



Decision Support for Drought Risk Management: Focus on the Future

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Monitoring Program Area Leader, National Drought Mitigation Center

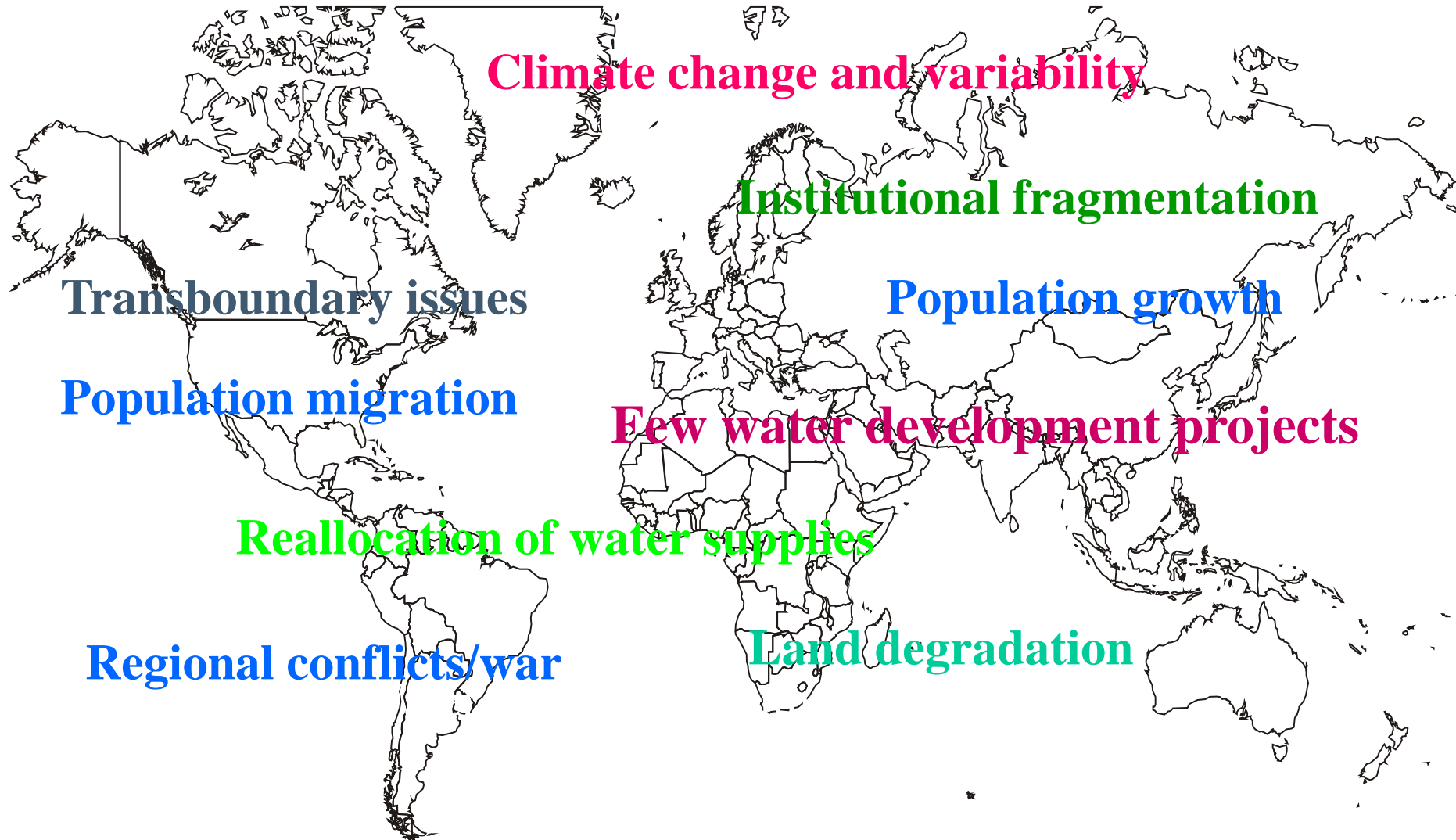
University of Nebraska-Lincoln, USA

2011 APEC Climate Symposium, Honolulu, Hawaii October 17-20, 2011

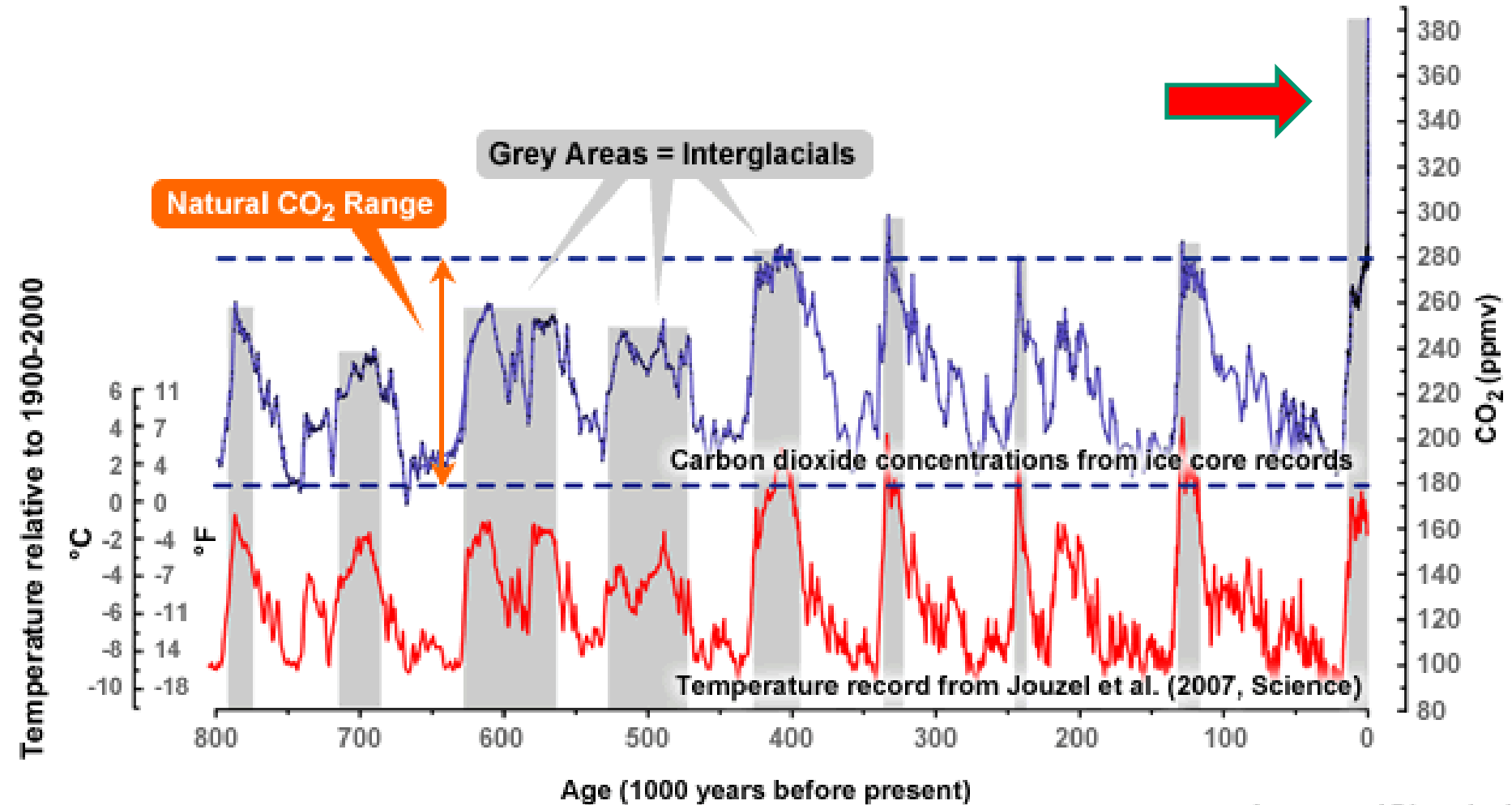
Outline

- **Overview and some Context**
- **The NDMC**
- **Risk Management Planning**
- **Drought Early Warning Systems (DEWS)**
- **Toward a Global Drought Early Warning System (GDEWS)**
- **Summary**
- **Workshop Instructions**

Future Challenges in Water Resources Management



A new realm of possibilities?



**Concern: unprecedented rate of change
and outside of historical norms...**

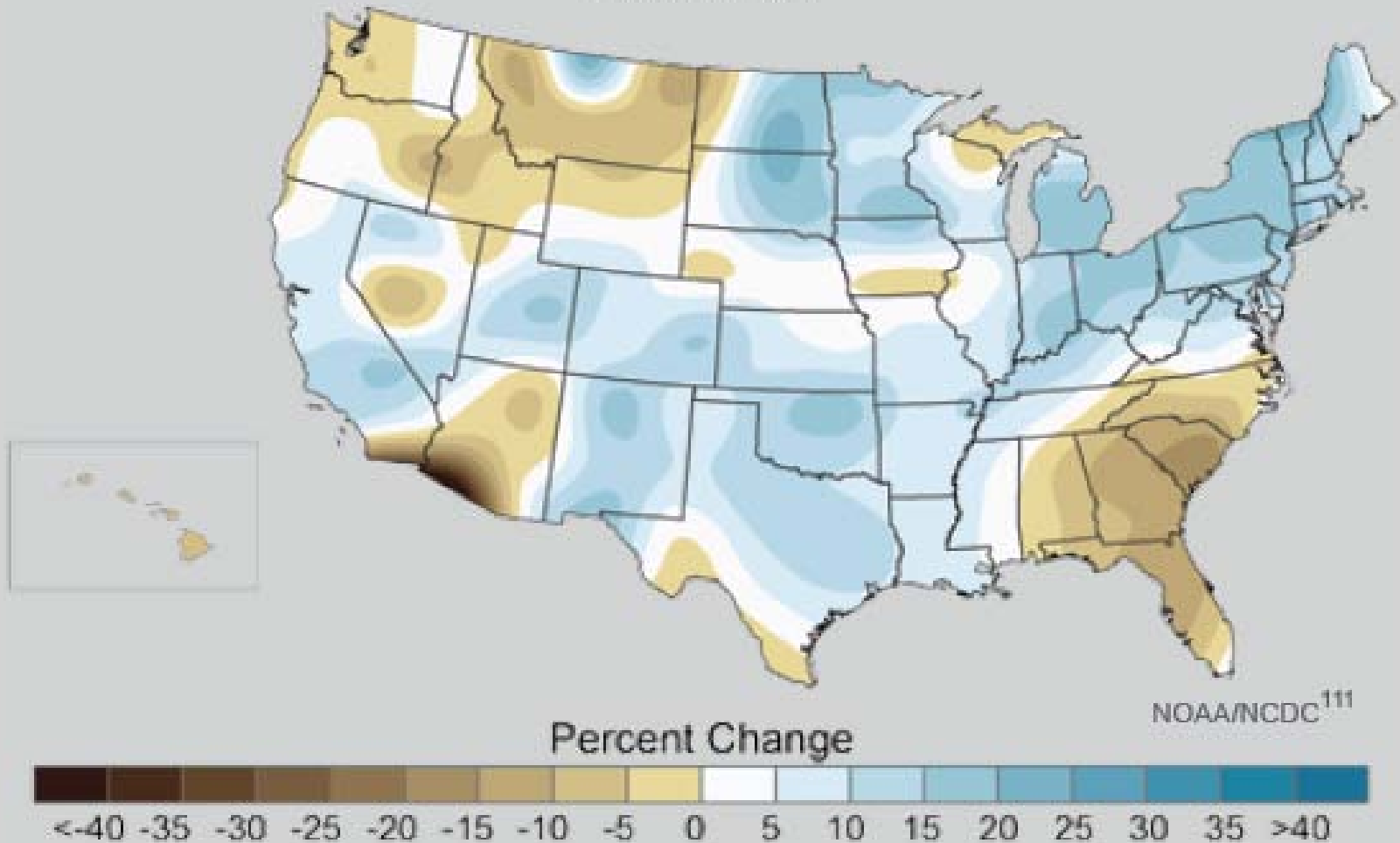
“Stationarity is Dead”

- **Stationarity: natural systems operate within an unchanging envelope of variability**
- **Climate change undermines the assumption of stationarity in water management**
- **Can't only use the past as a guide**
- **Need new scenarios and management ideas for an uncertain future**

Milly et al. (2008) Stationarity is Dead: Wither Water Management?
Science, Vol. 319, 573-574

Trends in the United States

Observed Change in Annual Average Precipitation
1958 to 2008

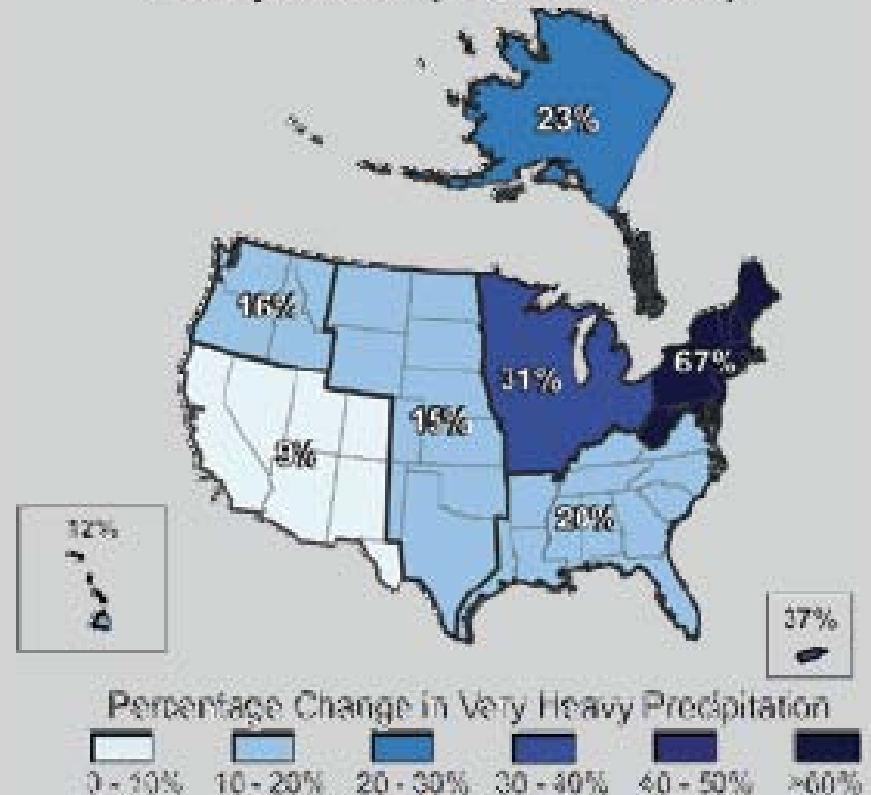


While U.S. annual average precipitation has increased about 5 percent over the past 50 years, there have been important regional differences as shown above.

