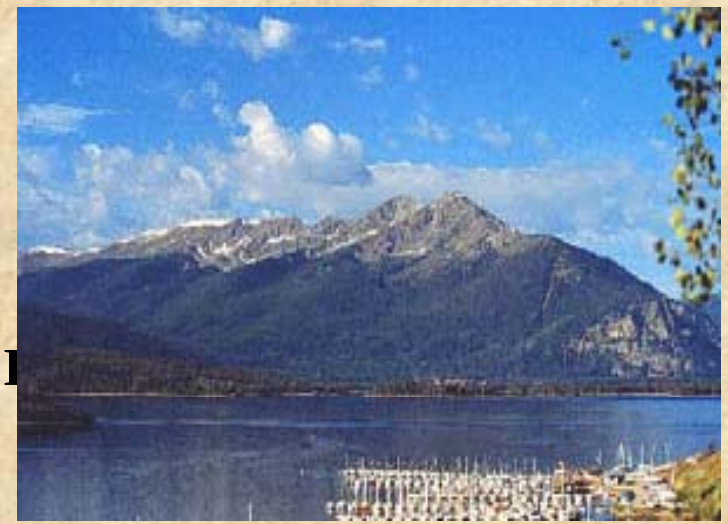
Western Water Assessment

Colorado
University of Colorado at Boulder

Lessons learned from the 2000s Western drought: Evolving linkages between research and services



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With contributions to the WWA team: Roger Pulwarty, Doug Kenney, Chris Goemans, Bobbie Klein, Brad Udall, etc…

And of course to our many opinionated stakeholders…

Western Water Assessment
http://sciencepolicy.colorado/wwa

NOAA-CIRES Climate Diagnostics Center

Cooperative Institute for Research in Environmental Sciences
CIRES

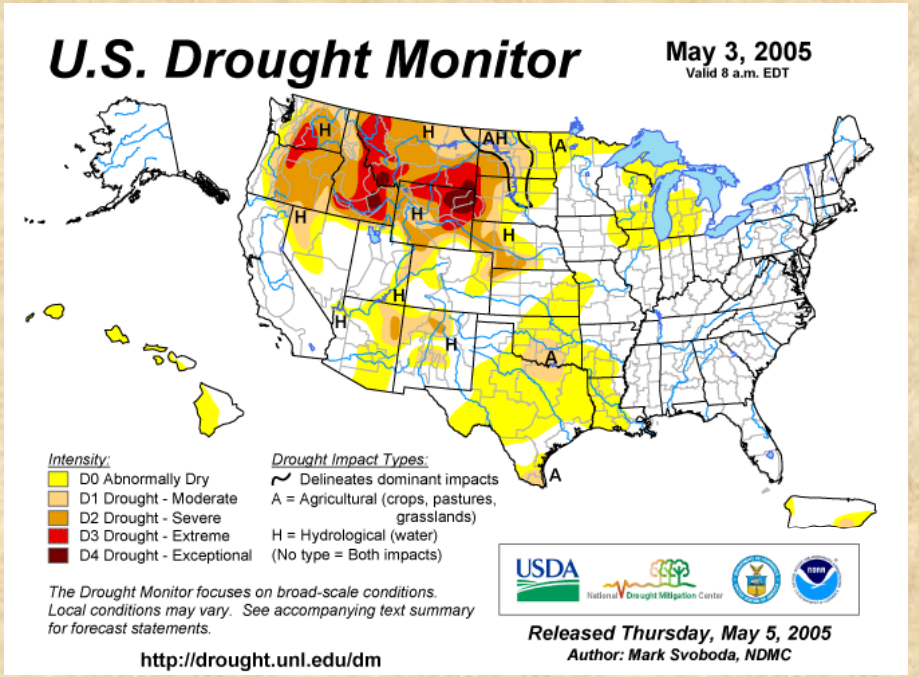
Overview and Summary points

- What is drought as a service need -- drought vs “climate”
- What WWA has learned from the 2000s western drought -- a history of WWA projects
  - Role of interactions in shaping research and experimental services
- Cases:
  - Aurora project: climate information to manage water demand (vs supply)
  - Glen Canyon Adaptive Management
- What drought/climate information was used, what users wanted/needed, and our inferences
- Drought risk management
  - More than just the right products, and occurs in a dialogue about risks
  - What are the spaces for interaction for these scientist-stakeholder dialogues, both on products and for services?
  - Understanding the nature of risk and information/knowledge needed to manage risk
  - Managing drought in the context of changing climate -- adaptation strategies
- Role of social sciences??

What is “drought” as a service need??

