REPORT

Water Managers Roundtable

Tuesday, March 18, 2008
8:30 a.m. – 3:00 p.m.

NOAA Earth System Research Laboratory
325 Broadway
Boulder, CO 80305

Sponsored by:
United States Climate Change Science Program
Western Governors' Association
Western States Water Council

Introduction

On March 18, 2008, the US Climate Change Science Program (CCSP), Western Governors Association (WGA), and Western States Water Council (WSWC) convened a roundtable of water managers and scientists from the western United States. The purpose of the roundtable was for CCSP to hear from a variety of water managers about their interests and activities, informational needs, and expectations for and ideas about future directions for climate research, observations, decision support, and communication as it relates to water management, particularly in the western United States. Participants had varying degrees of familiarity with the program (from never having heard of CCSP to working closely with the program) and represented a broad range of perspectives, including federal, state, and local government, water utilities, and academia (a full list is available in Appendix A).

During the discussion, we used the following broad topics to guide conversation:

1. Perspectives on climate data (measurements) and observations
2. Perspectives on climate products and services
3. Building relationships between CCSP and water sector information users
4. Time for a national climate service?

During the roundtable, we used several more specific questions to further prompt participants thinking about these topics (see Appendix B for the meeting agenda). The points raised during the discussion were recorded on large wall charts so that participants could review, revise, and expand upon their answers. As the dialogue progressed, it became evident that many of the issues related to the provision of climate information cut across the questions and are relevant for a variety of user communities.

The following summary attempts to draw out the themes that arose throughout the discussion. However, the issues covered here represent only a sample of those that water managers are and expect to be facing – there are many interactions between climate and water quantity, quality, and management that require long-term attention and effort. The discussion is summarized in this report using the following categories:

- Federal Observing Systems
- Federal Research and Development Programs
- Role of the Federal Government in Climate Change Research and Communication
- Water Supply- and Demand-Side Information Needs
- Data: Needs, Management, and Accessibility
- Research and Information for Applications
- Decision Support
- Interaction, Coordination, and Partnerships

Prior to releasing this report, CCSP provided roundtable participants with the opportunity to review this summary and provide additional comments and revisions, which have been incorporated into the final report.

Federal Observing Systems

Snow

SnoTel (SNOwpack TELemtry, a USDA NRCS product) provides data that many managers use. Additional monitoring data (e.g., winds, soil moisture) could be added to SnoTel fairly inexpensively or through coupling SnoTel sites with SCAN (Soil Climate Analysis Network, a USDA NRCS product) sites. These data would likely prove very valuable, making the potential loss of SnoTel much greater. While it may never be possible to have a "complete" SnoTel or SCAN, the current and planned distribution of sites should be analyzed and the results used to determine the most critical / beneficial places to install new sites.

SnoTel does not cover much of California and also has limited coverage in some other areas. California has a cooperative snow observations program that provides similar information plus additional runoff forecast products. California's program is a cooperative effort of state, federal, and local agencies and private utilities. Snow cover data is also needed – some of this can be provided through MODIS and SnoDAS (SNOw Data Assimilation System, NOAA / National Weather Service), although there are some limits of remote sensing, such as limited ability to parse snow cover within areas that also have high tree cover.

Data related to snowpack and snowmelt that are needed include how precipitation patterns might change with changing climate and how runoff patterns and timing will change with changes in snowmelt. Additional snow-related data needs include the timing and outcomes of rain on snow events and snow sublimation data from open sites.

Stream Gages

The USGS National Stream Information Program and associated stream gages are important data sources, with continuous records spanning years to decades. However, there are several concerns about the sustainability of both the network of gages and the associated data streams.

- Additional and more accurate gages are needed, including gages that are better able to measure low flows.
- Long-term data is the key to understanding climate change, thus as the gages are phased out or otherwise lost (e.g., through the designation of a "wilderness area"), these continuous series of data – and good chances for measuring and understanding climate change – are lost. Funding streams for continued operation of gages and exemptions allowing for basic data collection in wilderness sites would assist in preserving and sustaining these long-term data sets.
- The gages themselves are "old technology," but there is little or no money to update them with new and additional sensors.
- These gages are often now paid for in full by cooperating partners rather than by USGS and there is a need to ensure consistency in gage platforms so that data can be compared between sites. Absent federal funding for climate science quality information, there is no reason for USGS cooperators to fund a higher level of instrumentation and quality assurance / quality control than they need for their own purposes.

