July 2-6, 2012 / Cape Town, South Africa

Drought, Thresholds and Early Warnings

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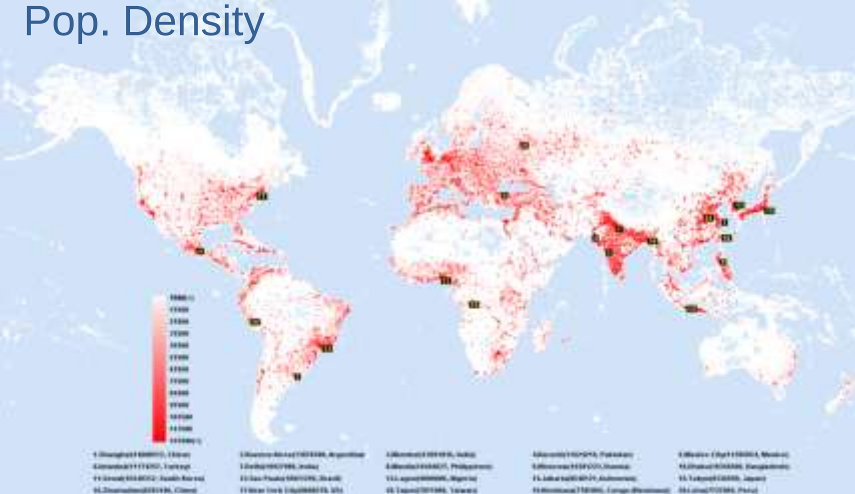
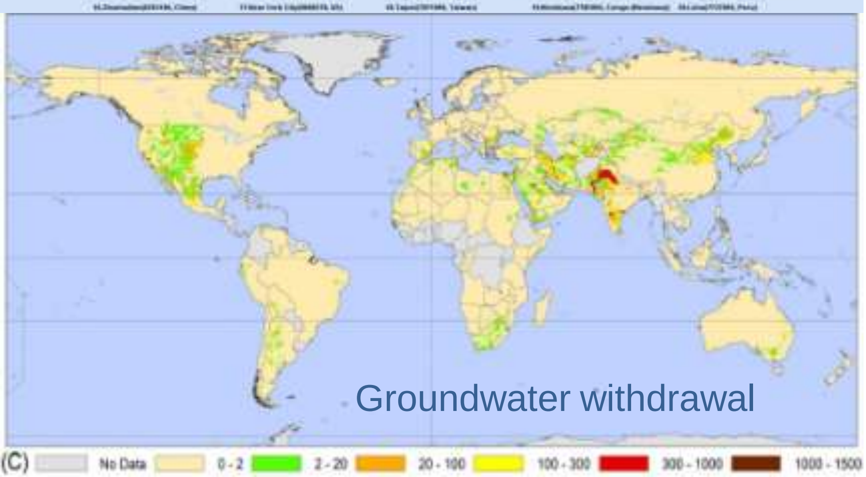
NIDIS

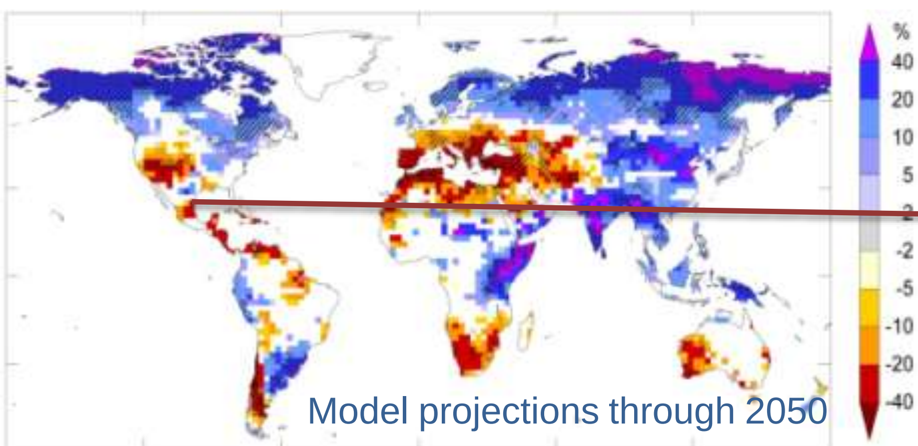
Cooperative Governance Traditional Affairs

GFDRR

ISDR

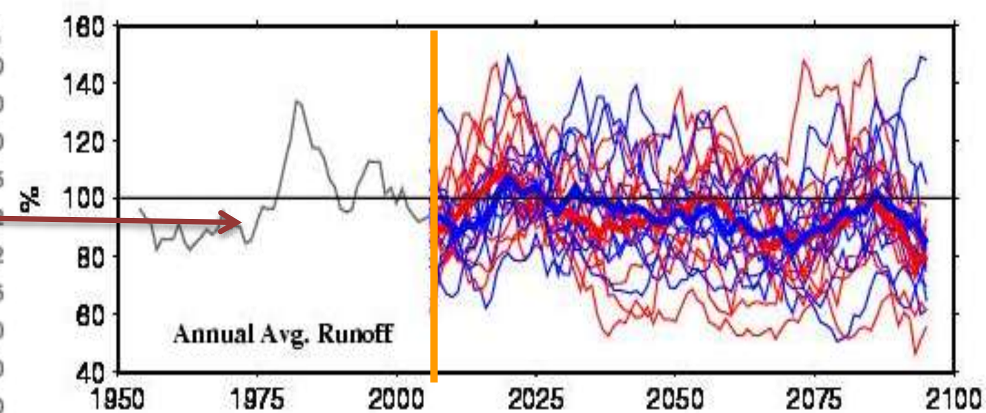




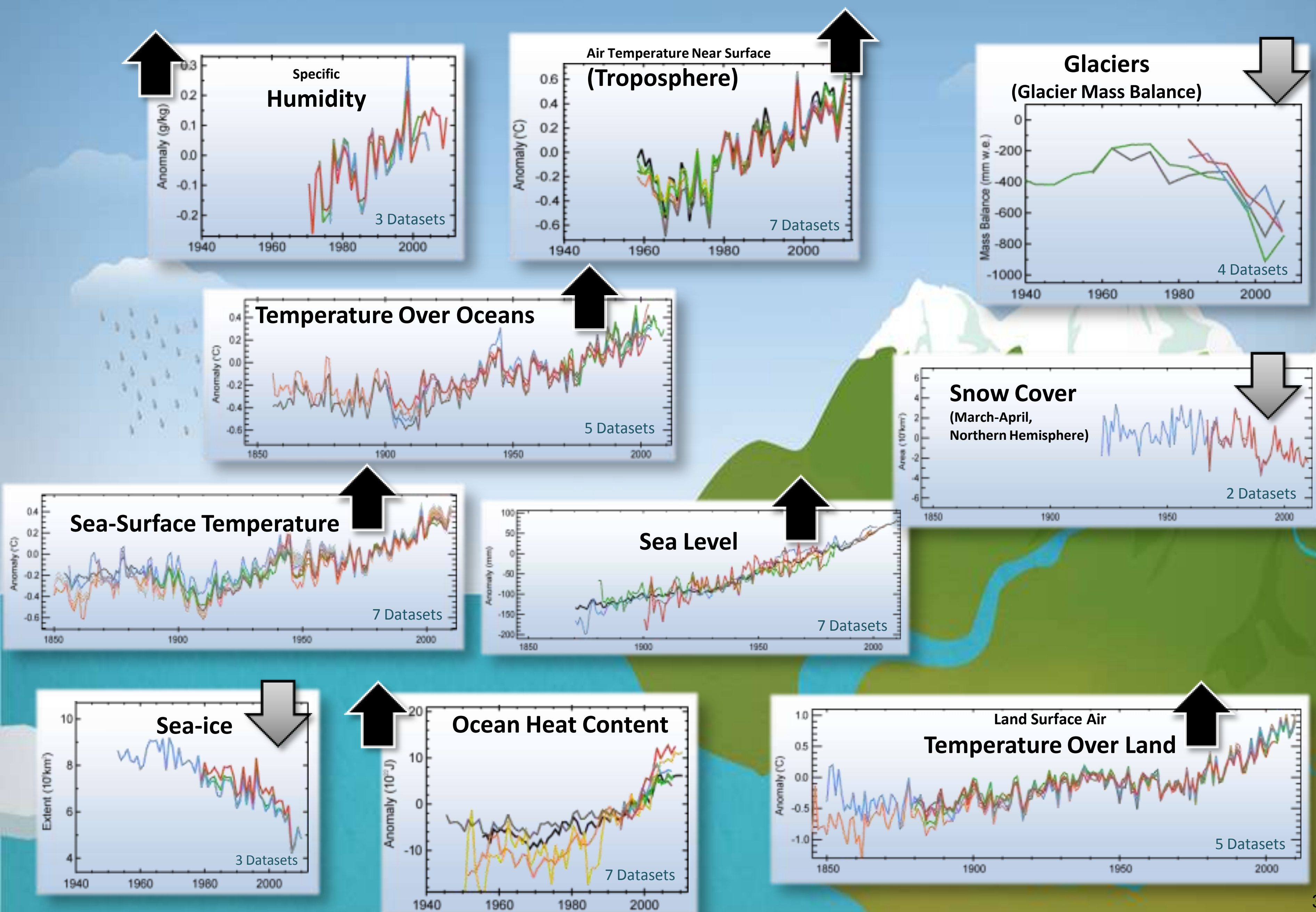


Are the assumptions about planning borne out by what we know from the climate record and for projected conditions?

