

# Climate Change and Cooperative Extension: On the front lines in a warming world

A photograph of two men standing in a desert field. The man on the left is wearing a blue plaid shirt and a green cap. The man on the right is wearing a dark long-sleeved shirt with a 'MOSSY OAK' logo and blue pants. They are looking towards a fenced-in area in the distance. A white Ford truck is visible on the left side of the frame. The background shows a vast, arid landscape under a clear blue sky.

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

# Climate Science Extension Specialist – University of Arizona

- 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 Climate Assessment for the Southwest (NOAA-RISA)
- 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 – position created in 2004
- Climate Science Extension recognizes needs and opportunities beyond traditional state climatologist role
- Growing network of climate extension agents and specialists at Land Grant and Sea Grant institutions

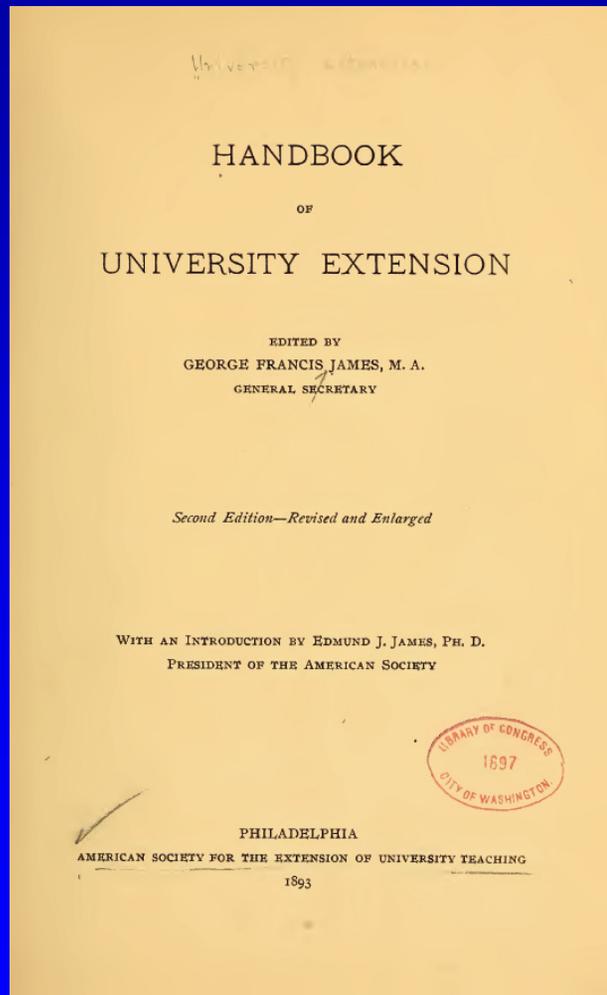


# Land Grant Universities: 'Lincoln's second best idea'

- Morrill Land Grant Acts (1862 and 1890): *"to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."*



# Something was still missing...



The movement for popular education known as University Extension should be a matter of profound interest to every American. It has a message for men and women alike ; for the educated as well as for the uneducated ; for the rich no less than for the poor. It seems likely to prove one of the great organizing and initiating forces so necessary and as yet unfortunately so rare in the educational and social life of the United States.  
- *American Society for the Extension of University Teaching, 1893*



# Final pieces

- Hatch Act of 1887: creation of agricultural experiment stations at Land Grant universities (applied research)
- Smith-Lever Act of 1914: creation of the Cooperative Extension Service...*”in order to aid in diffusing among the people of the United States useful and practical information on subjects related to agriculture and home economics, and to encourage the application of the same.”*
- Research-Education-Extension

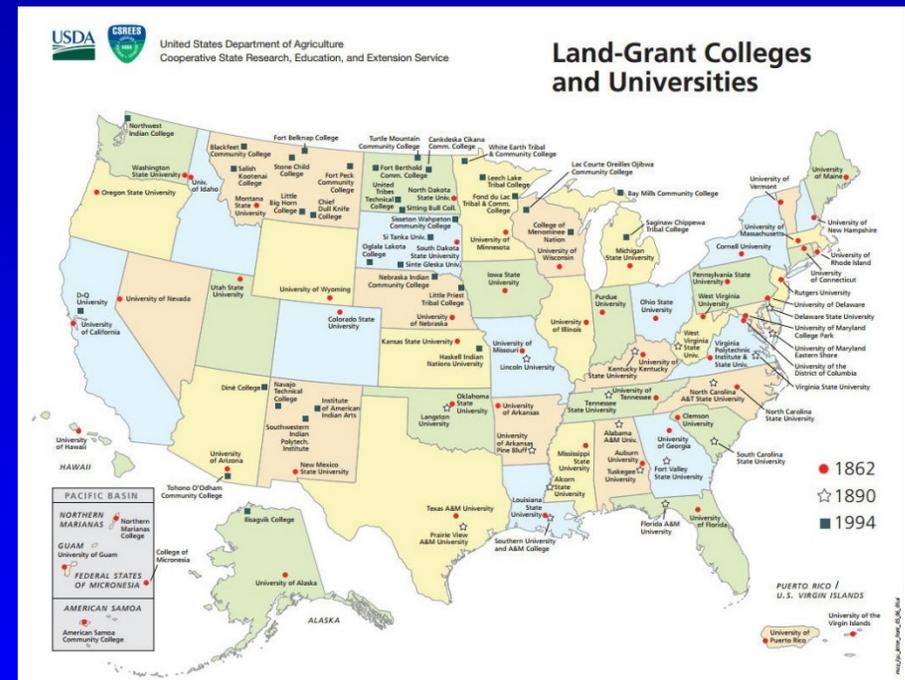


# 'A uniquely American invention'

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

• Over 2,900 county offices connected to over 100 Land Grant Universities\*

\* Subject to change



# Cooperative Extension: On the front lines in a warming world

- History of working on climate-related issues (e.g. 30's Dust Bowl)
- Cross-cutting expertise in working with diverse clientele; ongoing engagement
- Model of providing non-formal education and technical assistance
- How do we fit in now?



