Drought, early warning and climate services

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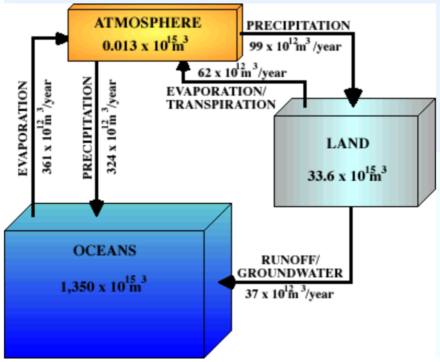
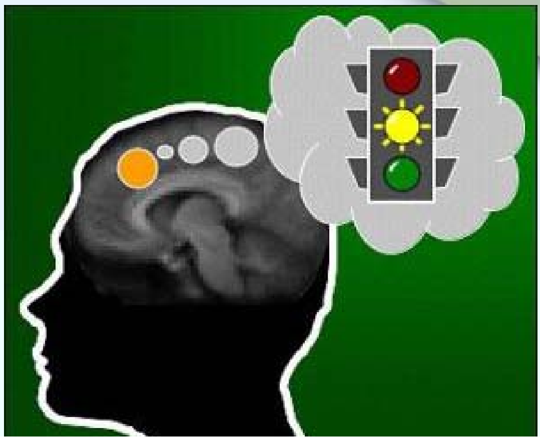
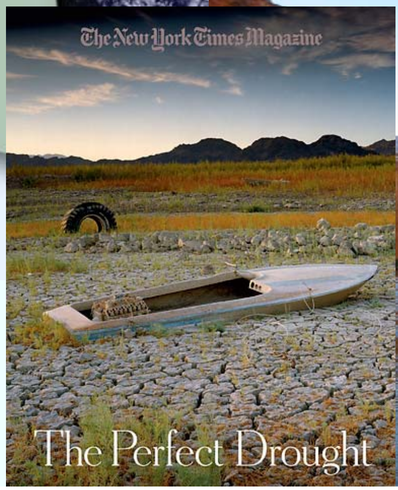
NOAA



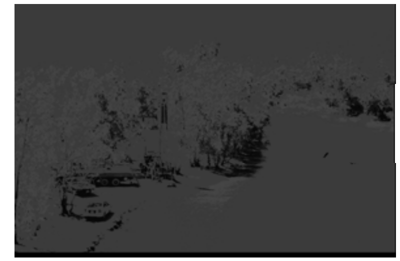




Impacts of a Changing climate

Climate Variability& change

Higher evaporation. More farm dams as surface water availability reduces?



Increased demand for groundwater as surface water availability reduces?

Greater irrigation efficiency as surface water availability reduces?

Increased evapo-transpiration due to higher temps?

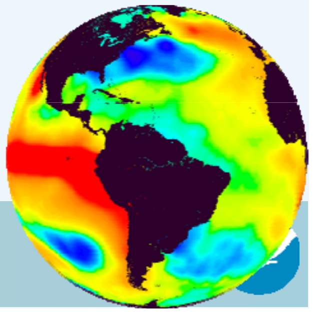
Higher frequency and intensity of wildfires due to higher temps and droughts?

“If we are not careful we will end up where we are going”

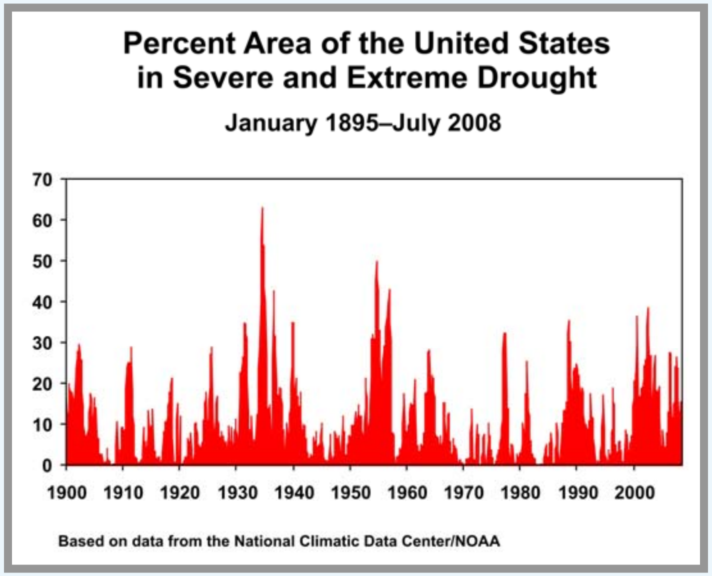
Central Arizona project Late-1980’s

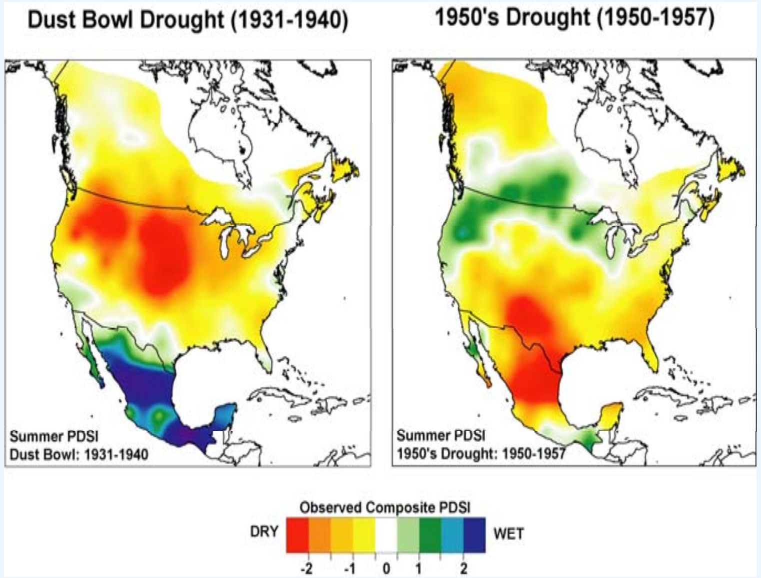
Development in Central Arizona 20 years later

Climate drivers of drought-a continuum



Drought: Diverse temporal and spatial scales

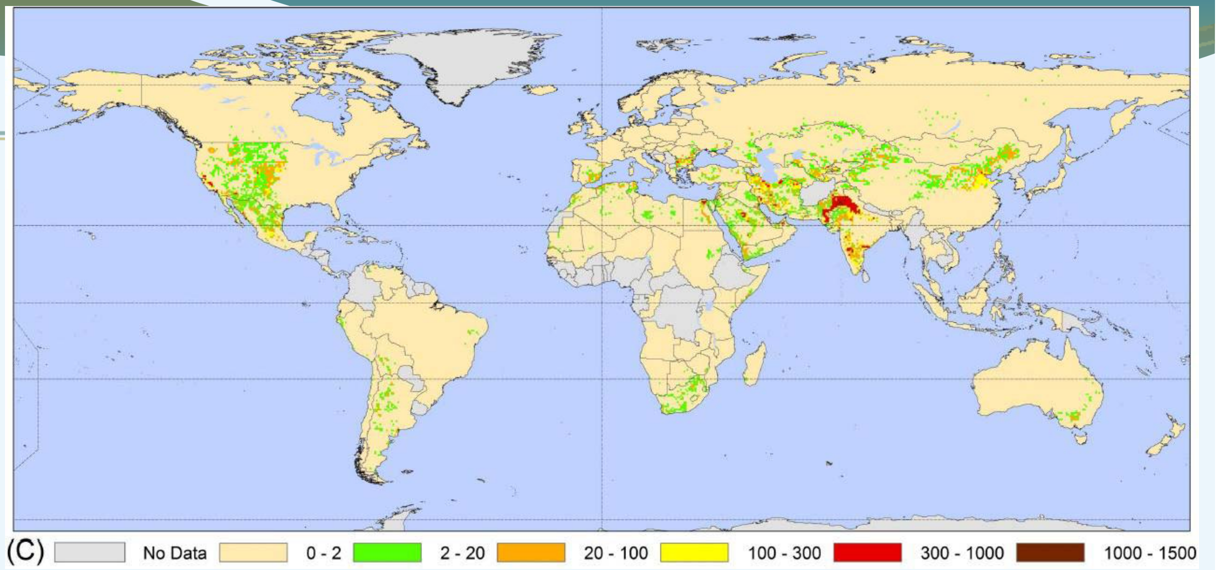




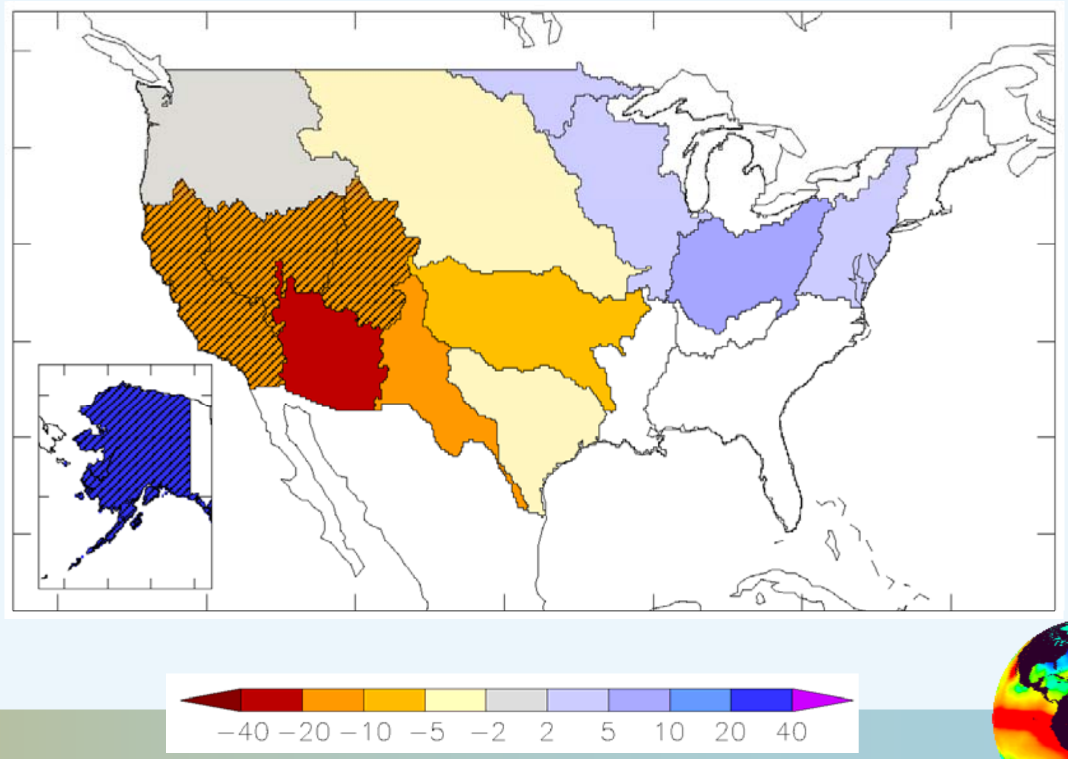
Groundwater depletion trends

(groundwater 30% of available freshwater on the planet)

1000 = one cubic kilometer of depletion per year



The future (2041-2060): where do the models agree?



What would “adaptation” address?

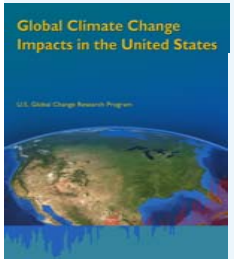
The threat already posed to society from today’s climate variations

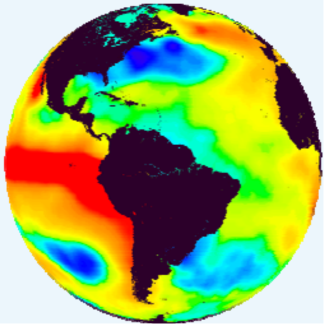
Climate-sensitive development paths that might put greater population, ecosystem services, and economies at risk

The potentially high-impact but still critically uncertain additional risks presented by climate change

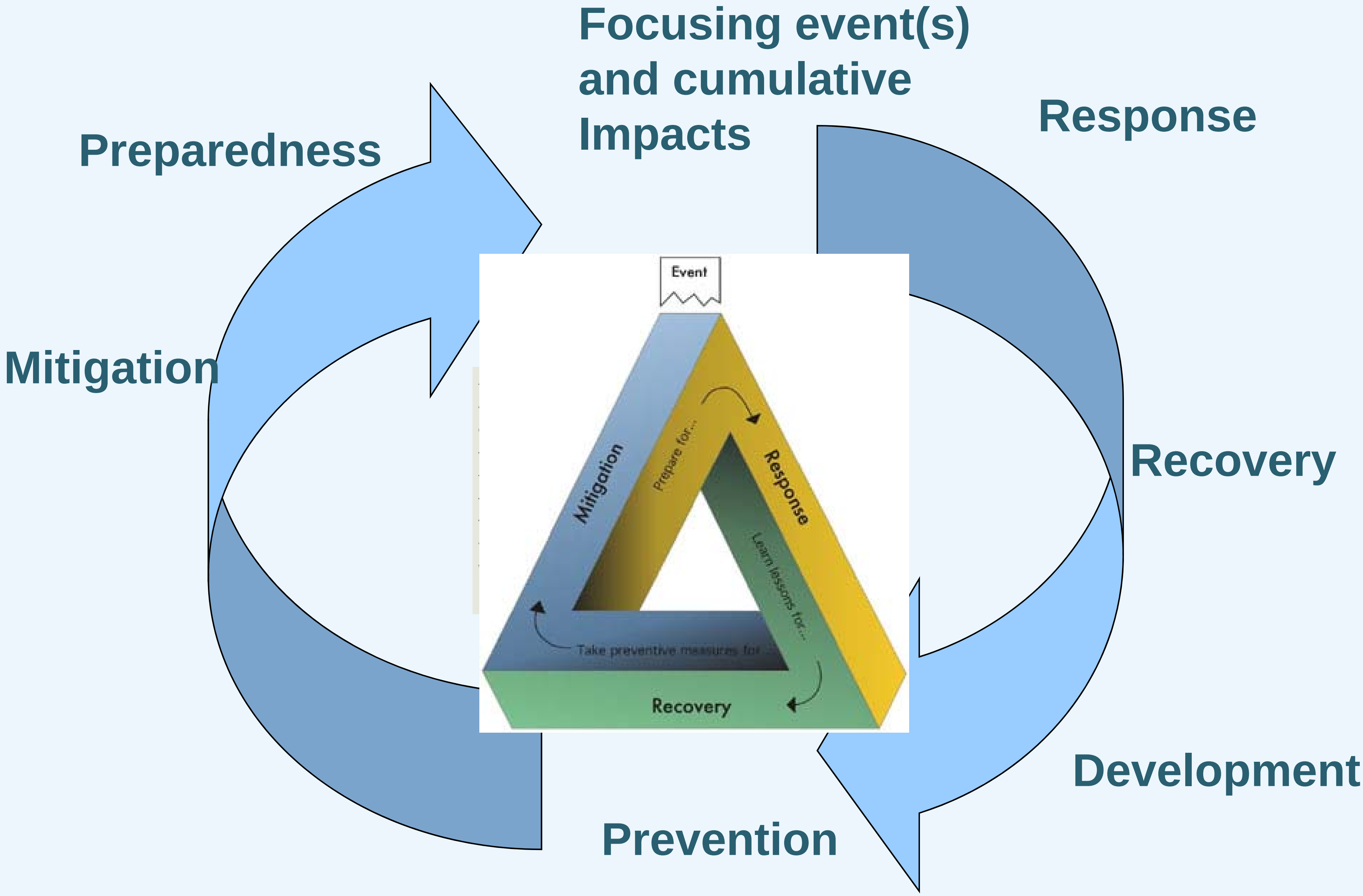
How do we “usually” adapt?

- Infrastructure/assets
- Technological process optimization
- Institutional and behavioral changes or reinforcement
- <u>Crisis, learning and redesign</u>





Event to event…....issue attention cycle



Focus on the critical problems: not just asking but answering the right question

"ALSO, THE BRIDGE IS OUT AHEAD"

Adaptation: Crisis, learning and redesign

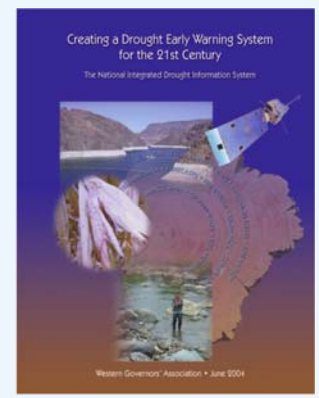
What has led to "action"?

1. Focusing events-extremes, legal decisions etc.
2. Leadership at different levels and the public are engaged:
3. **Supported framework for collaboration between research and management-integrated**, scenarios, scenarios/gaming, communication, embedding information into practice, evaluation
4. Existing social basis or even pressure for collaboration

Are droughts different from other hazards?

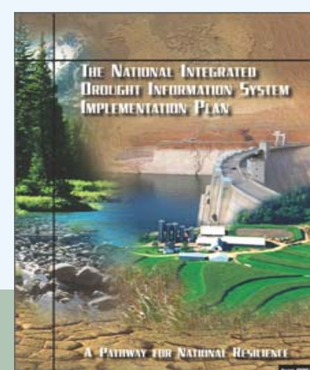
2000-2004 drought in the Colorado Basin

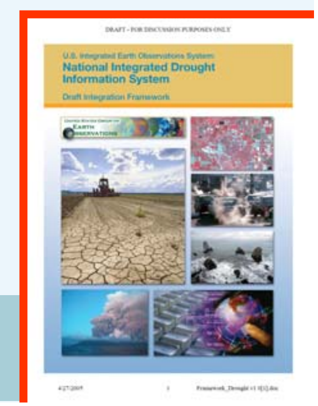
"No systematic collection and analysis of social, environmental, and economic data focused on the impacts of drought within the United States exists today" Western Governors Association 2004



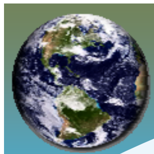
The NIDIS Act of 2006 (Public Law 109-430)

"Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts"





(www.drought.gov)



Three tasks under the NIDIS Act

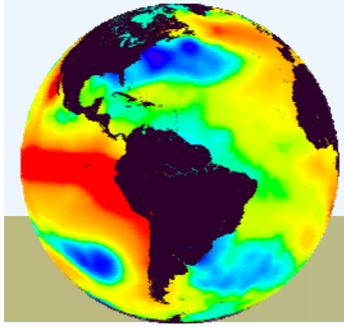
Public Law 109-430, 2006

(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;

