A photograph of two men standing in a desert landscape. The man on the left is wearing a light blue long-sleeved shirt, blue jeans, and a tan cowboy hat. The man on the right is wearing a light grey long-sleeved shirt, blue jeans, and a black baseball cap. They are both looking towards the right. The background shows a vast, flat desert plain with sparse vegetation and a range of brown mountains under a clear blue sky.

Beyond just talking about the weather: Examples of climate science extension in Arizona

**Mike Crimmins
Dept. of Soil, Water, & Env. Science &
Arizona Cooperative Extension
The University of Arizona**

Why climate science extension?

- History of delivering climate information to producers and natural resource managers
- Infrastructure, social networks, and credibility
- Experience in brokering partnerships, assessing needs, and translating science
- Climate sensitive clientele in a changing climate



A strategy for climate extension

- Forming partnerships and assessing needs
- Building climate literacy
- Interpreting climate information
- Building decision support tools
- Climate change extension



Forming partnerships and assessing needs

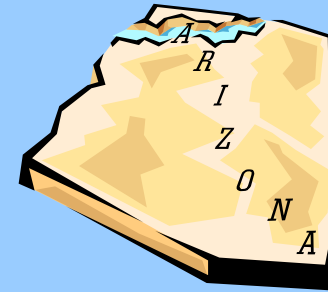
- Identifying climate science/information producers and end-users
- Finding partners within extension (agents, specialists) and external partners with outreach programs (e.g. state/federal agencies)
- Work with partners to identify climate-related needs across different sectors



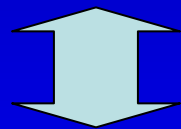
Flow of Climate Science and Services

AZ Climate Science End Users/Partners

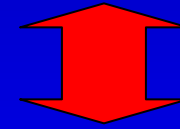
- Agricultural producers
- Natural Resource Managers (land, water, fire...)
- Watershed Alliances/Concerned Citizens
- Local, State & Federal Agencies
- University/Agency Scientists



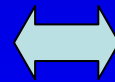
Utilization of information, identifying new needs



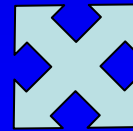
Translation, assessment,
& production



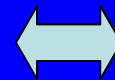
**Climate Assessment for
the Southwest**
NOAA RISA/Univ of Arizona