Precipitation Intensity

- More heavy precipitation during last 50 years, particularly in the Northeast and Midwest

Increases in Amounts of Very Heavy Precipitation (1958 to 2007)



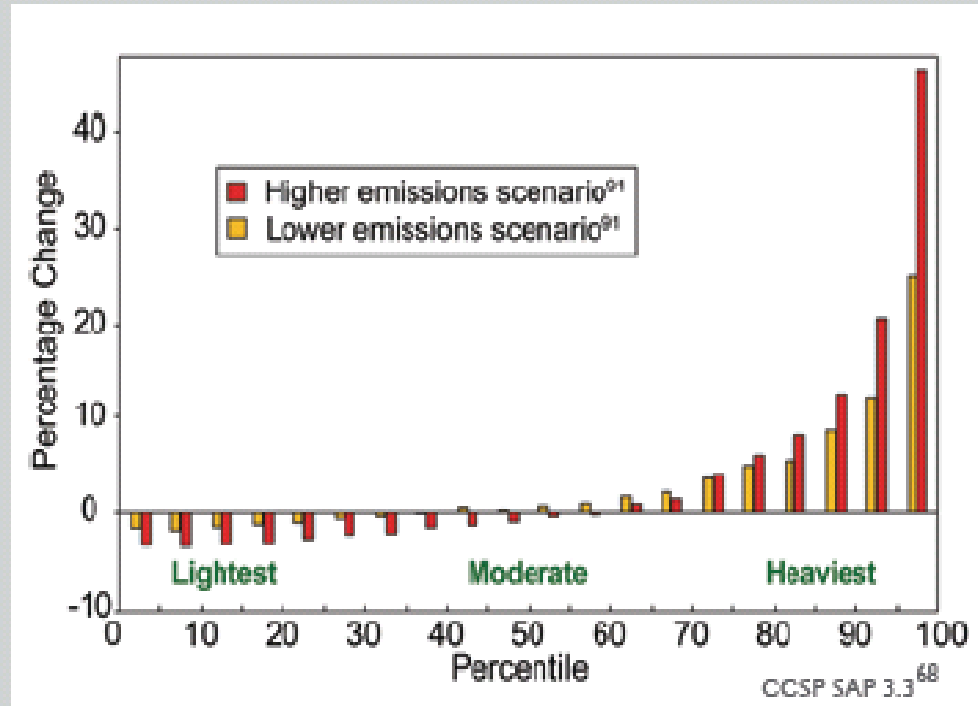
Updated from Groisman et al. 113

The map shows percent increases in the amount falling in very heavy precipitation events (defined as the heaviest 1 percent of all daily events) from 1958 to 2007 for each region. There are clear trends toward more very heavy precipitation for the nation as a whole, and particularly in the Northeast and Midwest.

Extreme Events

- **Less light rainfall events**
- **Heavier rainfall events**
- **1 in 20 year event could change to 1 in 4-15 year event**
- **Increased drought in some areas**

Projected Changes in Light, Moderate, and Heavy Precipitation (by 2090s)



The figure shows projected changes from the 1990s average to the 2090s average in the amount of precipitation falling in light, moderate, and heavy events in North America. Projected changes are displayed in 5 percent increments from the lightest drizzles to the heaviest downpours. As shown here, the lightest precipitation is projected to decrease, while the heaviest will increase, continuing the observed trend. The higher emission scenario⁹¹ yields larger changes. Projections are based on the models used in the IPCC 2007 Fourth Assessment Report.

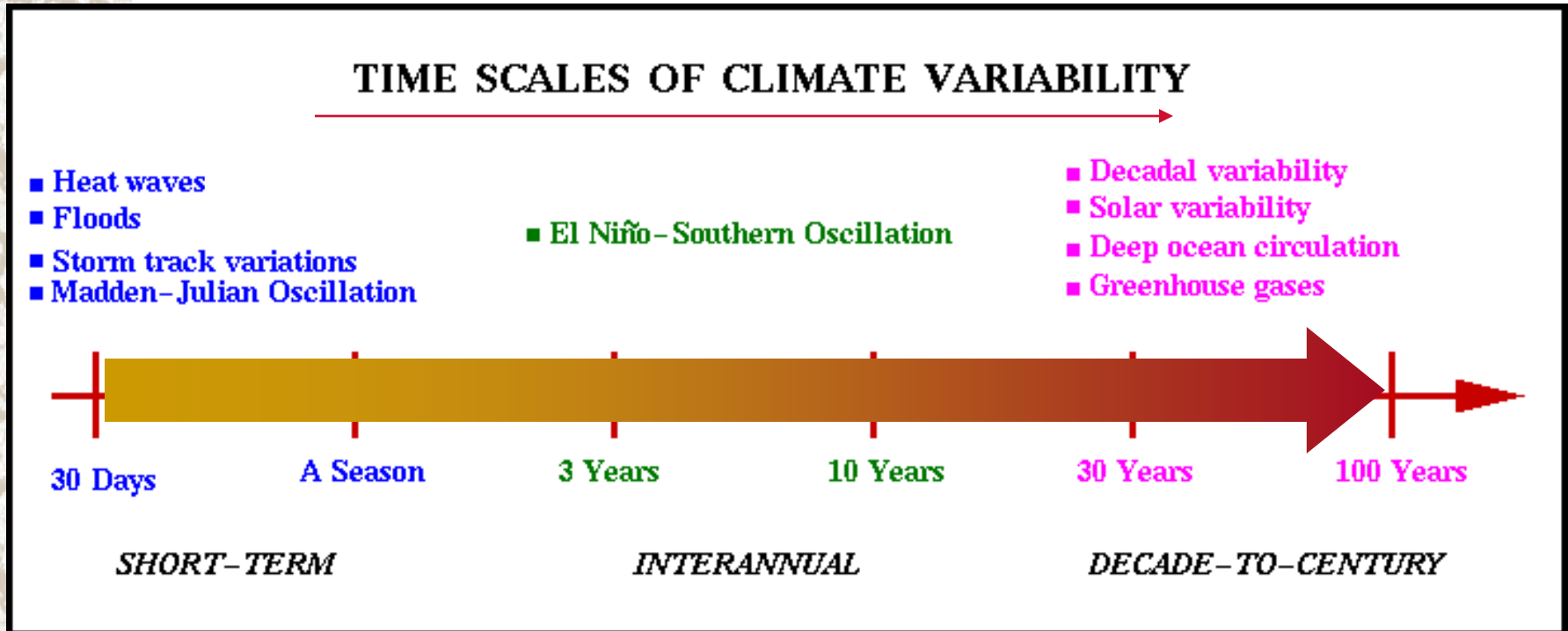
Snowfall Totals

Changes in Snowfall Contributions to Wintertime Precipitation 1949 to 2005



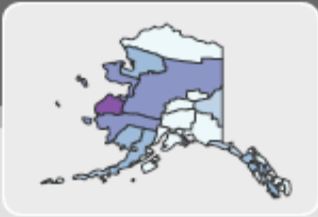
Trends in winter snow-to-total precipitation ratio from 1949 to 2005. Red circles indicate less snow, while blue squares indicate more snow. Large circles and squares indicate the most significant trends.¹⁴³ Areas south of 37°N latitude were excluded from the analysis because most of that area receives little snowfall. White areas above that line have inadequate data for this analysis.

Why Drought?



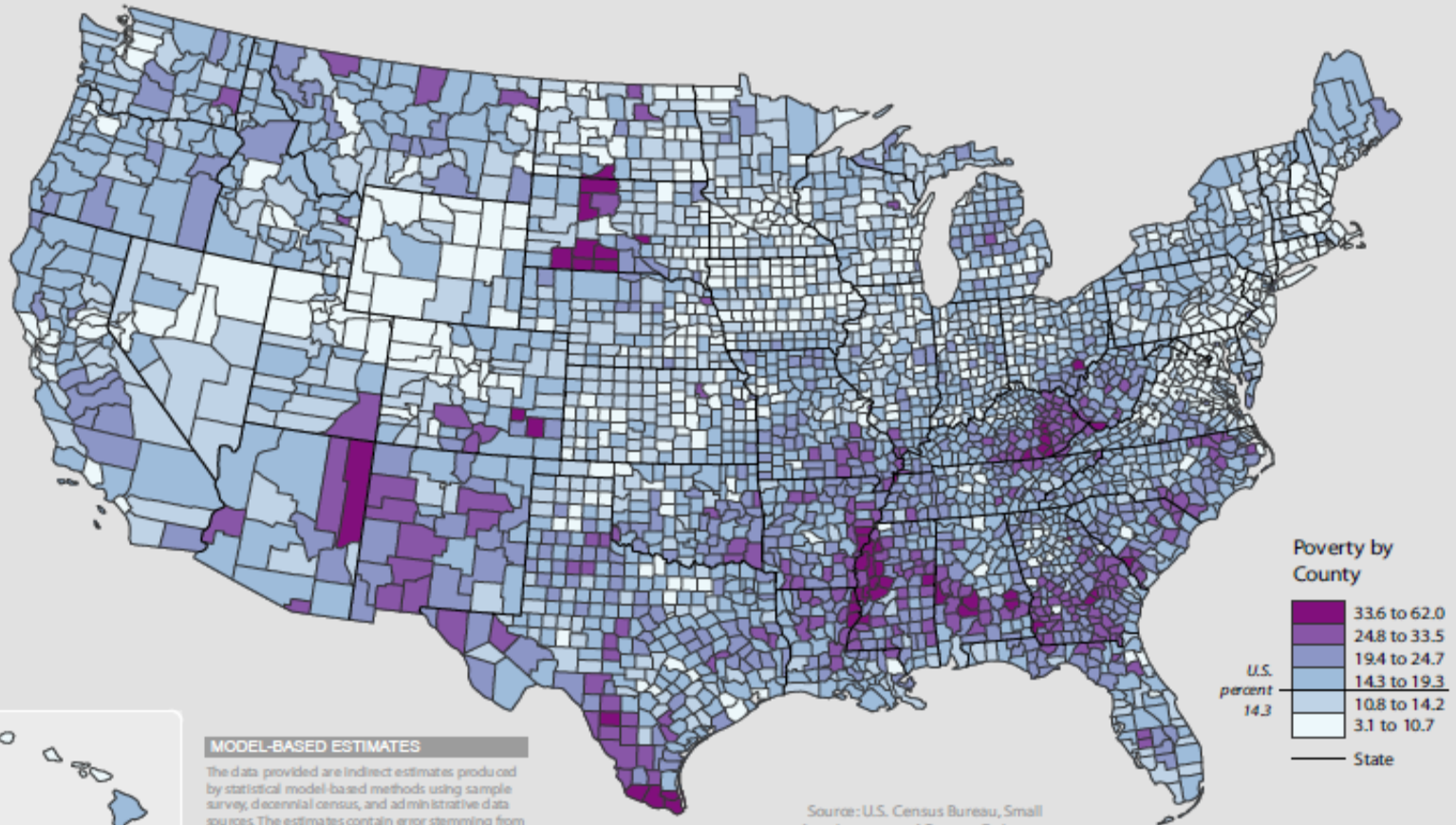
Droughts span an enormous range of temporal and spatial scales

Vulnerability: Not all droughts and their impacts are created equal!