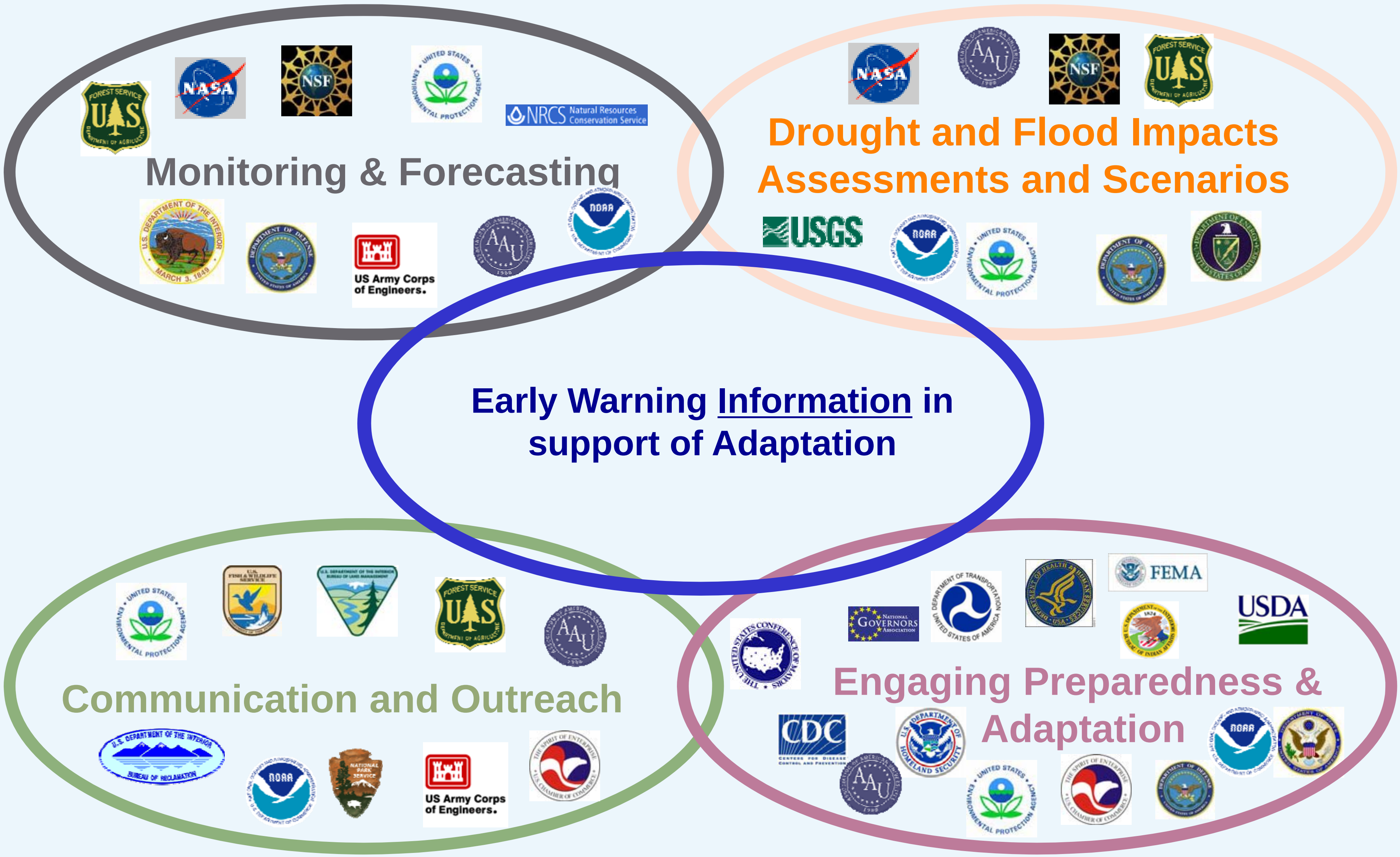
(II) Coordinate and integrate as practicable, Federal research in support of a drought early warning system

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

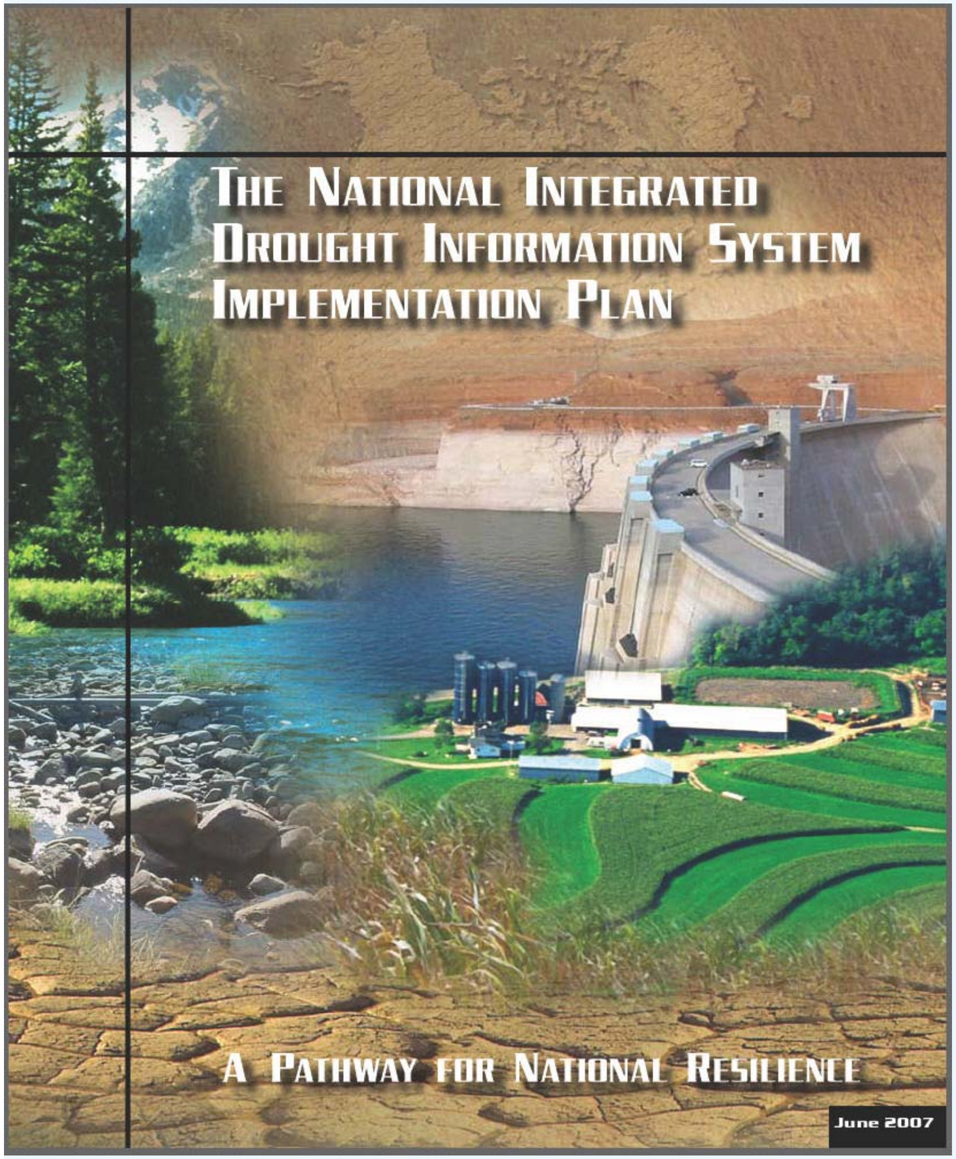


NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Drought and Water Resources:
Federal Partnerships (States, Tribes, Urban, other)



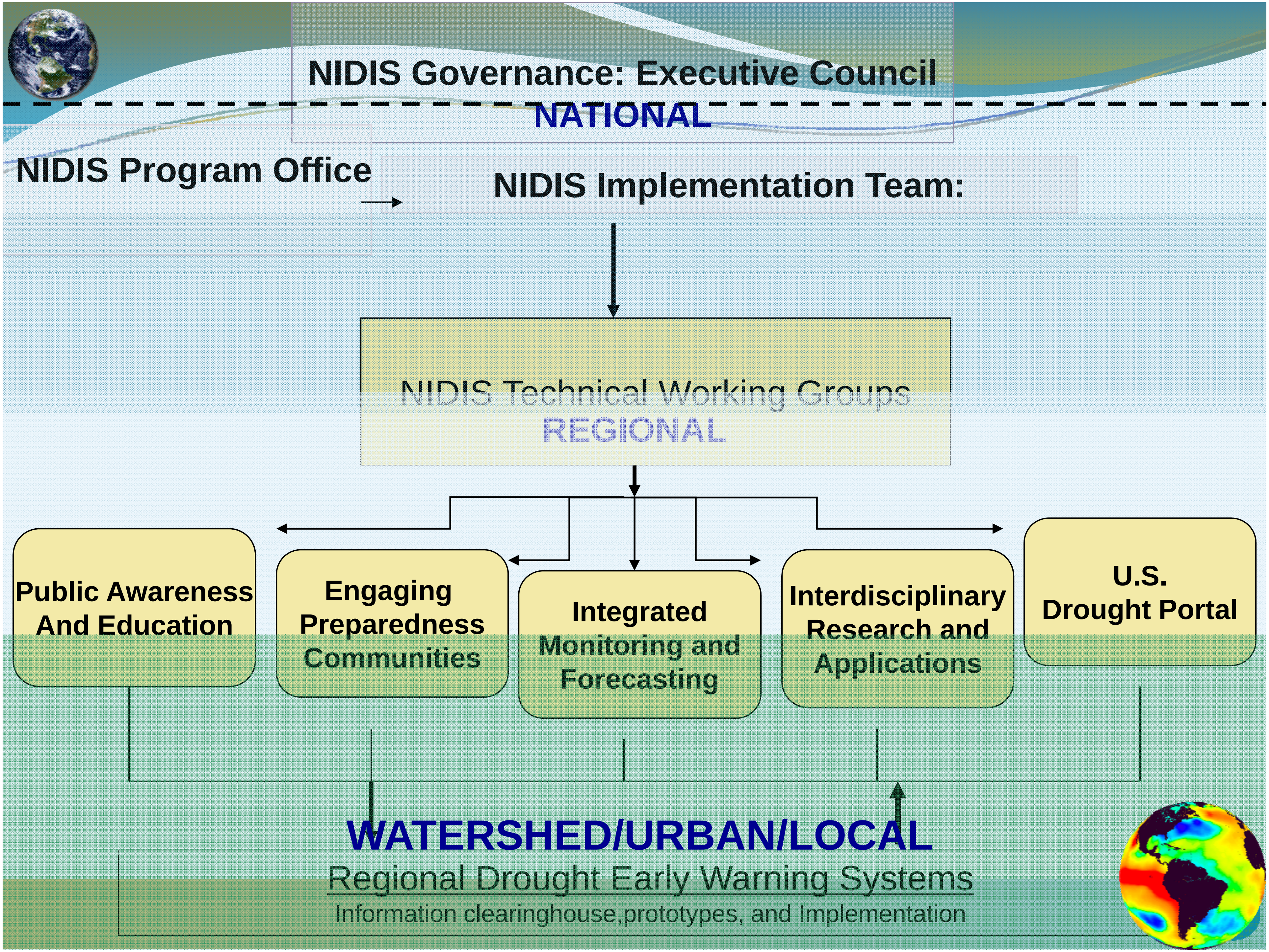
NIDIS Components



1. NIDIS Office

2. U.S. Drought Portal
3. Climate Test Beds/Drought
   Integrating data and forecasts
4. Coping with Drought-Grants-
   Impacts assessment and decision support research

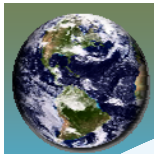
5. Regional Drought Early Warning Information Systems
   Design, Prototyping,
   Implementation


NIDIS Governance: 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 Systems
Information clearinghouse,prototypes, and Implementation

National Level: NIDIS Knowledge Assessments (selected);

What do we know? What do we need to know?

- **Remote Sensing Contributions to Drought Monitoring, February, 2008, Boulder-** NOAA, USGS, NASA, USDA, universities, state climatologists, state-local drought officials
- **National Status of Drought Early Warning Systems, June 2008, Kansas** City-NOAA, USGS, USAID, USDA, USACE, NASA, tribes, universities, state government, water managers
- **Drought, Climate change and Early Warning on Western Tribal Lands June 2009-** Columbia, Colorado, Rio Grande, Missouri Basin tribes
  - 2010-11 Four Corners region
- **WGA/WSWC Workshops on developing constituencies for NIDIS (April 2010, September 2010-Washington DC, 2011)**
- **Engaging Communities in Preparedness June 2011 Chicago**



Impacts Assessment and Decision Support Research

- **Adaptation Policies For Urban Water Resource Management-Short-Term Drought Responses And Long-Term Planning**

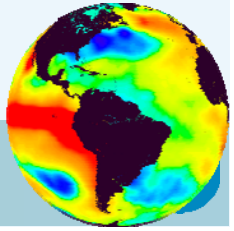
- **Socioeconomic Assessments to Build Community Resilience in Mitigating Drought**

- **Climate Information System to Enhance Drought Preparedness by Underserved Farmers**

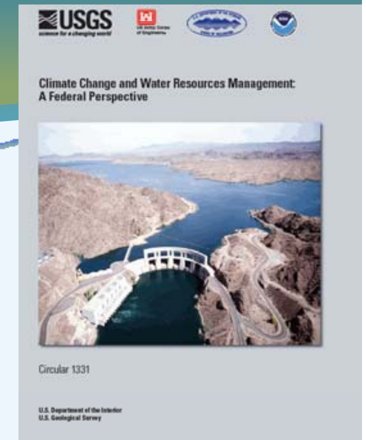
- ***Reconciling projections of Colorado River streamflow under changing climate conditions***

- **Ensemble Hydrologic Forecasts using dynamic estimates of evapotranspiration**

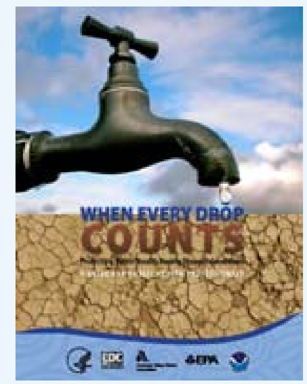
Drought Index Evaluation and Implementation in a Geospatial Framework Linked to Hydrologic Data Web Services



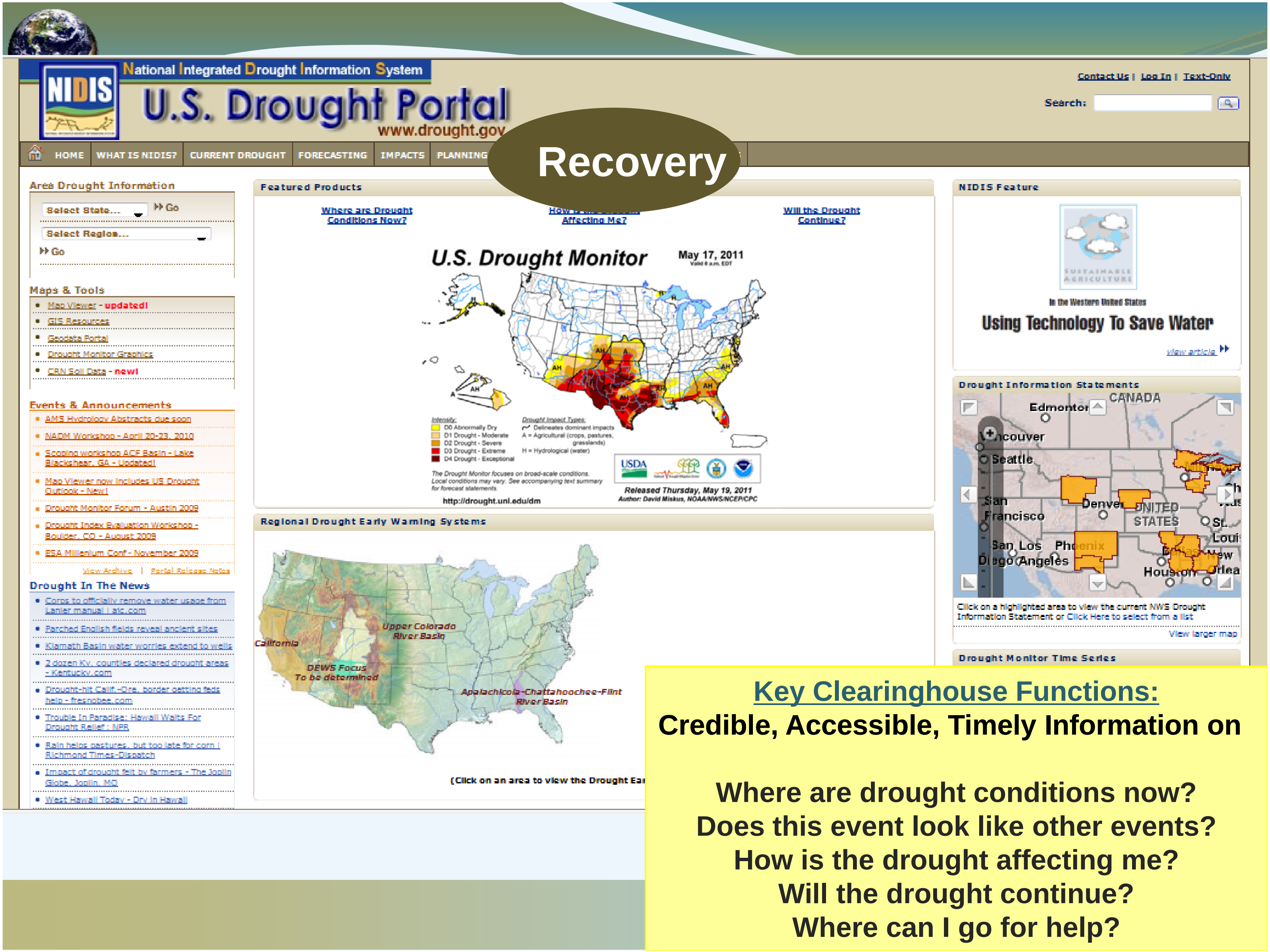
USGS 1331- Climate Change and Water Resources Management: A Federal Perspective 2009



Centers for Disease Control When Every Drop Counts: Protecting Public Health During Drought Conditions—A Guide for Public Health Professionals 2010



United Nations Global Assessment Report on Disaster Risk Reduction (GAR 2011)



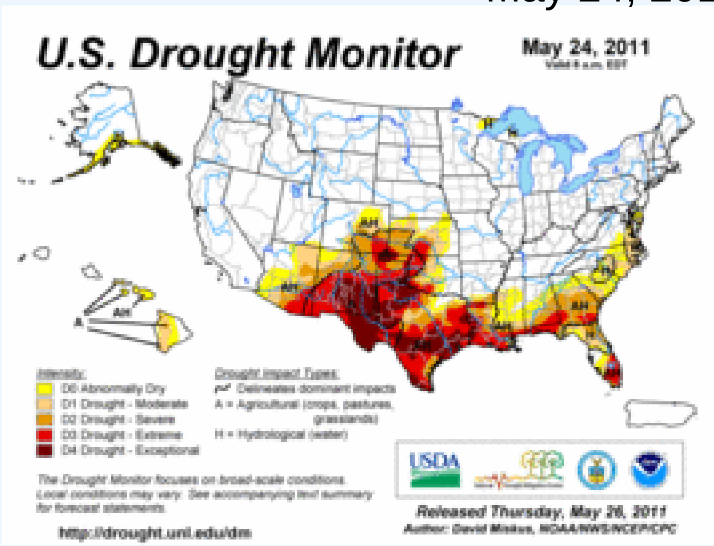
Recovery

Key Clearinghouse Functions:

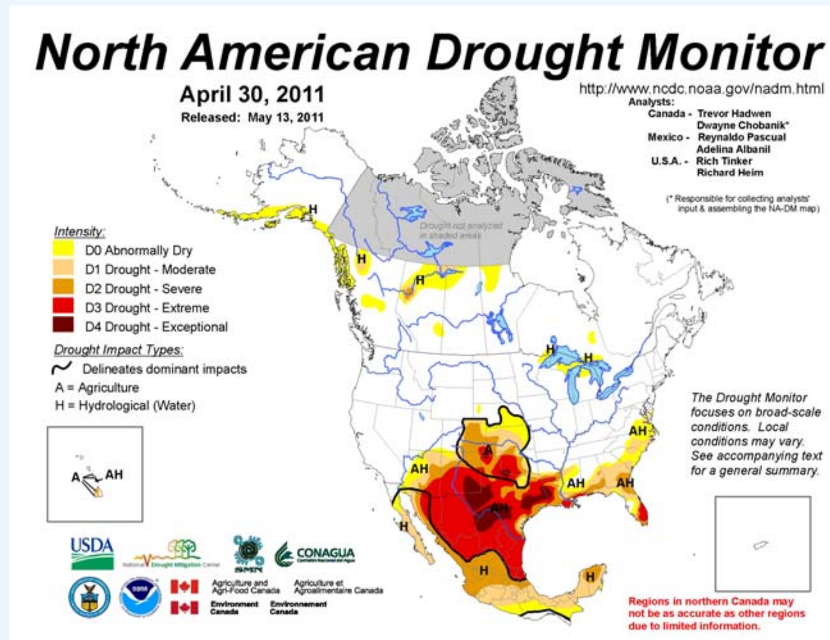
Credible, Accessible, Timely Information on

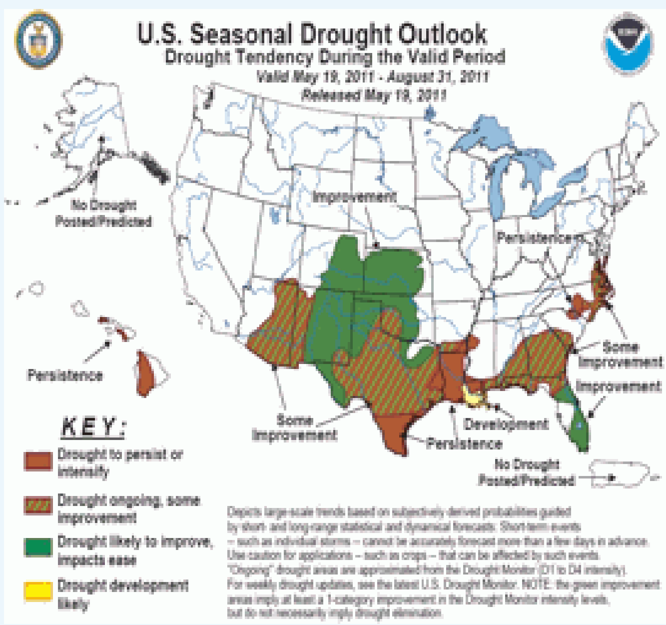
Where are drought conditions now?
Does this event look like other events?
How is the drought affecting me?
Will the drought continue?
Where can I go for help?

