Addressing Climate Change in Long-Term Water Resources Planning and Management

User Needs for Improving Tools and Information

Appendix D - Record of Perspectives Contributed by Other Organizations – Letter Comments

US Army Corps of Engineers®

January 2011

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U.S. Army Corps of Engineers Civil Works Technical Series CWTS-10-02

Appendix D - Record of Perspectives Contributed by Other Organizations – Letter Comments

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US Army Corps of Engineers®

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ASSOCIATION OF METROPOLITAN WATER AGENCIES

American Water Works Association

The Authoritative Resource on Safe Water℠

April 23, 2010

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RE: AWWA and AMWA Comments on *"Addressing Climate Change in Long-Term Resources Planning and Management: User Needs for Improving Tools and Information"*

Dear Dr. Brekke,

The American Water Works Association (AWWA) and the Association of Metropolitan Water Agencies (AMWA) respectfully submit for your consideration the following perspectives on the draft report entitled *"Addressing Climate Change in Long-Term Resources Planning and Management: User Needs for Improving Tools and Information."* Additional perspectives are provided in the attached Excel spreadsheet

AMWA and AWWA together represent drinking water utilities of all sizes that serve more than 90% of the U.S. population. Our members, along with other water sector utilities (wastewater, flood management and stormwater), will be among the principal stakeholders dealing with the challenges that climate change will bring upon our communities. AWWA and AMWA have commented on several governmental climate change initiatives the last two years, including: White House Council on Environmental Quality Interagency Climate Change Adaptation Task Force, EPA's Office of Water Climate Strategy, the revised research plan for the Climate Change Science Program (USGCRP), and the National Academies America's Climate Choices Program. AWWA and AMWA urge Reclamation and USACE to review the work being performed as part of these initiatives. Better collaboration between federal agencies on climate change adaptation projects will lead to cohesive approaches and outcomes that benefit all involved.

Climate change is not typically considered holistically across all sectors in a geographic region, resulting in stove-pipe decision making. In order to determine the best use of available resources to address climate change, effective communication is needed between all of the different impacted sectors and stakeholders. This will allow for the development of a comprehensive local and regional approach to address the impacts of climate change that addresses local land use, population growth and other factors.

Effective planning requires a process that brings together the institutions and entities comprising communities, regions and sectors so as to avoid sub-optimal actions that may be good for one sector but very bad for another. Many communities are creating task forces that include these varied interests to analyze options and to advise local, regional and state agencies regarding adaptation and mitigation strategies. In addition, it is important to recognize the interrelations between the water and energy sectors, as each relies on the resources of the other.

Effective communication across all sectors is important so that information about what works and what doesn't can be used to avoid repeating mistakes. Each sector needs to organize to share information particular to its operations, and at the same time, sectors must interact to optimize adaptation plans from individual communities to regions to states and to the nation. This interaction will identify additional specifically targeted research needs to be addressed by the scientific community. Climate change researchers, including governmental agencies, should work to develop partnerships with water sector organizations to improve communication and input between researcher organizations and the water sector, and ensure that the climate change research is properly applied for water resource planning.

In the introductory section of the report, we are heartened to see that Reclamation and USACE recognize the importance of incorporating climate projection information into the water resource planning process. The traditional concept of stationarity no longer applies when planning for the future of the nation's water resources. An increased rate of climate change impacts may significantly impact the design and management of drinking water systems. Acceptance of non-stationarity for water resource planning within Reclamation and USACE is essential to providing a reliable supply of drinking water that can meet our present and future needs.

Research is an extremely important part of climate change adaptation. AWWA and AMWA believe that what is needed is a comprehensive, unified, and coordinated federally sponsored applied research program to develop decision support tools, adaptation action plans, mitigation strategies and better information on the impacts of climate change on water quality and quantity, stormwater management and wastewater treatment. Reclamation and USACE should participate in federal research programs to ensure that the outcomes support the goals of their respective organizations. Some examples of data and research needed include:

- Improving the quality, coverage, accessibility, and user-friendliness of regionally-resolved information regarding climate impacts on temperature, precipitation patterns, hydrology, water quality, extreme events and ecosystems.
- Reducing uncertainty in projections of how the climate may change by improving and refining the GCMs and downscaling techniques used to project climate changes.
- Developing decision support tools for planning, decision making and policymaking that can accommodate deep uncertainty and the potential for abrupt climate change. An example is the ability to evaluate and revise flood rule curves on existing Corps of Engineers and Bureau of Reclamation projects, which is an important aspect of utilizing downscaled GCM data and applications to hydrologic models.
- Enhancing the collection, maintenance, and accessibility of data and key databases and making the data more useful for decision-making purposes. Climate change related data should be easily accessible through a single online portal. For the water sector, the Water Research Foundation is seeking to maintain all relevant information on a single portal (www.theclimatechangeclearinghouse.org).

- Coordinating international research and cooperation, particularly with regions of the world that are arguably experiencing the effects of climate change now, such as Australia.
- Ensuring that water utilities and other water resources stakeholders throughout entire U.S. have access to regional climate information and technical expertise that is currently provided through federally-sponsored programs such as NOAA Regional Integrated Sciences and Assessments (RISA) program.
- Researching adaptation strategies to ensure that they are based on sound science.

The report identified NOAA and USGS as being the federal agencies that will develop the science strategy to meet the user needs identified in this report. It is very important that Reclamation and USACE remain engaged in that process to ensure that the strategy will lead to the development of information that adequately meets their planning needs as well as the needs of other water resource planners. Additionally, Reclamation and USACE should strengthen their relationships with their other federal partners, state and local water utilities, research organizations, and water sector associations. A collaborative approach that incorporates all the relevant stakeholders is the most effective way to identify best management practices for long-term water resource planning in a changing climate.

AWWA and AMWA look forward to remaining involved in future revisions of this document. Please contact Cynthia Lane at AWWA (202-326-6122, clane@awwa.org) or Erica Brown at AMWA (202-331-2820, brown@amwa.net) if there are any questions regarding these comments or about research and information needs for water utilities in light of climate change impacts.

Best regards,

Thomas W. Curtis
Deputy Executive Director
AWWA Government Affairs

Diane VanDe Hei
Executive Director
Association of Metropolitan Water Agencies

Attachment: Excel Feedback Form from AWWA and AMWA

cc: Dr. Curtis Brown, US Bureau of Reclamation, Director, Research and Development Office
Robert Pietrowsky, Director, Institute for Water Resources, U.S. Army Corps of Engineers

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To : Dr. Levi Brekke, Hydraulic Engineer, US Bureau of reclamation
From : Dr Nigel Quinn, Research Leader, HEADS, Berkeley National Laboratory
Date : April 9, 2010

Re : Contribution of perspectives to Climate Change and Water Working Group

This is a very comprehensive and timely document that has taken the most wholistic approach to long-term water resources planning I have seen to date.

There are a few important potentially impacted sectors that are missing from the Natural Systems Response section in the gap analysis. One of these is managed seasonal wetlands (wetlands are mentioned generically later in the document). There are approximately 170,000 acres of seasonally managed wetlands in the San Joaquin Basin alone. Since other areas such as groundwater, anadromous fisheries, riparian vegetation and ecosystems, and non-native vegetation have been explicitly recognized – it is important to recognize the unique hydrology of these ecosystems. To date there have been no ecosystem impact studies of future potential climate change. Another related sector subject to climate related impacts is land subsidence. This is not covered by the current descriptor for groundwater impacts which considers only recharge and stream-aquifer interactions. Reclamation is currently struggling with conveyance canal subsidence issues resulting from an unprecedented volume of groundwater extraction that has been fueled by Recovery Act stimulus to production well development – especially in water supply challenged areas such as the western San Joaquin Basin.

Another significant oversight is that of data sharing and dissemination. The report properly identifies the need to review the literature and obtain better data and has a separate section dealing with communication of results from climate change analysis. However the difficulties agencies experience sharing databases with each other and providing easy access to data fundamental to long-term impact analysis studies is legion and ongoing. Two federal agencies that appear to have difficulty sharing data are the two involved in this new partnership – Reclamation and the Army Corps of Engineers. For example, in 2005, Reclamation was involved in a modeling study of the lower San Joaquin River and sought San Joaquin River bathymetry data from the USCOE San Joaquin Basin Comprehensive Study during development of a MIKE-21c hydrodynamic model. An e-mail response from USCOE, Sacramento suggested that Reclamation pursue a FOIA request to acquire this data. Despite intervention by Reclamation's interagency geodatabase manager and senior USCOE personnel – the request was unfulfilled after 3 months. The data was finally obtained through an intermediary, the California Department of Water Resources – who happened to be a partner in the acquisition of the original data. National Security was cited as the issue that constrained data sharing in this instance and the fact the USCOE was not required to disseminate the data in a format others could interpret (Reclamation did not have the capability of reading MicroStation format files). The Consortium might want to include a separate task related to data and information sharing architectures and the development of long-term collaborative data acquisition and sharing strategies related to the analysis climate change impacts and formulation of mitigation plans. In

the example provided River bathymetry data is fundamental to flood management and hydrologic modeling of the Basin and can impact studies of ecosystem response, water quality, ground-surface water interaction etc.

The European Community, through projects such as ORCHESTRA (http://www.mssanz.org.au/modsim05/papers/denzer.pdf and http://www.mdpi.com/1424-8220/8/3/1755/pdf) created a European Spatial Data Infrastructure, to implement metadata rules for data and services, to implement rules for harmonized spatial data specifications (exchange and update, ID systems, thesauri, key attributes, etc.) and to implement rules for network services (upload, discovery, view, download, transformation, etc.). ORCHESTRA (http://www.eu-orchestra.org) was launched in September 2004 and another related environmental sensor data sharing initiative called Sensors Anywhere (SANY, http://sany-ip.eu/) was launched in September 2006. This successful, 20 million Euro initiative allows data sharing between over 20 institutions located in 14 countries. The computer software operates at the operating system level allowing myriad computer networks to interface without compromising the integrity of the local network or ceding control to systems outside local firewalls. The system relies on a common data ontology that allows free and reliable data sharing without need for excessive metadata. A system modeled on ORCHESTRA could perform a useful function for those federal agencies and outside collaborators attempting to cooperate and collaborate within the Consortium. Data sharing need not be confined to weather variables such as air temperature (T), precipitation (P) and the 5 runoff (Q) conditions defined in Brekke et al. 2009a but include those data routinely collected by each agency or agency partner and critical for climate change impact analysis.

Some thoughts on user needs for improving tools and information for adapting to climate change

Jay R. Lund, Director
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Steering Committee Member of California Water and Environment Modeling Forum
27 March 2010

Disclaimer: The perspectives submitted are those of the author and do not necessarily represent the views of any organization.

Realities of Adapting to Climate Change

Climate warming is already influencing water management in some parts of the United States, such as California. Climate change effects are likely to increase with time and become more widespread, with increases in sea level rise, higher temperatures, and earlier snowmelt, and likely changes in overall precipitation, the frequencies of floods and droughts, human water demands, and habitat ranges of various ecosystems and species. All of these changes will occur on top of other changes such as increases in population, shifts in economic sectors, changes in national demography, changes in water use technology, and improvements in scientific understanding. Responding effectively to climate change will require more than adapting to climate change alone. Climate change adaptations will often need to be adaptive for other large-scale changes as well.

Important details of climate change will remain mysteries for at least several decades, no matter how much scientific research progresses. Estimating changes in flood frequencies (especially with non-stationarity) will require many decades, posing profound challenges for how we plan and design flood management infrastructure and floodplains. Similar challenges arise for planning infrastructure and policies for droughts and long-term environmental protection. Uncertainties regarding climate change magnitudes are unlikely to be greatly narrowed, from planning and design perspectives, in our lifetimes, and may not be significantly narrowed for more than a generation. We must learn to deal with this and our planning, design, and applied analytical capabilities must cease to hope for a rapid elimination of uncertainties regarding climate change.

