6-12-2003

Improved Drought Planning for Arizona

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Conference on Water, Climate, and Uncertainty:
Implications for Western Water Law, Policy and Management
June 11-13, 2003

I. Introduction

The State of Arizona is one of only 15 states that does not have a statewide drought plan, despite its significant vulnerability to drought. Although a previous attempt to develop a statewide plan was initiated in 2001, no comprehensive plan was completed. The only plan that is currently in place is a "Drought Incident Annex" to the Department of Emergency Management Plan, prepared in May of 2001. This annex identifies the responsible state agencies and focuses on potable water, fire suppression and agriculture in the context of emergency response.

Arizona has recently committed to developing a drought plan that will use the lessons learned by other states and providing some enhancements that can be used elsewhere. The new drought planning effort is expected to benefit from collaborative planning efforts with the University of Arizona, which will provide natural and social science expertise including the stakeholder-driven research initiatives of the Climate Assessment for the Southwest (CLIMAS) project. It is anticipated that stakeholder input will help shape the plan's research, monitoring and communication processes and explore new types of relationships among agencies, researchers and stakeholders. In addition, the plan will focus on adaptive management and a monitoring, assessment and response process that will incorporate new information as it is available. Finally, the plan will differ from efforts in some other states by including a focus on adaptation and reduction in vulnerability to future droughts.

Background

Drought conditions currently exist throughout Arizona, and are particularly acute in the northern plateau region. Precipitation in six of the last seven years has been significantly below normal, and in 2002, surface water flows and reservoir storage levels were the lowest ever recorded in many areas[3]. Drought conditions have affected rural areas most severely, in part due to a heavy dependence on groundwater and a lack of alternative supplies. The major metropolitan areas of Phoenix and Tucson have been less heavily affected due to the availability of surface water supplies from the Central Arizona

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[3] See USGS Water Resources Data for Water Year 2002 – Arizona, released May, 2003.

Project, the Salt River Project and significant investments in recharge systems, though water levels in wells have dropped significantly throughout the state.

Governor Janet Napolitano signed Executive Order 2003-12, establishing the Arizona Drought Task Force, on March 20, 2003. The Governor directed the Department of Water Resources to provide leadership in this effort and required the development of the state's first comprehensive drought plan. All other emergency management planning and response activities remain within the purview of the Department of Emergency Management and Military Affairs. The Task Force itself is comprised of state agencies and elected officials; however all meetings are open to the public and participation in the drought planning process is encouraged.

The Executive Order requires preparation of a short-term drought plan to respond to potable water needs, as well as non-potable needs for agriculture, wildlife and wildfire this summer (2003). The short time frame available to develop this plan requires heavy dependence on previous drought planning efforts. The Order also requires development of a long-term, comprehensive plan that will provide for drought planning efforts throughout the state and a coordinated response framework. This longer-term effort is intended to recognize and build upon existing drought efforts, and to reduce the impact of drought on economic activities, communities and habitat throughout the state. The final major assignment is the development of a statewide conservation strategy that focuses on education, technology transfer and assistance.

The Drought Task Force is comprised of representatives of twelve state agencies, plus the Arizona Corporation Commission, the Office of the Governor, and Senate and House of Representatives. The state is expected to have an oversight and coordination role in the implementation of the drought plan, so formal membership is limited to state representatives.

Approaches of other states

Colorado developed one of the first state drought plans, and its approach was considered the model for many years. The Colorado plan focuses primarily on identifying and responding to drought events as they occur. However, some more recent drought plans, such as New Mexico's, place greater focus on mitigation. The Montana planning process has been very successful, and has resulted in a long-term commitment to monitoring and assessment. The Montana Drought Task Force has been meeting monthly since 1991; more than 12 years. The drought plan recently developed for Georgia had a comprehensive planning focus involving stakeholders that was quite successful. Lessons can be learned from the successes and failures of other states; for reviews of drought impacts and drought planning in the US, see BAMS (2002), Keenan and Krannich (1997), Shepherd (1998) , Wilhelmi and Wilhite (2002), Wilhite (2000, 1997, 1996, 1991), and Wilhite and Rhodes (1994). The National Drought Mitigation Center in Lincoln, Nebraska, provides a clearinghouse for information on drought planning as well as access to a wealth of experience in drought planning throughout the U.S. and internationally.

II. Potential contributions

Arizona's drought planning process anticipates providing contributions in several areas. First, new communication techniques and sources of information are being developed that incorporate local stakeholder knowledge but also connect to national drought monitoring procedures. The Task Force will utilize the social science expertise of the project team at the University of Arizona in combination with the experience in collaborative planning and consensus building within the Department of Water Resources. Other major water interests in the state have contributed staff and support to the drought planning process and their assistance should expand the knowledge network. Working to improve the quality of the monitoring and assessment process from both a "top-down" and a "bottom-up" perspective may provide lessons that can be useful elsewhere.

Second, it is hoped that the strong climate research group at the University of Arizona, in cooperation with researchers at various other Arizona institutions, federal agencies and data centers, can enhance the utility of drought-related information for decision-makers. The Task Force will seek to provide new ways to incorporate climate prediction capability, paleo-climate information and monitoring data at the regional scale to enhance the utility of drought-related information for decision-makers. There is a need to assess the current drought indices, monitoring techniques and trigger points to ensure their applicability in the Southwest, particularly in light of the varied landscape types in Arizona's primary physiographic regions (basin and range, Mogollon Rim, Colorado plateau) and the influence of local and regional elevation-induced weather and climate patterns.

Third, this effort will focus on defining the conditions that create vulnerability to drought and identifying potential adaptive responses. This is intended to increase the effectiveness of drought planning and reduce long-term costs related to emergencies. There are many ongoing studies within the three Arizona Universities as well as within government agencies and stakeholder groups that can be used to identify and assess the components of vulnerability.

Fourth, the process that is being designed will focus on building institutional relationships and on an adaptive approach that incorporates new information over time. Previous work (see, for example, Sarewitz, Pielke Jr. and Byerly Jr. 2000; Jasanoff and Wynne 1998; Gibbons et al. 1994) shows that trust between stakeholders and those who generate the scientific information, and capacity-building to interpret and evaluate such information (see, e.g., Nicholls 1999, Stern and Easterling 1999), are integral components of a successful planning process. This type of focus, on process and trust-building, should prove more robust over time in responding effectively to changing conditions.

III. Process

While the initial focus of the Drought Task Force will be on short-term drought response, a significant portion of Task Force time will be devoted to development of the long-term plan. The longer-term planning process is expected to include a series of workshops to be held around the state to provide input to the proposed plan. These workshops will afford opportunities for individuals to provide input to the plan development process and to air their concerns regarding drought impacts on their businesses, livelihoods and communities.

An important part of the process will be developing a virtual drought planning capability, by taking advantage of Web-based information technologies. Some of the products identified for the Drought Plan Web site were tailored for use in the Southwest by CLIMAS under its 2002-2003 END Insight (El Nino-Drought Insight) Initiative. Through this Web site, Task Force members and the public will have access to the most up-to-date information on drought conditions, climate and weather forecasts, and other pertinent information. Users will also have access to guidelines regarding appropriate interpretation and use of the information provided. This latter feature is essential, for information (particularly forecasts) can vary substantially over time and space in terms of skill, accuracy, and relevance. Hopefully some of the information will be provided in interactive formats, allowing users to tailor the results to fit their needs.

Internet-based communication will play an important role in the development of the plan. Because a large number of stakeholders have indicated an interest in participating, (three hundred people are on the mailing list after only one official meeting), and there are limited resources available to support the process, administration of multiple meetings of interest groups could easily become overwhelming. The Task Force will rely on email and the Web in addition to face-to-face meetings.

IV. Climate Inputs: New Contributions

Many existing drought plans do not take interannual to decadal-scale climate projections into account. A proactive stance toward drought impacts, however, may be significantly enhanced through judicious use of such information. Projections that assume that the current negative phase of the Pacific Decadal Oscillation (PDO) will persist and will enhance the probability of dry conditions during La Niña events provide a focus for thinking about drought and its impacts over timeframes of several years to a decade or more for the Southwest. Introduction of hydroclimatological projections at multiannual and decadal scales into Arizona's drought planning process poses significant opportunities, as well as challenges. Longer-term projections, even those that are significantly hedged by uncertainty, can provide valuable information about the possible range and intensity of drought. Such projections allow a broader assessment of potential drought impacts and identification of early steps to reduce vulnerability and enhance adaptive capacity. Among the many challenges to integration of such information is educating Task Force members and the public about the availability and use of forecast products, as well as their skill and accuracy over time, space, and across water use sectors of the state.