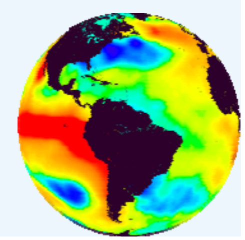
May 24, 2011



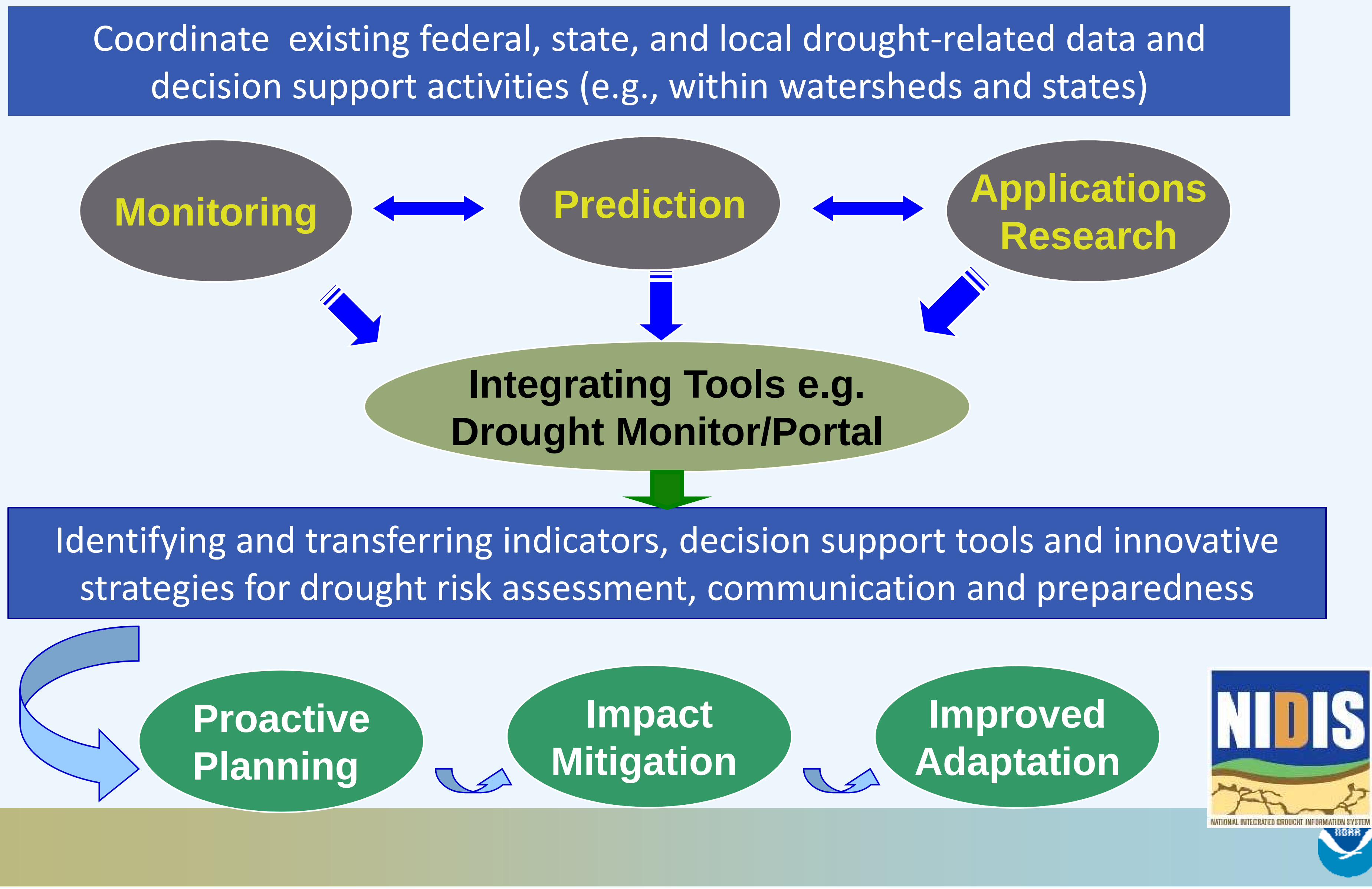
U.S. Drought Monitor



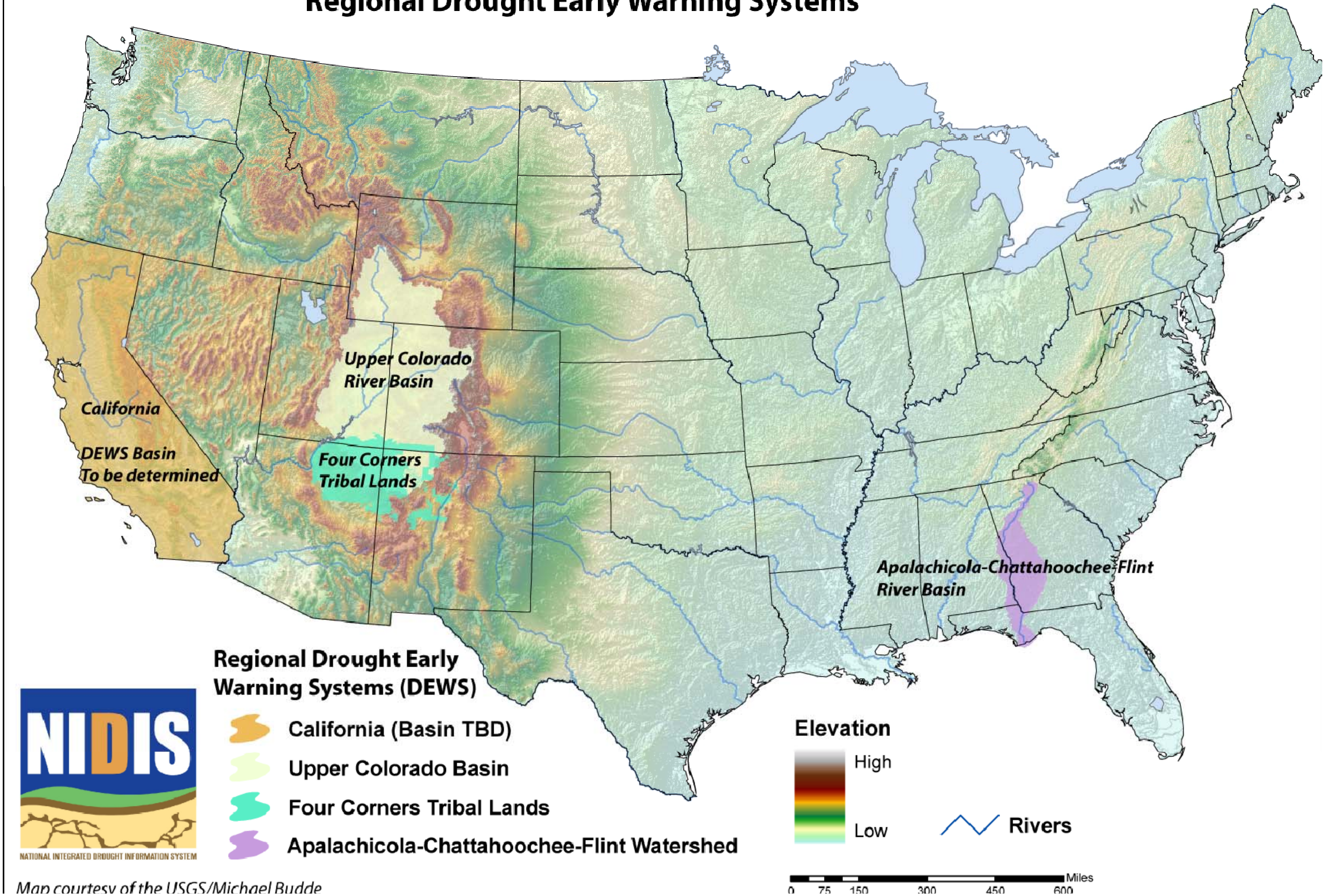




NIDIS REGIONAL INFORMATION MANAGEMENT MODEL



National Integrated Drought Information System (NIDIS)
Regional Drought Early Warning Systems



Map courtesy of the USGS/Michael Budde

Regional DEWS Implementation: Upper Colorado River Basin

Categories of drought information users & analysis

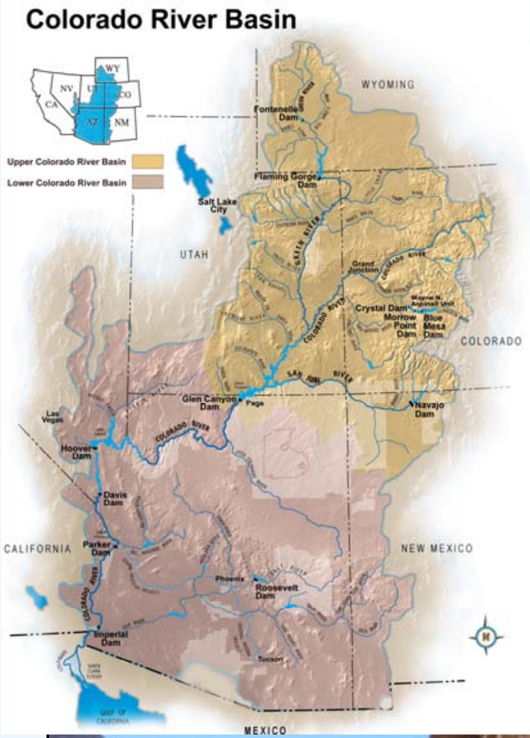
Upper Basin down to Lake Mead

•Coordinated reservoir operations: Low flow shortage triggering criteria (Powell/Mead)

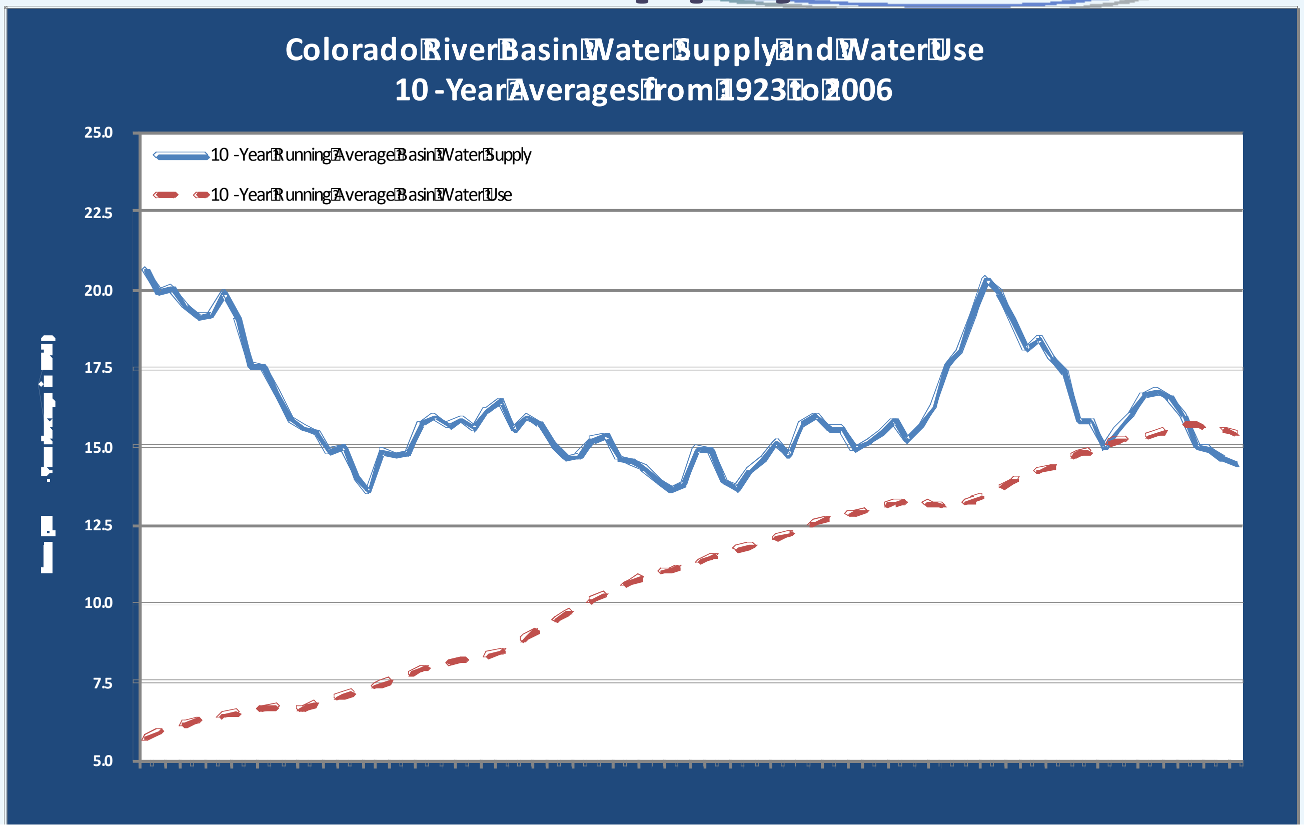
Sub-basin

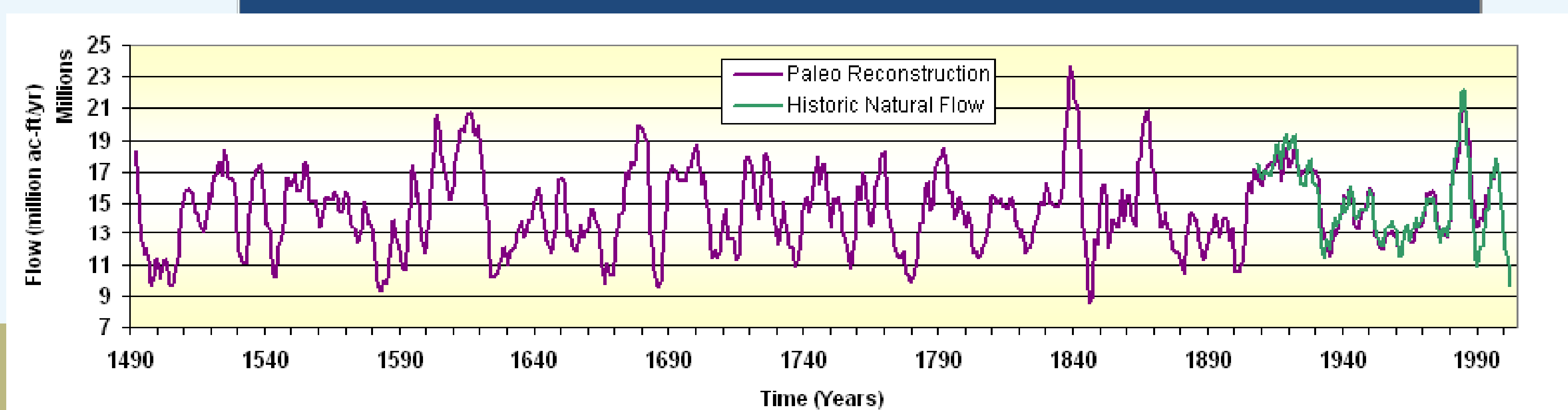
•Inter- and Intra-basin transfers; Front range urban-agriculture-Changing water demand during drought

•Ecosystem health/services including recreation and tourism impacts

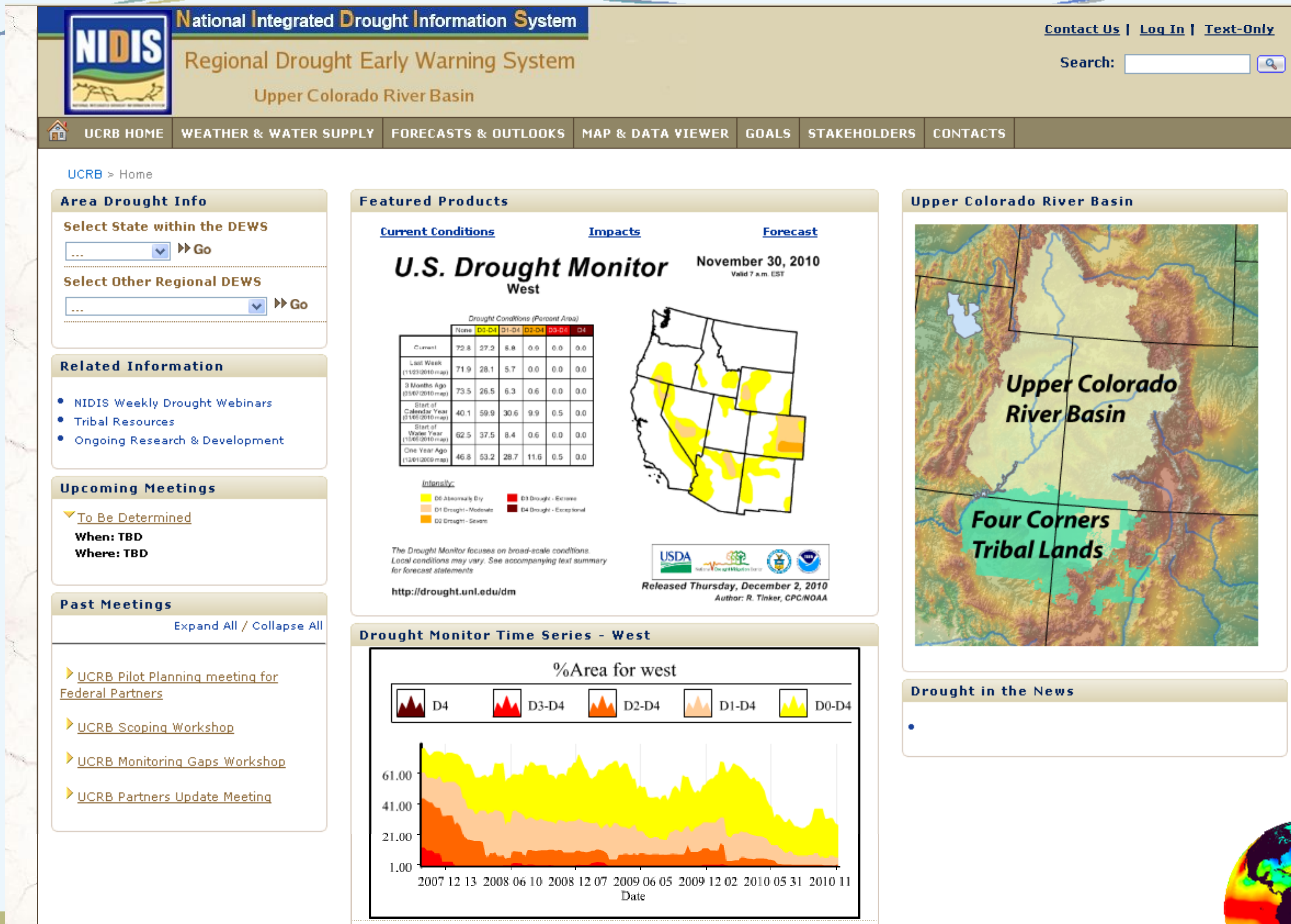


olorado River Water Supply & Use





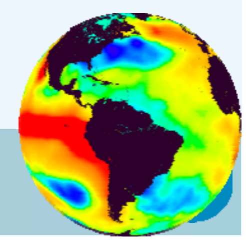
US Drought Portal – Regional DEWS



NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

NIDIS Implementation Team: Over 50 Federal, state, tribal and private sector representatives nationally