Remote Sensing

Remote sensing data are likely to become increasingly important, as evidenced by the large portion of CCSP budget devoted to MODIS, LandSat, and other remote sensing. Many data sources already exist, but these may be available in useful formats or at appropriate scales, managers are not necessarily aware of the existence of the data, or they may not know how to use the data. An important question to consider is how water managers educate themselves about what is available and how they integrate this available information into their day to day operations and planning. In addition, there should be a venue in which managers can keep abreast of any potential threats to sensors and data streams. One way to help users identify this information is through a CCSP or other federal "stamp" that identifies high quality data and how it is supposed to be used, similar to the "stamp" for the Synthesis and Assessment Products.

Different users have different priorities for and metrics for "success" of a project: for example, NASA is worried about completing a project on time and on budget, while users of the information are worried about the number and types of sensors. For example, although the Landsat series of satellites has been very successful as measured by the extensive use resource managers make of the imagery, the LandSat Data Continuity Mission is considered a failure in another regard, as it may lack critical sensors (e.g., possible loss of a thermal infrared sensor to the next follow-on Landsat) that could be important for water, carbon, ecosystems, and land use managers. Another problem associated with Landsat is that NASA built and launched the satellite, but operation is being handed over to USGS, which has a different mission than NASA.

There needs to be a class of intermediaries who can work at the interface of science and management and can help to identify existing tools, tools in need of further work, and new tools that might be useful and to implement "gap filling" techniques, such as using GIS tools in place of missing thermal band on Landsat.

Federal Research and Development Programs

Regional Integrated Sciences and Assessments (RISA)

The eight NOAA RISAs are funded at a fairly low level, but provide key interactions between academic, state, and federal researchers and translation functions between science and decision making. For example, the Climate Impacts Group (Pacific Northwest) includes a state climatologist and the project gets a lot of respect both in the academic and management communities.

The RISAs were formed with the anticipation of eventually having an operational entity that will take over and expand on their work, but so far there are no prospects for this to occur.

The RISA programs recently sent a letter to CCSP [during the public comment period on the draft Revised Research Plan] detailing the need for better coordination across federal agencies, an interagency communications strategy, early stakeholder involvement and coproduction of knowledge, use of social science to understand decision environments and constrain priorities, and production of useful regional-scale information, knowledge, and decision support tools.

A "multi-agency RISA," perhaps coordinated through the CCSP, would be helpful in expanding the concept to other aspects of climate change not covered by the current format.

Federal Grants Programs

The federal science agencies have research and grant programs that the academic community is well aware of, but management practitioners often do not know much about these programs. Managers expressed frustration with the academic focus of agency research programs, which rarely have strong connections to the management community even when explicitly focused on applications. One way to reduce this problem and to encourage better alignment between science and applications would be to engage in more "user-driven" research programs that draw on the input of managers (e.g., through targeted or ongoing dialogues with the user communities about requirements, key decision cycles, and other issues) to craft calls that are responsive to specific sets of user needs. These should occur in addition to more "academically-driven" research programs that generally focus on discovery science.

While "curiosity-driven" research is important, the results need to be better communicated and translated in order to be useful to water managers (CCSP's *Our Changing Planet* provides some results; also see "Data Clearinghouse(s) and Other Services," p. 10). Grant programs should encourage and foster interactions between academic and user communities at the start of the process, as plans to implement outreach later in the process are not always fully considered in the review process or enforced once the grant is in place.

Additional Activities

The NASA Applied Science Office is one place that may fund research on management and applications. NASA has yearly solicitations through Research Opportunities in the Spaces and Earth Sciences ('ROSES') providing approximately $6 million dollars yearly for end to end projects and feasibility studies. This current year NASA is highlighting climate change and water resources.

The National Research Council recently received (via an appropriation to NOAA) $6 million to look at the frontiers of climate science, mitigation, adaptation, and climate services. Activities associated with this study may be one place for managers to provide additional input about climate information and service needs. The planning processes for this work are currently underway and workshops are planned for 2009; more information is available from http://dels.nas.edu/basc/climate-change/index.shtml.