PERCENT IN POVERTY, 2009

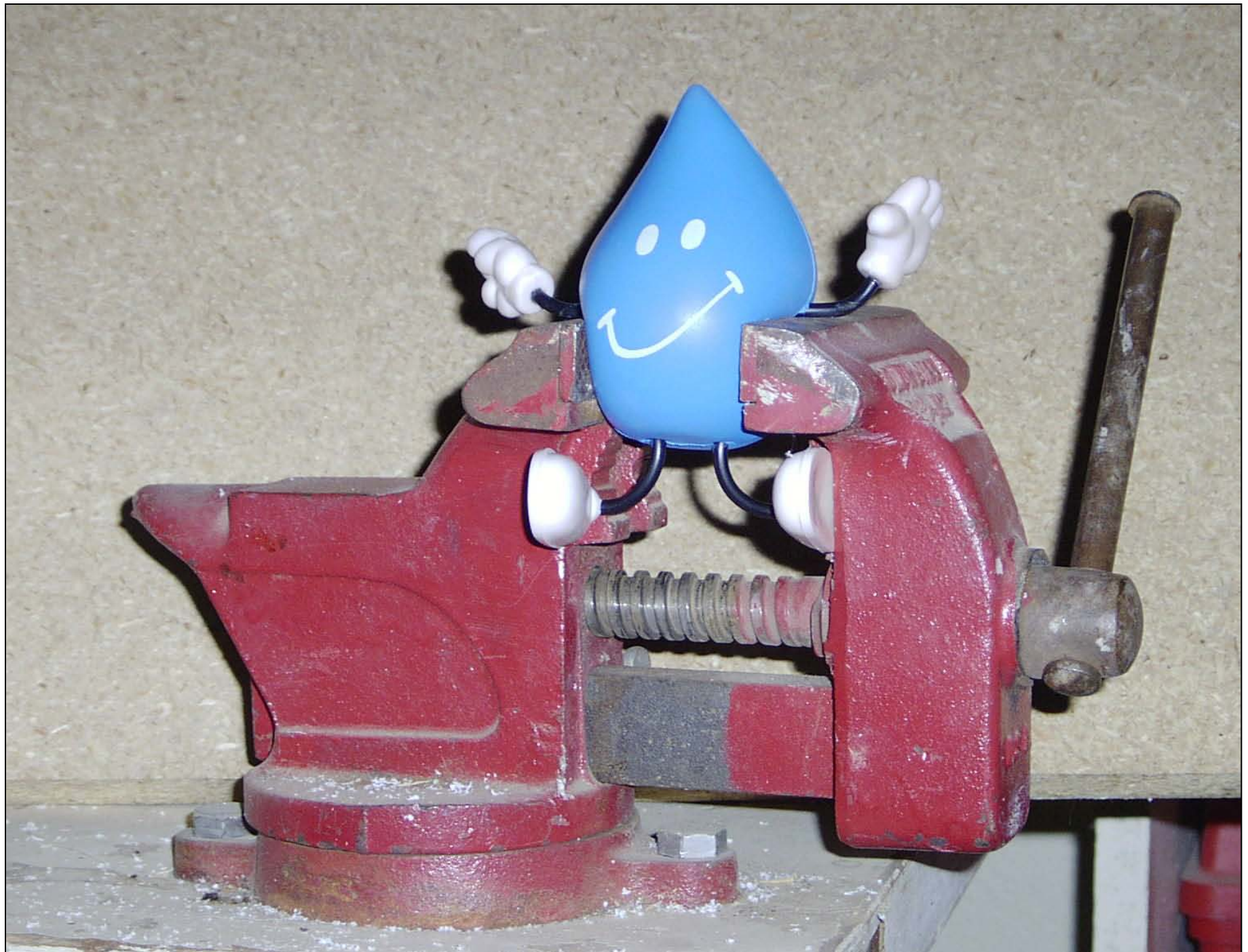
Total Population



MODEL-BASED ESTIMATES

The data provided are indirect estimates produced by statistical model-based methods using sample survey, decennial census, and administrative data sources. The estimates contain error stemming from model error, sampling error, and nonsampling error.

Source: U.S. Census Bureau, Small Area Income and Poverty Estimates (SAIPE) Program, Dec. 2010



Drought: “a force for truth”

- *“Societies will manage climate change in the same way they will manage droughts (for better or worse)”*
- Analysis of drought risk management is the starting point for a comprehensive institutional analysis
- Stress from drought highlights:
 - Strengths and weaknesses that are usually hidden
 - Political priorities and underlying cultural values revealed by difficult choices

(Daniel Connell, Australian National University, 2010)

Billion Dollar Disasters

(from NCDC, 1980-2010)

<u>Disaster</u>	<u>Events</u>	<u>Damage\$</u>	<u>\$/Event</u>
Hurricanes	27	367	13.6
Tornadoes	23	45	2.0
<i>Droughts</i>	<i>15</i>	<i>185</i>	<i>12.3</i>
Floods	12	68	5.7
Fires	10	19	1.9
Winter-related	12	41	3.4
Total	99	725	7.3

A World of Extremes: 2011 Billion Dollar Disasters

- Groundhog Day Blizzard, 1/29 – 2/3
- Tornadoes, 4/4-5
- Tornadoes, 4/8-11
- Tornadoes, 4/14-16
- Tornadoes, 4/25-30
- Tornadoes, 5/22-27
- Drought, fires, heatwave, spring, summer, fall
- Mississippi River flooding, spring and summer
- Upper Midwest/Missouri River flooding, summer
- Hurricane Irene, 8/27-29

“You can’t manage what you don’t measure.....and you can’t measure what you don’t monitor....”

(An old business adage applied to drought early warning!)

National Drought Mitigation Center



Founded: 1995 at the University of Nebraska-Lincoln by Dr. Don Wilhite. Dr. Mike Hayes is the current Director.

Mission: To lessen societal vulnerability to drought by promoting planning and the adoption of appropriate risk management techniques.

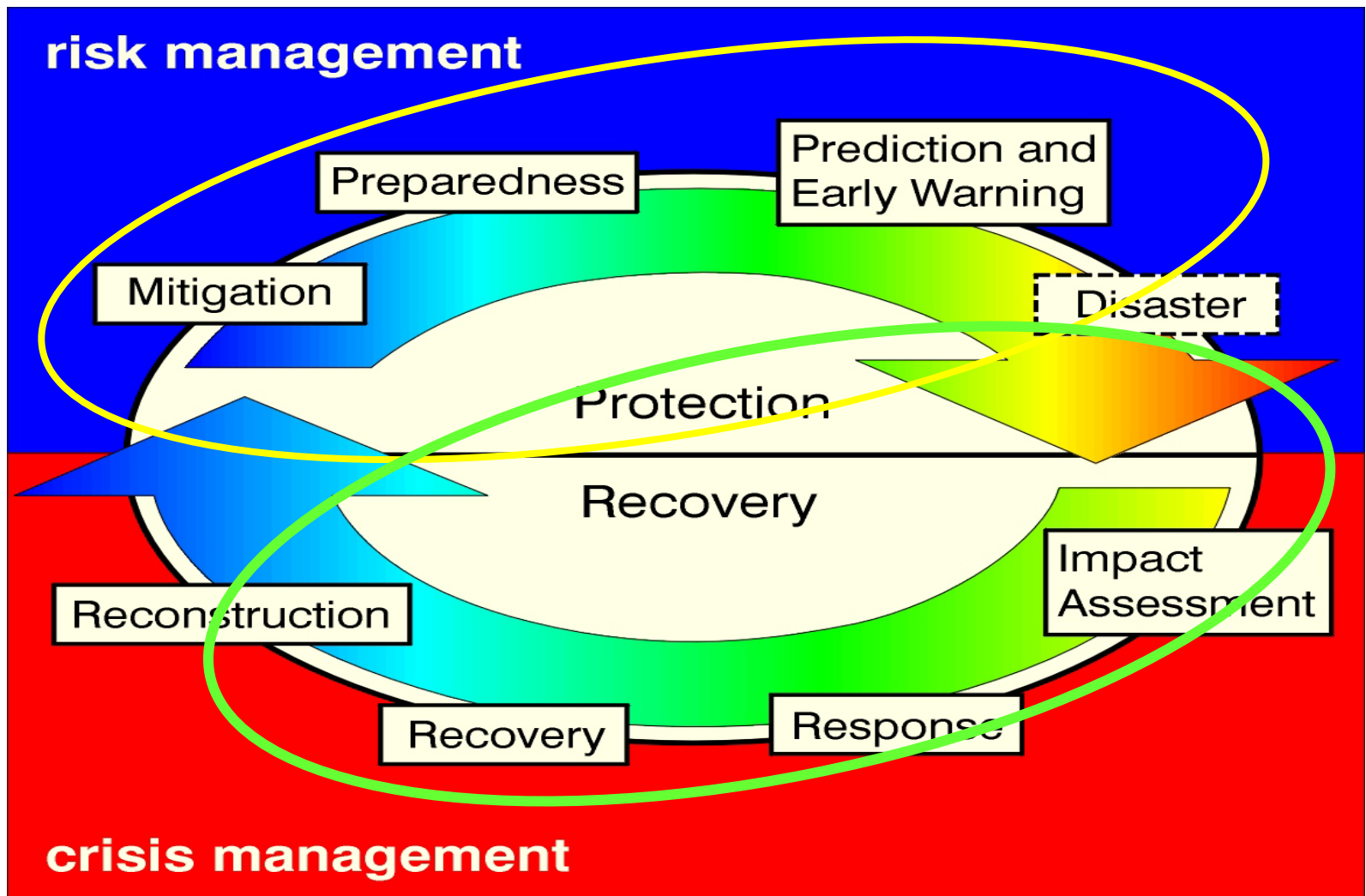
Drought Mitigation

Mitigation: actions and programs done before a drought that would reduce long-term vulnerability to future droughts

“Adaptation” in climate change vocabulary



The Cycle of Disaster Management



NDMC Program Objectives

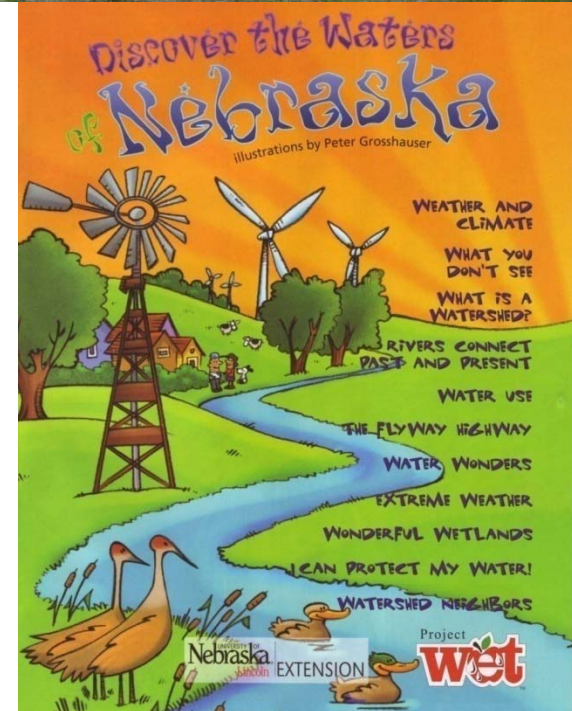
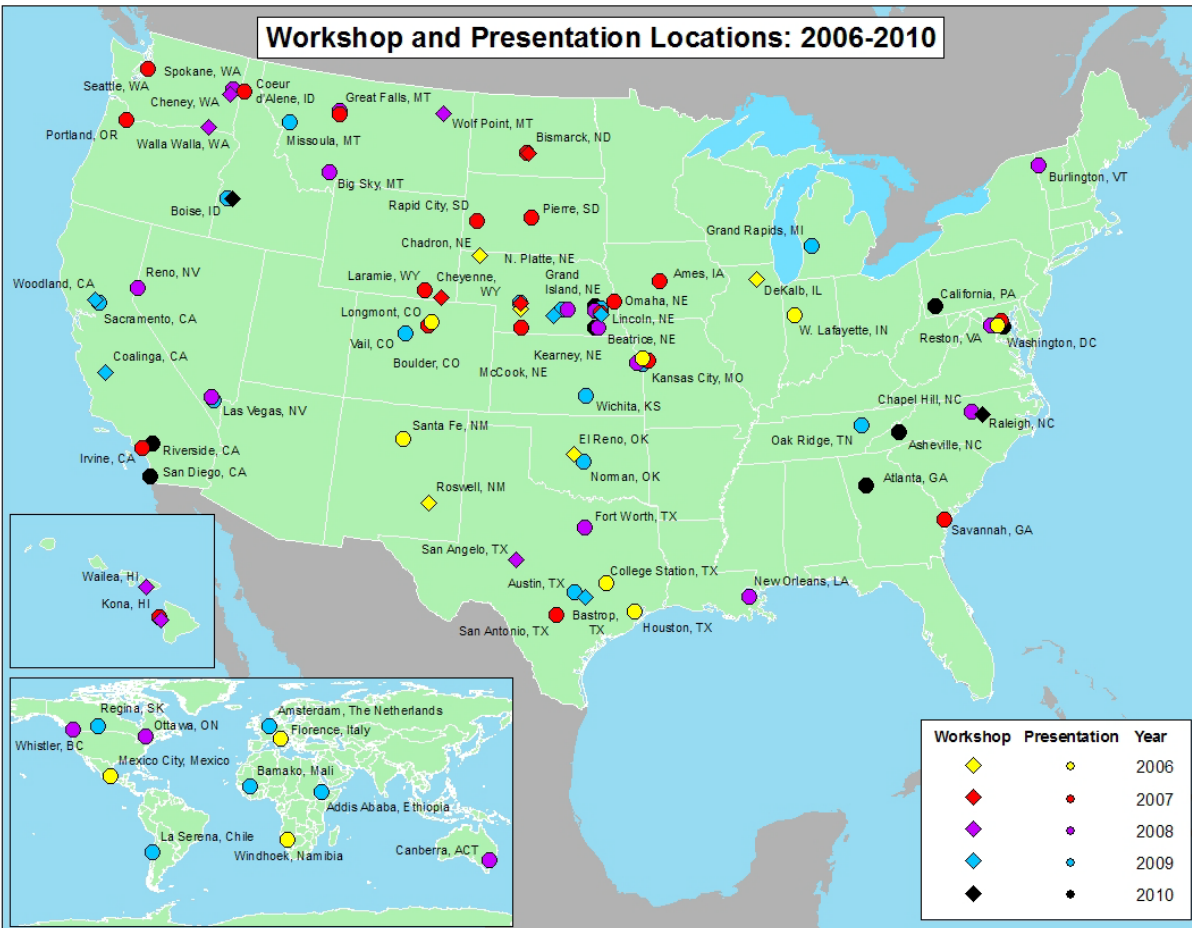
- *Improve **the science*** of drought monitoring, planning, and mitigation
- Build ***awareness*** of drought and its ***impacts*** on society and the environment, and how human actions affect our vulnerability to drought
- Focus the attention of policy makers on the importance of ***drought policy and planning*** in the wise stewardship of natural resources