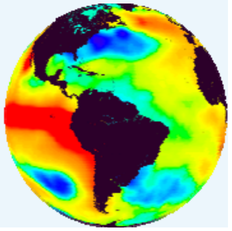
Integrated Monitoring and Forecasting	NRCS, USGS River Forecast Center, BoR Climate *Prediction* Center USDA
Interdisciplinary Needs Assess., Research, Applications	Regional Integrated Sciences and Assessments Regional Climate Centers NCAR
U.S. Drought Portal	NCDC NDMC-NOAA,USGS, USDA, USBoR
Public Awareness And Education	State Climatologists NWS-CSD USDA
Engaging Preparedness Communities	NDMC State Offices, RISAs US BoR, USACE



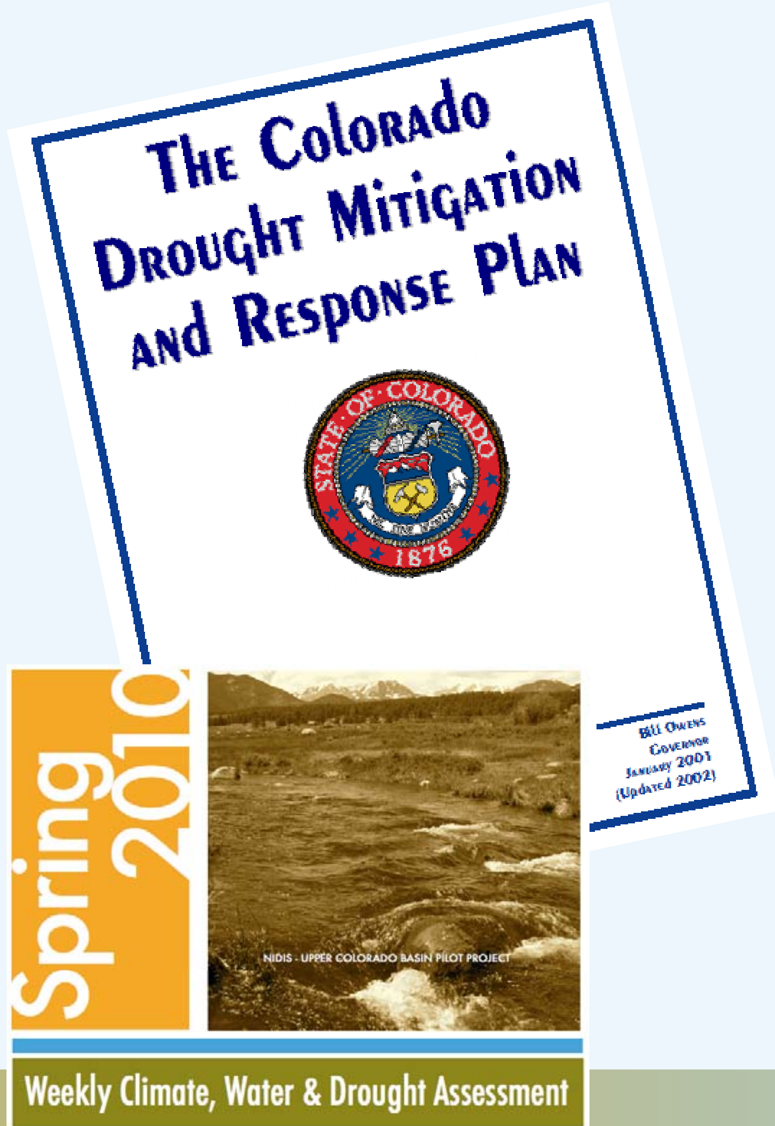
Spatial Resolution/ Time Horizon	Operational Activity	Decisions
Basin-wide over decades	Long-term Planning	Operating Criteria and Guidelines
Basin-wide over 1-2 years	Mid-term Operations	Annual Operating Plan
Sub-basin over 4-6 weeks	Short-term Scheduling	Water and Power Schedules
		Unit Commitment Economic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

NIDIS Products and Services in the Colorado Basin to date

- New watershed-based drought indicators and triggers used in the Upper Basin
- Improved linkages between climate and streamflow modeling during drought
- Spatial analysis of water demand during drought
- Low flow impacts database for 164 NWS forecast points
- UCRB Community Colorado Basin-specific Drought Portal
- Weekly Drought and Water Outlook webinars/early warning discussions with resource managers in the UCRB
- Engaging underserved communities



Upper Colorado Basin Drought Outlooks



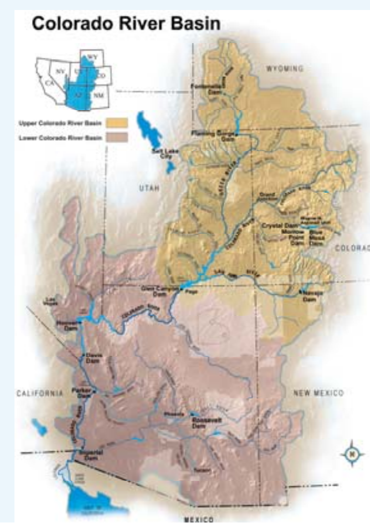
Revision of the Plans to meet drought requirements of the State Natural Hazard Mitigation Plan, <u>as well as FEMA and EMAP</u>

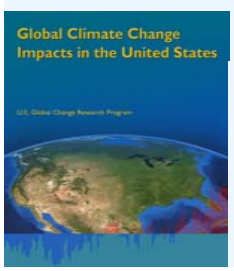
NIDIS role

- **<u>Development of indices</u> that incorporate current surface water conditions and a forecast component**
- **<u>Assessment of trigger points and responses</u>**
- **<u>Weekly Early Warning Webinars</u>**
- **<u>(coordinated with River Forecast Center briefings)</u>**

Colorado River Interim Guidelines - Time to think-A Robust Solution?

- 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**





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

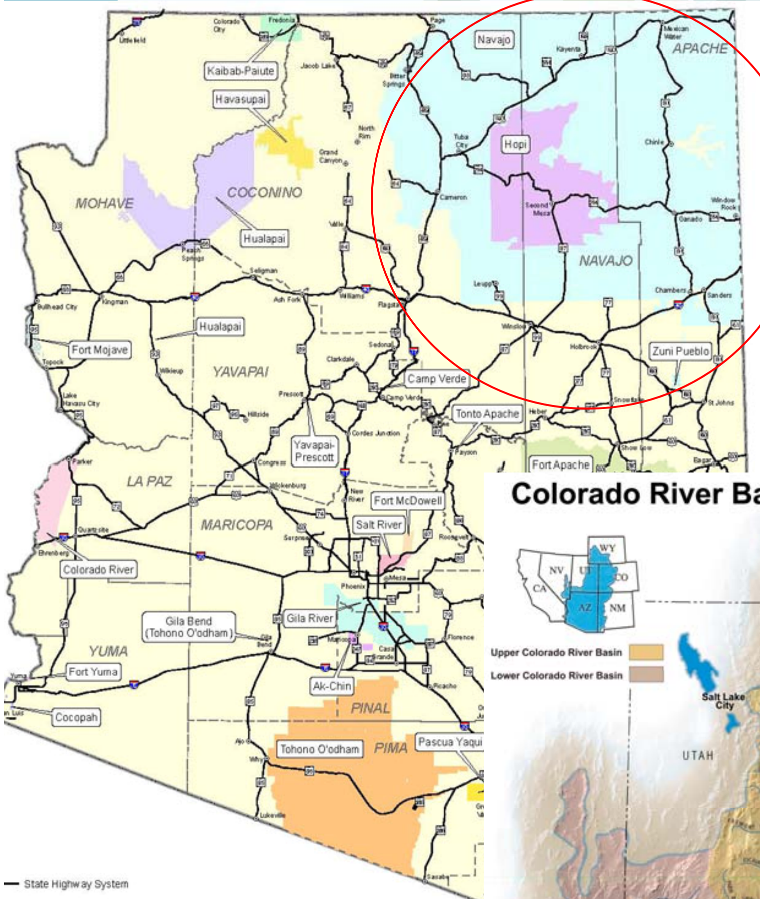
(US/DoI Bureau of Reclamation)

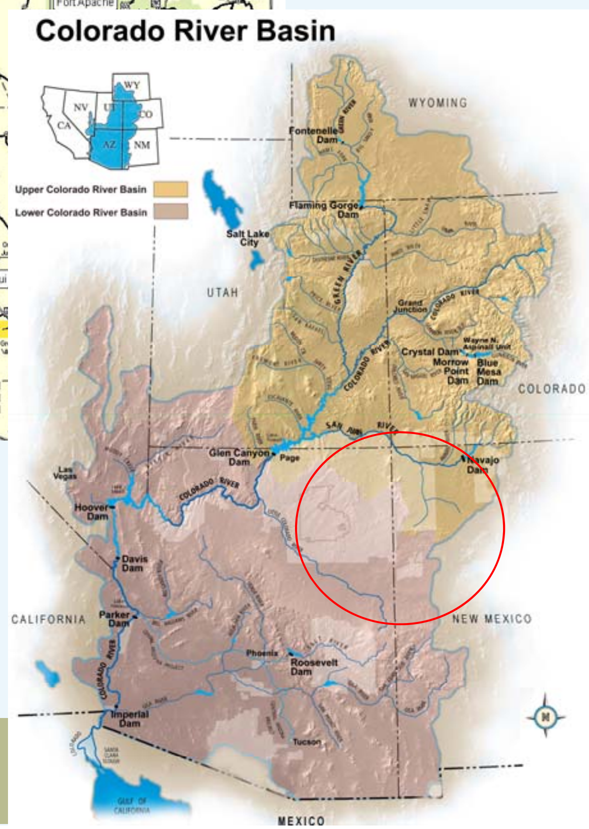
Year 2 Actions

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

1. Value of improved information using past conditions
2. Responses for projections/ scenarios(seasons, decadal, change)
3. Develop EWS Fora
4. Feedback on priorities (e.g. data gaps) to Executive Council

Native Nations in SW are major land managers



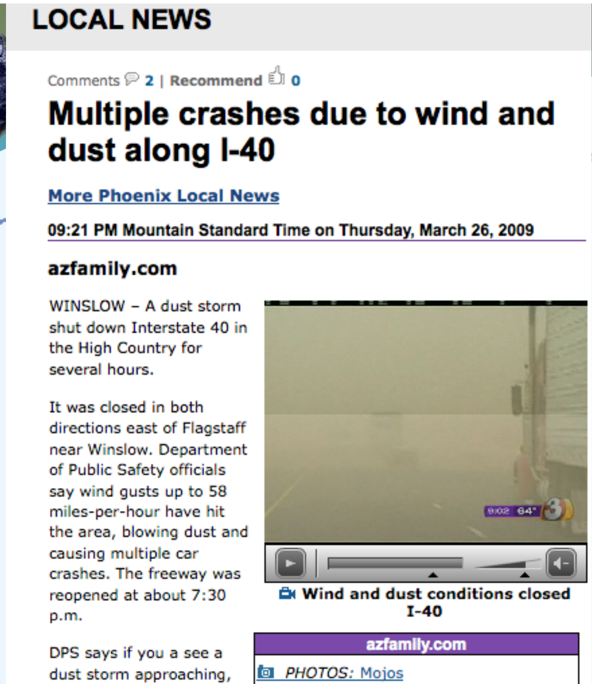


- 6 million acres/ 242kha of land
- held in trust by the US for American Indian tribes and Alaska Natives
- Reservations and tribal lands are >25% of land in AZ
- Confronting same climate trends, need same info, but context is different
  - cultural ties to landscape
  - federal trust relationship
  - widely variable capacity

Kayenta, AZ 2004

Margaret Hiza
Redsteer USGS

Landscape changes



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

azfamily.com

WINSLOW – A dust storm shut down Interstate 40 in the High Country for several hours.

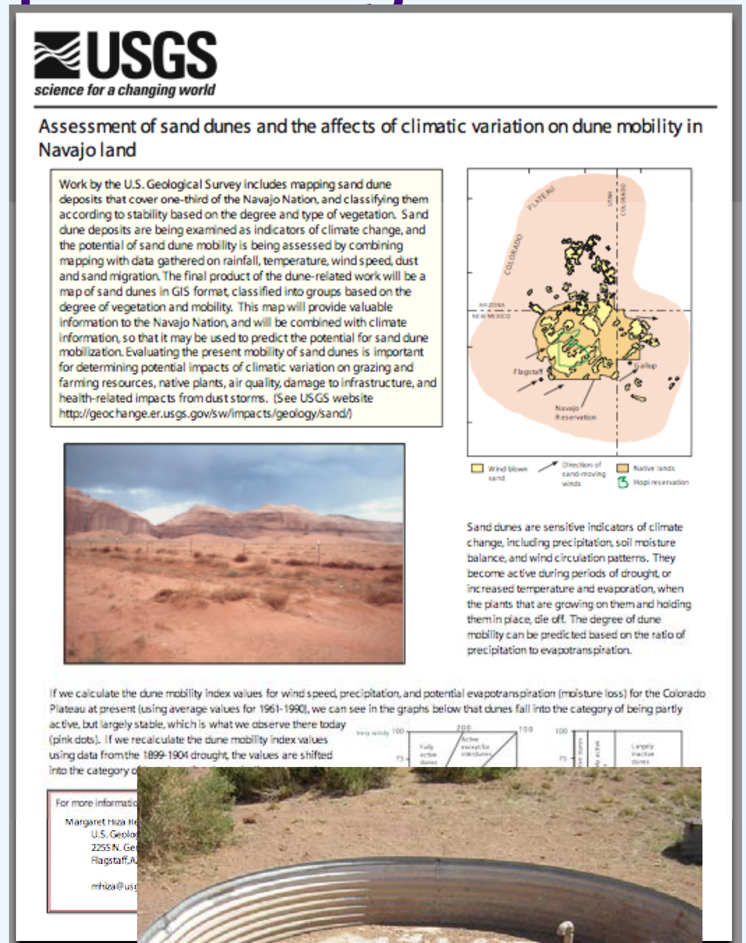
It was closed in both directions east of Flagstaff near Winslow. Department of Public Safety officials say wind gusts up to 58 miles-per-hour have hit the area, blowing dust and causing multiple car crashes. The freeway was reopened at about 7:30 p.m.

Wind and dust conditions closed I-40

azfamily.com

PHOTOS: Mojos

DPS says if you a see a dust storm approaching,



USGS
science for a changing world

Assessment of sand dunes and the affects of climatic variation on dune mobility in Navajo land

Work by the U.S. Geological Survey includes mapping sand dune deposits that cover one-third of the Navajo Nation, and classifying them according to stability based on the degree and type of vegetation. Sand dune deposits are being examined as indicators of climate change, and the potential of sand dune mobility is being assessed by combining mapping with data gathered on rainfall, temperature, wind speed, dust and sand migration. The final product of the dune-related work will be a map of sand dunes in GIS format, classified into groups based on the degree of vegetation and mobility. This map will provide valuable information to the Navajo Nation, and will be combined with climate information, so that it may be used to predict the potential for sand dune mobilization. Evaluating the present mobility of sand dunes is important for determining potential impacts of climatic variation on grazing and farming resources, native plants, air quality, damage to infrastructure, and health-related impacts from dust storms. (See USGS website http://geochange.er.usgs.gov/sw/impacts/geology/sand/)

Wind blown sand
Direction of sand-moving winds
Native lands
Hopi reservation

Sand dunes are sensitive indicators of climate change, including precipitation, soil moisture balance, and wind circulation patterns. They become active during periods of drought, or increased temperature and evaporation, when the plants that are growing on them and holding them in place, die off. The degree of dune mobility can be predicted based on the ratio of precipitation to evapotranspiration.

If we calculate the dune mobility index values for wind speed, precipitation, and potential evapotranspiration (moisture loss) for the Colorado Plateau at present (using average values for 1961-1990), we can see in the graphs below that dunes fall into the category of being partly active, but largely stable, which is what we observe there today (pink dots). If we recalculate the dune mobility index values using data from the 1899-1904 drought, the values are shifted into the category o

For more informatio

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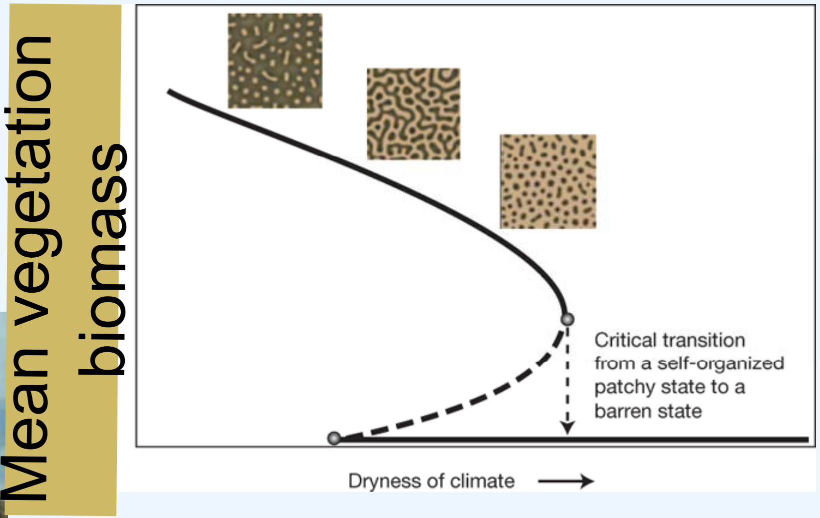
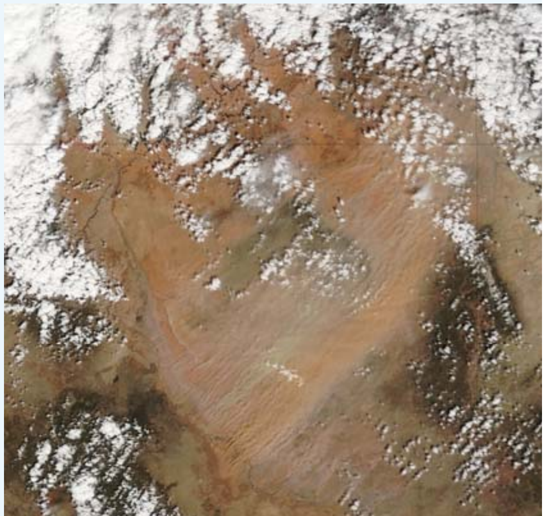
Landscape changes-
Drought Early Warning on Tribal Lands in the Four-Corners Region



(Nature, 2009)




LOCAL NEWS

Comments 2 | Recommend 0

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Co-produced Scenarios: 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

