WORKSHOP SUMMARY

NOAA's National Weather Service

Office of Climate Water and Weather Services

Climate Services Division

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1. Introduction

The National Weather Service Climate Services Division (CSD), in conjunction with the California Department of Water Resources (CDWR), the National Integrated Drought Information System (NIDIS), and the Water Education Foundation hosted the 8th Climate Prediction Applications Science Workshop (CPASW) in San Diego, CA, on March 2-4, 2010.

New for CPASW was an integrated theme of Managing Water Resources and Drought in a Changing Climate. Focusing CPASW around a theme provided an open forum to exchange ideas, build mutually beneficial collaborations, and share best practices within this specific climate sensitive sector. The format of the workshop differed from previous years in that it was conducted mostly through panel discussions. The agenda included a significant amount of discussion time to foster a more open forum for participants to exchange experiences and perceptions on (1) specific uses of climate data, information and predictions; (2) best practices in adaptation planning; (3) available tools and future needs for effective decision support; (4) building collaborative partnerships; and (5) new methods and techniques for applying climate predictions.

Another new aspect of the workshop was the addition of break-out sessions. The break out sessions were added to identify how climate products and services can be enhanced to support management of water resources and drought beyond what is currently taking place, to help identify and clarify user needs, and to encourage and facilitate engagement and partnerships.

2. Recurring Themes

2.1 Communication and Outreach

The way in which climate information is conveyed is critical to its usefulness. The topic of communication was addressed in nearly each panel discussion. Participants discussed the challenge of communicating climate science and trends in a way that is understandable and relevant to users. Often climate scientists and climate information users might use the same terminology but with different meanings. Collaborative efforts and attention to definitions of terms should be prioritized to identify solutions to barriers in two-way communication.

Greater efforts must also be made to communicate the uses, benefits, and availability of climate products. Consideration should be given to packaging products in ways that are understandable by multiple users and that serve multiple users' needs. This could include multiple translations for one product or developing products that are customizable to serve the needs of various different users. It is noted that this can be a resource challenge. Thus efforts should be made to invest in bridge-building organizations or intermediaries who could distribute and communicate climate information in a more stakeholder focused manner. Leveraging partnerships, already established networks, and focused training for intermediaries can also aid in developing collaborative efforts.

2.2 Engagement

Effective communication is closely linked with constructive engagement of users. Workshop participants agreed that efforts to develop projects, programs, and products should start with a clear understanding of the needs of the end user, and the decisions they are faced with making. Users should be engaged in the beginning – from research through the development of an operational product and sustained services. Some participants cautioned that enough time should be given before introducing products to the public or widely distributing them to ensure the product is far enough along its development phase and credible. Typically, industry won't fund or use research until it is at the 80% level of completion. More investigation is needed on the best approaches and timing for engaging users in the product development phase.

Workshop participants also identified a gap in engagement between the research community and operations community. Both communities have just enough resources to complete their own research/operational mandates and have little time and resources left to make a concerted effort at bridging the gab between research and operations. Closer engagement of these two communities will allow for the development of research projects that will successfully lead to an operational product. Sensible investments in bridge-building communities can aid in providing a vehicle for engagement of the research and operations communities.

2.3 Decision Support

Water resource managers are often charged with balancing judicial guidance with the best options for adaptation. They also face the challenge of making planning decisions today for 30, 40, or 50 years in the future. Decision makers need tools that provide 'real options' – options based on an analysis of how the future might change and the best possible choice for maximizing investments. Robust decision making can also aid in identifying the best available options when there is a high-level of uncertainty. Intermediaries can assist with packaging information so that it is useful for a variety of decision makers. However more discussion is needed to identify a method for scaling efforts so they are effective.

For science to be actionable, investments should be made in a sustained and continuous decision support infrastructure, in addition to investments for improving climate science. This would require a much tighter connection between decision makers and the science community. For many decisions, the science does not need to be precise for it to be useful. Decision makers and scientists must work together to identify the temporal and spatial scales, and level of accuracy that is considered 'good enough' for decision making. Furthermore, decision makers are more inclined to take action based on climate information when they hear it directly from a scientist who can communicate complex scientific issues in an understandable manner. This level of engagement requires integration, partnership, collaboration, communication, compromise and understanding.