Role of the Federal Government in Climate Change Research and Communication

The US Climate Change Science Program

Although there is a Water Cycle Interagency Working Group in the CCSP, its focus is primarily on the physical science side of water, rather than on the applications that might be of greater interest to water managers. More attention needs to be focused on the water management sector – perhaps through an additional working group, including water managers in the existing Water Cycle Science Steering Group, or other forms of engagement with entities such as the Association of State Floodplain Managers, National Water Resources Association, American Waterworks Association, and Water Environmental Research Foundation, and with federal agencies that are not well integrated into CCSP efforts (e.g., the water quality side of EPA, US Bureau of Reclamation, US Army Corps of Engineers).

There are very few mechanisms for reporting successful interagency cooperation as a part of the current federal government performance measurement process, so CCSP-related activities may not be recognized or acknowledged.

The CCSP Coordination Office is fairly small (10-20 staff) and there is not a central budgetary authority for interagency projects. Because of this, it is often difficult to determine who is responsible for initiating and carrying out large projects and users cannot go to a "one stop shop" to provide input on research and information needs, review available data and research results, and access products. While the CCSP products (e.g., Our Changing Planet, Synthesis and Assessment Products) and websites do provide some synthesis of information, additional attention to how best to promote and distribute products within the user communities and to organization of the websites is still needed.

Interactions between Federal, State, and Local Government

Climate activities at the federal, state, and local government levels are still highly "balkanized," although recent discussions about organizing a national climate service under the auspices of NOAA or as an interagency enterprise may help to address some concerns.

There are currently no formal mechanisms to expand and replicate local programs – just the hope that professional networking activities (e.g., conference attendance, etc.) and other coincidental encounters will be enough to move ideas toward broader acceptance. The federal government could help to coordinate the flow of information about various programs amongst regions, serving as a bridge between local, state, and regional efforts while allowing these activities to remain relevant at these scales.

Although some state and local governments have demonstrated leadership in addressing climate change, many state and local governments lack any formal requirements to take climate projections into account when making decisions (even long-term decisions about infrastructure). Therefore, the federal government needs to find a way to overcome this lack of incentive to participate if it does attempt to provide the coordination function mentioned above.

Information Needs about Water Supply and Demand

Supply-Side

A key challenge for water managers is how to deal with potentially-significant and highly uncertain information about potential climate change. Therefore, they need climate scenarios to provide a range of future climate change and some notion of its uncertainty to help determine if water supplies will be adequate and how to deal with short-term and seasonal changes in supply. In addition to these likely ranges, managers need more information about extreme events (e.g., storms, drought) in order to make plans for operations during times of very high or very low water supply. Typically extremes, rather than means, drive water management planning.

Forecasts for multi-year climate patterns that affect supply (e.g., El Niño Southern Oscillation / ENSO, Pacific Decadal Oscillation / PDO) are needed in order to carry out long-term planning for reservoir rule curves and operating guidelines.

Downscaled forecasts (e.g., watershed or regional scale) for climate-induced changes in hydrology need to include the following:

- Runoff, including seasonal timing of runoff and short-term runoff during storms
- High resolution climate forcing data that include precipitation, temperature, humidity, solar radiation
- Wind and soil moisture, especially needed are more and better data and forecasts for high elevations

Accurate measurement of water quantity is increasingly important for compacts related to water supply (also see “Stream Gages,” p. 3).

A best practices manual that translates the array of data and predictions into “best assumptions” about how water supply might change would be useful.

Demand-Side

There has been little attention paid to how demands for water are likely to change over time. Better information is needed about potential changes in the demand side of water management, including high-resolution spatial and temporal predictions showing how changes in demography and climate will impact the use (e.g., domestic / sanitary needs, commercial agriculture practices) and value of water. Of particular importance is the development of better demographic forecasting tools that can incorporate climate change impacts on future population growth and distribution.

Data: Needs, Management, and Accessibility

Data Gaps

Data are essential for managers to do their jobs. Without sufficient data sets, managers are unable to document problems in the environment or to evaluate the success of their management practices.

Benchmark data sets (e.g., natural or unimpaired streamflow) and comparative site data are needed, especially for activities which require baseline information as a part of decision making.