Climate information developed by CLIMAS and others for the Southwest provides a foundation for tailoring products specifically for use in Arizona drought planning. Such products include climate anomaly maps, water supply outlooks, drought indices, sea surface temperatures and related ENSO (El Nino-Southern Oscillation) activity. Likewise, trends and patterns from the historical and paleo records provide important perspective on how anomalous recent conditions may be. These types of information can be valuable in providing early warning of impending drought, enhancing assessment of unfolding drought conditions, and activation of triggers linked to specific response activities.

Given the high degree of variability of Arizona's topography, climate and hydrological conditions, and the importance of societal factors (economic, political, land use, livelihood, size of community, demographics, etc.), downscaling climate information whenever possible for local applications is essential. The Arizona drought planning process provides an opportunity for collaboration with the University of Arizona to develop and disseminate such information specifically for drought monitoring and response.

V. Adaptation/vulnerability

Degree of vulnerability and ability to adapt to threats or hazards are important indicators for assessing drought impacts. *Vulnerability* in this context refers not only to the extent to which an entity *exposed* to a hazard or threat, but the extent of the actual or potential *adverse impact* of that hazard or threat. The degree of vulnerability to drought, then, is defined by the type and degree of impacts associated with diminished availability, accessibility, and quality of water in the form needed for the activity in question (e.g., drinking water for human consumption, soil moisture sufficient to support forage for livestock, or fuel moisture levels affecting wildland fire hazard). The relative ability of an entity to avert or mitigate the depredations of the threat, in this case drought, indicates the level of adaptive capacity present. Where sufficient alternative sources of potable water exist,[4] for example, vulnerability of drinking water supplies to drought may be minimal. Where soil moisture or fuel moisture levels are exceedingly low and no feasible mitigation alternatives exist (for example, shifting cattle to another pasture area), vulnerability is extremely high.

As noted above, the Governor's Drought Task Force initiative recognizes most of the drought-sensitive sectors in Arizona: agriculture and livestock, wildland fire, wildlife and wildlife habitat, municipal and industrial water supply, etc. In addition to the areas required by the Executive Order, the Task Force may address impacts on recreation, tourism and electric power generation. In order to identify and design appropriate drought response triggers, the vulnerability factors for particular sectors and geographical areas must be defined based on objective criteria. The process for developing these criteria will depend heavily on stakeholders.

[4] Communities with legal and physical access to substantial groundwater supplies and the resources to pay the costs of pumping the water even as depth to water increases may fall into this category.

Adaptation options that will reduce or avert future vulnerability should be identified and linked to drought vulnerability criteria.. The expertise that CLIMAS has developed in assessing vulnerability and identifying adaptation strategies provides a foundation for working with stakeholders. It is anticipated that information developed through CLIMAS and the drought task force process will facilitate development of programs that encourage appropriate adaptations to the current drought and that will sustain adaptive behavior and management to minimize or avert impacts of future drought events.

VI. Implementation

Capacity building is an essential component of the Arizona drought planning process. The emphasis on capacity building recognizes the politics of the state, which places a maximum value on retention of local control. Indeed, retaining power at the local level has previously resulted in some resistance to state-level drought planning. Through advocating local empowerment and acknowledging current drought planning efforts, the Arizona plan will recognize the strengths inherent in local knowledge about conditions, practices, and values, while providing a comprehensive statewide support structure to help communities and impacted sectors be better prepared for drought in the future.

The Arizona drought plan seeks to integrate science and public policy in ways that allow refinements as expertise and experience grows on both sides of the interface. For this to occur, however, the plan and its implementation must remain sufficiently flexible to incorporate advances in longer-term climate and hydrologic forecasting. Such forecasting is a scientific "work in progress" and one in which knowledge gains are made more easily in some areas of research and development than in others. Adaptive management that is flexible enough to adjust to changing vulnerabilities and adaptive capacities within the state is equally essential. On the public policy side of the interface, applied science requires development of usable products, in a timely manner, that meet the needs of the state. The products must be intelligible to non-experts and must be relevant to the decisions that must be made.

Close interaction between scientists and decision-makers throughout the drought planning process will be essential. If accomplished as envisioned, the integration of a wide array of hydroclimatic information with an emphasis on framing decision criteria in terms of vulnerability and adaptation, Arizona will go "one step beyond" many other US drought plans.

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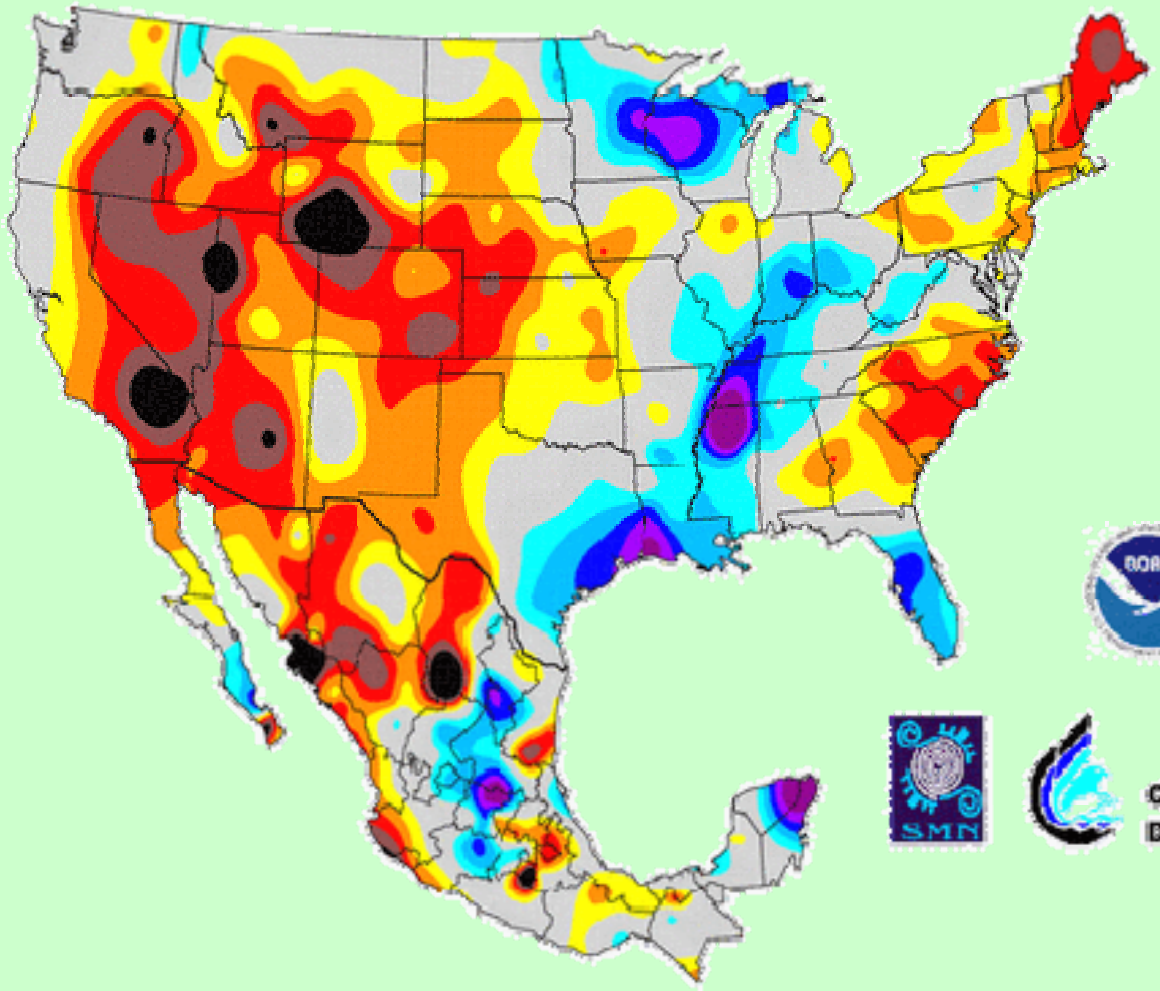
24-Month Standardized Precipitation Index
April 2001 - March 2003



