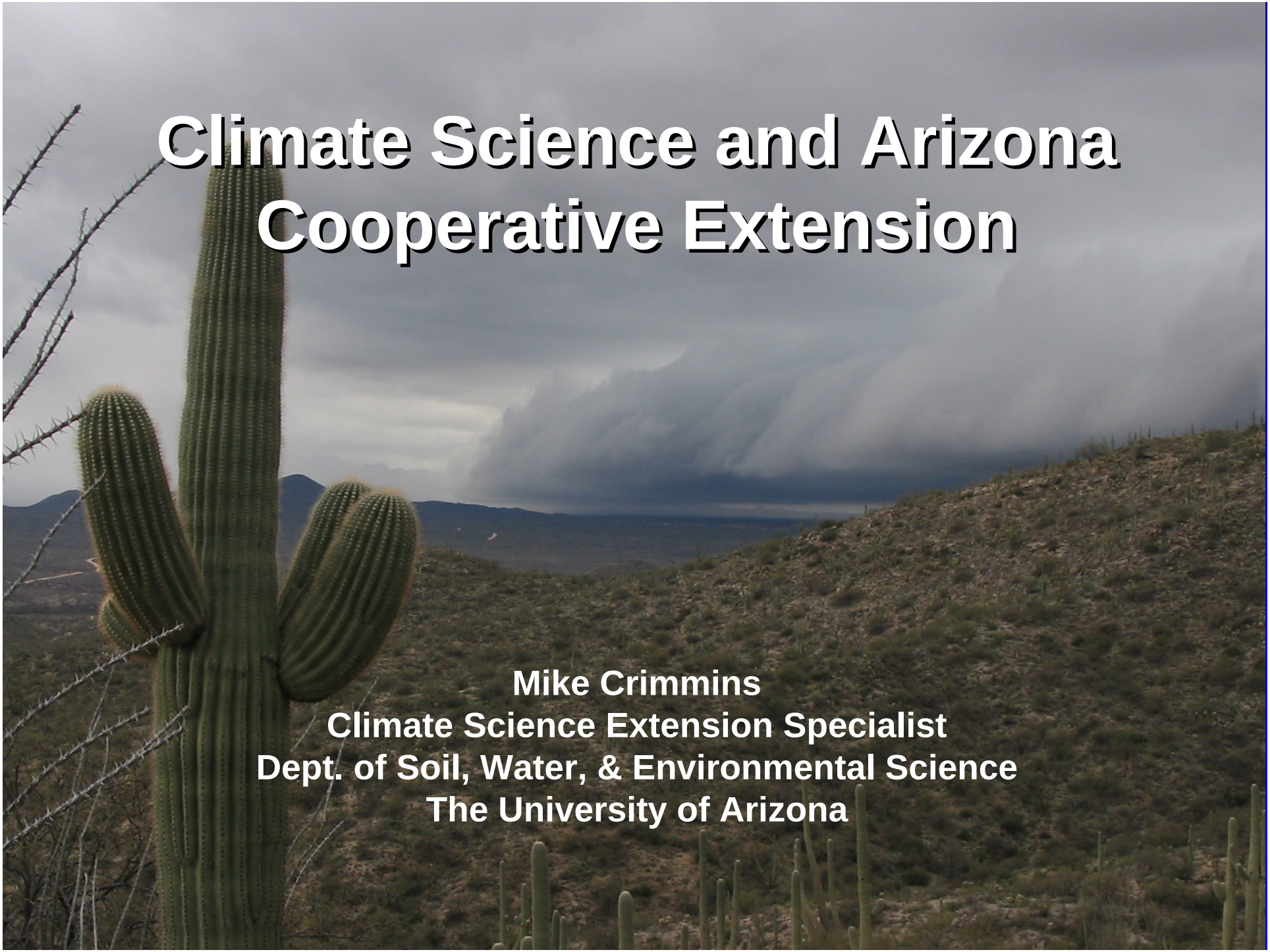


Climate Science and Arizona Cooperative Extension

Mike Crimmins
Climate Science Extension Specialist
Dept. of Soil, Water, & Environmental Science
The University of Arizona

Presentation Overview

- About my new position
- About Extension
- Educational/Outreach Programs
- Research and Development
  - Climate Science and Resource Management
  - Citizen Science

What is a Climate Science Extension Specialist?

- Develop extension programs that address climate related issues of importance to Arizona and the desert Southwest
- Work with stakeholders and natural and social scientists on program development
- Facilitate partnerships between Arizona Cooperative Extension and the Institute for the Study of Planet Earth
- Expected areas of programmatic focus include the impact of climate variability/change on regional water supplies, range management, and forest ecology and management.
- 70% Extension/30% Research

Climate Science Extension

- NOAA recognized success of NASA model
  - Built on existing, proven model in Geospatial Extension position
  - Capitalized on existing infrastructure and social networks provided by Arizona Cooperative Extension
- Climate Science Extension recognizes needs and opportunities beyond traditional state climatologist role
- Arizona has first NOAA-sponsored Climate Science Extension program in country
- Climate extension concept is growing with support of top-level NOAA administrators and program managers

Why a 'Climate Science' Extension Specialist?

- Climate has traditionally been addressed within Extension by crop meteorologists, agronomists, and soil science specialists
- Arizona has unique climate-related extension needs beyond traditional agriculture
  - water resource management
  - ***land management***

Program Objectives

- Improve climate literacy across Arizona and the greater southwest U.S.
- Increase the utilization of existing climate products and develop new tools
- Assist in the development of climate monitoring networks
- Encourage and facilitate public participation in climate science
- Ultimately develop an extension program that highlights the importance of climate science in resource management and contributes to sound policy development and decision-making

Why Extension?

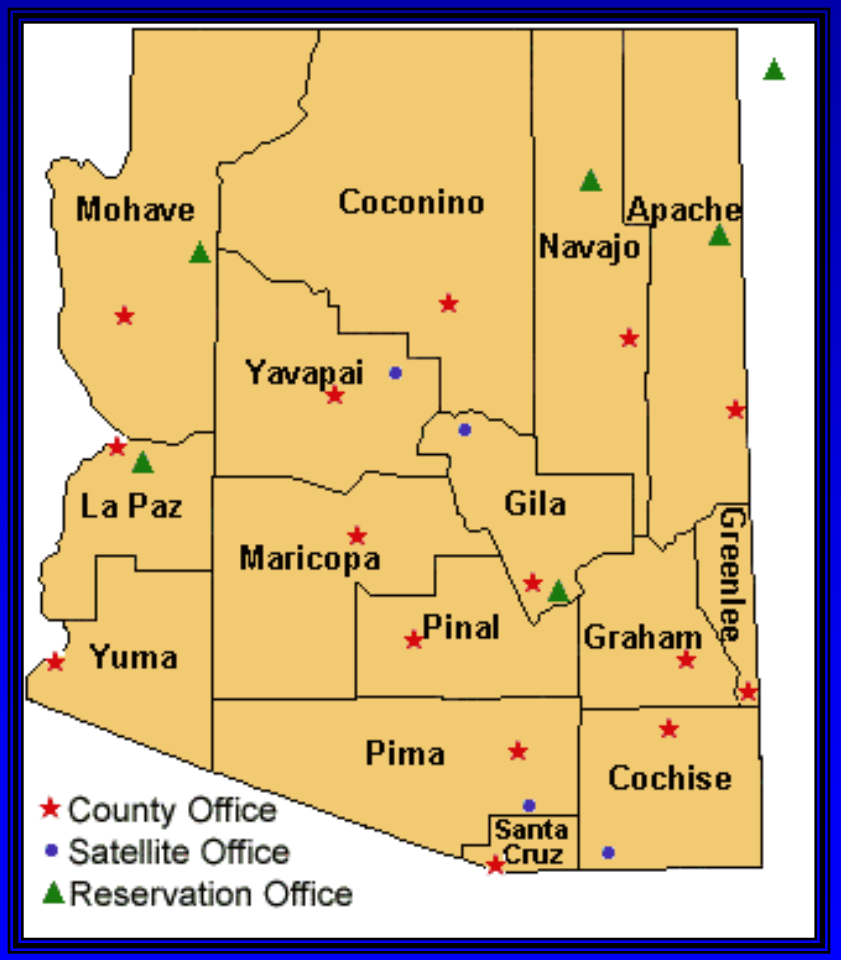
Cooperative Extension is a non-formal educational network bringing research-based information into communities to help people improve their lives

National Drought Committee members, 1936 (Library of Congress)

Infrastructure and People

- 68 FACULTY off-campus
- 43 FACULTY on campus
- 150 STAFF supporting programs
- 14,000 VOLUNTEERS
- 100,000 YOUTH enrolled in 4-H Youth Development programs
- 250,000 PARTICIPANTS in 2004

(from D. Young, 2005)