Paleoclimate data, which can help in creating reconstructions of precipitation and streamflow, can be very useful as a public awareness and outreach tool as well as for planning and modeling, but they are not widely available. This paleoclimate data, when available, can often be easily integrated into existing analytical tools commonly used by water managers.

Key data gaps include water quality and sedimentation, groundwater information (trends in elevation, bracketing of uncertainty, regional models, and links to existing models such as ModFlow or GSFlow), evapotranspiration, and winds.

Data on current and potential landscape changes within watersheds, including insect infestation and impacts, fires, and land use / land cover change, are needed to determine potential changes in stream temperature, water quality (especially important for areas that currently employ filtration avoidance measures), and hydrology.

There often seems to be an assumption on the policy side that the data are there, despite numerous reports to the contrary. While there are numerous written materials from a variety of sources that document data gaps, these reports are often fairly narrowly focused and are often not brought to the attention of Congress (e.g., through briefings to Congressional staffers) or other decision makers. A comprehensive survey of where the data gaps exist for water resources issues and potential ways to fill these gaps is needed, perhaps through a process similar to that which produced the *Decadal Survey of Earth Observations from Space*. In addition, a concise summary of the survey (one to a few pages) and a list of key recommendations or priorities arising from the survey should be developed, along with a strategy for bringing the survey to the attention of decision makers (e.g., Congress) and other stakeholders who may be able to provide additional support for the recommendations (e.g., real estate, development, and business communities).

Data Accessibility

Various data sets on water quality and stream temperature exist, but these are often non-continuous and not well coordinated.

Data should be available in common formats such as HydroXML so that they can be more easily used in a variety of applications.

Proprietary issues with data must be resolves in order to provide geographically and temporally integrated data sets.

Research programs do not always focus on user-driven research and practitioners are often not involved at the front end of the research process, thus by the time that research is ready to transition to end users, there is rarely funding, expertise, or structure to provide translation. However, some information is often better than none, and basic data sets can still be very useful in seeding management activities. Management agencies may also be able to do some of the data transformation, analysis, and interpretation using their own resources and expertise, and in some cases find the raw data sets better suited to their needs. On the other hand, many local and state management agencies do not have the capacity to complete large-scale data transformations to meet their needs, so some translation functions and initial work to make sure that data are accessible will always be necessary.

Data Clearinghouse(s) and Other Services

Data clearinghouse(s) will help managers identify what data are available and how to access them. CCSP should investigate ways to implement clearinghouse functions that will identify data, important studies, and products coming out of the federal government, academia, and other sources that are of use to managers, especially those items that come out of CCSP-supported activities. An abstracting service or listserv that provides a short description of the study or report, data stream, or product could provide some of the needed information; the summaries provided by the RISAs at Scripps Institute of Oceanography and the University of Colorado are an example of this on a small scale. Another method of providing updates on available data and tools could be through the implementation of a regularly-scheduled teleconference or videoconference that includes both managers and scientists within a particular region, similar to those organized by the Alaska RISA.

Creating a team of federal managers (similar to the Federal Support Team formed by the Western States Water Council) may be one way to quickly identify and organize various streams of data coming out of the local, state, regional, and federal agencies. In the long term, there should be a federal liaison that can help local, state, and regional managers understand and access the variety of data sources available.

Data from several sources should be consolidated or made accessible through a web portal in order to help identify where data is currently being collected and where gaps still remain. However, web portals alone are only a small piece of the toolkit needed to communicate and translate program information to users. An important issue is developing protocols for integrating data into a larger data management system fairly quickly while also keeping costs low and following appropriate quality assurance and quality control practices.

Tools that automatically download data and clip them to a particular region or location, such as SnoDAS is able to do, are useful in linking data streams with decision support systems.

Downscaled data are important, but before these data can be widely used, there are several considerations that must be addressed: “best practices” for downscaling and groundtruthing these downscaled data, including confidence levels and assumptions made during downscaling; standards and requirements for metadata, such as how and when sensors have been upgraded; and how various standards and protocols for data gathering and downscaling line up. Downscaled data must be provided in formats that are useful to water managers (e.g., climate modelers use gridded data, while water managers use discrete data points).