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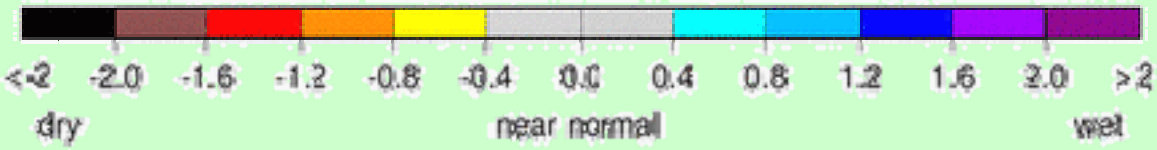
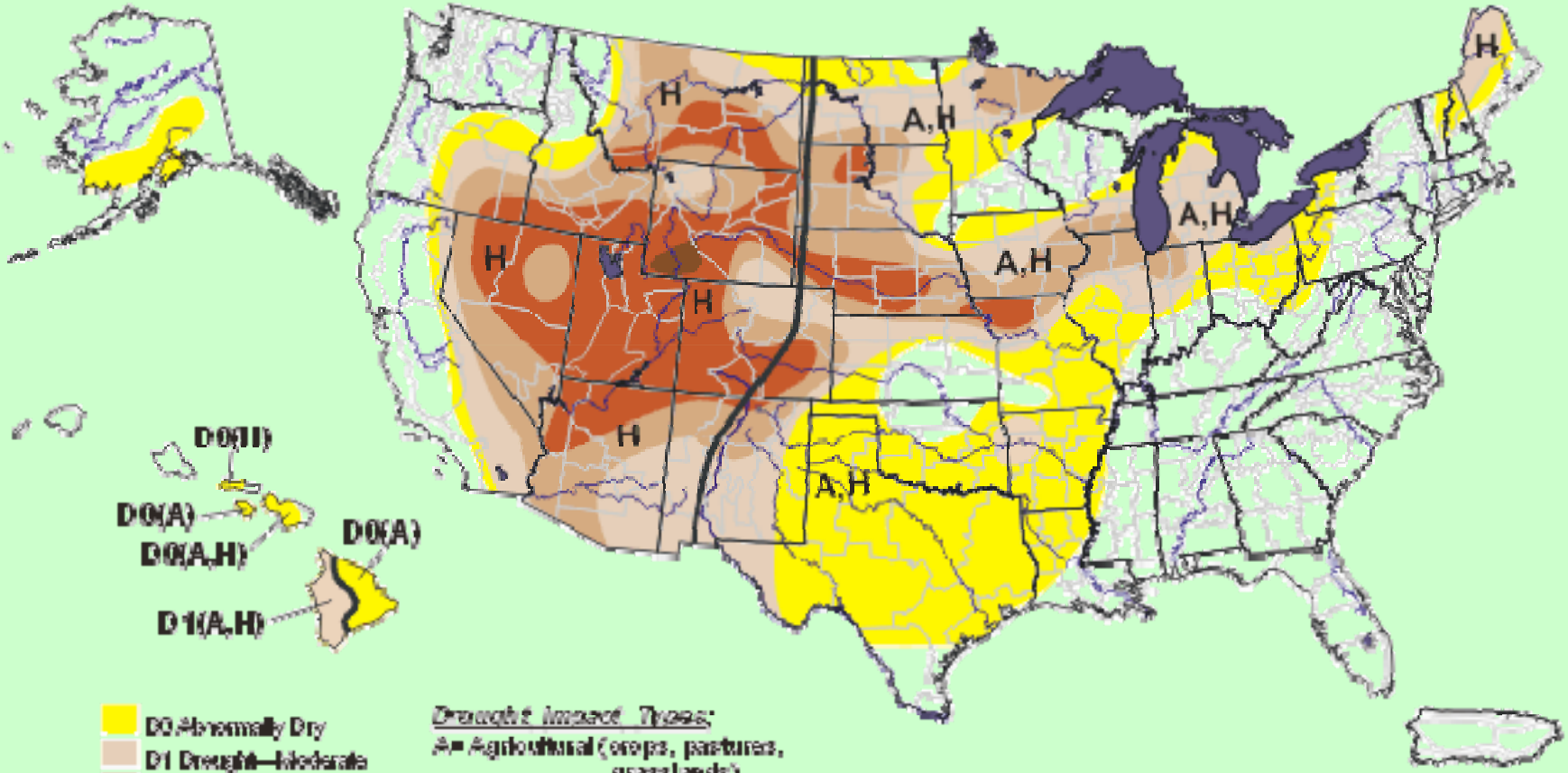


U.S. Drought Monitor

April 29, 2003
Valid 8 a.m. EDT



D0 Abnormally Dry
D1 Drought—Moderate
D2 Drought—Severe
D3 Drought—Extreme
D4 Drought—Exceptional

Drought Impact Types:
A= Agricultural (crops, pastures, grasslands)
H= Hydrological (water)
/ Delineates dominant impacts
(No type = both impacts)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

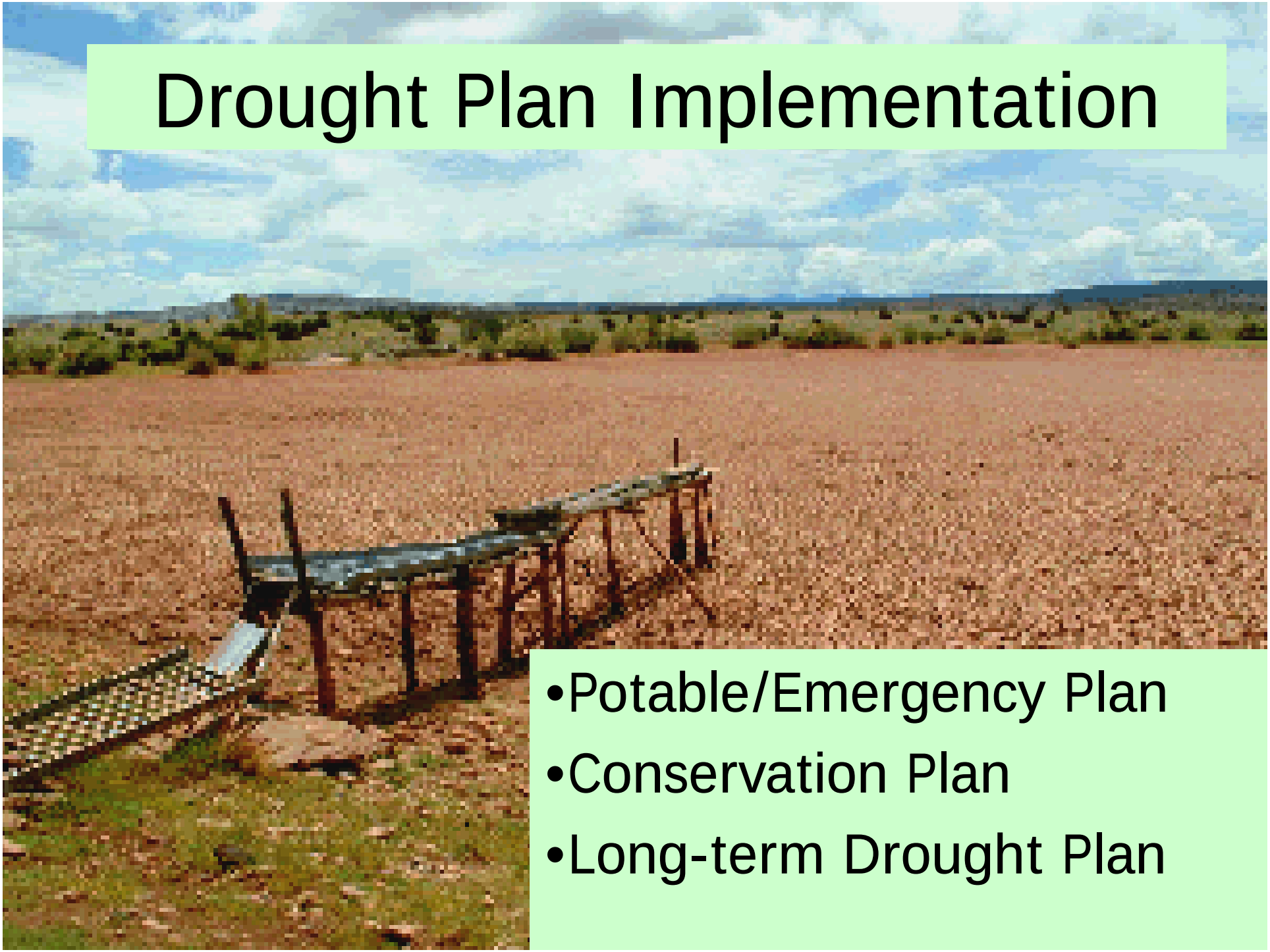
Released Thursday, May 1, 2003

Author: Richard Heim, NCDC

Governor's Drought Task Force

- Executive order 2003-12, March 2003
- ADWR is lead agency; state agencies are members
- Jurisdictions, Indian tribes, water and electric utilities, and the public are invited to participate

Drought Plan Implementation



- Potable/Emergency Plan
- Conservation Plan
- Long-term Drought Plan

Potable/Emergency Plan (2003)

- Potable Water Needs: Water companies and individual wells
- Fire Suppression
- Monitoring for impacts to Agricultural Operations, Wildlife and Habitat

Conservation Plan

- Education, Outreach and Technology Transfer
- Rural Communities Focus
- Capitalize on Existing Media Programs
- Conservation Clearinghouse

Long-term Drought Plan

Components:

Monitoring

Assessment

Response

Adaptation

Coordination with:

Watershed Initiative

Existing Drought Plans

Multiple Stakeholder Groups

National Drought Mitigation Center

Long-term Drought Plan Topic Areas

- Irrigated Agriculture
- Range and Livestock
- Wildlife and Habitat
- Municipal/Industrial Water Supply
- Commerce, Recreation and Tourism
- Other: Energy, Native American Issues, Water Quality