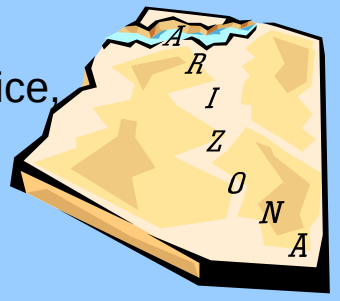


Flow of Climate Science and Services

Climate Science End Users

•**Federal & State Agencies**: U.S. Forest Service, Natural Resources Conservation Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, Arizona Department of Water Resources

•**Professional Societies**: Arizona Society for Range Management, Southwest Vegetation Management Association, Arizona Hydrological Society



Climate Assessment for the Southwest
NOAA RISA/Univ of Arizona

University of Arizona Climate Science Extension

National Oceanic & Atmospheric Administration

University of Arizona Research Community

Partnerships within Extension

- Working with Extension Specialists in other disciplines (e.g. range, watershed management, ag. economics)
- Regular meetings and working groups
- Programming climate science in existing programs
- Established relationships with communities around the state

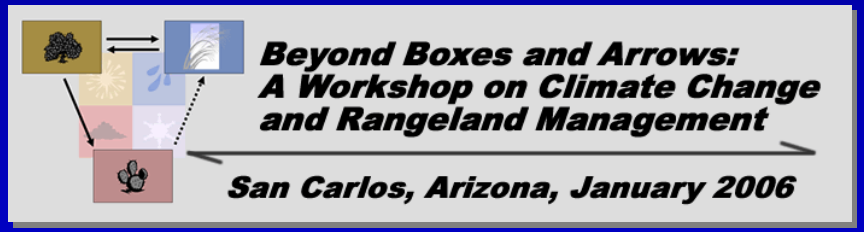
Cooperative Extension workshop at Society for Range Management winter meeting (2005)

Partnerships Outside of Extension

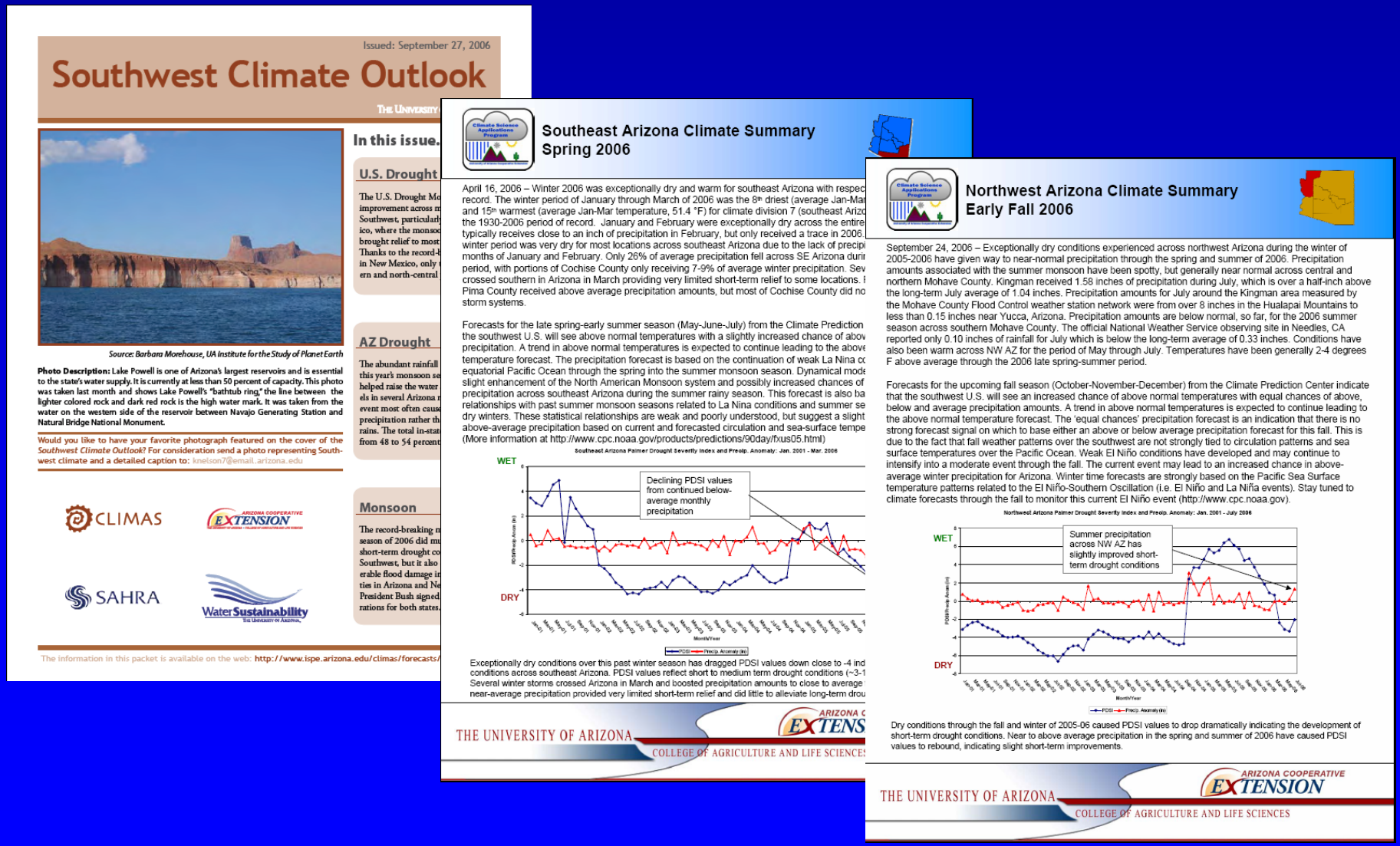
- Ongoing coordination and cooperation with CLIMAS
- Working with federal, state, and local land management agencies
- Bringing extension resources to state-level committees
- Collaborating with other on-campus research groups (e.g. SAHRA, ISPE, Arizona Remote Sensing Center)

Vertical Integration

- Workshop on climate change and range management organized in conjunction with Arizona Society for Range Management, CLIMAS & Cooperative Extension
- Presentations and panel discussions with both university and agency scientists were followed by a hands-on climate-range management exercise
- Pre & Post-workshop surveys conducted



Communications: Monthly to Seasonal Climate Bulletins



Issued: September 27, 2006

Southwest Climate Outlook

THE UNIVERSITY

In this issue.

U.S. Drought

AZ Drought

Monsoon

Source: Barbara Morehouse, UA Institute for the Study of Planet Earth

Photo Description: Lake Powell is one of Arizona's largest reservoirs and is essential to the state's water supply. It is currently at less than 50 percent of capacity. This photo was taken last month and shows Lake Powell's "bathtub ring," the line between the lighter colored rock and dark red rock is the high water mark. It was taken from the water on the western side of the reservoir between Navajo Generating Station and Natural Bridge National Monument.

Would you like to have your favorite photograph featured on the cover of the *Southwest Climate Outlook*? For consideration send a photo representing Southwest climate and a detailed caption to: knelson7@email.arizona.edu

CLIMAS

ARIZONA COOPERATIVE EXTENSION

SAHRA

WaterSustainability THE UNIVERSITY OF ARIZONA

The information in this packet is available on the web: http://www.ispe.arizona.edu/climas/forecasts/

Southeast Arizona Climate Summary
Spring 2006

April 16, 2006 – Winter 2006 was exceptionally dry and warm for southeast Arizona with respec record. The winter period of January through March of 2006 was the 8th driest (average Jan-Mar and 15th warmest (average Jan-Mar temperature, 51.4 °F) for climate division 7 (southeast Arizo the 1930-2006 period of record. January and February were exceptionally dry across the entire typically receives close to an inch of precipitation in February, but only received a trace in 2006. winter period was very dry for most locations across southeast Arizona due to the lack of precipi months of January and February. Only 26% of average precipitation fell across SE Arizona durir period, with portions of Cochise County only receiving 7-9% of average winter precipitation. Sev crossed southern in Arizona in March providing very limited short-term relief to some locations. Pima County received above average precipitation amounts, but most of Cochise County did no storm systems.

Forecasts for the late spring-early summer season (May-June-July) from the Climate Prediction the southwest U.S. will see above normal temperatures with a slightly increased chance of abov precipitation. A trend in above normal temperatures is expected to continue leading to the above temperature forecast. The precipitation forecast is based on the continuation of weak La Nina co equatorial Pacific Ocean through the spring into the summer monsoon season. Dynamical mode slight enhancement of the North American Monsoon system and possibly increased chances of precipitation across southeast Arizona during the summer rainy season. This forecast is also ba relationships with past summer monsoon seasons related to La Nina conditions and summer se dry winters. These statistical relationships are weak and poorly understood, but suggest a slight above-average precipitation based on current and forecasted circulation and sea-surface tempe (More information at http://www.cpc.noaa.gov/products/predictions/90day/fxus05.html)

Southeast Arizona Palmer Drought Severity Index and Precip. Anomaly: Jan. 2001 - Mar. 2006

WET

DRY

Declining PDSI values from continued below-average monthly precipitation

Exceptionally dry conditions over this past winter season has dragged PDSI values down close to -4 ind conditions across southeast Arizona. PDSI values reflect short to medium term drought conditions (~3-1 Several winter storms crossed Arizona in March and boosted precipitation amounts to close to average near-average precipitation provided very limited short-term relief and did little to alleviate long-term drou

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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 1.58 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 8 inches in the Hualapai 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. The official National Weather Service observing site in Needles, CA reported only 0.10 inches of rainfall for July which is below the long-term average of 0.33 inches. Conditions have also been warm across NW AZ for the period of May through July. Temperatures have been generally 2-4 degrees F above average through the 2006 late spring-summer period.