***“End-to-End”: Research-Applications-Operations-
Outreach Continuum***

Outreach: Building Trust



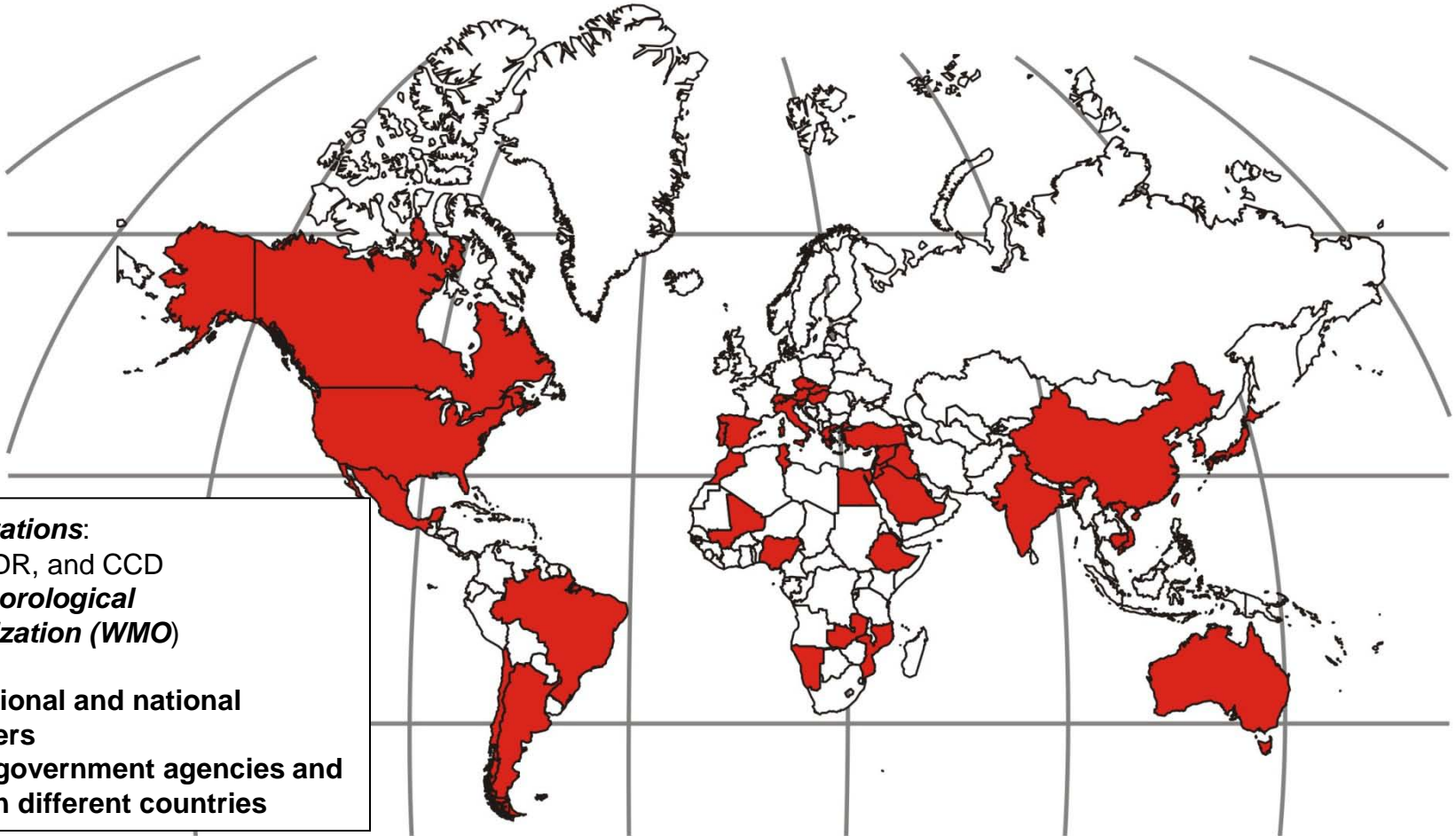
Workshop and Presentation Locations: 2006-2010



NDMC Stakeholder Interactions

- Workshops, Listening Sessions
- Media Contacts
- Surveys
- Evaluator Networks
- Drought Impact Reporter
- Drought Ready Communities Project
- Ranch Planning Project
- *Discover the Waters of Nebraska*
- Climate Change Literacy for Educators
- *DroughtScape/Website*
- Nebraska's Climate Assessment and Response Committee
- Conferences, Events

NDMC International Activities



- **UN organizations:**
FAO, ISDR, and CCD
- **World Meteorological Organization (WMO)**
- **USAID**
- Various regional and national drought centers
- Numerous government agencies and universities in different countries

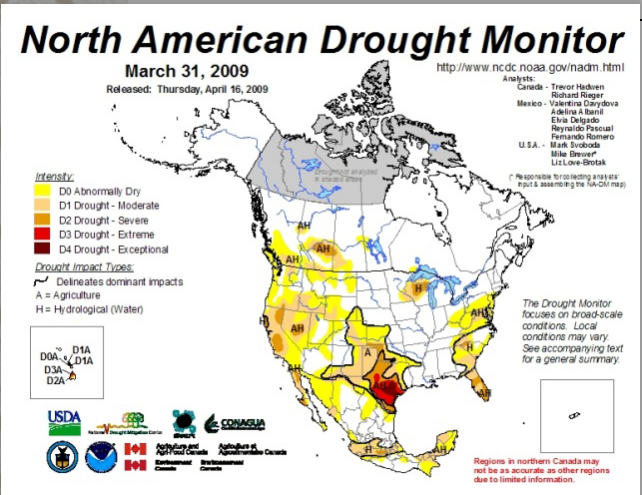
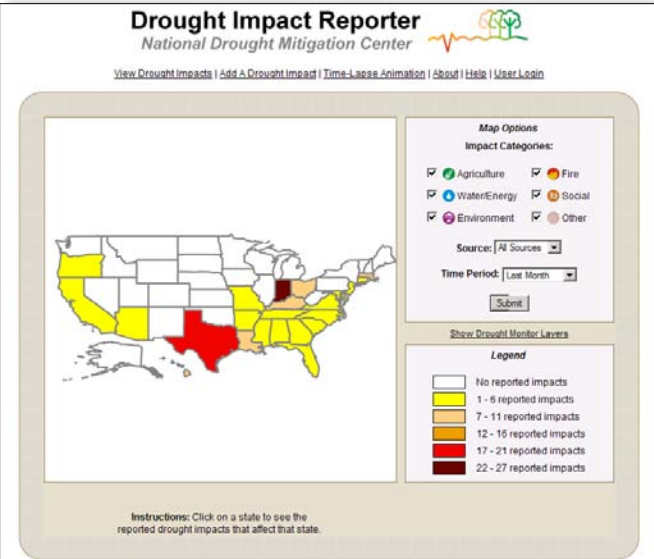
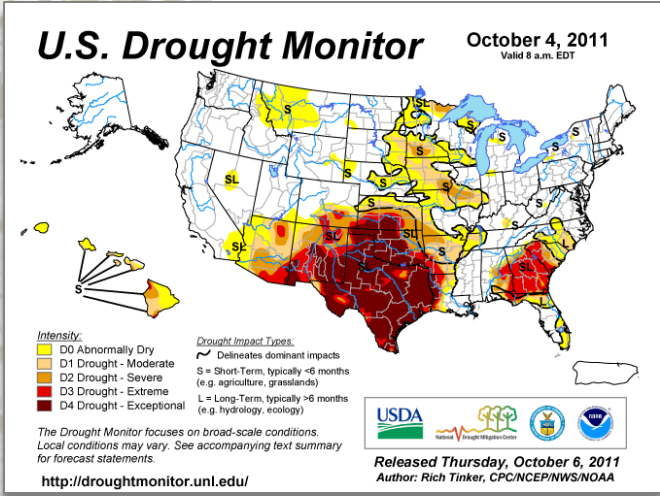
Activities 2005–2011

Australia • Austria • Brazil • Cambodia • Canada • Chile • China • Czech Republic • Egypt • Ethiopia • European Union • India • Iraq • Italy • Japan • Jordan • Mali • Mexico • Morocco • Mozambique • Namibia • Netherlands • Saudi Arabia • Slovakia • Slovenia • South Korea • Spain • Switzerland • Syria • Tunisia • Turkey • United States • Vietnam • Zambia

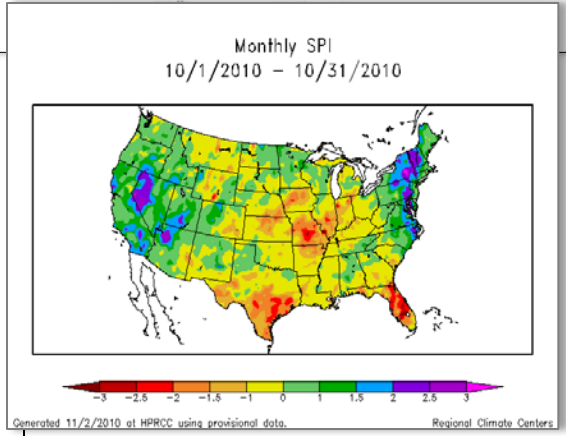
NDMC's Monitoring Program Area

Mark Svoboda
Monitoring

Activities



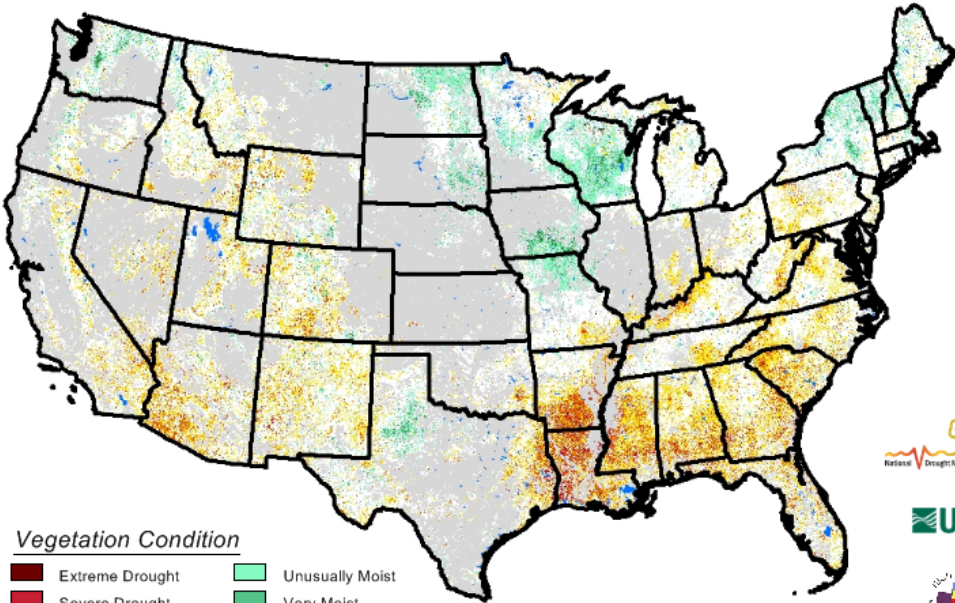
USDM
NADM
DIR
NIDIS
SPI
Atlas



NDMC's GIScience Program Area

Vegetation Drought Response Index
Complete

November 1, 2010



Vegetation Condition

- | | |
|--------------------|-------------------|
| ■ Extreme Drought | ■ Unusually Moist |
| ■ Severe Drought | ■ Very Moist |
| ■ Moderate Drought | ■ Extremely Moist |
| ■ Pre-Drought | ■ Out of Season |
| ■ Near Normal | ■ Water |