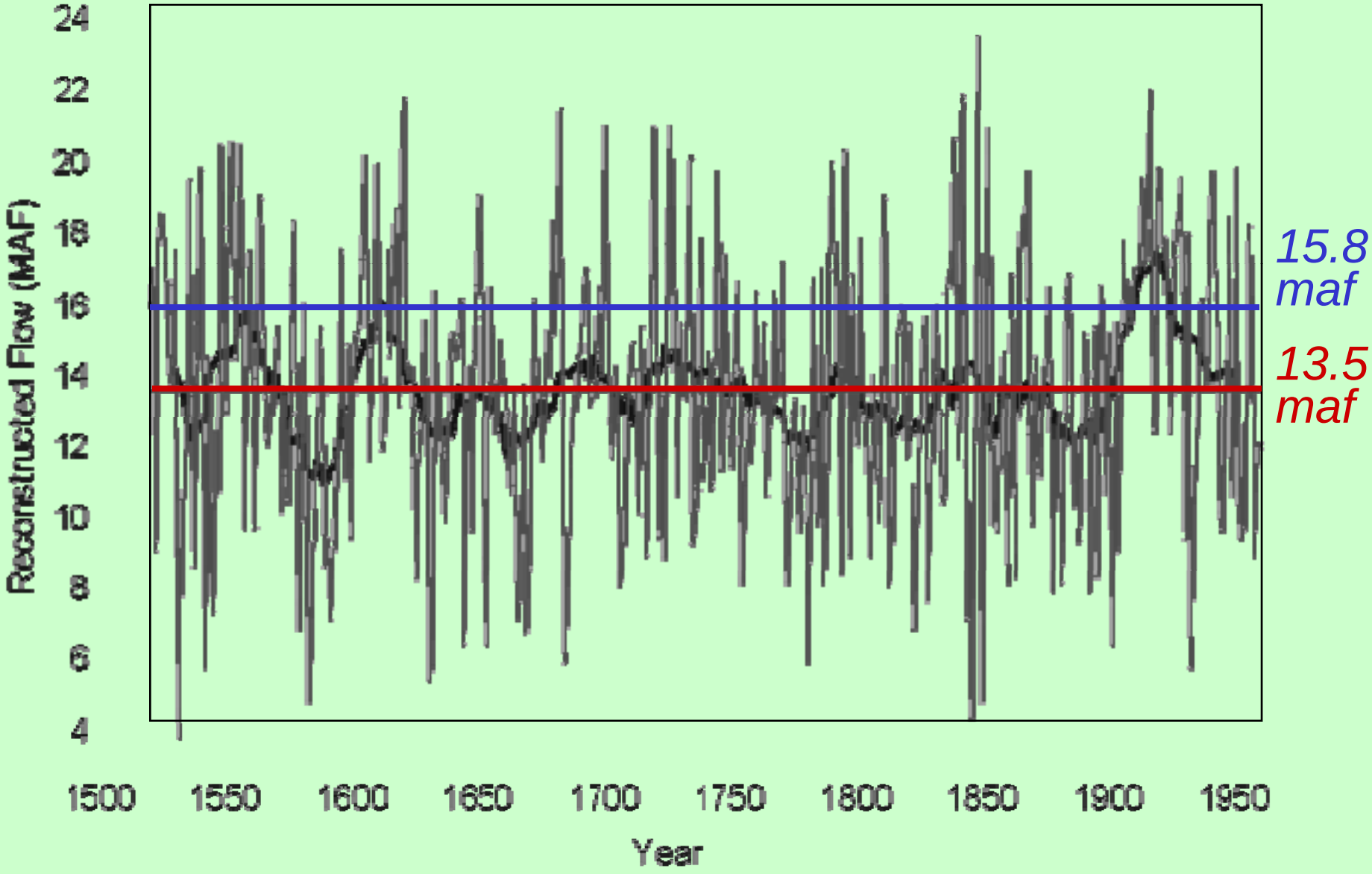
Collaborative Planning Efforts University of Arizona/CLIMAS

- Social Science:
  - Enhanced stakeholder input
  - New relationships between agencies, stakeholders, researchers
  - New communication techniques, email and web-based planning and info exchange
  - Components of vulnerability/criteria for risk assessment
  - Adaptive responses/mitigation

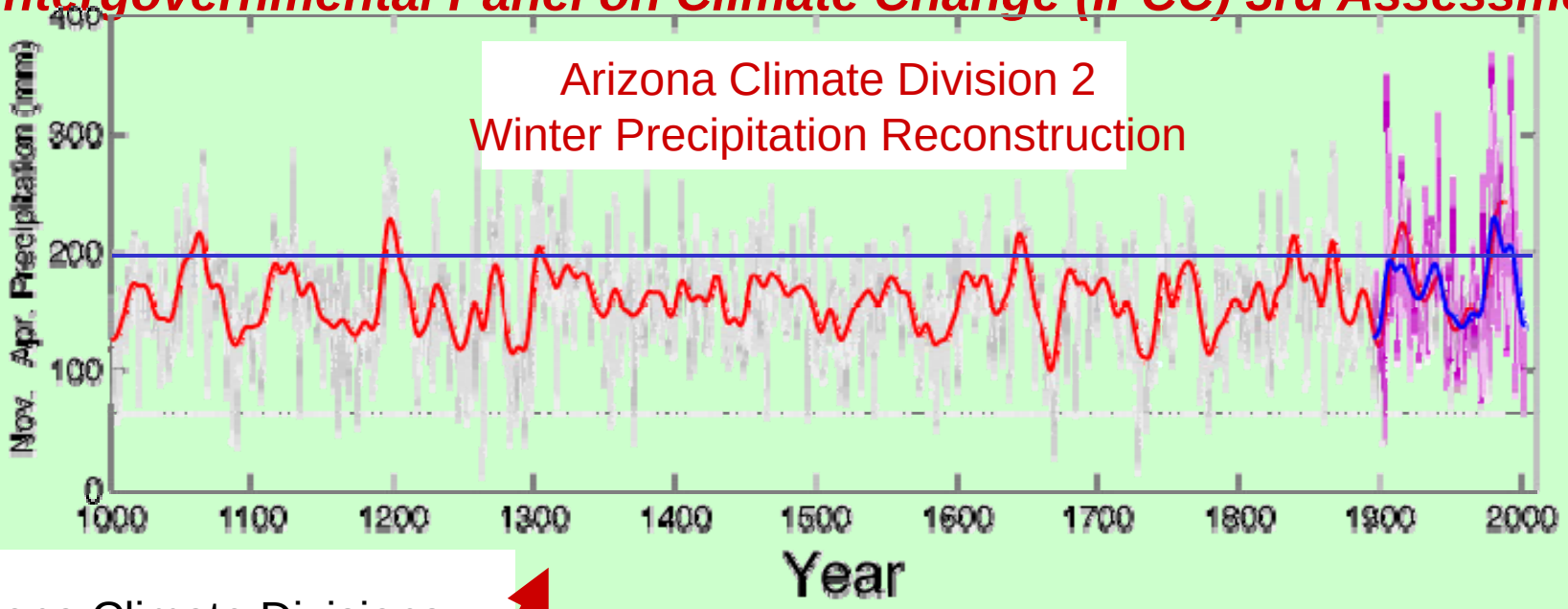
Collaborative Planning Efforts University of Arizona/CLIMAS

- Physical Science:
  - Improved monitoring and assessment, "bottom-up and top-down"
  - Improved indices and triggers in context of multiple landscape types
  - Value-added interpretation
  - Improved predictive capacity, including use of interannual to decadal-scale climate projections

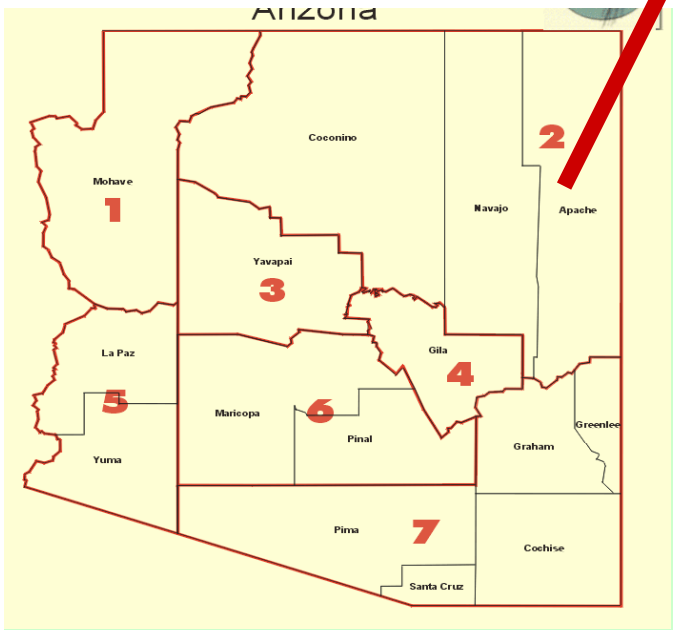
Reconstruction of Long-term Colorado River Flow based on Tree-rings (Stockton and Jacoby, 1968)