2.4 Science and Technology Issues and Priorities

Improving forecast skill and reliability is crucial to increase users' confidence on climate prediction products. Hydrometeorology expert participants looked at historical records (1900-2006) and showed pronounced multi-year to multi-decadal U.S. drought variability, but saw no convincing evidence of long-term trends toward more or fewer events from the observations. Also examined was the changing of stationarity predicted by IPCC models, which indicated that more hydrologic extremes would be expected due to intensification of the hydrologic cycle caused by global warming. It was shown that historical trends in the number of U.S. precipitation exceedance events were small compared to the uncertainty of intensity, frequency and duration (IFD) values. Questions were raised on the accuracy of model projections and whether or not downscaling would add value for regional applications considering regional trends in extreme events were not always captured by the models. Studies also showed difficulties in assessing the significance of model discrepancies, and distinguishing between deficiencies and natural variability. The value of traditional stochastic hydrology methods should not be underestimated and research is required to advance the science of addressing non-stationarity.

Though regional climate services are highly demanded by users in all geographical locations, the predictability of climate is not evenly distributed in space and time. Gaps were shown between what is known and knowledge that is needed in regional applications. Current ‘state of the art’ climate forecasting and teleconnection research showed no clear link of California multi-year droughts to either ENSO or PDO phases. The dominance of ENSO teleconnection research to improve ISI forecast should not dwarf other efforts (i.e., detecting the linkage between summer trends in SLP near Azores and runoff in Sacramento and San Joaquin basins, the impact of the Indian Ocean dipole, etc.). A good fraction of annual precipitation from ‘atmospheric river’ events, which could be linked to MJO and ENSO, are still poorly understood. Studies showed high sensitivity of the Colorado River flows to the projection of warming. Underlying mechanisms for the flow changes must be understood in order to provide meaningful information that incorporates uncertainties in future climate change projections for water managers and policy makers. Additional research needs were identified such as detecting sensitivities of regional impacts to the projected changes of temperature and precipitation.

Coupling the advancement of climate science with water resource practices has is a key mechanism for developing needed tools and products for applications. Climate information products should not only contain rainfall intensity but also frequency and duration to be considered useful for civil engineering. Because of different corporate cultures, values, languages, as well as the loading dock method used for information transfer which involves little interaction with practitioners, statements on trends in rainfall intensity were often misinterpreted.

Enhancing partnerships with social scientists to maximize the delivery of climate information to users with unsophisticated knowledge was another prominent discussion at the workshop. Lessons learned emphasized the importance of sharing goals and resources, leveraging expertise and fostering extension networks to identify and understand specific information needs, then relate those needs to the design and function of operational tools and communicate information back to stakeholders.

Water utilities emphasized the importance of climate model agreement on change in key parameters, narrowing the uncertainty range of model output, increasing resolution at a spatial and temporal scale that matches water utility current systems, and improving projections within water utility planning horizons. It was also suggested the development priorities need to be more focused on the enhancement of global and regional climate model ensembles, development of regional climate model components, improved use of observations to constrain climate model projections, improved modeling of the tropical Pacific, improved decadal prediction, and development of probabilistic downscaling for extremes and daily data.

3. Break-out sessions

A new feature of the workshop was the addition of break-out sessions. The break out sessions were added to facilitate discussions that identified how climate products and services can be enhanced to support management of water resources and drought beyond what is currently taking place, and to help identify and clarify user needs. The workshop planning committee worked with partners to develop questions that the break-out groups would use to frame their discussions. Following is a summary of those discussions.

3.1 What is needed for climate predictions and climate information to be actionable/useful for decision making?

The group that participated in this break-out session represented a wide range of interests, including academia, and federal and local government. Group members first identified priorities for making climate information actionable, and then identified near- and long-term suggestions for addressing these priorities.

<u>Priorities</u>

- Products must be user driven with user engagement from the outset
  - Product forums could be developed to gather input
  - Follow-up as products are developed
  - Facilitate a mutual awareness of product design and applications
- Training on products and interpretation of products must be provided
- Information must be trusted, realistic, timely, understandable at appropriate scales

- Useful formats for broad user groups must be available
  - Leverage new technologies
  - Hierarchy of sophistication
- Information must be packaged with a policy perspective first, then a technical perspective
- Products must be cross-cultural and applicable to a variety of users

Long-term Suggestions

- Continue to improve the basic science needed to understand climate phenomena
- Commit to user engagement
- Secure long term funding
- Identify a threshold for climate information that is 'good enough/close enough' to use for water resources decision making

Near-term Suggestions

- Needs assessments can ensure user driven engagement
  - Consider developing 'climate counselors' who would help users identify and communicate their needs
- Training and interpretation should come with the product, however we need to understand the limitations
- Communicate these priorities to NOAA Climate Service discussions
- Invest in education at multiple levels and understand their training needs (new v/s repeat users); Consider the idea of an 'ecosystem of users'
- Document follow-up; track how information is used
- Perform case studies on the use of products

3.2 What guiding principles should be adhered to when establishing priorities for developing and decommissioning products?