Capabilities and Needs of Local Agencies and Water Users

Local governments and water users will remain at the font line of impacts and adaptation for climate change. Local governments and water users are most directly damaged by floods and water shortages, and mostly responsible for financing water and water-related activities. They typically have the greatest presence on the ground, and often have greater financial and institutional capabilities and operational and planning flexibility and responsiveness than federal or state agencies. Effective adaptation to climate change will be predominantly local.

Local interests are likely to find most forms of federal involvement inconvenient and undesirable, even where there might be a national interest in federal involvement. Federal and

broader regional interests are likely to benefit from some often substantial federal involvement. Local interests, such as floodplain residents, often benefit from federal involvement over longer time frames.

Roles and Useful Activities for Federal Agencies

Federal and state agencies will retain important roles and interests, limited by diminished long-term financial and institutional capabilities. Important federal activities include:

1. *Environmental protection.* National interests in environmental protection often conflict with the narrower interests of local water agencies and large water users. Federal regulation and guidance on long-term environmental protection with climate change is an important neglected area of activity. Integration of often fragmented federal perspectives and capabilities is likely to be needed for federal involvement to be more effective and efficient.

2. *Flood management policies and standards.* In most of the US, federal flood policies and local land use policies are the predominant means of managing floods and flood risks. Improving federal flood management policies, procedures, data, and analysis will be immensely important to improving flood management and climate change adaptation. Establishing technical levee and flood standards, policies, and methods that are useful and practicable locally is a broadly needed activity where federal agencies should have a comparative advantage.

3. *Broader regional strategy and analysis.* In much of the country, federal studies, regulations, and proposals are often the only broad regional perspective on environmental protection and water management. These often provide an essential framework for local and state agencies to collaborate and cooperate for mutual and broader benefit. Federal agencies are often not effective in this role and should seek to develop more capability here.

4. *Federal project operations.* Most large regional water systems have large federally owned and operated components. Reoperation of these projects will become more important with climate change and will require technical capabilities and authority often available only at the federal level. The long-term safety of federally owned and designed structures should also include more standardized consideration of climate change.

5. *Updating operating policies for federal reservoirs and other facilities.* Many federal reservoir operating policies have not been revised for many decades. They are often poorly adapted to current conditions and are becoming less suitable for the future. Many operating policies should be updated and a more adaptive policy for updating operating policies is needed.

6. *Federal hydropower licensing.* The federal government regulates and licenses most hydropower. Standard policies are desirable for integrating consideration of climate change into such long-term licenses.

7. *Funding to support federal interests.* The greatest local interests in federal involvement will be to gain federal funding and avoid federal regulations. Federal funding can often help local agencies modify local projects to support federal interests. Realistically, federal funding is likely

to be insufficient to provide such incentives broadly. Ill-founded hope for federal funding sometimes delays local actions that would be useful for both local and national interests.

8. *Long term research.* While climate change uncertainty will large and unavoidable for the foreseeable future, scientific research on climate change will continue to have near-term and long-term benefits and should continue. However, we should be realistic about the benefits of climate science research for applied planning, design, operations, and policy problems. Additional research from an applied decision-making perspective also is needed, often quite separate from fundamental climate science. Pragmatically, many climate adaptation decisions are unlikely to benefit fundamentally from additional climate science research for some time.

Concluding Thoughts

Federal activities in climate change have so far been mostly scientific with some additional studies of potential climate change impacts. As federal activities in the climate change area evolve, they need to be supplemented by qualitatively different applied activities which can respond to evolving regional water and environmental challenges that include climate and other changes. These federal activities and policies will need to be designed to protect federal interests while working with better-funded, more nimble, and more narrowly focused local interests. Federal agencies are generally not yet on a course to be useful or effective in this arena.

Further Reading

Connell, C. (2009), "Bring the Heat, but Hope for Rain – Adapting to Climate Warming in California," Masters Thesis, Hydrologic Science, University of California, Davis.

Fissekis, A. (2008), "Climate Change Effects on the Sacramento Basin's Flood Control Projects," Masters Thesis, Civil and Environmental Engineering, University of California – Davis, Davis, CA.

Hanak, E. and J. Lund (2008), *Adapting California's Water Management to Climate Change*, Public Policy Institute of California, San Francisco, CA, November.

Harou, J.J., J. Medellin-Azuara, T. Zhu, S.K. Tanaka, J.R. Lund, S. Stine, M.A. Olivares, and M.W. Jenkins (in press), "Economic consequences of optimized water management for a prolonged, severe drought in California," *Water Resources Research*.

Klemes, V. (2000a), "Sensitivity of Water Resource Systems to Climatic Variability" in V. Klemes, *Common Sense and Other Heresies: Selected Papers on Hydrology and Water Resources Engineering*, Canadian Water Resources Association, Cambridge, Ontario.

Klemes, V. (2000b), "Design Implications of Climate Change" in V. Klemes, *Common Sense and Other Heresies: Selected Papers on Hydrology and Water Resources Engineering*, Canadian Water Resources Association, Cambridge, Ontario.

Tanaka, S.K., T. Zhu, J.R. Lund, R.E. Howitt, M.W. Jenkins, M.A. Pulido, M. Tauber, R.S. Ritzema and I.C. Ferreira (2006), "Climate Warming and Water Management Adaptation for California," *Climatic Change*, Vol. 76, No. 3-4, pp. 361-387, June.

Water Supply in a Changing Climate

The Perspective of Family Farmers and Ranchers in the Irrigated West

a report prepared by the family farm alliance • august 2007

Family Farm ALLIANCE SM

Protecting and enhancing
Western irrigated agriculture

Water Supply in a Changing Climate

The Perspective of Family Farmers and Ranchers in the Irrigated West

a report prepared by the Family Farm Alliance

Channel restoration project completed by Ladder Ranch along Battle Creek, Wyoming.

Family Farm ALLIANCE SM

Protecting and enhancing
Western irrigated agriculture

EXECUTIVE SUMMARY

The Family Farm Alliance is a grassroots organization of family farmers, ranchers, irrigation districts and allied industries in 16 Western states. The Alliance is focused on one mission: To ensure the availability of reliable, affordable irrigation water supplies to Western farmers and ranchers. We are also committed to the fundamental proposition that Western irrigated agriculture must be preserved and protected for a host of economic, sociological, environmental and national security reasons – many of which are often overlooked in the context of other policy decisions.

Climate change in the Western United States is not only tremendously important to the Alliance, it also is immediately relevant to farmers, ranchers and small communities all over the West. We are increasingly hearing reports that predict dire long-term hydrologic forecasts for the West. Despite the highly variable and uncertain nature inherent with climate change predictions, it can safely be concluded that, in the West, there will be less water stored in our biggest reservoir... the snow pack. More water in the form of rainfall and runoff will come at farmers and ranchers sooner in the season, when it may not be useful and may even present a threat.

Irrigators and agricultural consultants have identified several impacts to crops and livestock– both good and bad - that climate change may generate in the coming decades. Overall, hydrologic impacts in the form of the "triple threat": 1) increased evaporation of snowpack and surface water; 2) increased crop evapotranspiration and consumptive use; and 3) decreased groundwater recharge and surface runoff – will mean less water to work with and higher water needs.

Western water supplies are already inadequate to meet the demands of agriculture, future energy needs, urban growth and environmental enhancement. Global climate change, we're told, will further reduce those supplies. Working with farmers has made us incredibly sensitive to the big picture ramifications facing the future of Western agriculture, and the critical role reliable water supplies play in that big picture. We must immediately begin to address the critical challenges we face. A practical, prioritized approach to addressing these challenges is possible:

The fruits of the harvest, Umatilla Basin Project, Oregon, 1914. Source USBR

1. **The federal government must work in partnership with the states and local water managers to *prioritize research needs and quantify projected West-wide hydrologic impacts*;**
2. **State and local water management agencies should take the lead to *implement a balanced suite of conservation and supply enhancement actions*;**
3. **The federal government must *streamline the regulatory process to facilitate development of new infrastructure* by state and local water agencies;**
4. **Congress and the Administration should *make self-sufficiency in food production a national priority*; and**
5. **At all levels of government and in our communities, we must *find ways to protect farmland*.**

Millions of acres of barren Western lands have been transformed into the most efficient and productive agricultural system in the world. Now is not the time to retreat from our investment. Now is the time to enact sound policies that encourage continued investment in irrigated agriculture. Allowing water-short cities to absorb farmers' water supplies will significantly diminish domestic food production at exactly the

same time global warming is predicted to severely adverse impact food production worldwide.

The U.S. recently became a net importer of food, and the safety of that food is becoming increasingly suspect. President Bush has given a new Cabinet-level committee just 60 days to develop plans to guarantee the safety of food and products imported into the U.S.[1] As food production moves off shore, a large part of our security is moving with it.

Climate change could further strain fresh water supplies in the American West. We must begin to plan for that now, and not wait until we are forced to make decisions during a crisis. Relying on agriculture to be a "shock absorber" to soften or eliminate the impending water shortage is not planning. It is a choice to put our heads in the sand and hope for the best. It is a decision that could worsen the overall impact of climate change on our nation's economy and security.

[1]The Interagency Working Group on Import Safety was established and met for the first time in July 2007.

Family Farm ALLIANCE SM

Protecting and enhancing
Western irrigated agriculture

www.familyfarmalliance.org

BACKGROUND ON THE FAMILY FARM ALLIANCE

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Alliance Involvement with Climate Change Issues

The Family Farm Alliance Board of Directors at its 19th Annual Meeting in Las Vegas in February 2007 established a subcommittee to develop a white paper that addresses the important issue of climate change, its possible impact on Western water supplies and irrigated agriculture, recommendations on how to plan and provide stewardship for this change. The board of directors felt that this issue could once again demonstrate the Alliance's realistic approach to problem solving.

The members of the subcommittee assigned to this task were pulled from the Alliance's Advisory Committee, and include Gary Esslinger (Elephant Butte Irrigation District, New Mexico), Jamie Mills (Newlands Water Protective Association, Nevada), Dick Moss (Provost & Pritchard, California), Bob Stackhouse (Central Valley Project Water Association, California), Jeff Sutton (Tehama-Colusa Canal Authority, California). Alliance President Patrick O'Toole (Ladder Ranch, Wyoming), Executive Director Dan Keppen (Oregon), Counsel Gary Sawyers (California) and Joe Raeder (Washington, D.C.) contributed to this effort. We also appreciate the input provided by Colorado Water Resources Research Institute at Colorado State University, the Wyoming Water Association, and the Wyoming Water Development Commission.

CLIMATE CHANGE IMPACTS TO AGRICULTURE: OUR CONCERNS

Potential Climate Change Scenarios

In the past six months, the public has been inundated with a flood of new studies that focus on projected climate change impacts to Western water resources. Predictions and conclusions reached about the impacts climate change will have on future water resources availability are as varied as the Western landscape. However, we are increasingly hearing reports that predict dire long-term hydrologic forecasts for the West. One such analysis by Richard Seager at Columbia University in New York suggests the region is in the early stages of a profound shift in climate that may last for decades. The models used in that study predict prolonged drought conditions in the western U.S., with rainfall reducing by about 1.4 inches each year until 2150. Seager's work suggests that drying of arid lands in the southwestern United States and northern Mexico will have

important consequences for water resources, regional development and cross border relations and migration. According to the models, the drying should already be underway and, over the length of time it takes to plan significant changes in water resource engineering and allocation (years to a few decades), will become well established.