<http://hdl.loc.gov/loc.pnp/fsa.8b28188>



Climate Science Applications Program - University of Arizona Cooperative Extension



# Case study for the 3rd National Climate Assessment (2014)

- ***‘Weather, Climate, and Rural Arizona: Insights and Assessment Strategies’***  
(Brugger and Crimmins 2012, formal technical input to NCA submitted by March 1, 2012)
- Funded by USGCRP through subaward to existing NOAA-RISA programs (UofA Climate Assessment for the Southwest)
- Objective: ‘To learn how rural Arizonans understand, plan for, and respond to weather and climate in their daily lives...’
- ***Utilized the Cooperative Extension network***





The art of adaptation: Living with climate change in the rural American Southwest



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Anthropocene

ABSTRACT

As adaptation has come to the forefront in climate change discourse, research, and policy, it is crucial to consider the effects of how we interpret the concept. This paper draws attention to the need for interpretations that foster policies and institutions with the breadth and flexibility to recognize and support a wide range of locally relevant adaptation strategies. Social scientists have argued that, in practice, the standard definition of adaptation tends to prioritize economic over other values and technical over social responses, draw attention away from underlying causes of vulnerability and from the broader context in which adaptive responses take place, and exclude discussions of inequality, justice, and transformation. In this paper, we discuss an alternate understanding of adaptation, which we label “living with climate change,” that emerged from an ethnographic study of how rural residents of the U.S. Southwest understand, respond to, and plan for weather and climate in their daily lives, and we consider how it might inform efforts to develop a more comprehensive definition. The discussion brings into focus several underlying features of this lay conception of adaptation, which are crucial for understanding how adaptation actually unfolds on the ground: an ontology based on nature–society mutuality; an epistemology based on situated knowledge; practice based on performatively adjusting human activities to a dynamic biophysical and social world. We suggest that these features help point the way climate change adaptation, and one more fully informed Anthropocene.

1. Introduction

As adaptation has come to the forefront in climate change discourse, research, and policy, much scholarly attention is being directed toward how the concept should be defined and understood by the climate change research community. Meanwhile, although it is widely recognized that adaptation is primarily a local process (e.g. Klein et al., 2007), investigating how local-level decision-makers, who are experiencing and responding to climate variability and change in their daily lives, understand the concept has been neglected. Working in the tradition of social constructivism, social scientists have demonstrated the power of discourses – understood as frameworks of meaning, consisting of concepts, attitudes, beliefs, and practices, that both enable communication among different

actors and systems they speak – to frame solutions (e.g. Darier 2003). Because “lan- tion, and action” (R phenomenon of cli human society, it is continue to question shape our understand, funding of research organizations to add To that end, this from an ethnograph Southwest, where a region of North Am 2010), understand, their daily lives. If adaptation with that Change (IPCC Third

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E-mail addresses: julieb@u.arizona.edu, julieb3@email.arizona.edu (J. Brugger), crimmins@email.arizona.edu (M. Crimmins).

# More results from study published here...

Brugger, J., Crimmins, M. 2013. The art of adaptation: Living with climate change in the rural American Southwest. *Global Environ.Change*, <http://dx.doi.org/10.1016/j.gloenvcha.2013.07.012>

Brugger, J. and M. A. Crimmins. 2014. Designing Institutions to Support Local Level Climate Change Adaptation: Insights from a Case Study of the U.S. Cooperative Extension System. *Weather, Climate, and Society*, July 21, 2014. doi:10.1175/WCAS-D-13-00036.1.



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Weather, Climate, and Society 2014 : e-View  
doi: <http://dx.doi.org/10.1175/WCAS-D-13-00036.1>

### Designing institutions to support local level climate change adaptation: Insights from a case study of the U.S. Cooperative Extension System