Brian Wardlow

Activities

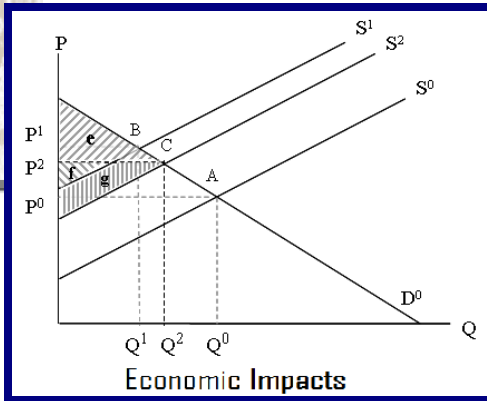
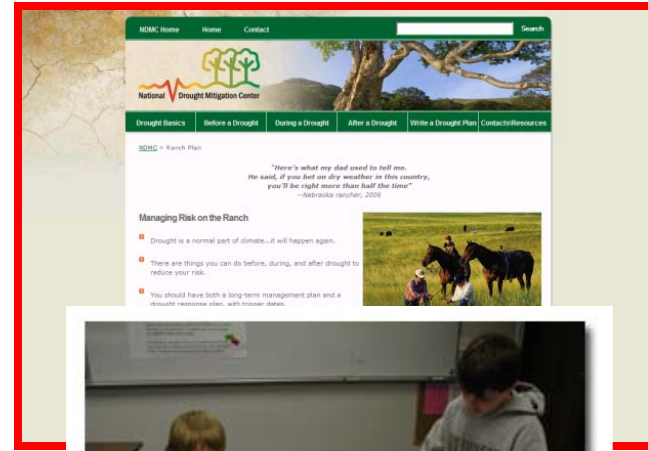
Remote Sensing
GIS
VegDRI
VegOut

NDMC's Planning and Social Science Program Area

Cody Knutson

Activities

Stakeholders
Guides
Planning
Education



Economic Impacts

How to Reduce Drought Risk

Preparedness and Mitigation Working Group
March 1998
Principal Author:
Cody Knutson,
National Drought Mitigation Center
Mike Hines,
National Drought Mitigation Center
Tom Phillips,
U.S. Bureau of Reclamation



Republican River Basin Water and Drought Portal

Welcome to the Republican River Basin Water and Drought Portal

Water resources in the Republican River Basin are vital to the sustainability of the life that surrounds them... It's also necessary for crop production, animal life, and the hydrological cycle. This portal was created to provide comprehensive information on emerging and ongoing water and drought issues for anyone that has an interest in the Republican River Basin. It will also give stakeholders the information and tools needed to enhance the Basin's drought and water shortage preparedness.

The links listed to the left lead to information about past, current, and potential water and drought conditions. You will also find sections on actions that can be taken to foster effective water and drought management, educational tools, research that has been done in the Basin, and legislative information.

The portal is part of the National Integrated Drought Information System (NIDIS), which is a national effort to provide enhanced access to drought-related information. The National Drought Policy Commission was established under the National Drought Policy Act of 1996 to ensure collaboration between different government agencies on drought-related issues. The Commission issued a report titled Preparing for Drought in the 21st Century in 2000. Following the Commission's recommendations, the National Integrated Drought Information System (NIDIS) was established in the Western Governors' Association meeting in 2004. The NIDIS Act was introduced in the U.S. Congress and signed by the President in 2006. To learn more about NIDIS, see the national website at <http://www.drought.gov>

What's New

Listening Sessions getting set for Wiley, Colby, and McCook...

We will continue to add content to this website. Please visit us again to find more and updated information. Your feedback is important to us. Please send comments to "Knutson@unl.edu"

Recent Drought News

"National Drought Mitigation Center and NIDIS to Host Listening Sessions May 27-29" - NDMC (2.25.2008)
www.ndmc.unl.edu/newscenter/

"Nebraska court battle over Republican River the cat is out of the bag" - U.S. Water News (2.18.2008)
www.ajswr.com

Why Track Drought Impacts?

- Establish an impacts **baseline** for monitoring
 - Climate change
- To know where to direct **relief**
- To reduce **vulnerability** in advance of the next drought
- **“Ground truth”** indices
- No single method exists for collecting and/or **quantifying** drought losses
- Very little in the way of **environmental** or **qualitative** collection

Must understand drought impacts

- symptoms of underlying vulnerabilities

Economic Category

- Agricultural
- Industry
- Tourism and Recreation
- Energy
- Financial
- Transportation

Social Category

- Stress and Health
- Nutrition
- Recreation
- Public Safety
- Cultural Values
- Aesthetic Values

Environmental Category

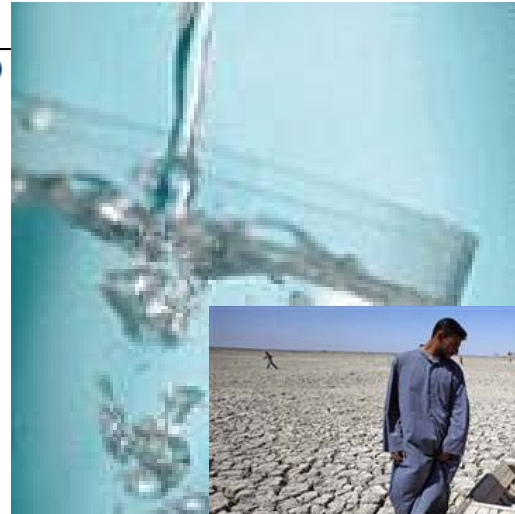
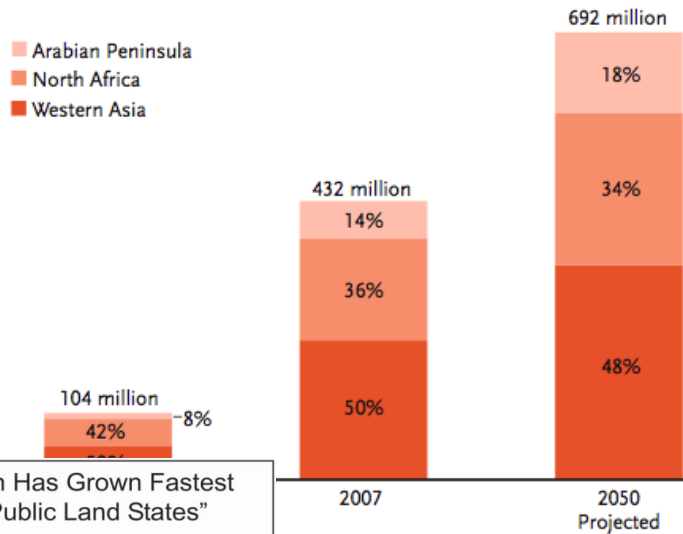
- Animal/Plant
- Wetland
- Water Quality



Why are Drought Impacts Occurring?

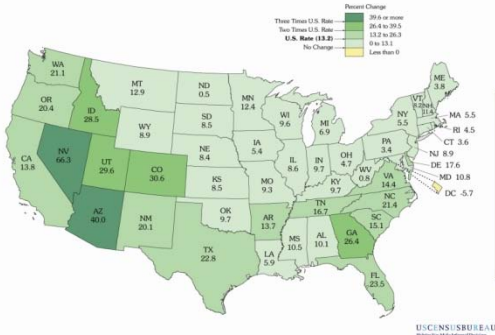
- *what are the underlying vulnerabilities for a particular place?*

Population Growth in the MENA Regions: 1950, 2007, and 2050

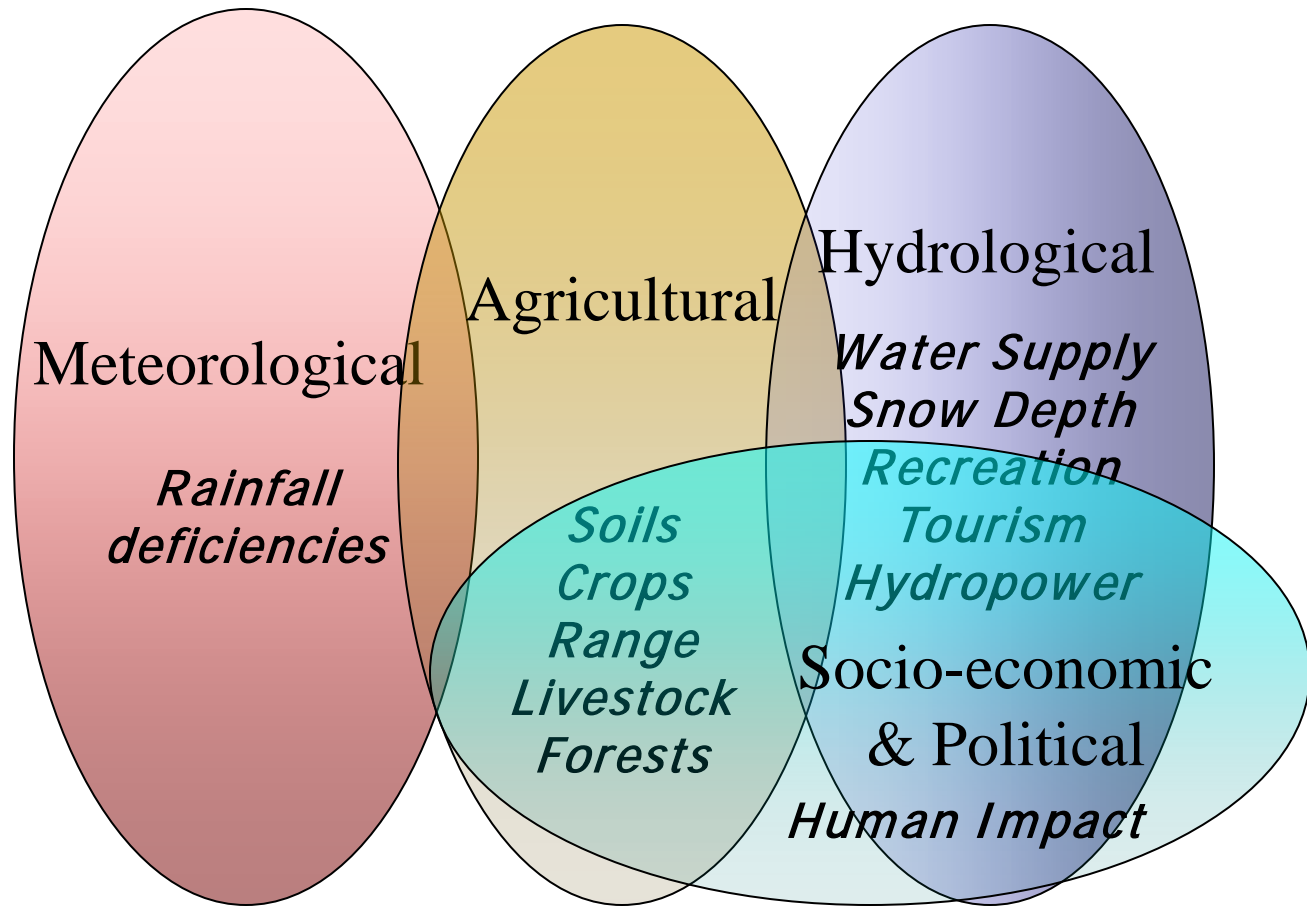


Demographic Changes: Population Has Grown Fastest in the West, Particularly in the "Public Land States"

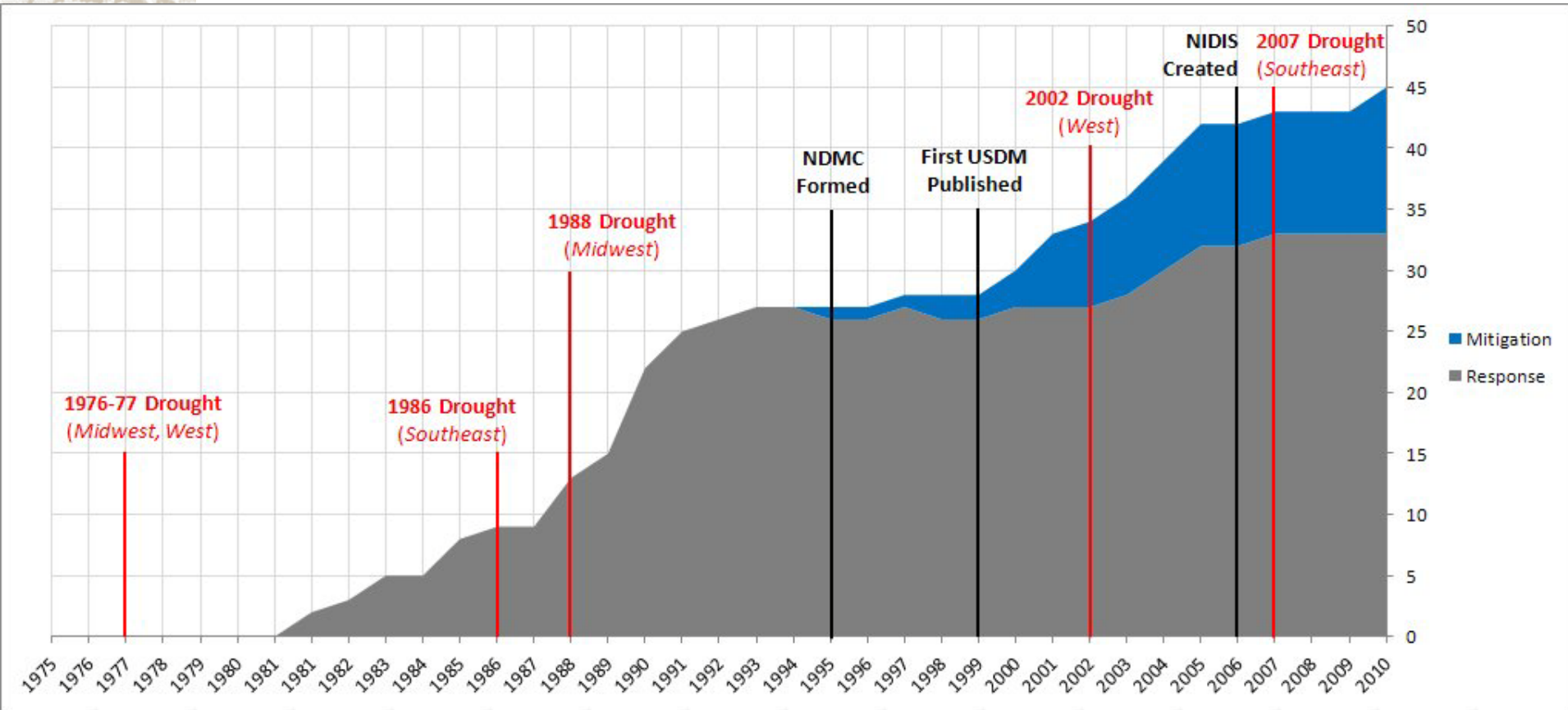
Percent Change in Resident Population for the 48 States and the District of Columbia: 1990 to 2000