*University of Arizona
Cooperative Extension*



**Partners: NOAA, AZ SCO,
WRCC, USGS, NRCS...**

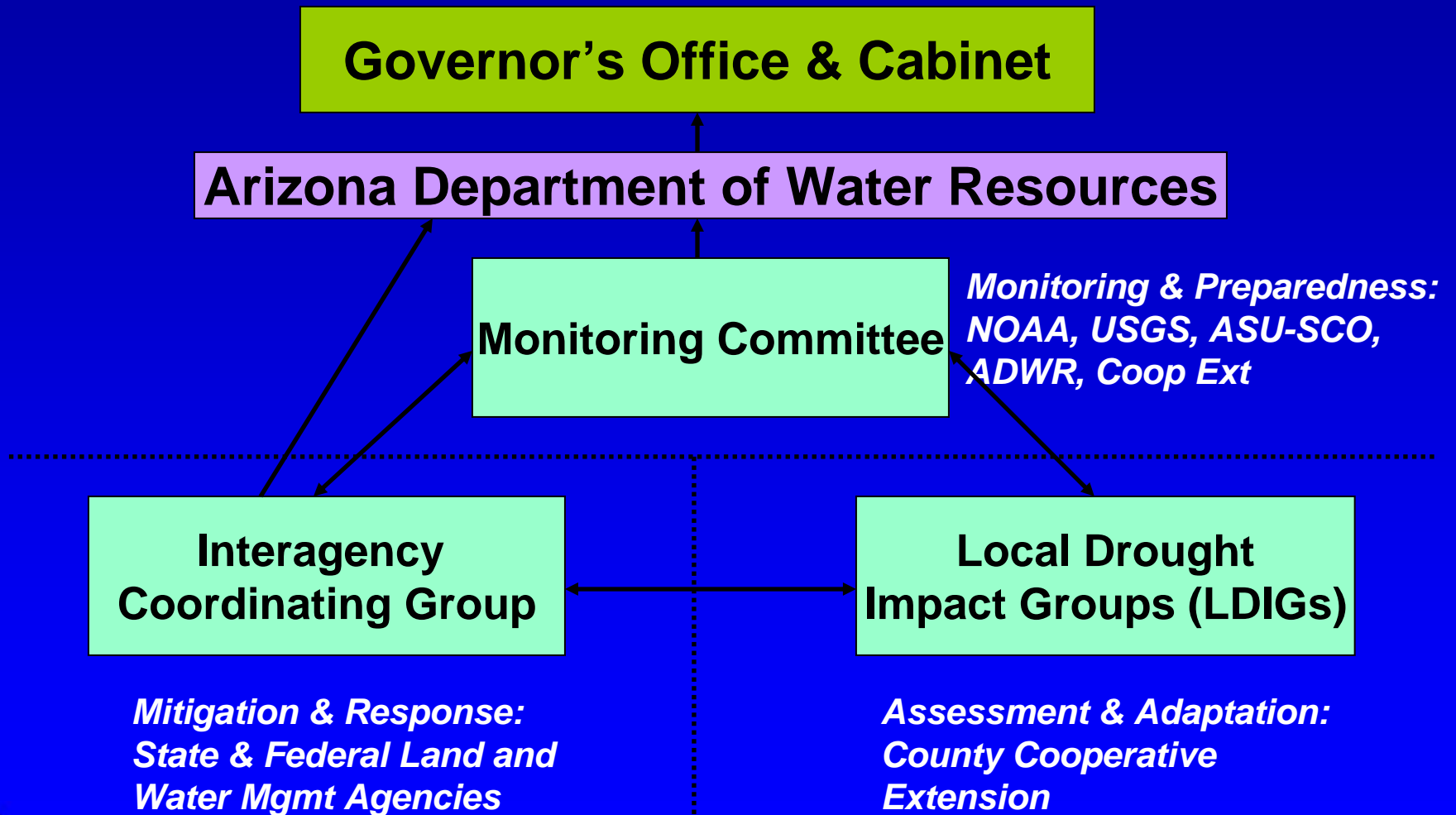


**University of Arizona
Research Community**

Climate science production



Example: AZ Governor's Drought Task Force



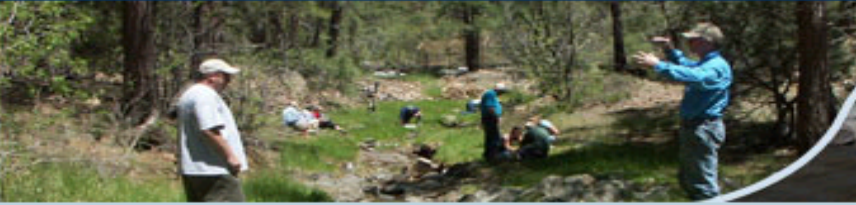
From ADWR 2006



Climate literacy

- Presentations on basic Arizona climatology (e.g. Cattle Growers, BLM Range Managers)
- Master Watershed Steward Program
- Learning modules
- Extension bulletins





Online Learning Modules

| [Home](#) | [About](#) | [Classes](#) | [For Stewards](#) | [Resources](#) | [Newsletter](#) | [Blog](#)

Accessing Climate Data from the Western Regional Climate Center website

[Click to Begin](#)



Western Regional
Climate Center

<http://www.wrcc.dri.edu/>



ADOBE CAPTIVATE™

Extension Bulletins

- ‘Outreach’ publication
- Being developed with diverse partners (e.g. CLIMAS, NOAA-NWS, AzDWR)
- Peer-reviewed
- Wide distribution through extension county offices, programs, & websites
- Very few existing climate related publications

ARIZONA COOPERATIVE
EXTENSION

THE UNIVERSITY OF ARIZONA
College of Agriculture and Life Sciences

AZ1417 08/06

ARIZONA AND THE NORTH AMERICAN MONSOON SYSTEM

Climate Science Applications Program

Introduction

Arizona receives most of its annual precipitation in two distinct seasons, winter and summer. Winter precipitation is produced by large-scale surface low pressure systems that traverse the Southwest, drawing in moisture from the Pacific Ocean and producing widespread rain and snow (Figure 1a). Energy to fuel these large-scale low pressure systems comes from the upper-level (~20,000 ft) mid-latitude and subtropical jet streams that are typically active in proximity to the southwest U.S. during the winter (Woodhouse 1997). Occasionally, energy will break away from these main jet streams and move slowly across the Southwest as circulation features called “cut-off” low pressure systems.