This break-out group consisted of five participants, all NOAA employees. After discussing the question and reviewing suggestions, the group decided to clarify the question (underlined words are added to the original text):

What guiding principles should be adhered to when establishing priorities for developing services and policies for commissioning and decommissioning services and products?

Important discussion points included:

- Continuously involve stakeholders; early in the process
- 'Don't reinvent the wheel'
    - Look to others who may already have existing policies (e.g., NWS directives, http://www.weather.gov/directives/010/010.htm)
- All services and products should be driven only by specific end-user need(s) and/or congressional policy mandates
    - Address separate and potentially conflicting national, regional, local, and individual needs
    - Assess expected number of potential users
    - Address broad sectoral needs
    - Feasible and sustainable and consistent
    - Avoid producing products and services because *'we can'* or *'we have always done this'*
- All products and services should be regularly reviewed to ensure that they continue to provide value (i.e., socio-economic benefits, etc)
    - Use critical and honest review processes
    - Modify or eliminate processes as necessary
- All development should be targeted to support the delivery of products and services
    - Target applied versus pure science
    - Focus on filling known gaps in product suite and service
    - Leverage external expertise - avoid "not invented here syndrome"
    - Ensure allocated resources for maintenance and operations
- Established standards should be adhered
    - Quality, objectivity, and skill
    - Formats, accessibility, and timeliness
    - Interpretation, user-training, and value
- Recognize that no one can do everything
    - Be willing to let others contribute - eliminate turf

  - Recognize the principles of the Fair Act - Encourage a collaborative climate enterprise
  - Consider the possibility that we corporately have all the resources that we need
- Products should be appropriate to the socio-political and economic environment
  - Ethical
  - Transparency, objective, environmental sustainability

3.3 How can we leverage partnerships to facilitate the transfer of data and information to operational tools?

The break-out group was unsure how to treat this question and instead focused on the key things that make successful partnerships. The group focused on primarily three areas. These areas included: *Understanding User Needs*; *Communication*; and *Investment* of the partnership and its *Benefits*.

Understanding User Needs

- Need clear idea about user needs when building/developing prototype products and tools
  - Partnerships must be built around specific questions
  - Start at both the national and regional/local level
- Users have very diverse needs and requirements. National associations that represent multiple regions and needs can be very useful to identify key areas, however, they are not sufficient by themselves
  - Identify at what level the partnerships should be located, and if it is at multiple levels identify roles at each level

Communication

- Use translators that have credibility to make the connection between users and developers (e.g. extension, Regional Climate Centers, Regional Integrated Sciences and Assessments teams, state governments)

Investment and Benefits

- Successful partnerships have a mutual investment and must have outcomes that benefit all partners
- Partnerships begin at the beginning of product development and should leverage both resources and outcomes in a way that the whole is greater than the sum of the parts
  - Effective partnerships have synergistic outcomes
- Successful partnerships take time to develop and require iteration and persistence

- It is acceptable to make mistakes and this is inevitable when working with a diverse group of stakeholders

4. Reviews and Suggestions

CPASW was comprised of 75 participants from a variety of sectors including federal and local government, academia, and the private sector. A review of the evaluation forms revealed that the participants were very satisfied overall with the meeting. Participants were pleased with the sector focus, though at times felt it focused too heavily on California. They also liked the panel format with extended discussion time. Many respondents suggested that even more discussion time was necessary. Participants were also satisfied with the agenda topics and suggested that more users be included on panels, and that the panels incorporate more real-life applications or case studies of climate prediction applications in future meetings. Participants were exceptionally pleased with the addition of break-out sessions and suggested that these be held earlier in the workshop. Participants were also highly satisfied with the workshop location, meals, and other logistics. However local participants were not pleased that the hotel did not provide the State rate and as a result found lodging elsewhere.

Suggested topics for future workshops included social science applications, climate related risk, interactions among climate and land use change, applications to planning, water and energy linkages, local and regional level downscaling, applications of regional modeling, and valuation of climate forecasts and information, and bridging the gap between public, politician and scientific communities.