Hydroclimatic predictions for decision support: Insights from user studies

Andrea J. Ray, Robin Webb & Roger S. Pulwarty
NOAA-CIRES Climate Diagnostics Center
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Overview

- **HEPEX need to "Listen to user demands"**
- **A larger purpose for the HEPEX objective [maybe at the end?]**
- **Users, who are they? who works with them? What do they think about?**
  - Integrated Science and Assessments projects
  - Findings of these projects about studying and working with users
- **Mechanisms to elicit user needs**
  - Integrate and synthesize needs across groups
  - Determine what services should be: part of a dialogue about risks
  - Take advantage of social science studies of cognition, adoption and diffusion of innovations, and methodologies
  - Problem orientation: drought, hydropower, multi-purpose reservoir management
- **Maintain partnerships with user communities long enough to sustain cycles of user studies - research - product development - prototype testing**
- **Some examples from RISAs**
- **Case study: CBRFC, Week2, and the fish**
- **Conclusions, including thoughts on regional projects from a user study perspective**

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Who are the Users?

- Municipal/residential and industrial water users and organizations
- Agricultural water users and organizations
- Government managers, regulators, policymakers, planners (local, state, federal)
- Professional organizations and networks of all of these
- Scientists and engineers
- Providers of products and services (govt, pvt, media)
- NGOs (e.g., biodiversity interests)
- Recreation interests, individual and companies
- Boundary organizations, which work between scientists and users
- Guilds

What do they want? Historical data and projections of these at a basin scale:

- Snowpack/SWE
- Soil moisture
- Streamflow current/forecasted
- Timing of spring peak; “holes” in a river (low flows)
- Reservoir levels
- Ground water
- Surface water supply index (SWSI)
- Palmer Drought Index
- Temperature
- Evapotranspiration, evaporative losses
- Demand metrics, water and hydropower
- Outlooks of these, and how ppt and temp outlooks relate, e.g., ppt needed to raise levels to near-average or other thresholds☐

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Who studies users?

Integrated Science and Assessments

- Academic communities: natural hazards, climate and society interactions, climate impacts studies
- Sensitivities and vulnerabilities to weather and climate, needs for information, information pathways, institutional issues, capacity issues
- NOAA RISA: Regional Integrated Science and Assessments
- NSF HERO: Human Environment Research Observatories
- Int'l Human Dimensions of Global Change Program
- New focus under CLIVAR
- Others, NSF-, NASA-, NOAA-funded, also foundations, esp. for climate change
- Ongoing efforts with existing user-partnerships

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Regional Integrated Science & Assessment (RISA) experiences

- Seven regional projects, US and border focus, earliest began ~1995
- 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 sustaining partnerships *over time*
  - Reservoir management, drought task forces, climate change and state water supply planning

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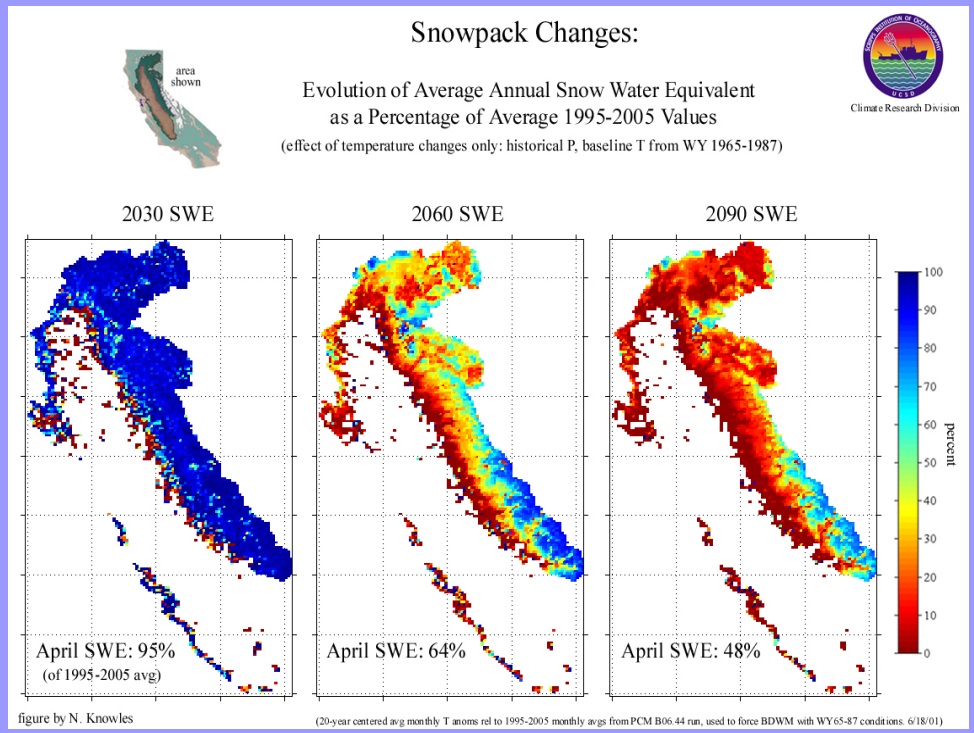
CLIMAS experience with users: Arizona Drought Task Force