Intergovernmental Panel on Climate Change (IPCC) 3rd Assessment



Arizona Climate Divisions

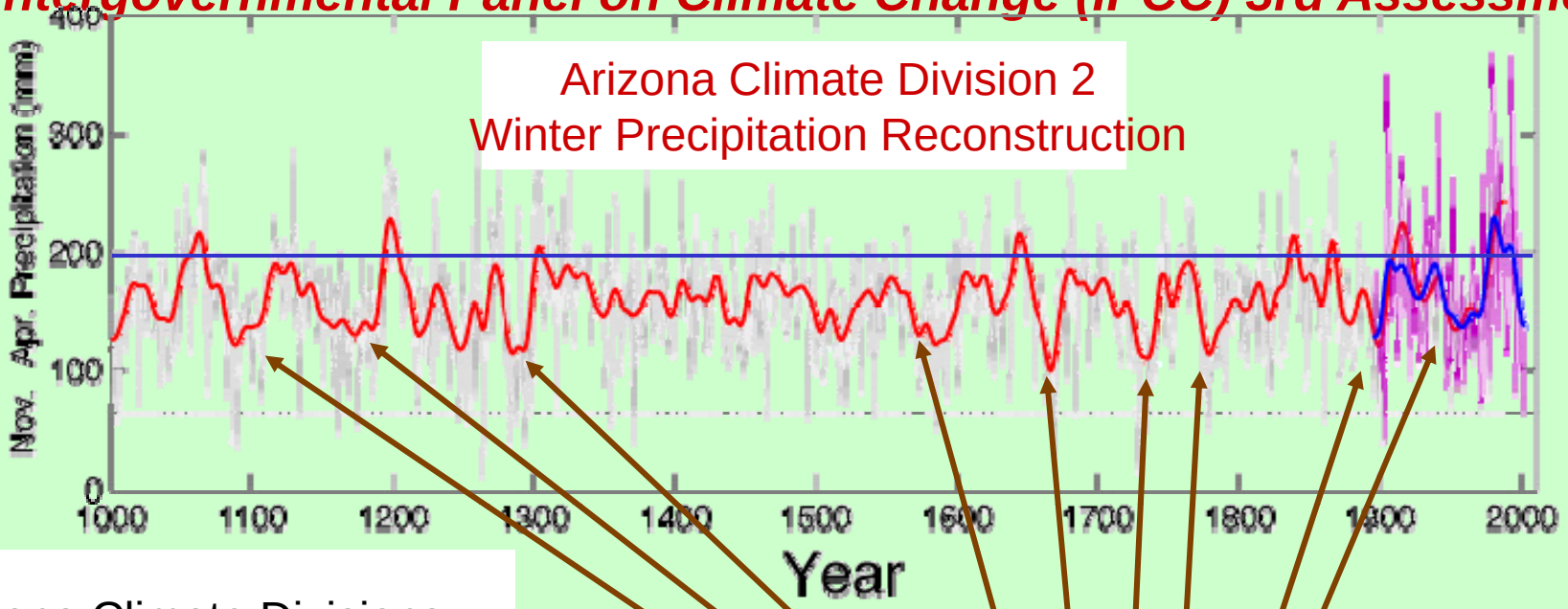


Reconstructed precipitation over the last 1000 years also suggests that:

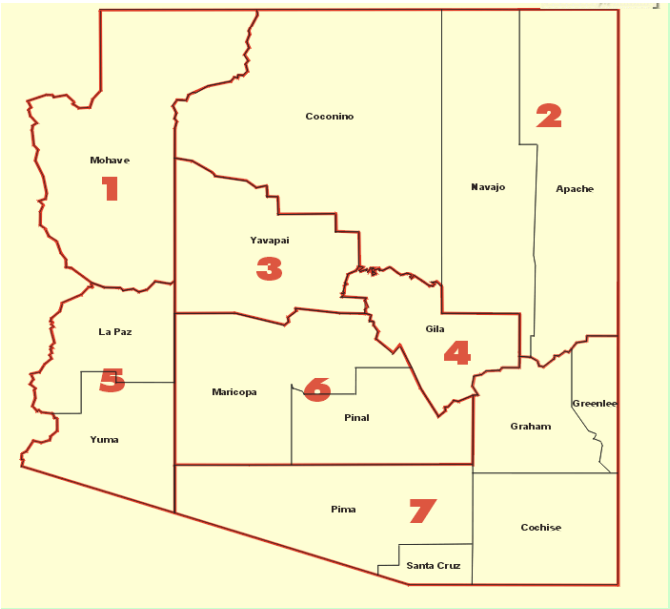
1) the late 20th century Arizona was also anomalously wet (by 25%)…

(new results from UA Prof. M. Hughes and team)