The Western Regional Climate Center (http://www.wrcc.dri.edu/) provides a good example of a data clearinghouse (oriented more toward climate scientists than water managers), but some users may be put off by the need for a user name and password for long-term access to the data (even though access itself is free). Other data systems that water managers currently use include the California Data Exchange Center (CDEC), SnoTel, the Snow Data Acquisition System (SnoDAS), various National Weather Service databases, and various USGS databases. In many cases, these sources have a vast amount of data, but it is difficult or time consuming to track down all of the needed data sets.

One possible aid in collaboration would be a clearinghouse that could assist in identifying priority stream gages for installation and upkeep and facilitate cooperation of management agencies in funding these priority gages through pooling of resources. Such cooperation may also provide the added benefit of encouraging data users to look beyond their basin in building partnerships.

Those designing and implementing a clearinghouse should consider how to make sure that potential users know where the data is and how to access it – this should include outreach and training activities as a part of the ongoing clearinghouse function. Issues that must be considered early on include what types of training would be available (e.g., in person, web FAQs, etc.), who would be responsible for training, where financial and technical support for training would come from, and how to best engage the people and resources necessary to carry out training.

Research and Information for Applications

The next round of IPCC assessments is unlikely to provide results at a finer scale; instead, it will likely expand the number of disciplines in which it reports results (e.g., biogeochemistry, ecology). A challenge to the federal government and other researchers is thus to go beyond the activities of IPCC by conducting research and reporting results at local and regional scales.

More information is needed about the ecological thresholds of change and climate change effects on important species, including feedbacks of these changes to the water system and to the social systems that depend on those ecological and water systems. For example, one line of inquiry might relate to how earlier spring runoff might impact the timing and availability of water for recreational fishing and boating and how these changes might be mitigated by changing the operation of reservoirs and dams. Another line of inquiry might follow the impact of changes in water supply on wildlife habitat (including habitat for threatened and endangered species such as salmon) and how these impacts might impose additional constraints for water management activities (e.g., maintaining a minimum reservoir level or output for habitat conservation or fish access purposes).

The ability to identify and value ecosystem services underpins market-based approaches and is important to include in decisions about water transfers. Most states require consideration of the public interest in transfers, which is where ecosystem service valuation could be included.

Research is needed on short-term and extreme events, such as storms, that could have significant effects on flood control and urban drainage operations. Often the spatial and temporal scales provided by models are nowhere near fine enough to inform the rapid decision processes related to these operations (e.g., rainfall may be needed as finely as 3 – 5 minute intervals). The results of this research can be used to construct scenarios that can be used in planning for new and updated stormwater and wastewater systems.

While CCSP has worked on East Coast sea level rise, there is little or no information about uncertainties (e.g., ice sheet dynamics) associated with estimation of sea level rise on the West Coast. Precise coastal and bathymetric mapping is also lacking.

More user-driven research is needed to support the needs expressed by stakeholders with respect to adaptation. This includes studies of why and where adaptation is necessary and studies of the tools that will support implementing adaptation measures.

Research should not be prematurely rushed into practice just because there is a demand – quality assurance and quality control measures must still be fully incorporated.

Wyoming is conducting a five year, $9 million research project on weather modification (i.e., cloud seeding), but there are still many questions about the utility, costs, legal liabilities, and environmental justice issues related to large-scale weather modification activities. The results of activities such as this one must be peer-reviewed and widely-disseminated and it remains to be seen whether weather modification can generate the benefits claimed by its proponents.

Decision Support

More research (including pilot studies) is needed to determine how best to provide translation of scientific research results into usable information for decision making. For studies that have already been completed, CCSP or others need to implement communication and outreach plans to share the results.

Decision support systems must incorporate both environmental and societal information, including the constraints introduced by existing or proposed regulations or laws, such as the Endangered Species Act.

The development of decision support systems must both maintain the integrity of science and make the science results useful to the decision process. It is important to avoid competing claims about science that may detract from progress.

Currently the indicators of success in deliberative processes are not well defined – more work is needed to determine how to measure the quality and acceptability of results in the scientific and policy realms.

Downscaling climate models is essential. Many managers are stuck at the step of linking Global Circulation Models (GCMs) with hydrology models used in planning for utility or water supply management. Decision support systems that start with GCMs and IPCC emission scenarios show a large range of impacts and are not necessarily at a scale fine enough for local planning, making it difficult to use the results for planning. GCMs do not provide useful information on extreme events. Techniques or design standards must also be established for applications such as development of storms for flood control and stormwater planning.

