] Colorado's Grand and Summit counties now have over 1000 square miles of diseased and dying trees.

[7] Westerling, A. L., H. G. Hidalgo, et al. (2006). "Warming and earlier spring increase western US forest wildfire activity." Science 313(5789): 940-943.

the task. Does anyone really think an effective way to manage $2b of climate change science occurring in thirteen different federal agencies is by a small office overseen by a national interagency committee without budgetary authority? Despite good intentions, the Climate Change Science Program (CCSP) is a feel-good veneer on a problem that requires a far bigger response with an effective management structure. In addition, it is now time to include resource managers and decision makers along with scientists in the management of this very important program.

One sign of the current management problems is that despite being eager for climate change information, almost no water manager in the country is aware of the Climate Change Science Program. And they are certainly not aware of the twenty one Synthesis and Assessment Products being rolled out over the next two years, several designed specifically for decision makers[8]. Another example is the lack of resources for "decision support", the term used to describe information readily usable by policymakers. This is clear from both the small budget devoted to these activities and from actions of the program. I attended a CCSP workshop in 2005 on Decision Support attended by several hundred scientists yet there were just a handful of resource managers and decision makers in the audience. Please note that none of my comments are meant to malign the hardworking staff or management of the CCSP; they simply do not have the resources to pursue their mission effectively.

A National Climate Service, an idea under discussion by some in NOAA and in the academic community, might provide an umbrella to solve some of the climate variability and change needs of decision makers if it were crafted with care. This enterprise would "connect climate science to decision-relevant questions and support building capacity to anticipate, plan for, and adapt to climate fluctuations."[9] NOAA's new National Integrated Drought Information System (NIDIS) is one contribution to climate services. A national service would need to work closely with the many federal agencies that already deal in climate. Done effectively, this service would allow research scientists and resource managers to overcome the differences between the academic and management worlds. This concept already passed Congress in 1978 as Public Law 95-367 but has languished for lack of funding.

National scientific leadership should also entail a coherent policy for dealing with data. Simply put, no data means no science, and bad data leads to bad science. Good management also requires good data. In my experience with scientists, the first thing they love to argue about is data, the best example being the current dispute over hurricane trends. We will never end these arguments, but we should do our best to minimize these problems when possible. All data – National Weather Service data, USGS streamflow data, and National Resource Conservation Service snow and soil moisture data among many others -- should be covered by a consistent national plan and be provided adequate funding. Data collection is unfortunately the first thing that gets cut in time of shortfall. Meta-data, that is data about data, is especially critical ancillary data because it lets scientists cull bad data from good.

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[8] Namely 3.1: Climate Models: An Assessment of Strengths and Limitations for User Applications; 4.3: The effects of climate change on agriculture, land resources, water resources, and biodiversity; and 5.1: Uses and limitations of observations, data, forecasts, and other projections in decision support for selected sectors and regions.

[9] Miles, E. L., A. K. Snover, et al. (2006). "An approach to designing a national climate service." PNAS 103(52): 19616-19623.

Devote More Scientific Resources to Regional Problems

In the last two years, the confluence of the severe on-going drought, eye-opening information on far more serious droughts in past centuries supplied by tree-rings, and the growing scientific certainty over the causes of climate change, have provided a focus such that water utilities and managers are now ready to be full participants in the scientific enterprise on climate. This means, however, that we need to be able to provide regionally specific information on risks, such as changes in snowpack, timing of spring runoff, increases in water demand from temperature increases, amount of sea level rise, and changes in the length of the growing season. Unfortunately, to date, scientific assessments like the IPCC have focused on the global and continental scale effects of climate change and hence are of limited use to regionally focused decision-making.