What we've learned: Defining Impacts

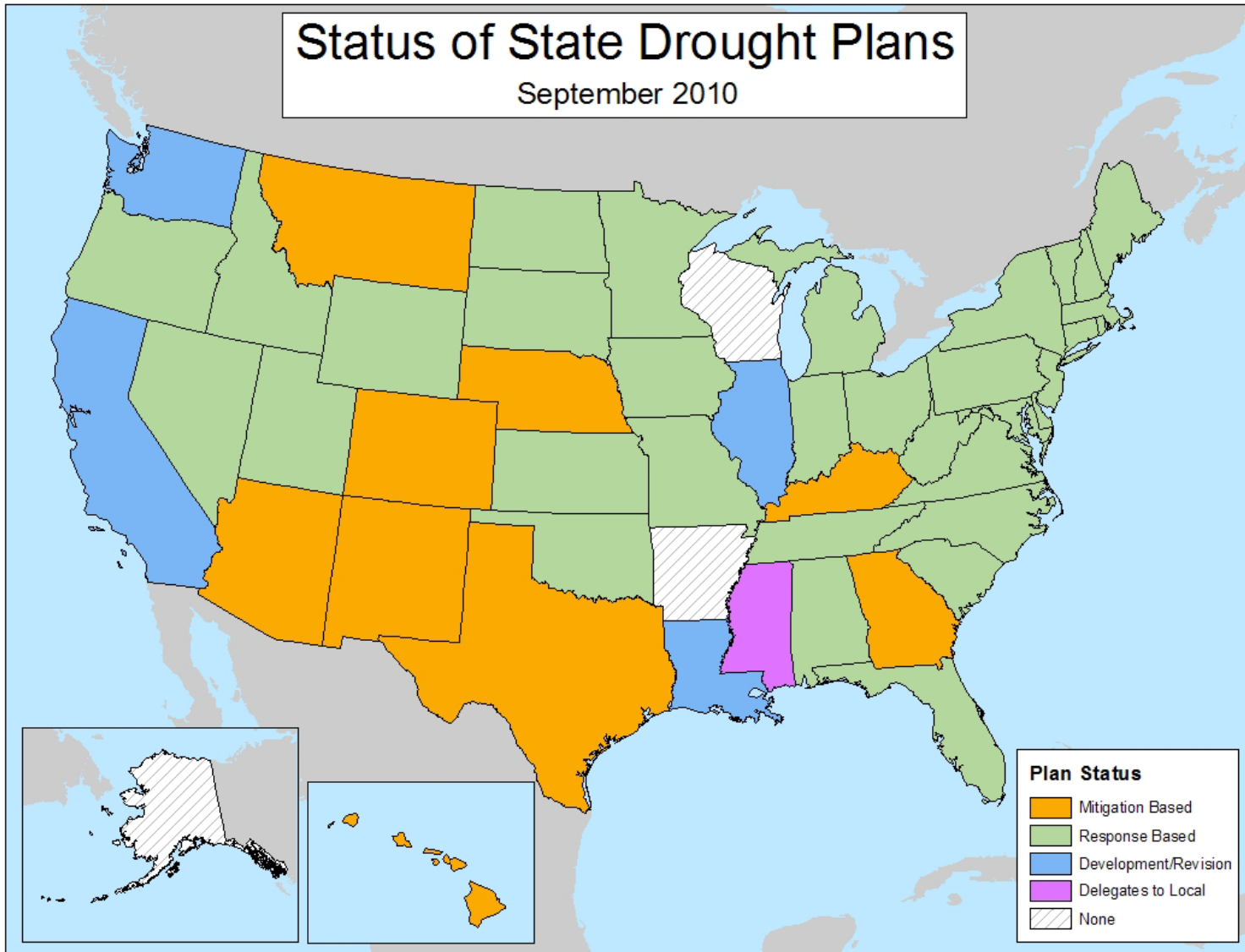


Focusing Events: Windows of Opportunity for Drought Planning



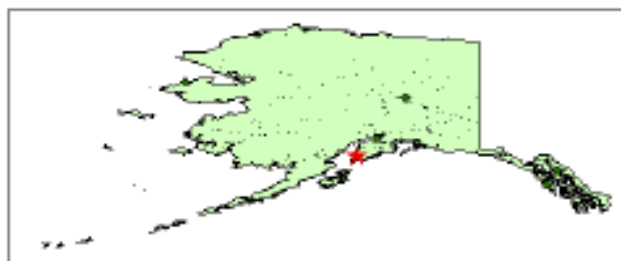
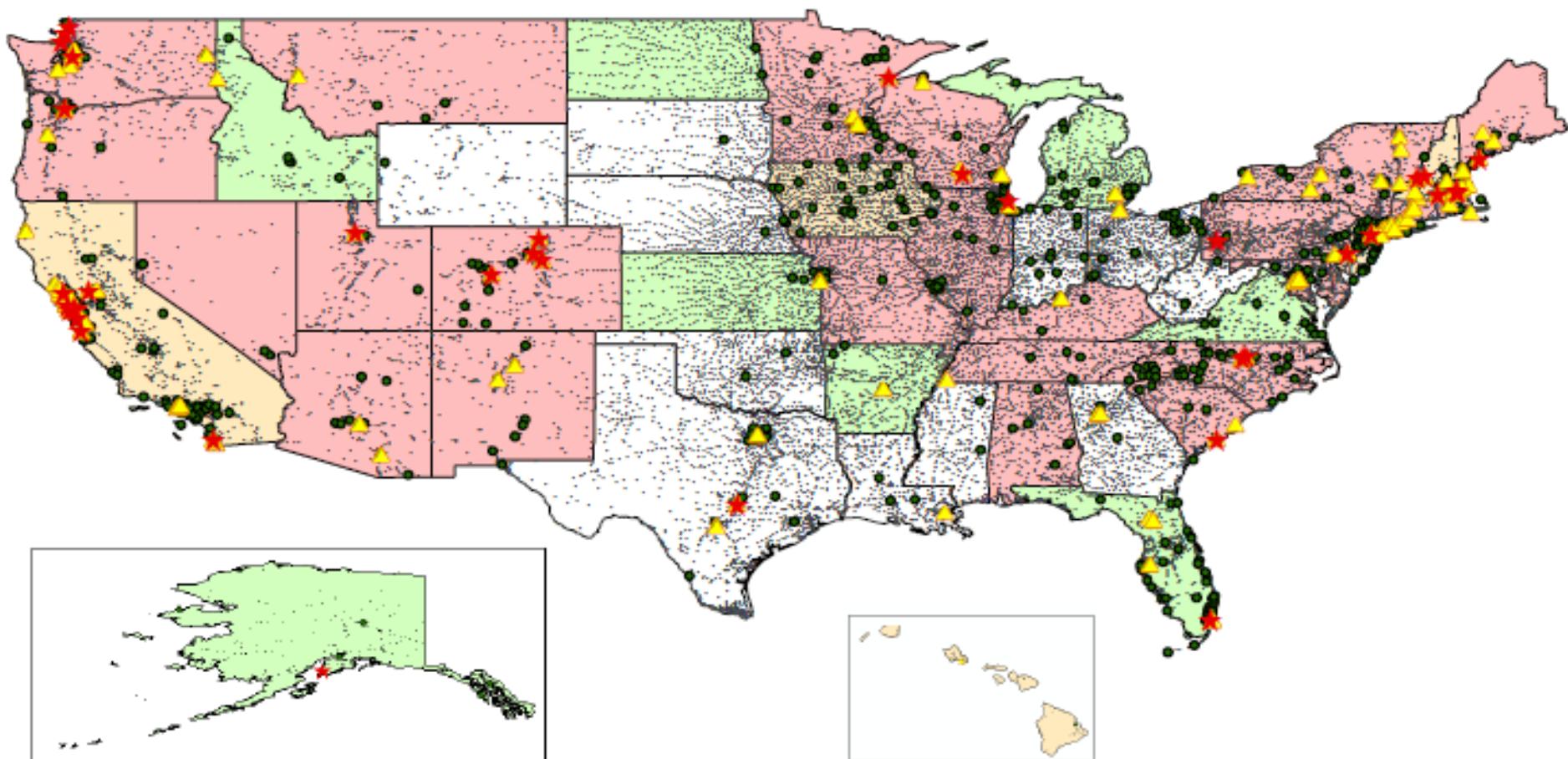
Status of State Drought Plans

September 2010





U.S. Climate Change Action Map



Legend

- | | |
|---|---|
|  States Completed Climate Action Plans |  Jurisdictions with Local Climate Action Plans |
|  States in Revision of Climate Change Plans |  Jurisdictions Joined the Cities for Climate Protection (CCP) Campaign |
|  States in Progress of Climate Action Plans |  Jurisdictions Signed the Mayors Climate Protection Agreement |
|  States DO NOT Have Climate Action Plans |  Jurisdictions DO NOT Have Any Actions |

Date of this Map:
September 18, 2008

Created by
Dr. Zhenghong Tang

17085 0 170 Miles



Drought Plan Components

■ ***Monitoring and early warning***

- assess, communicate, and ***trigger*** action
- ***Foundation*** of a drought mitigation plan

■ **Vulnerability assessment**

- Who and what is at ***risk*** and why?

■ **Mitigation and response actions**

- Actions/programs that ***reduce risk and impacts*** and enhance recovery

Most processes and plans in the past have primarily focused on monitoring and response...

Tools for Planning: NDMC and NIDIS

- All droughts are “local”
- Planning is a “living” process
- Planning should start local
- Planning at all scales
- Now what?



What are Drought Monitoring and Early Warning Systems?

A drought monitoring system will **track, assess and report** climate and water supply trends and current conditions (e.g., rainfall, reservoirs, impacts, etc.) (modified from WMO – No. 1006e)

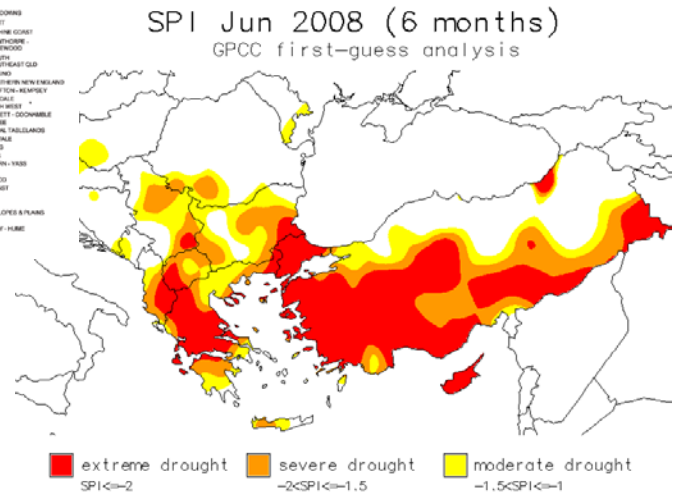
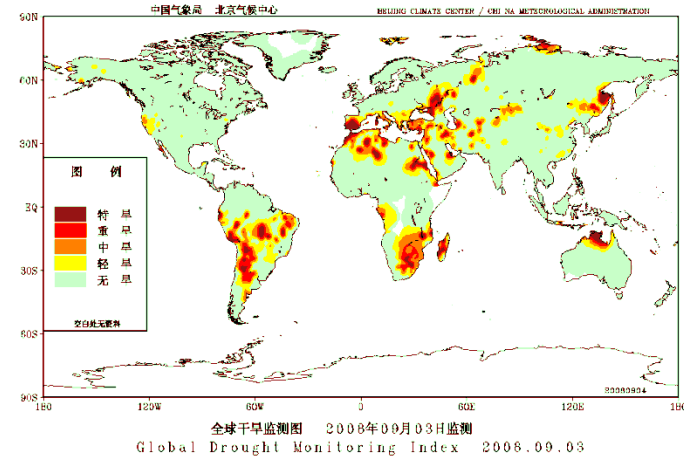
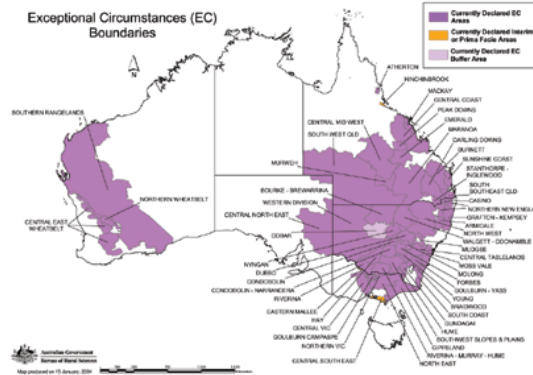
An early warning system facilitates “the **provision of timely and effective information**, through identifying institutions, that allow individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response” (ISDR, 2003).

