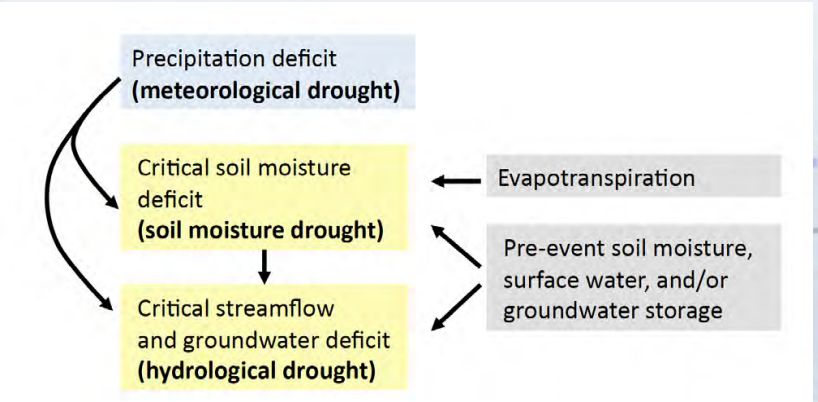
National Integrated Drought Information System

Drought and Water in the West

Roger S. Pulwarty
Climate and Societal Interactions and
National Integrated Drought Information System
NOAA Boulder CO

State and Tribal Partners, Municipalities, NDMC
NOAA, Dept. Interior, USDA, USACE, EPA
State Climatologists



Drought: a continuum

Droughts span a large range of temporal and spatial scales

Impacts result from a number of complex variables

Heat Waves

Floods

Storm Track Variations

Madden-Julian Oscillation

El Niño-Southern Oscillation++++++

Decadal Variability

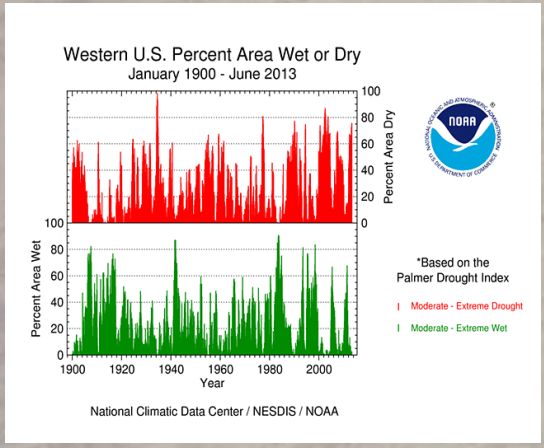
Solar Variability

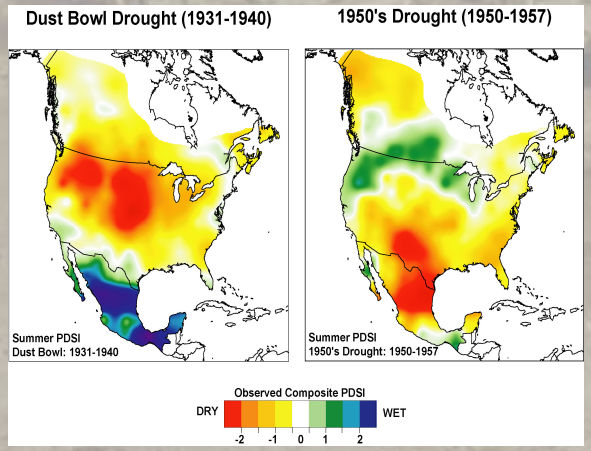
Deep Ocean Circulation

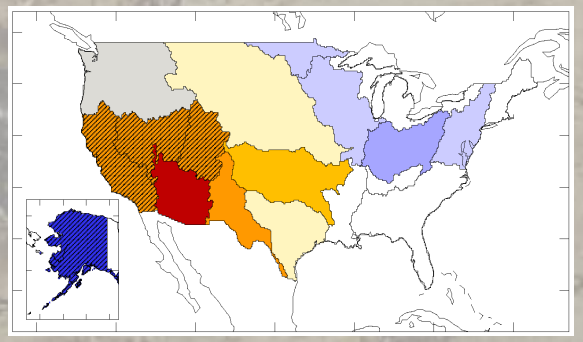
Greenhouse Gases

30 DAYS | 1 SEASON | 3 YEARS | 10 YEARS | 30 YEARS | 100 YEARS

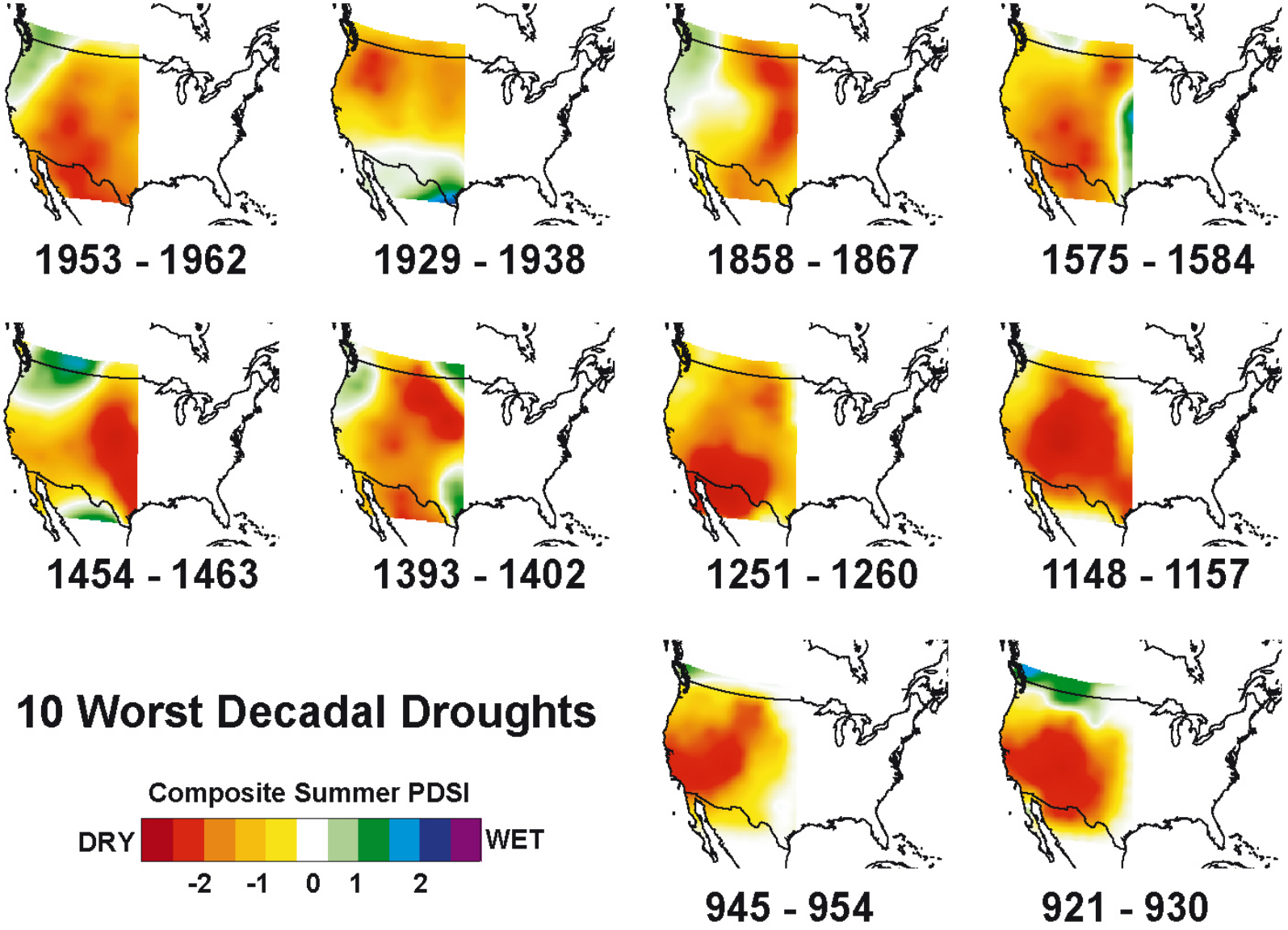
SHORT-TERM | **INTERANNUAL** | **DECADE-TO-CENTURY**







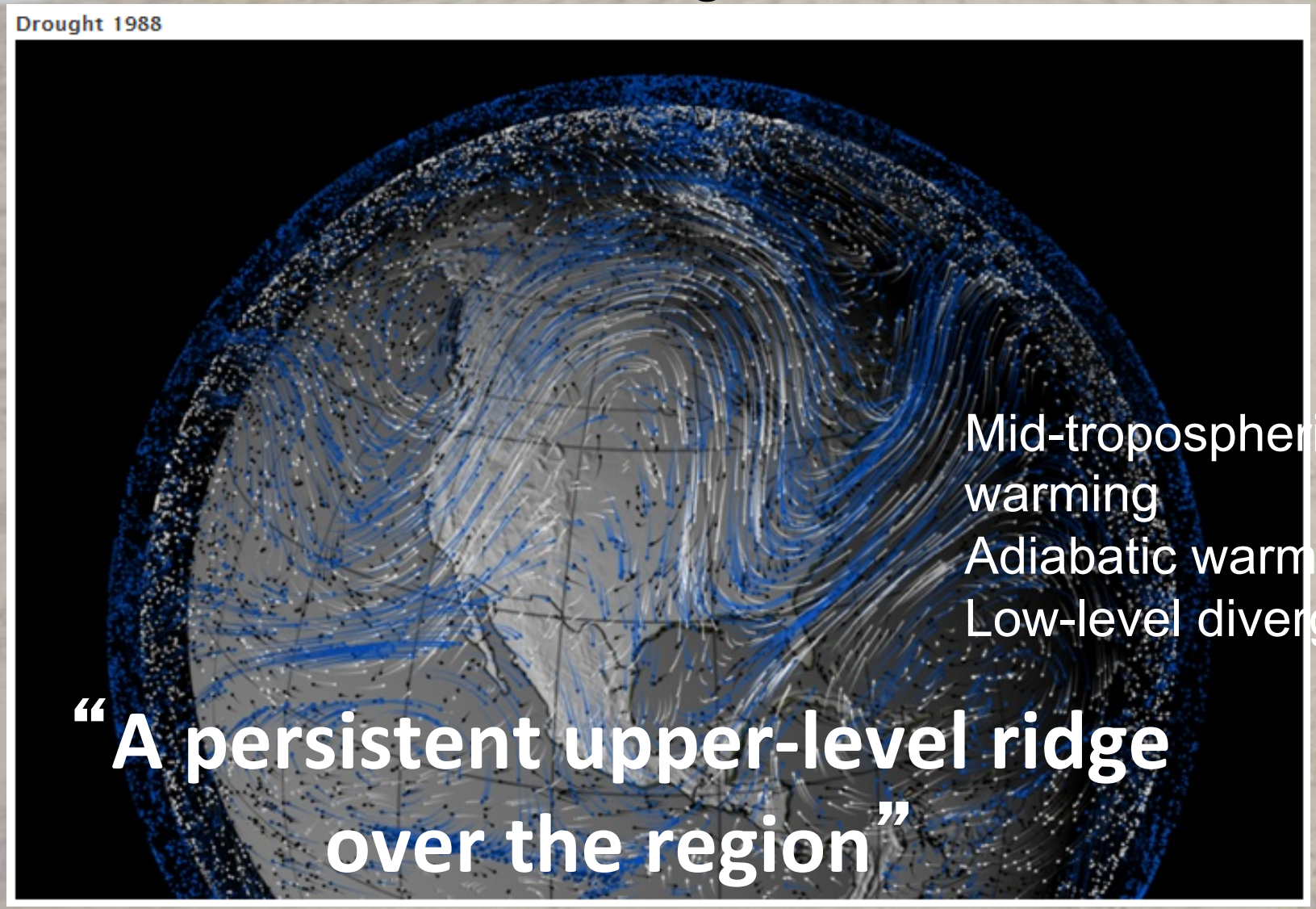
Modern



Medieval

NASA Earth Observatory:

Winds of Drought, Winds of Flood



http://earthobservatory.nasa.gov/IOTD/view.php?id=46145&src=eoa-iotd

Three tasks under the NIDIS Act

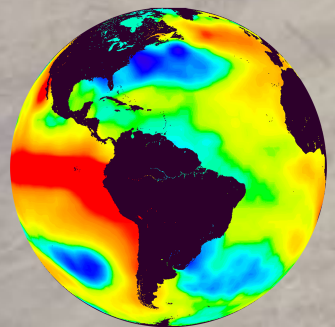
(Public Law 109-430, 2006) "*Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts*"

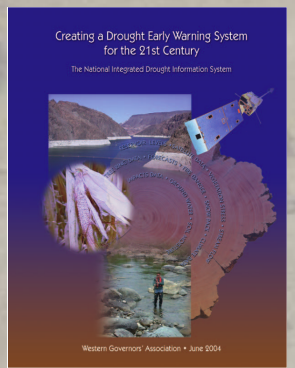
(I) **Provide an effective drought early warning system:**

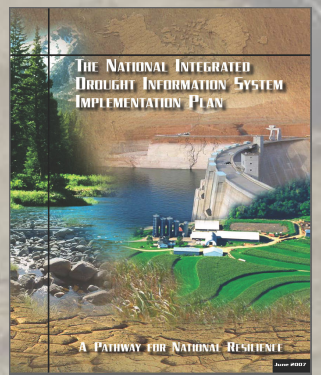
(a) collect and integrate key indicators of drought severity and impacts; and
(b) produce timely information that reflect local, regional, and State differences;

(II) **Coordinate and integrate as practicable, Federal research in support of a drought early warning system**

(III) **Build upon existing forecasting and assessment programs and partnerships**



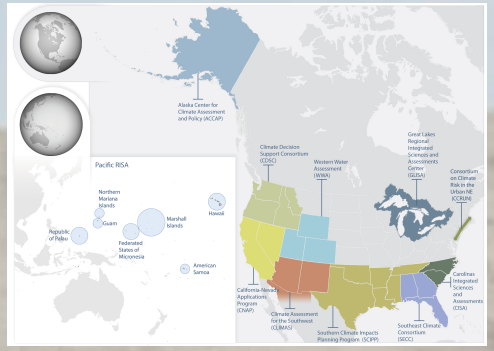




NIDIS

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Support cross-regional efforts to assess user needs, test drought-focused decision support tools



Regional Integrated Sciences and Assessments (RISA)

Sectoral Applications Research Program (SARP)

NIDIS

PL 109-430

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

NATIONAL DROUGHT MITIGATION CENTER (NDMC)

Drought Monitor

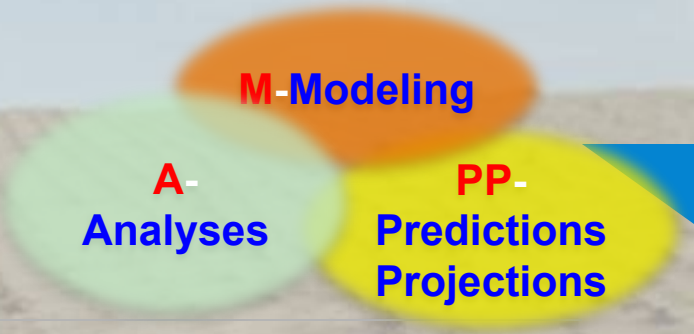
Identify socio-economic effects of drought, data and info needs of resource managers and policy/decision makers

Evaluate and transition drought information products to operations

Coping With Drought Research and Applications

Regional Climate Centers
State Climatologists

Cross-agency MAPP Drought Task Force



Retrospective Drought Analyses

Why droughts occur? Which past droughts were more predictable and why? Were they well predicted and by which systems?

Underpinning Science

How can we improve the depiction of soil moisture and ground water? Which drought precursors can be leveraged to used to improve prediction? Which processes regulated drought development/ intensity?..