Summer precipitation in Arizona is the result of very different atmospheric features. The mid-latitude jet stream retreats far north during the summer and the subtropical jet stream is replaced by a large high pressure system anchored over the eastern Pacific Ocean (Figure 1b). The mechanism that produces summer precipitation is not associated with large-scale jet streams or strong low pressure systems, but from convective thunderstorms that arise through the combination of solar heating and moisture. Sunshine and solar heating are plentiful across Arizona during the spring and summer, but moisture levels adequate for thunderstorm development are not always present. A subtle change in circulation patterns during the summer opens up a flow of moisture from the south that dramatically increases convective thunderstorm activity across the state. That subtle change in circulation patterns is the North American Monsoon.

How does the monsoon work

The official definition for the word ‘monsoon’ is a persistent surface windflow pattern caused by differential heating that shifts direction from one season to another (Gies 1996). The most intensively studied monsoon on Earth is the Indian, or South Asian, monsoon where surface heating of the Tibetan plateau during the summer causes warm, moist air and thunderstorms from the Indian Ocean to stream inland across south Asia. Winds shift direction during the winter as the Indian Ocean is warmer than the continent, bringing an end to the rains. This shift in winds, from onshore to offshore and then back onshore, happens




Figure 1. Average flow patterns and moisture advection boundaries for (a)



Interpreting and communicating climate information

Southwest Climate Outlook

Issued: September 27, 2006

Monthly/Quarterly Bulletins

Online, interactive presentations

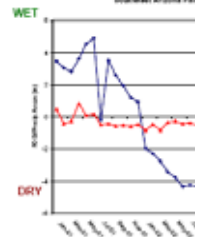


Southeast Arizona Climate Summary Spring 2006



April 16, 2006 – Winter 2006 was an exceptional record. The winter period of January through March was the 15th warmest (average Jan-Mar temp the 1930-2005 period of record). January typically receives close to an inch of precipitation, with the winter period was very dry for most local months of January and February. Only 20 inches of precipitation fell in the region during the period, with portions of Cochise County crossed southern in Arizona in March per Pima County received above average precipitation from storm systems.

Forecasts for the late spring-early summer the southwest U.S. will see above normal precipitation. A trend in above normal temperature forecast. The precipitation to equatorial Pacific Ocean through the spring slight enhancement of the North America precipitation across southeast Arizona due relationships with past summer monsoon dry winters. These statistical relationships above-average precipitation based on our (More information at <http://www.cpc.noaa.gov>)



Exceptionally dry conditions over this past season across southeast Arizona. PDSI (Palmer Drought Severity Index) Several winter storms crossed Arizona in March near-average precipitation provided very little

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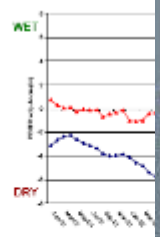


Northwest Arizona Climate Summary Early Fall 2006



September 24, 2006 – Exceptionally dry conditions experienced across northwest Arizona during the winter of 2005-2006 have given way to near-normal precipitation through the spring and summer of 2006. Precipitation amounts associated with the summer monsoon have been spotty, but generally near normal across central and northern Mohave County. Kingman received 1.56 inches of precipitation during July, which is over a half-inch above the long-term July average of 1.04 inches. Precipitation amounts for July around the Kingman area measured by the Mohave County Flood Control weather station network were from over 3 inches in the Flagstaff Mountains to less than 0.15 inches near Yucca, Arizona. Precipitation amounts are below normal, so far, for the 2006 summer season across southern Mohave County. Precipitation totals for the entire fall to date are also below normal. The fall has also been warm across NW AZ for the fall above average through the 2006 fall.

Forecasts for the upcoming fall expect that the southwest U.S. will see an in below and average precipitation and the above normal temperature forecast strong forecast signal on which to be due to the fact that fall weather pattern surface temperatures over the Pacific intensity into a moderate event through average winter precipitation for Arizona temperature patterns related to the El Niño climate forecasts through the fall to



Dry conditions through the fall and winter short-term drought conditions. Near to a value to record, indicating slight short

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Interactive presentation interface showing various climate data and forecasts.