- **CLIMAS activities**
  - **On-going participation at meetings and in the water management process**
  - **Co-lead of the AZ drought task force; participated in creation of State Plan**
- **Drought Monitoring Challenges**
  - **System that accounts for diverse topography**
  - **Monitoring multiple sources of surface water, including imports**
  - **Gaps in monitoring networks, including groundwater and soil moisture networks**
  - **Multiple scales that might affect adjacent areas in different ways**
- **Integrative research strategies**
  - **Empirical studies, multi-method**
  - **Interdisciplinary**
  - **Interactive and iterative with stakeholders**

California Assessment Project (CAP) experience with users: Climate Change

- Participates in state meetings on water planning
- Key information galvanized interest from state legislature

- Other RISA activities
  - CIG hosts regular workshops with water managers; ten years of interactions; climate change analyses
  - Southeast Consortium's Agricultural web-based planning tools
  - State climatologists



River Forecasts for Upper Colorado Reservoir Management

Current reservoir management concerns are hydropower generation, irrigation, flood control, water for recreation, and water quality

- A new issue is how to provide spring peak flows and late summer minimum in stream flows to support the recovery of of endangered fish.
- Opportunity: Reservoir managers are seeking new tools to help in a more complicated job, and thus open to using climate information
- Need for improved river forecasts
- RISA, CBRFC, CDC

Colorado Pike Minnow

User Study for the USBR Aspinall Unit

- Identify critical problems which are sensitive to climate
  - Evolving reservoir management in which demands now are closely balanced with supply but new uses are being legally proscribed
- Identify decisionmakers and their key stakeholders
  - USBR has authority to manage, but USFWS, NPS, have interacting legal authorities, as do some other stakeholders
- Assess how climate variability interacts w/ the critical problems
  - Decision calendar for annual operating plan helped organize recurring decisions and ID potential climate
- Identify user groups who may be willing partners
  - Deadlines to write ESA recovery plans and formal filing for a federal reserve water right for a national park are requiring USBR to accommodate these in their operations
  - Drought also resulted in finding flexibility and new ways of operating

Identify societally-relevant problem sensitive to climate variability

Begin developing experimental methods for forecasting runoff

Identify decision-makers and their key stakeholders

Continue developing experimental methods and present results

Assess how potentially predictable aspects of climate interact with critical problems

Link with federal R&D labs to improve potential transfer to operational products

Pilot implementation of experimental streamflow forecasting methodology in the Upper Colorado River basin in spring 2003

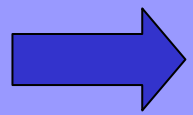
Document and assess how knowledge is used is used in reservoir operators' decision process ***as well as*** assess improvement of forecast

User Study Approach

- One mechanism for assessing user needs
- Dimensions to characterize about the user-context:
  - Identify critical problems which are sensitive to climate
  - Identify decisionmakers *and* their key stakeholders
  - Assess how climate variability interacts with their critical problems
    - Decision calendar may help organize recurring decisions and show when products are needed
  - Identify user groups who may be willing partners in testing and prototyping this new technology
    - Potential users in a rapidly evolving phase of their critical problem may be more open to interacting as partners
    - Social changes, legal or policy change, or a climate event such as drought or flood

Some perspectives from user studies: Need to change our perspectives as scientists on production of knowledge