Drought Task Force

Research to advance drought understanding, monitoring and prediction

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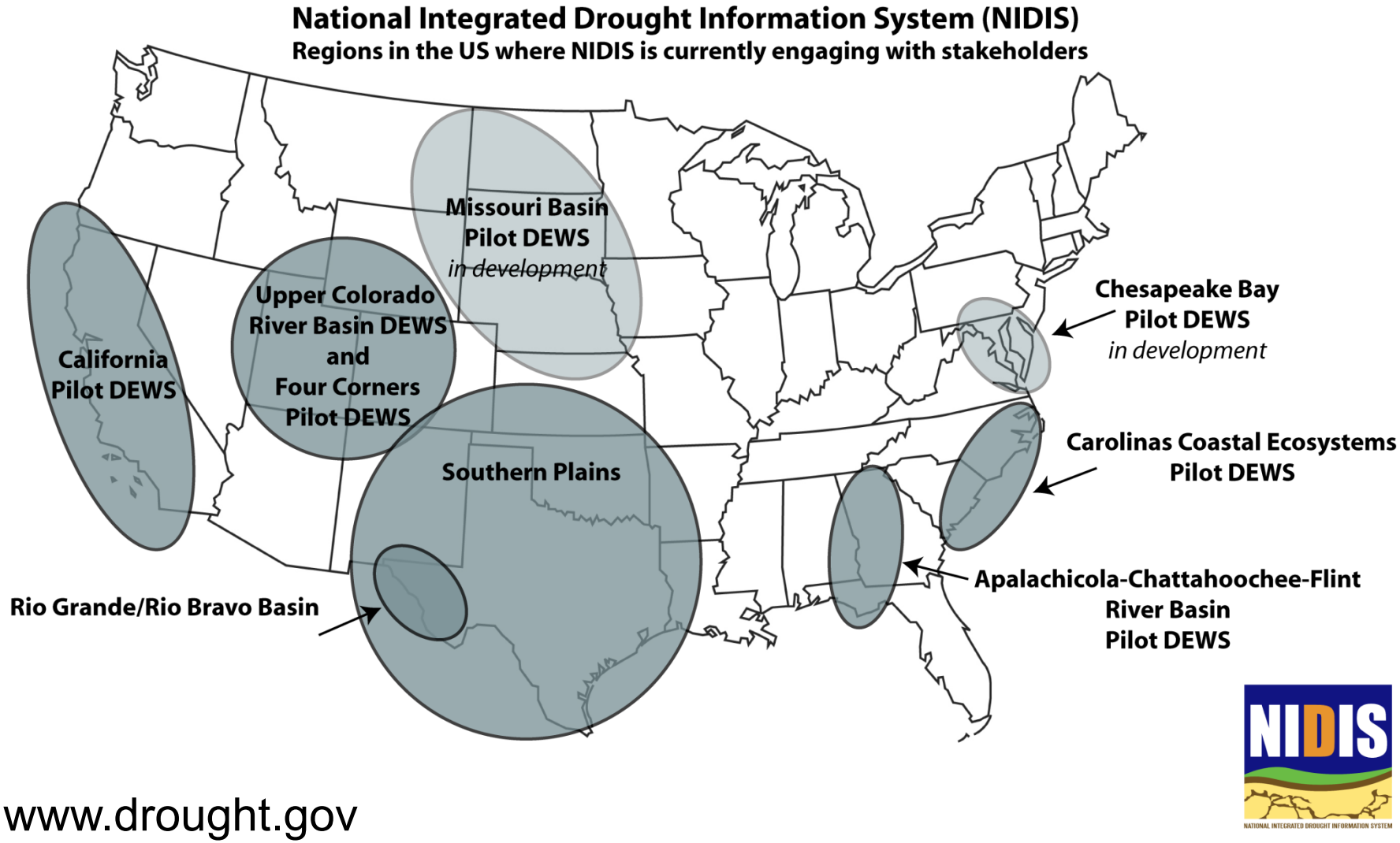
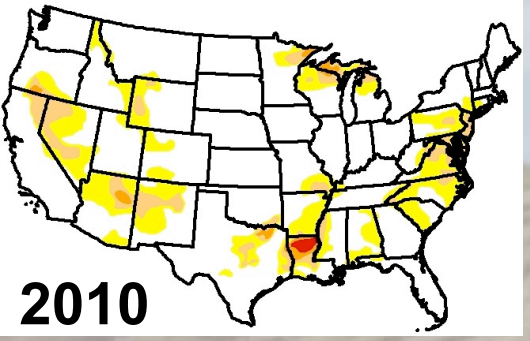
Assessing and Improving Capabilities

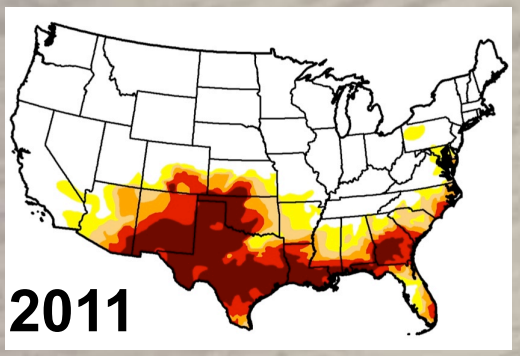
What is the current state of capabilities?

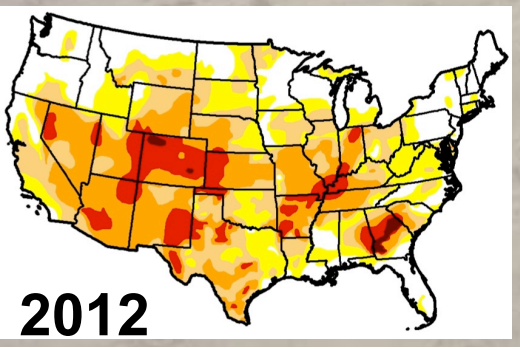
Which research advances can lead to improved drought monitoring and predictions?

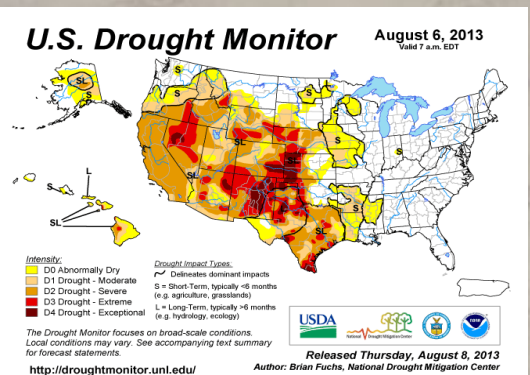


www.drought.gov









How did we get here? Status and antecedent conditions

Is this drought like others? Why has it been dry/drier than normal?

What are the impacts and where did they occur?

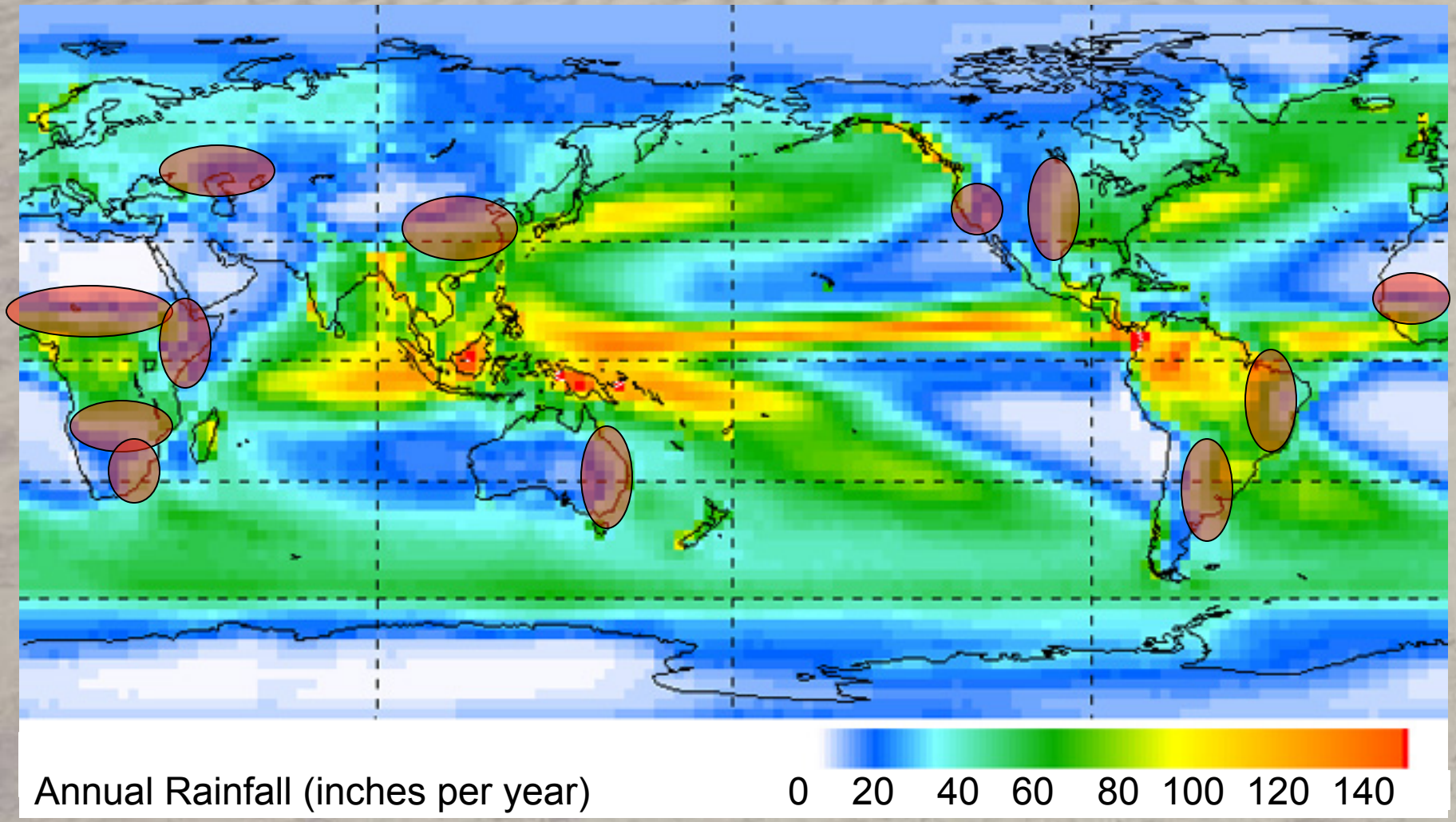
What information is being provided and by whom?

How bad might it get and how long will it last?

Are information needs being met?

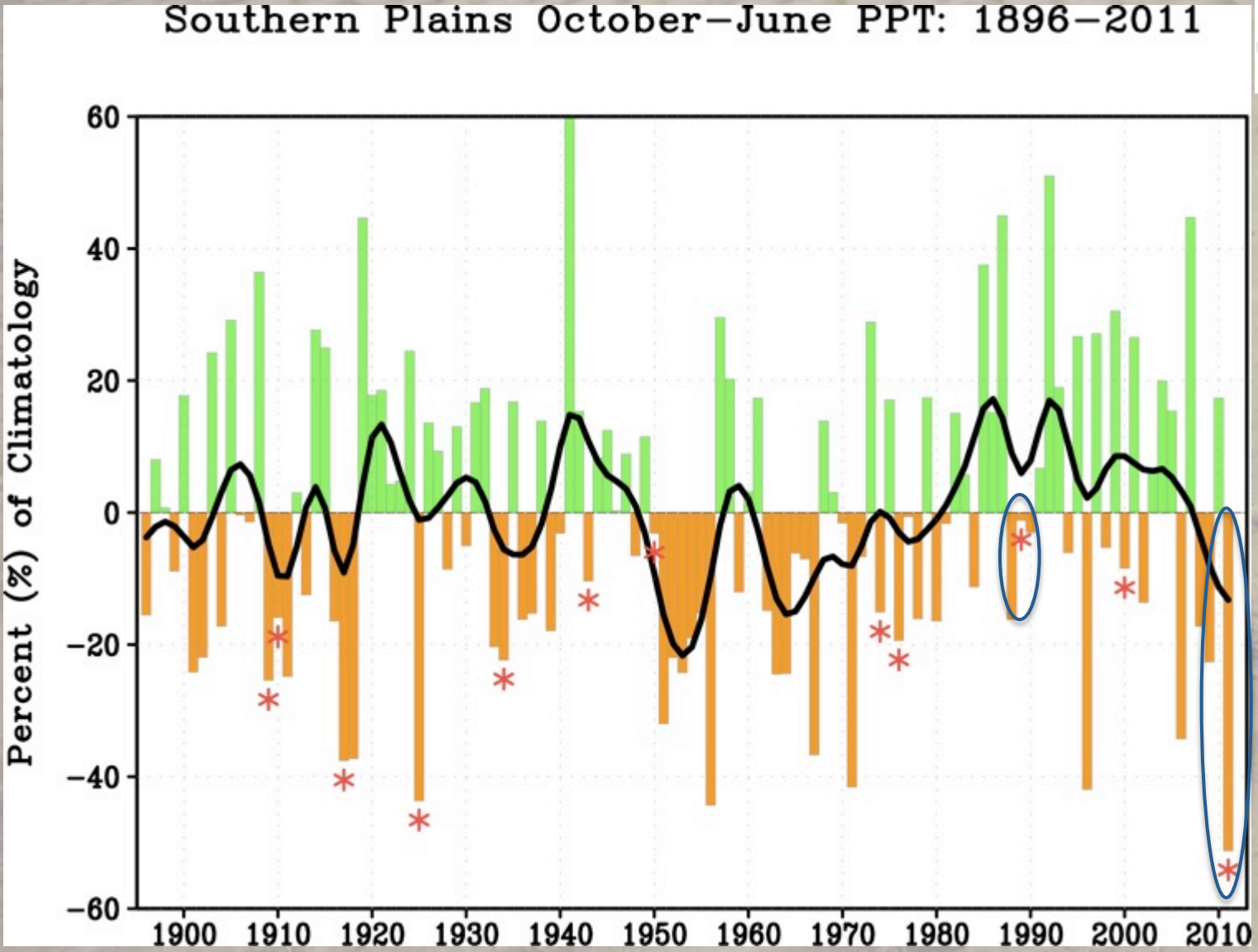
How are we planning for this year and for longer-term risks and opportunities?

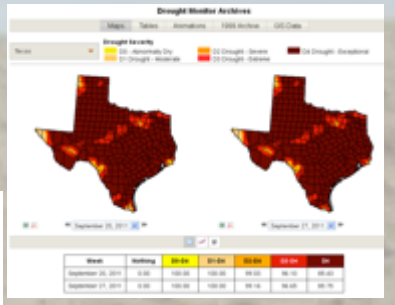
Why do some places experience more drought conditions than others?