One example of the burgeoning demand for climate change information came out of a water utility climate change summit early this year hosted by the San Francisco Public Utilities Commission (SFPUC) which I attended. This watershed event brought together some 250 water and wastewater utility leaders from around the nation, agency officials, top climate researchers, representatives from NGO's and the business community. Organized by and for water utility leaders, the Summit focused primarily on adaptation responses utilities are - and should be - thinking about in light of climate change. As a result of that Summit, a steering committee chaired by SFPUC General Manager Susan Leal and made up of managers of some of the largest utilities in the nation -- Metropolitan in Southern California, New York, Seattle, Las Vegas, Denver, Portland and San Diego-- has begun meeting to learn from one another and speak with a collective voice about what they need from federal, state, and regional agencies.

Much of the regional response needs to revolve around regionally specific climate modeling; this is an explicit concern of the utility group. Regional modeling is urgently needed to inform water supply and capital improvement planning in the water and wastewater utility community. We know the climate models have problems dealing with precipitation in mountains, and they do not represent important aspects of climate variability like decadal fluctuations. They most certainly are not a substitute for judgment. But they are the only tool we have for investigating likely future conditions and as such are critical. Used with care these models can provide an estimate of the range of possible future conditions. Despite their limitations, we must move forward with all forms of regional modeling as quickly as possible and this includes educating decision makers on their strengths and limitations.

Regional water management organizations need to work with regionally-based entities to solve their climate needs. During their 10-year existence, the existing RISA programs have provided valuable climate-related services and information for portions of the country. Seattle Mayor Nickels' leadership on climate change with the US Conference of Mayors is in part due to his connection to the Climate Impacts Group at the University of Washington. The California Applications Project at the Scripps Institution of Oceanography has been heavily involved with Governor Schwarzenegger's climate change initiative. My program has recently convened a panel of experts to draft a road map to help the Lower Colorado office of Reclamation prepare for climate change. Time over and again, RISAs have shown the capability of providing regionally relevant information on a whole host of issues ranging from information about past climates, to seasonal forecasts, and recently to climate change.

The RISAs provide one model of meeting regional climate needs that with additional resources could be scaled up to cover the nation. But this can not be done overnight. The effort takes time, dedication and commitment; overcoming the differences between the academic and professional management world can be challenging but innovative solutions come when academics, federal employees, and professionals share and combine their knowledge.

Conclusion

Drought and increased demand have combined to create a serious water supply problem on the Colorado River which climate change threatens to make far worse. To help the nation adapt to water supply problems caused by climate variability and change, we need more effective federal climate change science management and much more regionally-directed science. Both of these will require the involvement of resource managers and stakeholders in addition to scientists. Solutions will involve challenges to everyone. Scientists will need to understand needs and constraints of decision makers and adjust research to fit. Water Managers will need to understand the science better, and learn how to fit the uncertainty of climate change into their already significant capability to deal with variability. And even Congress will need to provide the necessary structure and oversight to allow the best climate change adaptation response possible.

Someone once said that the "proper response to uncertainty is insurance, not denial." It is time that we start acquiring 'insurance' against the effects of climate change by making sure that we have the necessary management, resources, tools and people to pursue critically needed water sector climate change adaptation measures. Thank you for the opportunity to address you today.

Bradley Udall Biographical Sketch

Brad Udall is on the research faculty at the University of Colorado where he serves as the Director of the CU-NOAA Western Water Assessment. The Assessment is an interdisciplinary NOAA-funded project designed to assist water managers and other users of climate data and information.

Brad was a contributor to the recent National Integrated Drought Information System plan and is a reviewer of the Intergovernmental Panel on Climate Change 4th Assessment Report. His research focuses on Colorado River hydrology, climate, law, and policy. As a frequently requested speaker, his recent engagements have included the U.S Conference of Mayors annual meeting, the University of Colorado Law School Conference on Climate Change, the ICLEI North American Congress, the Western Coalition of Arid States 2006 Winter Conference, the Western States Water Council, the National Association of Clean Water Agencies, and the San Francisco Public Utilities Commission Climate Change Summit.

Brad has an engineering degree from Stanford and an MBA from Colorado State University. He was formerly a consulting engineer and the managing partner at Hydrosphere Resource Consultants, where he worked on interstate litigation on the North Platte River, endangered species on the Columbia River, future Front Range supplies, and shortage issues on the Colorado River.