Several other studies further focus on specific regions or watersheds and are briefly discussed below.

Yuma Water Users Assocation installed extensive improvements including automated water tracking systems, measurement stations, and key canal structures. Source: U.S. Dept. of Interior website

Arizona

Experts in Arizona say that climate change is occurring and will likely have more impacts in the future to water resources. A climatic water budget runoff model has been developed for the Salt and Verde River basins of central Arizona (Balling, 2007), which used the outputs of six global climate models to estimate runoff in the future under assorted "scenarios" developed by the Intergovernmental Panel on Climate Change (IPCC). Due to projected warmer temperatures by the year 2050, projected changes in runoff for the two basins suggest that the runoff from the Salt and Verde will have approximately an 85% chance of being less in the future due largely to warming in the study area. This could have significant impacts for these two basins, which have six dams, a variable hydrology, and a total storage capacity of 2.3 million acre-feet (as compared to the 50.2 million acre-feet "live" capacity of Lakes Powell and Mead on the Colorado River).

California

A report released by the State of California (California Climate Change Center, 2006) predicts that climate change will result in a drastic drop in the state's drinking and farm water supplies, as well as more frequent winter flooding. The report suggests that warmer temperatures will raise the snow level in California mountains, producing a smaller snowpack and more winter runoff. This means more floodwaters to manage in winter, followed by less snowmelt to store behind dams for cities, agriculture, and fish. By the year 2050, the statewide snowpack would shrink by 5 million acre-feet, more than the total capacity of Lake Shasta, the state's largest reservoir.

In an "average" winter, the slowly melting snow from the Sierra Mountains gets captured downstream by Central Valley reservoirs. By 2050, however, the State study predicts that average snowpack is likely to diminish by more than a third, and more precipitation will fall as rain rather than as snow, making it harder for the reservoirs to capture for the long summer the same amount of water. The dwindling snowpack could reduce deliveries of Sierra supplies to Central Valley farmers and cities by 10%.

According to another recent study developed by the University of California (Tanaka et al, 2007), agricultural water users in the Central Valley are the most vulnerable to climate warming. For the driest climate warming scenario assessed, the predicted hydrology would reduce agricultural water deliveries in the Central Valley by about a third. For that dry scenario, financial losses to the agricultural community would "likely result in an uncompensated structural change in the agricultural sector".

Colorado River Basin

A February 2007 report by a National Research Council (NRC) committee says agriculture is the likeliest target for shifting use to urban needs in the fast growing West. But it cautions that "the availability of agricultural water is finite." It adds that rising population and water demands "will inevitably result in increasingly costly, controversial and unavoidable trade-off choices" in managing a shrinking resource.

In the NRC study, tree-ring based reconstructions of the Colorado River's flow over hundreds of years show that average annual flows vary more than previously assumed and that extended droughts are not uncommon. Future droughts may be longer and more severe because of a regional warming trend that shows no signs of dissipating, the report adds. It also states that a preponderance of evidence suggests that rising temperatures will reduce the river's flow and water supplies.

Coping with water shortages is becoming more difficult because of rapid population growth. Technology and conservation will not solve the limited water supply problem in the long run, the report warns. For many years, understanding of the river's flow was based primarily on records from stream gages. But the tree-ring data demonstrates that the river occasionally shifts into decades-long periods in which average flows are lower, or higher, than the 15 million acre-feet average of the gauged record. In particular, tree-ring reconstructions show that the years 1905-1920 were exceptionally wet, which is significant because the Colorado River Compact governing allocation of water between upper and lower basin states was signed in 1922 when it was assumed that annual average river flow was closer to 16.4 million acre-feet. Tree-ring data also indicate that extended droughts are a recurrent feature of the basin's climate.

The committee also looked at how a steadily rising population and related increases in water demand will affect Colorado River water management. The population across the western United States has grown rapidly. Despite some successful water conservation efforts, urban water use in the region has increased significantly along with the expanding population. Increasing urban water demands are often met through sales, leases, or transfers of water rights from farm users. Although a significant portion of available water in the West is devoted to agriculture, this allocation is finite, the committee warned. Water transfer agreements will be limited in their ability to satisfy growing, long-term demand. Such agreements may also cause problems for third parties, such as downstream farmers or ecosystems. Technology and conservation measures are useful and necessary for stretching existing water supplies, the committee acknowledged, but any gains in water supply will be eventually absorbed by the growing population.

Hoover Dam, on the Colorado River. Source: USBR.

The NRC Colorado River report recommended that another study be undertaken of water use patterns and demands, population projections and possible effects of transferring water from agriculture to urban areas. The latter recommendation is one the Family Farm Alliance asked a U.S. Department of Agriculture advisory committee to implement (Family Farm Alliance, 2006).

Pacific Northwest

The IPCC recently released a report (Intergovernmental Panel on Climate Change, World Meteorological Organization, 2007) that predicts climate-change related impacts to water resources in the Pacific Northwest. Similar to predictions made in other parts of the West, dwindling moun-

tain snowpack is expected to make summer water scarce especially east of the Cascades, where agriculture is a strong component of rural communities.

Snowpack in the Cascade Range holds two-thirds of the region's stored water. As it melts during the dry summer months, it fills rivers, generates hydropower, and helps meet the water needs of irrigation, fish, recreation and growing urban areas. But, as noted earlier, Cascade snowpack has diminished in the past fifty years and is expected to further shrink. Projected warmer winter temperatures will cause snowpack to melt earlier in the spring, which could exacerbate both spring-time flooding and late-summer drought conditions. This prediction does not bode well for irrigation-dependent eastern portions of Oregon and Washington.

Ladder Ranch, Wyoming

"We expect more contention over water resources much like what we have seen in the Klamath Basin," Mark Abbott, co-chair of Governor Kulongoski's Climate Change Integration Group, recently told the Oregonian newspaper (Hill, 2007).

Utah

A 2003 study directed by Congress and led by Utah State University professor Frederick Wagner lays out a variety of possibilities if temperatures increase from nearly 4 to 6 degrees Fahrenheit by 2100. The potential scenarios range from increased precipitation (with decreased snowpack and greater downstream flood risks) to decreased precipitation (desertification and a decline in water resources). In all scenarios, water management changes would be required, and the worst-case scenario would likely trigger water transfers from agriculture to urban areas, which would contribute to a sharp decline of farming and ranching. A particularly vulnerable area is the heavily populated Wasatch Front, where the nearby Great Salt Lake could rise, causing extensive flooding.

The impacts in all of these scenarios are exacerbated by a backdrop of a dramatic explosion in growth and development in recent decades. Across the Colorado River Basin, which includes parts of Utah, 85 percent of the water consumed by households, industry and farms comes from snowmelt. As in other parts of the Mountain West, the biggest factor in terms of warming temperatures will be the timing of the snowmelt and the amount of variability between rain and snow.

Water resources experts in Utah also realize that new surface water storage projects may be necessary to capture more snowmelt or more water from other sources (Schmidt, 2006). The Southern Nevada Water Authority – which has essentially used up its share of Colorado River water - is already planning to take groundwater out of aquifers near and under the Utah-Nevada state line and pipe it to Las Vegas. Ranchers in this area are fighting this proposal.

Summary of Anticipated Impacts

Summary of Potential Hydrologic Impacts

The Western Governors' Association (WGA) recently testified in support of a bill that would reorient and fully fund the U.S. Global Change Research Program to make it more user-driven. The WGA testimony (Bittleman, 2007) mirrors many of the common themes and findings developed in the reports identified above. WGA found that we can expect to see the following general effects and impacts caused by warming future temperatures in the Western U.S.:

- *Smaller snow packs and earlier snowmelt* will affect reservoir storage and demand for water and impact productivity and value of hydroelectric generation;
- *More rain than snow* is likely, with uncertain projected impacts to overall precipitation amounts in specific areas;
- *Extreme flood events* could be more common and larger; and
- *Droughts and higher temperatures* would be more intense, frequent and last longer, which would increase stream and reservoir evaporation, diminish surface water supplies, and stress groundwater supplies and water quality.

Despite the highly variable and uncertain nature inherent with climate change predictions, it can safely be concluded that, in the West, there will be less water stored in our biggest reservoir. . . the snow pack. More water in the form of rainfall and runoff will come at farmers and ranchers sooner in the season, when it may not be useful and may even present a threat.

Potential Impacts to Crops and Livestock

Irrigators and agricultural consultants have identified several impacts to crops and livestock– both good and bad - that climate change may generate in the coming decades.

Overall, hydrologic impacts in the form of the "triple threat": 1) increased evaporation of snowpack and surface water; 2) increased crop evapotranspiration and consumptive use; and 3) decreased groundwater recharge and surface runoff – will mean less water to work with and higher water needs. However, other more specific impacts include:

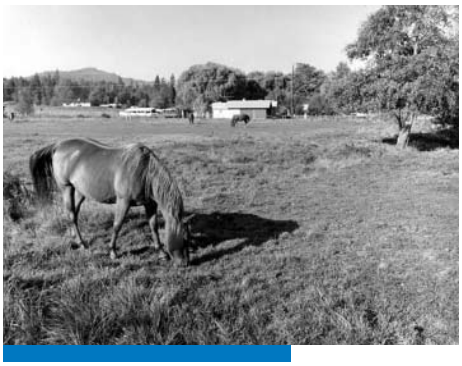
Negative Impacts to Crops

- The potential for increased heat stress to crops during pollination and maturation – which will impact both crop yield and quality;
- Increased weed competition and spread of invasive species;
- Increased insect and disease over-wintering;
- Increased soil salinity and related water quality impacts;
- Increased night temperatures, which can increase respiration and reduce yields;
- Concern about loss of pollinators (honeybees); and
- Potential loss of soil carbon.

Irrigated crops turn carbon dioxide into oxygen

Negative Impacts to Livestock

- Increased range and pasture competition from weedy and invasive species;
- Potential for increased summer heat stress due to prolonged number of days where temperatures exceed 90°F;
- Change in native range forage quantity and quality; and
- Loss of irrigated lower value crops (hay and grain). Water shortage or continued conversion of these crop lands towards support of ethanol or biodiesel will further reduce feeding industry competitiveness.



There are also possible benefits to crops and livestock resulting from predicted climate changes. For example, increased CO_2 levels have been shown to increase crop growth in laboratory and greenhouse settings. At this time, however, the impact in actual field situations is unclear. Also, in northern parts of the country, the increased number of frost-free days and increased "heat units" would benefit growers. Similarly, milder winters may improve the wintertime rate of weight gain and survival rates for calving and lambing operations.

WHAT WESTERN IRRIGATORS HAVE DONE

While a great deal of scientific inquiry and public discourse has been focused on climate change and its possible consequences for the planet's future, Western irrigators and irrigation districts are concerned about the problems threatening their water supplies today – drought and urban population growth. Even without climate change, these factors present an immediate crisis for agricultural water users in the West. If the effects of climate change are anything like those outlined in the research summarized previously, Western irrigated agriculture could be largely eliminated. This is of extreme concern to farmers and ranchers and their communities. It ought to be of great concern to our nation as a whole because climate change may result in a disruption of food production worldwide. If that is what is in store for us, then clearly this country cannot afford to lose the food production capacity of Western irrigated agriculture.

The ongoing, initial response of irrigators and water agencies to current water supply challenges can provide some insight into the possible measures that might be taken to cope with long-term water supply reductions resulting from climate change.