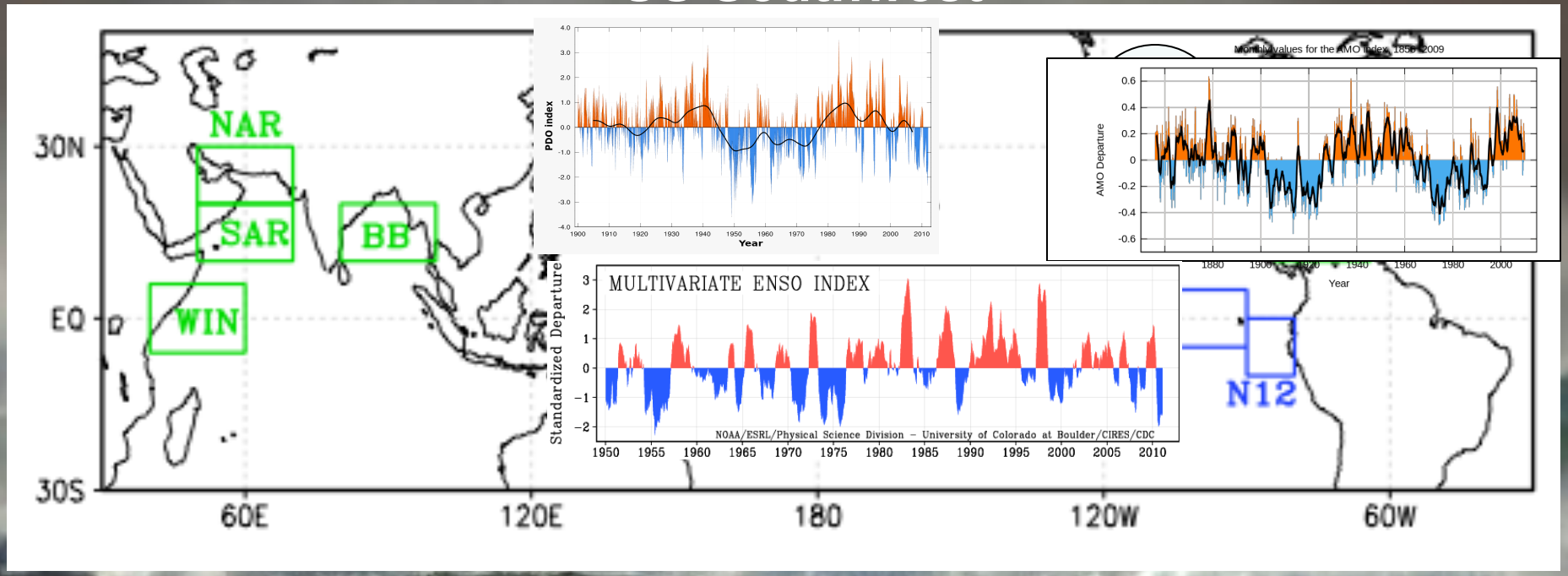
Just barely enough rain, and large variations from place to place

What drives climatological drought in the Western US ?

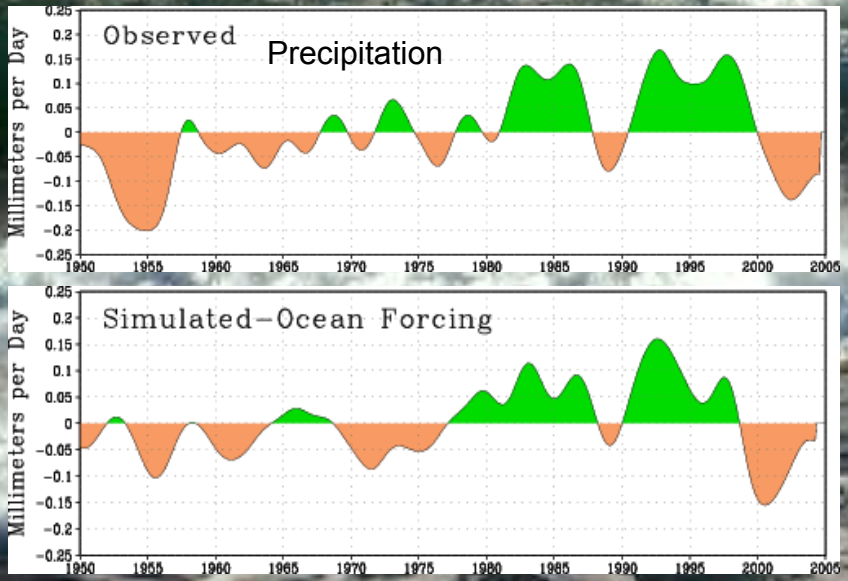




Drought Early Warning-Useful monitoring regions for the US Southwest



Improved monitoring and projections of the ocean will be critical for the future predictions of drought in the semi-arid West.



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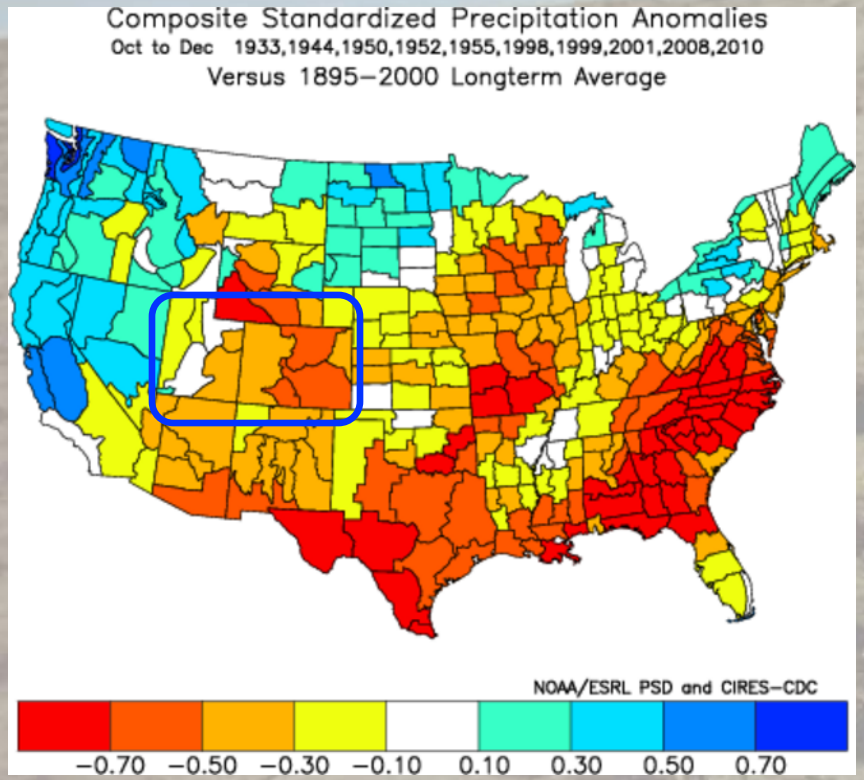
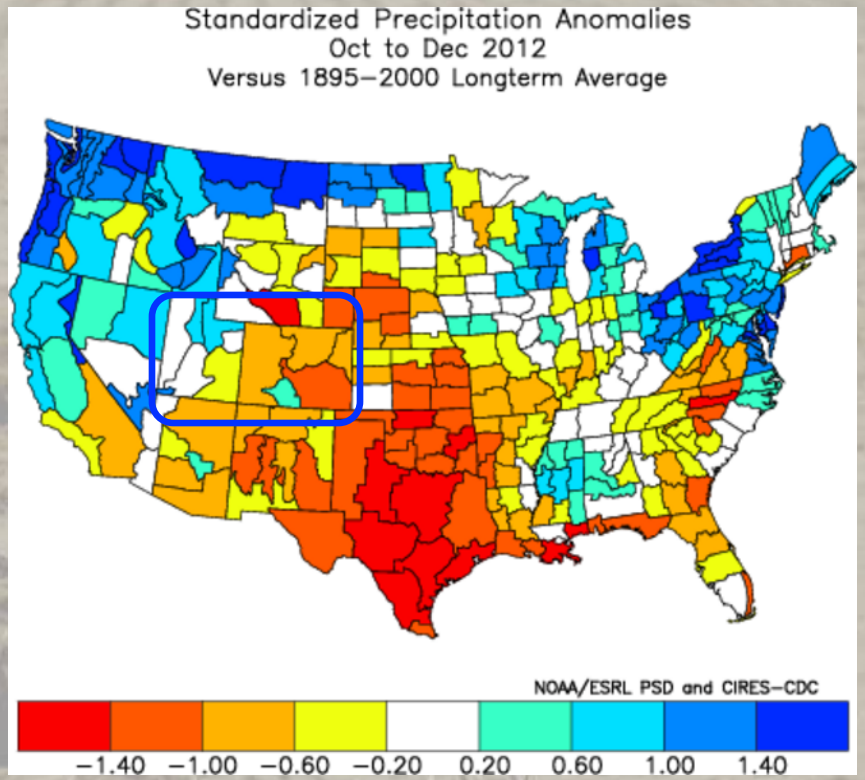
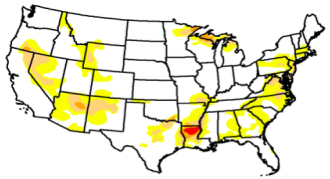
How did the low <PDO-AMO> composite work out in late 2012?



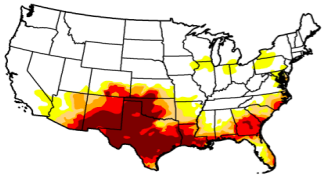


After being consistently low for much of the last decade, the difference in normalized anomalies between PDO and AMO reached its lowest value on record last summer.

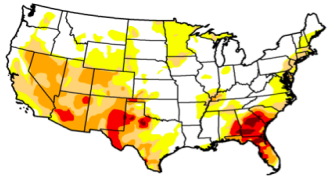
In 2012, dry conditions prevailed as expected not just in Colorado, but also AZ&NM, from TX into MO, and from FL north to VA, while the greater Pacific Northwest wound up wet, as expected...



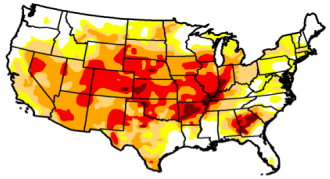
July 2010
8% moderate
to exceptional



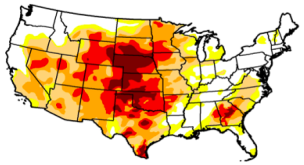
July 2011
28% moderate
to exceptional



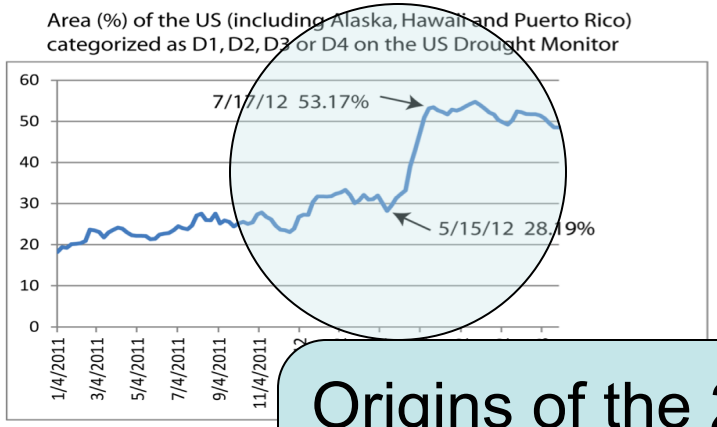
May 2012
35% moderate
to exceptional



July 2012
64% moderate
to exceptional



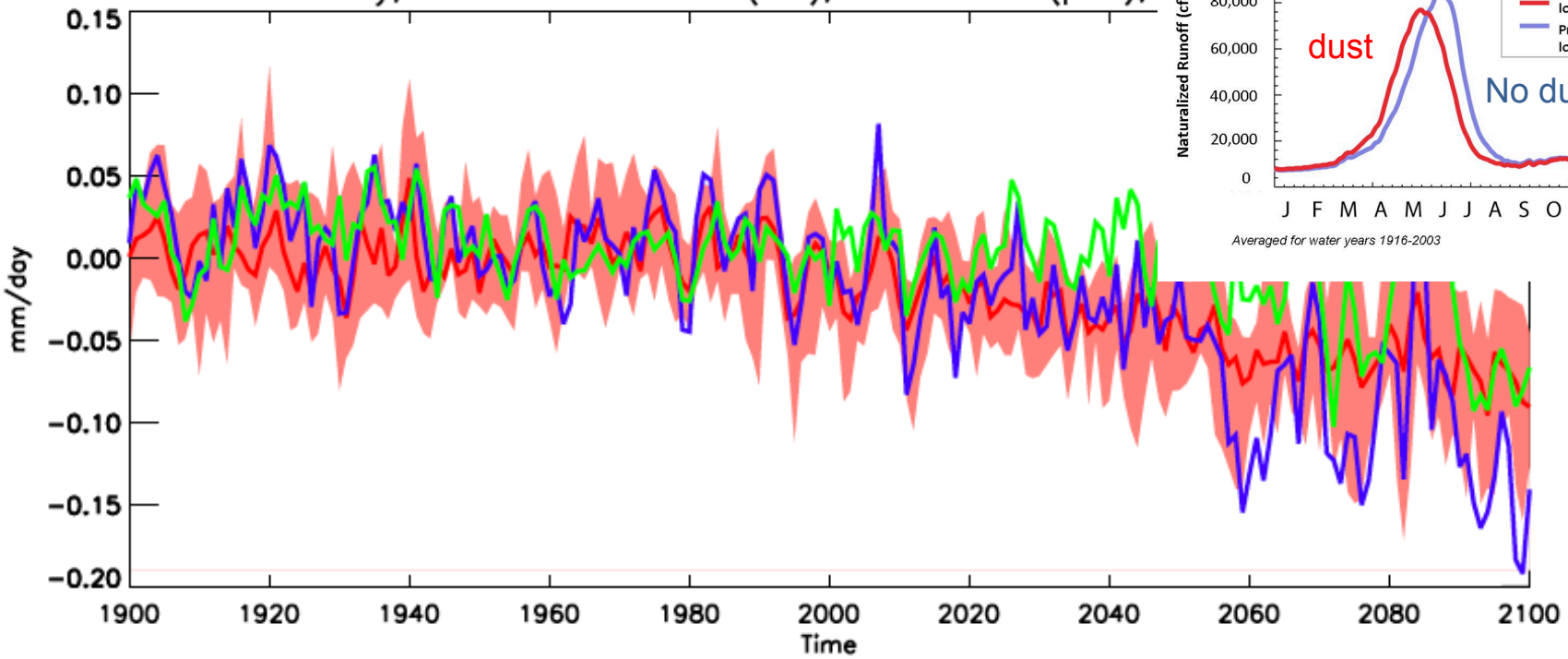
January 2013
58% moderate to
exceptional



Origins of the 2012 Drought- NIDIS-MAPP Report 2013

Figure 1. How did we get here? Antecedent conditions and status (S NDMC, 2013)

P, *E* and *P-E* averaged across all of SW North America in the IPCC AR5 global climate model simulations and projections for 1900 to 2100



Ongoing transition to a drier climate

? Precipitation minus evapotranspiration

ruce McBroom / © Apple Corps Ltd.

Since 1880 a strong signal of U.S. warming having maximum amplitude over the southwestern U.S. consistent with historical observations

- The percent of the U.S. experiencing moderate to severe drought suddenly increased and remained at elevated levels during the first decade of the 21st Century

- Even a perfect SST prediction would likely capture much less than half the total variance in annual precipitation over North America

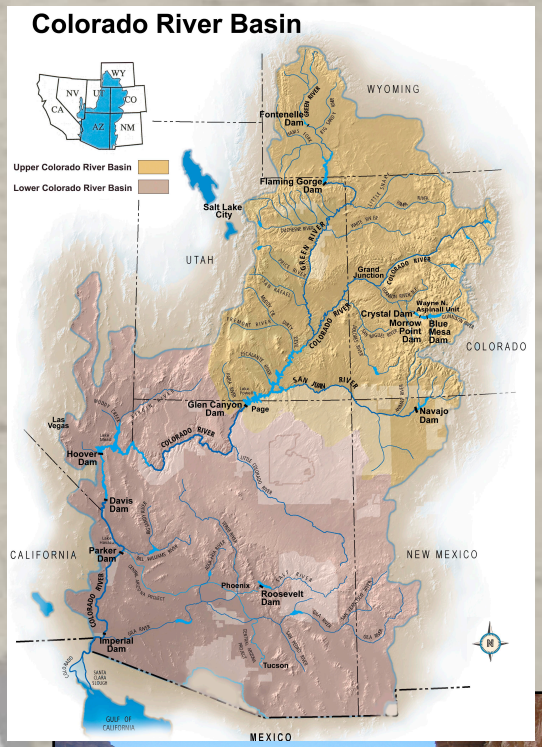
The Southwest U.S. - drought conditioning may be entered more quickly and alleviated more slowing due to long-term warming.