Many potential futures



Observed Global Changes-What is in the data



Climatic drivers of drought- a continuum

Heat Waves

Floods

Storm Track Variations

Madden-Julian Oscillation

El Niño-Southern Oscillation++++++

Decadal Variability

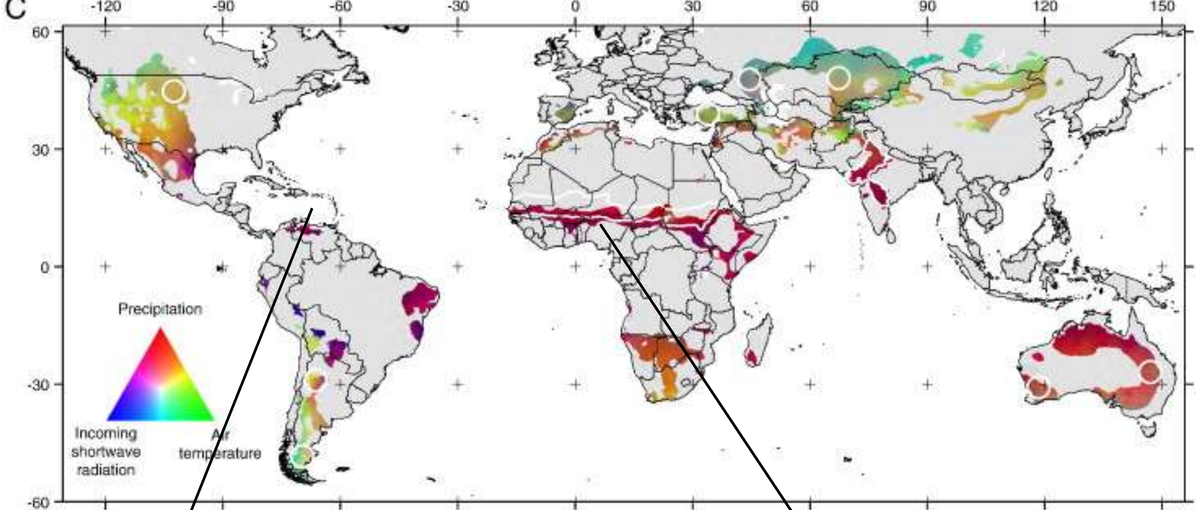
Solar Variability

Deep Ocean Circulation

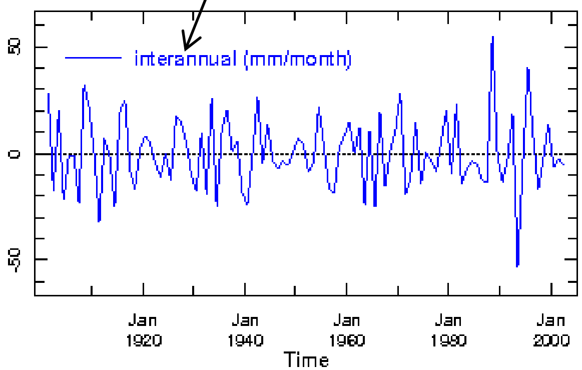
Greenhouse Gases

Droughts span an enormous range of time scales

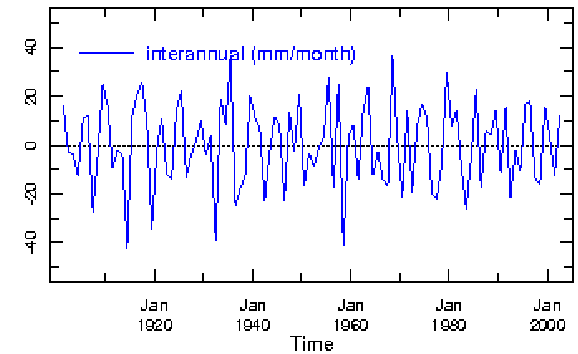
Droughts are caused by a number of complex variables- land surface feedbacks



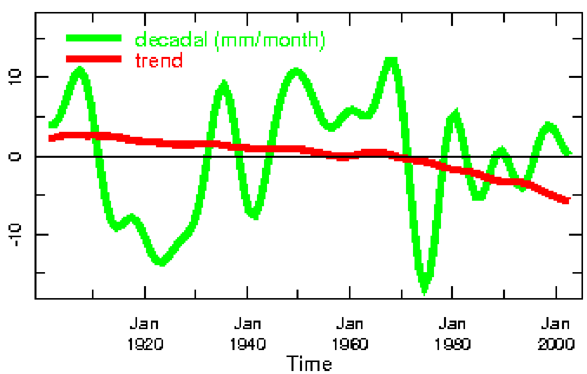
77%



Interannual (precipitation)

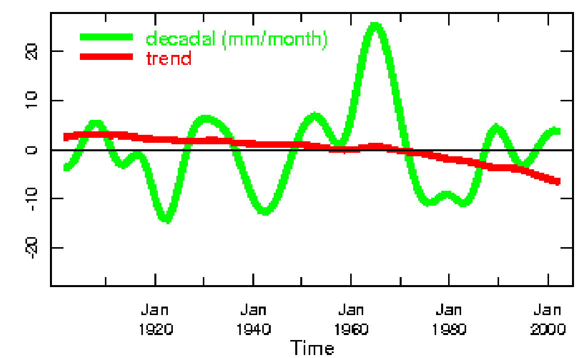


23%



Decadal

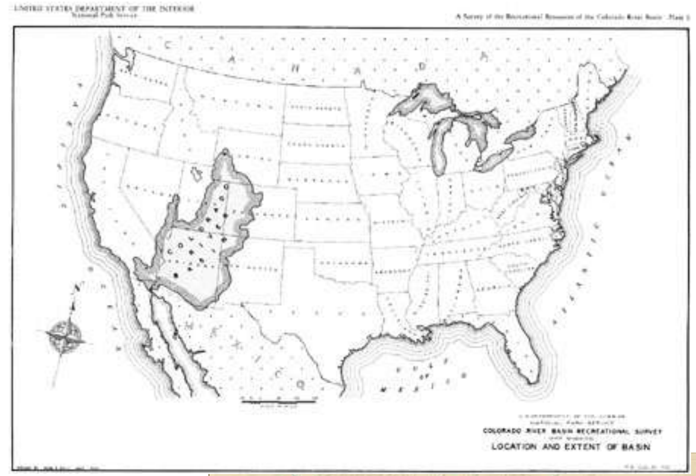
Trend (20th Century)

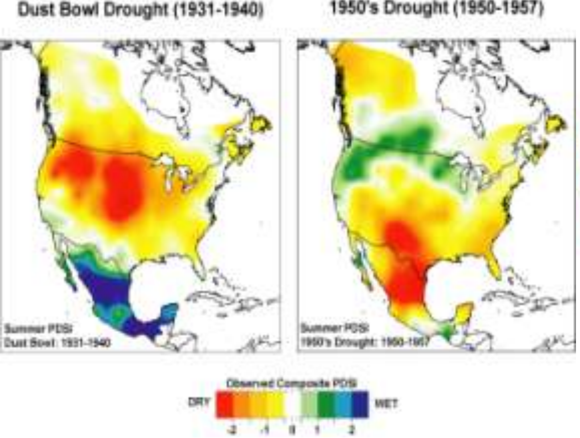


The Colorado River Basin:
Two perspectives on the same drought(s)