Patterns shift – more winter precipitation relative to summer

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

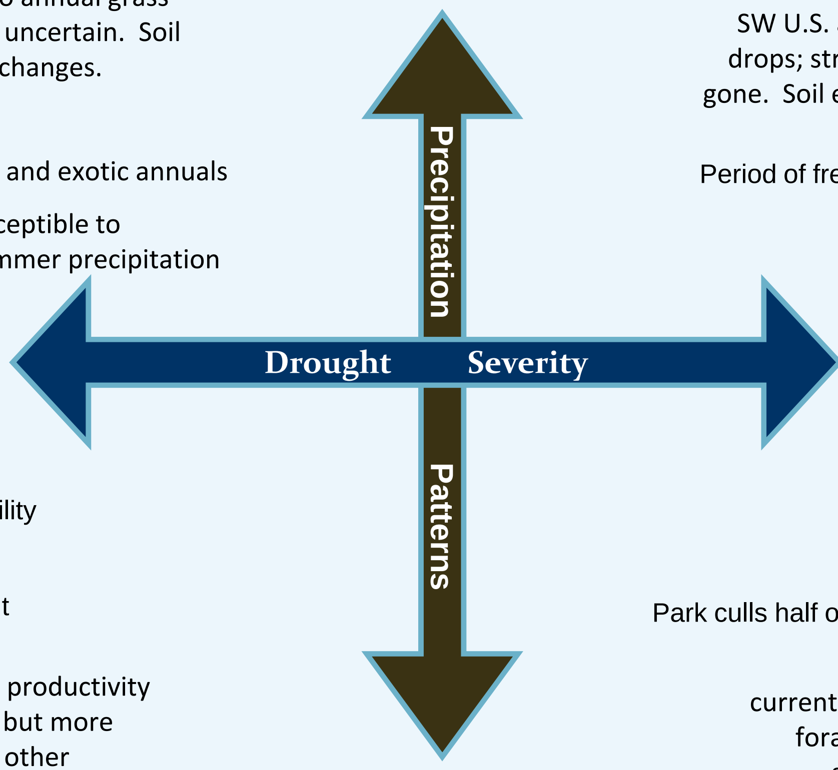
Novel Ecosystem

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

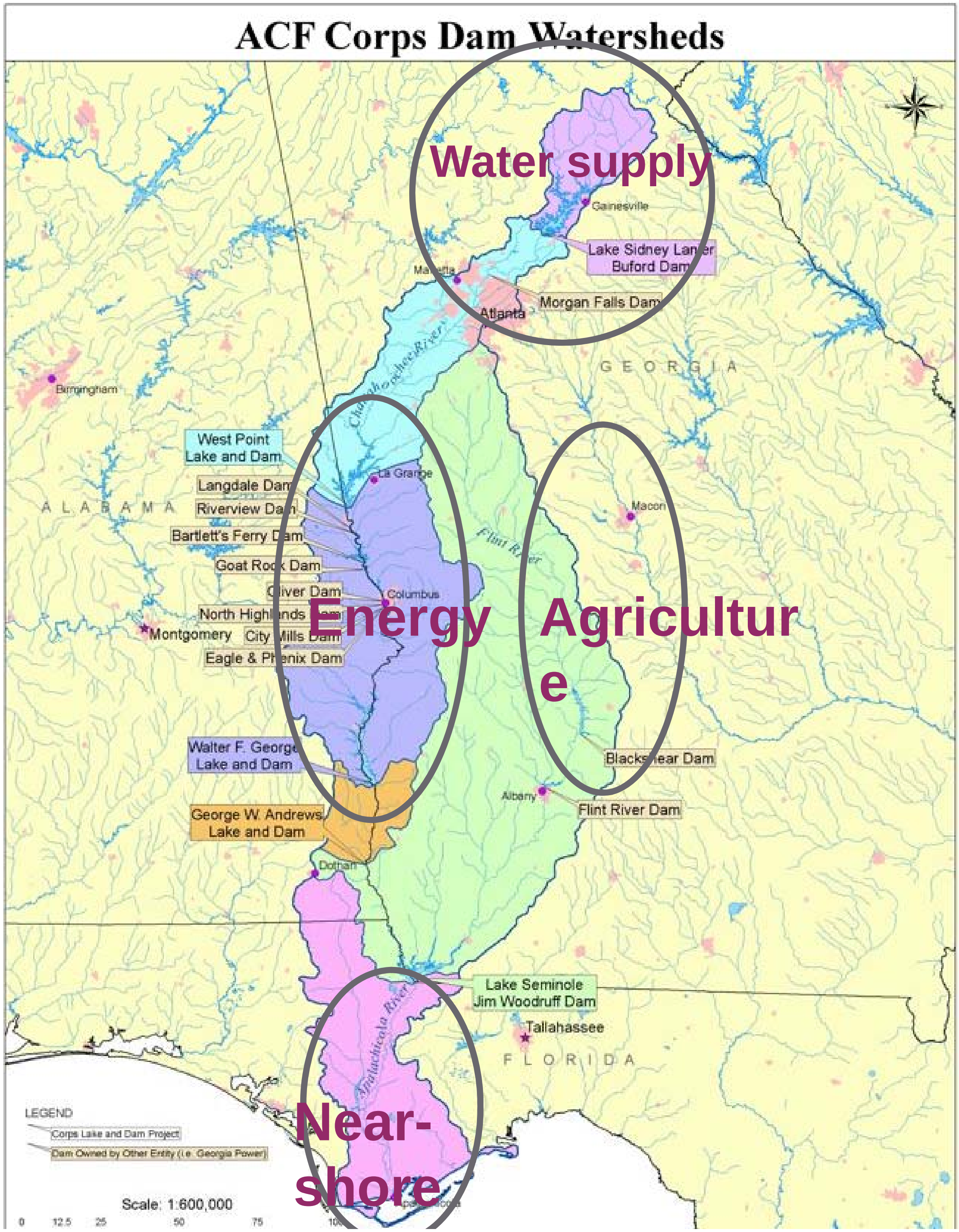
Extreme heat events – camp fire bans

Decreased water availability

Park culls half of the bison 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.

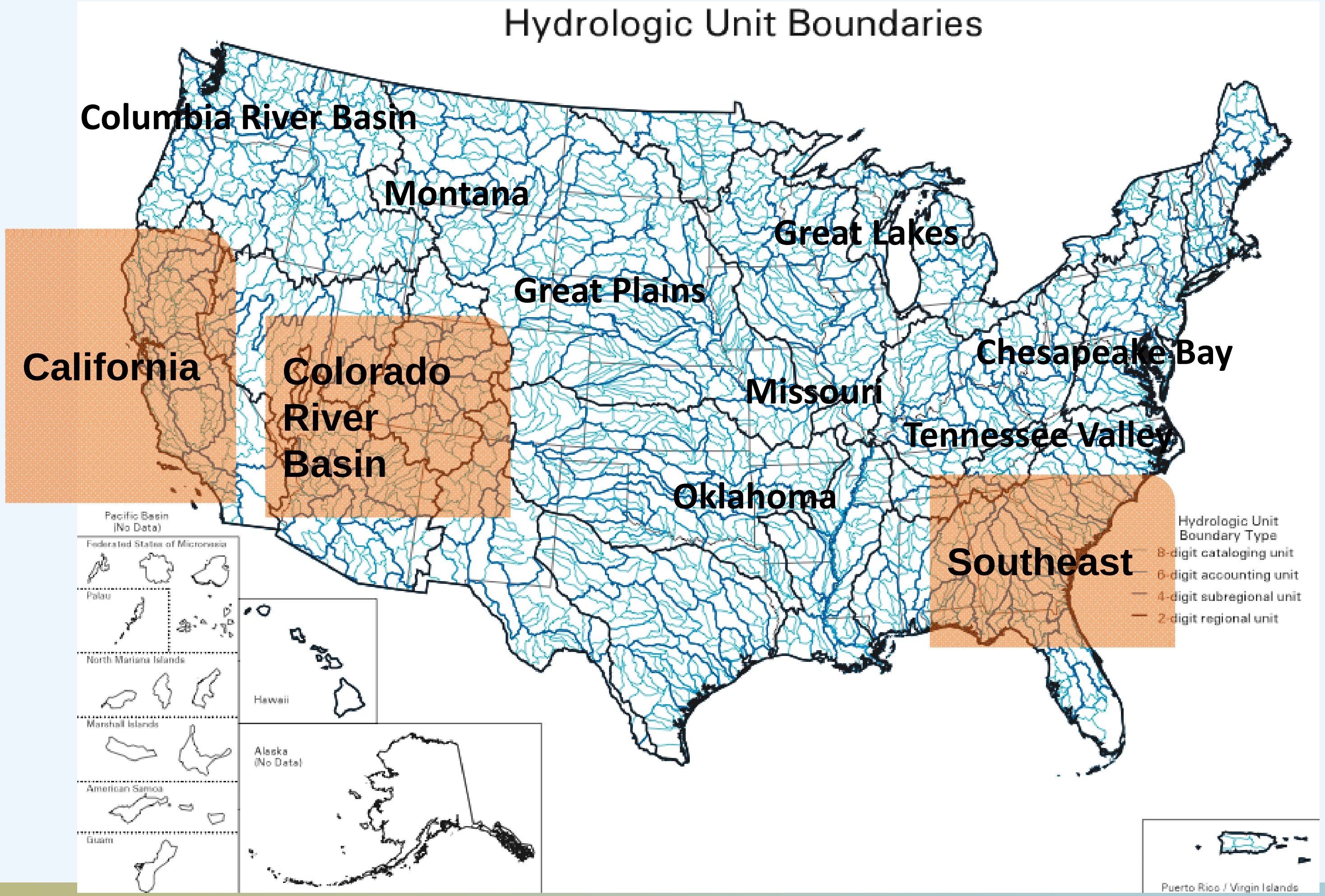
Shortgrass Prairie



Apalachicola-Chattahoochee-Flint Basin

Regional Drought Early Warning Systems

Highlighted-first round prototypes;
Non-highlighted-second round Regional DEWS



The development phase or regional drought early warning information systems:

Information-integration, diffusion, use, evaluation

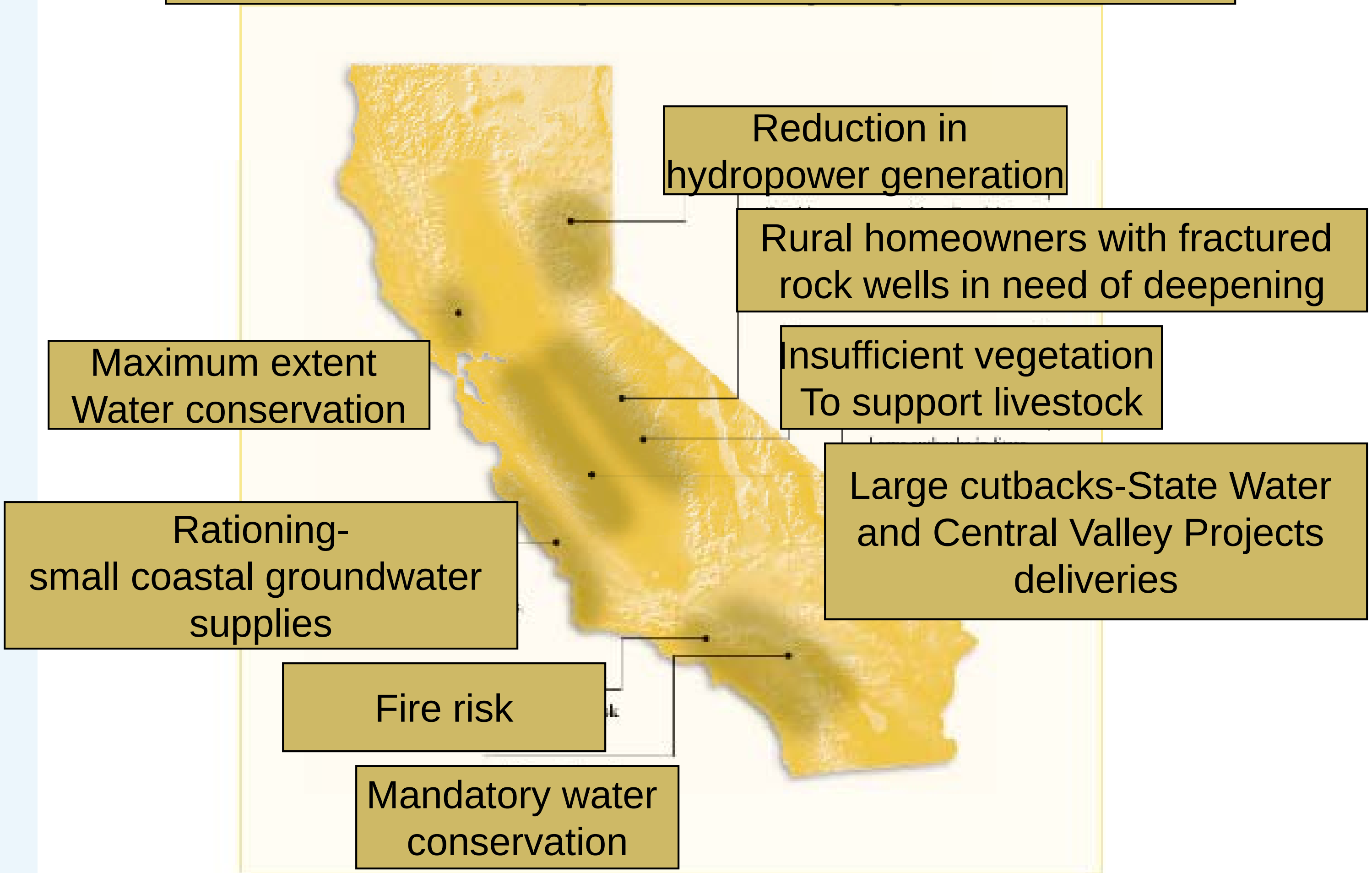
- Allows for existing barriers to cross-agency collaboration to be addressed
- Innovations and new information to be introduced and tested, and
- The benefits of participation in design, implementation and maintenance to be clarified

Mature prototypes becomes the regional system.

Lessons become more likely to be successfully transferred within or to other as yet underserved regions.

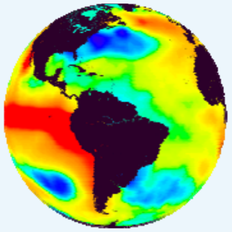
- Identifying appropriate partners, stakeholder representatives
- Setting goals/priorities, and involving partners in problem definition
- Using professionals from relevant agencies etc. to build common ground
- Producing collectively authored gaps assessments
- and agreement on the way forward
- Building longer term collaborative partnerships
- Tradeoffs-Decision quality vs decision acceptability

California- Recent drought impacts



“We would cite the National Integrated Drought Information System (NIDIS) as one example of how federal agencies can work together and with states ……NIDIS is not perfect yet– but it demonstrates key elements of how….to deliver actionable information to end users and decisionmakers”

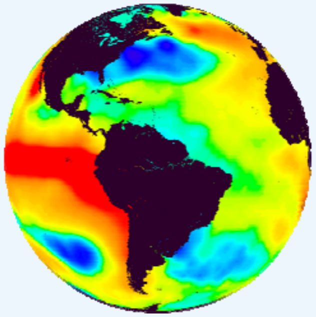
Western Governors letter to CEQ-Response to CEQ Adaptation Interim Report May 21, 2010



NIDIS as prototype: Informing climate services development

“If we don’t get NIDIS right, we can’t get a national climate service right”

Kelly Redmond, Western Regional Climate Center

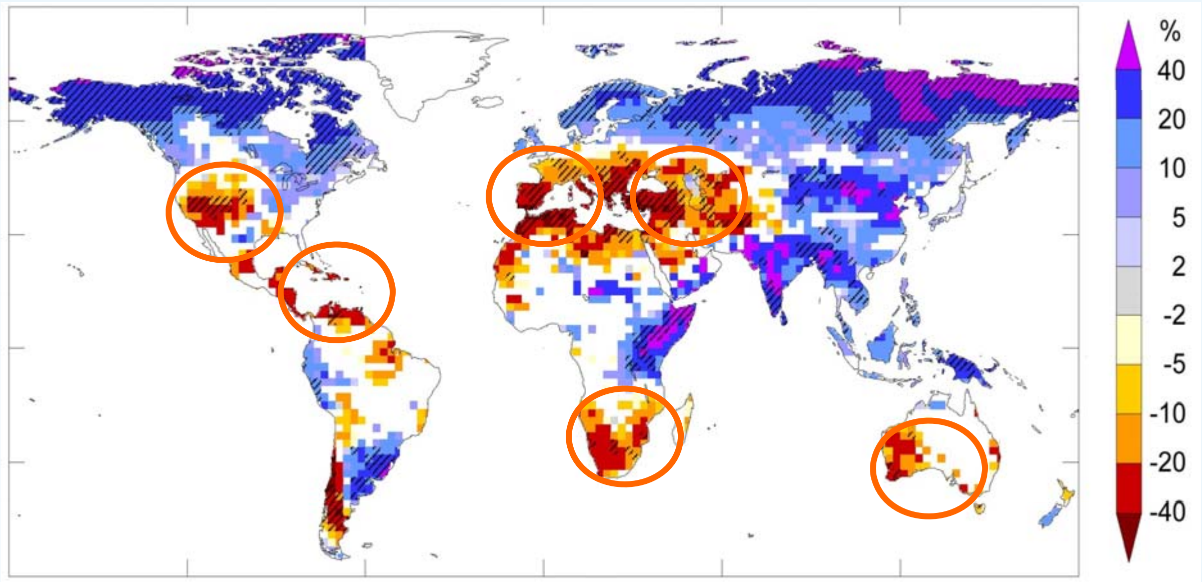


6th Drought Monitor Forum
Austin, Tx Oct. 7-8, 2009

Need for exchange of experience and learning among different basins

How is awareness of slow onset problems in the context of seasonal to decadal-scale variability and longer-term change developed ?

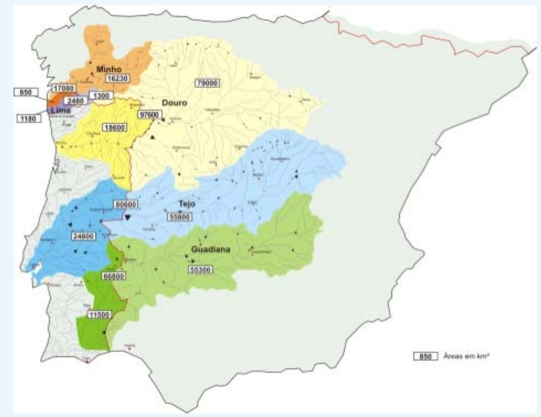
How are adjustments and adaptations being designed, implemented, and evaluated ?