Drought Monitoring State of the Science: Where are we now?

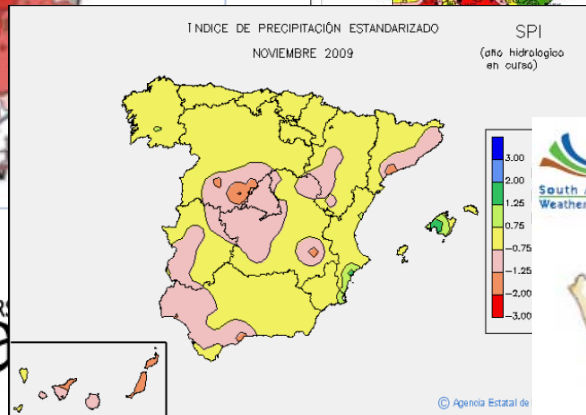
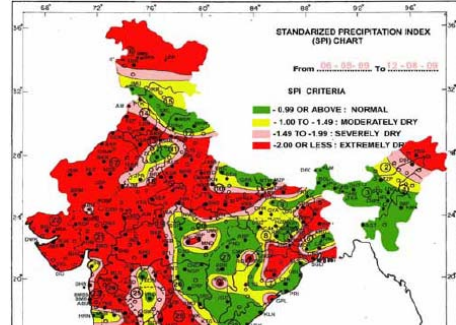
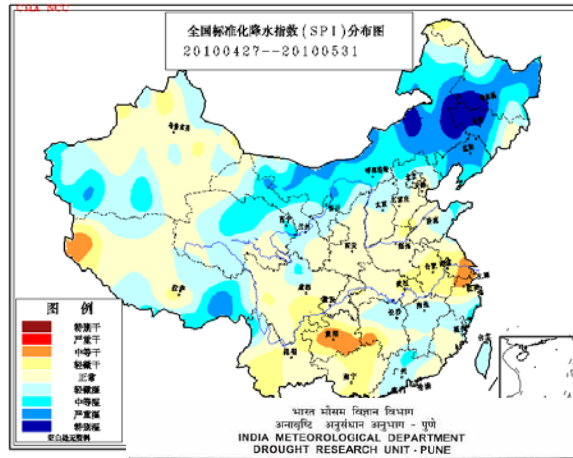
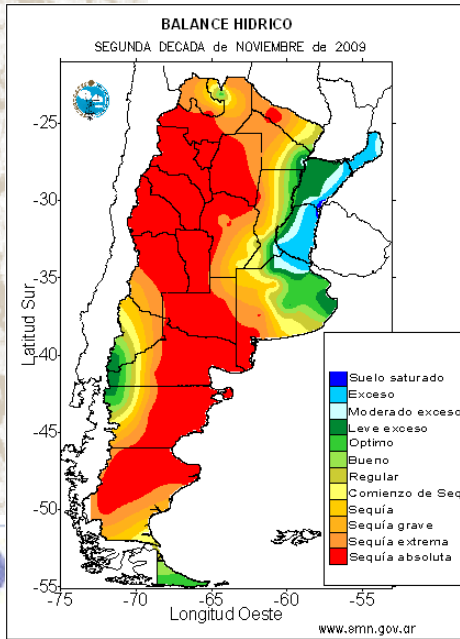
- WMO/WCC-3, GDPN/GEOSS is a way to **learn/leverage** from one another
 - Canada/Mexico/United States/Africa/EDO
 - UN/WMO/GEO/others
- Many regions/countries are **working together** to better monitor drought
- Monitoring of **impacts** globally is virtually non-existent
- Early warning/monitoring just one key: **THEN WHAT?** Need linkages to risk/vulnerability assessment and planning for adaptation
- Many **indicators/indices don't reflect reality** in various regions, or for various season(s).....or for both!

.....the *rapid onset* of National Drought Centers/Strategies

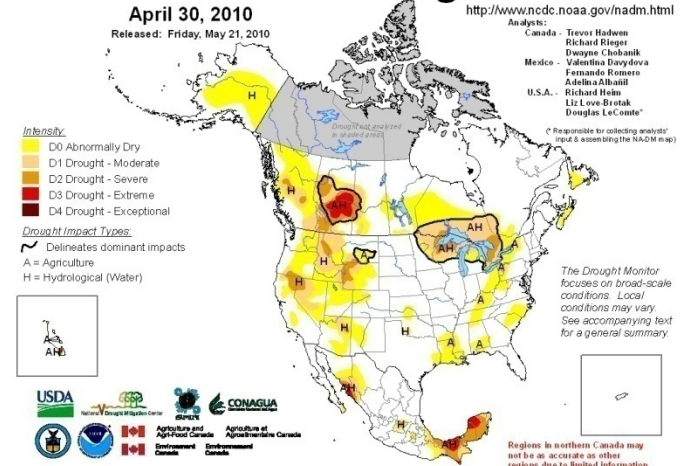
- Australia
- South Africa
- Canada
- United States
- Slovenia/Southeast Europe
- Spain
- EU/JRC
- Turkey
- Portugal
- South Korea
- China
- India
- Pakistan
- Morocco
- Syria
- Brazil (Sao Paulo state)
- Jordan
- Iran



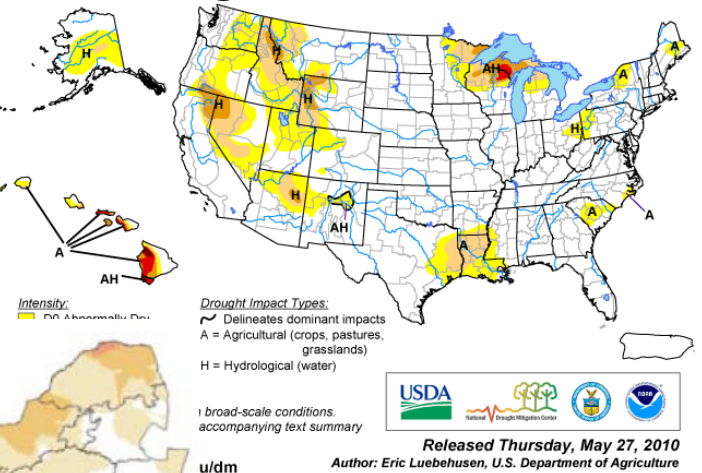
Drought Monitoring/Reporting Systems



North American Drought Monitor



U.S. Drought Monitor

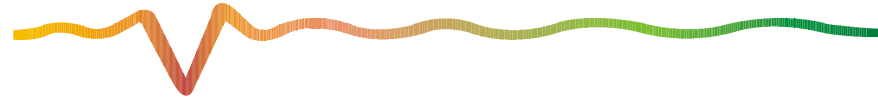


Rainfall deficiencies: 10 months
1 April 2002 to 31 January 2003
Distribution based on gridded data
Product of the National Climate Centre

Nebraska UNIVERSITY

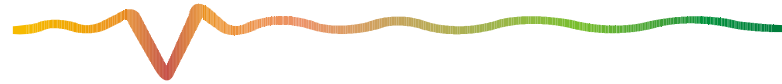
National Drought Mitigation Center

The Importance of Drought Early Warning Systems (DEWS)



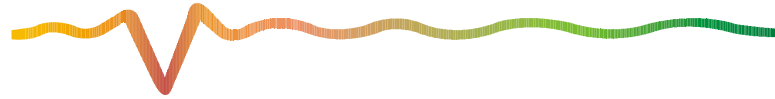
- Allows for **early** drought detection
- Improves response (**proactive**)
- Data and tools for **decision support**
- **“Triggers”** actions within a drought plan
- A critical **mitigation** action
- **Foundation** of a drought plan

Components of a Drought Early Warning System (DEWS)

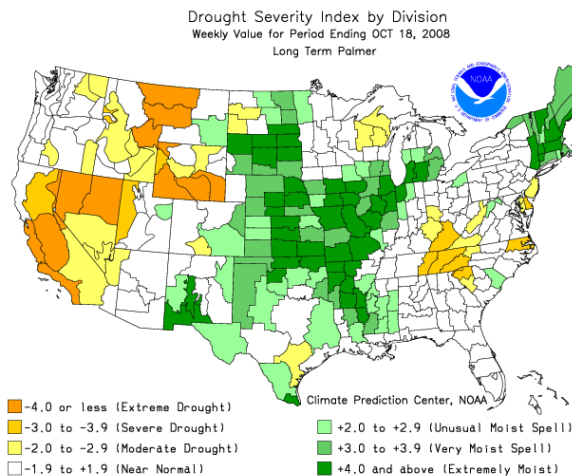


- Monitoring **AND** Forecasting
- Access to **timely** data
- **Synthesis/analysis** of data used to “trigger” set actions within a drought plan
- **Tools** for decision makers
- Efficient **dissemination/communication** (WWW, media, extension, etc.)
- Drought risk **planning**
- **Education** and Awareness

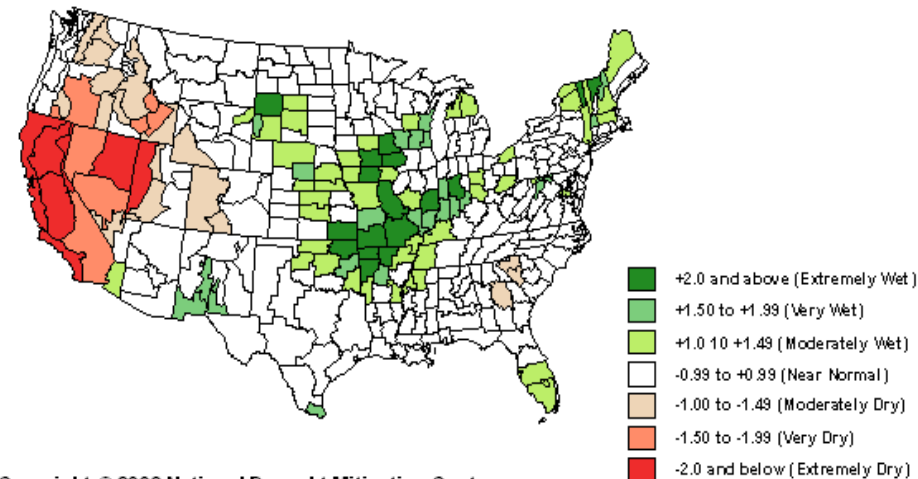
Approaches to Drought Assessment



- **Single index or indicator (parameter)**
- **Multiple indices or indicators**
- ***Composite (or “hybrid”) Indicator***



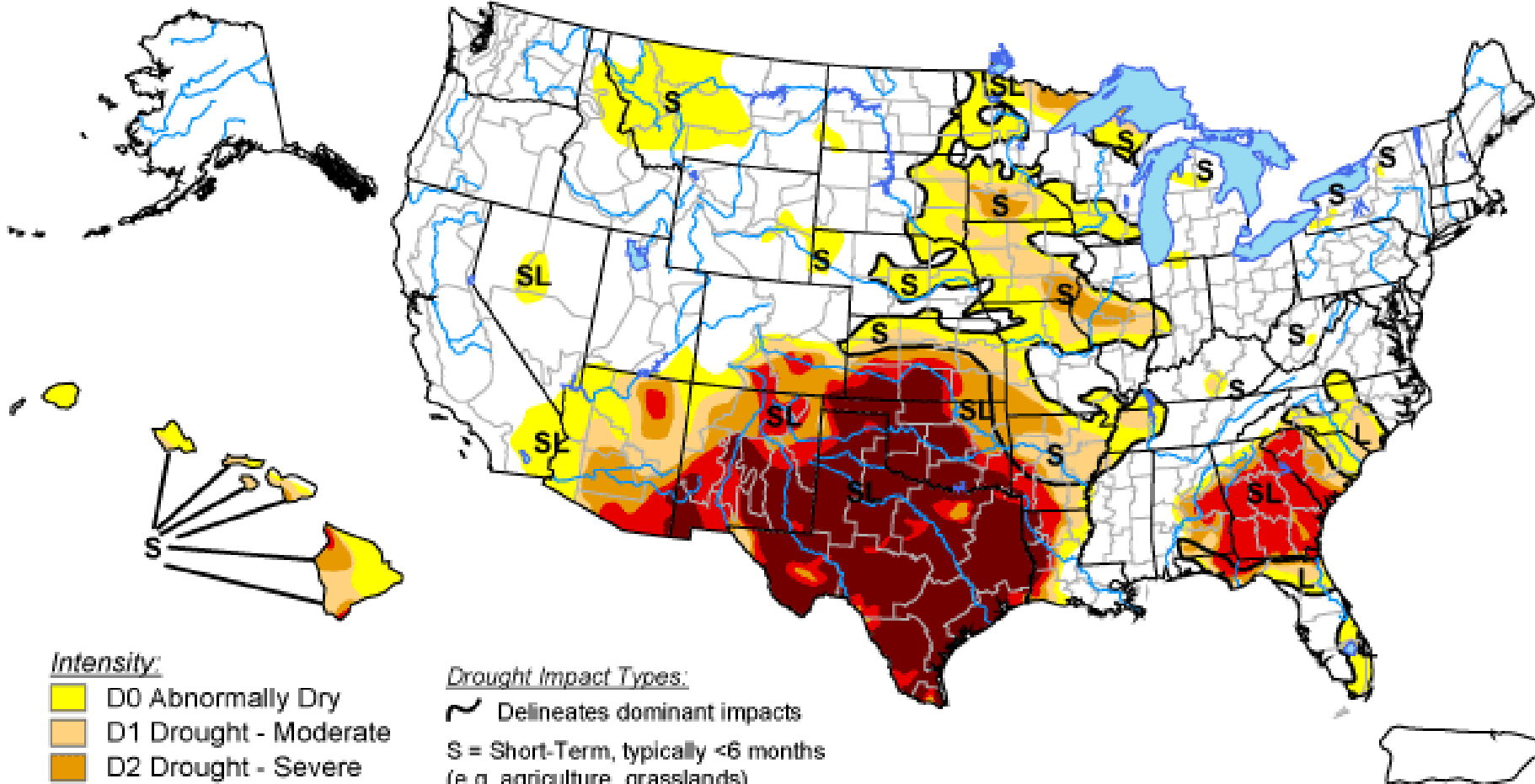
6-month SPI through the end of August 2008