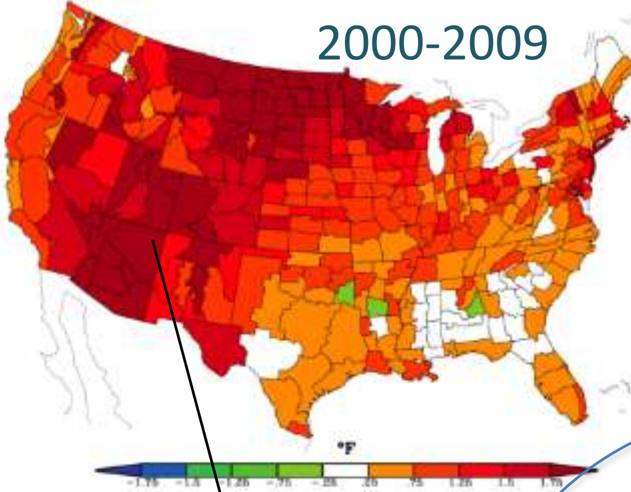
- Operation governed by the “Law of the River” including:
  - Colorado River Compact (1922)
  - Boulder Canyon Project Act (1928)
  - U.S.-Mexico Water Treaty (1944)
  - Colorado River Storage Project (1956)
  - Colorado River Basin Project Act (1968)

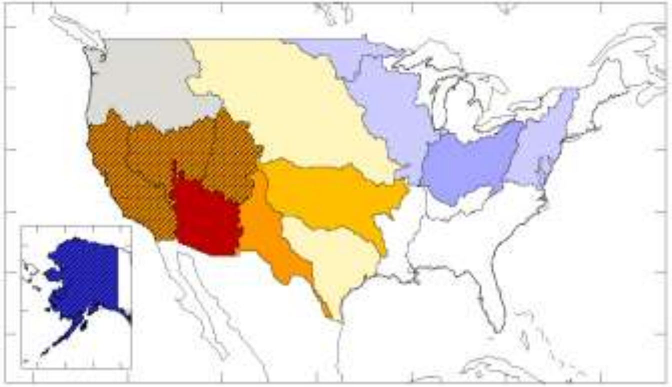
- ”Closed” water system
- Very variable hydrology
- Large amount of storage capacity