- Problem Identification: drought vs climate
  - Drought not an issue itself, but as it relates to other water problems
  - Role of perception, Spring of 2005
    - “The drought is over, time for a flood??” Salt Lake City Tribune, April 12 2005; “The drought is over,” Utah Center for Weather and Climate, based on the Drought Monitor

- Lake Powell then at 37%
- Irony of risk of a call on the river, even if Utah flooded that spring
- D0, D1…DX don’t always correspond to managers’ own perception of drought and how it relates to variables critical to them
- Time scales of risk and information

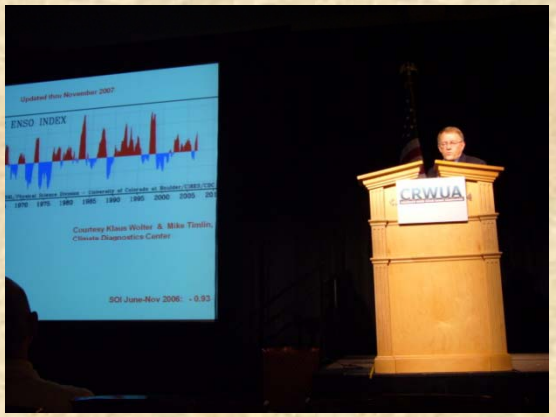


Assessing the drought

- Context for drought information needs
- Who determines water shortage and how: individuals, managers of overlapping resources/areas, political dimension
- Information available to assess conditions is distributed across multiple agency webpages, may not be easily evaluated on spatial scales of interest
- Social monitoring of drought:
  - Organizations and individuals assess drought according to their own jurisdictions
  - Drought Task Forces
  - Reservoir and basin management groups
  - Basin councils
  - Related resource management groups
    - Environmental, irrigation
  - Managers' own perception of drought may not link to drought status
- [analysis and formulation of response alternatives]

Regional Integrated Science & Assessment contributions

- Empirical studies
- Decision studies of water management and agriculture
  - Characterize decisions and decisionmakers
  - Institutional/legal
  - Organizational/behavioral
- Experiments in communicating with stakeholders
- Understanding user needs
  - Perception, cognitive, communications studies
- Experiments in creating and maintaining partnerships *over time*
  - Reservoir management, drought task forces, climate change and state water supply planning
- Two cases and WWA experiences….



Case: Diagnosis and Impacts of Warm Season Storms, Floods and Sediment Inputs into the Middle Colorado River: Applications to Decision Making and Adaptive Management

- Glen Canyon Dam Adaptive Management Program (GCDAMP): to balance numerous, often competing, objectives, such as, water supply, hydropower generation, low flow maintenance, maximizing the tributary supplied sediment, endangered species recovery, and flood control.
- Key concern identified by the GCDAMP: need sediment input into the Grand Canyon; warm season floods produce these
- Use of monitored and predictive information on the warm season floods (at point-to-regional scales) has been identified as lead-information that can potentially facilitate improved planning and operations.
- Project mapped physical processes alongside planning & decision processes for the releases from the Dam which are aimed at achieving restoration and maintenance of sandbars and instream ecology.

Grand Canyon region, cont

- Management occurs in the context of a range of variability
  - Extremes of one type (flooding, high flows)may ocur during a drought
  - “test releases” of flood flows implemented during 2004 and 2006vduring dry or drought conditions
- Monitored and predictive information on the warm season floods (at point-to-regional scales) is lead-information that can potentially facilitate improved planning and operations.
- Can’t escape needing information on both sides of the extremes
- Similar issues in Aspinall EIS/Gunnison River endangered fish recovery
- Shaleen Jain, Roger Pulwarty & Jon Eischeid;
  Theodore S. Melis & David Topping

Case: Aurora project, Kenney et al

- Rapidly growing suburban Denver; junior surface water rights, groundwater table decreasing
- Demand management worked following the 2002 drought, but we didn't know what efforts were successful
- Better supply forecasts of limited use
- Demand management provides one of the best opportunities to acapt to climate change and climate variability

- Utility-controlled variables are one factor in conservation: Price elasticity of demand, rebates, water restrictions; use "smartreaders" and block rates
- Understanding of behavior suggests potential for use of summer weather and climate forecasts, both in utility planning and for individual users
  - Week 2 forecasts; seasonal demand calculations; suite of drought outlooks? Wk2-1 month-3 month

What WWA has learned from interactions in the 2000s drought

- Pre-WWA workshops
  - Established connections with key water management communities; ‘97-98 El Nino and ‘99 La Nina prompt interest in seasonal forecasts
- 1st WWA workshop, summer 1999
  - Seasonal forecast use for ESA river management
- Reservoir management workshops, 2 basins, 1999-2000
  - CBRFC connection; Ray work on decision process; Clark et al. river forecast work --> week 2 forecast applications
  - Ongoing participation in basin technical working groups (USBR, CRWCD, SEO, etc)
- 2002 Drought -- Rapid Response activities
  - Climate info sheets; regular participation in the Colorado Water Availability Task Force; Kenney and Klein studies of municipal drought plans; study w/ CSU-Extension on ag responses and decisions
  - Drought focussed interest, but a big question was whether representative droughts used in planning were reasonable
  - Interest in paleoclimate reconstructions --> training workshops (Woodhouse)
- WY2005 Colorado Basin Outlook briefing, SLC, Nov 2004
  - Need coordinated message, don’t argue the science at a stakeholder briefing
  - Well attended, interest in, request for future meetings
- 2005 and 2006 Colorado and WY climate workshops
  - Increasing interest in climate change; Interest in demand side management as an adaptation strategy; increasing focus to municipal management and climate change