- Information as a commodity
- Externally generated, research-based information [legitimacy]
- Decisions based on efficiency, optimization
- Methodologies for providing model output as the end product to operational management



- Information as a process of negotiation, i.e., what information is needed in a given context, i.e. drought, and for a given sector)
- Information produced within management organizations or agencies or by accustomed source
- Decisions based on acknowledgement of interdependence of organizations & missions
- Dialogue about risks vs. constructing and delivering a risk message; climate- related decision support systems

Perspectives and problem framing

	Researcher	Water manager
Goals		
Time frame		
Spatial resolution		
Accessibility		
Basis for Decisions		
Expectation		
Frame		
Nature of Use		

Some perspectives from user studies: Framework for analyzing water-related decisionmaking

- **Problem Identification**
  - **Water management issues rarely isolated: e.g. water for hydropower releases related to flood control space, recreation levels, irrigation release schedule, downstream water compact allocations, etc**
  - **Role of risk perception**
- **Problem formulation**
  - **What information is available and assessed; who discusses, in what fora**
  - **How responses are determined, analyzed**
- **Decisionmaking**
  - **Which responses advanced; which chosen; innovations**
  - **Example: management options for Lake Powell system for 2005**
- **Implementation**
  - **Dynamics, institutional and organizational issues**
  - **Innovations & how they emerge during implementation**
- **Evaluation of outcomes: benchmarks of equity of access, impact mitigation, diversity of water uses**

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Some conclusions from across user-studies projects: needs for water-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
- Benchmarks beyond “idealized value”
- 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

Conclusions

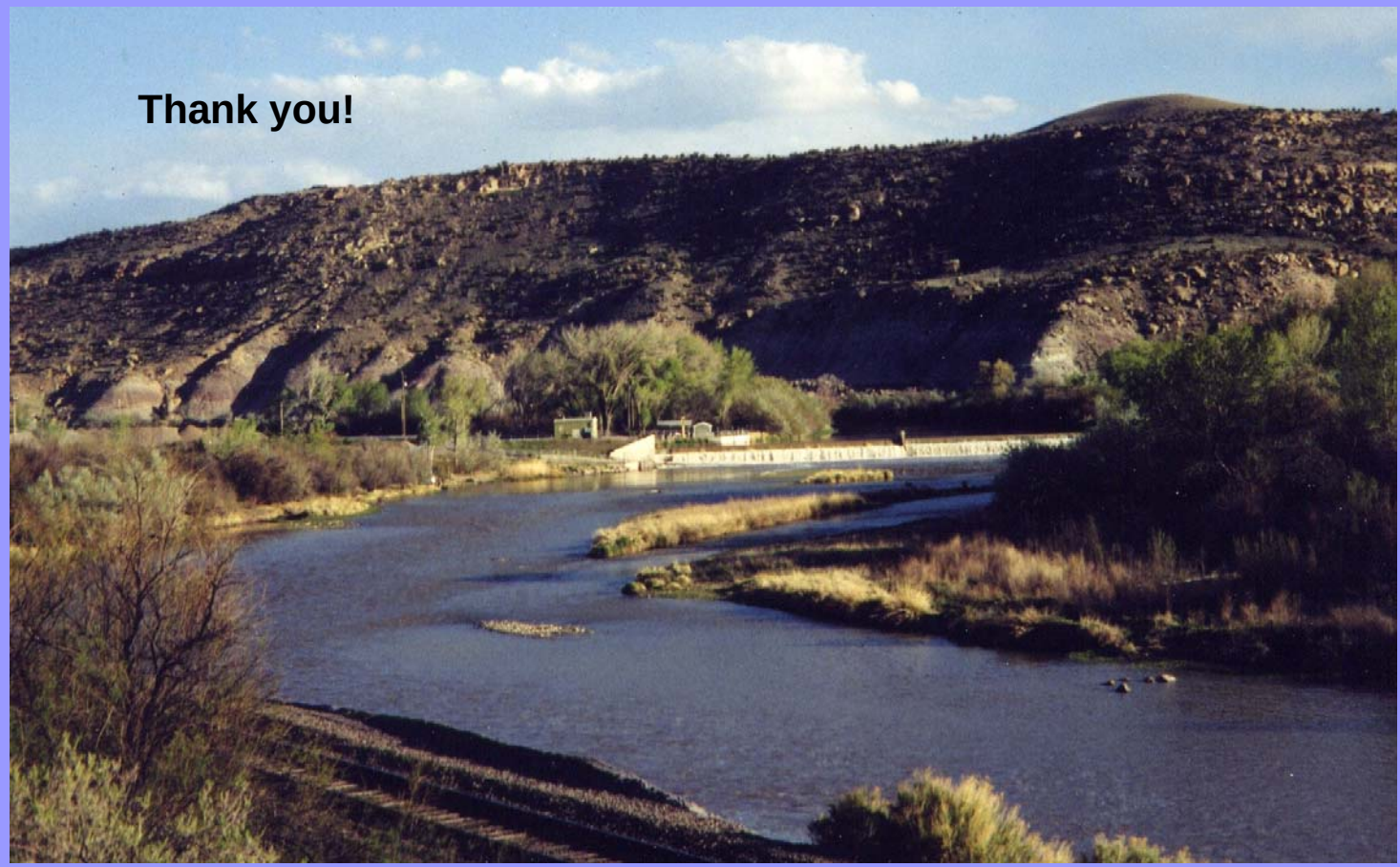
Insights from Integrated Science and Assessments