Julie Brugger<sup>a,\*</sup> and Michael Crimmins<sup>b</sup>

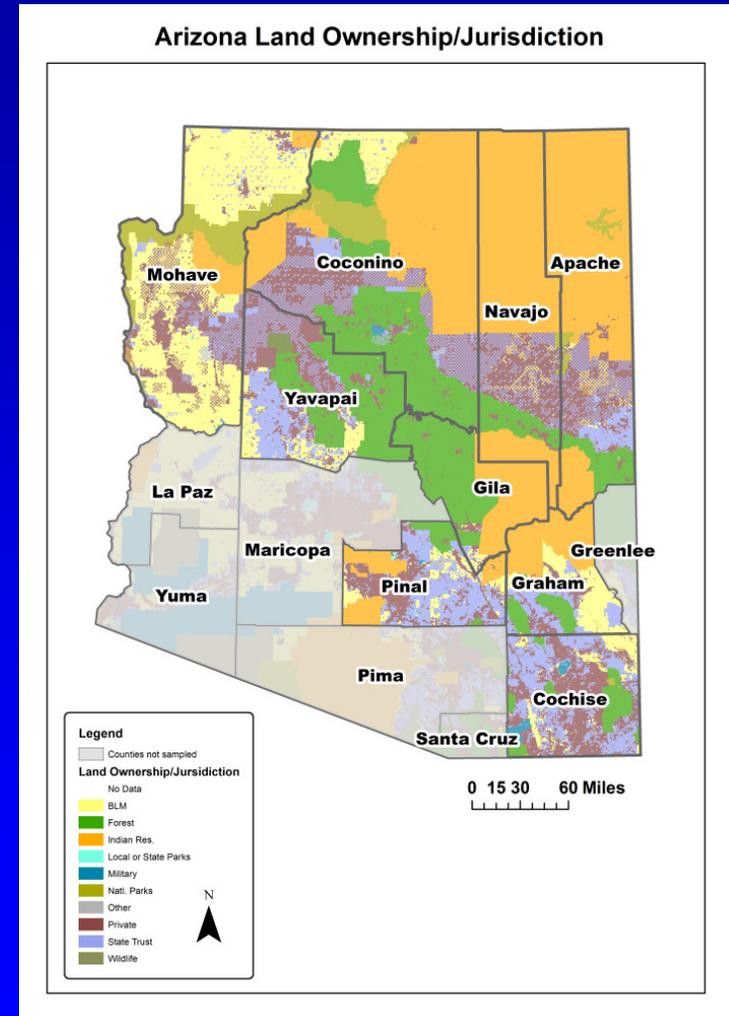
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<sup>b</sup> University of Arizona, Dept. of Soil, Water, & Environmental Science, PO Box 210038, Tucson, AZ 85721-0038, U.S.A.



# Project Structure

- Series of focus groups in eight counties between April-Sept 2011
- Pre-interviews with each county extension director to scope out main issues and key participants
- 10-20 participants in each group; 2-3 hours in length (over lunch)
- Facilitated by Brugger (anthropologist) and Crimmins (climatologist)
- Focus groups recorded and transcribed; analyzed using ethnographic methods





# ***Rural Arizonans are highly attuned to the weather and climate***

- Avid consumers of weather and climate information with many collecting their own data; highly literate in concepts like ENSO
- High awareness of past conditions and stories of past extreme events
- Weather/climate connections to water was the most discussed topic; drought, wildfire

***“The weather in northern Arizona, I’ve lived my whole life here, and the only consistency I ever found was its inconsistency.”***



***“Everything we do is based on the climate”  
(Farmer)***

***“My whole life is centered on climate. And I’m obsessed with rainfall, precipitation, temperature, wind, to an extent that most people would find unhealthy” (Rancher)***

***“I stay very in tune to what’s happening daily, what’s happening weekly, what’s happening monthly, because everything we do in the forest is weather dependent”  
(Forest Manager)***



# *Almost all agree that the climate is changing*

- Many discussions and stories surrounding observed changes
  - Rainfall patterns in space and time
  - More intense storms and droughts
  - Temperature extremes; both freezing and heat events
- Events like Wallow Fire (2011), short-term drought and Feb 2011 freezing event arose in almost all group discussions



***“I think the last five years in farming, there probably hasn’t been a normal year yet. A very late frost this year and last year both, just really late cold weather, well into April, end of April, first part of May, that seriously affect the germination of our cotton crop. ... So it’s general weather patterns that to me are a big concern, and just it seems like a change in the seasons. Seems like we’re getting much later springs and unfortunately we’ve had later falls as well...” (Farmer)***



***“I guess I could say things in the last year or so have gone extreme. Had extreme winds this spring, like I’ve never seen; last winter we had a winter like you can’t believe. The winter before that we had no snow to speak of; last year, we had the Cowpunchers Rodeo in Williams, it rained seven inches in three days. Those kind of things; the fires”  
(Rancher)***



***“We depend upon what the book says about climate: a bimodal climate where forty percent of the moisture falls in the winter months. And the last six years, that’s only happened once – last year. I’m still waiting for my winter moisture. All these storms that go through in the winter time pass north of us...”  
(Rancher)***



# *Climate change and global warming*

- ‘Climate change’ and ‘global warming’ were cautiously brought up in several focus groups
- ‘Climate change’ often meant observed, natural changes in climate, not human-caused
- Most group discussions were hesitant to link any observed changes to anthropogenic climate change



***“Again, talking about is this the norm now. I’ve always, and I still wonder all the time, is this...? They talk about global warming all the time, is this just a historical cycle that we’ve gone through over millions and millions of years, is this just part of that process, or is there something that is really causing these climate changes, such as the greenhouse gases and everything else? How much is there to that? Not being a scientist, I can’t answer that question, but it certainly enters my mind. Is it another cycle or not?” (County Supervisor)***



***“I think what I’ve seen in my lifetime is a change away from the really reliable storm monsoons that I remember as a child. And I’ve thought about my own memories about this a lot, thinking that, “No, you just imagined it that way because that was your childhood.” But now in looking back at records you really do see that there was a wetter time when it was more reliable. So I am, without apologies, a believer in climate change. I believe that I’ve lived and experienced climate change in my lifetime...” (Rancher)***