- **A complete explanation of these droughts must invoke not just the ocean forcing but also the particular sequence of internal atmospheric variability - weather - during the event.**

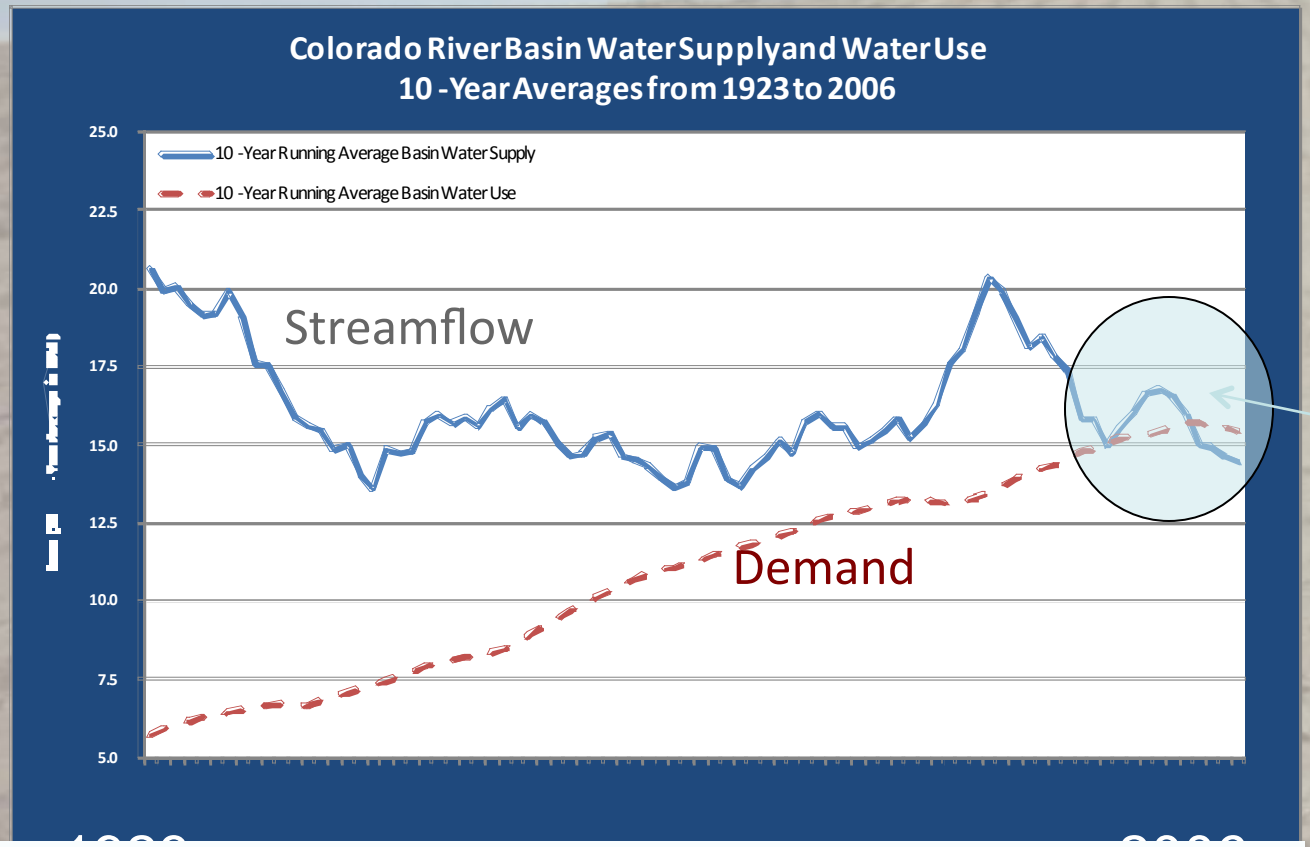
Upper Colorado River Basin

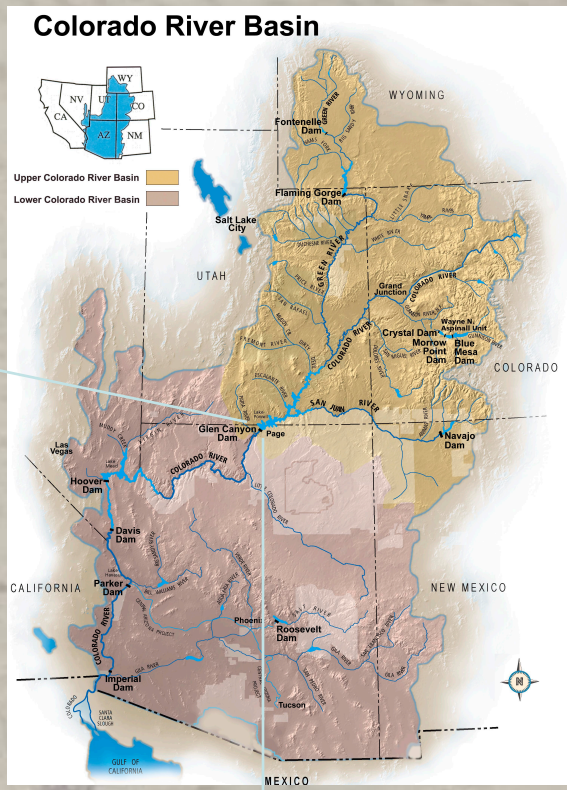
Categories of drought information users & analysis

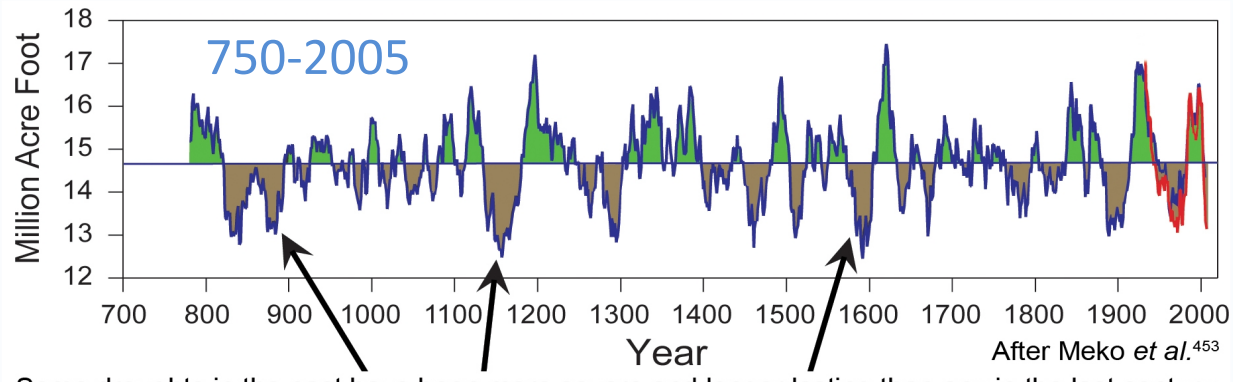
- Coordinated reservoir operations: Low flow shortage triggering criteria (Powell/Mead)
- Inter- and Intra-basin transfers; Changing water demand during drought
- Ecosystem health
- Underserved communities



Colorado River Water Supply & Use





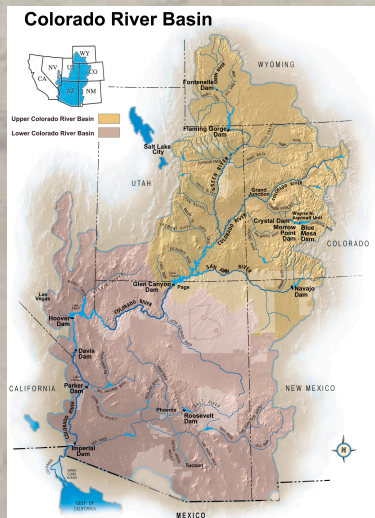


Some droughts in the past have been more severe and longer lasting than any in the last century.

Who manages the watershed?

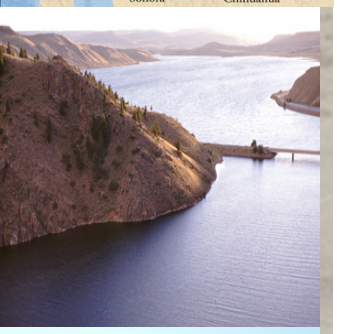
Colorado River Interim Guidelines - Time to think?

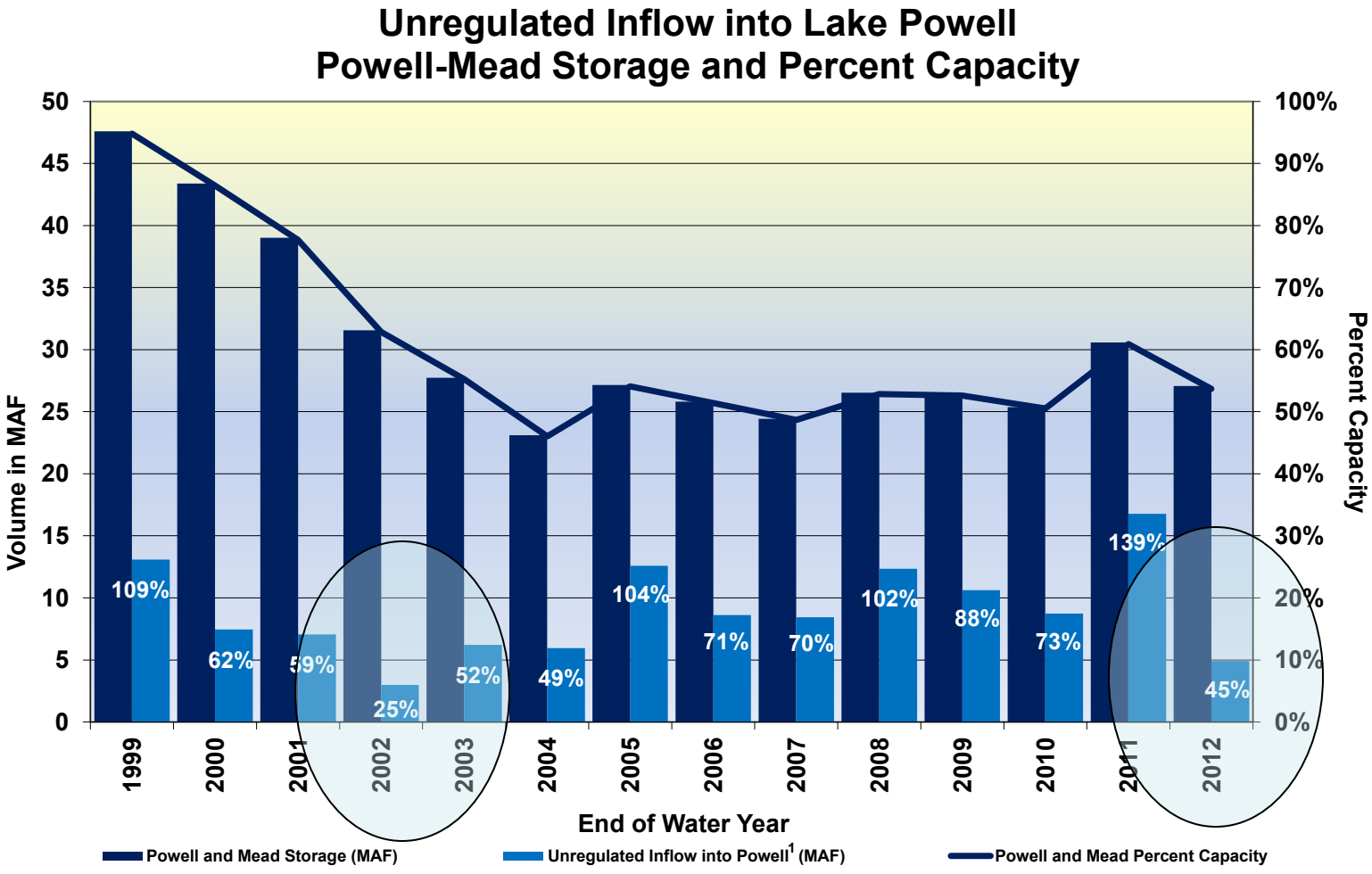
- Operations specified through the full range of operation for Lake Powell and Lake Mead
- Encourage efficient and flexible water use and management in the Lower Basin through the Intentionally Created Surplus (ICS) mechanism
- Strategy for shortages in the Lower Basin[2], including a provision for additional shortages if warranted
- **In place for an interim period (through 2026) to gain operational experience**
- **Basin States agree to consult before resorting to litigation**
- **Minute 319**



1. Issued in Record of Decision, dated December 13, 2007; available at http://www.usbr.gov/lc/region/programs/strategies.html
2. Mexico water deliveries are not directly effected by these guidelines (US/DoI Bureau of Reclamation)

State of the Colorado System (Water Years 1999-2012)





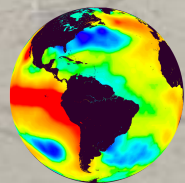
[1] Percentages at the top of the light blue bars represent percent of average unregulated inflow into Lake Powell for a given water year. Water years 1999-2011 are based on the 30-year average from 1971 to 2000. Water year 2012 is based on the 30-year average from 1981-2010.

In the Colorado River's 100-year recorded history, 1999 through 2010 ranks as the second-driest 12-year period

CO Basin Early Warning Information System

Existing mandates, decision cycles, and organizational capacities to guide implementation of the pilot-workshops, interviews, reports

- Colorado Division of Water Resources (CDWR)
- Colorado State Climatologist
- Colorado River Water Conservation District (CRWCD)
- Colorado Water Conservation Board (CWCB)
- CU – Western Water Assessment, CIRES, and CADSWES
- Denver Water Board
- Northern Colorado Water Conservancy District (NCWCD)
- Wyoming State Engineer
- Wyoming State Climatologist
- Utah State Climatologist
- Western Regional Climate Center
- National Center for Atmospheric Research (NCAR)
- National Drought Mitigation Center (NDMC)
- USDA: Natural Resources Conservation Service
- USFS: Region 2
- USBR: Eastern Colorado Area Office, Great Plains Region, Office of Policy and Programs, Research and Development
- USGS: Colorado Water Science Center, Central Region, Grand Canyon Monitoring and Research Center
- NOAA: Earth System Research Laboratory, National Centers for Environmental Prediction, National Climatic Data Center, National Weather Service



Summer 2012

MANAGING DROUGHT
IN THE SOUTHERN PLAINS

You are invited to join us in a webinar (web-based seminar) series to discuss drought conditions, impacts and resources available to help manage drought in the Southern Plains. Webinars will be held on the 2nd Thursday of each month at 11:00 A.M. Central

To register or for more information, contact:

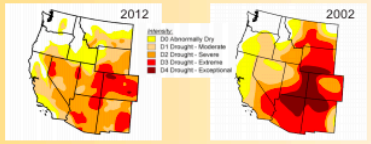
http://ccc.atmos.colostate.edu/drought_webinar_registration.php

The 2012 Drought in Colorado, Utah and Wyoming

A July 2012 update from the
Western Water Assessment and the National Integrated Drought Information System

Under a second winter of La Niña, drought conditions emerged midway through the 2012 water year, with low snowpacks melting out early during a very dry and warm spring. Spring and early summer runoff over most of the region was well below average, with flows similar to 2002 and other benchmark drought years. Continued dry and hot conditions in June dried out vegetation and led to very large and intense wildfires in all three states, along with widespread rangeland, pasture, and dryland crop losses.

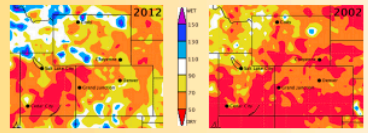
Drought Conditions as of early July



US Drought Monitor for July 10, 2012 (left) and July 9, 2002 (right)
(Source: www.droughtmonitor.unl.edu/monitor.html).

According to the July 10 US Drought Monitor, severe or worse drought conditions cover nearly all of Colorado, most of Utah, and about half of Wyoming. In early July 2002, conditions were generally worse than 2012 across the three-state region, except for north-central Colorado and far northwestern Utah. The severity of the drought classification (D1–D4) is based on hydro-meteorological variables such as precipitation, soil moisture, streamflow and temperature. Note that the Drought Monitor is now based on more detailed spatial input compared to 2002.