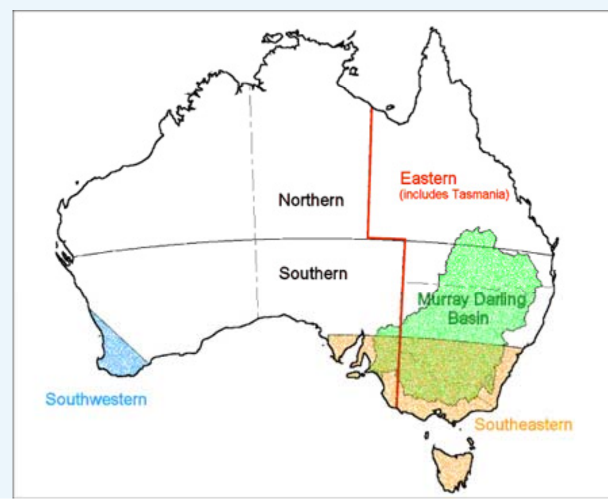


NIDIS-Transferability

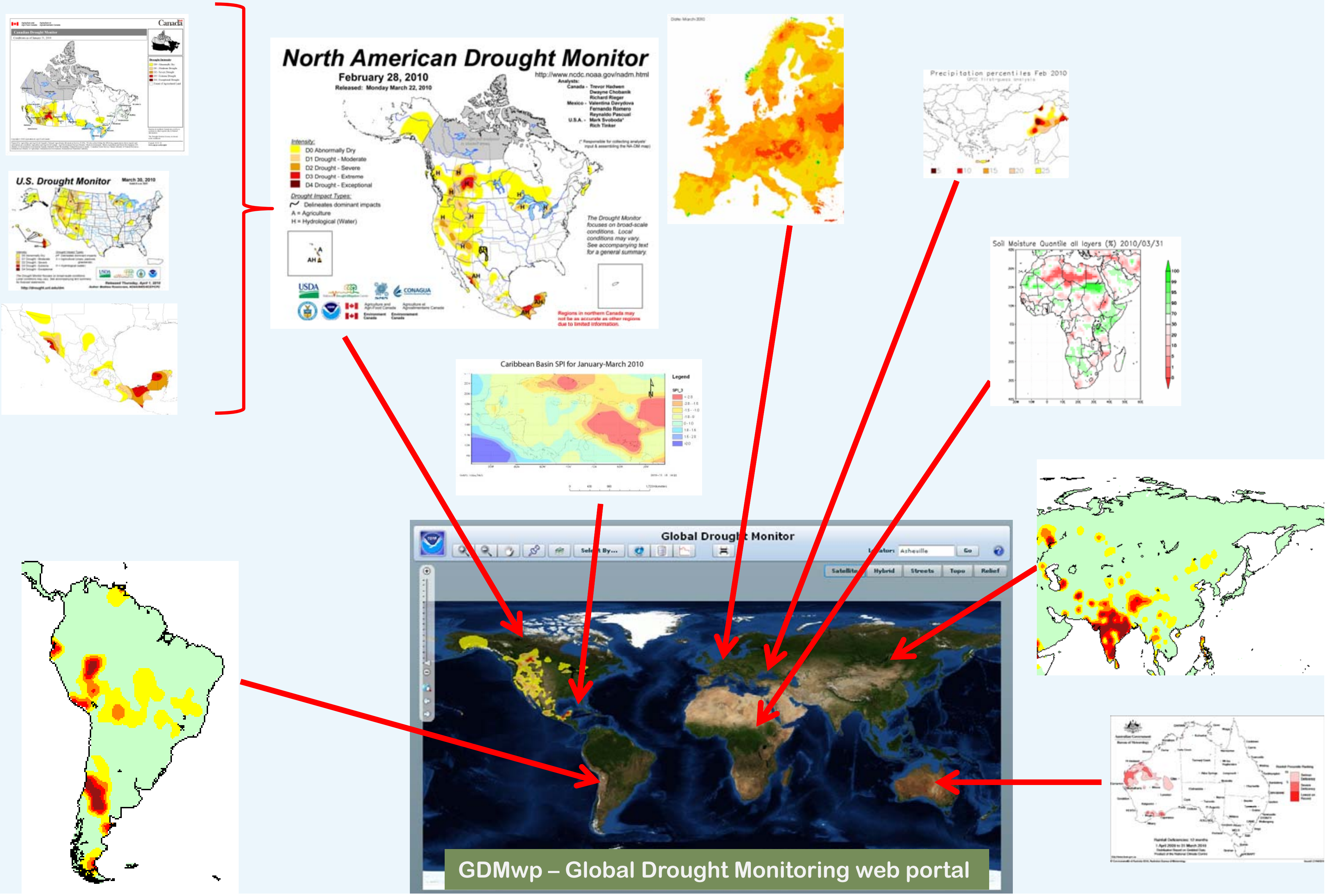
- FEWSNet
- GEO Water Resources

- Mediterranean/Iberian Peninsula
- Australia (MDB/Colorado)
- India NIDIS
- Caribbean Basin
- US-Canada PNW
- GIDIS-





Global Drought Monitoring Conceptual Framework



The "Services" Challenge

Identify user requirements
Conduct research

Develop applications and capacity
Integrate knowledge and products

Deliver information
Data quality control

MONITORING/FORECASTS

&

DEVELOPMENT
(Assessments,int.products)
&

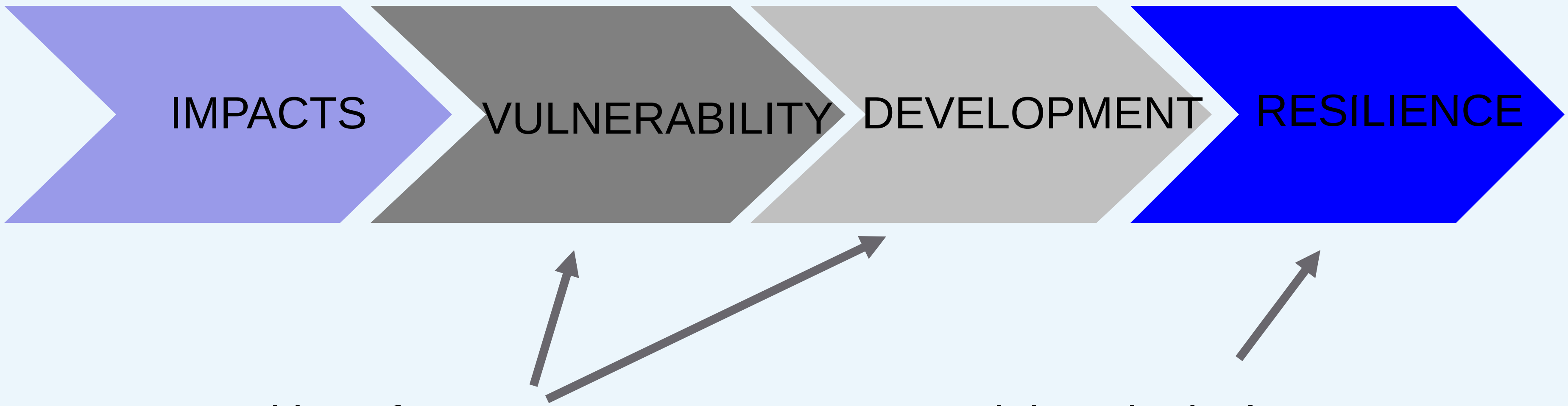
PROTOTYPING
(Scenarios, Applications)

DELIVERY/MAINSTREAMING

Relative status of information

STATIC…………………………EMERGENT/DYNAMIC

Watershed transitions



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

Limits of co-production

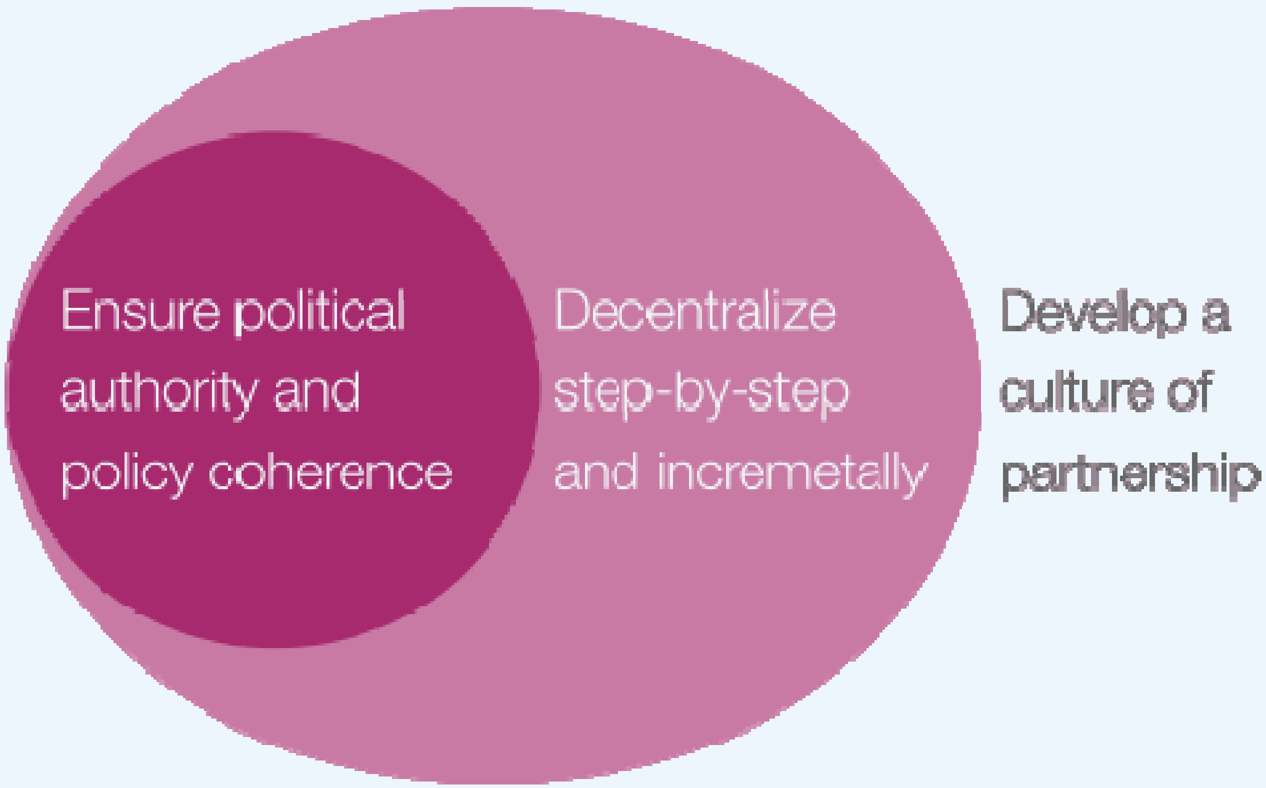
Social-ecological

Path dependence

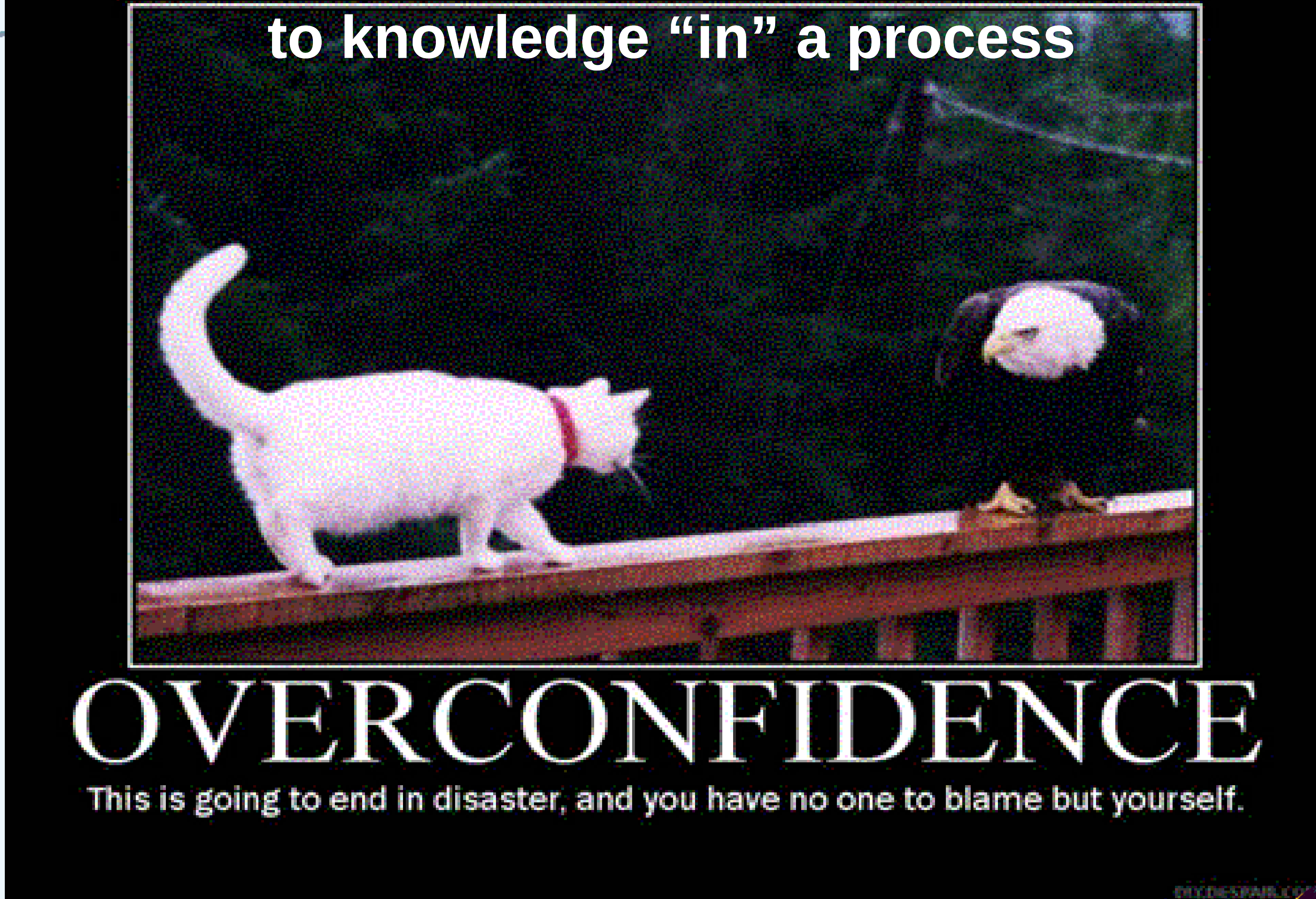
Organizational boundaries

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

Risk governance



Knowledge “of” a process is not equal to knowledge “in” a process



Challenges

- Develop strategic responses to crises: forseeable, impending, actual; and
- Provide implementable options to critical actors for decision-making

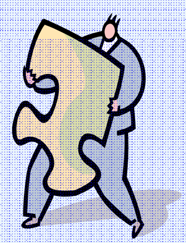
A systemic view would involve assessing:

- Impediments to the flow of knowledge among existing network components
- Policies and practices that can give rise to failures of the component parts working as a system
- Opportunities for and constraints to learning and institutional innovation

Visit the Global Assessment Report 2011 online:
www.preventionweb.net/gar

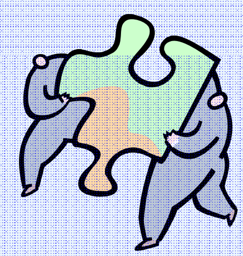
Moving beyond impacts reports- Engaging communities, resources managers in a changing climate

(Federal data, NDMC, RISAs, RCCs, State Climatologists….. NIDIS)



Integrated Climate, Ecosystems, Hydrology:Technical Info & Data

+



Watershed, state, tribal, local: Experience & Knowledge

=

Decision Support

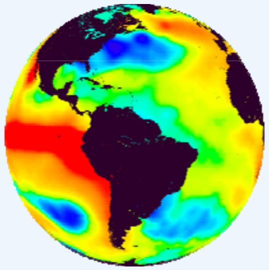
Climate information: Needs,usability,evaluation

Entry points for proactive
Planning-triggers and indicators

Enabling adaptation:

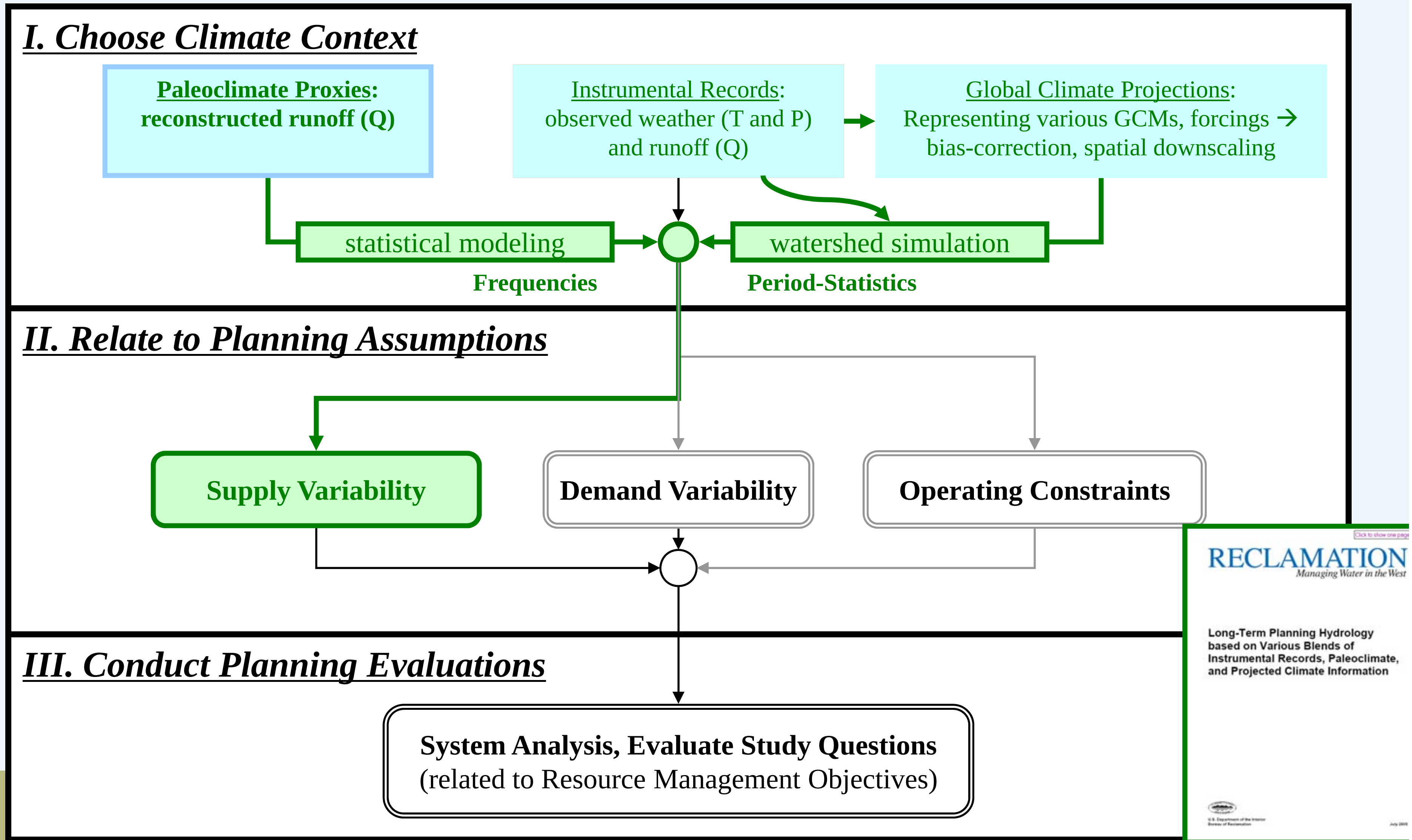
Best available drought risk
& water supply information
Input to drought planning,
preparedness and adaptation

THANK YOU!



BACKUP SLIDES

Supply Variability: Blend paleo, instrumental and projected climate (Reclamation-Brekke and Prairie 2009)



Challenges in a changing climate

Assessing progress for each element of planning and implementation

(i) **Capacity and coordination**

Priorities for early adaptation action, including land use planning, building design, emergency planning, local infrastructure provision and green space management

(ii) **Decision-making**

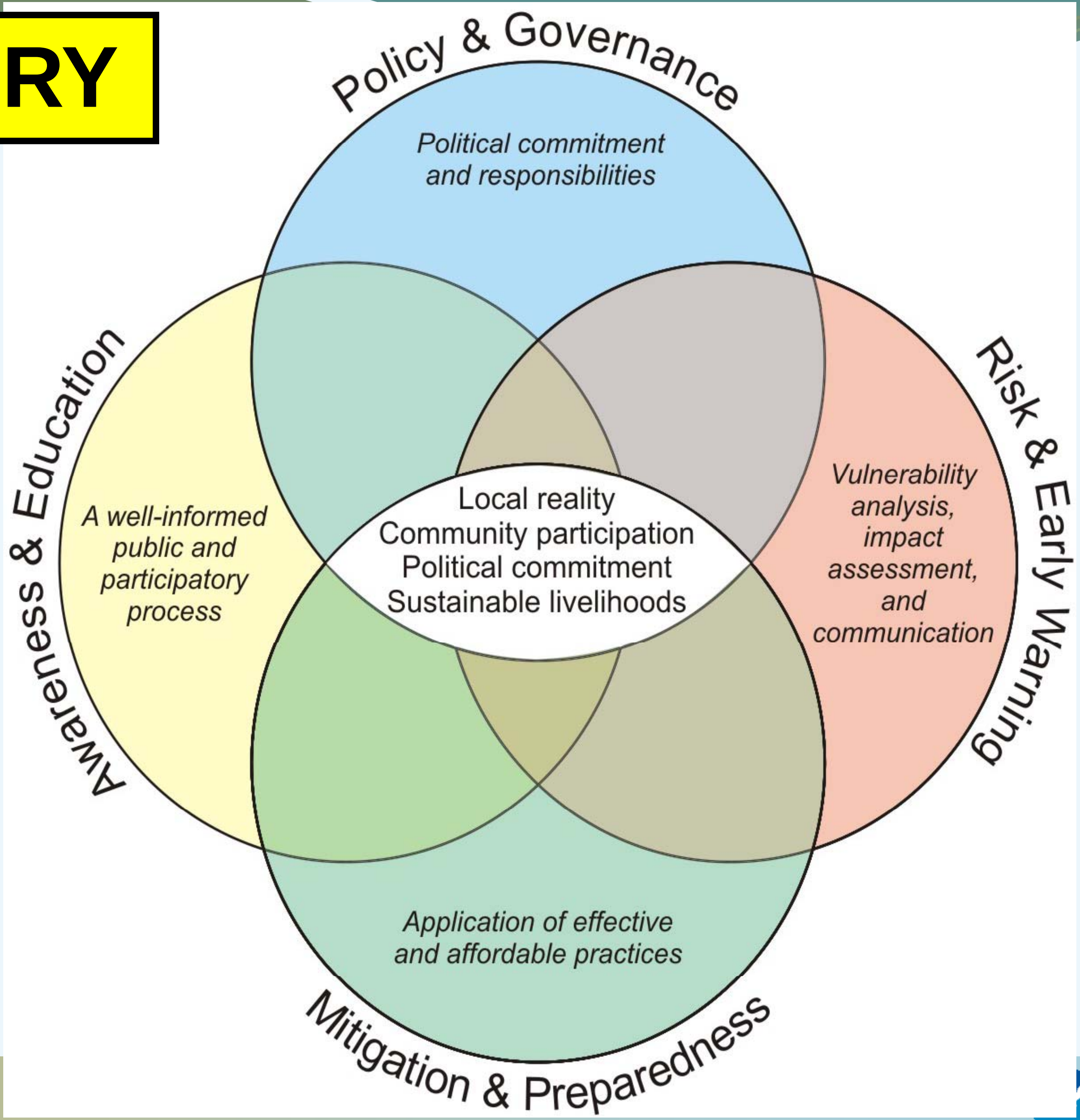
- Monitoring decision-making is not straightforward
- Wide range of organisations that are relevant to adaptation,
- Sources of evidence here will include: Analysing how climate change is considered in decisions on regionally significant infrastructure projects, in local planning policies and in local development decisions.