Water Conservation Improvements

Farmers and ranchers are remarkably resourceful business people, who employ creative strategies to survive prolonged drought periods. Throughout the West, creative measures have been taken to develop and efficiently manage water resources for irrigation:

- In the San Joaquin Valley of California, state-of-the-art drip irrigation systems water some of the most productive farmland in the world. Drip irrigation has also been recently installed on thousands of acres of California's Imperial Valley
- Further north, in the Sacramento Valley, producers and local governments are working to develop a regional water management program that will help address not only water quantity challenges, but also water quality and environmental issues. Those same growers 15 years ago were key players in a state-managed drought water bank that temporarily transferred local water to southern California to meet other statewide needs.
- In Idaho, water users are working with state and federal agencies and the Nez Perce Tribe to settle longstanding disputes and create more certain water supplies.
- Along the Columbia River, irrigators are developing water exchange programs to increase supply reliability while improving salmon habitat.
- In the Klamath Basin of Oregon and California, the federal government is spending millions of dollars to temporarily compensate producers for re-allocating

water for environmental demands. Stored water is being shifted from its initial intent - crop production - to a perceived need; to create artificial lake levels and artificial river flows in a naturally occurring cycle.

Farm Practice Improvements

Western farmers and ranchers are already taking actions to reduce greenhouse gases and other possible contributors to climate change. Some of these actions are undertaken consciously with this objective in mind; others have been implemented as part of the broad portfolio of actions that successful farmers have to take to stay profitable in today's fierce economic and regulatory climate. In virtually every Western state, there are examples of activities that agricultural producers are taking that have the overall effect of reducing carbon dioxide emissions, which many policy makers and media spokespersons believe are a primary contributor to global warming. These actions include:

- Use of cleaner and more efficient diesel engines;
- Reduction of energy needs on farms;
- Use of biodiesel;
- Low-till practices;
- Creation of methane plants to maximize dairy production and reduce waste and methane emissions to the atmosphere;
- Involvement in conservation programs (Conservation Reserve Program and other programs provided by the Farm Bill conservation title), which provide incentives to set aside thousands of acres of farmland for wildlife habitat; and
- Selling carbon credits to industries for approved management actions.

Probably most obvious - and most importantly - crops turn carbon dioxide into oxygen. Further, new research suggests that irrigation has kept croplands cool, essentially countering rising temperatures caused by greenhouse gas emissions over the last half century (Kueppers et al, 2007). That impact may be compounded by the predicted decreases in water available for agriculture in the future due to climate change. This, in turn, would cause more reductions in water supply, which would further restrict irrigation.

Drip irrigation system on wine grapes in Westlands Water District (California)

Success of Conservation Projects in Meeting Previous Challenges

Conservation efforts have been effective, but it overstrains credibility to believe that conservation alone will supply enough water for the tens of millions of new residents expected to arrive in Western cities during the coming decades. Also, conservation does not work in many cases, especially where the desire is to increase in-stream flow. Water that is conserved tends to be used by the next junior downstream appropriator and the flow remains the same.

The above examples demonstrate the creative measures that have been taken to develop and efficiently manage water resources for irrigation. These examples represent just a handful of the creative water management programs that Western irrigators are working on. Efforts to conserve water in urban areas have also been impressive, particularly in the Southwest.

Consider the commendable and dramatic conservation measures imposed by the Southern Nevada Water Authority (Authority)

in the urban areas around Las Vegas:

- In 2005, community residents and businesses converted more than 15 million square feet of turf, resulting in savings of more than 846 million gallons of water. The progress in 2005 brought the Water Smart Landscapes program total since 1999 to 67.8 million square feet, with a savings of more than 3.7 billion gallons of water. This helped the community achieve water savings of about 29.5 percent—surpassing the 25 percent goal five years ahead of the planned 2010 deadline.

Wyoming wetlands created via partnership with private landowners and U.S. Dept. of Agriculture. Western irrigators are involved in conservation programs, which provide incentives to set aside thousands of acres of land for wildlife habitat.

- New restrictions were imposed on landscaping;
- Use of recycled water was stepped up dramatically;
- Casino-hotels along the Las Vegas Strip have made significant investments in water features, capturing and treating grey water and using recycled water; and
- A stiff four-tier rate structure was imposed, as were high connection charges.

With conservation measures in place, southern Nevada reduced water use by 65,000 acre-feet in two years. However, despite these aggressive conservation actions, the Authority is moving with equal determination to develop new water supplies in other parts of the region, since probabilities of shortages on the Colorado River are likely going to increase over time. As noted earlier, the Authority is already planning to take groundwater out of aquifers under the Utah-Nevada state line and pipe it to Las Vegas.

So, this particular example – which describes some of the most innovative and aggressive conservation measures undertaken in the West – suggests that even the highest level of conservation is insufficient to keep up with new demands caused by new residents moving to Las Vegas. We envision similar situations to arise in other parts of the West as a result of climate change and ever-increasing population growth.

Impacts of Previous Challenges to Meet Diminished Water Supplies

The West is the most rapidly growing part of the United States. Yet, water supplies there are essentially static. In some areas, urban demand for water – and land – is straining agriculture and rural communities to the breaking point. New environmental water demands imposed by regulatory agencies or courts also first look to agriculture (Family Farm Alliance 2006). This is happening in every state, but farmers and ranchers point to some striking examples:

- A report released in April by Environment Colorado found that, from 1987-2002, Colorado lost an average of 460 acres per day of agricultural land. The report predicts 3.1 million more acres will be lost to development by 2022.
- Arizona's Salt River Project (SRP) is the "poster child" for transfers of agricultural water to urban areas. In a few years, the SRP will cease to provide water to agriculture in order to meet new demands exerted by development.
- In Las Vegas, Nevada, over 70,000 new residents are moving in every year, and Southern Nevada Water Authority is looking to rural areas to satisfy its growing thirst.

- A restoration agreement developed for the Platte River could potentially dry up hundreds of thousands of acres of farmland in Nebraska and Wyoming, in order to reallocate water to meet the perceived needs of ESA-listed fish and wildlife.
- According to the American Farmland Trust, the California Department of Conservation documented more than 1 million acres of farmland in the state that were converted between 1988 & 1998. Last year, California's population officially topped 37 million, and the California Department of Finance predicts that the state's population will reach 59.5 million by the year 2050 (State of California, 2007).

Farmers, ranchers and rural communities cannot solve the water supply problem created by the Western population boom. Nor can they be expected to sacrifice their livelihoods for the "greater good" of golf courses, strip malls and housing developments.

Farmland is disappearing at a time when the U.S. needs a stable domestic food supply (just as it needs a stable energy supply). We are concerned that this critical issue – which becomes even more serious when viewed in the context of projected climate-change impacts to water supplies - is being overlooked by our national leaders.

A reliable, safe and sustainable domestic food supply is just as important as a strong military to the protection of our national interests. The post 9/11 world of terrorist threats makes the stability of domestic food supply even more pressing.

Other Potential Future Demands on Western Water Supplies

Throughout the West, we are seeing proposals to build plants to make ethanol, another "answer" that may (or may not) lower greenhouse gas emissions. An April 2007 *Sacramento Bee* editorial provides a reality check on how much water it would take to grow all the corn required to meet California's goal of producing a billion gallons of ethanol a year. According to the *Bee*'s calculations, that's about 2.5 trillion gallons of water for 1 billion gallons of ethanol, which is more than all the water from the Sacramento-San Joaquin Delta that now goes to Southern California and valley farms. Because there is only so much water for agriculture in California and other Western states, this means that some other existing crops will not be grown, thus furthering our dependence on imported food sources.

With the high priority currently placed on ethanol and other biofuels, corn is currently a hot commodity. Because there is only so much water for agriculture in Western states, this means that some other existing crops will not be grown, thus furthering our dependence on imported food sources.

Another growing demand that will be placed on Western water resources is driven by power requirements. The total water consumed by electric utilities accounts for 20 percent of all the nonfarm water consumed in the United States. By 2030, utilities could account for up to 60 percent of the nonfarm water, to meet the water needs required for cooling and pollutant scrubbing. This new demand will likely have the most serious impacts in fast-growing regions of the U.S., such as the Southwest. Even without warming climate conditions, continued growth in these regions will put the squeeze on both water and power use. When you throw in climate change considerations, the projections look worse (Spotts, 2007).

THE IMPORTANCE OF WESTERN IRRIGATED AGRICULTURE

Western Irrigated Agriculture is Vital to the National Economy

Western water policy, over the past one hundred years, is one of the great success stories of the modern era. Millions of acres of arid Western desert have been transformed into the most efficient and productive agricultural system in the world.

Sprinkler irrigation keeps croplands cool, essentially countering rising temperatures caused by green-house gas emissions over the last century.

The Bureau of Reclamation operates about 180 projects in the 17 Western States. Reclamation projects provide agricultural, household, and industrial water to about one-third of the population of the American West. About 5 percent of the land area of the West is irrigated, and Reclamation provides water to about one-fifth of that acreage (in 1992, some 9,120,000 acres). Reclamation is a major American generator of electricity. In 1993, Reclamation had 56 power plants on-line and generated 34.7 billion kilowatt hours of electricity. All of this has been done for a total federal investment of $11 billion (U.S. Bureau of Reclamation).

A 1998 study by Dr. Darryl Olsen and Dr. Houshmand Ziari, estimates the impact of irrigated agriculture in the Western states to be $60 billion annually (direct and indirect income). Using Reclamation's estimate that 20% of irrigated agriculture receives water from Reclamation projects, then the annual return to the economy from the $11 billion investment in the federal system is $12 billion annually. In other words, the economy of the United States receives a greater than 100% return each year on this investment.

Western Agriculture Provides a Safe, Domestic Food Supply

Americans are justifiably concerned about the recent contamination of wheat gluten imported from China and used in pet food that killed thousands of animals in the United States. Earlier this year, federal agencies revealed that domestic chickens and pigs had been given feed similarly tainted by imported ingredients, and that many of the affected chickens had entered the nation's food chain. Those two events graphically demonstrate just how vulnerable the American public is to lax food safety standards in other countries, or potentially, to acts of food-based terrorism.

We all know that this country imports huge amounts of food. We've also now learned that the federal Food and Drug Administration (FDA) inspects only about one percent of that imported food. The call has now gone out to radically increase the FDA's inspection capabilities. Recently, former Secretary of Health and Human Services Tommy Thompson advocated for a doubling of the FDA's resources.

Mr. Thompson knows what he's talking about. This is the same man who, as he was leaving the Bush Administration, bluntly said, "I cannot understand why the terrorists have not attacked our food supply, because it is so easy to do."

However, while Mr. Thompson's proposal to bolster FDA's resources would represent an improvement, in reality, it means the agency would be able to inspect a whopping 2% of the imported food supply, thus leaving 98% un-inspected. Nobody should be very com-

fortable with an expanded inspection process that gives a foreign terrorist a 98% chance of succeeding in poisoning a commodity that finds its way into our food supply.

Yes, the U.S. has recently exp-erienced failures in its own food safety systems. But domestic food safety issues are within our power to address. Contamination of food stuffs produced by factories and farms beyond our borders is not.

RECOMMENDATIONS

So how will we meet the ever-increasing demand for water in the West in an era when there will be an ever-decreasing supply? Improved conservation and efficiency by urban and agricultural water users is certainly part of the solution, but only part. Climate change could further strain fresh water supplies in the American West. We must begin to plan for that now, and not wait until we are forced to make decisions during a crisis.

What We Must Avoid

Relying on agriculture to be a "shock absorber" to soften or eliminate the impending water shortage is not planning. It is a choice to put our heads in the sand and hope for the best. It is a decision that could worsen the overall impact of climate change on our nation's economy and security. Allowing water-short cities to absorb farmers' water supplies will significantly diminish domestic food production at exactly the same time climate change is predicted to severely adverse impact food production worldwide.