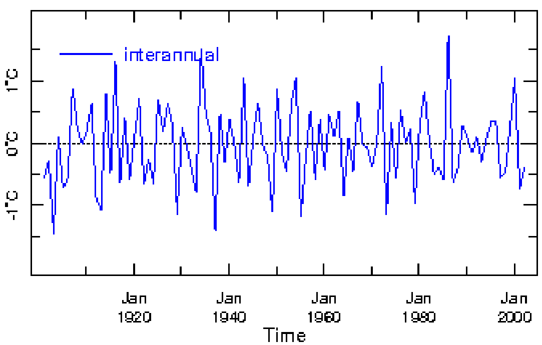




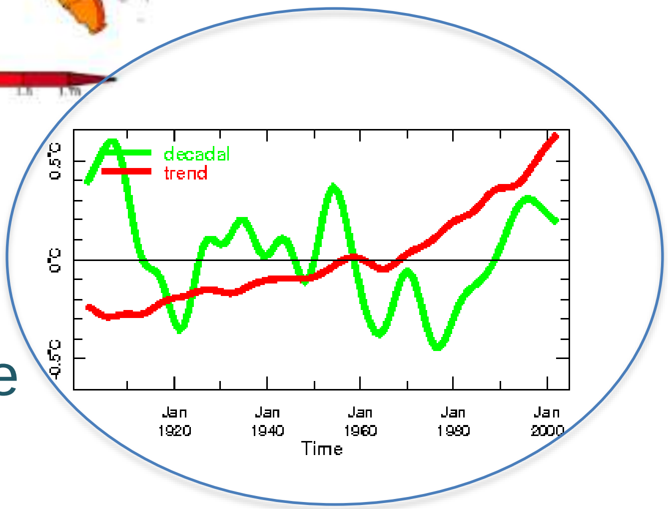
2000-2009

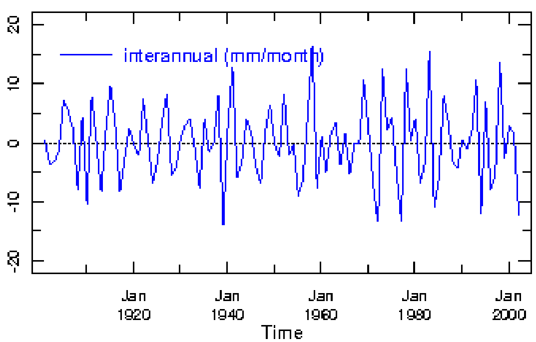




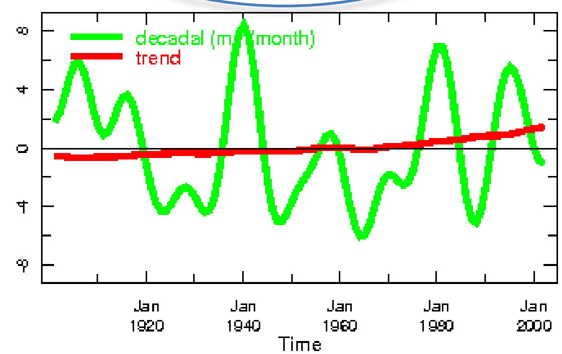


Temperature



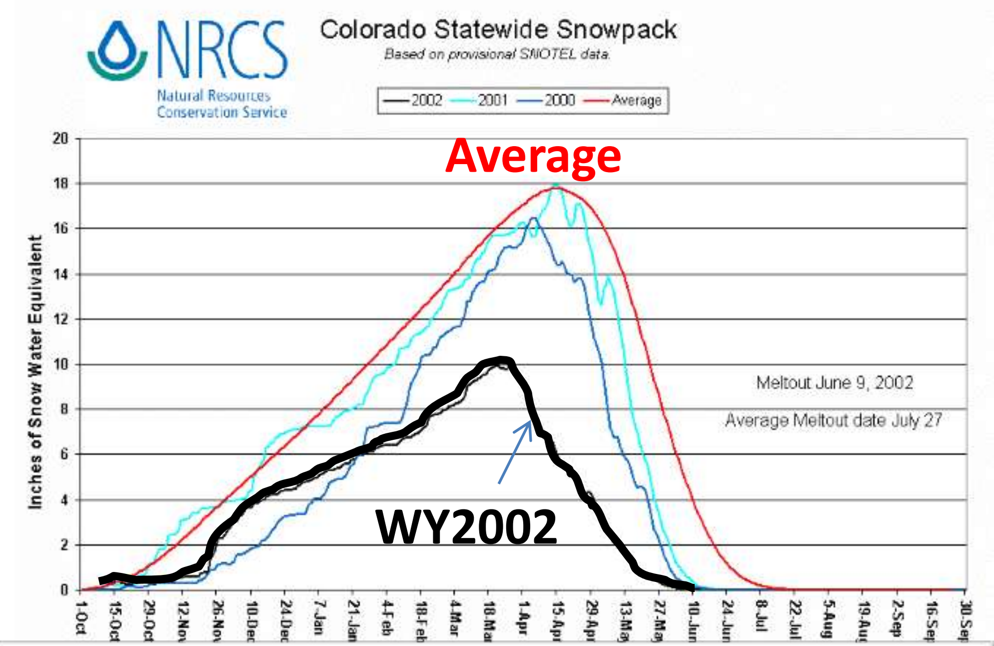


Precipitation

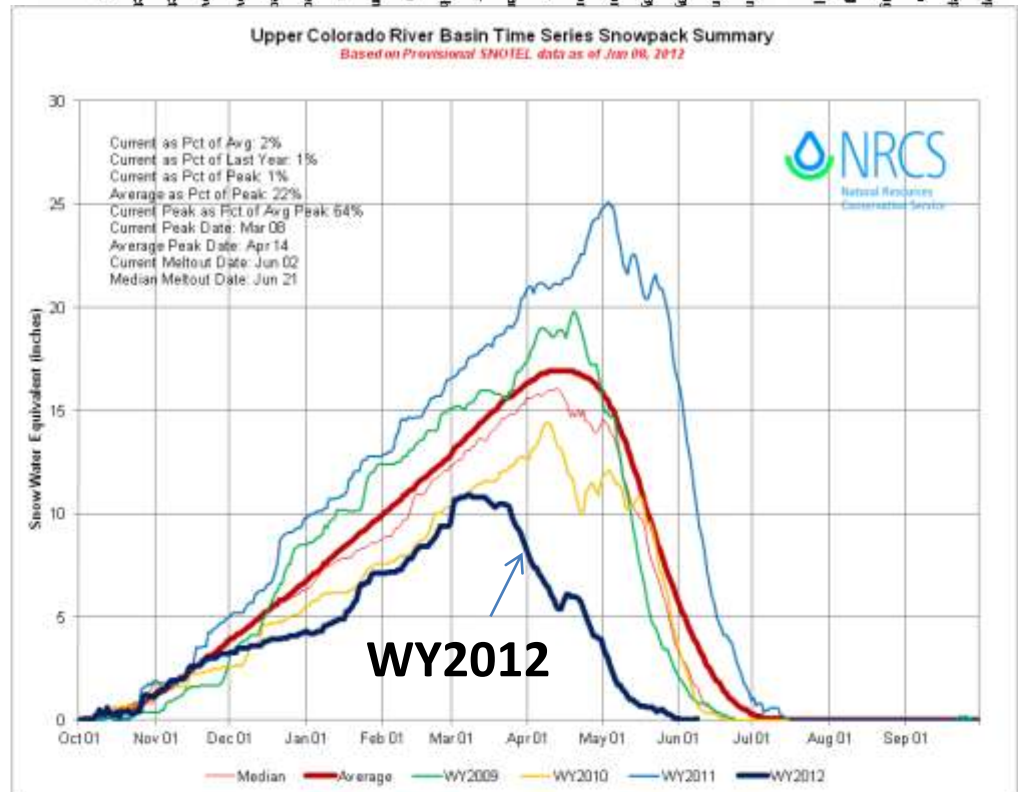


Colorado Drought:

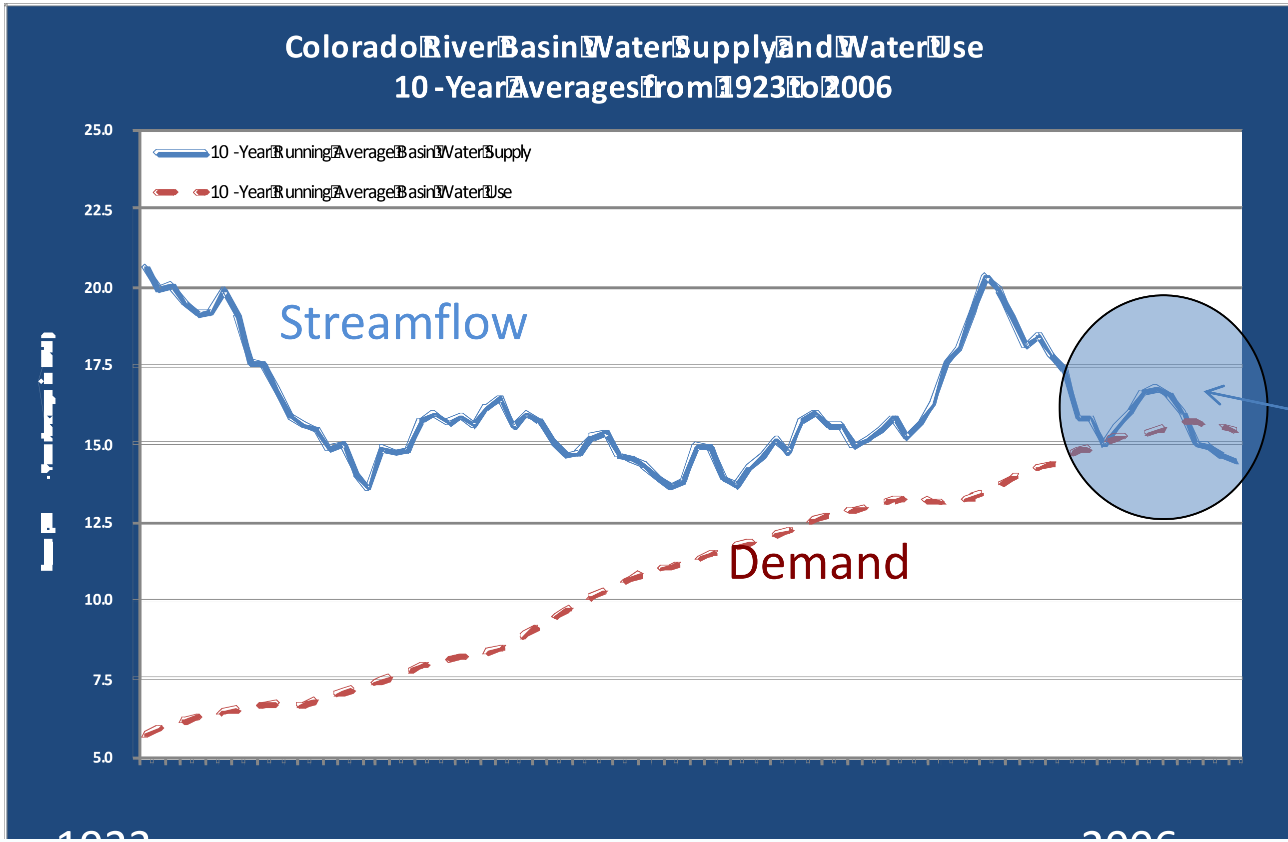
- Maximum snowpack on 2002 at 56% of average. Complete meltout 48 days earlier than average

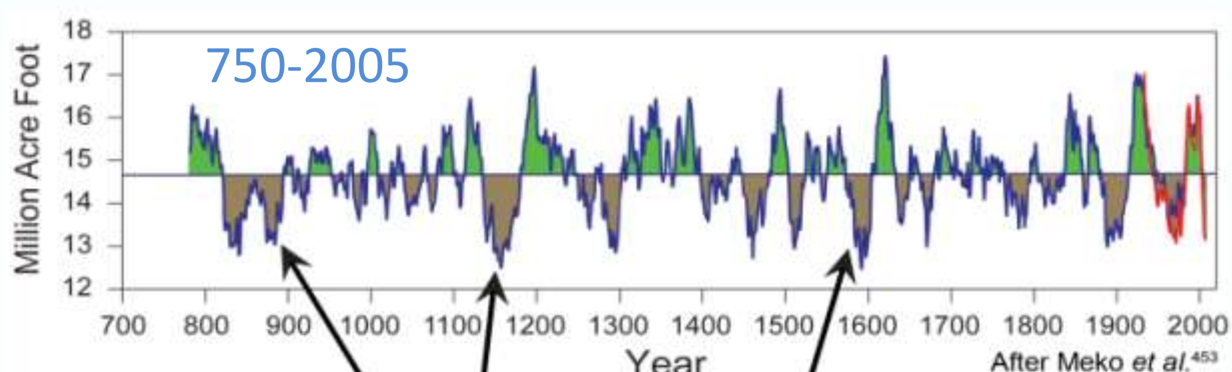


- Precipitation deficits have persisted throughout most of the decade (some good years such as 2011)



Colorado River Water Supply & Use





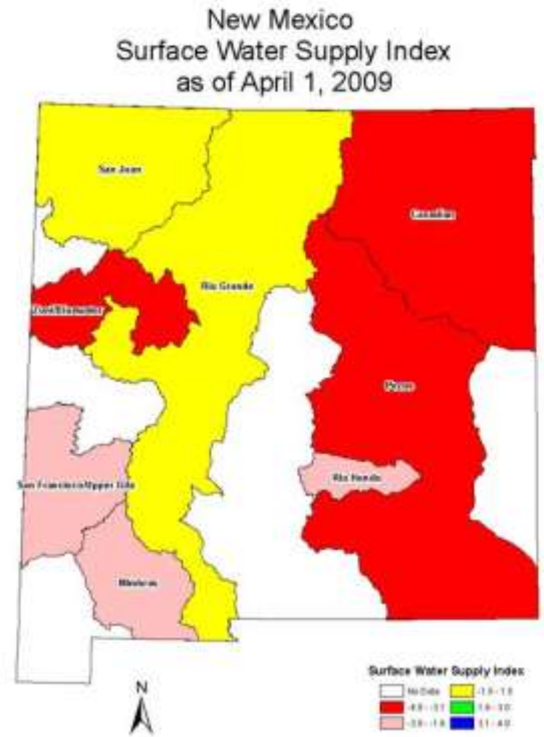
Some droughts in the past have been more severe and longer lasting than any in the last century.