***“I see a lot of support for what we [Extension] do. And climate change in particular, I think what I’ve seen is a lot less people questioning as to its validity and whether it’s a real thing now. They might not like the term climate change or sustainability but I think they at least realize that it’s something that’s real and they’re going to have to work into their vocabulary with other words if they can’t use the words that I just used. And given that we have a fairly conservative audience here, that’s the group of people that are really most resistant to accepting climate change in my opinion and I think they’re ah, beginning to think otherwise. I don’t think it’s as much of a political football as it used to be...” (Extension Specialist)***



# What did we learn?

- No issue in getting people to talk about weather and climate!
- Overwhelming consistency among groups...the climate is changing
- Questions still remain on attribution
- Many creative adaptive responses to recent changes, but legacy resource issues remain fundamental problem
- Overall enthusiasm for assessment process
- Process served as climate education opportunity

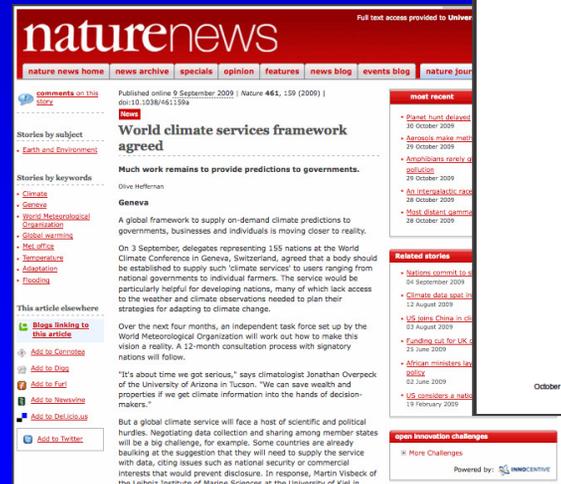
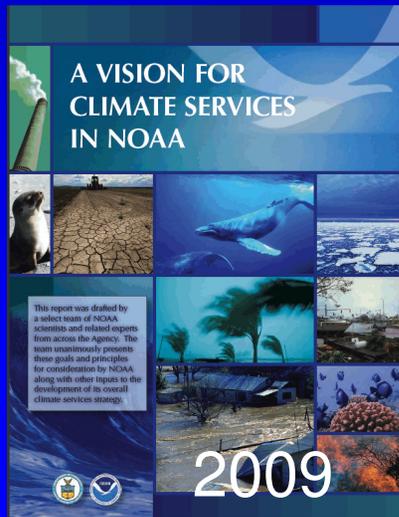
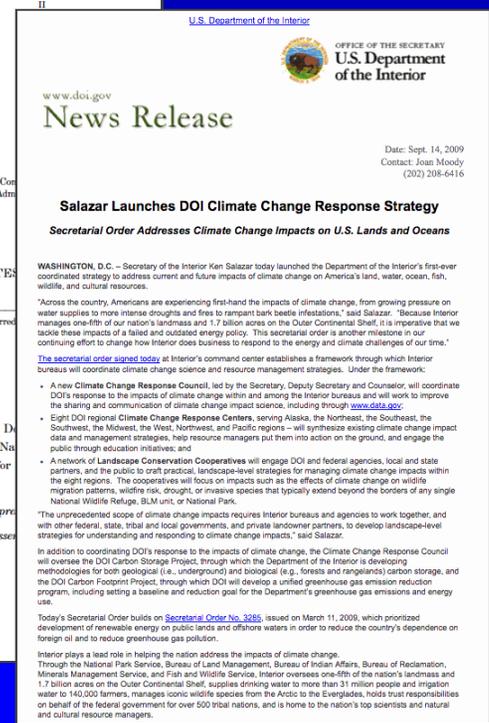
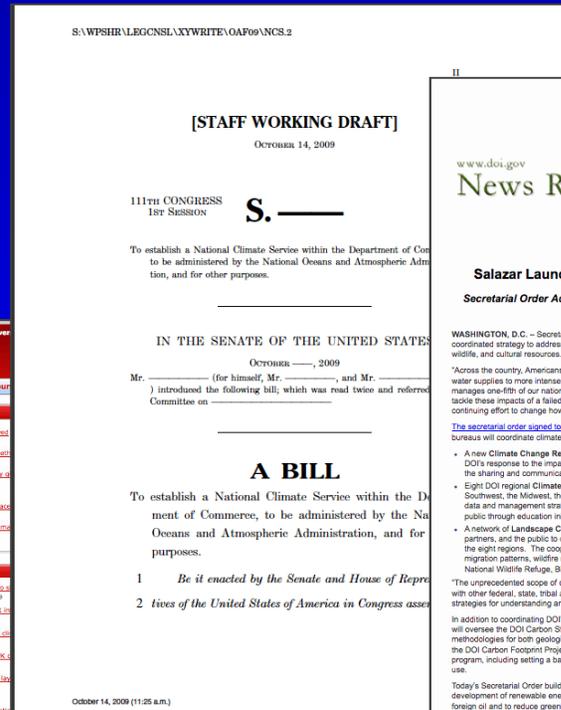
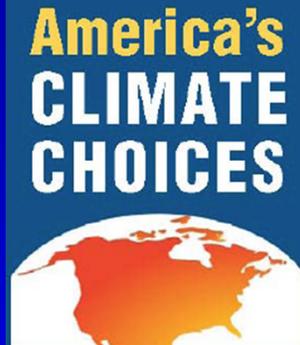
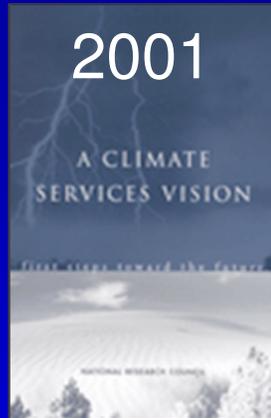
**“My God, this is rural America, and weather is important to us!”**