Intergovernmental Panel on Climate Change (IPCC) 3rd Assessment



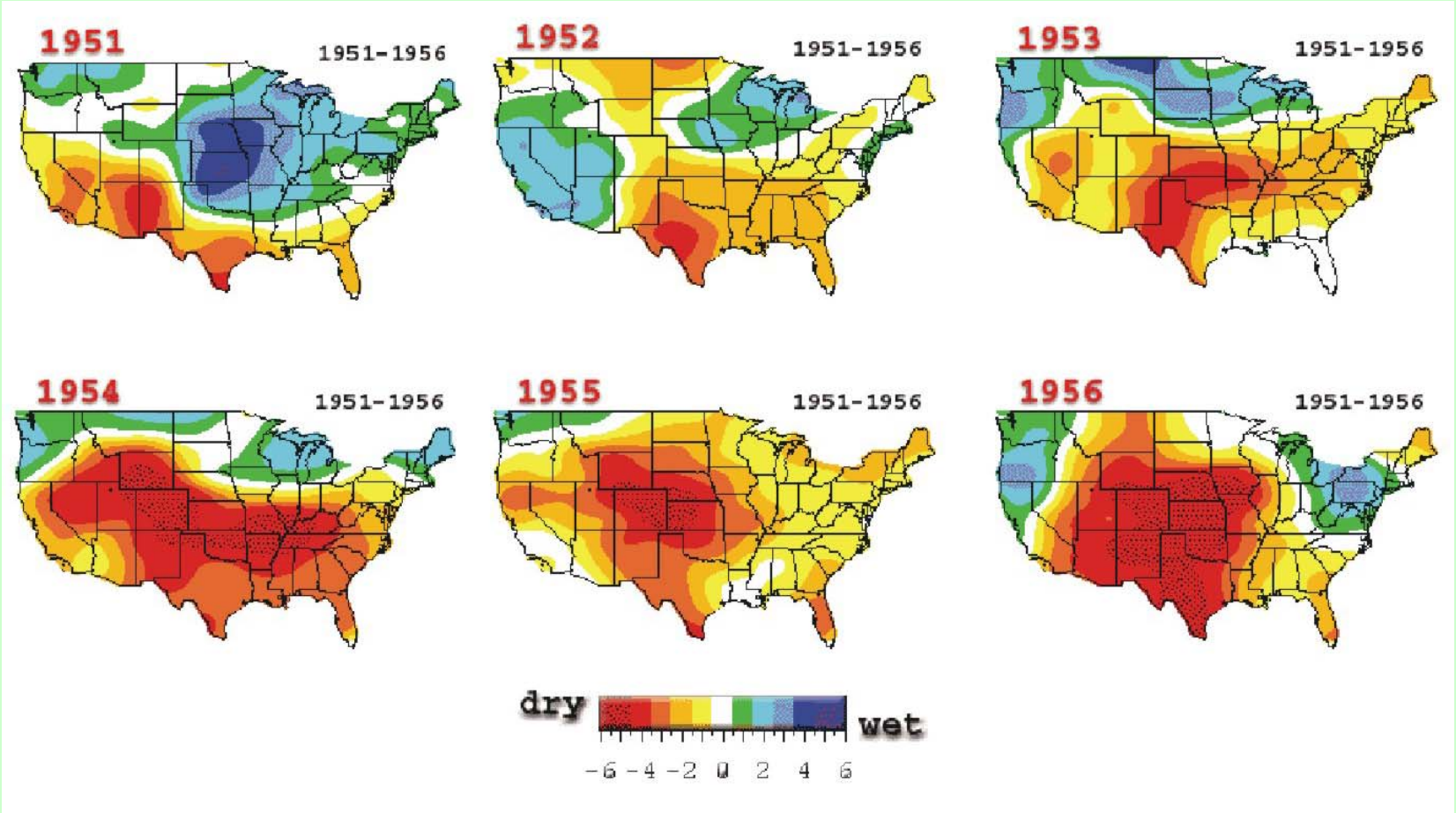
Arizona Climate Divisions



…and

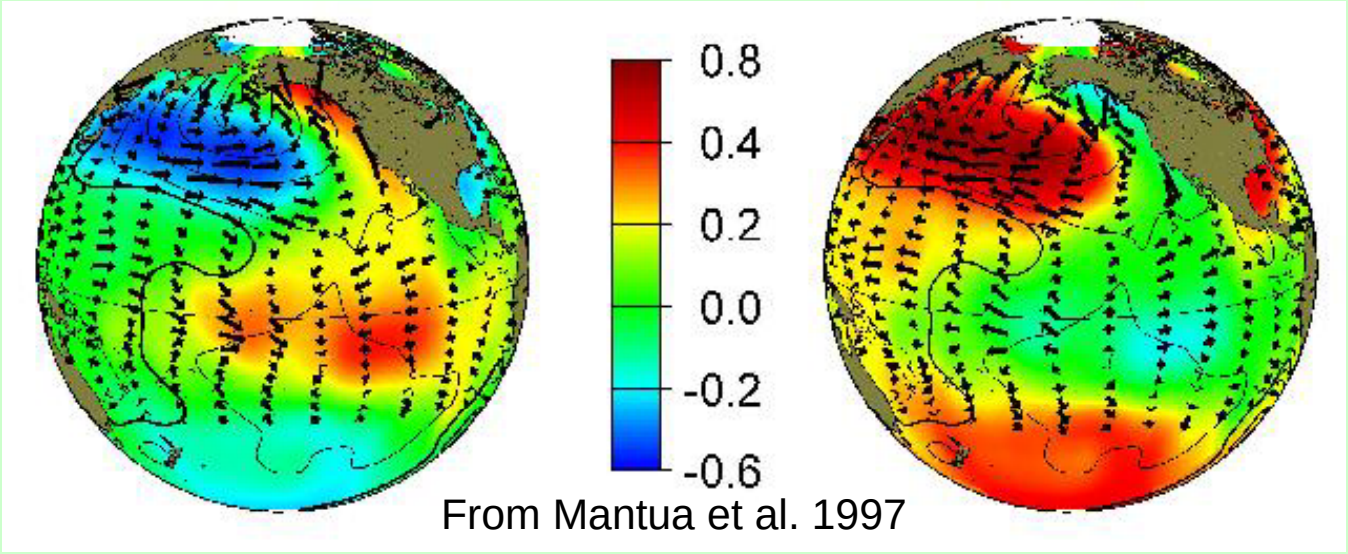
2) that droughts lasting a decade or more are not that uncommon

1950s Drought



Courtesy of National Climatic Data Center Paleoclimatology Program

Pacific Decadal Oscillation



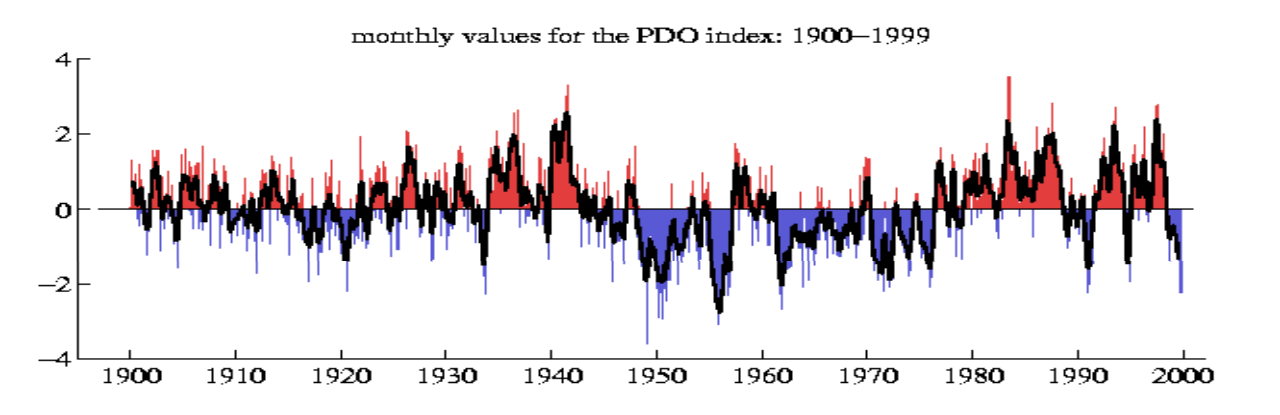
From Mantua et al. 1997

Warm (positive) Phase

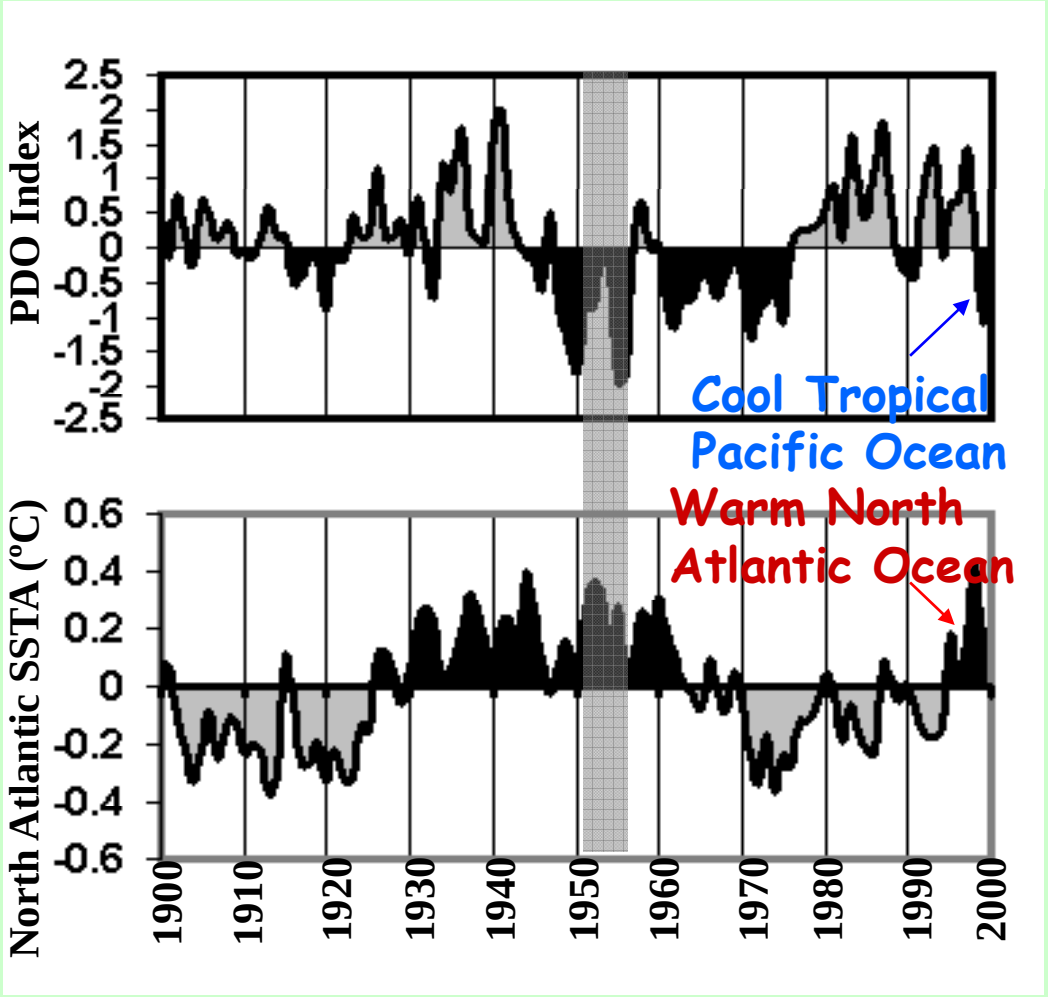
- Enhanced El Niño
- Weakened La Niña
- Increased winter precip.

Cool (negative) Phase

- Weakened El Niño
- Enhanced La Niña
- Diminished winter precip.