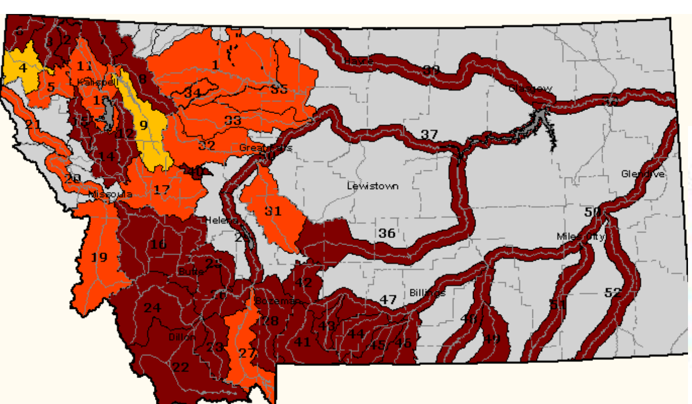
I. The Colorado Basin-An innovation in "adaptation" interim through 2026

Spatial Resolution/ Time Horizon	Operational Activity	Decisions
International-Regional over Decades	Long-term Planning	Operating Criteria and Guidelines
Region-wide over 1-2 years	Mid-term Operations	Annual Operating Plan
Sub-basin over 4-6 weeks	Short-term Scheduling	Water and Power Schedules
Single project over 1-7 days	Real-time Control	Automatic Generation and Control

Surface Water Supply Index (SWSI)

- Developed in 1981 for Colorado (adopted by other Western States)
- Integrates Snowpack, Reservoir Storage, Streamflow, & Precipitation at High Elevation
- Standardized Units
- Plotted by River Basin