**“...we know that things are changing and we have to adjust and adapt.”**

**“I enjoyed it and think that those type of forums is exactly the role that Extension should play.”**



# Dramatic increase in interest in climate services/extension



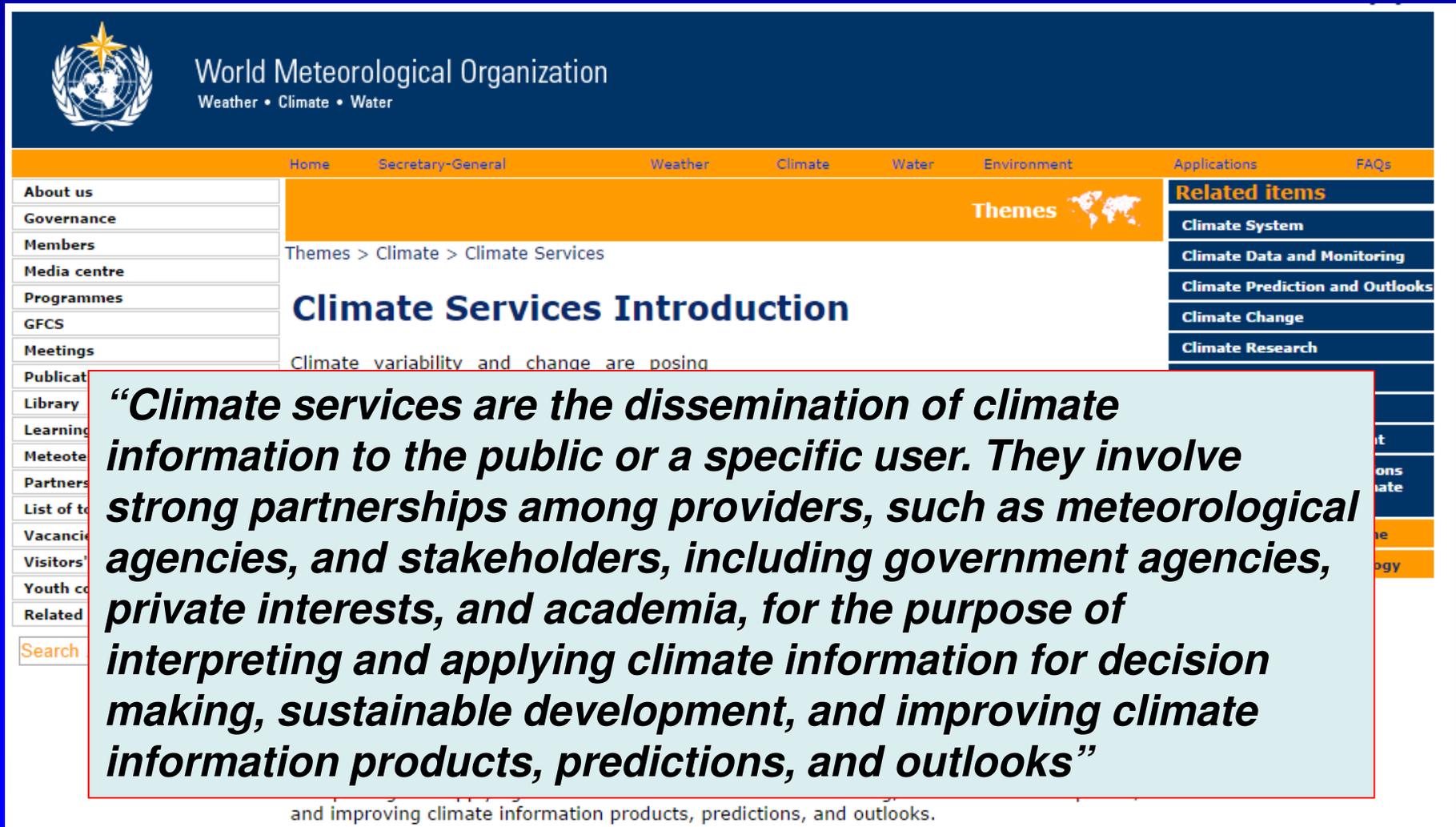
(slide courtesy of D. Ferguson)



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# Climate Services?



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Related Links

Themes 

Themes > Climate > Climate Services

## Climate Services Introduction

Climate variability and change are posing

***“Climate services are the dissemination of climate information to the public or a specific user. They involve strong partnerships among providers, such as meteorological agencies, and stakeholders, including government agencies, private interests, and academia, for the purpose of interpreting and applying climate information for decision making, sustainable development, and improving climate information products, predictions, and outlooks”***

and improving climate information products, predictions, and outlooks.

**Related items**

- Climate System
- Climate Data and Monitoring
- Climate Prediction and Outlooks
- Climate Change
- Climate Research

# Lessons Learned in Climate Services



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# 1. Assessing needs is critical

- Stakeholder needs are often undefined and changing
- Iterative and ongoing assessment approach is necessary (communication between producers and consumers of information)
- Core function of Cooperative Extension
- Need to eventually deliver on identified needs, though...



*Cooperative Extension workshop at Society for Range Management winter meeting (2006)*



# Assessment to product example

- NWS-FEMA-CLIMAS partnership
- Iterative design process
- Physical and social science methods
- Transition to operations...?