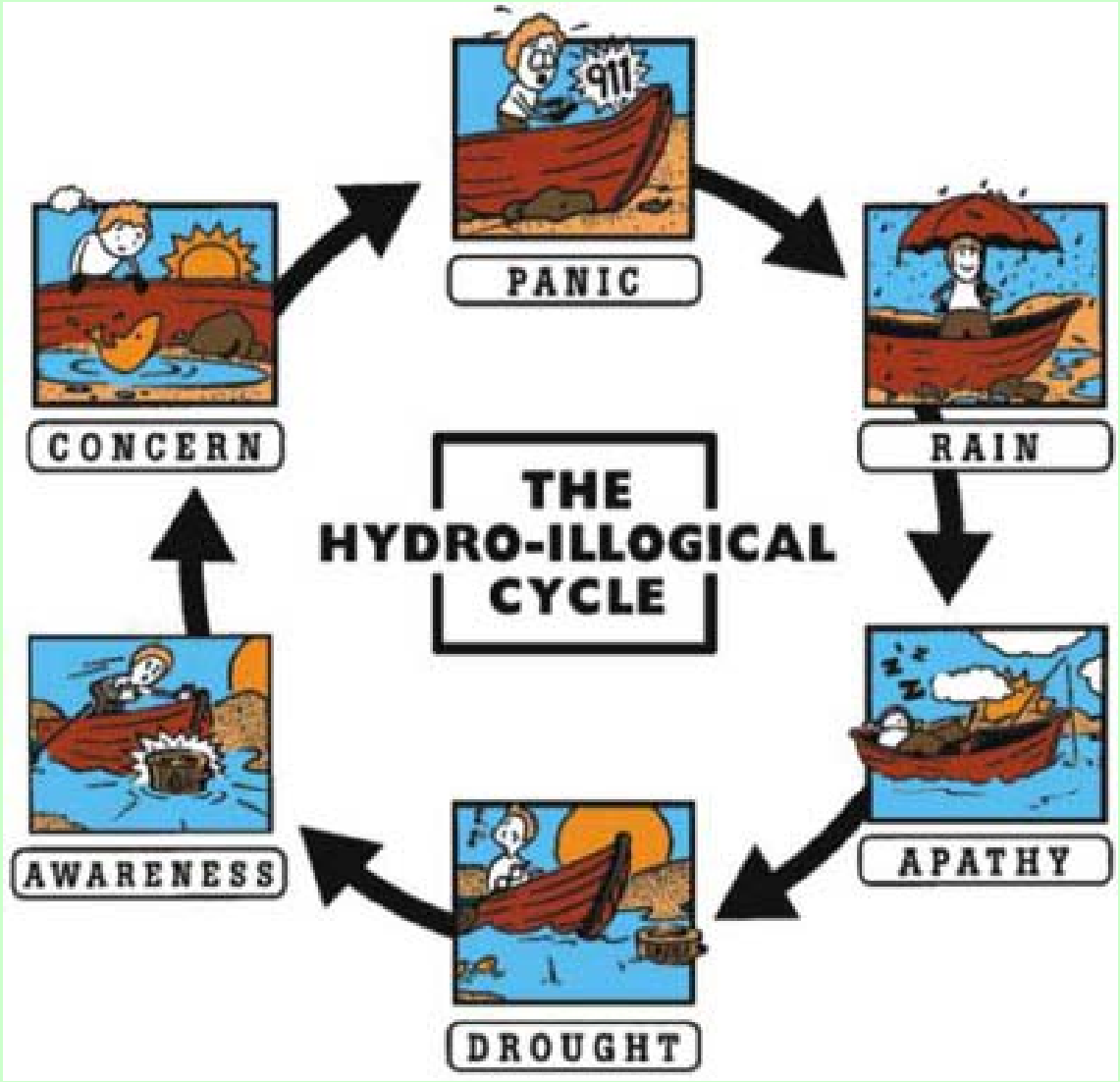


PDO-AMO Interactions???



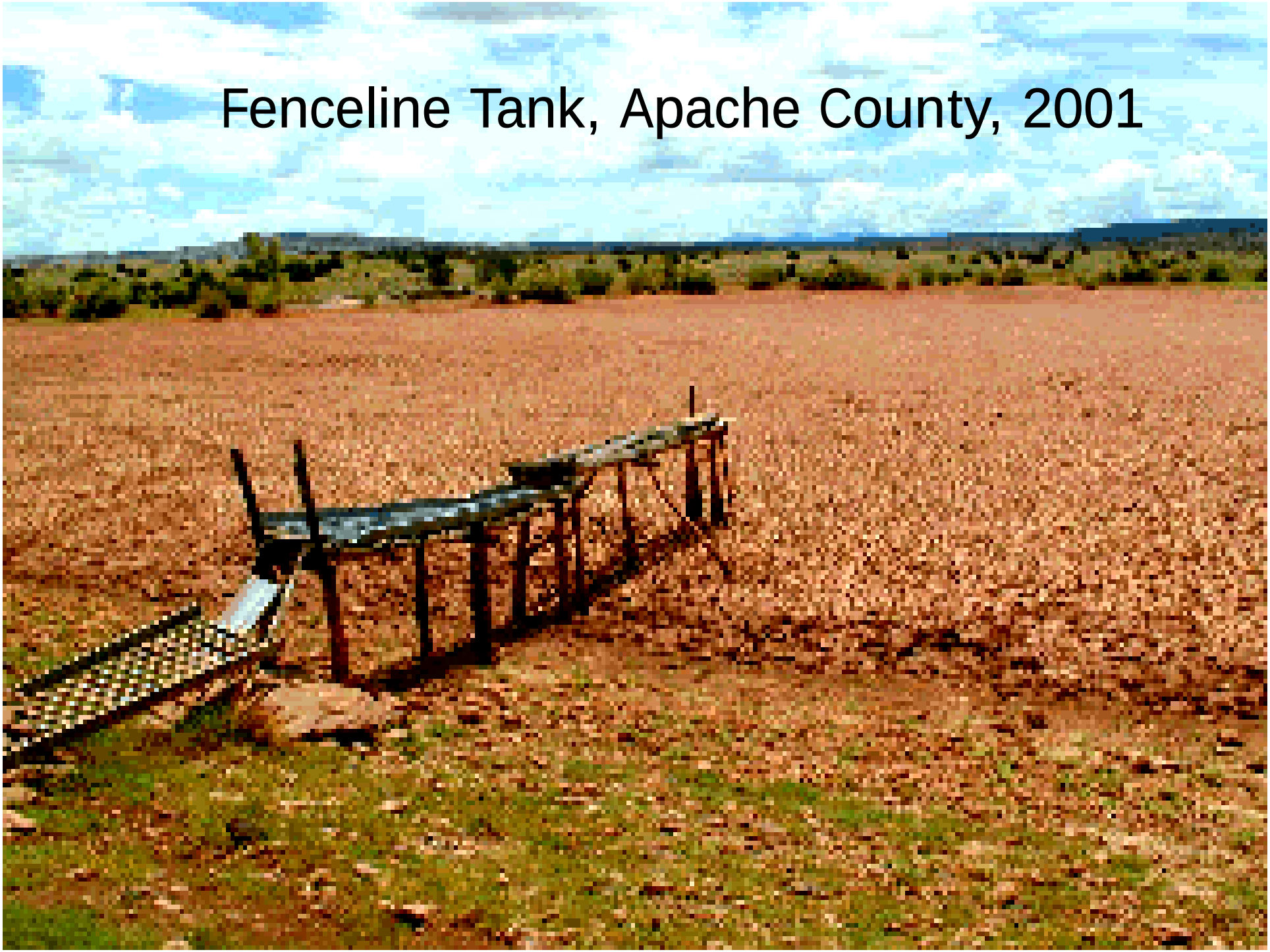
Warm Atlantic Ocean + Cool Pacific Ocean = Megadrought??