What Needs to be Done

Western water supplies are already inadequate to the demands of agriculture, urban growth and environmental enhancement. Global climate change, we're told, will further reduce those supplies. Working with farmers has made us incredibly sensitive to the big picture ramifications facing the future of Western agriculture, and the critical role reliable water supplies play in that big picture.

We must immediately begin to address the critical challenges we face. A practical, prioritized approach to addressing these challenges is possible, and essential. Our recommendations follow.

Grand Coulee Dam, Washington. The federal investment in the Columbia River Basin Project and other Western water projects generates a greater than 100% return each year. Source: USBR.

1. ***Prioritize Research Needs and Quantify Projected West-Wide Hydrologic Impacts***

Our country has tremendous, but limited, resources available to fix our problems, so accordingly we must prioritize and sequence our actions. An initial priority research item should be a comprehensive validation of West-wide changes in climate change-driven streamflow. This should be followed by quantification of the amount of additional above- and below-ground reservoir storage, conservation targets, etc. required to re-regulate the anticipated hydrologic regime changes. To optimize water management for beneficial use, researchers should look at scenarios where storage is spaced through the drainage. Potential storage sites should be located at high and low elevations to regulate and subsequently re-regulate the water supply to maximize beneficial use. A study of this type would quickly illustrate to policy makers the need to start modernizing our water infrastructure.

Congress should also authorize the U.S. Department of Agriculture (USDA) to work with national agricultural associations to assess the collective impacts to agricultural land and water use changes in western states over the last 10 years, as well as predicted trends. A study of this sort may provide the type of hard findings that may help wake up policy makers to the "big picture" ramifications of what is occurring across the Western landscape.

Both of these proposed studies lend themselves well to a private-public partnership that would add non-governmental farming

organizations, state agencies and academic institutions to a team of federal agencies including the expertise found within the Natural Resources Conservation Service, Bureau of Reclamation, and U.S. Geological Survey. For example, the Family Farm Alliance has partnered with Colorado State University and recently developed a proposal to the USDA for a project that would assess public attitudes and perceptions regarding agricultural water use in the West. That proposal has been funded by USDA. A similar type of proposal – one that involves producers, state and federal agencies, and academia - could be developed to create a partnership of the above agencies and other entities to collaboratively lead a climate change / hydrology research effort.

2. *Implement a Balanced Suite of Conservation and Supply Enhancement Actions*

We believe that it is possible to meet the needs of cities and the environment without sacrificing Western irrigated agriculture. To achieve that goal, we must expand the water supply in the West. There must be more water stored and available to farms and cities. Maintaining the status quo simply isn't sustainable in the face of unstoppable population growth, diminishing snow pack, increased water consumption to support domestic energy, and increased environmental demands.

It is simply ludicrous to believe that conservation alone will supply enough water for the tens of millions of new residents expected to arrive in Western cities during the coming decades. Farmers and ranchers understand that conserved water cannot realistically be applied to instream uses, as it will more likely be put to beneficial use by the next downstream appropriator or held in carryover storage for the following irrigation season.

Whether water shortages are attributable to drought or to climate change, reason dictates that measures should be implemented to provide more certainty for impacted water users. These measures should include rehabilitation of existing facilities and construction of new infrastructure. Many of the West's Reclamation projects are nearly a century old and many are badly in need of repair and/or modernizing. Rehabilitation measures should focus on maximizing the conservation effort through increased delivery efficiencies, construction of re-regulation reservoirs to minimize operational waste, and construction of new dams and reservoirs in watersheds with inadequate storage capacity to increase beneficial use and provide operational flexibility. Additional groundwater supplies should also be developed, but in a manner where groundwater use falls within the safe yield or recharge parameters of the aquifer. Conjunctive management of surface and groundwater supplies should be encouraged. As an example, groundwater might be utilized more during drought and allowed to recover during wet cycles. Installation of additional stream gauges, water meters, groundwater monitoring wells and better estimates of consumptive use are of paramount importance for the equitable management of available water supplies.

Temporary water transfers, conservation, recycling, and desalination efforts must

continue. However, these demand management actions must be balanced with supply enhancement measures that provide the proper mix of solutions for the varying specific circumstances in the West.

Many water projects are ready to be developed in the West (see Family Farm Alliance, 2005; also U.S. Bureau of Reclamation, 2005). While conservation and recycling programs have done a tremendous job of meeting new growth, only a small amount of new water storage capacity has been developed in the past 30 years. We cannot continue to "conserve just a little more" forever. It's time to start implementing the water infrastructure needed to cope with a changing climate, meet the needs of a burgeoning population, and support a healthy agricultural base in the West.

3. Streamline the Regulatory Process to Facilitate Development of New Infrastructure

Modern, integrated water storage and distribution systems can provide tremendous physical and economic flexibility to address climate transformation and population growth. However, this flexibility is limited by legal, regulatory, or other institutional constraints, which can take longer to address than actually constructing the physical infrastructure (Tanaka et al, 2007).

The often slow and cumbersome federal regulatory process is a major obstacle to realization of projects and actions that could enhance Western water supplies. In addition, there exists with agencies a defeatist attitude that no dams or water supply projects will be built. So, there is no commitment to earnestly begin and engage in the difficult problems described above.

4. Make Self-Sufficiency in Food Production a National Priority

Remarkably absent from the newly-ignited dialogue about food safety is a recognition of the importance of a secure and sustainable domestic food supply. Politicians from both parties now routinely urge us to end our reliance on foreign energy sources, but nobody is talking about food independence. A national response to climate change should include as one of its goals self- sufficiency in food production. It is time for our national leaders to stand up and focus on improving the security, stability, and economic aspects of domestic food production so that our food remains readily available, ample, affordable, and safe.

5. Find Ways to Protect Farmland

As previously noted, new research suggests that irrigation has kept croplands cool, essentially countering rising temperatures caused by greenhouse gas emissions over the last half century. Crops also turn carbon dioxide into oxygen. In addition to a multitude of other benefits (economic, security, habitat and open spaces, to name a few), our diminishing farmland needs to be protected. Federal funds and other money should also be authorized to help local governments protect farmland, analyze ways to keep farmland in production, set up grant programs for local governments and provide technical assistance to farmers. Congress should consider the option to encourage states to lease development rights from farmers to buffer their farmland.

Friant Dam, on the San Joaquin River, California. Temperance Flat Dam would be a new structure constructed on the San Joaquin River, above Friant Dam, which would provide much needed water supplies and hydroelectric power. Source: USBR

Opportunities exist to improve water conservation in Western agriculture, such as finding ways to minimize channel seepage losses. However, conservation alone cannot supply enough water for the tens of millions of new residents moving to the West. Source: USBR.

Conclusion

Europeans aggressively protect their farms and food production capability because they still remember the hungry years during and after World War II when they relied on other nations, America in particular, to feed them. The time has come – indeed, it's long overdue – for the United States to similarly adopt an overriding national goal of remaining self-sufficient in food production. Policy decisions on a wide range of issues ranging from taxation to the management of natural resources should then be evaluated to be sure they are consistent with that goal.

"Management of natural resources" equates to implementation. We must immediately begin on-the-ground work to maximize the ongoing conservation effort through increased delivery efficiencies, construction of re-regulation reservoirs, and construction of new dams and reservoirs in watersheds with inadequate storage capacity to increase beneficial use and provide operational flexibility.

It's hard to imagine a simpler or more important step to safeguard the American public.

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Climate Change: Implications of Hydrologic Loading Shift at Dams?*

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Hydrologic Safety for Dams. The purpose of dam safety is to protect a dam from both failure and resultant consequences including impacts downstream and loss of water resources. Safety considerations become the controlling factor in designing a new or rehabilitating an existing dam to meet required safety standards. The hydrologic safety standard is a key component of the overall safety requirement. Specifically, the ability of a dam to safely pass an extreme flood including its peak and volume is a major concern in the determination of its hydrologic safety.

Required Frequency Curves for Risk Assessment. A dam's spillway capacity should be designed to accommodate the so-called "inflow design flood" (IDF). The design flood should be established through an analytical determination and comparative evaluation of the potential overtopping failure consequences for alternative spillway capacities. In order for risk-informed decision making, the hydrologic hazard curves are the primary basis to evaluate an appropriate IDF. They provide frequency distributions of magnitudes and annual exceedence probabilities (AEPs) for the entire ranges of peak flow, flood volume, and reservoir elevations. The flood frequency curves are typically based on historical flood records, paleoflood data (if available), and significant extrapolation.

Ensured Quantity and Quality for Hydrologic Data. It is important to note that hydrologic frequency analysis of precipitation or flood is based on the essential assumption: historical hydrological data are stationary. The statistical characteristics of stationary data do not change with time. A statement has been made recently that climate change (i.e. uncertain and changing climate) makes the stationary assumption incorrect. The role of hydrologists/meteorologists in tomorrow's society will be to address this and other challenges including: data quantity and data quality (QA & QC). Particularly, the data quality needs to be ensured which may involve 2-dimentional non-stationary data including watershed development/ watershed disturbance and hydroclimate change.

Future Needs. Sufficient evidence on the analyses of long term hydrologic data in a large scale climate region is required to support the statement that climate change makes available data invalid for frequency analysis. During the study period, the progress needs to keep the public informed. If the results of study confirm that climate change may have a significant impact, then appropriate statistical technology to model reliable frequencies of flood/precipitation data and to estimate the ultimate PMP should be developed for use in the dam safety field.

**The perspectives submitted above are those of the author and do not necessarily represent the views of the agency.*

United States Department of the Interior

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MEMORANDUM

To: Director, Research and Development
Attn: 86-69000 (CBrown)

From: Michelle H. Denning
Regional Planning Officer

Subject: Mid-Pacific Region Review of the Information and Tools Needed to Incorporate Global Climate Change Information Into Our Management of Water and Water-Related Resources

The Mid-Pacific Region appreciates the opportunity to review and comment on the report "Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information."

We are providing our comments and suggestions in three parts. Our general comments and suggestions are included in this memorandum. Technical remarks and editorial suggestions related to specific parts of the report are attached (Attachment 1). Finally, our ranking of the relative priorities of user needs/gaps is provided in the spreadsheet downloaded from the website (Attachment 2).

We strongly support the goal of identifying information and tool gaps related to long-term planning and analysis for climate change. This is an especially important effort because climate change is scientifically complex and fraught with deep uncertainties due to longer time horizons than addressed by traditional planning approaches. Furthermore, we think the process of engaging the Federal and non-federal water management and research communities, in both identification of needs and development of solutions, will produce more comprehensive, timely, and cost effective results. It will also facilitate collaborative partnerships that serve to resolve conflicts. We recognize that the Bureau of Reclamation's climate change program is just getting underway and that this report represents a positive step toward informing and involving the regions in the program. We strongly suggest that this involvement be further developed by establishing a Reclamation-wide working group tasked with the mission of establishing a consistent approach to addressing climate related impacts and developing adaptation strategies.

Comments received from various Mid-Pacific Divisions and Area Offices are summarized below in terms of identified needs and process comments:

- The need for information that could improve our understanding of the complex interdependencies and interactions between climate and natural resources both in the long and short term.
- The need for predictive tools for quantifying changes and long-term variability in hydrology and meteorology affecting water projects' water supply and operations.
- Access to information regarding regional climate trends to inform regional water management decisions.
- The information gaps' priorities were difficult to rank without an explanation of what constitutes a "low ranking priority" versus a "medium priority" information gap, etc.

We look forward to working with you on developing and implementing effective solutions to the long-term planning and analysis challenges of climate change, and we are confident that this report is a step in the right direction. If you have any questions related to our comments, please do not hesitate to contact Dr. Michael Tansey, Regional Climate Change Coordinator, at 916-978-5197 or mtansey@usbr.gov.