[www.climas.arizona.edu/content/fema-dashboard](http://www.climas.arizona.edu/content/fema-dashboard)

## Climate Information for Disaster Management: Bridging the Weather and Climate Timescales (A CLIMAS, NWS Western Region, and FEMA Region IX collaboration)

### OVERVIEW

The Federal Emergency Management Agency (FEMA) Region IX (CA, AZ, NV and Pacific Islands) has based its disaster management preparations on weather information for decades. Climate information, which conditions weather risk, however, has been underutilized. Hurricanes, atmospheric rivers, floods and other climate-related extremes commonly strike Region IX and have led to 154 federal disasters between 1964 and 2007. Climate phenomena like El Niño Southern Oscillation (ENSO) and the Madden Julian Oscillation (MJO) in combination with past and current conditions provides untapped opportunities to leverage climate information to help FEMA better monitor, anticipate and prepare for potential disasters.

The Climate Assessment for the Southwest (CLIMAS), the National Weather Service (NWS) Western Region, and the Response Division of FEMA Region IX are collaborating to co-design a hydroclimate dashboard that integrates into FEMA disaster management, stewarded by the NWS, and studied by CLIMAS.

### PROJECT OBJECTIVES

1. Enable the use of climate information in FEMA Region IX disaster management
2. Evaluate the use and usefulness of a co-designed climate information product
3. Critique theories of the co-production of knowledge and climate services within a climate case study
4. Develop best practices that inform scaling the integration of climate information across FEMA regions

### CO-DESIGNING THE DASHBOARD

Accessing, interpreting and disseminating climate information are common problems, ones also faced by FEMA Region IX. These challenges have emerged, in part, because climate information is copious, difficult to interpret, and often generated outside the specific decision context. Research suggests that adapting this "loading dock" of information requires a more explicit treatment of context. This project studies and addresses these challenges by applying the six "Principles of

Effective Decision Support endorsed by the National Research Council (2010).

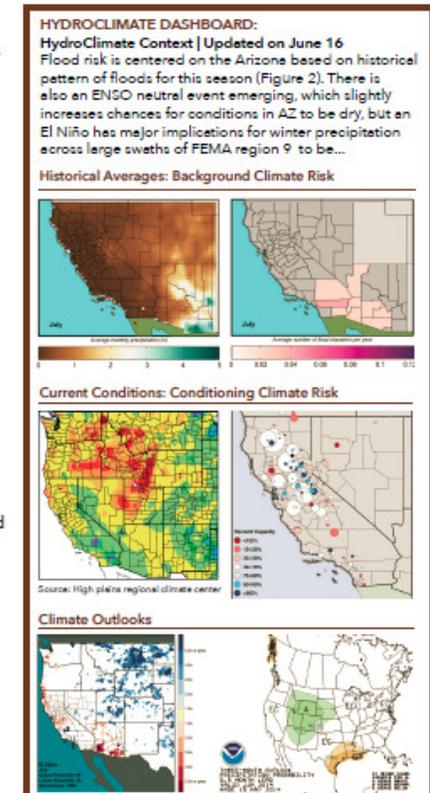


Figure 1. Mock Draft of the HydroClimate Dashboard. Not shown are maps related to MJO and other climate phenomena and conditions that influence risk.

(Guido, Meadow, Crimmins, and McLeod)



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## 2. Great need for training and outreach

- End users need guidance on 'best practices' for interpreting and implementing weather and climate information
- Literacy in basic underlying concepts (e.g. probabilities in seasonal climate outlooks) is crucial to adoption of products
- Multiple training avenues from web-modules to workshops exist



*Willcox Farm and Ranch Weather Workshop (2014)*



# Value of face to face workshops

- Network building
- Two-way learning (needs, concepts, opportunities)
- Adaptive teaching of complex concepts (e.g. probability outlooks)

## Farm and Ranch Weather and Climate Workshop

June 12, 2014 – 8:30 -12pm

*(Check-in begins at 8am)*

Willcox Community Center – fireplace room

312 W Stewart Street, Willcox

University of Arizona Cooperative Extension and the National Weather Service – Tucson Forecast office are sponsoring a morning long training workshop on weather and climate information focused on supporting agricultural and resource management decision- making. Topics will include:

- Finding and interpreting NOAA-NWS weather monitoring and forecast products
- An overview of the UofA Arizona Meteorological Network and crop and irrigation management products
- A discussion of drought monitoring efforts including an overview of the U.S. Drought Monitor
- El Niño and an update of seasonal forecasts through winter of 2014/15

The workshop will end with an informal discussion of information needs and opportunities for further product and service development to support southeast Arizona. Lunch will be provided.

Please register for the workshop by June 6th by calling 520-384-3594 or by emailing Connie at [cforsyth@ag.arizona.edu](mailto:cforsyth@ag.arizona.edu)

Sponsors include Southeastern Arizona Ag Day and...



*(Crimmins, Brown, Brost, Meadows)*



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# 3. Invest in information synthesis and translation

- Product end-users (e.g. resource managers) often don't have time or interest in integrating and analyzing multiple data sets or information sources... 'bottom line'
- Products that interpret and/or synthesize information are highly valued
- Opportunity to improve literacy and highlight new products

Southwest Climate Outlook  
Nov. 9 Issue 11  
November 23, 2009

In this issue...  
Feature Article page 3  
Amit-shaped cumulus clouds dotted the sky in early June, occasionally bursting with heavy rains in many parts of New Mexico and southwestern Arizona. The multi-tiered moisture turned the stalks of blue and black grama grass a light green, filled each pond...