(iii) Timeliness of action

- depends on regional/local circumstances-surprises
- cost-effectiveness of adaptation measures
- implementation monitoring and evaluation

SUMMARY

Principal Elements of Drought Risk Reduction Framework



Risk Profiles

Vulnerable Sector/ activity/ group	Magnitude	Rates of Change	Persistence and reversibility	Likelihood and confidence	Distribution	Potential for Adaptation
Economic sectors (Water, Ag, Tourism etc.) Communities at risk Bounded ecosystems such as coastal, mountain are already stressed	Situation of existing Levels of vulnerability for different magnitudes of change, especially thresholds, relative to temperature, precipitation or the other critical parameters that create the vulnerability	Critical rates/steeper response curves that affect vulnerability	Likelihood that the vulnerable sector will be affected by an irreversible impact and whether it is likely to persist.	Overall confidence and likelihood, but state confidence also with any specific figures or points.	Distribution of impacts – both physically and socially within countries (not in a simple developed/developing dichotomy).	Capacity for adaptation. Is adaptive capacity sufficient to delay or prevent adverse impacts and at what cost.

WGII &Leggett and Pulwarty

Mission: Implement a dynamic, accessible, authoritative drought information system

NOAA Produces:	With Our Partners:	Used By:
Monitoring and Forecasting		
U.S. Drought Monitor	USDA, National Drought Mitigation Center	USDA, state and local governments
U.S. Soil Moisture Monitoring	DOE, USDA (NRCS)	USDA, agricultural producers
Normalized Difference Vegetation Index	USGS, NASA	USAID (FEWS NET)
Crop Moisture Index	USDA	USDA, agricultural producers
Ensemble Water Supply Forecasts	USDA	USBR, USACE, state water management agencies, local district water managers
Soil Moisture Anomaly Forecast	USDA (NRCS)	USDA, agricultural producers

NOAA Produces	With Our Partners:	Used By:
Products Informing Risk Assessment and Management		
Reconciling projections of future Colorado River stream flow in a changing climate	USBR, USGS, University of Washington, University of Colorado, University of Arizona, University of California-San Diego	USBR, state and local water providers, reservoir managers, Water Conservancy Districts
USGS Circular 1331: Climate Change and Water Resources Management: A Federal Perspective	USGS, USBR, USACE	USBR, USACE, Water Utilities
Climate Change in Colorado: A Synthesis to Support Water Resources Management and Adaptation	Colorado Water Conservation Board, University of Colorado, Western Water Assessment RISA	Colorado water planners, State Climatologists
Managing Threatened and Endangered Salmon in Low Water Conditions	USBR, CA Department of Fish and Game, CA Department of Water Resources, University of California Davis, Humboldt State University	NMFS, CA Department of Fish and Game, CA Department of Water Resources, Pacific Fisheries Management Council
Assessing Drought Indicators and Triggers	USGS, USDA (NRCS), Colorado Water Conservation Board, Colorado State University, Utah State University, University of Wyoming	USGS, USDA, USBR, water planners/providers, reservoir managers, State Climatologists

Type I: Those that are well-known cases from the past where a threshold was reached and the management challenges are explicit. What lessons are available to learn that are already well documented?

Type II: Those that are emerging now and often feature aspects of accelerating change or where the accumulation of small change appears to lead to some large change in management or policy response

Type III: Those that present very large scale, system-wide challenges. Type 3 cases are examples where we know the system well enough, or the science well enough, to think that we really ought to be concerned, that there is an important tipping point/or threshold out there

Drought Preparedness for Tribes in the Four Corners Region Workshop

April 8-9, 2010, Flagstaff, Arizona

Tribal perspectives on critical issues

Local Knowledge & Drought: How do we incorporate local knowledge?

What are current vulnerabilities and impacts tied to drought and climate change?

Critical drought-related information needs on tribal lands in Four Corners region

Improved monitoring emerged as the highest priority near-term need

Revisiting past events with key basin and local decisions

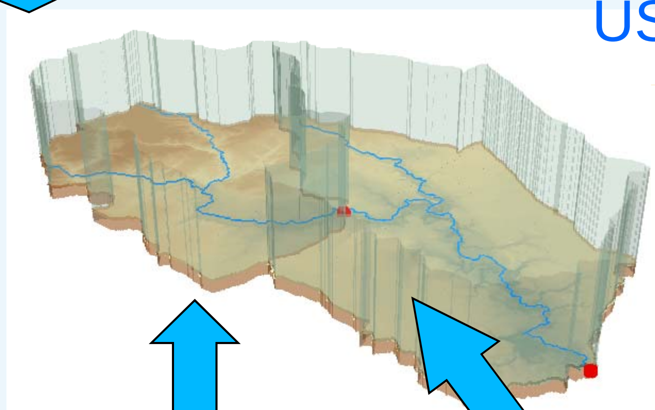
Weekly drought situation assessments- webinars presented by key resource reps. (coordinated by State Clim. and RFC)

Information inputs into existing drought and water resources preparedness and adaptation plans

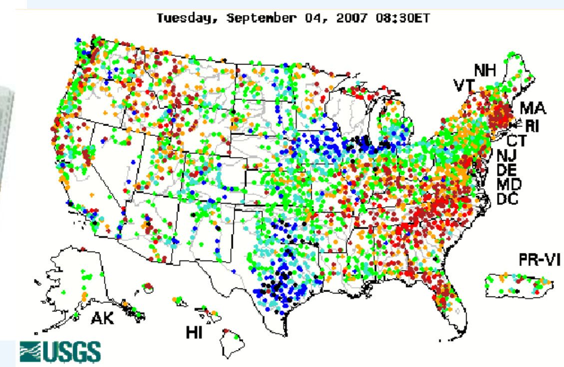
- Gaming scenarios on sensitivity, projections, potential surprises-short-term adjustments-long term risks
- Modifications of existing plans-prioritized actions

Connecting geospatial and temporal water resources data

Digital Watershed

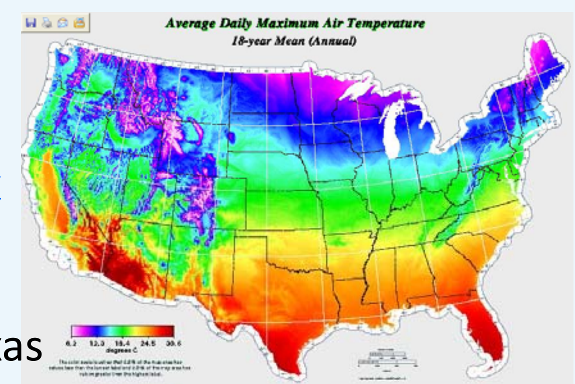


USGS NWIS Streamflow

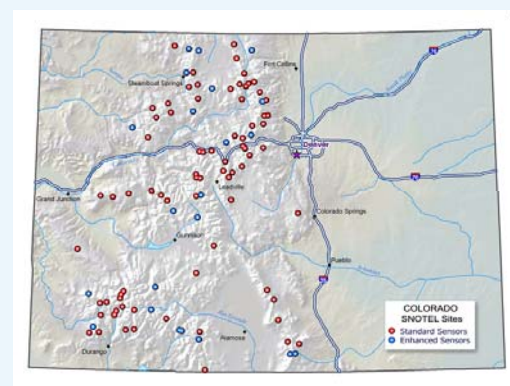


NHDPlus

NOAA NCDC and ASOS

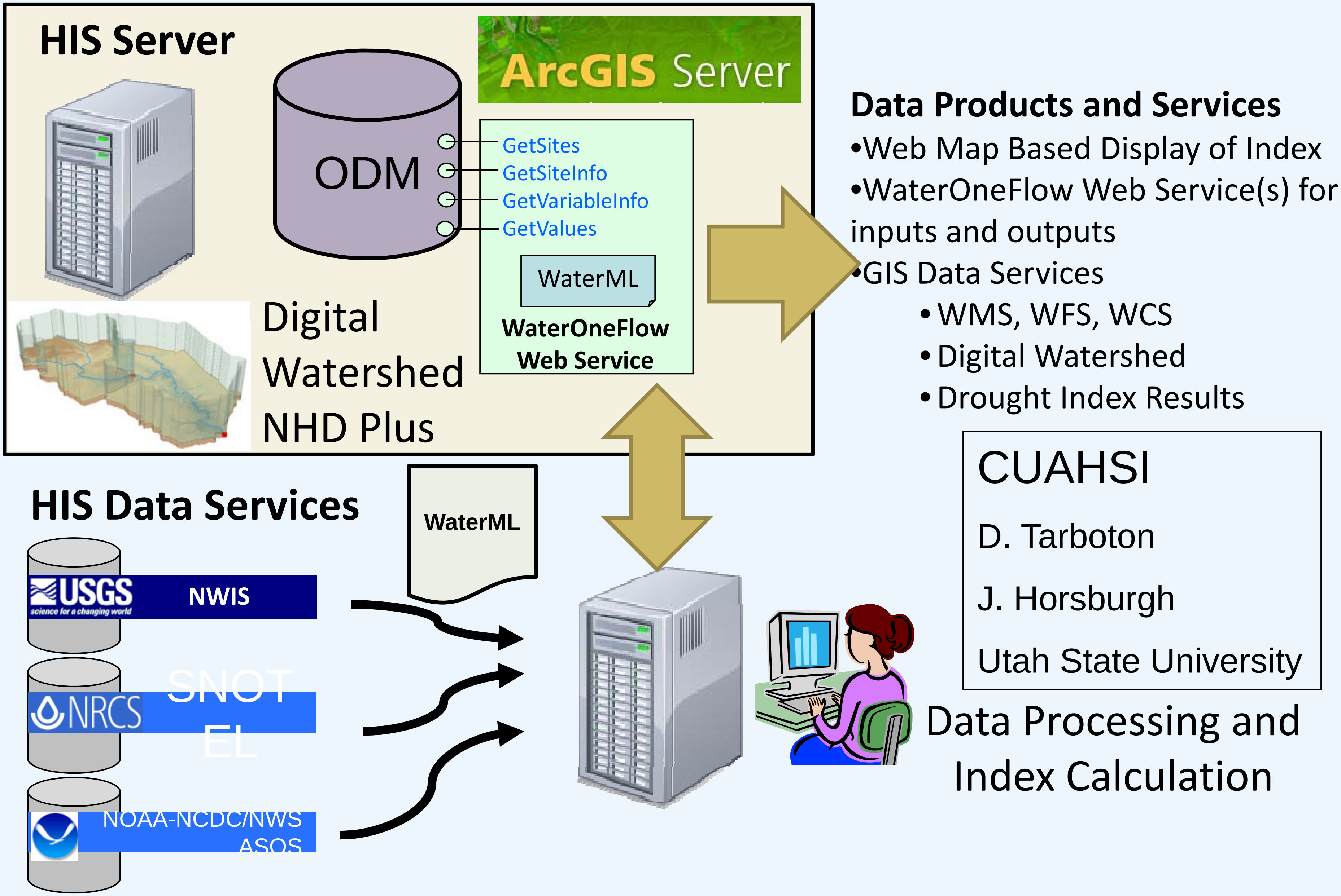


NRCS Snotel



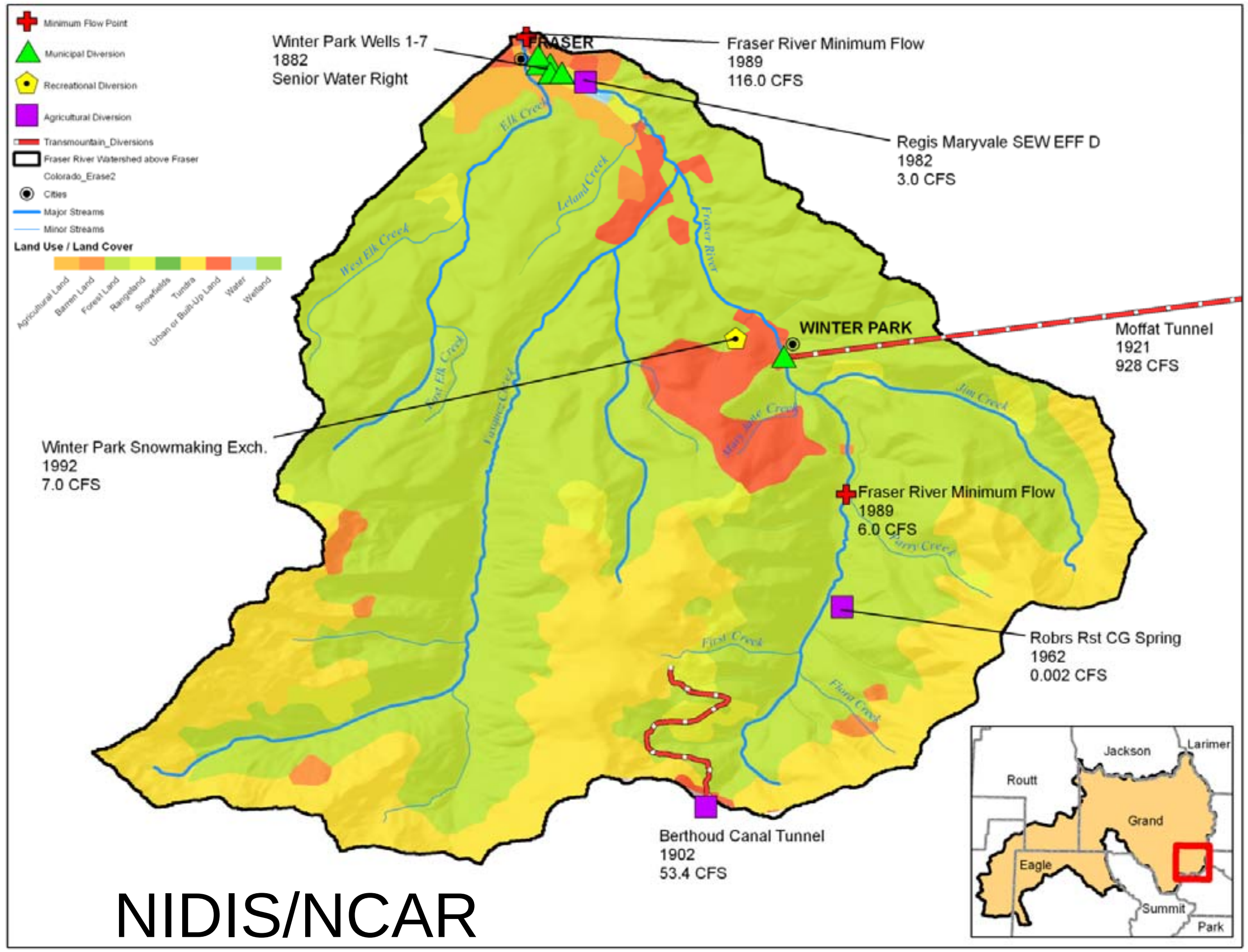
David Maidment, U Texas

CUAHSI HIS Custom Drought Index Server



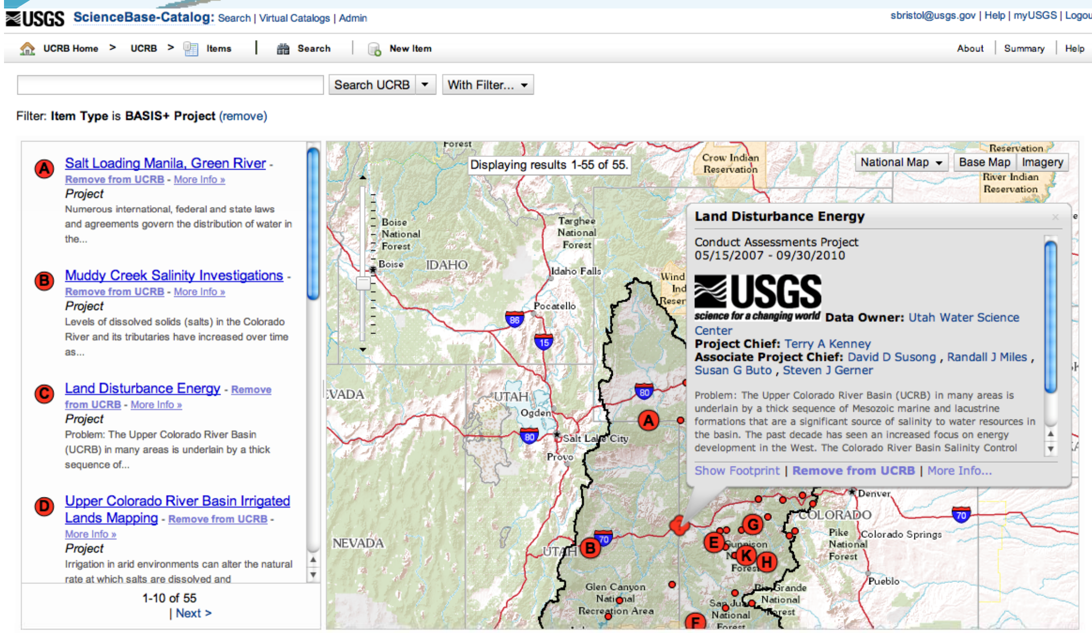
Upper CO Basin Water Demand Spatial Analysis

Drought vulnerability GIS database that represents relationships among water users and their respective sources of water supply



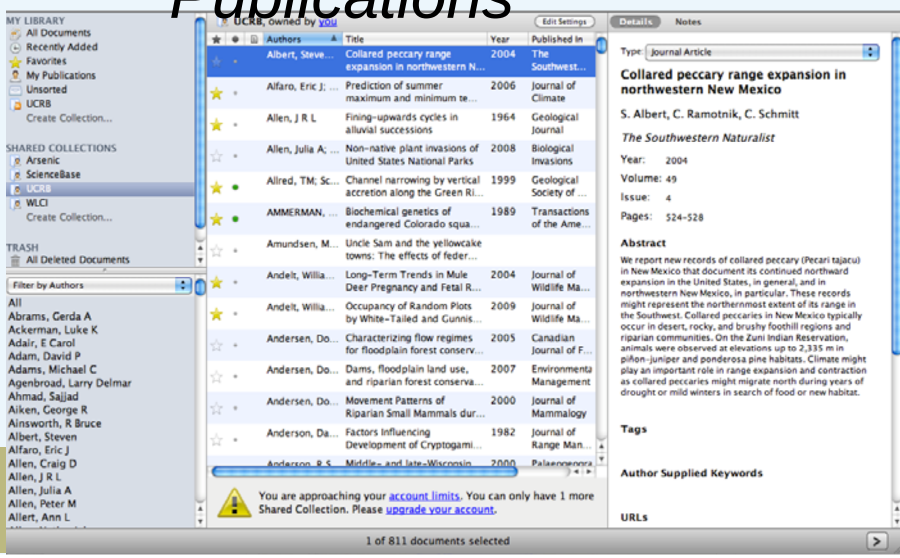
Data Mining for Water Availability, Ecosystem Change, and Services