Forecasts for the upcoming fall season (October-November-December) from the Climate Prediction Center indicate that the southwest U.S. will see an increased chance of above normal temperatures with equal chances of above, below and average precipitation amounts. A trend in above normal temperatures is expected to continue leading to the above normal temperature forecast. The 'equal chances' precipitation forecast is an indication that there is no strong forecast signal on which to base either an above or below average precipitation forecast for this fall. This is due to the fact that fall weather patterns over the southwest are not strongly tied to circulation patterns and sea surface temperatures over the Pacific Ocean. Weak El Niño conditions have developed and may continue to intensify into a moderate event through the fall. The current event may lead to an increased chance in above-average winter precipitation for Arizona. Winter time forecasts are strongly based on the Pacific Sea Surface temperature patterns related to the El Niño-Southern Oscillation (i.e. El Niño and La Niña events). Stay tuned to climate forecasts through the fall to monitor this current El Niño event (http://www.cpc.noaa.gov).

Northwest Arizona Palmer Drought Severity Index and Precip. Anomaly: Jan. 2001 - July 2006

WET

DRY

Summer precipitation across NW AZ has slightly improved short-term drought conditions

Dry conditions through the fall and winter of 2005-06 caused PDSI values to drop dramatically indicating the development of short-term drought conditions. Near to above average precipitation in the spring and summer of 2006 have caused PDSI values to rebound, indicating slight short-term improvements.

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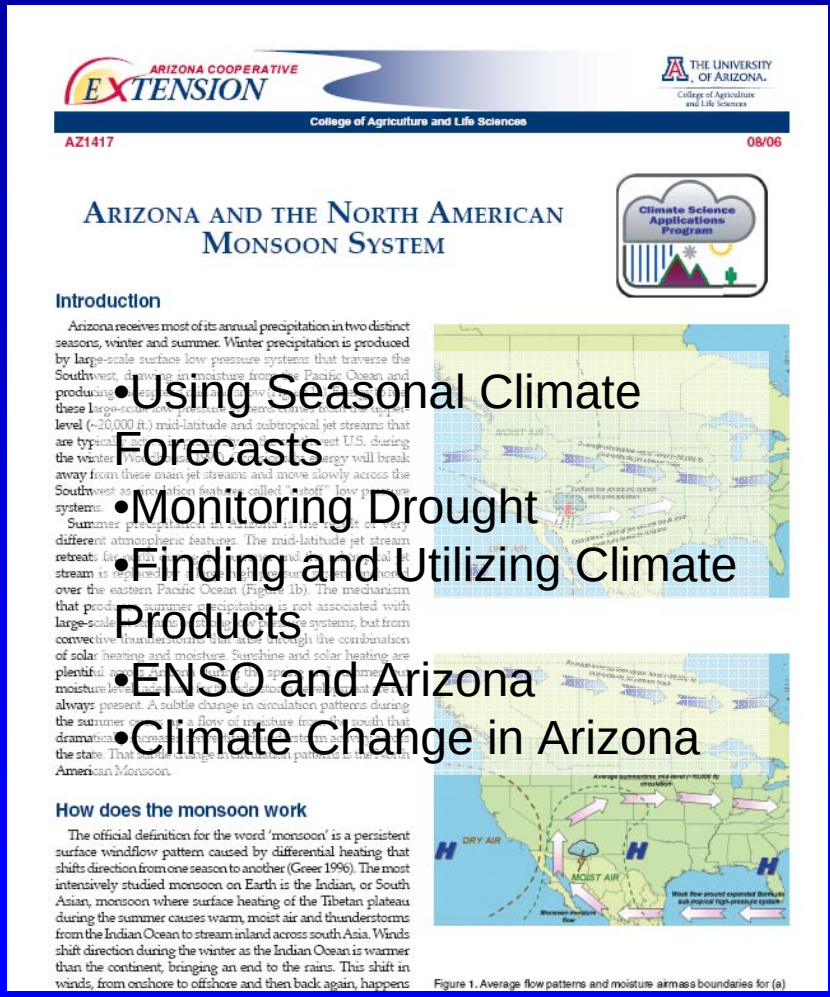
ARIZONA COOPERATIVE EXTENSION

Communications: 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

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 [illegible] these large-scale [illegible] level (~20,000 ft.) mid-latitude and subtropical jet streams that are typically [illegible] Southwest U.S. during the winter. [illegible] energy will break away from these main jet streams and move slowly across the Southwest as [illegible] called "cutoff" low pressure systems.

Summer [illegible] different atmospheric features. The mid-latitude jet stream retreats [illegible] stream is [illegible] over the eastern Pacific Ocean (Figure 1b). The mechanism that produces summer precipitation is not associated with large-scale [illegible] systems, but from convective thunderstorms that arise through the combination of solar heating and moisture. Sunshine and solar heating are plentiful [illegible] moisture is [illegible] always present. A subtle change in circulation patterns during the summer causes a flow of moisture from the south that dramatically [illegible] the state. That subtle change in circulation patterns is the North American Monsoon.

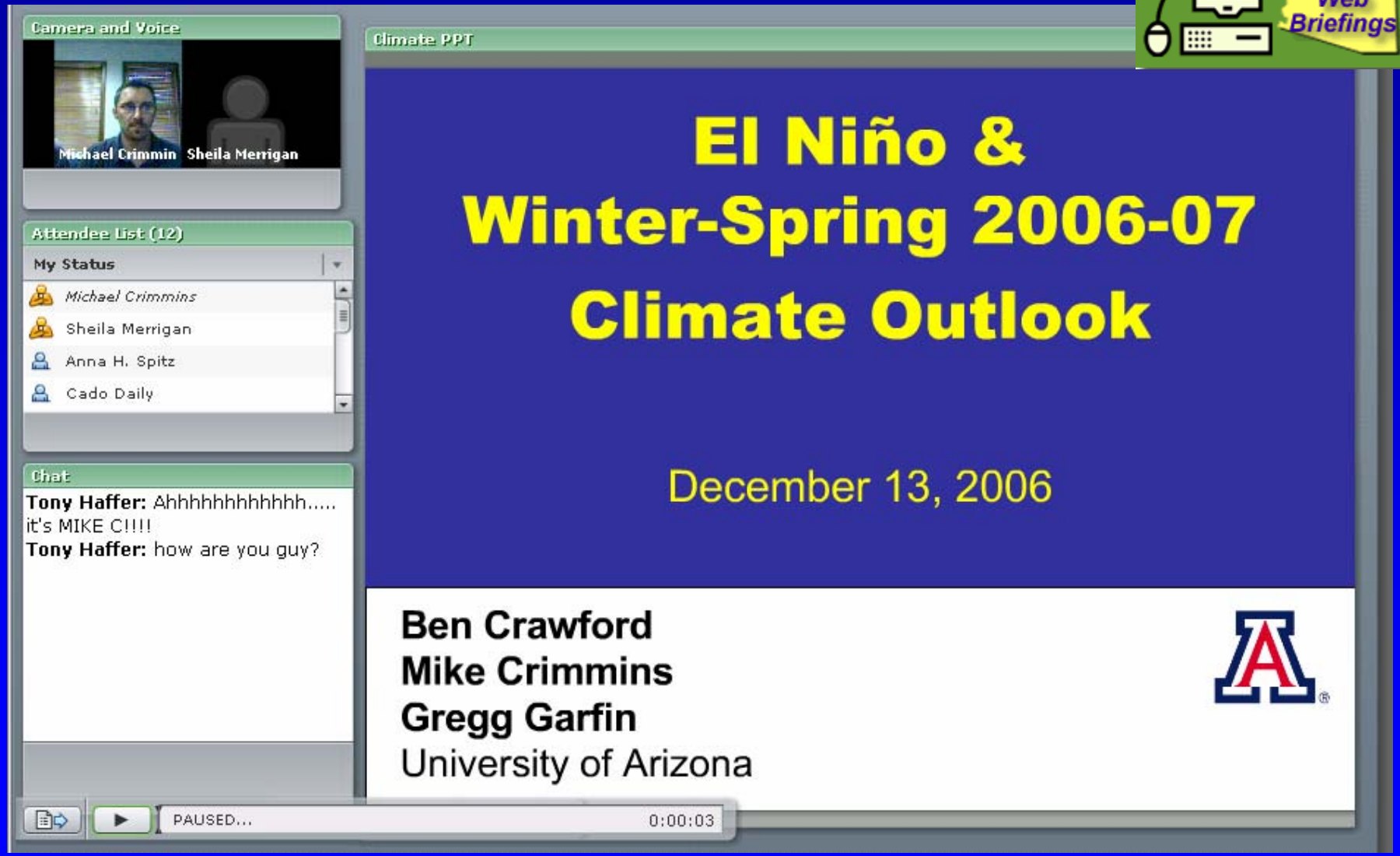
How does the monsoon work

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 (Greer 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 again, happens