Snowpack page 13  
The early season snowpack in Arizona and New Mexico as of November 18 predominantly contain low-snow average snow water equivalent (SWE), according to the National Resource Conservation Service's (NRCS) SWEA-TET monitoring stations...

Photo Description: Clouds shade parts of the craggy cliffs on the eastern side of the Chisos Mountains in southern Arizona.  
Source: Zack Galis; CLIMAS, October 18, 2009

Would you like to have your own Southwest Climate Outlook? For a free climate and a detailed copy...

Southeast Arizona Seasonal Climate Summary: Winter 2015-16

January 20, 2016 - The October-December period was relatively active weather-wise in concert with the ongoing strong El Niño event underway in the Pacific Ocean. Several cut-off low pressure systems (including one that crossed the Southwest twice) drew subtropical moisture into southern Arizona throughout the month of October producing several rain events. Beginning in November the weather pattern transitioned into a more typical winter time storm track with storm systems originating in the Gulf of Alaska periodically diving south across Arizona and New Mexico. These storms brought periodic cool downs, but often lacked much in the way of moisture. Two events, one in mid and late November tapped into some moisture being precipitation and snow to the region. This pattern continued through December with only one mid-month event bringing much in the way of additional precipitation. Overall, the October-December period was near to slightly above-average due mostly to precipitation picked up in October. Temperatures were also near to slightly above average as well due largely to the balance of cool overnight temperatures and several warm spells in October and again in November and December.

The strong El Niño event underway is expected to persist through late spring and should continue to raise our chances of observing above-average precipitation for the January through April period. Several more wet periods like the one in early January should continue to emerge over the next several months helping to continue to alleviate any remaining short-term drought conditions.

Arizona - Precipitation (Above/Below Normal) (mm)

Arizona - Mean Temperature (Above/Below Normal) (°F)

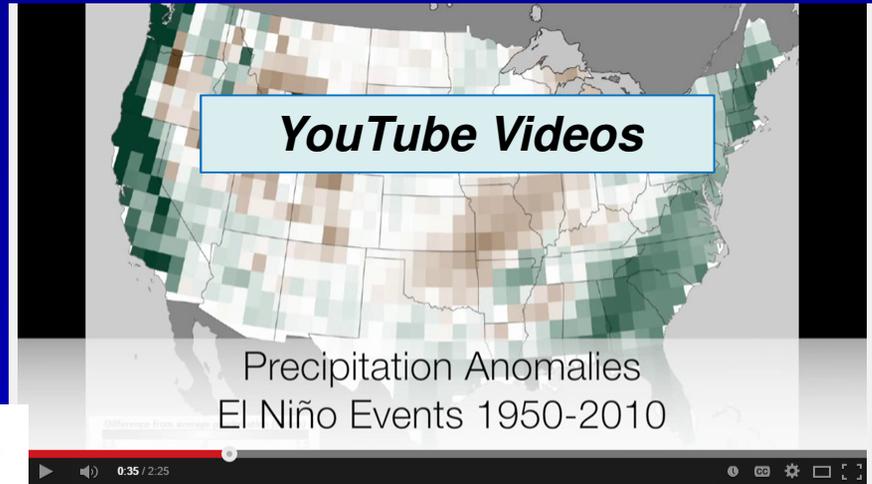
October-December precipitation and temperature anomalies from the Westwide Drought Tracker  
(<http://www.arizona.edu/wwdt/>)

More information available at:  
<http://climas.arizona.edu/CLIMAS>  
<http://www.climas.arizona.edu>  
Questions/Comments? Contact Mike Cronin, [cmcronin@gmail.com](mailto:cmcronin@gmail.com) or [arizona@climas.arizona.edu](mailto:arizona@climas.arizona.edu)

Southeast Arizona Seasonal Climate Summary—Winter 2015-16



# Multiple communication pathways with ongoing assessment...



Podcast Series:  
Southwest Climate Podcasts

Podcast Hosts:  
Michael Crimmins  
Zack Guido

Producer:  
Ben McMahan  
Emily Huddleston

Available on iTunes

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Sept 2014 Southwest Climate Podcast: Tropical Storm Climatology & El Niño Summary

Wednesday, October 1, 2014

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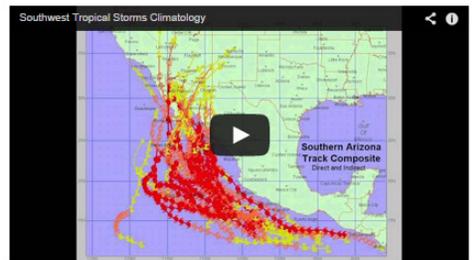
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SW\_ClimatePod\_10.01.2014.mp3

## Monthly weather and climate podcast

Intro & F	0:00
Tropical	0:06
Norbert	4:45
What is	7:53
El Niño	9:45

We are introducing a new feature: video mini-segments from the podcast. The first of which comes from last month's podcast, and addresses monsoon & drought in response to a listener question, and is viewable on youtube. This month's video podcasts will be added to this page as we release them