- Experience and literature on working with users
- Synthesize and organize needs
- Hydroclimate information as part of a dialogue about risks vs. constructing and delivering a risk message

(probabilistic information)

- User studies and partnerships already underway in a number of places
  - Time needed for learning, resources to sustain
  - Understanding of user-, sector, problem-oriented contexts
- Regional projects
  - Build on GEWEX Continental Scale Projects legacy, which include legacy of applications and user studies
  - CLIVAR/VAMOS: North and South American Monsoon projects and associated applications efforts
  - In the US: NOAA/RISAs, NSF/HERO, other user-oriented projects

Andrea.Ray@noaa.gov
Roger.Pulwarty@noaa.gov
Robert.S. Webb@noaa.gov
NOAA/CIRES Climate Diagnostics Center

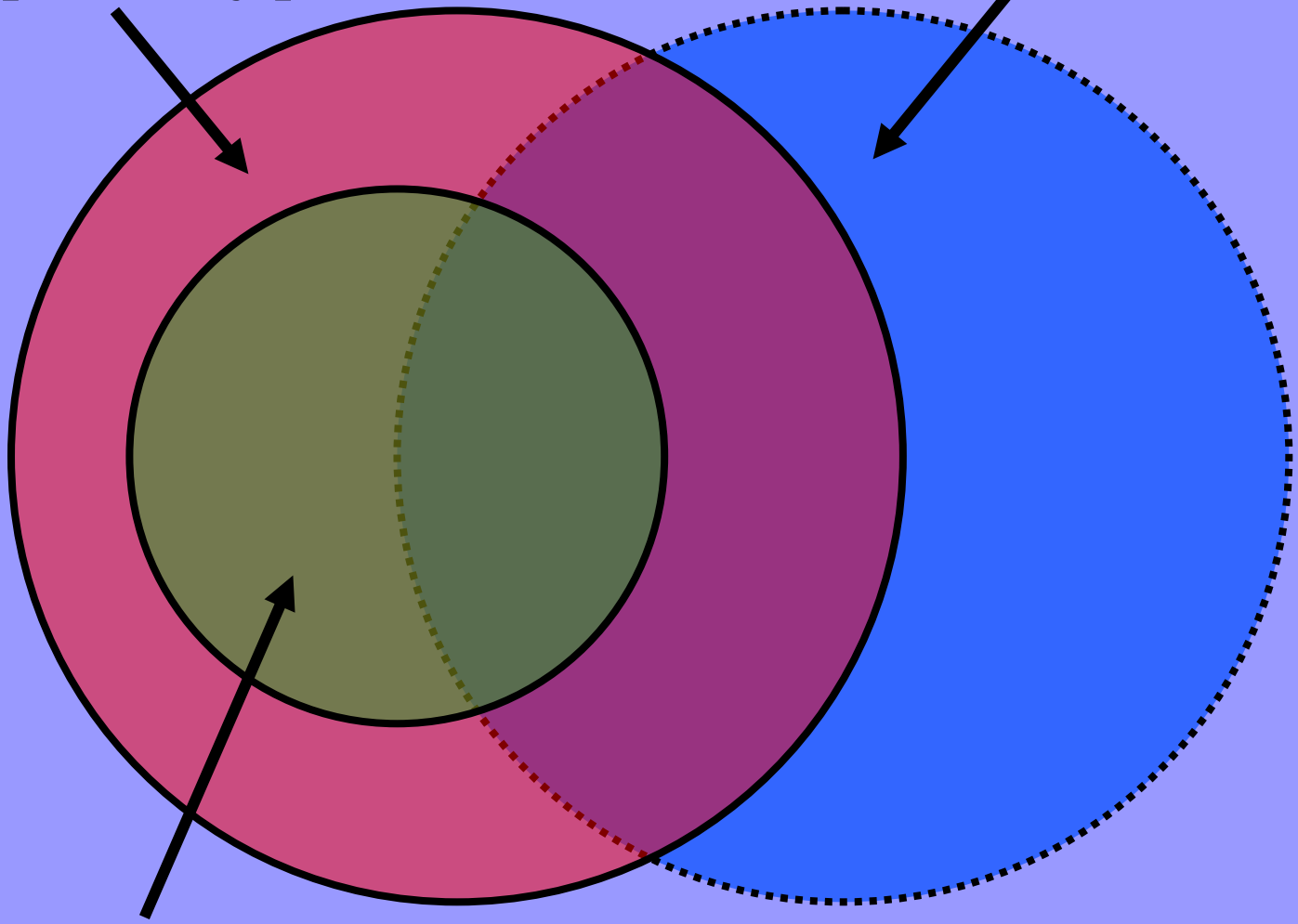


extras

HEPEX objective: "hydrological ensemble forecasts to make decisions…for the economy, for public health, and safety"

- **O**perational products AND information serving larger societal goals and policy mandates
  - ➢ Climate information to establish sensitivities and vulnerabilities of human and ecological systems
  - ➢ Service as part of a dialogue about risks vs. constructing and delivering a risk message
    - ➢ Probabilistic information
    - ➢ **Reducing and managing uncertainty**
  - – **Technical/prediction skill and limitations**
    - **Bridging the gap among climate, hydrologic, and management models**
  - – **Institutional/Legal**
  - – **Behavioral/Organizational**
- **Evaluating the effects of climate conditions and value of forecasts**
  - – **Evaluating management tradeoffs, processes, outcomes**
  - – **Typical benchmark: idealized expected value $$**
  - – **Other benchmarks:** ***mitigate societal disruption, equity of access to water and information; protecting new uses, e.g.,***

Relationships among current products, potentially predictable, and needed climate information