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

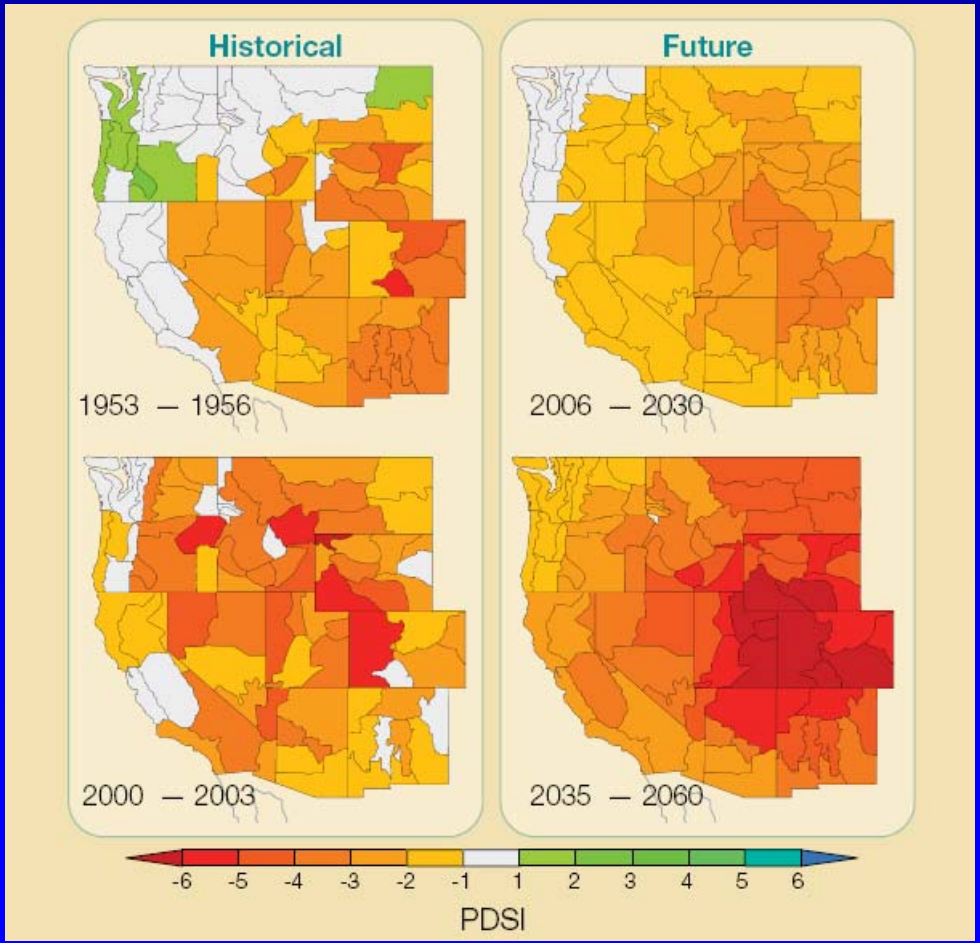
- Using Seasonal Climate Forecasts
- Monitoring Drought
- Finding and Utilizing Climate Products
- ENSO and Arizona
- Climate Change in Arizona

Exploring new forms of communication…



Extending Information on Climate Change

- Critical need for cutting edge climate change information
- Extension approach has included workshops, presentations to community groups, fact sheets, web-site development, and tools for teachers
- New approach under development: Team of social scientists and climatologists developing strategy to map out social networks of science/policy communications at county-level.

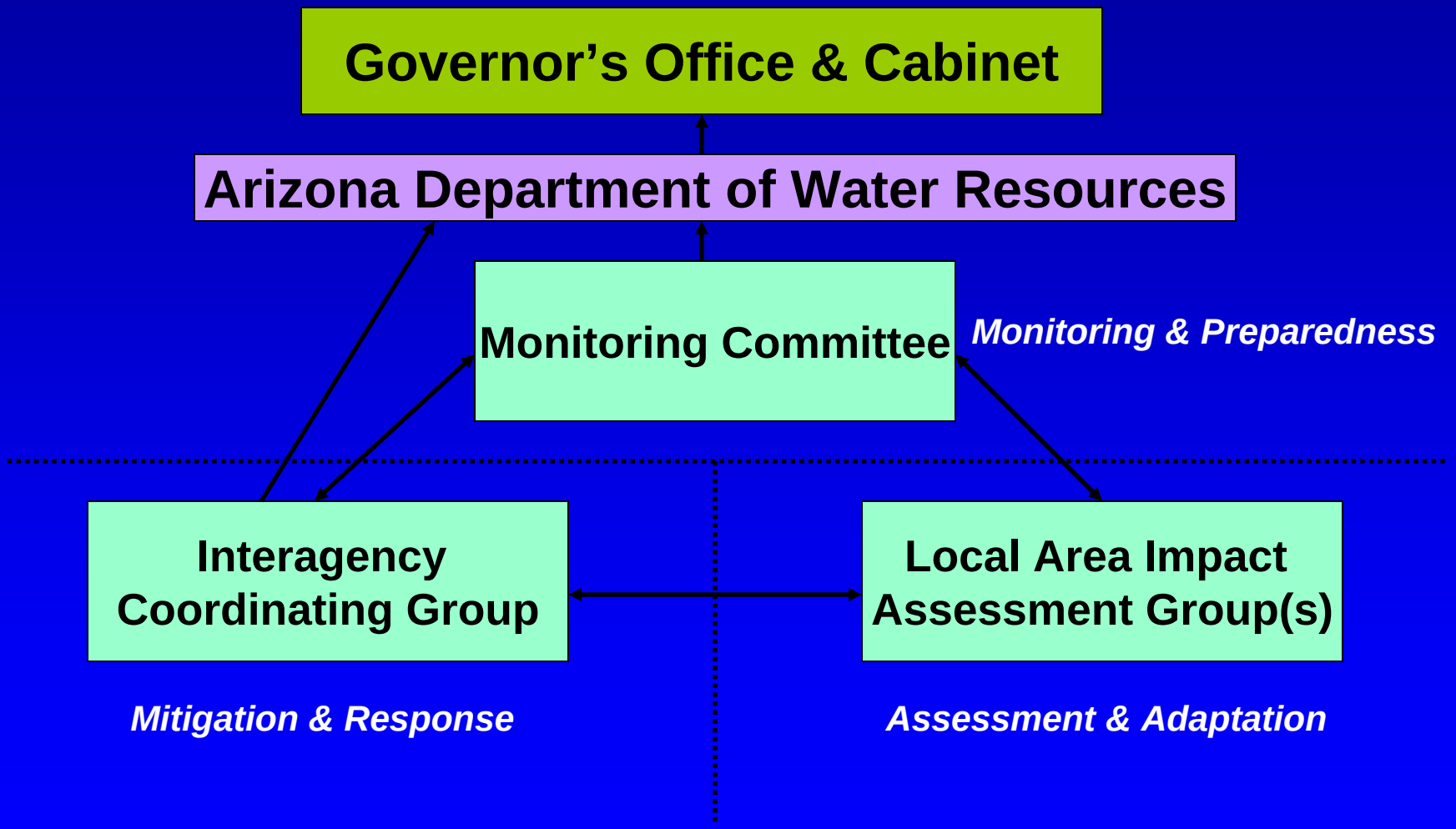


Hoerling & Eischeid 2007

Extension Example: Arizona Drought Preparedness Plan

- Coordinated effort led by ADWR to monitor drought, recommend actions to Governor and provide planning support to citizens of Arizona
- Plan works to empower local communities to develop drought plans and mitigation strategies
- Sustained focus on issue through wet and dry cycles
- Extension is taking a leadership role at county level

Organizational Structure



From ADWR 2006

Local vs. National Drought Monitoring

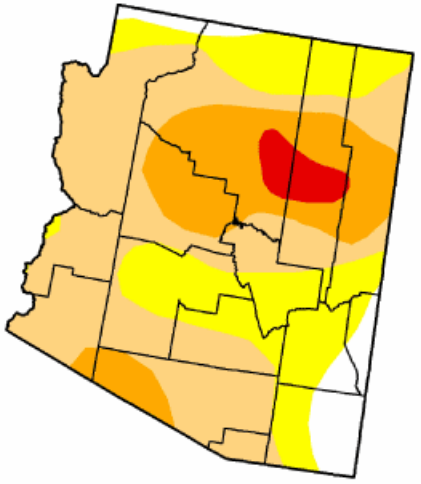
U.S. Drought Monitor

October 10, 2006
Valid 8 a.m. EST

Arizona

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	6.3	93.7	67.9	22.7	3.0	0.0
Last Week (10/3/2006 map)	5.4	94.6	75.9	28.5	7.3	0.0
3 Months Ago (7/18/2006 map)	0.0	100.0	95.6	79.1	46.1	6.4
Start of Calendar Year (1/3/2006 map)	2.8	97.2	40.4	0.0	0.0	0.0
Start of Water Year (10/3/2006 map)	5.4	94.6	75.9	28.5	7.3	0.0
One Year Ago (10/11/2005 map)	49.9	50.1	11.2	0.0	0.0	0.0