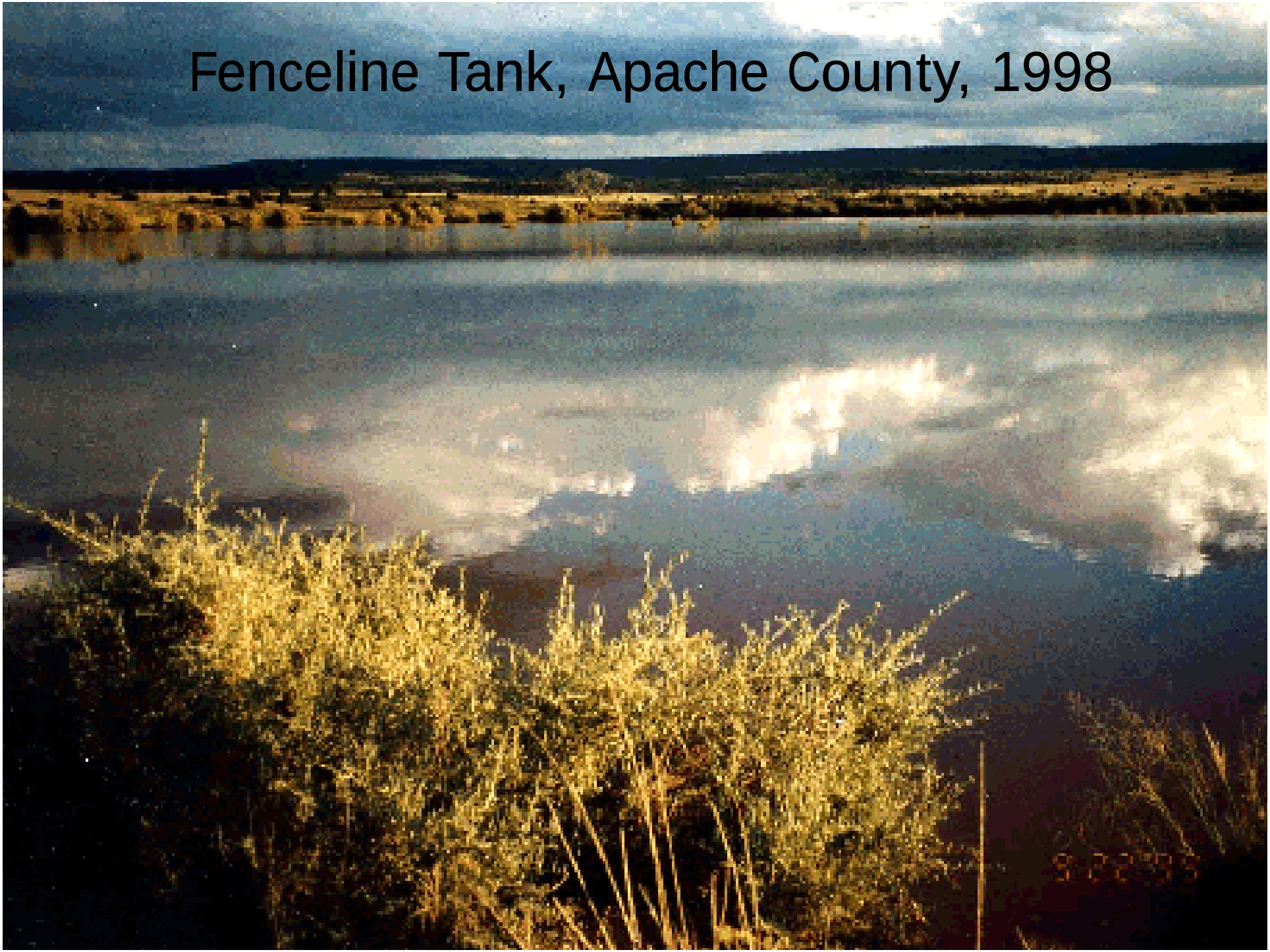
Challenges



after National Drought Mitigation Center

Fenceline Tank, Apache County, 2001




Fenceline Tank, Apache County, 1998

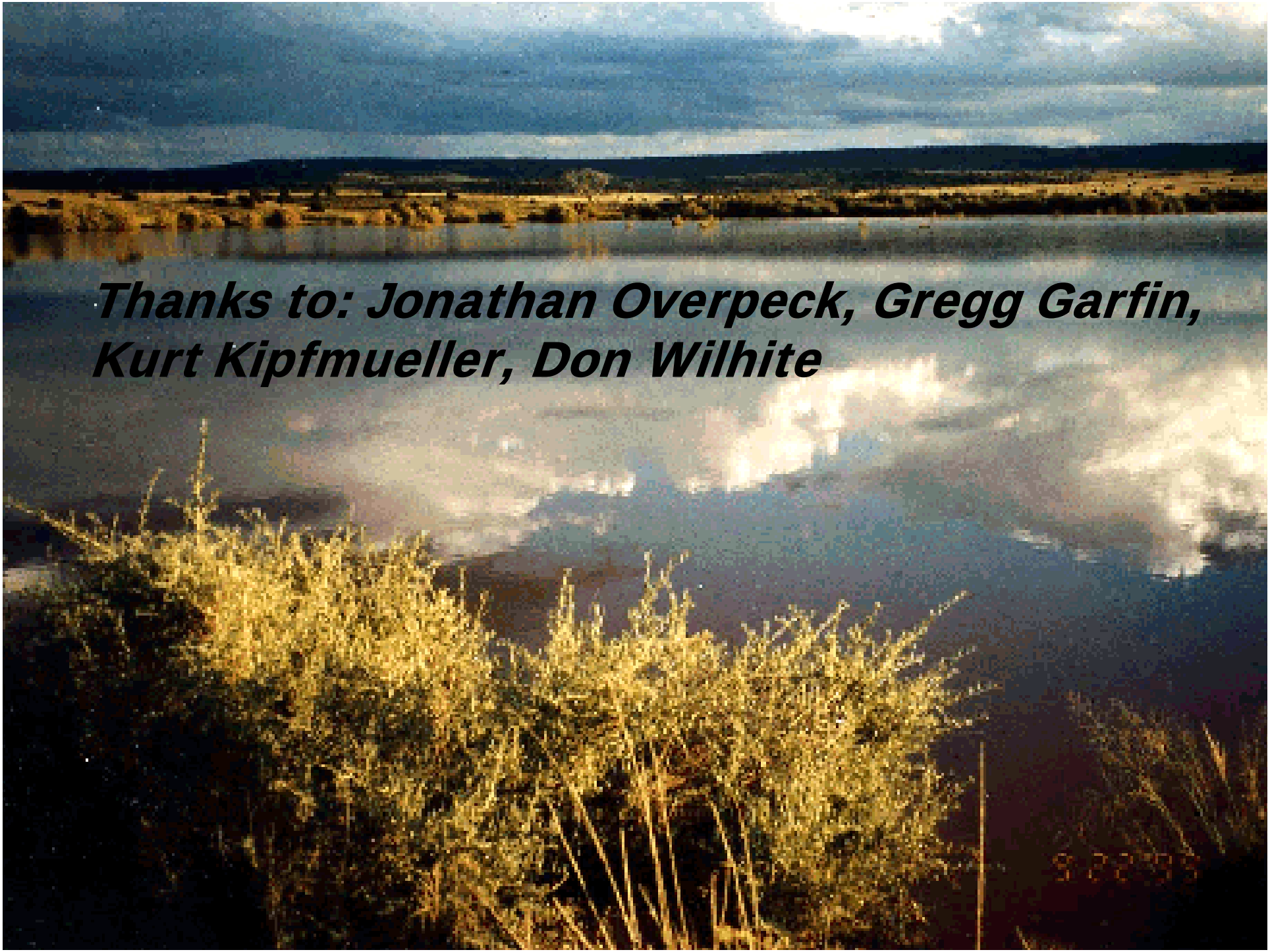

Thanks to: Jonathan Overpeck, Gregg Garfin,
Kurt Kipfmueller, Don Wilhite

Table 1. Barriers to the Use of Climate Information by Water Managers
[Adapted from *Pulwarty and Redmond,* 1997; *Pulwarty and Melis*, 2001]

Certainty
- Forecasts are not seen as accurate enough to justify action
- Experts disagree, or are perceived to disagree (desire for unanimity among experts)
- Inability to verify or track information based on own experience
- Validation statistics of previous forecasts or "skill scores" are not available, or are not considered to be accurate enough to justify action
- Perception of "waffling" in successive forecasts due to new information gives impression of lack of certainty
- Role of climate information in reducing risk is unclear
- Response to climate information is viewed as more risky than using established procedures
- Manager's overconfidence in ability to manage and control risky situations
- Lack of an explicit characterization by scientists of degree of uncertainty
- Manager's overconfidence in their own knowledge, or based on heuristics covering a relatively short time span

Communication
- Overuse of disciplinary language without context (use of jargon)
- Users face new or changing definitions of terms
- Media coverage inadequate, inappropriate or inaccurate
- "Clients" are not challenged to be more precise about their needs
- Negative perceptions about the utility of climate information
- Issues in visualization of complex information

Focus
- Spatial information is too broad and non-specific or difficult to interpret
- Desired information not provided or available (the science is not yet available to meet the user's needs)
- Groundwater managers may not have the same need for climate information as surface water managers
- Water managers may be overloaded with information, not able to sift for relevant material
- Water managers' job expectations do not encourage incorporation of risk assessment and probabilistic information

Trust
- Perception of communication as "marketing" rather than based on common interest

Resources
- Failure to recognize resource limitations: time, money, staff and data may not be available to incorporate the new information
- Funding institutions may not be willing to fund applied research

Timing
- Forecast information is not available on a timely basis, relative to decision calendar of manager

Training
- Scientists are trained within specific disciplines, and rewarded for staying within their disciplines; they are not trained as integrators
- Water managers may be trained primarily as engineers, only have experience within particular job applications
- Lack of familiarity with the methodologies for analyzing climate data (and their limits)
- Inability of forecasters to recognize competing or shifting goals, need for a flexible response
- Lack of procedures for incorporating climate impacts information/models in decision-making
- Water managers may have analyzed the information available and concluded it is not applicable to their system

Boundary
- Inability to access data or apply management solutions across jurisdictional and institutional boundaries
- Enitities located near places where boundary conditions change, eg climate divisions, watershed boundaries, etc. may have difficulty accessing information that is useful to them.