Attachments – 2

cc: 86-68210 (LBrekke)

Mid Pacific Region

Technical Remarks and Editorial Suggestions

On

Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information

1. Executive Summary – pg vi Table ES-1 Gap 2.1 Column 2: acronym WSWC is not defined; the color scheme for the relative priorities needs an explanation.

2. Executive Summary – pg viii Table ES-1 Gap 5.2 Column 1: Suggest adding land use to list of socioeconomic factors.

3. List of Acronyms – pg xi : Add BCCA Bias Correction Constructed Analogues; Line 36 has missing information

4. Section 2.1 - pg 7 Lines 21-26: Comment - The P&Gs do call for an assessment of risk and uncertainty as part of a feasibility investigation. It seems reasonable that climate uncertainty should be included in such analysis.

5. Section 2.2.1 - pg 9 Lines 5: After … other weather variables add text *including carbon dioxide (CO2), relative humidity (RH), net radiation (NR), and wind speed (U).*

6. Section 2.2.1 - pg 9 Lines 25: After "such as" insert text *population,*

7. Section 2.2.1 - pg 10 Figure 2: Why is box with "watershed simulation" greyed out?

8. Section 2.3 – pg 13 Line 32: Replace "System**6"** with System

9. Section 2.3 – pg 13 Figure 4: Comment – The text in the Option 5 box implies that a single scenario of projected climate is used. The text should reflect the use of multiple scenarios to reflect the range of climate uncertainties.

10. Section 2.4 – pg 17 Figure 5: Comment – Why wouldn't 2, 3 & 7 be applied to the paleo-climate data also.

Attachment 1

11. Section 2.4 – pg 17 Figure 6: Comment – Why wouldn't 2, 3 & 7 be applied to the paleo-flood data also.

12. Section 2.4.1 – pg 19 Lines 31-46: Comment – If the literature summary activities are to be effective in providing a consistent discussion of climate change knowledge and implications for Reclamation, it will be necessary to organize an outreach effort such as a Reclamation-Wide Climate Working Group so that the information gets outs to the Regions and Area offices. Otherwise, they will be great information but only a few will know about it.

13. Section 2.4.1 – pg 20: Comment – The idea of targeting future syntheses to discipline-specific audiences is good. I suggest that the DOI Landscape Conservation Cooperatives (LCC) offer Reclamation the opportunity to participate in the discussions about the impacts of climate change on ecosystems and plans for adaptation.

14. Section 2.4.2 – pg 25 Line 20: Suggest adding (BCCA) after word bias-correction

15. Section 2.4.2 – pg 26 Lines 13-15: Comment – The perception held by water resource planning managers that "global to regional climate projections currently have limited applicability in supporting water resources investigations" is the result of their experience with traditional planning approaches. The objective of the traditional approach is to select an "optimal" action based on reasonably anticipated future conditions. When presented with climate change where there is deep uncertainty about future conditions, the search for an optimal solution is questionable because it is not possible to specify future conditions with sufficient certainty. In planning for climate change, it is more advantageous to develop a range of plausible future conditions and evaluate a wide range of potential actions against this ensemble to ascertain under what future conditions different actions remain viable. This results in a portfolio of actions which may be employed under different conditions over time. In the language of Long Term Policy Analysis (LPTA), this approach is termed Robust Decision Making and has the objective of risk reduction in face of unquantifiable uncertainty.

16. Section 2.4.2 – pg 26 Lines 28-37: Comment – The question of "stationarity" of statistical relationships under climate change also needs to consider changes in land-atmosphere interactions due to evolving ecosystems. In many native vegetation dominated landscapes especially those with significant topographic relief, it is reasonable to anticipate climate induced changes in vegetative communities which would likely affect the "stationarity" of prior statistical relationships.

17. Section 2.4.3 – pg 28 Line 36: Add word “in” after managers

18. Section 2.4.4 – pg 38 Line 1: Change Section number from 2.3.4 to 2.4.4

19. Section 2.4.4 – pg 39 Line 22: Comment – The Mid Pacific Region in collaboration with U. C. Davis has been developing an integrated hydro-biological model (RHEM) of riparian vegetation growth driven by meteorological factors and conducting a field and laboratory research on cottonwood growth and transpiration including the effects of CO2. Some of this work has been published in the report “A Conceptual Framework for Modeling Physical River Processes and Riparian Habitat on the Sacramento River, California”, NODOS Project Report, April 2007. Additional publications are anticipated during 2010.

20. Section 2.4.4 – pg 40 Line 2: Suggest changing “composition (carbon dioxide)” to “conditions (CO2, RH, NR, U)” which were defined in Comment 5 above.

21. Section 2.4.4 – pg 40 Lines 10-12: Comment - The Mid Pacific Region is planning to work with California Water and Environmental Modeling Forum (CWEMF) to perform a peer review of groundwater models used in the Central Valley of California. Climate change modeling would be topic to include in this review.

22. Section 2.4.4 – pg 42 Lines 10-12: Comment – Through Reclamation’s participation in the DOI Landscape Conservation Cooperatives (LCC) an improved understanding of ecosystem relationships and the development of quantitative climate impact assessments and adaptation strategies may be pursued.

23. Section 2.4.4 – pg 43 Lines 19-25: Comment – The Mid Pacific Region has started to explore modifications to the Land Atmosphere Water Simulator (LAWS) model to simulate consumptive use, biomass production and crop yields directly from atmospheric conditions including CO2, T, NR and NR. These modifications to the LAWS model provide general capabilities which could be used in other Reclamation regions.

24. Section 2.4.4 – pg 44 Lines 41-42: Comment – Fire should be added to the Gap 4.12 discussion.

25. Section 2.4.5 – pg 47 Lines 25: Change “the” to “this” before the word “means”.

26. Section 2.4.5 – pg 47 Lines 33: Comment – Add bullet “project capital repayment, operation and maintenance costs “

27. Section 2.4.5 – pg 47 Lines 39-41: Comment – The California Water Plan (CWP) should not be characterized by “isolated researchers and research programs” giving “second-

thought" to planning for climate change. The CWP 2009 Update (www.waterplan.water.ca.gov/) used a multi-scenario based approach to assess a range of potential impacts to water supplies/demands at 2050. This approach addresses many of the limitations discussed in this section.

28. Section 2.4.5 – pg 48 Lines 1-7: Comment – This section seems to apply that finding relevant information on alternative ways to perform Long-term Policy Analysis (LPTA) is difficult to find. A very good source with lots of references and examples related to climate change is given by Lempert et al, 2003).

29. Section 2.4.5 – pg 48 Line 1: Comment – The idea of "**prediction** of future social, economic and institutional conditions…" is a big part of the problem. The LPTA plausible scenarios approach overcomes this problem by focusing on identifying a portfolio of near term actions which can be employed adaptively as future conditions become less uncertain.

30. Section 2.4.6 – pg 52 Line 5: Comment – The use of non-optimization techniques such as those described by Lempert (2007) should also be given careful consideration when conducting adaptation strategy evaluations.

31. Section 2.4.7 – pg 54 Line 19: Change "step" to "steps"

32. Section 2.4.3 – pg 56 Line 7: Comment – There is no footnote for this table.

“Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information”

By: Keith B. Duffy

Item	Page	Comment
1	General	There needs to be additional transparency in terms of climate change research and products coming from primary research institutions such as Universities. Transparency translates to better documentation of climate change data more one on one communication as well as group dialogues. It has been my experience that the some of the CC models tend to be ‘black boxes’ to the uninitiated. Due to budgets and time constraints it is difficult to ‘wrap ones head around’ the over arching concepts. Resources should be dedicated to Knowledge Transfer activities, between researchers and practitioners. Establishing the “Climate Change” Clearinghouses as well as online regional discussion forums is a step in the right direction. One of the biggest issues is coordinating the efforts of multiple agencies both local and federal. This has been a continuing theme expressed at conferences and in informal dialogue.
2	General	Related to resolving Gap 3.2. Basis for culling or weighting climate projections. A generalized, robust and extensible data analysis system is required to digest and analyze large spatial and dynamic data sets. It is likely that the system would be centered around or built up from a “powerful” data base engine. It would also be useful if the system came with a customizable and extensible scripting language such as Python in order that user could exert flexibility in analysis and visualize data better. For such a system it is recommended that the platform start out in a simple yet concise format and workflow to ensure that the system does not become too complicated. I understand some of the requirements are contradictory (simplicity and flexibility).
3	General	Allow researchers access to Agency resources, such as Super Computer resources in order to leverage researchers technical knowledge and client Agency resources. It is often the case that the researcher is resource poor but vision rich while the Client has the resources but not the technical know how nor insights to use resources most effectively. Interaction during resource sharing would encourage knowledge transfer and collaboration.
4	General	Patience is going to be required by Management in order to foster a comprehensive learning and understanding of Climate Change related issues and their interpretation and final incorporation into better planning. Understanding Climate change impacts is not going to “happen overnight” and it will take a longer amount of time to cycle between learning and implementation than is normally seen for other issues facing the Agencies.
5		Related to resolving Gap 3.2. More concise guidance on climate change

		projections selection is required from researchers. This would include more written definition of the projections in question, their strength and weakness for each locale. In addition, visualization software tools to process and visualize specific projection time series would be valuable.
6		I believe it was touched on in the draft document, but I think it would be beneficial to H&H practitioners if CC was represented in (familiar) Probability/Frequency tools (IDF curves, Point rainfall isopluvials etc). I understand that the uncertainty and variable assumptions about which projections to represent, complicate this goal, perhaps past the point of being practical. However, if the science can not provide practical and useable tools, perhaps scarce Agency resources should in general be allocated elsewhere, for the time being.
7		Related to leveraging the Corps strength in possessing significant resources to addressing the Climate Change issue, is there a dedicated USACE department that focuses on Climate Change Related Issues? Would HEC or ERDC (for example) be able to dedicate time and resources to develop tools to address Climate Change/ problems? There are several issues involved with this proposition. However, the underlying need exists. On the other hand I have seen the need to keep the local presence ingrained in the discussion and analysis, as regional peculiarities may significantly affect Climate Change understanding.

From: Lampley, Vechere V SAD [Vechere.V.Lampley@usace.army.mil]
Sent: Friday, April 16, 2010 10:25 AM
To: Brekke, Levi D
Cc: White, Kathleen D IWR; Edmond, Kaiser E SAD; Paynes, Wilbert V SAD; Prince, George R Jr SAD; Dixon, Lester S SAD; Smith, Christopher T SAD; Hinton-Lee, Chris SAD
Subject: FW: RE: SAD CG TASKER: USACE Review of Interagency Report - "Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information"

Sir:
In addition to the input forms that I have forwarded, below are written comments on the subject review from SAJ for your consideration.

1. Adaptive management and robust decision criteria were discussed in USGS Circular 1331 "Climate Change and Water Resources Management: A Federal Perspective" (2009). I believe adaptive management, robustness, resilience, and flexibility are some key tools for water managers to deal with climate change. The stated purpose of this draft report is to build on the foundation established by USGS Circular 1331. However, in my view this draft report barely dealt with the need for robustness, resilience, and adaptive management as tools for dealing with climate change. I feel this should be identified as a gap in tools in this draft report. To me a major impediment to robust and resilient design is focusing on the optimal solution. I think there are policies that need to be revised or changed in order for us to effectively deal with climate change (and for that matter to successfully accomplish environmental restoration). The 30 April 2009 Army Corps of Engineers' document "Building a Stronger Corps: A Snapshot of How the Corps is Applying Lessons Learned from Katrina" at http://www.mvn.usace.army.mil/pdf/USACEPKUpdateReport_Final.pdf argued: "... A key finding from the post-Katrina analysis was the need to adopt a systems approach to project planning and development—to move away from a project-by-project view to a more integrated one. ... Implementing Integrated Water Resources Management requires fundamental changes in the Corps' policies and procedures, but also in the nature of the way the American public views the Corps' role. Legislation and appropriations have an enormous impact on how, where, and when the Corps can conduct its programs. Operating procedures, laws, and policies must adapt as well. They must include provisions for adaptive management—a cycle of disciplined review and analysis of environmental factors and scientific advancement that periodically reassesses system objectives. Adaptive management cannot happen without a conscious and properly-funded planning and evaluation process supported by all levels of government. ...A commitment to organized and transparent adaptive management is the only rational solution to an uncertain future. ..."