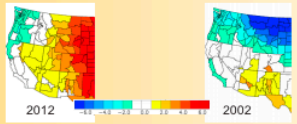
Water Year Precipitation through June



Percent of average (1995-2010) precipitation for the current water year to date, October 2011–June 2012 (left), with October 2001–June 2002 (right) for comparison. (Source: NWS COOP and SNOTEL data; Gary Bates, NOAA ESRL Physical Science Division)

For the water year to date (October 2011 through June 2012), a mixed first five months followed by an extremely dry March-June added up to dry conditions across all of the region, except for pockets in northern and southwest Wyoming, and southern Colorado. The driest areas, with less than 70% of average precipitation, included many of the key mountain headwaters in western and northern Colorado, and in Utah. But as dry as water year 2012 has been, 2002 was drier over the same period in nearly all parts of the region.

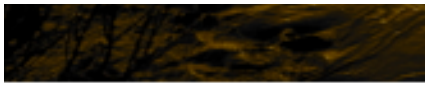
Spring and Early Summer Temperatures



March-May temperatures in 2012 (left) were 2° to 7° F above normal across the 3-state region, much warmer than the same period in 2002 (right). (Source: NOAA ESRL PSD Climate Analysis Branch, plotted from NOAA NCDC divisional data: http://www.esrl.noaa.gov/psd/data/usclimdivs/)

March-May 2012 was the 2nd warmest spring in C… the 3rd wa… 8th warme… warmth ha… the alread… excessive… soils and … the string… temperatu… across the… there were… late June … statewide… (114° F in…

For an expanded version of this overview, including additional graphics and text, see the Special Issue *Intermountain West Climate Summary* at www.colorado.edu/IWCS/2012_July.html



Central Region Drought Outlook
20 September 2012

Dr. Dennis Todey
South Dakota State Climatologist
South Dakota State University
16 August, 2012
dennis.todey@sdstate.edu
605-688-5141

Corn near Beresford, SD–9 Aug. 2012
Author photo

NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

CLIMATE AND TOURISM ON THE COLORADO PLATEAU

BY CHRISTINA ALVORD, PATRICK LONG, ROGER PULWARTY, AND BRADLEY UDALL

Tourism is a major economic driver for the Colorado Plateau states of Utah, Arizona, New Mexico, and Colorado. Yet despite the fundamental influence climate has on tourism services in the West, there is limited understanding of the relationship between climate and business operations and long-term sustainability. To address this relationship, participants from various agencies and interests

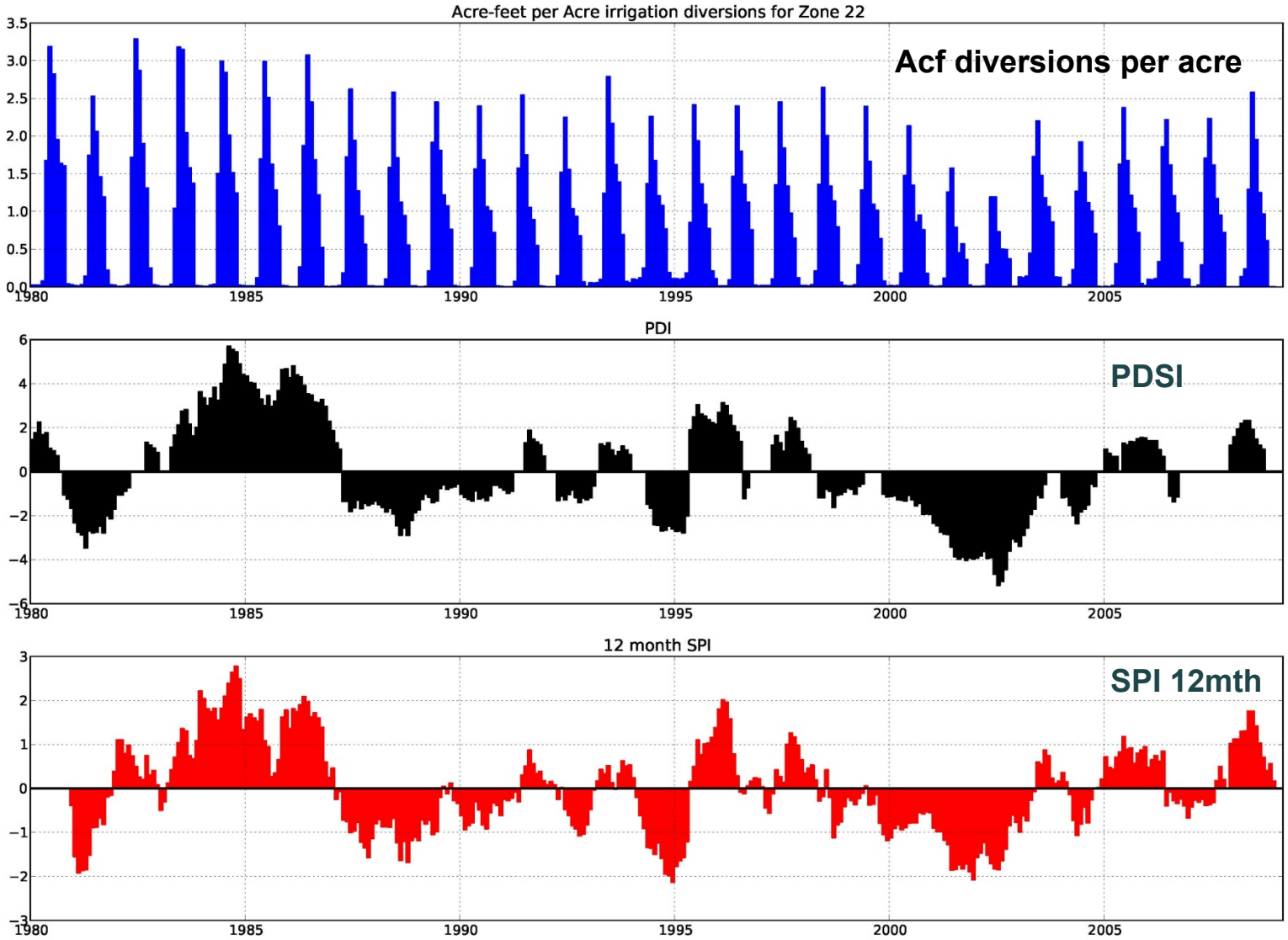
CLIMATE AND TOURISM ON THE COLORADO PLATEAU: A WORKSHOP SUMMARY

WHAT: Thirty representatives from research, industry, and environmental organizations discussed relationships between climate and Colorado Plateau tourism industries

Weekly Climate, Water & Drought Assessment

Relating Drought Indices to management

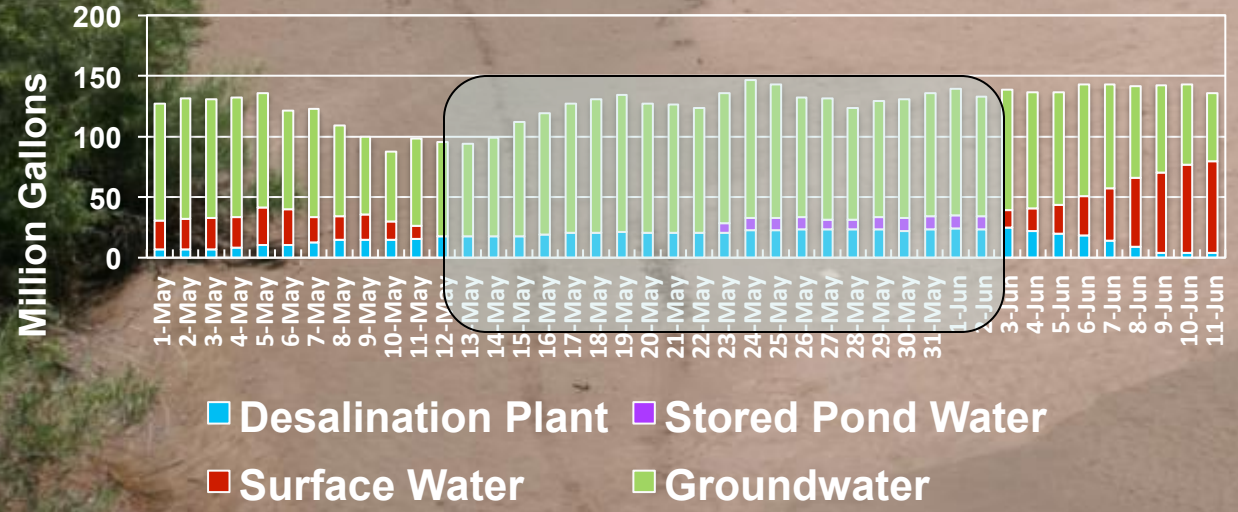
Irrigation diversions



Rio Grande Runs Dry

The fight for water in New Mexico
New York Times, 27 March, 2013

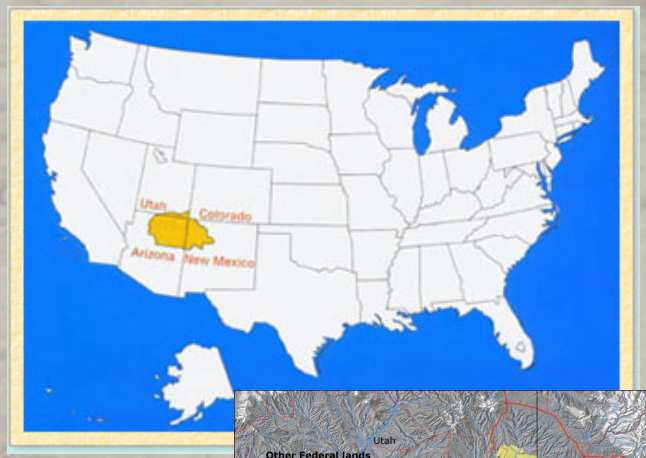
Despite summer storms, N.M. still in drought 31 July, 2013



El Paso Water Utilities Board

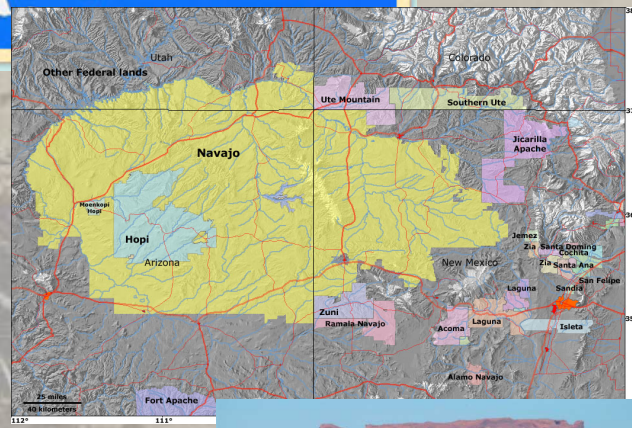
Another Perspective:
Drought and Climate Change on the Diné/Navajo and Hopi Nations and the Four Corners Region

Native Nations in Southwest US are major land managers

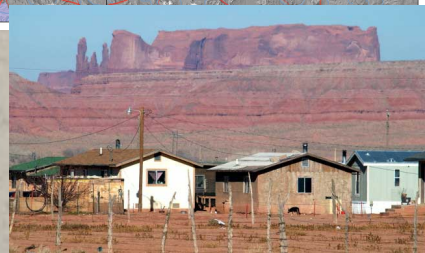


Regional Characteristics

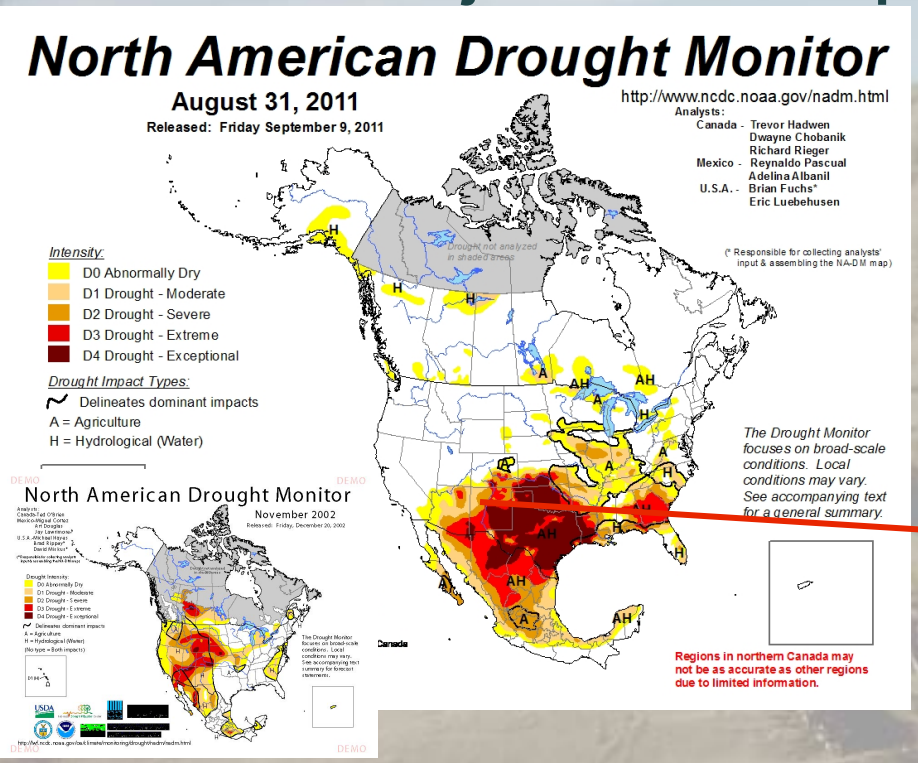
Reservation history and local land tenure