## Monsoon & Drought Q&A

CLIMAS - Climate Assessment for the Southwest

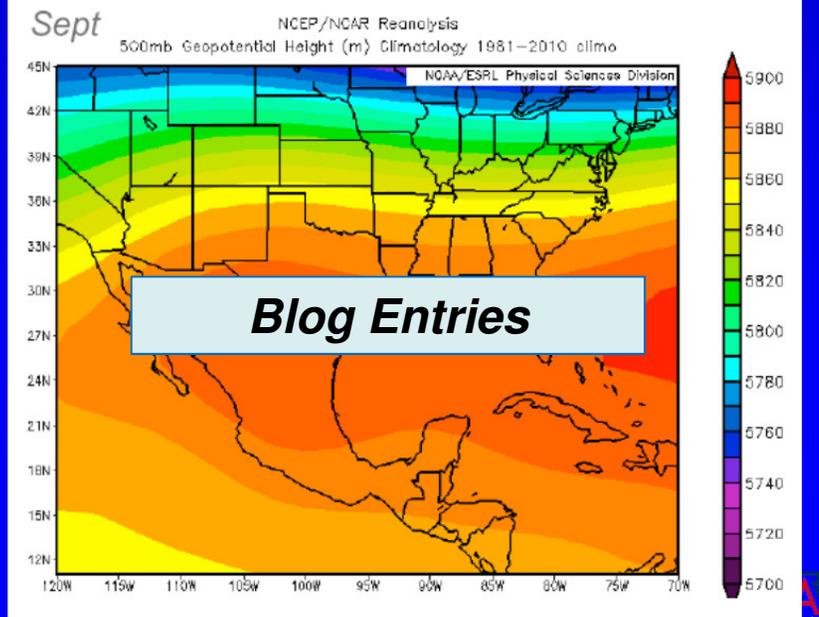
### Notes from an Applied Climatologist: Monsoon End Q&A

Monday, September 29, 2014

Michael Crimmins

### How Do We Know When the Monsoon is Over?

Across the southwest United States, the start of the summer monsoon season is pretty easy to recognize once you have experienced it firsthand a few times. Typically, one week it's hot and dry, and the next week, it's hot and sticky, but hopefully raining. (read more)



<http://www.climas.arizona.edu/blog>

(McMahan, Guido, and Crimmins)



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# 4. Build tools that matter

- One-size fits all decision support tools often fit no one in the end; users have specific needs
- Climate data and information is exploding in volume and depth, access is improving
- How do you quickly match a user need with existing data/information?
- Web application frameworks like *Shiny* as one solution



# Standardized Precipitation Index Explorer Tool

- Rapidly (2 months) developed a custom data exploration tool for USFS/Rancher workshop on drought monitoring
- Responding to specific requests for localized data, training on drought indices, seasonal outlooks
- Workshop assessments quantified improvement in understanding of indices, outlooks

Standardized Precipitation Index Explorer Tool

About Tool    Set location/time period    Site Climate Summary    SPI Timescale Comparison

SPI-Precip Comparison    Drought Category Transitions

Shiny by RStudio

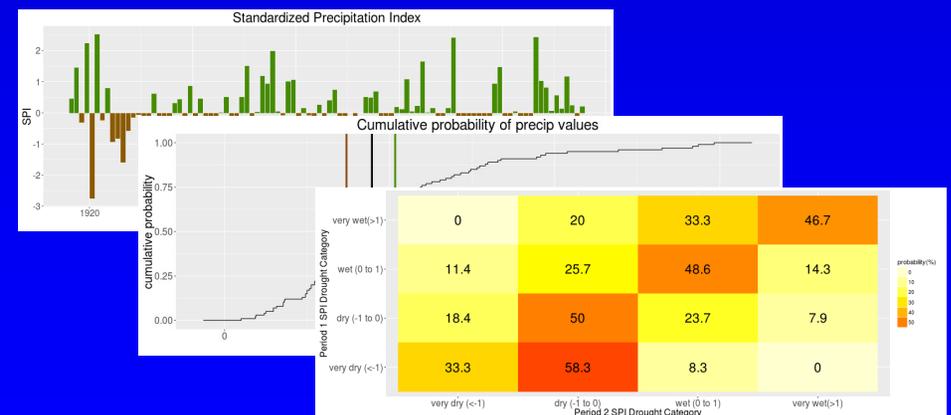
Links to other SPI resources:

- Western Regional Climate Center
- WestWide Drought Tracker
- International Research Institute for Climate and Society
- Drought.gov
- National Drought Mitigation Center

About the SPI Explorer Tool

The Standardized Precipitation Index (SPI) is a widely used drought index that has several strengths including the ability to calculate precipitation anomalies at different timescales and the ability to interpret SPI units (standard deviations) in probabilistic terms (click here for more info on the SPI). This tool was created to explore SPI values at specific locations by using a gridded climate dataset (PRISM Climate) to estimate local precipitation time series. Data are accessed through the Applied Climate Information Web Service and analyzed and plotted using several R based packages.

Contact Mike Crimmins (crimmins@email.arizona.edu) with questions or comments.



<https://uaclimateextension.shinyapps.io/SPItool/>



# Climate Extension for the 21<sup>st</sup> Century

- Extension is held up as a model ‘boundary organization’ (Cash et al. 2001), specifically in climate change decision support (NRC 2009)
- Interdisciplinary, expertise in co-production, flexibility to meet emerging needs, social and political capital
- Climate change is too big an issue to tackle alone; how do effectively support existing partnerships and develop new ones? What are our strengths? What should we focus on?



# Thanks!

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