Intensity:

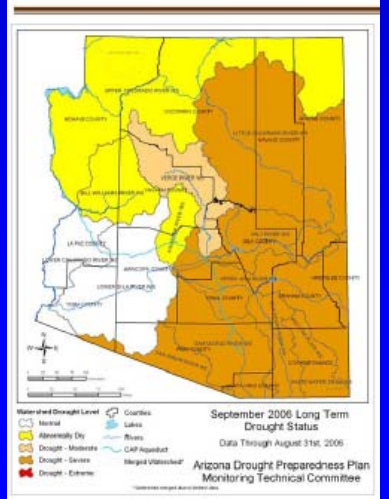
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

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

http://drought.unl.edu/dm

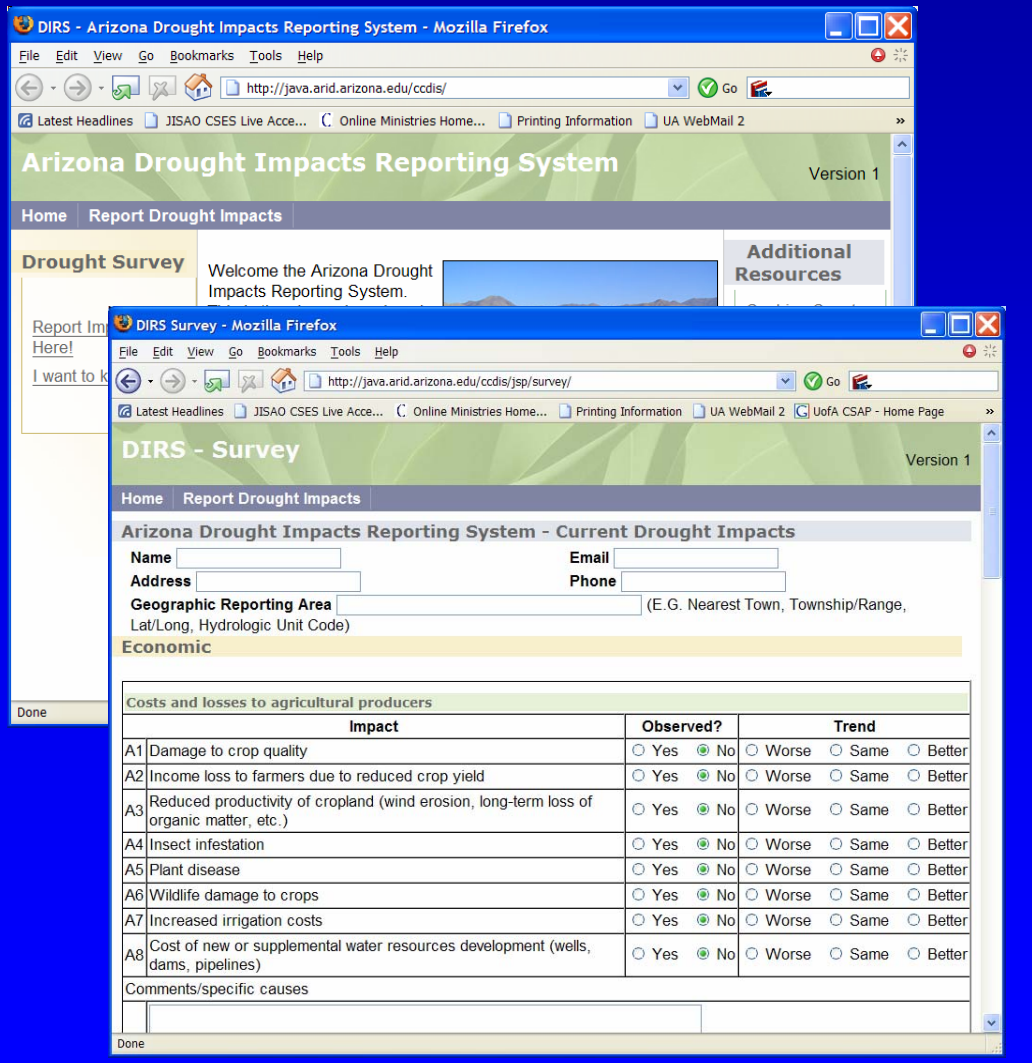
USDA National Drought Mitigation Center

Released Thursday, October 12, 2006
Author: Rich Tinker, Climate Prediction Center, NOAA



County Drought Impacts Reporting

- Critical link to corroborating observing network data
- Reporting worksheets developed with local guidance
- More timely response to the development of emergency or disaster level drought impacts
- A cooperative effort between UofA Coop Ext, CLIMAS, AZ Dept of Water Resources and the GDTF

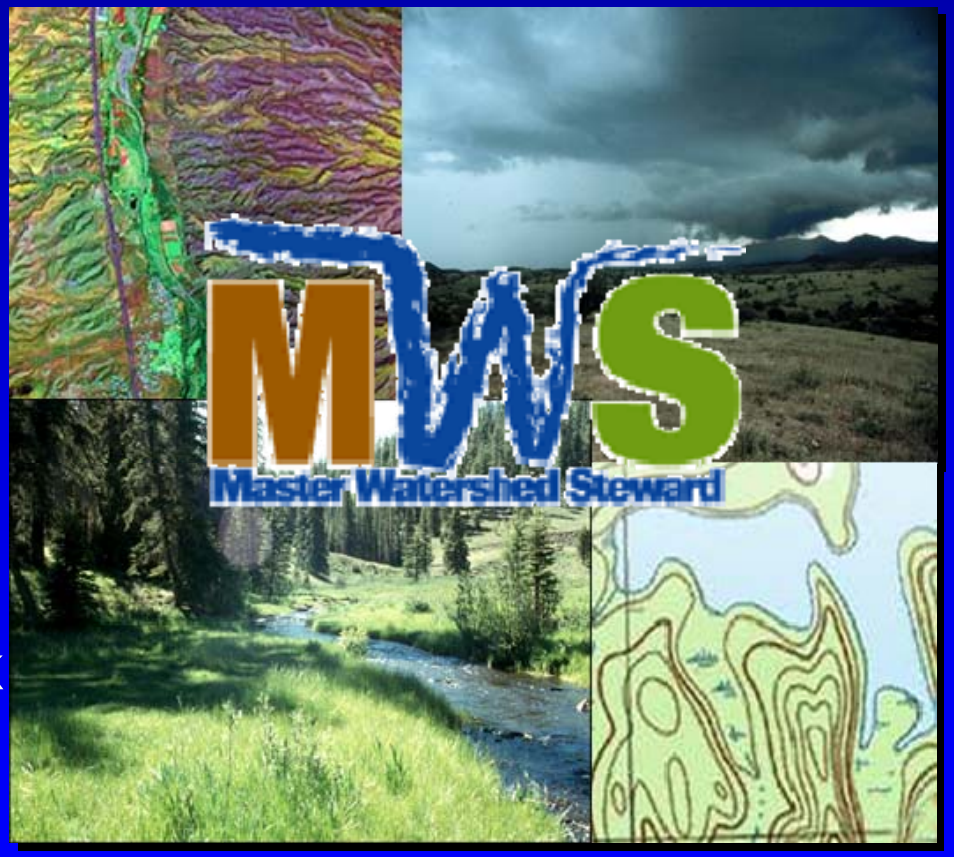


Citizen Scientists and Climate Science

- Citizen science is the effort of volunteers (regardless of age, location, or experience) in gathering data about our environment. (http://www.citizenscience.ca).
- Arizona could be the *citizen science* state!
  - Unique and challenging environmental concerns (water resources, land management, wildfire…)
  - Quickly changing demographics (new citizens to the state, large population of skilled and interested retirees)
- Successful citizen science programs already exist within cooperative extension
  - Master Watershed Steward
  - Master Gardener
- Great opportunities for both citizens and researchers to partner around climate science
- Researchers fundamentally need public to be engaged in their research and can benefit from their informal datasets (e.g. backyard rainfall or observations of flora and fauna)