HEPEX objective: "hydrological ensemble forecasts to make decisions…for the economy, for public health, and safety"
*** most moved to below

Integrated Science and Assessments findings:

should articulate a larger scope for work to develop products for decisions:

- Hydrologic and Climate "Services" as operational products AND as information serving larger societal goals and policy mandates
- Climate information to establish sensitivities and vulnerabilities of human and ecological systems
- Service as part of a dialogue about risks vs. constructing and delivering a risk message
    - Probabilistic information

Differences in perspective: scientists and managers

Factor	Scientist's perspective	Water Manager's Perspective
Identifying a critical issue	Based on a broad understanding of the nature of water management	Based on experience of a particular system
Time frame	Variable	Immediate (operations) Long-term (infrastructure)
Spatial resolution	Defined by data availability or funding	Defined by institutional boundaries or authorities
Goals	Prediction Explanation Understanding of natural system	Optimization of multiple conditions and minimization of risk
Basis for Decisions	Generalizing multiple facts and observations Use of scientific procedures and methods Availability of research funding Disciplinary perspective	Tradition; Procedure Professional judgment; Training Economics; Politics Job risks
Expectation	Understanding Prediction Ongoing improvement (project is never actually complete) Statistical significance of results Innovations in methods/theory	Accuracy of information Appropriate methodology Save money and time; Protect the public; Protect their jobs, agendas or institutions
Product Characteristics	Complex Scientifically defensible	As simple as possible without losing accuracy Importance of context
Frame	Physical (atmospheric, hydrologic, etc.) conditions as drivers Dependent on scientific discipline	Safety and well being Profit Consistency with institutional culture, policy, etc.
Nature of Use	Conceptual	Applied