Current uses of information for reservoir management

- NOAA/CPC forecasts incorporated in reservoir inflow forecasts and also considered independently by managers
  - Efforts to improve use of climate forecasts in river forecasts
  - But -- often little skill in the Upper Basin where most supply originates

- Drought of record used in planning: 1955-1967 (12yrs); Variability in natural flow into reservoirs Lake Powell 1906 - 2003, index sequencing in operations models

- Interest in longer records of variability:
  - Paleoclimate research (Woodhouse et al. new reconstruction for Lee's Ferry, May 2006 Water Resources Research)
  - Reconstructed hydrology -- New methodologies to combine paleo reconstructions of flow with historic gauge data (Rajagopalan et al.)
  - USBR conducting modeling and planning studies based on these studies What are the potential uses of paleo research

Current uses of climate information in municipal water management

- Use of the instrumental record of hydro-climate variables in planning and operations models
- The use of climate influenced hydro-climate parameters to generate projections of streamflow, reservoir contents, or water supply
  - SWE, historic records of streamflow, water year precipitation
- Use of paleoclimate data, e.g. reconstructions of SWE or streamflow
- Use of forecasts of climate variables, e.g., precipitation or temperature, such as the NOAA/CPC Monthly and Seasonal Climate Forecasts, or medium-range weather forecasts
- ➢ Climate variability reflected in annual and longer term operations in ways other than use of forecasts

Uses in Municipal Annual Operations

Current uses of climate relate information:

- NRCS/NWS April-July volume forecasts
  - MBRFC not as active in this part of their region as CBRFC, most perceive these as solely an NRCS product
- Arbitrary use of 10%-50%-90% exceedances to represent risk of extreme conditions
- Drought/ supply shortage assessment --relates to individual system
- Several municipalities consult CPC monthly and seasonal products, but say these only influence them when they're "on the fence"
- Interest in improved monthly and seasonal CPC forecasts, but:
  - Forecasts winter and spring only available for these climate divisions about 20% of possible lead times
  - Need better spatial resolution, eg Wolter experimental product

Longer term water planning

- Drought as part of longer term planning, beyond drought of record
- Assess the potential for future systems to cope with drought: streamflows from the historic record
- Planning for projects to “firm-up” yield
  - Windy Gap surpluses from early 90’s, but none since
  - Other supply options
- Demand projections: primarily population based
  - Temperature trend not considered
- Several agencies now using paleoclimate reconstructions to expand the types of drought they evaluate
- Interest in assessments: range of potential climate change scenarios, droughts that have occurred outside the instrumental record

How drought information might be used: WWA observations

- "Conversation" within water management groups and with their stakeholders, and with scientists
- Mental models of managers for their systems are important as well as hydrologic and management models
- Relationship of information to their triggers, thresholds
- As interested in the information behind the Drought Monitor as the DM itself, in order to make their own assessments
- Synthesis of research into products & analysis that connect climate impacts to water management impacts:
  - Temperature --> evaporation, rain/snow mix, urban demand, length of growing season
  - Timing of spring runoff (Dettinger, Cayan) --> water rights, reservoir reliability
  - Synchroneity (Hamlet, Jain) --> diversity of supply sources

What is needed to facilitate drought-related decisionmaking?

- Scientists need to collaborate with these sophisticated, but non-climate experts in a common language
- Variables and indices
  - flexible formats, areas, time scales
  - tools to relate observations, historical data, and forecasts to water managers perspectives, e.g. to their problems
- Ways to evaluate climate scenarios in their management scenarios
- Tools for managers to talk to their stakeholders
- Partnerships
  - Interactions maintained over time
  - Influence of scientists on the drought planning process and of water managers on science done
  - Innovation in both science and management from interaction
  - Fora for communication, learning, bringing perspectives together

Beyond forecasts --> "Services" for drought decision support

- Drought framing as part of climate and climate change
- Drought risk management
  - More than just the right products, and occurs in a dialogue about risks
  - What are the spaces for interaction for these scientist-stakeholder dialogues?
  - Understanding the nature of risk and information/knowledge needed to manage risk
  - Managing drought in the context of changing climate -- adaptation strategies
- Dialogue about climate-related risks with policy and planning for 20-50 year horizons
  - Not forecasting for these horizons, but inform long-lived policies likely to encounter multi-year droughts and impacts of observed trends

Beyond forecasts --> "Services" for drought decision support

- What's the role of social science within the creation of drought-related climate services??
- What is the physical science/social science partnership??
    - Not just that SS markets/helps market findings or that the focus is too science-driven
    - Not just what products are needed but what are the spaces in which knowledge is created and scientist-stakeholder interactions link research to services
    - "What skill can your applications use?" -- add richness to this discussion

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