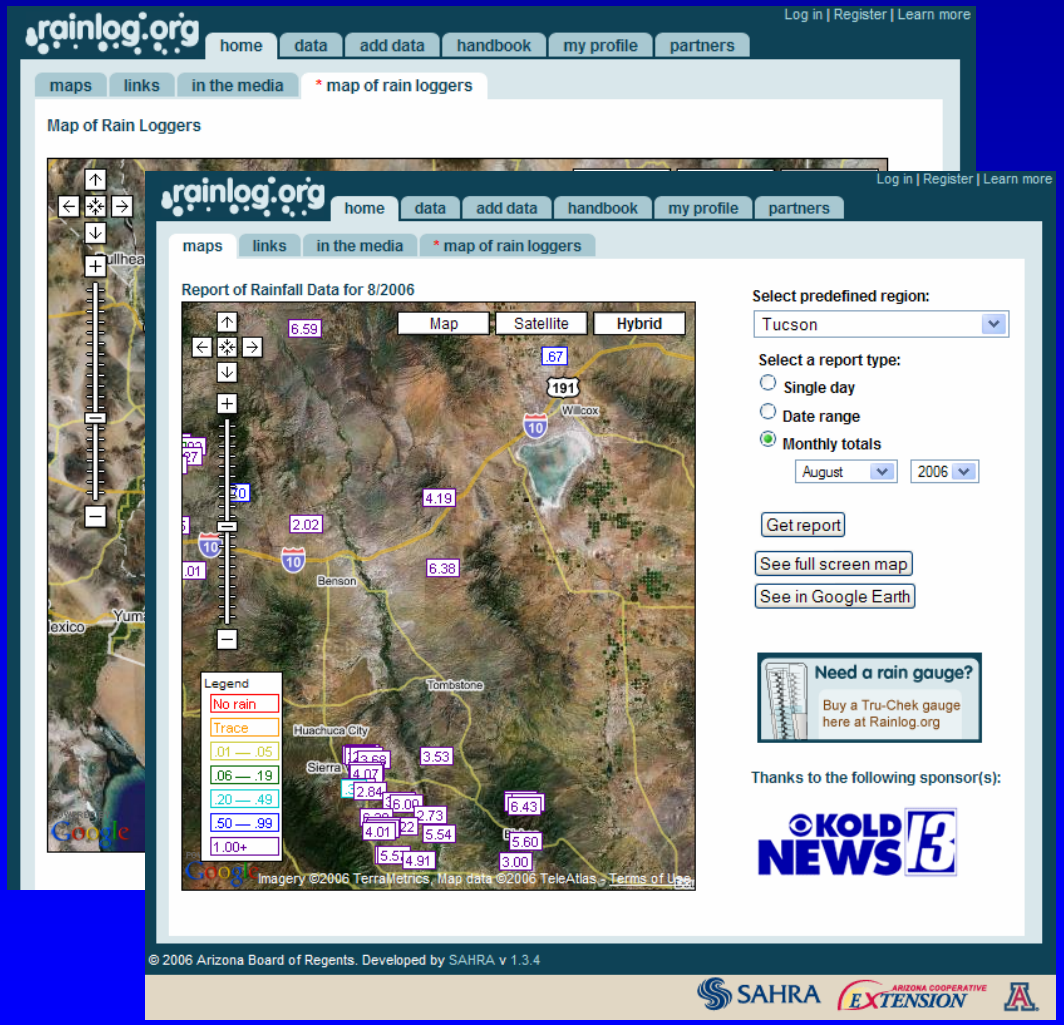
Master Watershed Steward Program

- Adult environmental education program = training citizen scientists
- Similar model to Master Gardener
- Climate is a core part of curriculum
- Service requirement
- Stewards = volunteer drought monitoring network (precipitation, drought impacts, phenology…)



RainLog: Volunteer Precipitation Monitoring Network for Arizona

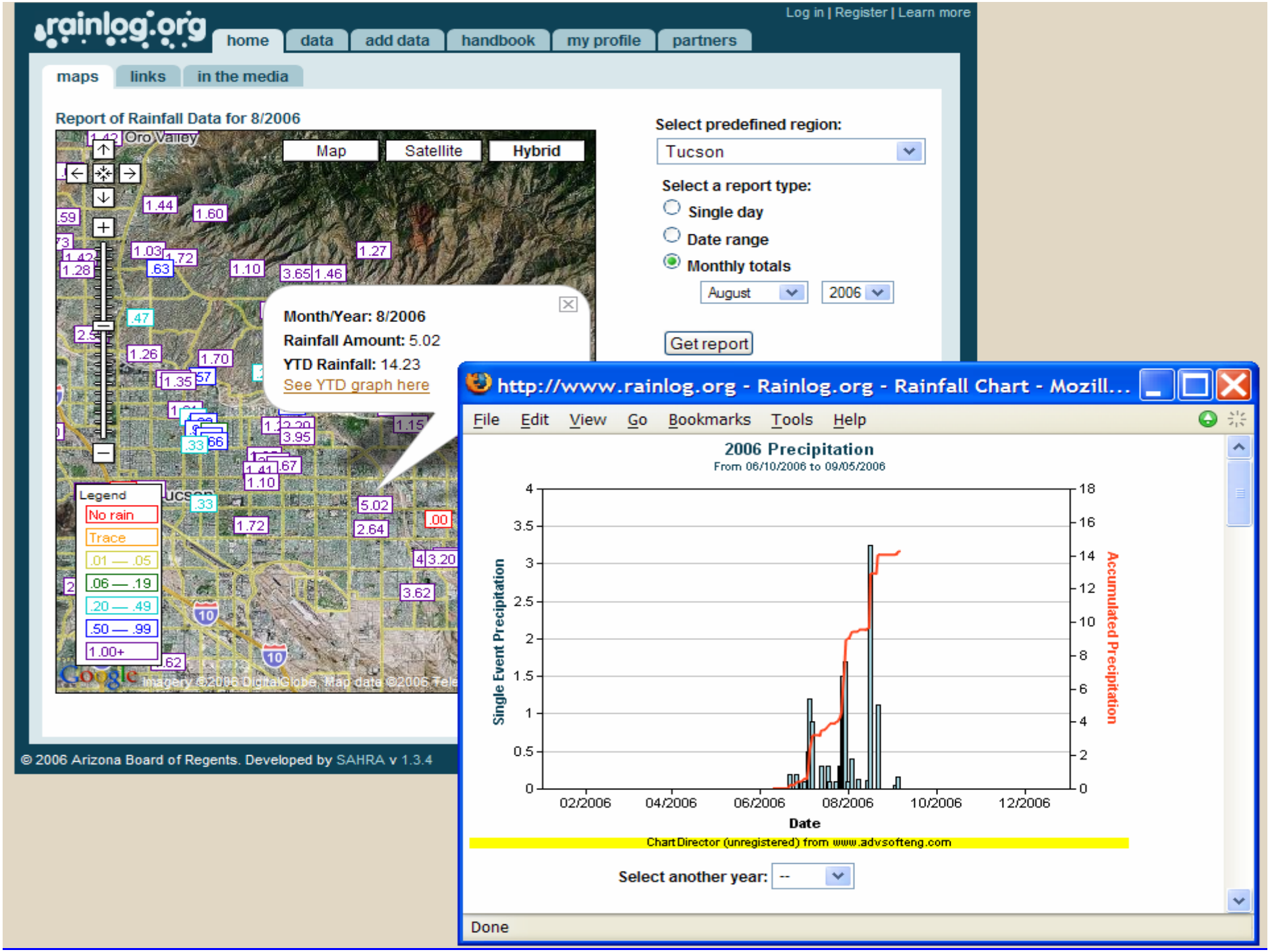
- Network developed by SAHRA and Arizona Cooperative Extension in support of state drought monitoring needs
- Has over 400 volunteers and is continuing to grow
- More observations for characterization of drought
- Tool to manage personal data (*My Rainlog*)
- Opportunity to engage public on climate and drought concepts



Visualizing rainfall data

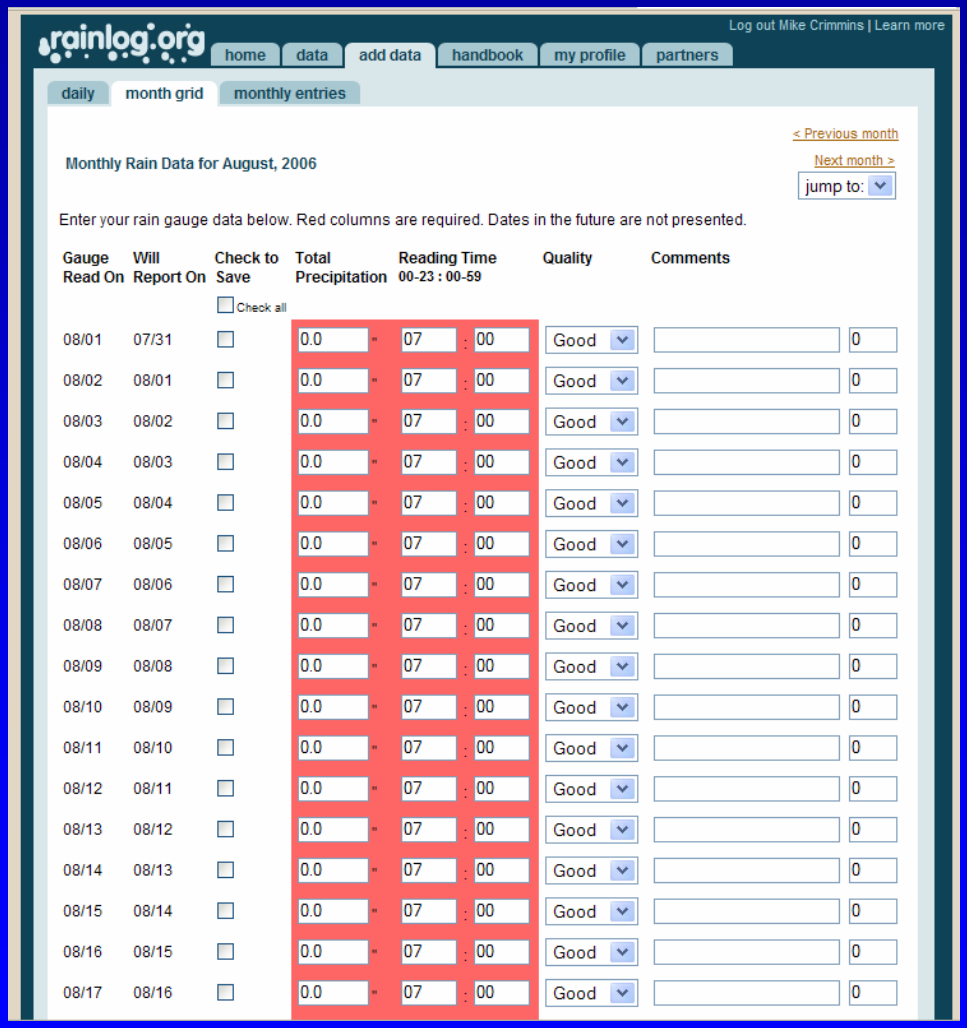
RainLog data can be shown:

- on maps for a user-defined time period
- as a time series plot
- in tables


rainlog.org
Log in | Register | Learn more
home
data
add data
handbook
my profile
partners
maps
links
in the media
Report of Rainfall Data for 8/2006
Map
Satellite
Hybrid
Oro Valley
Month/Year: 8/2006
Rainfall Amount: 5.02
YTD Rainfall: 14.23
See YTD graph here
Legend
No rain
Trace
.01 — .05
.06 — .19
.20 — .49
.50 — .99
1.00+
Select predefined region:
Tucson
Select a report type:
Single day
Date range
Monthly totals
August
2006
Get report
© 2006 Arizona Board of Regents. Developed by SAHRA v 1.3.4
http://www.rainlog.org - Rainlog.org - Rainfall Chart - Mozill...
File
Edit
View
Go
Bookmarks
Tools
Help
2006 Precipitation
From 06/10/2006 to 09/05/2006
Single Event Precipitation
Accumulated Precipitation
02/2006
04/2006
06/2006
08/2006
10/2006
12/2006
Date
ChartDirector (unregistered) from www.advsofteng.com
Select another year:
--
Done

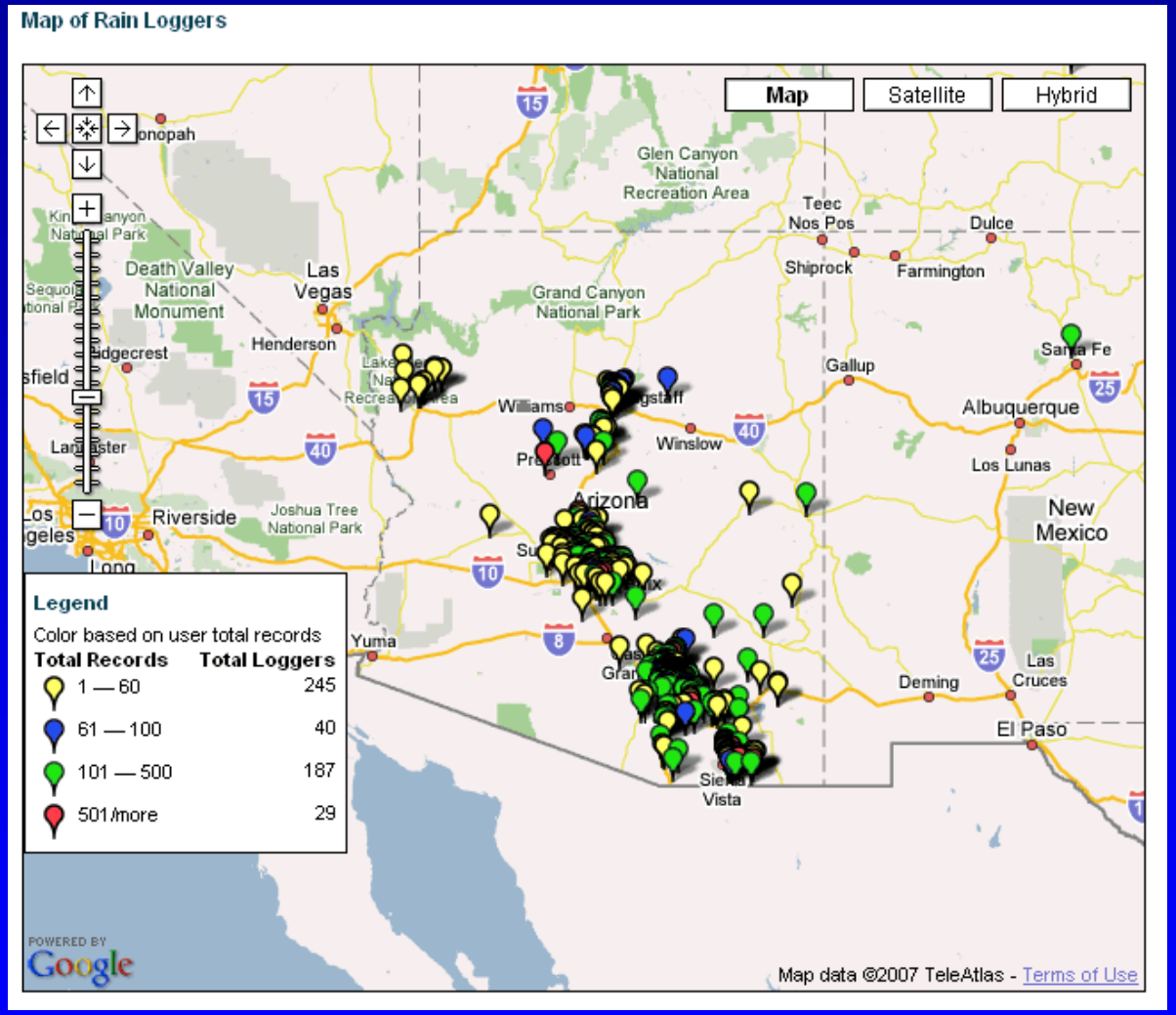
My RainLog

- Encouraging volunteers to submit, store, and manage their own historical data
- Special functions and tools to create reports and graphics
- Historical data allows for calculations of ‘normals’ and percentiles useful in drought monitoring
- Further engages volunteers as *Citizen Scientists*



Check out http://www.rainlog.org for more information!

Current Rainlog Volunteer Map: 600 members



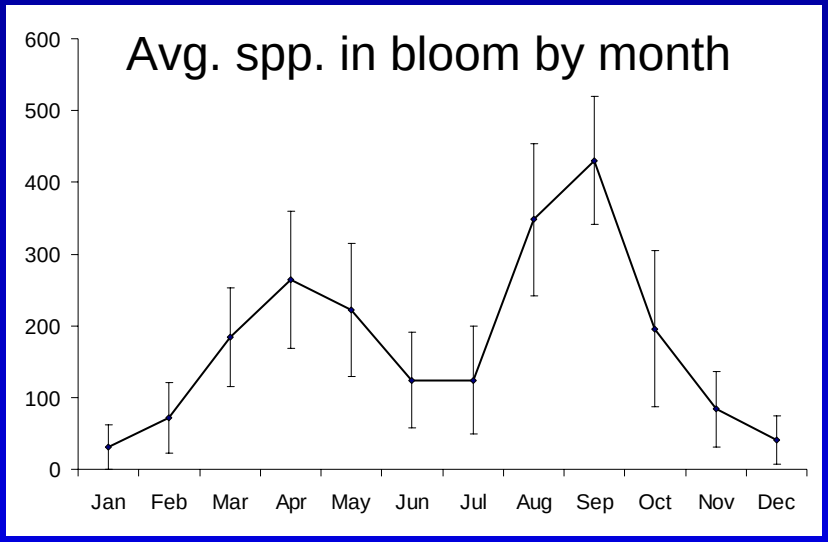
Partnering with Citizen Scientists

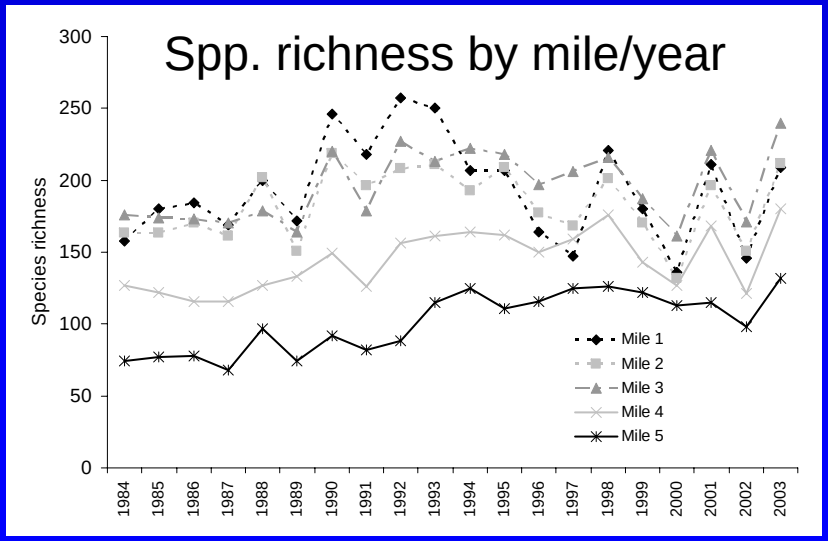
- Mr. Dave Bertleson, amateur botanist
- Hiked Finger Rock Trail 1,024 times between 1983-2004
- Collected phenological observations on over 400 species (total of over 110,000 records)
- Partnering on data analysis and connecting to National Phenology Network