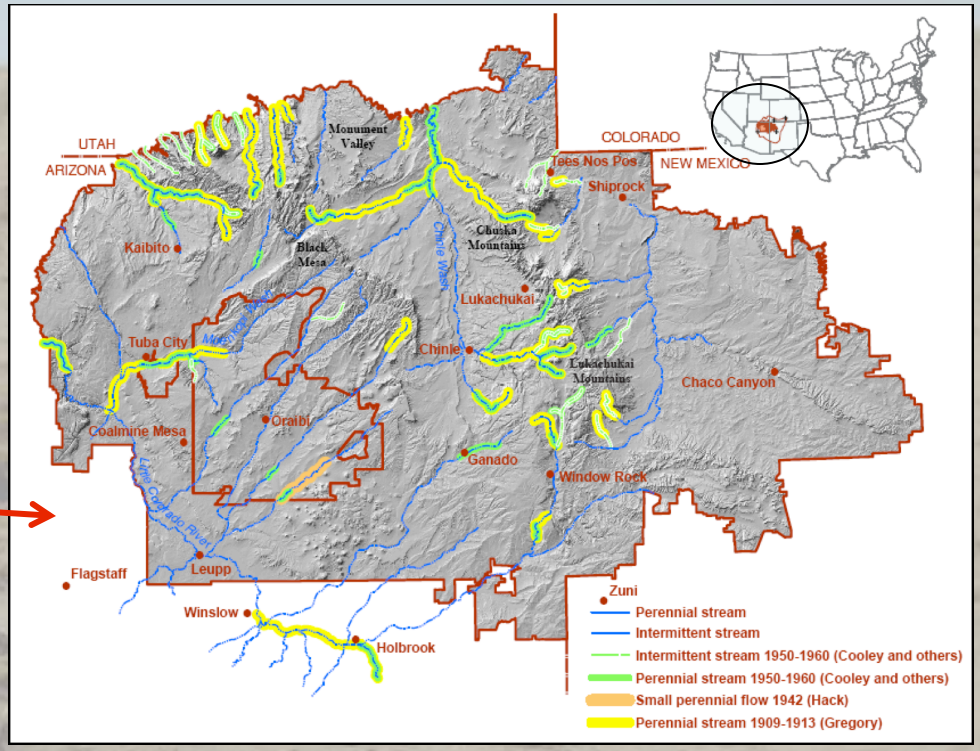


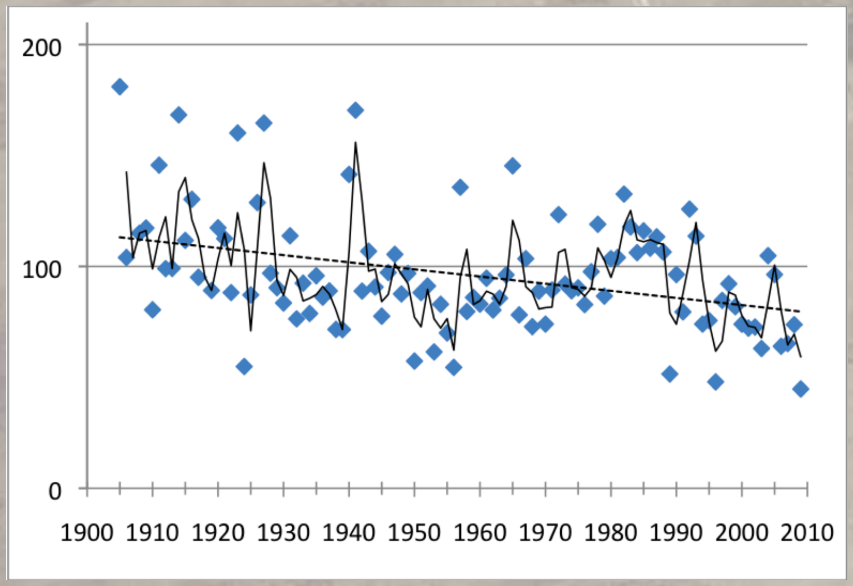
Drought and climate change: Thresholds

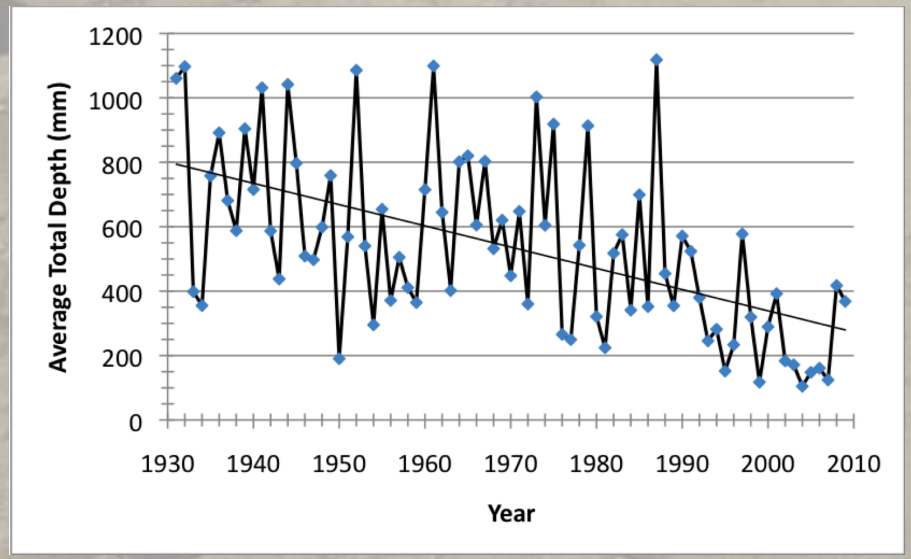


Navajo/Dine and Hopi (rain-fed) Homelands



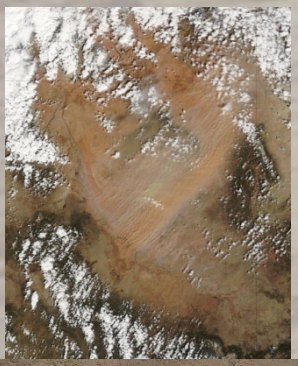




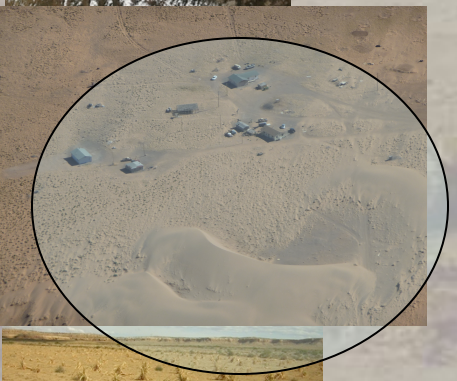


Landscape changes- Tribal Lands in the Four-Corners Region (USGS, NIDIS)

Sand Dune Mobility = W/(P/PE)



Stable Sand Dunes
= P/PE > 0.31 ⟶



Partly Active Dunes ⟶

Fully Active Dunes
= P/PE< 0.125 ⟶

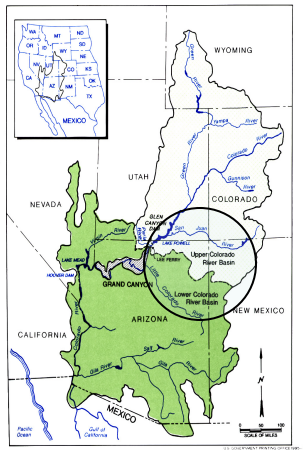
Changing Streamflow

Photographs of the stream flow in Wheatfields Creek upstream of Wheatfields Lake in April 2005 (left) and April 2006 (right).

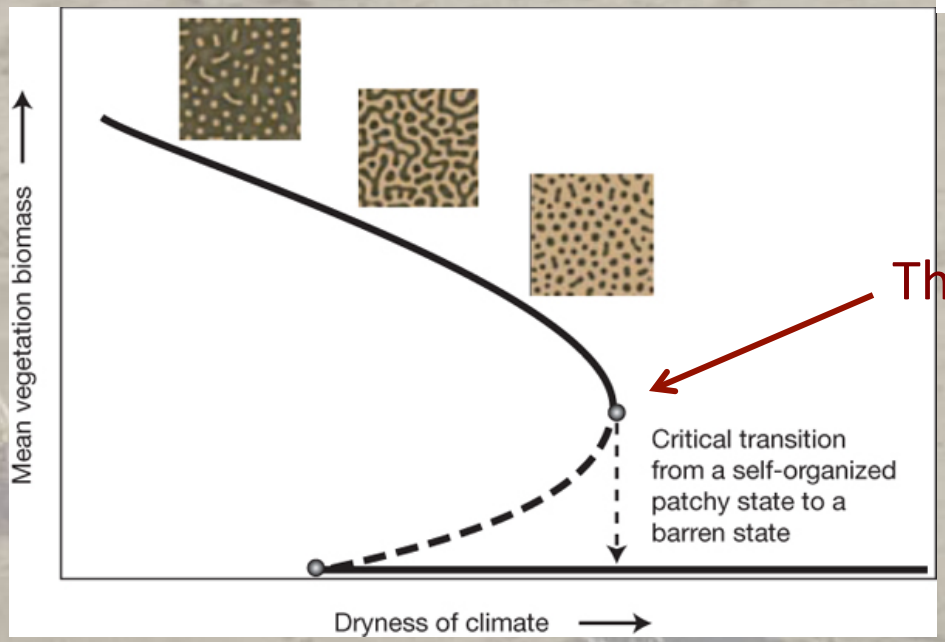
In this region, changes in average annual temperature
1° C increase =>50mm precipitation lost to evapotranspiration (ET)

Slide courtesy of Jolene Tallsalt Robertson, Navajo Nation Dept of Water Resources

Landscape changes-
Early-warning signals for critical transitions



Mean vegetation biomass



Dryness of climate

(Nature, 2009, Redsteer, 2011-UNISDR, NIDIS 2012)

LOCAL NEWS

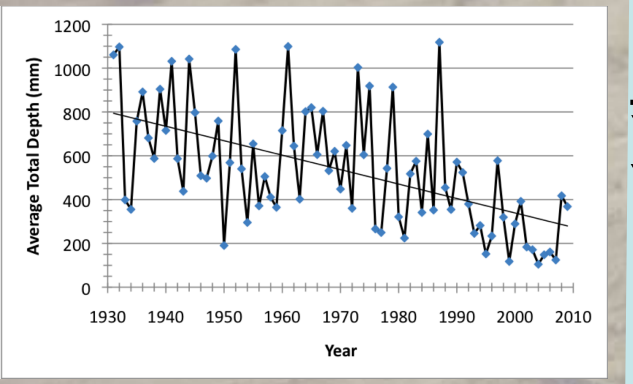
Comments 2 | Recommend 0

Multiple crashes due to wind and dust along I-40

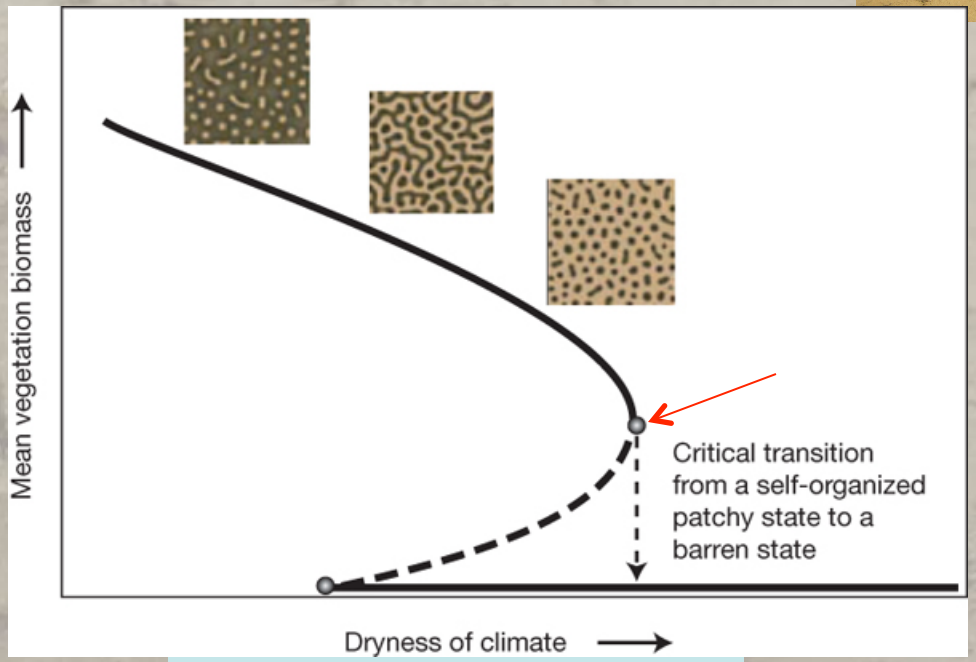
More Phoenix Local News

09:21 PM Mountain Standard Time on Thursday, March 26, 2009

Landscape changes- Early warning signals for critical transitions

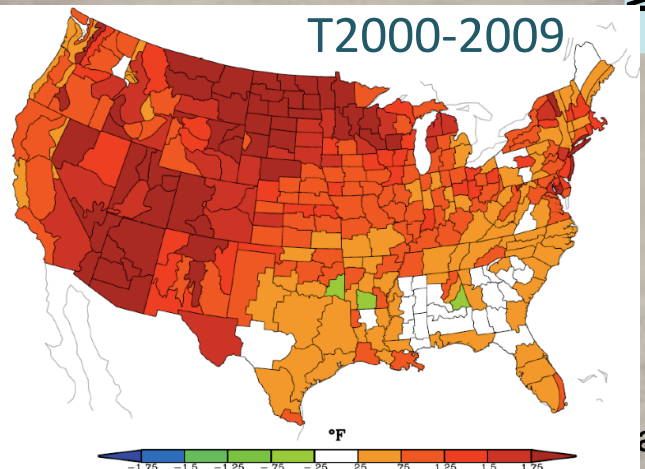


Mean vegetation biomass



Dryness of climate

(Nature, 2009)



a Redsteer, USGS, NIDIS)

Scenarios: Diné/Navajo Lands

Through conversations before and during workshops, the team identified the most important and most uncertain climate drivers that will affect conditions over the next 40 years. These were combined in the following matrix. (Also note that temperature increase was a 'given' so it applies in all scenarios

Shrubland

Ecosystem becomes more susceptible to annual grass invaders. Fate of pines and other trees uncertain. Soil erosion increases. Faunal composition changes.

Flash floods entering caves more often

Native grassland replaced by shrubland and exotic annuals

Ponderosa pine communities more susceptible to catastrophic fires due to decreasing summer precipitation

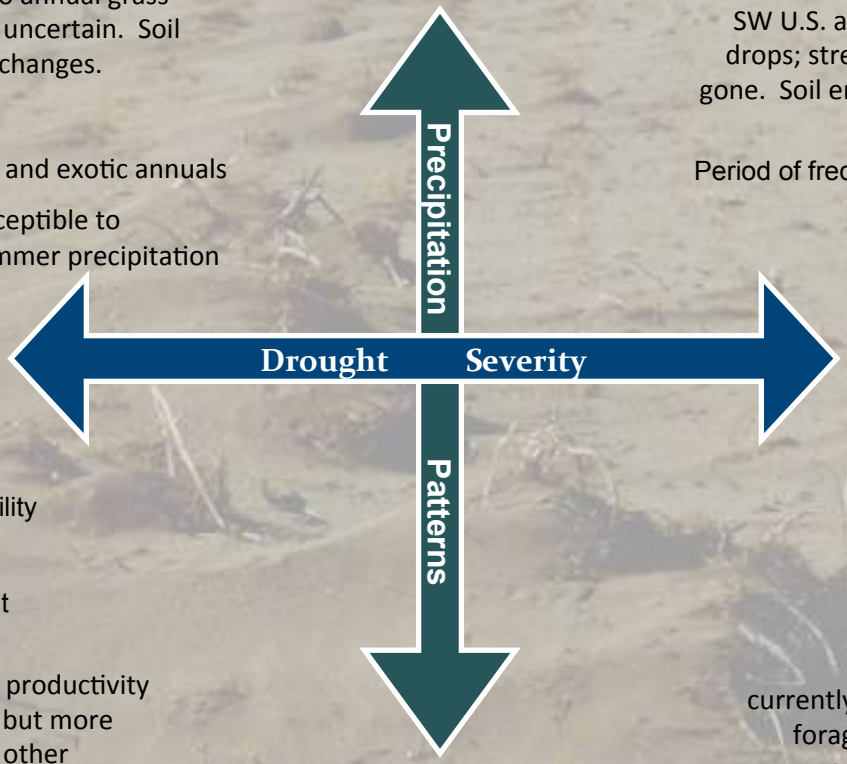
Patterns shift – more winter precipitation relative to summer

Novel Ecosystem

Climate changes quickly to something like southern SW U.S. and species migration limited. Water table drops; streams go from perennial to intermittent or gone. Soil erosion increases. Many fauna may not be sustainable.

Period of frequent, intense fire followed by decrease in fire because of lack of fuel

Tough decisions regarding above-ground mission



Duration and Frequency change little

Extreme Droughts become far more common

Changes seen as part of normal variability

Other management issues dominate

Streams more intermittent, trees dry out

Increased evaporation decreases plant productivity somewhat; ecosystem change occurs, but more slowly and/or to lesser degree than in other scenarios.

Extreme heat events – camp fire bans

Decreased water availability

Grazing herd – limits on carrying capacity

Forest is more restricted by moisture than currently. Megafauna capacity decreases because forage production is lower. Water table drops; spring and stream flow decreases or ceases, depending on location.