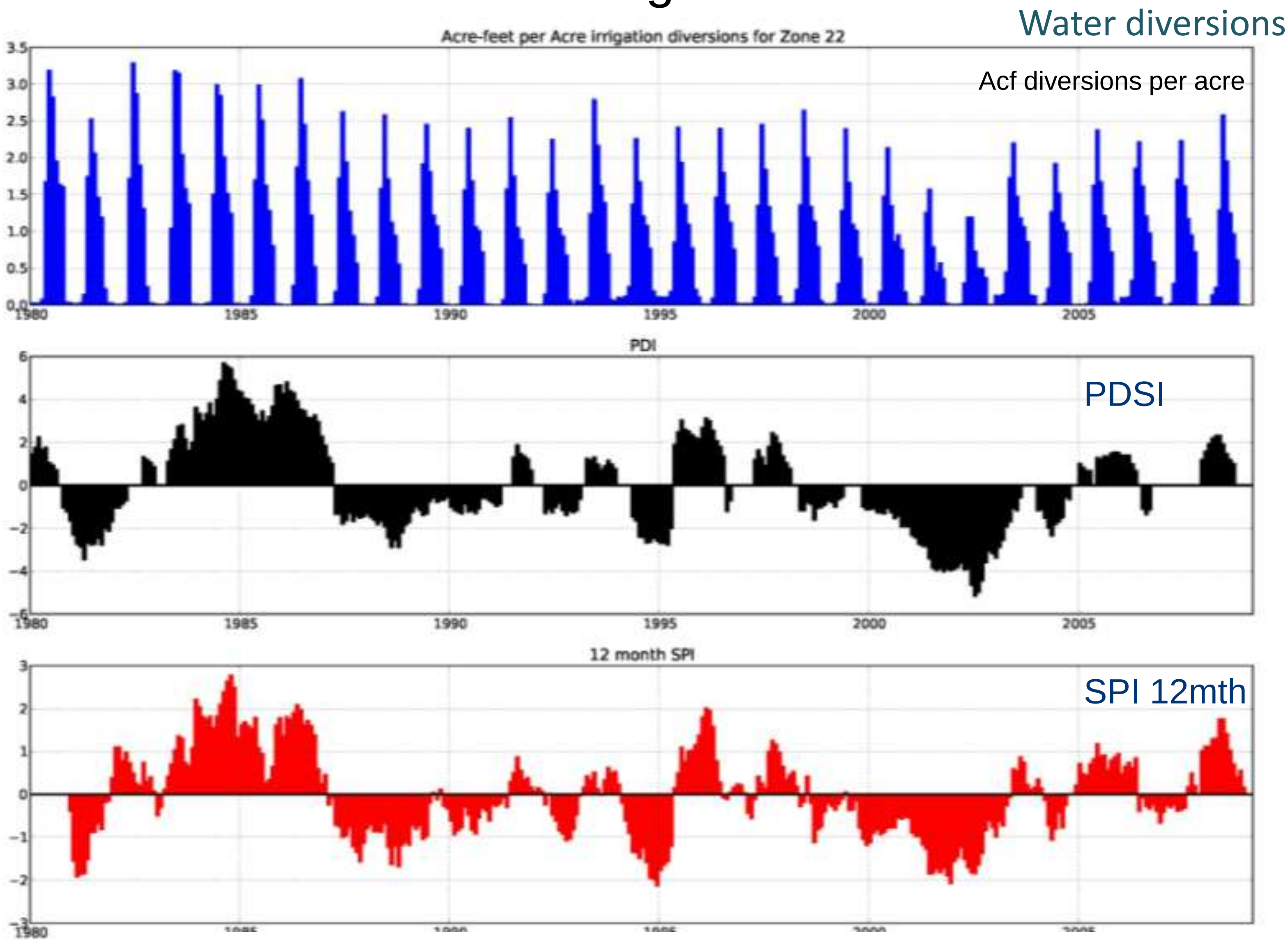




http://www.wcc.nrcs.usda.gov/wsf/swsi.html

Relating Drought Indices to management

Irrigation diversions



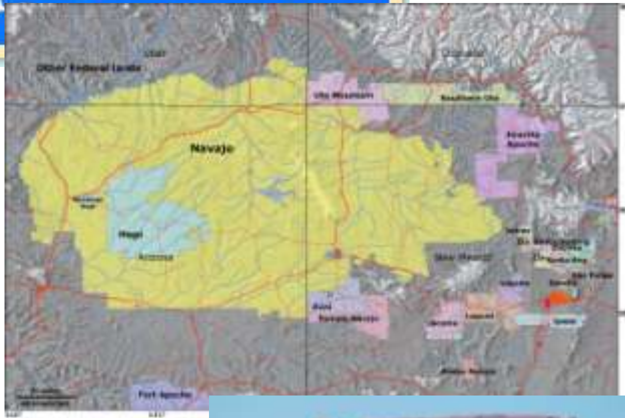
2012 **UR Forum** Mapping Global Risk

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

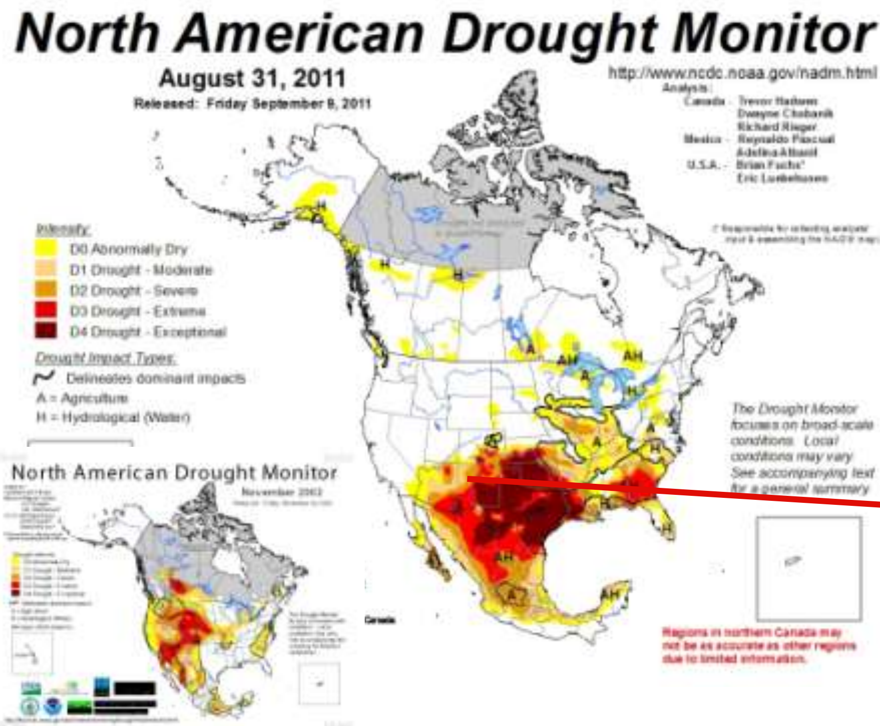
Regional Characteristics

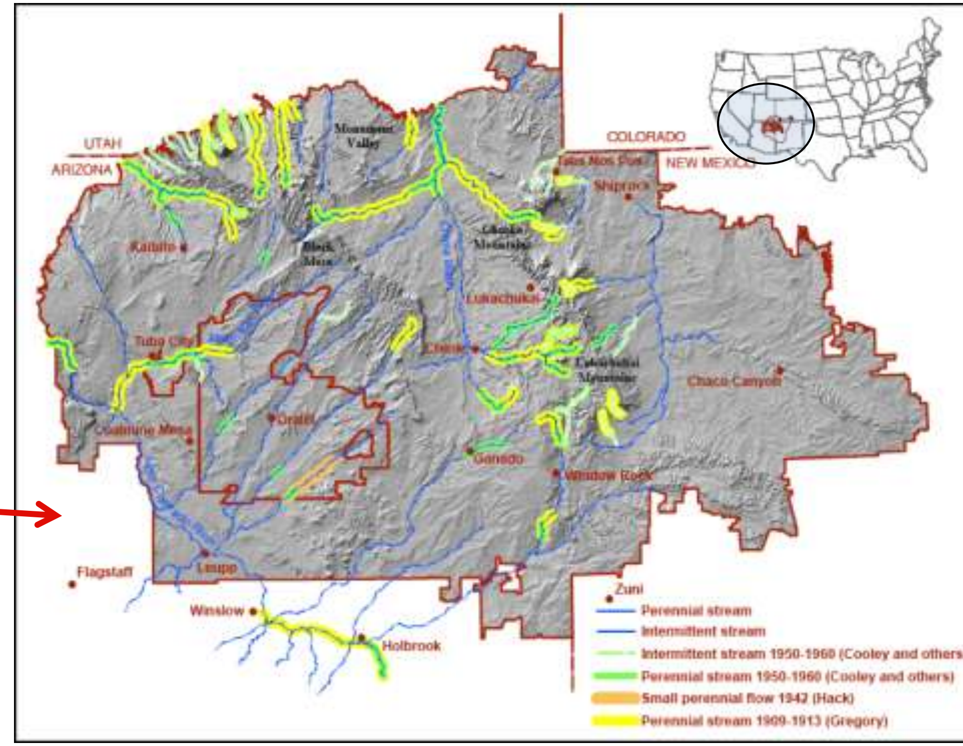
Reservation history and local land tenure

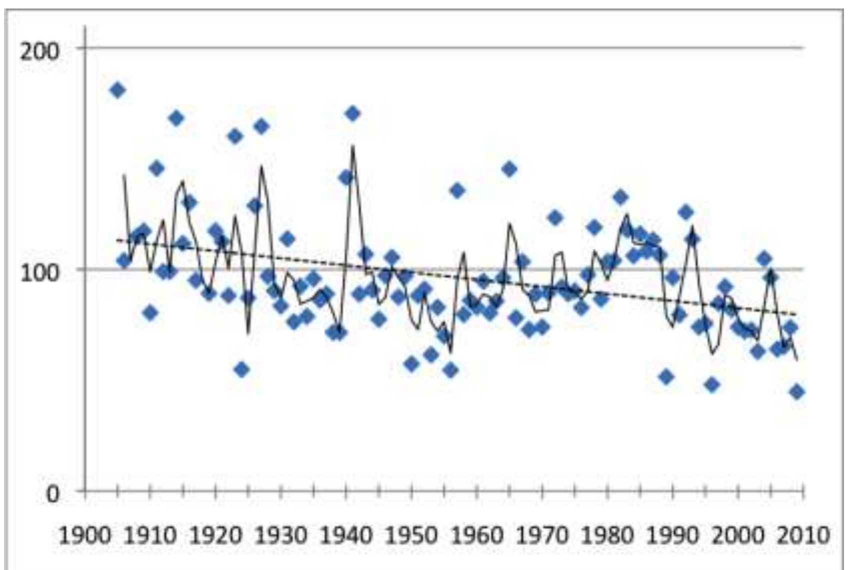


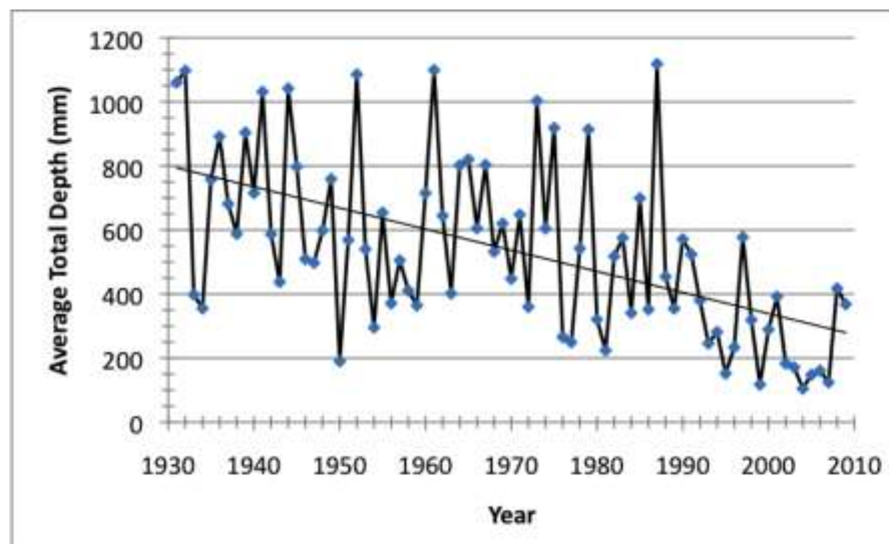
Drought and climate change: Thresholds

Navajo/Dine and Hopi (rain-fed) Homelands









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

1º C increase =>50mm precipitation lost to evapotranspiration (ET)

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

Sand Dune Mobility = W/(P/PE)

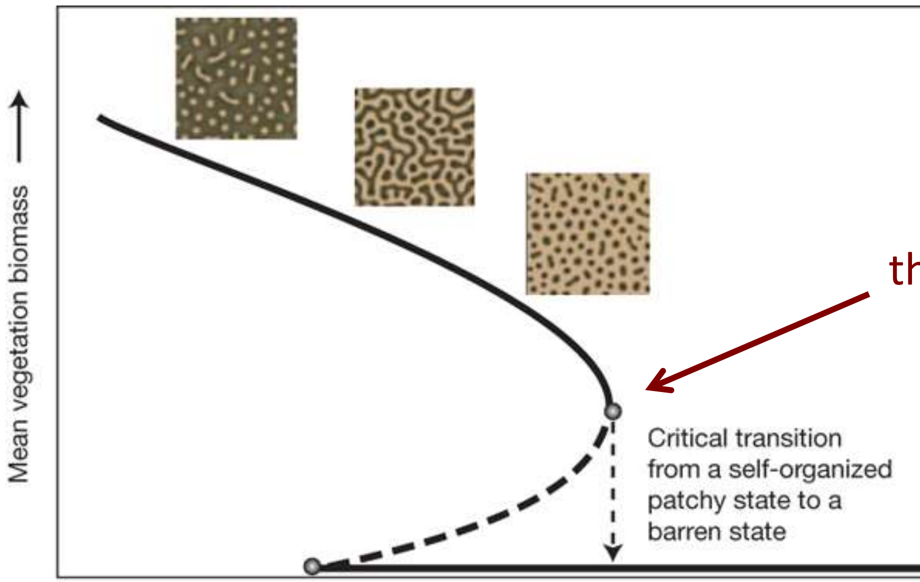
Stable Sand Dunes
= P/PE > 0.31

Partly Active Dunes

Fully Active Dunes
= P/PE< 0.125

Landscape changes-
Native American Lands in the Four-Corners Region-Early-warning signals for critical transitions

Mean vegetation biomass



threshold

Dryness of climate →


LOCAL NEWS

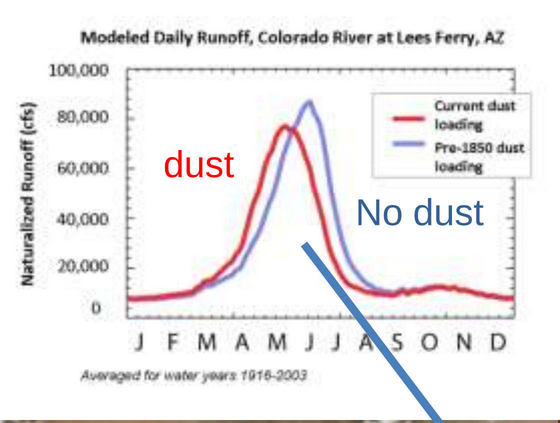
Multiple crashes due to wind and dust along I-40

More Phoenix Local News

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

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

Dust from NE Arizona



Traditional Knowledge and Perspectives:

- Increases our ability to understand changing environmental conditions
- Refines timing of events
- Fills monitoring gaps
- Procedural equity