Finger Rock Trail, Santa Catalina Mtns.
(courtesy of W. van Leeuwen)

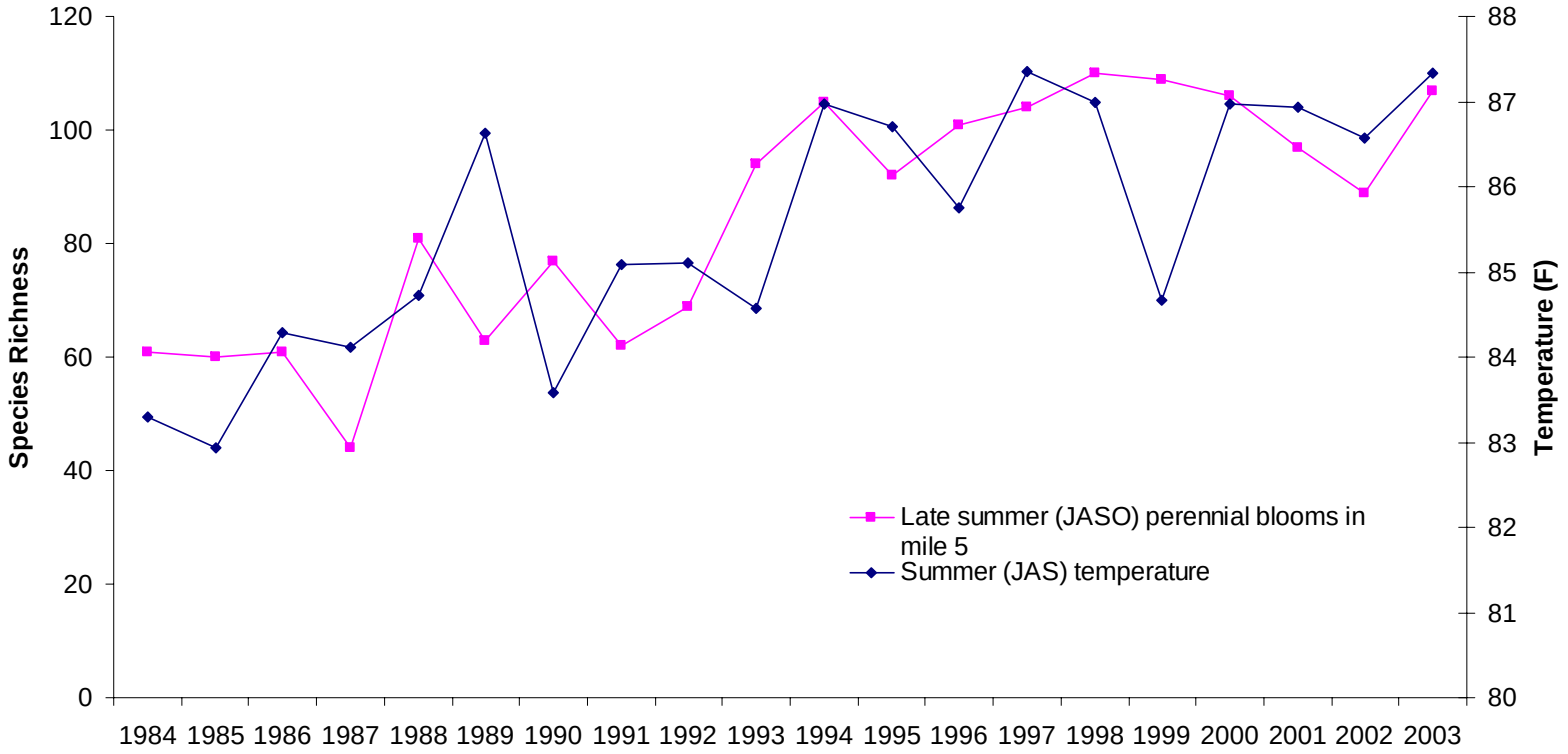
Finger Rock Trail Phenology

- Partnering on data analysis to support development of local phenology monitoring protocols and quantification of ecological change (w. T. Crimmins, W. van Leeuwen, M. Losleben, and J. Balmat)
- Community level pheno-climate analysis complete
- Additional work on interactions between trends in temperature and observed phenology changes





Increasing temps and phenology changes



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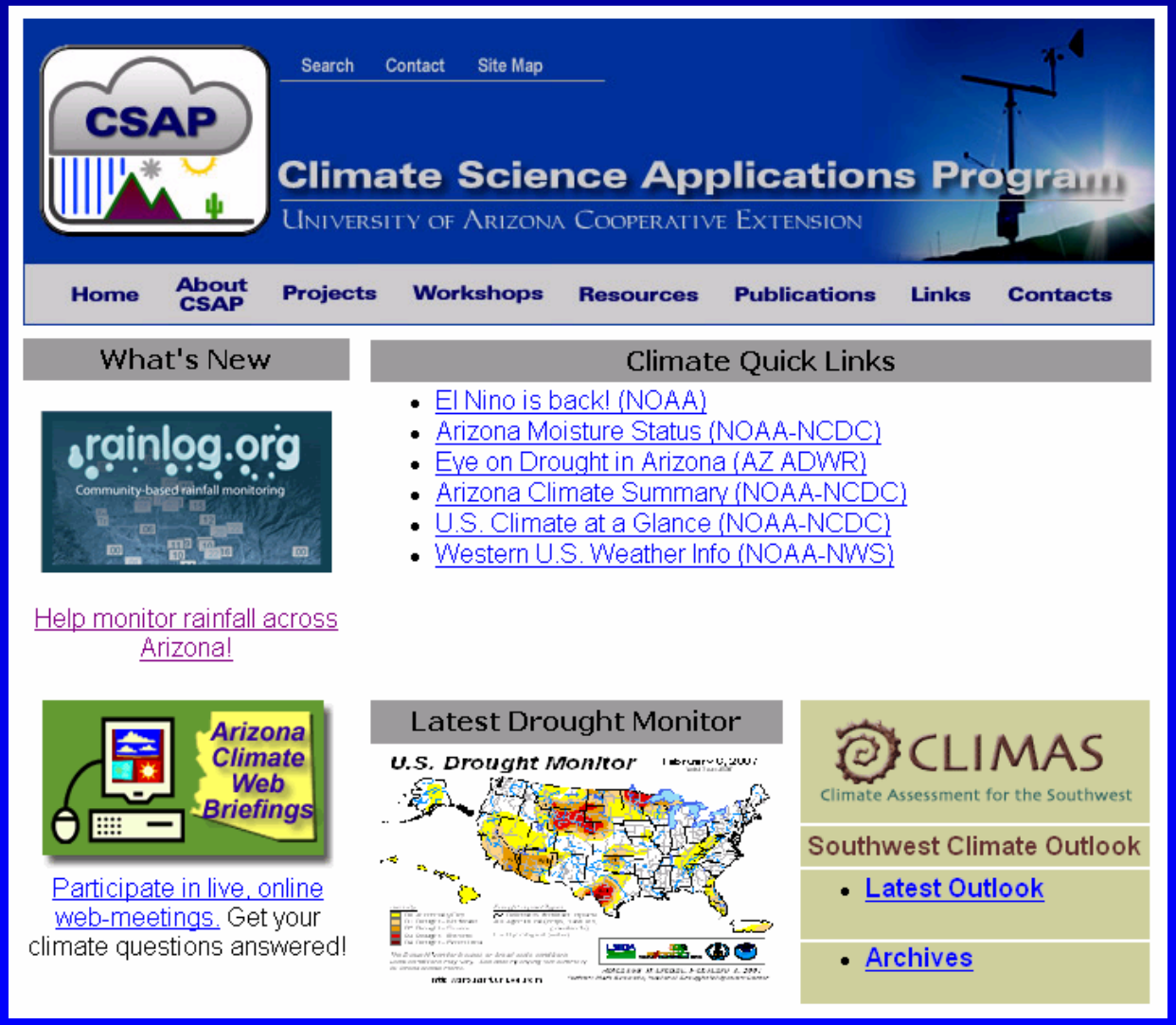

http://cals.arizona.edu/climate