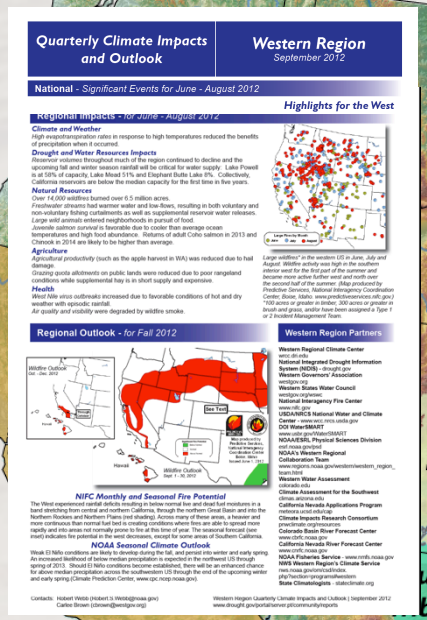
Patterns change little

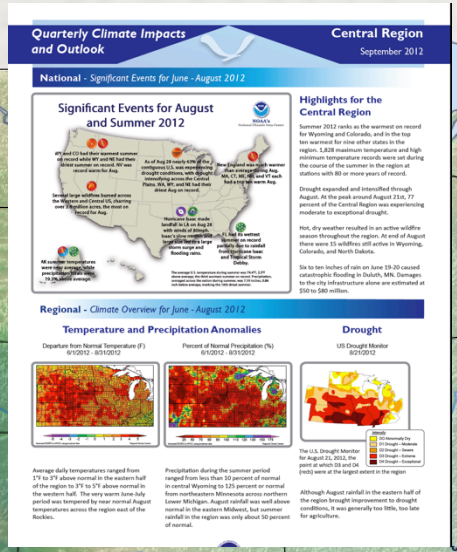
Mixed-grass Prairie

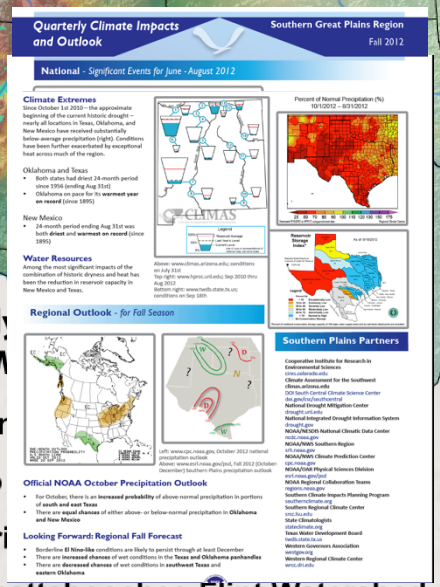
Shortgrass Prairie

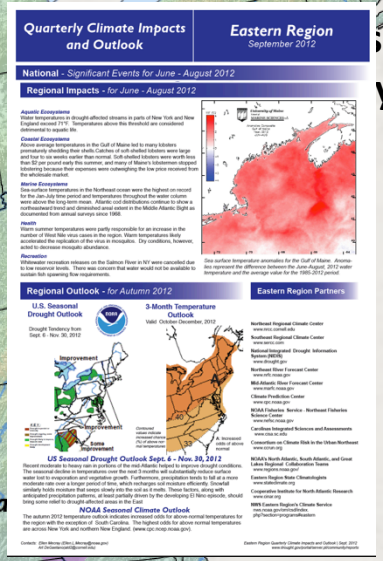
www.drought.gov

Drought Portal Regional Pages









Upper Colorado River Basin

Montana

Apalachicola River Basin

Regional Drought Early Warning Systems (DEW

California (Basin

Upper Colorado

Four Corners Tri

Apalachicola-Chattahoochee-Flint Watershed

NIDIS

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Elevation

High

Low

Rivers

0 75 150 300 450 600 Miles

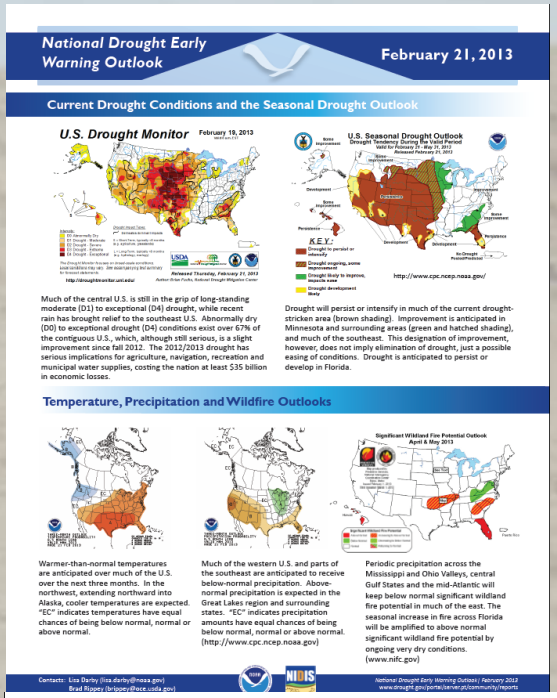
35

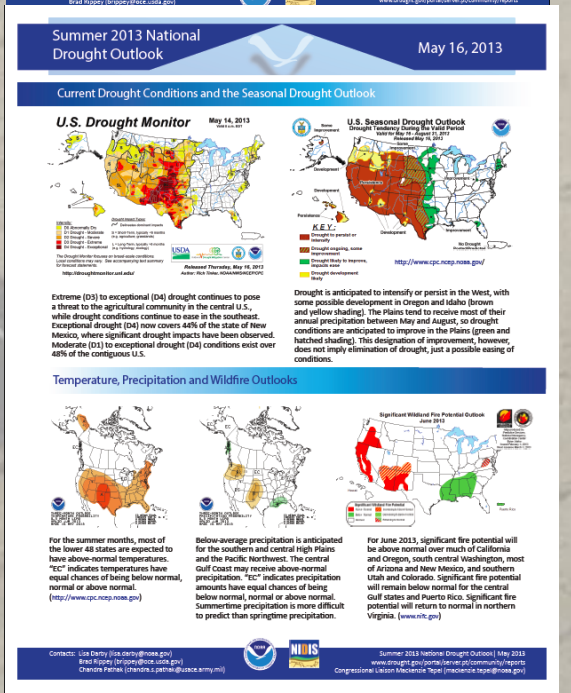
Map courtesy of the USGS/Michael Budde

National Governors Association Meeting
24-27 February, 2013

MOU Between DOC and USDA

MEMORANDUM OF UNDERSTANDING
BETWEEN THE
U.S. Department of Commerce
AND THE
U.S. Department of Agriculture





United States Senate Committee on
AGRICULTURE
NUTRITION
& FORESTRY

Opening Statement of Chairwoman Debbie Stabenow (D-Mich)

Drought, Fire and Freeze: The Economics of Disasters for America's Agricultural Producers

February 14, 2013

Apr 25 2013

Full Committee Hearing SD-366 Senate Dirksen Building

Explore drought and the effects on energy and water management decisions.

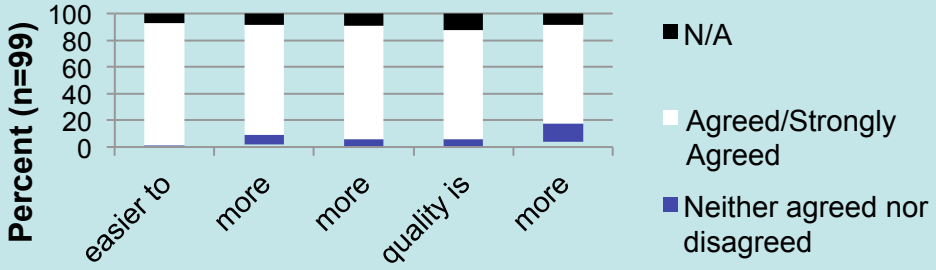
NIDIS EVALUATION SURVEY

9/17/2012 Executive Summary

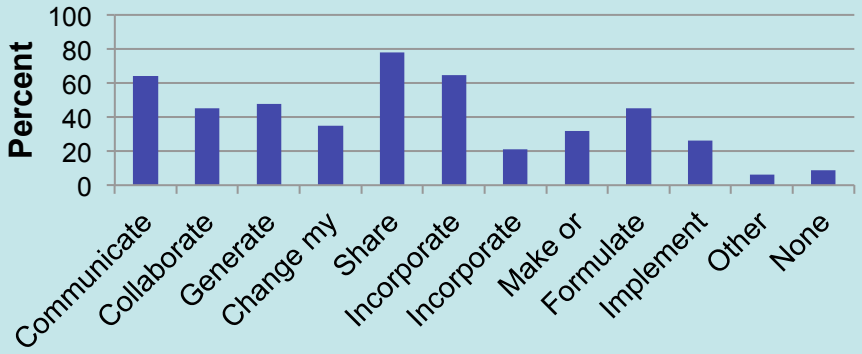
culate outside of NIDIS
gation Center. Comments,
Tonya Haigh, NDMC,

Drought-Ready Communities
A Guide to Community Drought Preparedness

Compare your readiness for drought before 2002 with now, information is...



Actions Taken as a Result of NIDIS



Risk information governance

NIDIS Governance model; Executive Council

NATIONAL

NIDIS Program Office → NIDIS Implementation Team:

NIDIS Technical Working Groups

REGIONAL

Public Awareness And Education

Engaging Preparedness Communities

Integrated Monitoring and Forecasting

Interdisciplinary Research and Applications

U.S. Drought Portal

WATERSHED/URBAN/LOCAL

Regional Drought Early Warning Information Systems

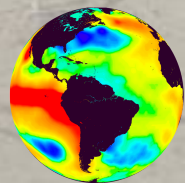
Information clearinghouse,prototypes, and Implementation

The NIDIS touch

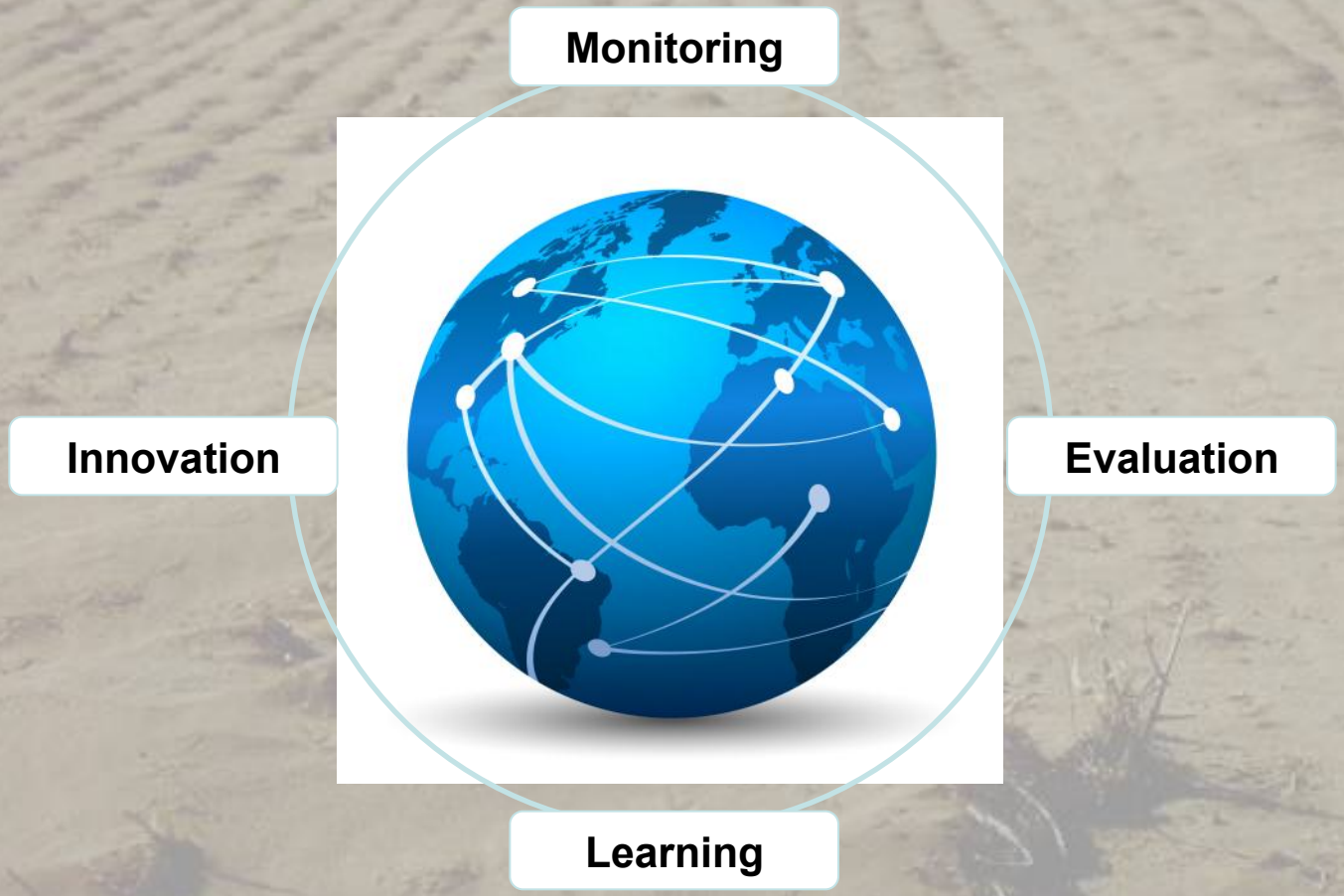
- **Developing an Information Pedigree-Relevant, authoritative, accessible, compatible/usable**
  - No substitute for monitoring and understanding local climates
  - Place multiple indicators within **a consistent triggering framework- (e.g. climate and vegetation mapping)** before critical thresholds

- **Overcoming impediments to information flow**
  - Existing barriers to cross-agency collaboration made explicit
  - Innovations and new information to be introduced and tested, and
  - The benefits of participation in design, implementation and maintenance to be clarified

Mature prototypes become the regional early warning system and are more likely to be viewed as transferable



Learning to manage risks in a changing climate

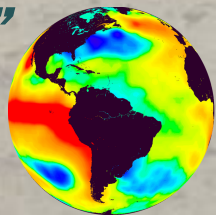


Are we doing and not learning?
When and where do opportunities for learning occur?

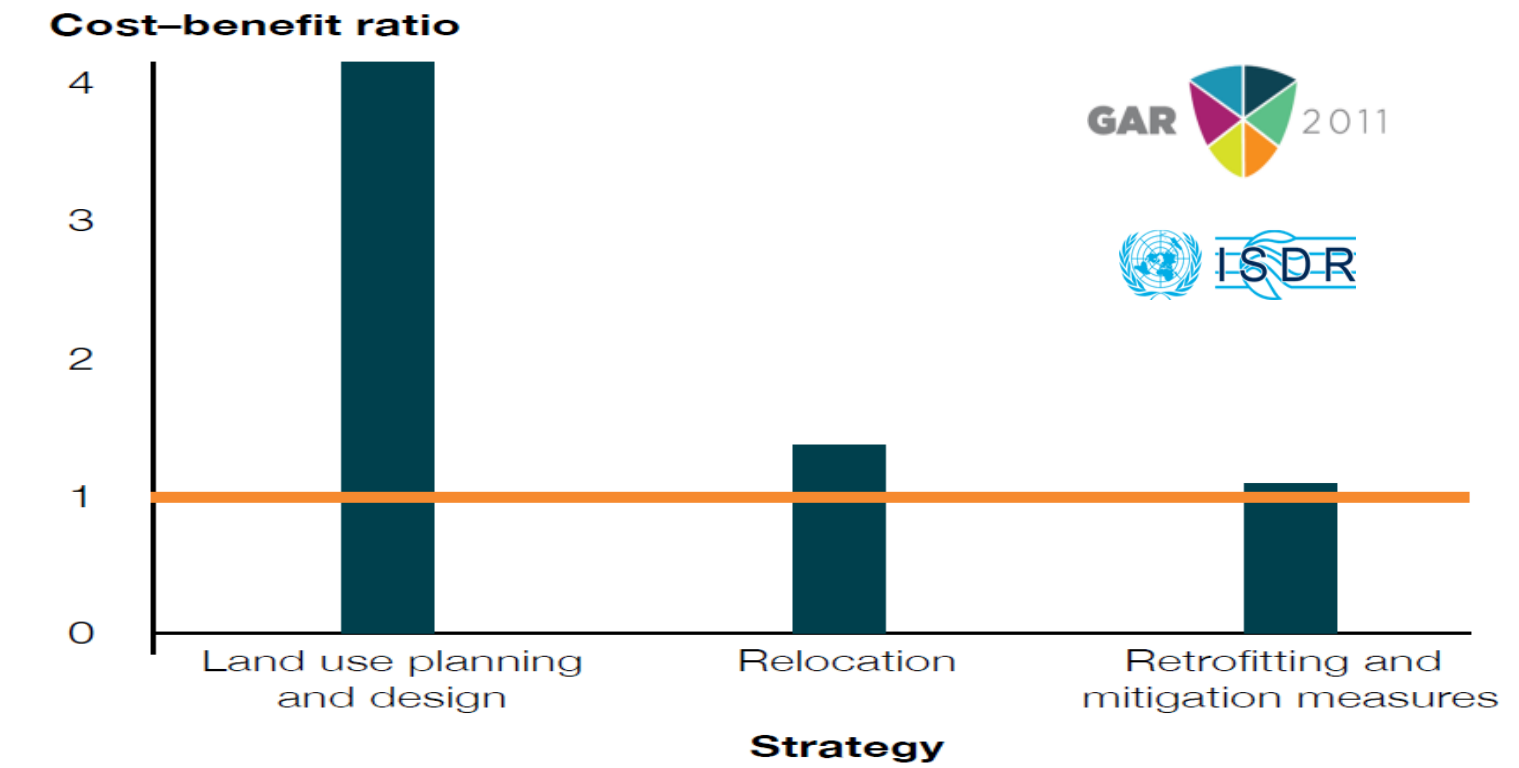

PRIVATE PROPERTY
NO TRESPASSING
NO HUNTING
NO BIOLOGISTS OR
BIOLOGICAL INVESTIGATIONS
BY ANYONE.
WALT ANDERSON
BOX 297 – RED ROCK, NM – 88055