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

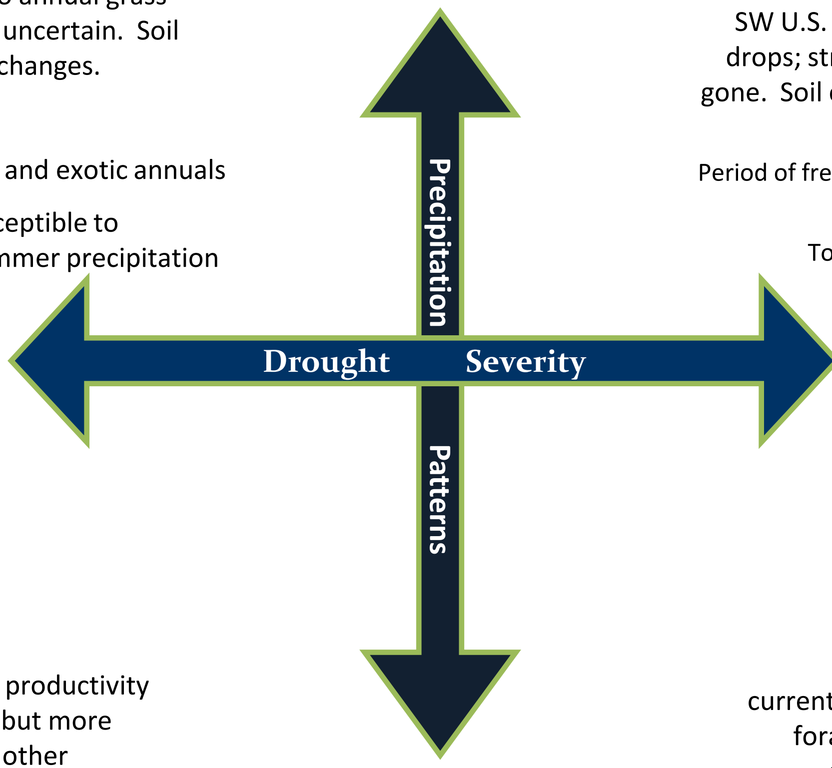
Novel Ecosystem

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.

Mixed-grass Prairie

Patterns change little

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.

Shortgrass Prairie

So what is needed?

Jolene Tallsalt Robertson
Hydrologist, Navajo Nation
Department of Water
Resources

Dr. Margaret Hiza
US Geological Survey

Rachael Novak
US Environmental
Protection Agency

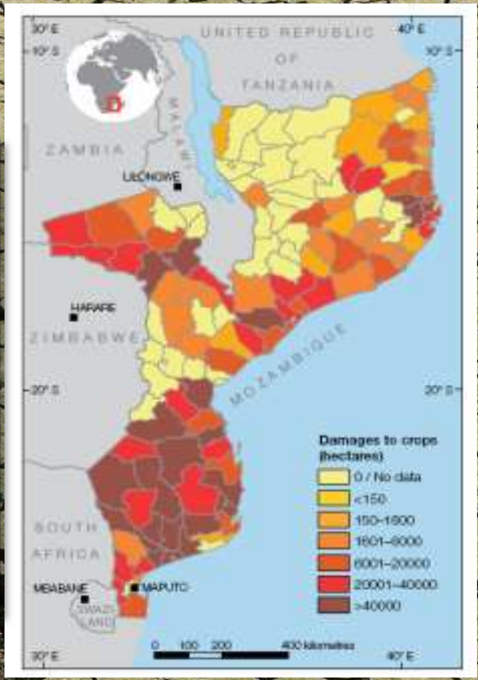
Casey Kahn-Thornbrugh
Adjunct instructor of Geography
Tohono O'odham Community
College
&
PhD Candidate, UA School of
Geography & Regional
Development

More Native researchers (cultural, social, physical, natural) to work for their communities

Drought remains a hidden risk

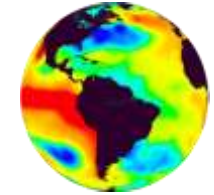
Most estimates of disaster losses exclude indirect losses – livelihoods, informal economies, intangible losses including ecosystem services, quality of life and cultural impacts

In some areas drying due to climate change will be overlain on the periodic droughts those areas have always experienced!



Short-term actions do not always provide long term risk reduction- can reduce or increase longer-term risks

For exposed and vulnerable communities, even non-extreme weather and climate events can have extreme impacts



Thresholds: Variability and Change

Type I: **Those that are <u>well-known cases from the past</u> where a threshold was reached and the management challenges are explicit**

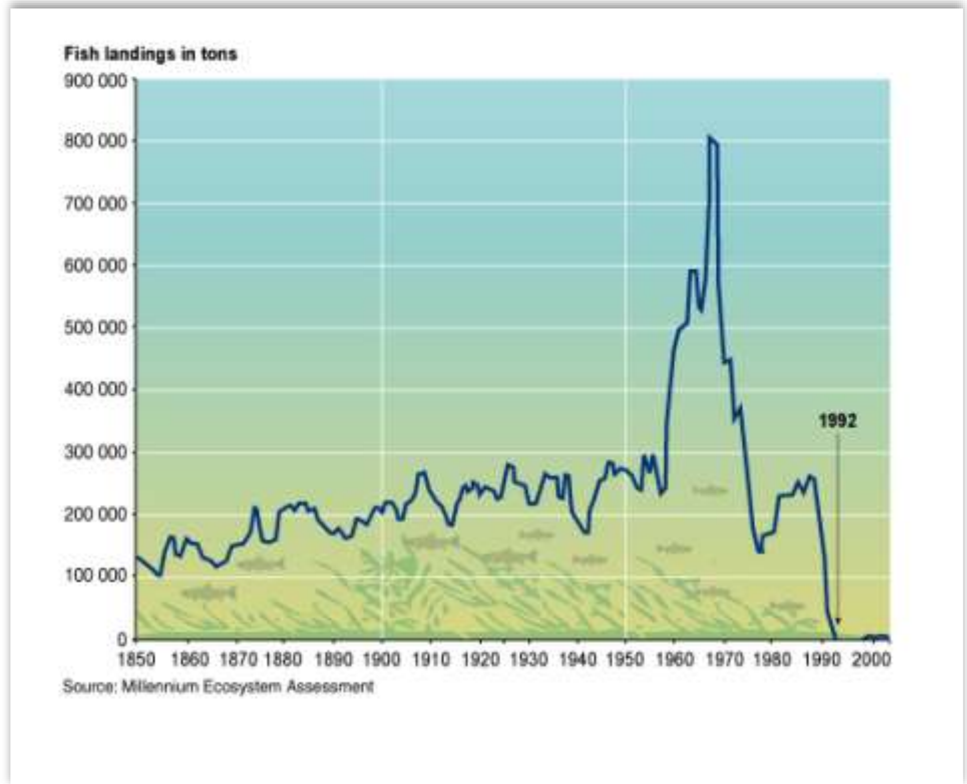
Type II: **Those that are emerging now and often feature <u>aspects of accelerating change</u>**

Type III: **Those that present very <u>large scale, system-wide challenges</u>**

Type 3 cases are examples where we know the system well enough, or the science well enough, to think that we ought to be concerned