2. The concept of using robustness in water resources planning, engineering, and management has been around since at least the 1970's and has some roots in the concept of ecological resilience introduced by Buzz Holling. James Hanchey, Kyle Schilling, and Gene Stakhiv from the Corps of Engineers' Institute of Water Resources (IWR) in their paper "Water Resources Planning Under Climate Uncertainty" (Congressional Research Service, 1989) argued that a robust water resources system is able to absorb the inevitable range of uncertainties associated with the planning and design of a water resources project. These uncertainties include the typically cascading or cumulative uncertainties of model selection, parameters, and data and what is sometimes called strategic uncertainty - i.e., the forecasts of future conditions, needs, and project outputs. The UNESCO Working Group/ASCE Task Committee on Sustainability argued in the book "Sustainability Criteria for Water Resources Systems" (1999) the best way to enhance sustainability is to maintain reversibility and robustness. They defined reversibility as keeping design and management options open or available for future generations and robustness as the ability to adapt to varying and often unforeseen conditions in the future with little additional costs. Robust, or flexible, systems may not

be the most cost effective for the forecasted future condition, but rather are designed to be near cost effective for a wide range of possible future conditions. Adaptive Management (AM) can help address scientific/technical uncertainties by incorporating robustness and flexibility into the planning and implementation, and by learning through monitoring and assessment. One of the Comprehensive Everglades Restoration Plan (CERP) Adaptive Management principles is to incorporate flexibility and robustness into project and program planning, design, construction, and operations to address uncertainty. The National Research Council's Committee on Independent Scientific Review of Everglades Restoration Progress in their First Biennial Review of CERP Progress (2006) supported the use of robustness, which was described as the ability of key design parameters, including engineering, operations, and hydrologic responses, to operate effectively in the face of variability and uncertainty of future events. Flexible alternatives ensure the capacity to change in response to future conditions to optimize restoration performance and improve the chance of success of achieving ecosystem goals. For more details on the use of adaptive management in CERP you can see the draft CERP Adaptive Management Integration Guide Version 3.2 (March 2010) that is posted at http://www.evergladesplan.org/pm/program_docs/adaptive_mgmt.aspx for a 45 day review.

3. There is some concern that climate change may affect the frequency or intensity of hurricanes in the Atlantic Basin. However, I could not find that this was mentioned in the draft report. I think this is an information need for those managing water resources in the Atlantic Hurricane Basin. For some more information on paleoclimate work of interest to us in the Atlantic Hurricane Basin you can see the Atlantic Hurricane Reanalysis Project at http://www.aoml.noaa.gov/hrd/project2005/hurdat.html , the work of Cary Mock at University of South Carolina at http://www.cas.sc.edu/geog/research/climatelab/climmock.html , and the NOAA Technical Memorandum NWS SR-224 Chronological Listing of Tropical Cyclones Affecting North Florida and Coastal Georgia 1565-1899 by Al Sandrik and Chris Landesa at http://www.aoml.noaa.gov/hrd/Landsea/history/index.html .

Vechere' V. Lampley
Senior Regional Environmental Specialist
South Atlantic Division, Corps of Engineers
404-562-5227

Region 8 DRAFT Comments on
"Addressing Climate Change in Long-Term Water Resources Plan Needs …"

Thank you for providing a very thoughtful, structured process for U.S. Army Corps of Engineers (USACE) and Bureau of Reclamation (BOR) to gather comments on "Addressing Climate Change in Long-Term Water Resource Planning and Management: User Needs for Improving Tools and Information" (the report). We agree that improved tools and information are needed by our agencies to better incorporate global climate change information into our management of water and water-related resources. We need to inform ourselves and others about the potential impacts of climate change, reduce our vulnerability, and ultimately take steps to adapt and mitigate. We need to devise adaptation measures including management processes by which we can deal with the challenge.

Rather than focus on the topics covered well in your document and feedback form, we determined that it might be more helpful to provide comments on the topics that appeared to be critical knowledge gaps in the flow of activities proposed in the documents and excel spreadsheet. Also we have attempted to provide examples to better illustrate each of our suggestions.

1. Scope – Is climate relevant to the proposed project, solely or cumulatively?

Consideration needs to be given as to whether climate change is relevant to a proposed project, either directly or cumulatively. Changes in climate may affect the reliability of a project, and also affect the magnitude of potential cumulative impacts. In cases where the impacts of a project may be exacerbated by climate change, the environmental review should include an analysis of climate change.

Uncertainties as to how the climate and hydrology of a region will change in response to a global greenhouse warming are enormous. We agree at stated in section 2.4.8 that uncertainties in the evaluation's results must be disclosed and related to interpretation of results. However, one of the more likely impacts in our Region involves areas where precipitation currently comes largely in the form of winter snowfall, and where the annual hydrograph is dominated by a single late spring/early summer snowmelt peak flow. A warming would likely result in a distinct shift in the relative amounts of snow and rain and in the timing of snowmelt and runoff. A shift from snow to rain could increase the likelihood of flooding early in the year and reduce the availability of water during periods of peak demand, especially for irrigation. Many of the basins in the western United States are vulnerable to such changes as summarized by the Resources for the Future. We suggest a new Step 3.1 to address when and how a project needs to address Climate Change.

This issue is illustrated in the following example for the Northern Integrated Supply Project (NISP) in Colorado, a water supply project that proposes two new reservoir sites and uses agricultural and junior water rights from the Poudre River. In the NEPA document review EPA recommended at a minimum the EIS discuss how climate change may affect the reliability of the proposed alternatives, how climate change may further increase the

cumulative impacts to the resources affected by NISP and potential adaptation measures that may be needed over the life of the project. The "Joint Front Range Climate Change Vulnerability Study" would be directly applicable to NISP. A draft of the "Colorado River Water Availability Study" is available online and would be useful in identifying issues that may be transferable to NISP. The "Colorado Climate Change: A Synthesis to Support Water Resource Management and Adaptation" at: www.cwcb.state.co.us/Home/ClimateChange.

Furthermore in this example, Greenhouse Gas emissions for proposed projects are cumulatively relevant at a site specific level as required in the draft CEQ guidance on climate change and NEPA at: www.ceq.hss.doe.gov/current_developments/new_ceq_nepa_guidance where it does mention calculating greenhouse gas emissions from indirect impacts.

NEPA demands informed, realistic governmental decision making. CEQ proposes to advise Federal agencies to consider, in scoping their NEPA analyses, whether analysis of the direct and indirect GHG emissions from their proposed actions may provide meaningful information to decision makers and the public.

2. Data collection for regional specific modeling of both water quantity and quality, Not just downscaling of existing data and models.

The question is not just whether regional projections of climate change available, as suggested in Figure 4 of the report, but if that data can be collected and made available to make decisions. We suggest that there be a new Step 1.3 or an added Step to 2 to address new data collection. Part of the task would be to identify gaps and collect new data to inform modelling based upon this new data. Then as the project develops and is placed on line, data collection to inform adaptive management decisions is also needed.

Paleo-climate proxies, such as paleo-drought from tree-ring data and paleo-flood data collected for dam safety reviews or from geo-morphological mapping, may be useful to make the database upon which we make decisions more robust.

It is our understanding that topography and evapotransporation are major factors that have not yet been adequately addressed in the global climate change models. The coarse spatial resolution of climate models limits their ability to represent topographic effects related to snowfall, snowpack evolution, and regional precipitation patterns (Grotch and MacCracken, 1991; Giorgi and Mearns ,1991; Pan et al., 2004; Reclamation, 2007). Information that is needed to forecast water availability should include the evaluation of the quality of water with respect to the potential water uses. The availability of quality water also includes temperature and sediment levels adequate to meet the potential water use. Hurd and Coonrod (2007) report potential adverse water quality (including increased water temperatures) and reduced streamflow impacts that will affect aquatic habitat. Reduced flow also reduces dilution of contaminant concentrations.

Attached is an example of how the people in Montana would like to have climate change data presented in a form that they can use to make management decisions.

3. Evaluation of Alternatives - Resiliency versus optimization of project design and operation.

The effects of climate change on local and regional water supply and demand is largely unknown. This issue reinforces the need for institutions that facilitate adaptation to whatever the future brings and promote more efficient water management and use. Unlike the structural supply-side approach, demand management that introduces incentives to conserve and opportunities to reallocate supplies as conditions change does not require long lead times, large financial commitments, or accurate information about the future climate. Water supply, demands and constraints, as stated in section 2.2.1, are variable, but each should be given weight in decision-making. To move toward sustainability, it is critical that water resources management frameworks address the interactions among elements in each of these sectors. Scenario development and adaptive management need to include alternatives such as conservation, reuse and aquifer recharge.

Furthermore, resiliency under new conditions demands that project design include monitoring and adaptive management rather than optimization based on limited retrospective data. We need to determine how our built water systems and our governance systems can be made more reliable, resilient and sustainable to meet diverse and often conflicting needs, such as minimizing consumption of water for energy generation. In order to address this question we require a holistic, predictive understanding of complex water cycle and water resource processes, the feedbacks associated with the water system, and the vulnerability and resilience of water systems to climate and anthropogenic change. (National Science Foundation,)

In order to address this question we require a holistic, predictive understanding of complex water cycle and water resource processes, the feedbacks associated with the water system, and the vulnerability and resilience of water systems to climate and anthropogenic change.

In the Moffat Collection System Project in Colorado, currently under NEPA review, the applicants have proposed to meet almost half of the identified water supply need using conservation approaches. They also considered small amounts of aquifer recharge as an alternative to meet a portion of this demand. While this project utilizes conservation as a tool for demand reduction, in the future, conservation and similarly sustainable options should be considered viable alternatives to meet water supply needs.

From: Brown, Curtis A
Sent: Tuesday, May 11, 2010 3:57 PM
To: Brekke, Levi D; Hennig, Charles C
Subject: FW: Reminder and time extension to contribute to the Reclamation/USACE climate change user needs document

Curt Brown, PhD
Director, Research and Development
Bureau of Reclamation, 86-69000
PO Box 25007
Denver, CO 80225-0007
office: 303-445-2098
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From: Jones, Jeanine [mailto:jeanine@water.ca.gov]
Sent: Tuesday, May 11, 2010 3:12 PM
To: Brown, Curtis A
Cc: Nathan Bracken
Subject: RE: Reminder and time extension to contribute to the Reclamation/USACE climate change user needs document

Dear Curt and Levi,

Thank you for the opportunity to review this document. Comments on behalf of the Western States Water Council are attached. The comments have been provided on the spreadsheet form you requested, but we'd like to use this e-mail message to highlight a few over-arching points:

► Monitoring and data collection. This topic is virtually absent from the document (except for a brief mention on page 2), and no discussion is provided is provided on how monitoring and data collection relate to the overall scope of work being planned under the Secure Water Act. While the Council has gone on record as supporting climate change research – especially as it relates to regional climate modeling – it's fair to say that maintaining federal funding for basic data collection (e.g. USGS stream gages, USDA Snotel sites, NOAA's HRCN/Co-op program) trumps all in terms of priority. We believe that somewhere in the world of federal climate change adaptation, funding must be provided to maintain important long-term hydroclimate monitoring sites, as well as to add new monitoring sites (e.g. in higher elevation alpine rain to snow transition zones) for change detection and attribution. Data collection and analysis is a basic function of long-term planning (the focus of this document), and needs to be addressed here. Also, research to define needs for new monitoring networks/integration with existing networks would be a valuable addition to this document.