- Temperature and Precipitation (T&P) - 11/14/07
- Atmospheric Moisture (A) - My Status
- Climate - the jet stream? NWS Phoenix: Could you revise the overall wintertime precip pattern for La Nina conditions for the upper Colorado basin? NWS Phoenix: I apologize. I was referring to percent of normal tendencies. John Fleck: yes

Fall 2007 Climate Outlook

November 14, 2007

Mike Crimmins
Gregg Garfin



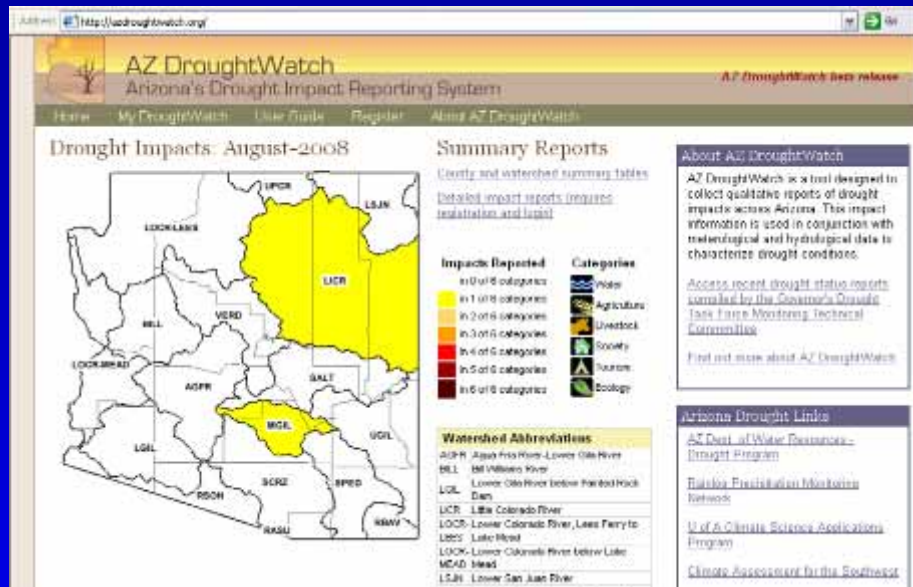
Share | Stop Sharing | Full screen | Print

Photo Description: Lake Powell is one of the state's water supply. It is currently at a low level. The photo was taken last month and shows Lake Powell with a lighter colored rock and dark red rock in the water on the western side of the reservoir. Natural Bridge National Monument.

Would you like to have your favorite Southwest Climate Outlook? For contact information and a detailed caption to



Decision support tools for drought monitoring and preparedness

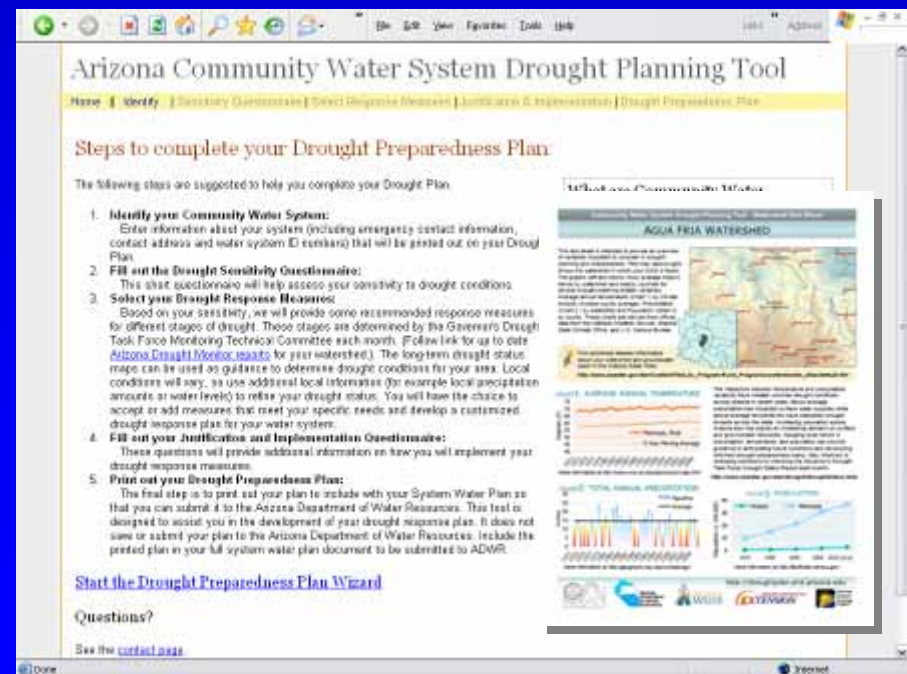


<http://azdroughtwatch.org>

Online drought impact reporting system developed in 2008 in support of improving drought status determinations made by the Governor's Drought Task Force

Drought planning tool developed in 2007 to support drought plan development by small community water systems as required by state law (HB 2277)