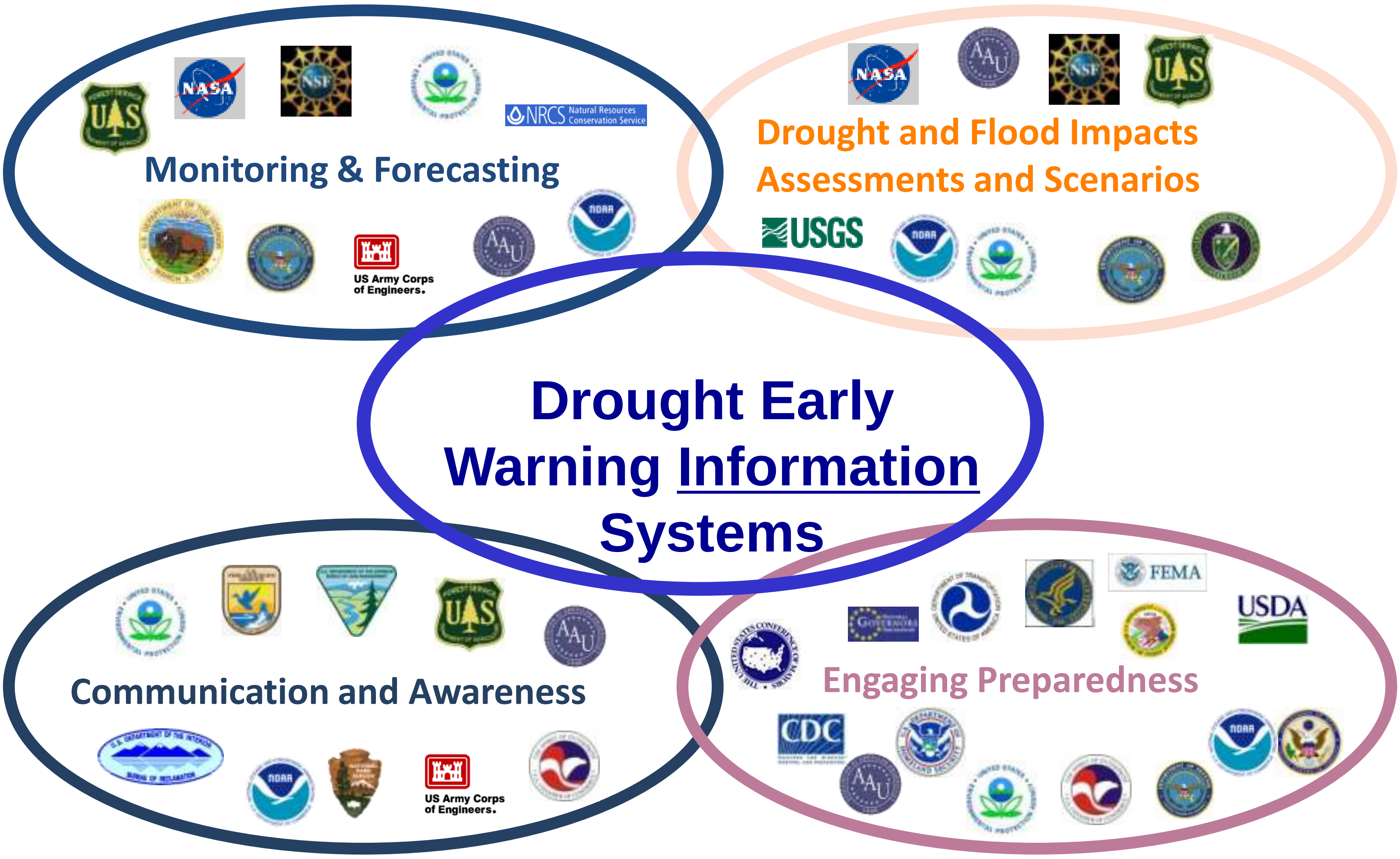
Other examples of nonlinear change

- Fisheries collapse
- Eutrophication and hypoxia
- Disease emergence
- Invasive Species and species losses
- Vegetation die-back
- *others*



Assessing Drought Early Warning Systems –WMO, NIDIS, UNISDR

International Drought Information Systems (November, 2011 ⟶ National Drought Policy 2013)


NRCS Natural Resources Conservation Service
Monitoring & Forecasting
US Army Corps of Engineers
Drought and Flood Impacts
Assessments and Scenarios
USGS
Drought Early
Warning Information
Systems
Communication and Awareness
US Army Corps of Engineers
FEMA
USDA
Engaging Preparedness
CDC

Extremes in the context of variability and change:

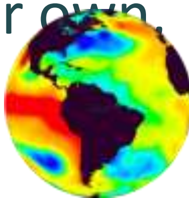
- Pressure for better information to support planning under changing extremes-rates and transitions

- Is a threshold an emergent property of some underlying set of attributes of a system? (models not calibrated for rapid transitions)

How does new information relate to what is already known?- how often should criteria for "robustness" be reconsidered?

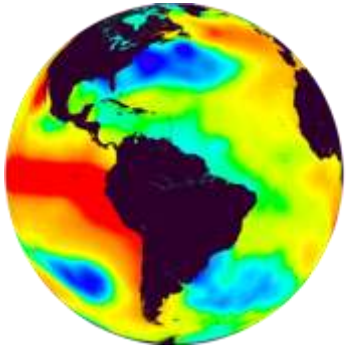
- Many public sector applications require a more systematic connection between early warning scenarios and recommended decisions than do private sector applications

- More challenging is understanding the socialization of lessons learned by particular individuals and organizations through their own, direct trial and error experiences




OVERCONFIDENCE
This is going to end in disaster, and you have no one to blame but yourself.

THANK YOU!

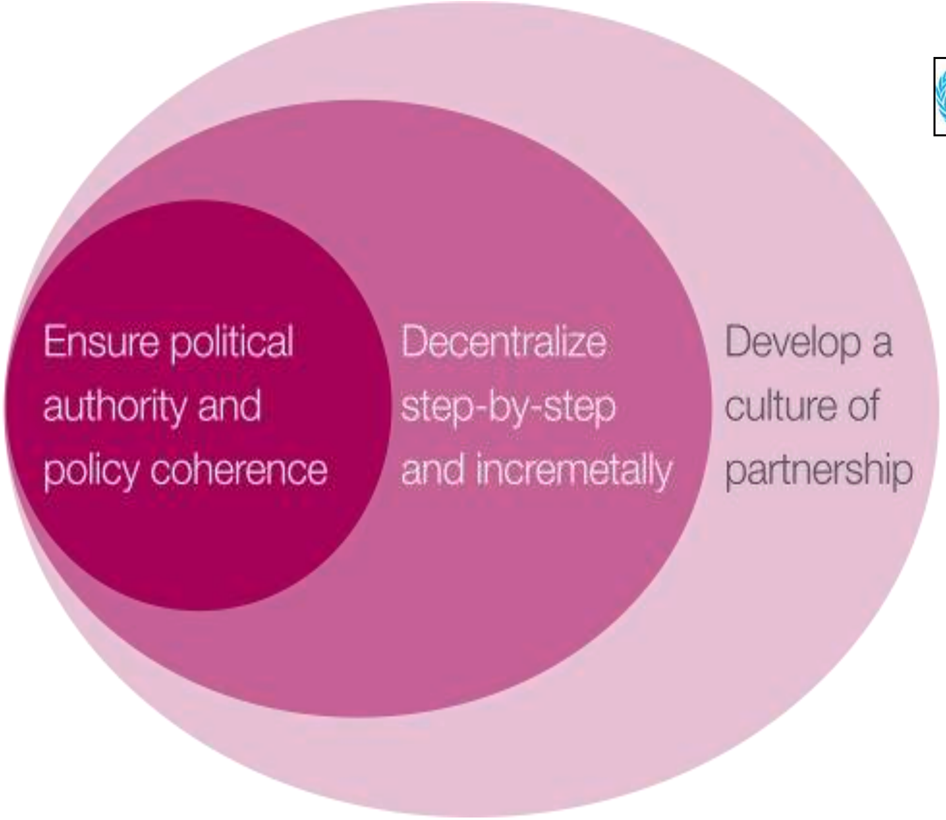


2012 UR Forum Mapping Global Risk

Backup slides

Climate risk management: governance

UNSIDR
Global Assessment of Disaster Risk Reduction 2011



<u>**Accountability**</u>- CRM needs to be located in a ministry or department, preferably with planning oversight and some fiscal responsibility-provide political authority and policy coherence across sectors. **Emergency management organizations can rarely play that role**

<u>**Efficiency-**</u> only occurs when CRM is carried out in partnership with at-risk households and communities and organizations that represent them. Benefits are cost-effectiveness, sustainability, citizenship and social cohesion.

- Much more work is needed to show the value of existing observations to improve impacts assessments and warnings

- Reference water data accounting/architecture

- Better understand whether and how best to use probabilistic information with scenarios-reliable set of statistical procedures to test whether an increase in autocorrelation is significant (response curve trigger- cross-correlation among units before a critical threshold

- Rates and transitions-Are critical climate (extremes+ variability+change) impacts occurring/predicted in 1, 5-20 yrs?

- Prototyping/ policy gaming: Given better data and information coordination, would responses have been improved for past events?

Why is “communication” not enough?

Broad societal processes that create dynamic pressures and unsafe conditions are not easy to change, yet are fundamental to human vulnerability

- The “push” supply of new information by would-be providers of information/technology , and the “pull” demand for new information from would-be learners is never linear
- Social process(es) of risk communication are more than “one-way” AND even more than “two-way”
- More challenging is an understanding the socialization of lessons learned by particular individuals and organizations through their own, direct trial and error experiences

Mexico- Water availability projection to 2030

At the national level, a 10% reduction in annual water availability ***was projected under climate change scenarios for 2030***

Actual pressure into water sources

"Business as usual"