► Priorities. Individual member states of the Council have different levels of interest or ability to make use of climate change information and research. The priority ranking on the attachment is intended to favor those items that could provide the most benefit to the most states.

► Intended audience. The research community is described as the intended audience of the document, and the level of writing is targeted to that audience. However, you have asked practitioners to review the draft. If you intend to have wider distribution of a second draft in the practitioner community – or if you intend to document to have any utility for practitioners – it needs to be written for a broader audience. As now written, few in the practitioner world would be willing to read it.

Jeanine

Jeanine Jones

Interstate Resources Manager, California Department of Water Resources

(916) 653-8126

From: Montano, Janet L [mailto:JMontano@usbr.gov] **On Behalf Of** Brown, Curtis A
Sent: Tuesday, April 20, 2010 2:10 PM
To: Amy Larson (amy@waterways.org); Arpita Choudhury (achoudhury@fishwildlife.org); Association of State Drinking Water Administrators (info@asdwa.org); Bill Rinne (Bill.Rinne@lvvwd.com); Brian Brady (bjbrady@iid.com); Brian Parsons (bparsons@asce.org); Chris Wood (cwood@tu.org); Dan Keppen (dankeppen@charter.net); David Behar (dbehar@sfwater.org); Earl Smith (earl.smith@arkansas.gov); Eric Kuhn (Ekuhn@crwcd.org); Eric Wilkinson (ewilkinson@ncwcd.org); Chung, Francis; Frank Kim (fkim@asce.org); Jay Lund (jrlund@ucdavis.edu); Jones, Jeanine; Jeanne Christie (jeanne.christie@aswm.org); Jennifer Gimbel (jennifer.gimbel@state.co.us); John Doyle (jdoyle@joneswalker.com); John Sullivan (John.Sullivan@srpnet.com); Jonne Hower (jhower@wswc.state.ut.us); Kay Brothers (kay.brothers@lvvwd.com); Larry Dozier (ldozier@cap-az.com); asfpm@floods.org; Linda Eichmiller (l.eichmiller@asiwpca.org); Linda Spiegal (lspiegel@energy.state.ca.us); lspragens@damsafety.org; Marc Waage (Marc.Waage@DenverWater.org); Mark Rentz (markr@acwa.com); Michael Sanio (msanio@asce.org); Michelle Maddous (michelle@maddauswater.com); Anderson, Michael L.; Mike Charles (mcharles@asce.org); Mike Wade (mwade@farmwater.org); Nigel Quinn (nwquinn@lbl.gov); Paul Fleming (Paul.Fleming@seattle.gov); Rich Satkowski (cwemf@cwemf.org); Roger Patterson (rpatterson@mwdh2o.com); Susan Gilson (sgilson@nafsma.org); Terry Sullivan (terry_sullivan@tnc.org); Tom Donnelly (tdonnelly@nwra.org); Tom Iseman (tiseman@westgov.org); twillards@wswc.state.ut.us
Cc: Gabaldon, Michael R; Finkler, Kira L; Robert.A.Pietrowsky@usace.army.mil; Quint, Robert J (Bob)
Subject: Reminder and time extension to contribute to the Reclamation/USACE climate change user needs document

This is a reminder, and an extension of time until **May 14, 2010**, to contribute your perspectives to the draft document *Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information.* The document was jointly prepared by the U.S. Bureau of Reclamation and Army Corps of Engineers (ACE) and can be downloaded at: http://www.usbr.gov/climate/userneeds/, along with more information about the document and how to contribute your perspectives. I sent the original invitation from myself and Mr. Robert Pietrowsky, Director, Institute for Water Resources, USACE to you by email on or about March 23, 2010.

Based on requests from a number of organizations, we have added an option to contribute your perspective in any form that you wish. Although our preference is to receive your perspectives and feedback in our structured feedback form (i.e. the first two tabs of the spreadsheet found at http://www.usbr.gov/climate/userneeds/), we will accept feedback in any form that works best for you (e.g. using the new third tab on the feedback form, e-mail, separate WORD document, memorandum, etc.). However, on the spreadsheet form, we're still interested in your priority indications for each gap statement in the space provided on the first tab.

Curt Brown, PhD
Director, Research and Development Office
Bureau of Reclamation, 86-69000

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WUCA
Water Utility Climate Alliance

Via Email

June 18, 2010

Curtis Brown
Director, Research and Development Office
Bureau of Reclamation
Denver, CO 80225-0007

Re: Comments on draft paper "Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information"

Dear Curtis,

Thank you for the opportunity to comment on the draft paper "Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information" ("Draft"). Our perspective will focus on water supply and management challenges covered in the paper, rather than flood control aspects.

The Water Utility Climate Alliance (WUCA) formed in 2007 to provide leadership and collaboration on climate change issues affecting the country's water agencies. The creation of WUCA stemmed from the firm belief of the eight founding members, now expanded to ten utilities delivering drinking water to over 43 million Americans, that climate change will exacerbate current challenges faced by the water sector as well as create new challenges that require focused attention and enhanced collaboration. Our primary focus has been on adaptation. Our members have testified before Congress over formation of a National Climate Service, engaged in processes developing a Strategic Plan for a National Assessment, tracked implementation of the Department of Interior's Secretarial Order 3289, served on EPA's Climate Ready Water Utilities Working Group, worked closely with Regional Integrated Sciences and Assessments (RISA) programs in a number of regions, and spoken at numerous conferences and workshops on adaptation issues on behalf of the water utility and adaptation communities. WUCA has collectively commissioned two well-received white papers on climate modeling and decision support planning (available at www.wucaonline.org) and has contributed to the development of consensus adaptation principles for the water sector (available at www.waterclimateforum.org/principles.html). Finally, individual members of WUCA have conducted and are today conducting some

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of the most advanced local impacts assessments to date, including downscaling studies, and therefore have direct experience in assessing climate impacts and developing adaptation strategies.

In our view, the Draft represents one of the best explorations of a core methodology water managers are using and will likely continue to use to evaluate the effects of climate change on their systems. Though at times difficult to penetrate and repetitive (in some respects we preferred the clarity of the July 30, 2009 revision), the Draft appears exhaustive in its literature review and systematically outlines key steps in the impacts assessment process. We believe these lines of analysis should continue to be pursued by the Bureau/Corps partnership, and be expanded as outlined below to include collaboration with water managers at the state, local, and regional level.

Comment

Our first comment is a general comment on the Climate Change and Water Working Group (C-CAWWG), the collaborative forum arising from the foundation established by USGS Circular 1331 and from which this paper emerged. A backgrounder (at http://www.esrl.noaa.gov/psd/ccawwg/docs/ccawwg_012010.pdf) lists two primary purposes for C-CAWWG:

1. Work with the water management community to understand their needs.

2. Foster collaborative efforts across the federal and non-federal scientific community to address their needs in a way that capitalizes on interdisciplinary expertise, shares information, and avoids duplication.

The Draft further describes C-CAWWG as intending to "generate collaborative efforts across members of the water management and scientific communities to develop, test, and apply new methods, tools, and capabilities."

We are unaware of the degree to which these collaboration and outreach efforts have taken place to date. WUCA member engagement in other federal climate change enterprises has made it clear we share the goals stated above (e.g. WUCA comments to Interagency Climate Change Adaptation Task Force, May 14, 2010). If outreach and collaboration efforts are planned, we request that our utilities, among the leaders nationally in addressing climate vulnerability at the local level, be included. (We may even have a few collaborations of our own that might support C-CAWWG's mission.) If outreach to expand the reach of C-CAWWG beyond federal agencies is not currently planned, we suggest this element of the C-CAWWG mission would be highly beneficial to federal and non-federal actors alike and should be pursued.

Comment

The outline and conclusions in Section 2.4 (Step-by-Step Capabilities in Quantitative Approach) offer valuable guidance to water managers seeking to integrate climate modeling tools in impacts assessment and planning. Our white paper, "Options for Improving Climate Modeling to Assist Water Utility Planning for Climate Change" – cited in the Draft – reaches similar conclusions as to the difficulties inherent in using these tools and the desirability of investing in enhanced skill both in general and for downscaling approaches in particular. Several WUCA members have pursued assessments in line with the step-by-step approach outlined in the Draft, and four members in particular are currently pursuing an ambitious assessment of both water supply and stormwater system vulnerability which will require us to follow many of these steps. In efforts like these, assessing the skill and uncertainties associated with each modeling tool will be critical in aiding planners and decision-makers.

Following are a couple of specific related comments:

1. You state that "Reclamation and USACE have access to a large collection of current global climate projections (and) numerous types of downscaling techniques." (p. 24). A footnote then states "… it is understood that members of the broader water management community share the same access as Reclamation and USACE, except in instances where noted."

   We believe the footnoted statement is theoretically true but in practice not true at all. While some utility managers have actually used certain datasets, such as the DCP archive, that number is miniscule compared to the number who aren't even aware that database exists or how to use it. The NARCCAP database, while used by the academic research community we believe, has not been directly used by non-federal water managers to our knowledge. And other potential modeling tools, including a number of dynamical and statistical downscaling tools and methods, as well as high resolution GCM output or perturbed physics approaches, are research subjects for WUCA precisely because we are generally unaware of their nature, skill, scales, and availability for our purposes. This is not at all a critique of federal water managers, of course, but rather goes to the vast chasm that currently exists between climate science *providers* and climate science *users*. Collectively, Reclamation, USACE, and the Water Utility Climate Alliance (not to mention NOAA, OSTP, EPA, USDA and additional federal and local partners) need to come together to help create a climate services structure, information flow, and science translation capacity that makes footnote 11 on page 24 of the Draft accurate.

2. The "culling and weighting" discussion, explored at a workshop attended by federal managers in 2008 and in Section 2.4.3, is a prime topic of interest to WUCA members. We have not reviewed the 2008 Brekke et al article cited, but it appears to focus on

GCM weighting. We suggest that an area of additional focus – and an area of potential collaboration with WUCA – would be to expand the culling and weighting analysis to other tools, particularly those producing output at spatial and temporal scales most suited for utilization in the hydrology models water managers use to calculate watershed runoff and reservoir storage. This is in line with Gap 2.3 of the Draft (p. 26), which points to the need to develop "information on the strengths and weaknesses of downscaled data and the downscaling methodologies used to develop these data." The skepticism on the part of water managers cited in the Draft as to the applicability of regional projections is accurate. It would also likely be true to say that these tools have been and will continue to be used in the absence of other options, and that therefore improving our understanding of what these tools do and don't do, the nature of uncertainties embedded in their outputs, and approaches to determining which are best used in impacts assessment is critically important.

Also important, as outlined in some detail in our white paper, is enhancing investment in research, computer time, and applications related to these tools to improve their skill over time. We encourage future C-CAWWG work to focus on what specific steps should be taken to enhance the skill of regional projection tools and better define how water and other resource managers at the state and local level can use these tools, including building upon the recommendations in the WUCA white paper.

We appreciate the opportunity to comment on the Draft, and your consideration of our views. Please don't hesitate to contact me at (415) 554-3221 or dbehar@sfwater.org if you have any questions.

Sincerely,

David Behar
Staff Chair
Water Utility Climate Alliance

cc: Levi Brekke