What has led to "action" or "reforms" in Western water? Crisis, learning and redesign

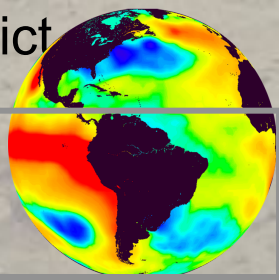
1. **Focusing events-extremes, legal decisions etc.**
2. **Leadership at each level (policy entrepreneurs) and the public are engaged:**
3. **Support for a collaborative framework between research and management-scenarios/gaming, embedding information into practice, evaluation,** should not imply advocacy
4. **Existing social basis or even pressure for collaboration** ***Tradeoffs between decision "quality" and "acceptability"***

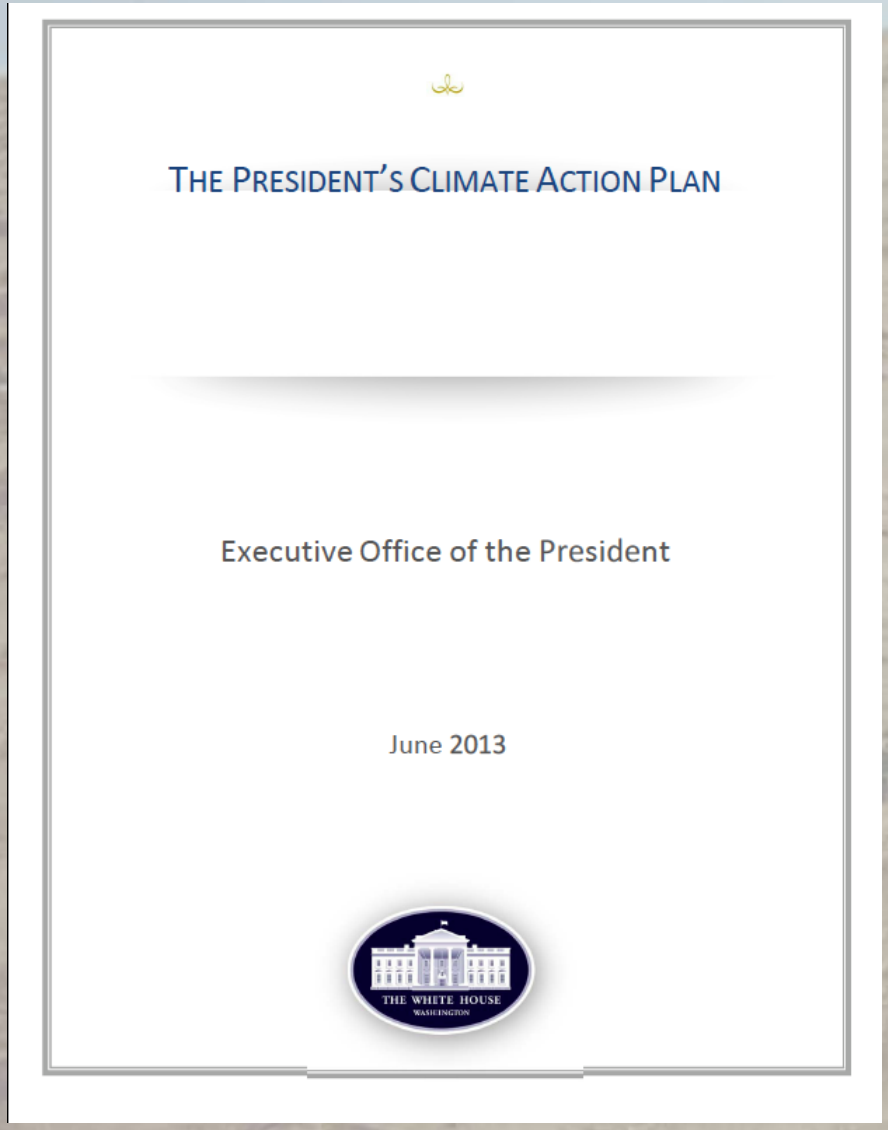


Best adaptation practices may be novel configurations of land and water resources and information to support those decisions



SMART Growth Conservation costs savings- 22 water city and district water plans in Colorado-water obtained by conservation is still the cheapest option per AF for development (Kenney et al 2010)





Mitigation-Cut Carbon "Pollution" in America

Prepare the United States for the Impacts of Climate Change

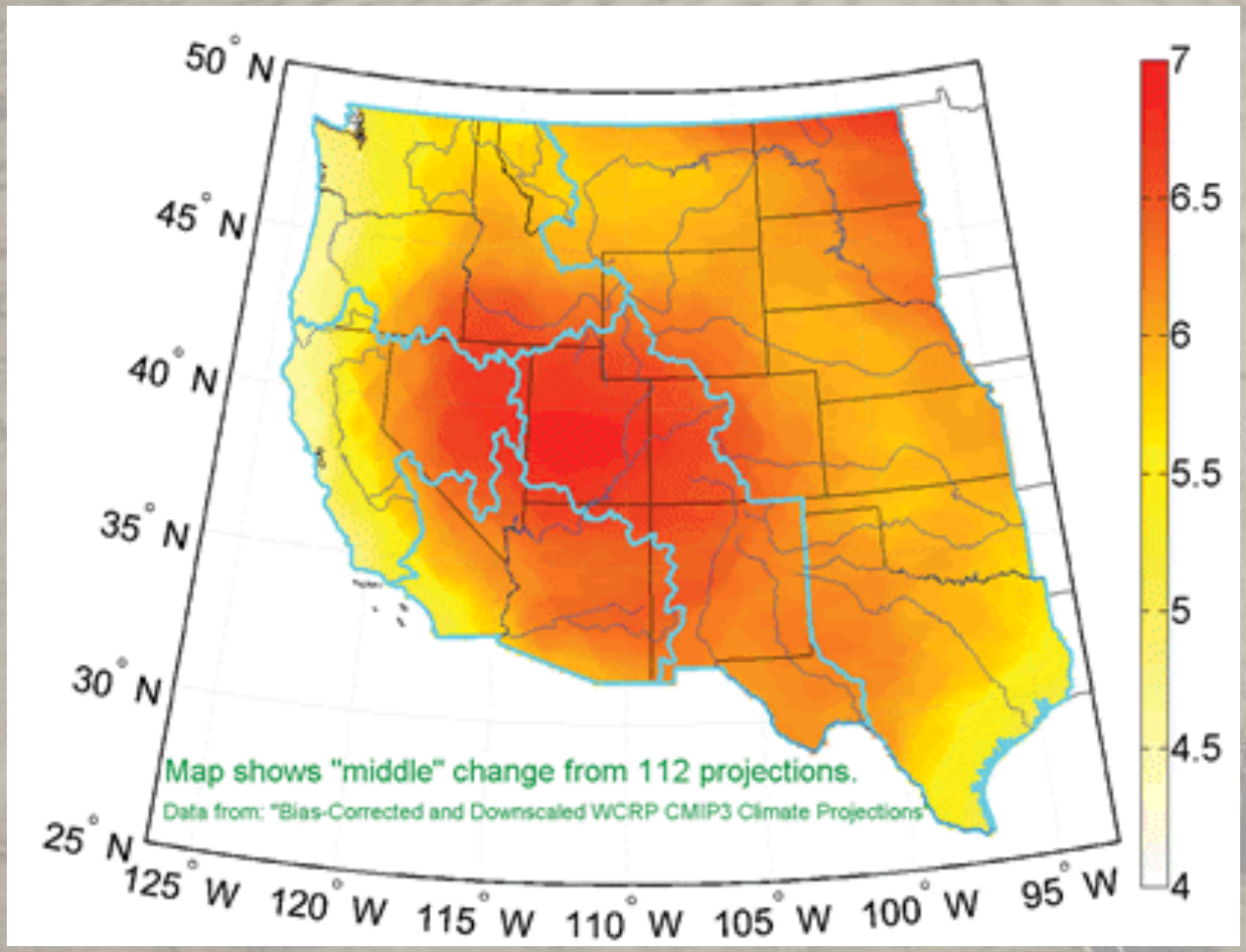
Lead International Efforts to Combat Global Climate Change and Prepare for its Impacts

Thank You!

Are we better off?

- The number of states and other institutions with improved capacity to inform risk management and reduce exposure to drought and flood risks
- The number of staff in or working with those institutions trained to develop and communicate local drought information and help reduce impacts
- The number of research projects that conduct and update drought impacts and user needs assessments in drought-sensitive parts of the US and
- The percentage of the U.S. population covered by adequate drought risk and early warning information systems

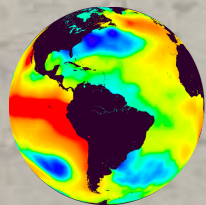
Future Western US/UCRB Temperature: High confidence in continued and substantial warming through 21st century



UCRB warms up
~4-5°F by ~2050
~6-7°F by ~2080

More warming in summer, less warming in winter

Projected increase in annual temperatures by **2070-2090** over 1950-1979 baseline, *median* of 16 downscaled GCMs x 3 emissions scenarios



Climate Goals Societal Challenges

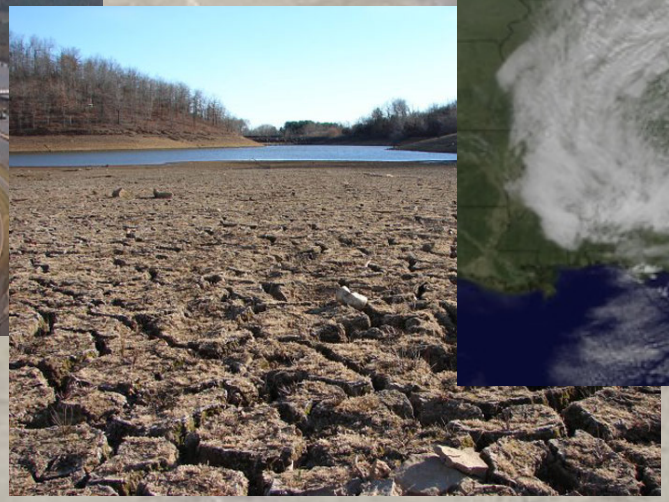
Opportunities for collaboration

Monitoring, Prediction and Risk assessment

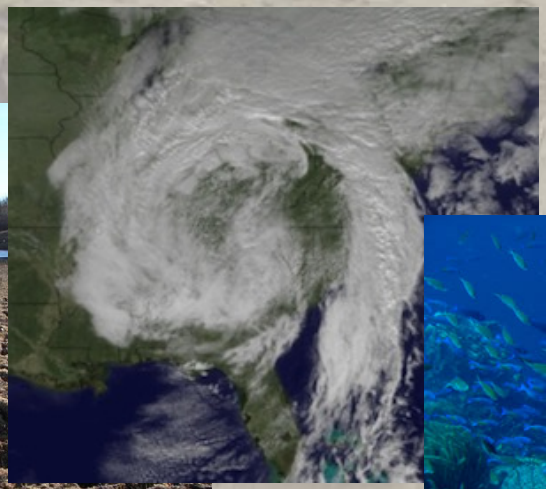
Decision support for risk management and adaptation

Cross-cuts- Health, Water-Energy nexus, others…

Coasts and Climate



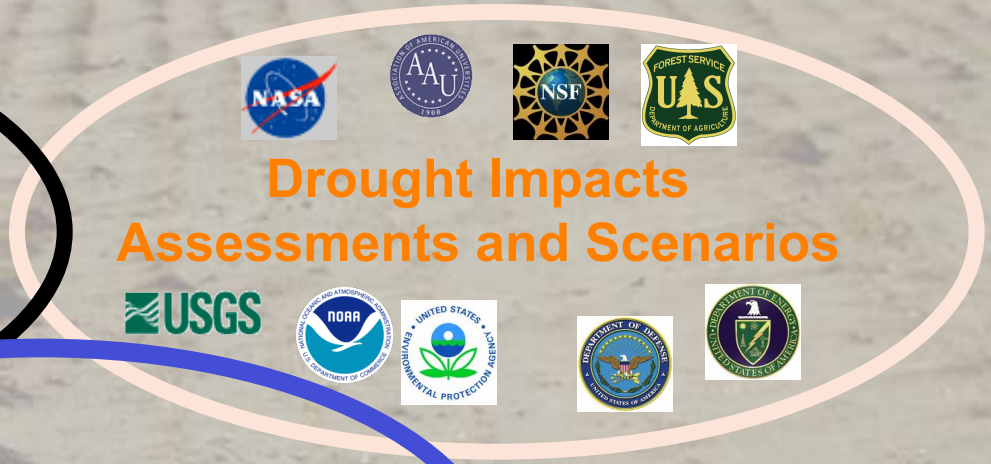
Drought and Water Resources

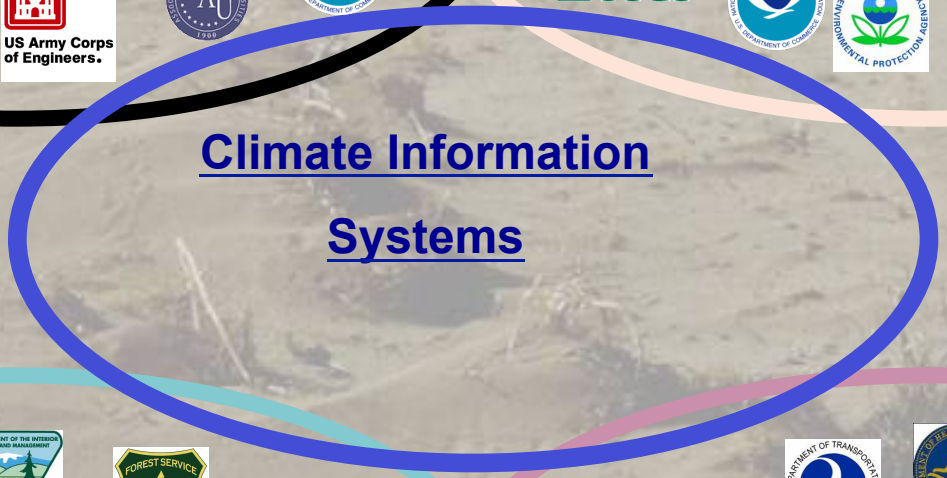


Weather-Climate Extremes

Marine ecosystems

NIDIS Drought Information Partners:
(Federal, States, Tribes, Private)





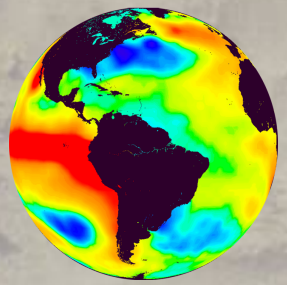
Translation……Transitions……Transformation?

Or adjustment without adaptation?

IMPACTS → VULNERABILITY → DEVELOPMENT → RESILIENCE

Transitions from applications to adaptation: Social-structural and spatial-temporal, resource management

Limits of co-production



Social-ecological

Path dependence

Organizational boundaries

<u>Joint monitoring and joint fact-finding</u>

Warmest Year on Record for the Continental U.S.

NOAA

- **3.25F** above 20th Century average