Moving from planning based on stationarity to scenario-driven planning increases the number of possible future conditions that are considered, making planning more complex. More information about the range of assumptions going into these scenarios is essential for effective planning and decision making.

Interaction, Coordination, and Partnerships

Encouraging productive relationships between water resource managers, universities, and the federal government is important. For example, partners from multiple backgrounds could work together to build an information network: state and local water managers could help to identify specific information needs, members of the academic community are able to provide expertise in science; government personnel such as USDA Cooperative State Research, Extension, and Education Service (CSREES) agents at land grant universities serve a translational role between science and user communities (although there are only three extension agents in the US specifically tasked to work on climate – one or two per state are needed at a minimum); and the state climatologist network reaches into all states and thus could serve as a means to distribute information widely (but is unevenly funded and thus success in individual states varies).

Some universities have aggressive outreach strategies (e.g., Scripps Institute of Oceanography, Arizona State University, and University of Washington) that help to push their work into the communities of practice. The NSF Decision Making Under Uncertainty centers (e.g., Arizona State, Carnegie Mellon, Columbia University, University of Colorado, RAND Corporation) may also be able to provide important insights about connecting science with users. The CCSP could learn much by engaging these groups in a conversation about how to get information to the users who need it. The user community must also be proactive and should engage in outreach to the academic and government sectors from which they do or hope to access information.

Having fully-funded federal research scientists at universities would go a long way toward providing linkages between the federal government, academia, and regional and local stakeholders. USGS and USDA's CSREES have done this to some degree, but additional placements from a broader range of agencies are still needed.

Work being done in nearby countries (e.g., Canada, Mexico) and in locations further afield needs to be better integrated with activities in the United States. This might be accomplished through networks built and maintained amongst professional societies and within / between governments.

Additional research is needed on questions such as "what are the components of a successful climate network?" in the context of information sharing, program implementation, and other areas. While there are currently planning activities under way to explore the formation of a National Climate Service, many questions remain, including whether this would be a single agency or multi-agency effort, how the efforts would be organized, and how a National Climate Service would relate to the CCSP.

Appendix A: Participants

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Appendix B: Agenda

WESTERN WATER MANAGERS' INPUT INTO CCSP STRATEGIC PLANNING

Hosted by:
U.S. Climate Change Science Program
Western Governors' Association
Western States Water Council

March 18, 2008

DSRC Multipurpose Room (GC402), NOAA
325 Broadway, Boulder, CO

Meeting Objective: To provide a forum in which CCSP can hear from Western water managers about their interests and activities, informational needs, and expectations for and ideas about future directions for climate research, observations, decision support, and communication. The input will be incorporated into CCSP's ongoing research and program planning processes.

8:30 a.m. Continental Breakfast available

9:00 – 9:15 Welcome and introductions

9:15 – 9:30 Meeting purpose and goals

9:30 – 10:30 Perspectives on climate data (measurements) and observations

- What do we use now for routine operations? For special purposes?
- Is it readily available?
- Is the continuity of the records adequate, or are they at risk?
- Are there important gaps in hydroclimate data collection programs?
- What would we like that we don't have?
- Are there data collection-related research needs, or partnership opportunities CCSP should be aware of?

10:30 – 12:00 Perspectives on climate products and services

- What do we use now?
- What's available that we don't use/isn't helpful?
- What would we like that we don't have?
- How do we find out about availability of existing or new products/services?
- What are our priorities for federal climate research?
- What is the appropriate role of universities (as opposed to federal agencies) in federally funded climate research?

12:00 – 1:00 Lunch

1:00 – 2:00 Building relationships between CCSP and water sector information users

- How might the delivery of federal climate products/services be improved?
- Is there a need for capacity building in the water sector?
- Are there examples of WGA/WSWC partnerships that could be applied here?
- What next steps should we take?

2:00 – 3:00 Time for a national climate service?

- What should the role of the federal government be in providing climate data, tools, and services?
- What functions should be included in a national climate service?
- Are WGA/WSWC interested in pursuing this concept?
- What research is needed to support a national climate service?

3:00 Adjourn