Projects

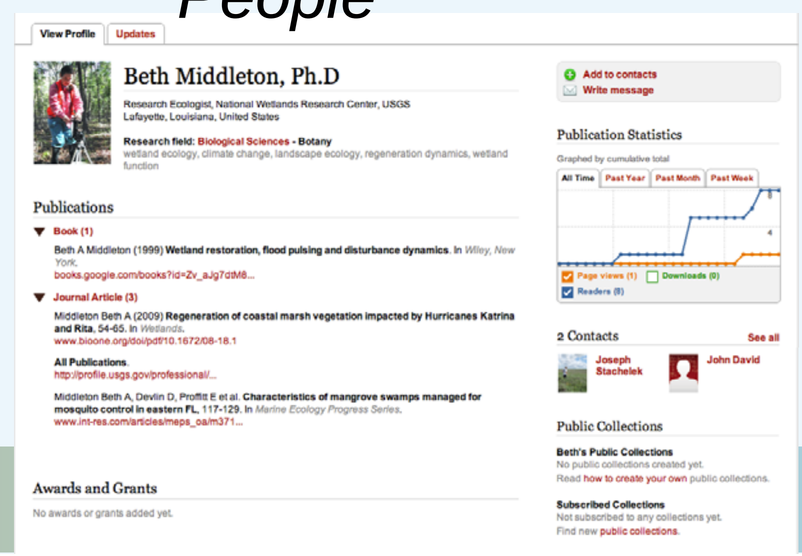


Portal development sponsored by USGS Climate Effects Network and NIDIS

Publications



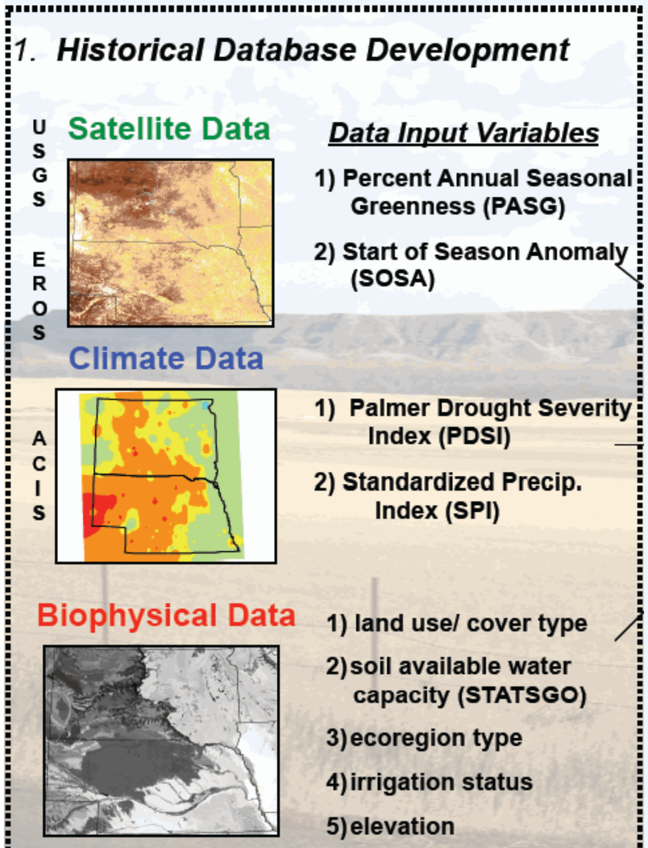
People



Vegetation Drought Response Index (VegDRI)

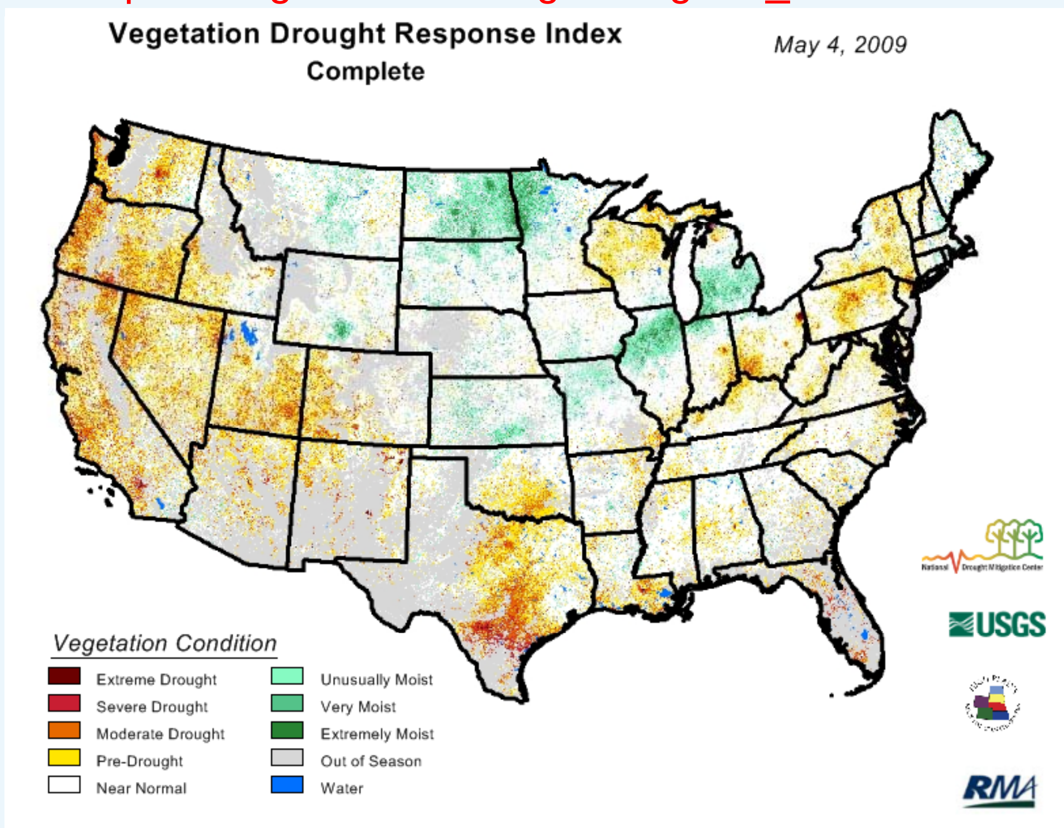
✓ Hybrid Drought Index that Integrates:

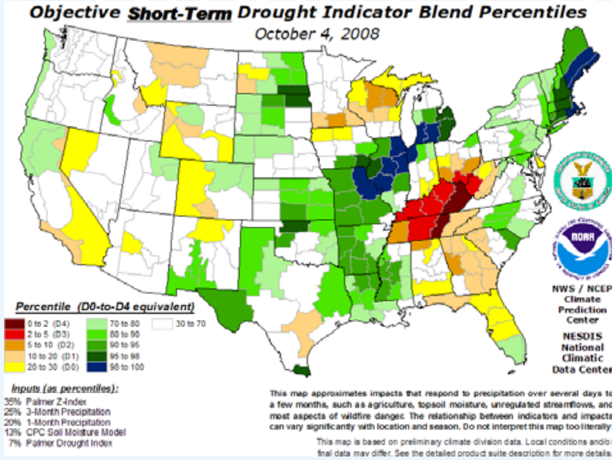
- Satellite-based observations of vegetation conditions
- Climate-based drought index data
- Biophysical characteristics of the environment

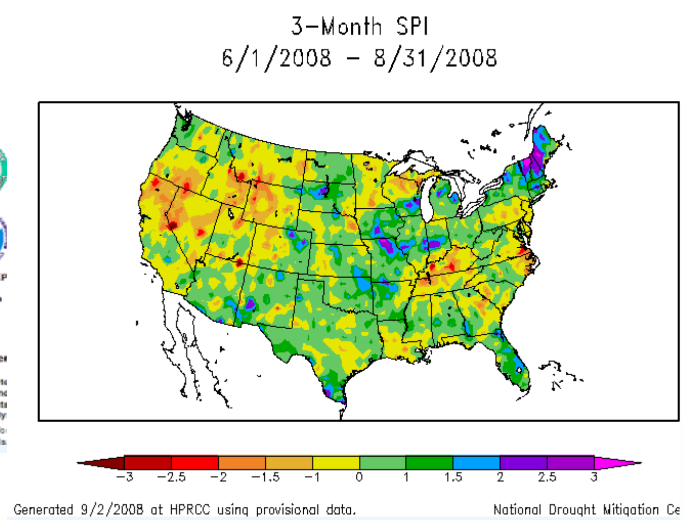


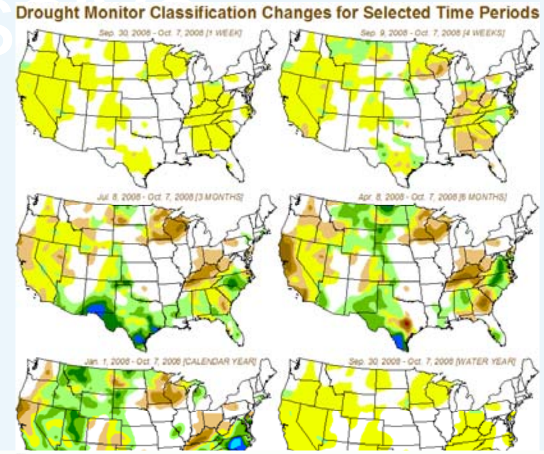
(Source: Wardlow, 2008)

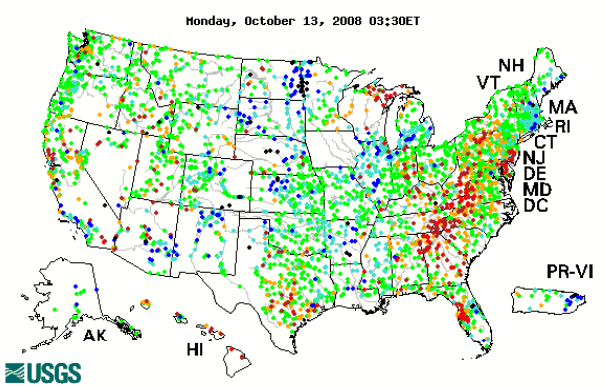
http://drought.unl.edu/vegdri/VegDRI_Main.htm

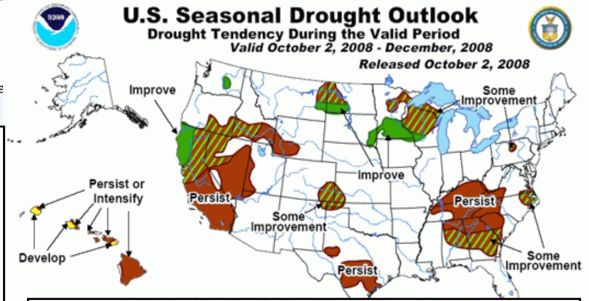


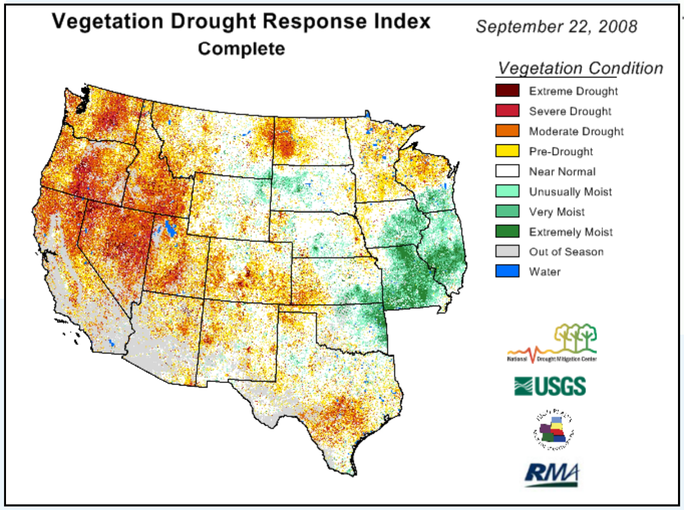


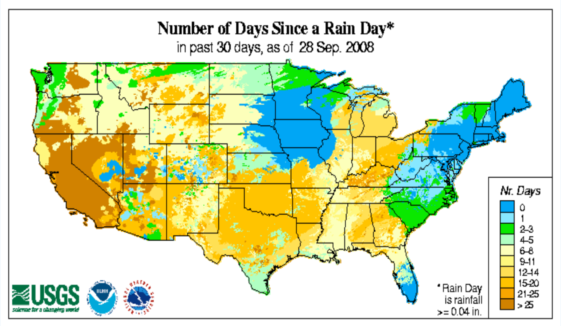


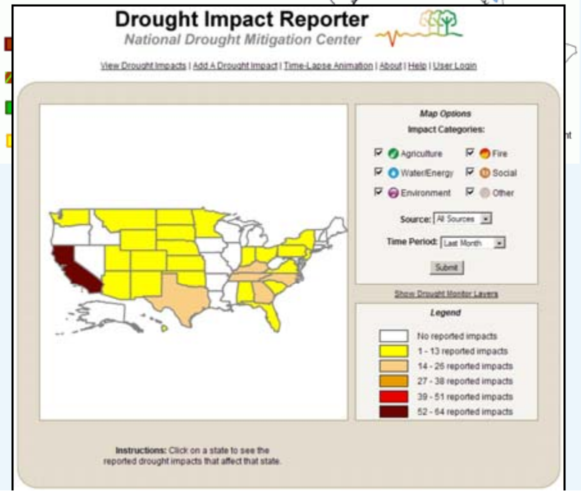






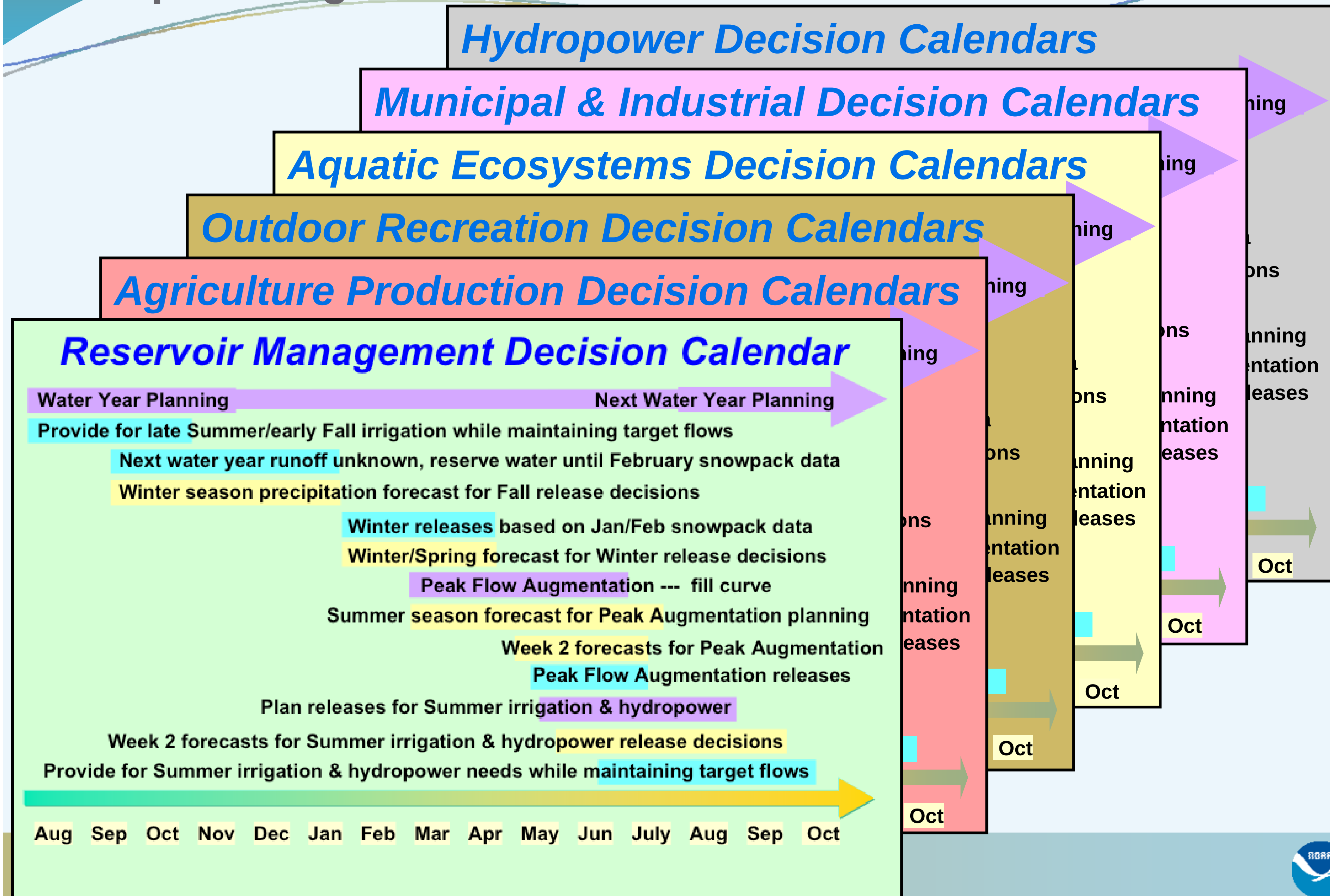






. . . . with more tools on the way!

Drought information and Resource Management: optimizing risk reduction



Regional Drought Early Warning System
Upper Colorado River Basin

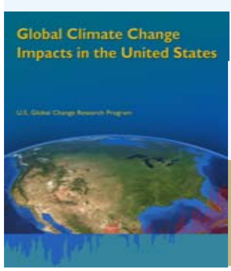
Given better data and information coordination, would responses have been improved for past events? Assess:

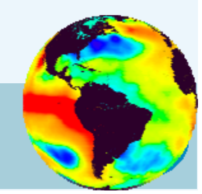
1. Value of improved information using past conditions
2. Responses for projections/ scenarios(decadal, climate change)
3. Feedback on priorities (e.g. data gaps) to Interagency Executive Council

Managing in a changing climate: Adaptation needs

(1) Understand adaptation as being driven by crises, learning and redesign- <u>Role of "surprises" in shaping responses</u>

- **Human action in response to projections is reflexive**
- **Key drivers, such as technological innovation and change, are unpredictable with great accuracy on scales that matter for regional and local decisions-both pressures and solutions**
- **The system may change faster than the models can be recalibrated, particularly during turbulent periods of transition-Projections may be most unreliable in precisely the situations where they are most desired**
- **Inactions, actions and consequences**





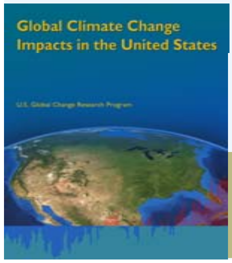
Adaptation needs-

(2) Early warning systems for critical thresholds across climate time and space scales: Extremes in the context of change

(3) Derive risk profiles and a portfolio of measures for each location/unit of analysis, identifying the broader economic, social and environmental benefits of each measure along with its cost

Methodological developments:

- Cost-effectiveness-costs of action and of inaction
- Technological Efficiency:Drivers of adoption
- Renewables:Viability and offsets
- Evaluation: Infrastructure vs emergent events



(4) Science for adaptation-

Sustain a collaborative framework between research and management -

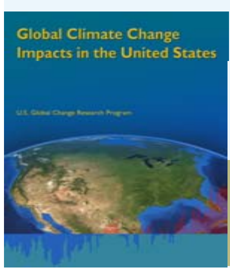
Engage both leadership and the public

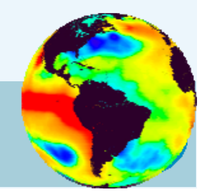
Scenario planning to address problem-definition and characterize multiple uncertainties

Prioritize and select climate adaptation and resilience measures and revise periodically

(extremes, variability and change) and development

- Assumptions-e.g. climate knowledge, forecasts of socio-economic trends and drivers of growth
- Effectiveness- Short-term adjustments/coping that constrain or enable longer-term risks
- Benefits-adaptation in support of development goals
- Limits-to adaptation e.g. ocean acidification





Definition of the core set of data, information and information technologies needed to maintain the minimum acceptable level of stewardship in the management of water resources and water infrastructure

CO Basin EWS

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