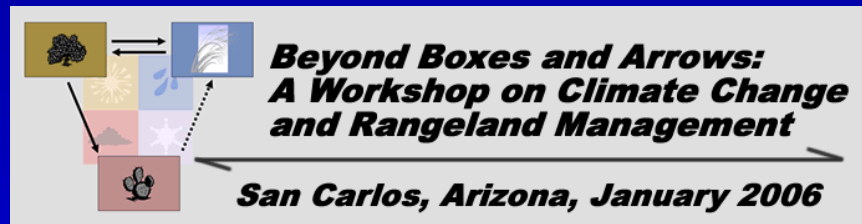
<http://droughtplan.arid.arizona.edu>



Extending climate change information to resource managers

- Series of U of A Extension Workshops on resource management and climate change
- Assessment of needs and strengthening of communication networks
- Novel approaches to explore climate change vulnerability
- Partnership between Agents, Specialists, and University/Federal Agency Researchers was key to success

Workshop on Climate Variability & Ecosystem Impacts in Southwestern Forests and Woodlands
Sedona, AZ 2005



Changes on the Range: Exploring Climate Change with Range Managers

Michael A. Crimmins,* George Zaines, Niina Haas, Christopher K. Jones, Greg Garfin, and Theresa M. Crimmins



Southwest Climate Change Network

- Developed by UofA Institute for Earth & Society, CLIMAS
- Definitive source for information on climate change and SW impacts
- Tools to track new research, share information, and collaborate on projects
- Climate Change Extension

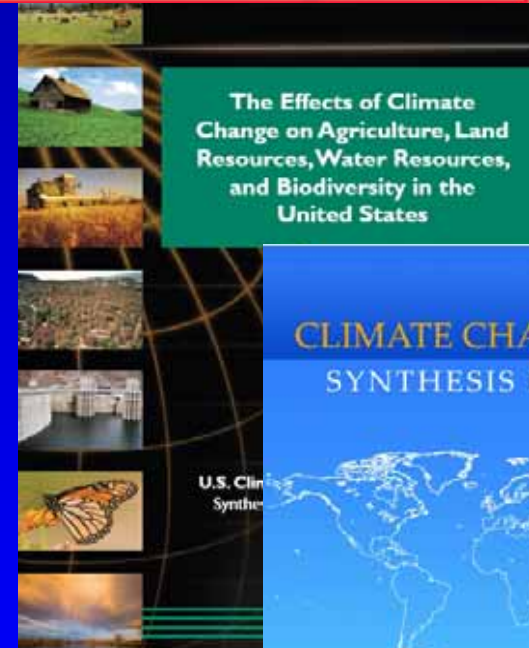
The screenshot shows the homepage of the Southwest Climate Change Network. The header features the title "Southwest Climate Change NETWORK" with a search bar on the right. Below the header is a navigation menu with links for Home, Climate, Impacts, Solutions, Knowledge Network, Features/Notes, Library, and Account. The main content area is divided into several sections:

- User Login:** A section for users to log in or register.
- Research News:** A list of recent news items, including "Have Extreme Weather In The Arctic Regions?", "No going back - sea level rise is here", "Sea level rise could hit more than anticipated", "Antarctic expedition prepared researchers for Mars mission", "Sea level rise would melt Antarctic ice sheets to sea level faster than expected", "World's largest on-ice glaciologist study", and "Global warming may delay recovery of stratospheric ozone".
- Feature Articles:** A list of featured articles, including "Can't Use Planning in the Changing Climate of the West", "Turning a Few Loops: When Tree-Rings Meet Water Policy", "Early Snowmelt Could Mean Disaster for River Ecosystems", and "Southwest Cities Find Ways to Reduce Their Carbon Footprint".
- Climate Change:** A section with links to "Temperature Changes", "Precipitation Changes", and "Streamflow: Natural Variability and Human-Induced Changes".
- Discussion:** A section with a link to "Welcome to the Southwest Climate Change Network".
- Calendar:** A calendar for the month of February.
- Figure of the Week:** A section titled "Temperature and CO2 Concentration in the Atmosphere Over the Past 400,000 Years" with a small graph and text describing the data.



Keeping up with climate change science

- Large and growing body of climate change information (IPCC reports, new US CCSP reports)
- Needs to be translated and integrated into local-scale discussions
- Extension can play a key role! (e.g. National Network for Sustainable Living Education)



Meeting the growing need for climate extension

- Extension's climate friends: NOAA, state climatologists, regional climate centers, RISA's, university research groups...
- Extension and the developing National Climate Service
- Sharing information and leveraging local efforts...eXtension?
- Show me the money!: need for serious investments in extension to meet these needs



Thanks!

crimmins@u.arizona.edu

<http://cals.arizona.edu/climate>