U.S. Drought Monitor

October 4, 2011


Valid 8 a.m. EDT



Intensity:

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

Drought Impact Types:

-  Delineates dominant impacts
- S = Short-Term, typically <6 months
(e.g. agriculture, grasslands)
- L = Long-Term, typically >6 months
(e.g. hydrology, ecology)

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

<http://droughtmonitor.unl.edu/>

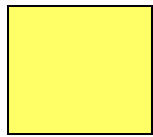


Released Thursday, October 6, 2011

Author: Rich Tinker, CPC/NCEP/NWS/NOAA

U.S. Drought Monitor Map

Drought Intensity Categories



D0 **Abnormally Dry (30%tile)**



D1 Drought – **Moderate (20%tile)**



D2 Drought – **Severe (10%tile)**



D3 Drought – **Extreme (5%tile)**



D4 Drought – **Exceptional (2%tile)**

North American Drought Monitor

August 31, 2011

Released: Friday September 9, 2011

<http://www.ncdc.noaa.gov/nadm.html>

Analysts:

Canada - Trevor Hadwen
Dwayne Chobanik
Richard Rieger
Mexico - Reynaldo Pascual
Adelina Albanil
U.S.A. - Brian Fuchs*
Eric Luebehusen

Intensity

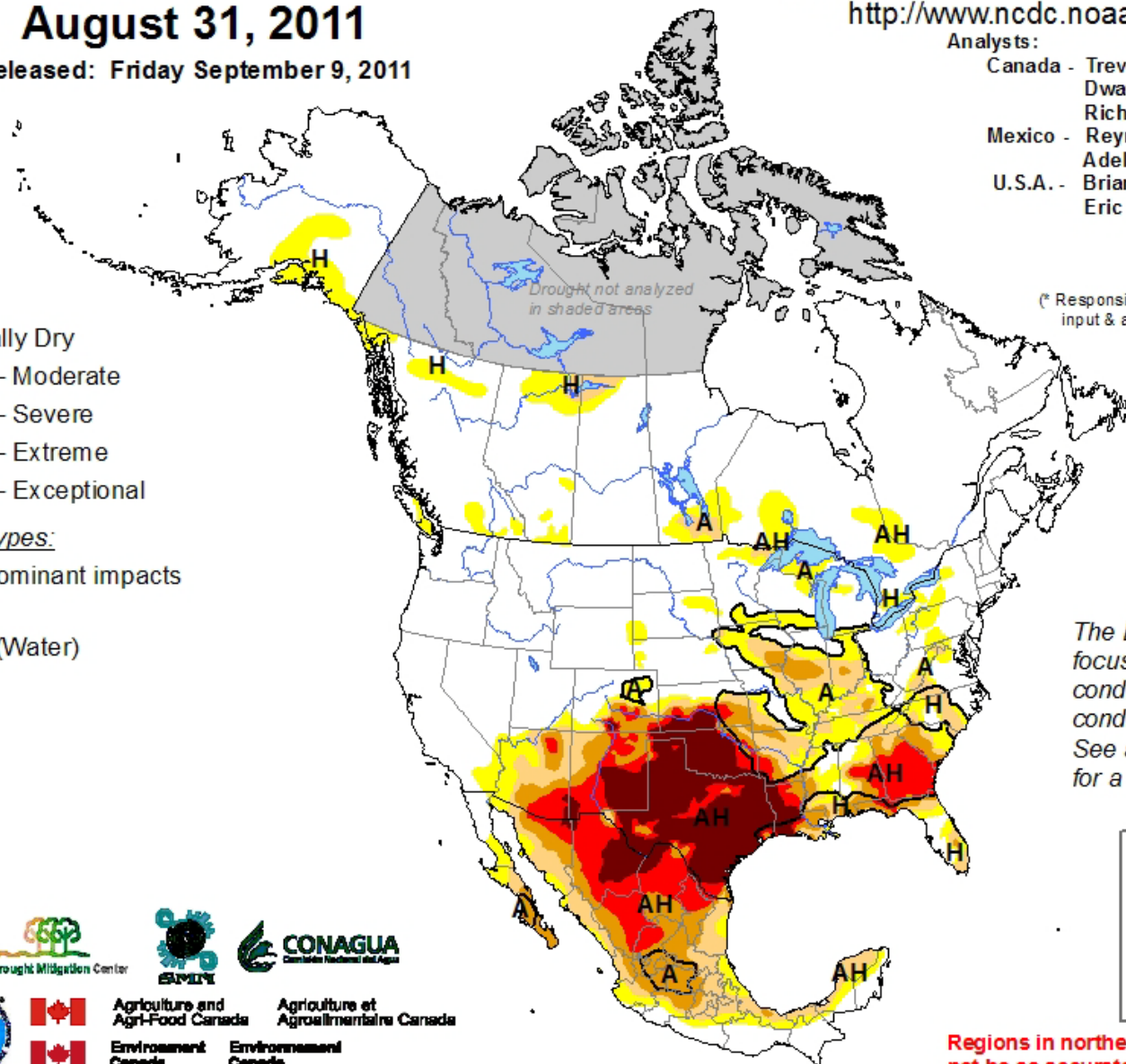
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

A = Agriculture

H = Hydrological (Water)



(* Responsible for collecting analysts' input & assembling the NA-DM map)

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



Agriculture and Agri-Food Canada

Agriculture et Agroalimentaire Canada

Environment Canada

Environnement Canada

Regions in northern Canada may not be as accurate as other regions due to limited information.

U.S. Seasonal Drought Outlook

- Issued every **two weeks**
- CPC **monthly precipitation** outlook
- CPC long-lead seasonal **90-day** forecasts
- Various medium- and short-range forecasts and models such as the **6-10 day and 8-14 day forecasts**
- **Soil moisture tools** based on the GFS model and the Constructed Analogue on Soil (**CAS**) moisture, the Climate Forecast System (**CFS**) **seasonal precipitation forecasts, climatology, and initial conditions.**

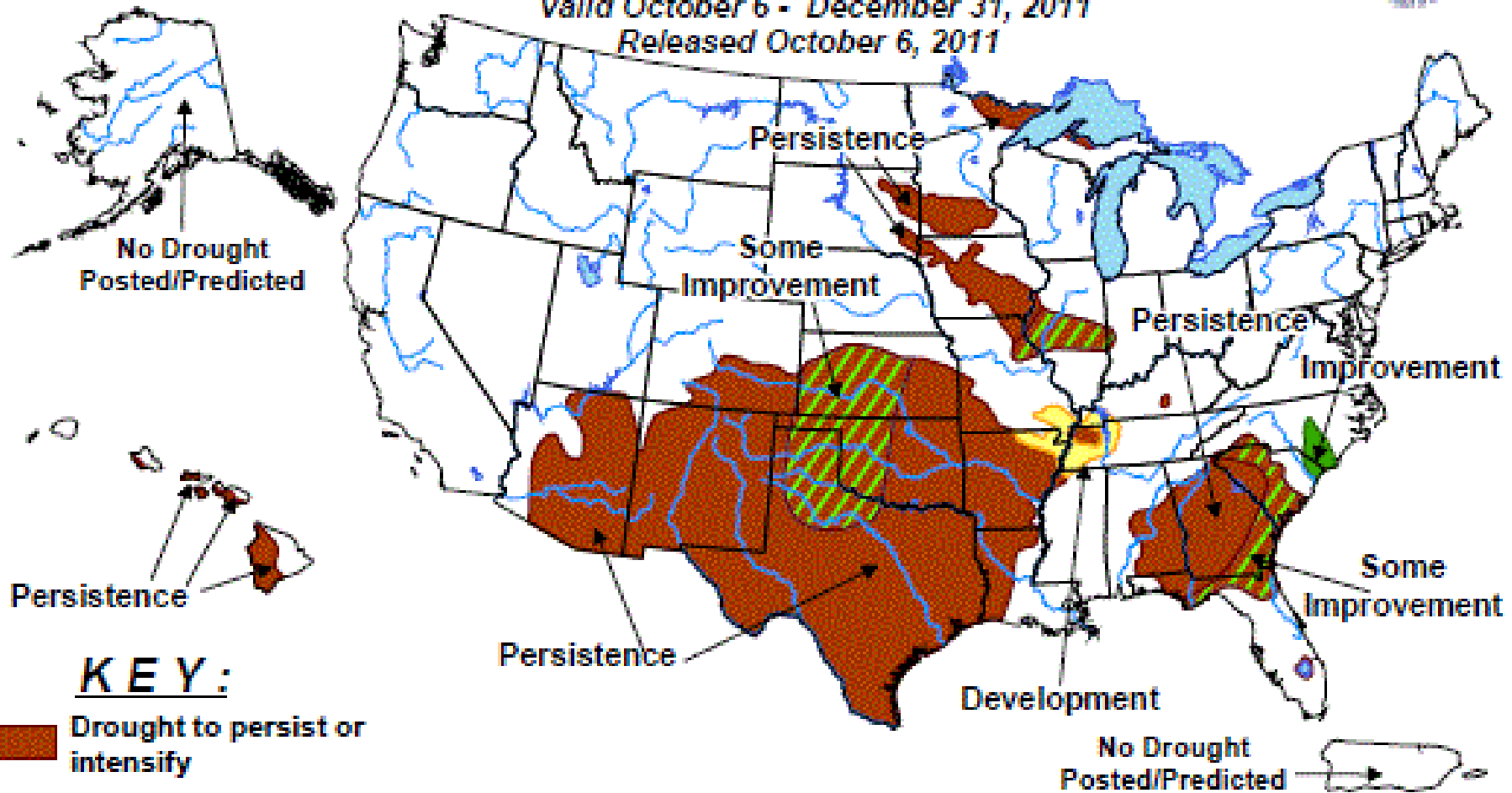


U.S. Seasonal Drought Outlook





Drought Tendency During the Valid Period



Valid October 6 - December 31, 2011
Released October 6, 2011



KEY:

-  Drought to persist or intensify
-  Drought ongoing, some improvement
-  Drought likely to improve, impacts ease
-  Drought development likely

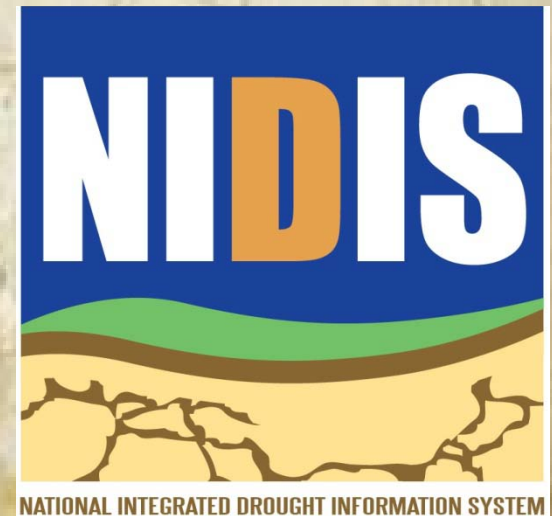
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events – such as individual storms – cannot be accurately forecast more than a few days in advance. Use caution for applications – such as crops – that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

National Integrated Drought Information System (NIDIS)

A NOAA-led Federal, State, Tribal and Local Partnership

(Public Law 109-430, 2006)

Goal of NIDIS: Improve the nation's capacity to 'proactively' manage drought-related risks by **providing decision makers with the best available information and tools** to assess the impact of drought and to better prepare for and mitigate the effects of drought.



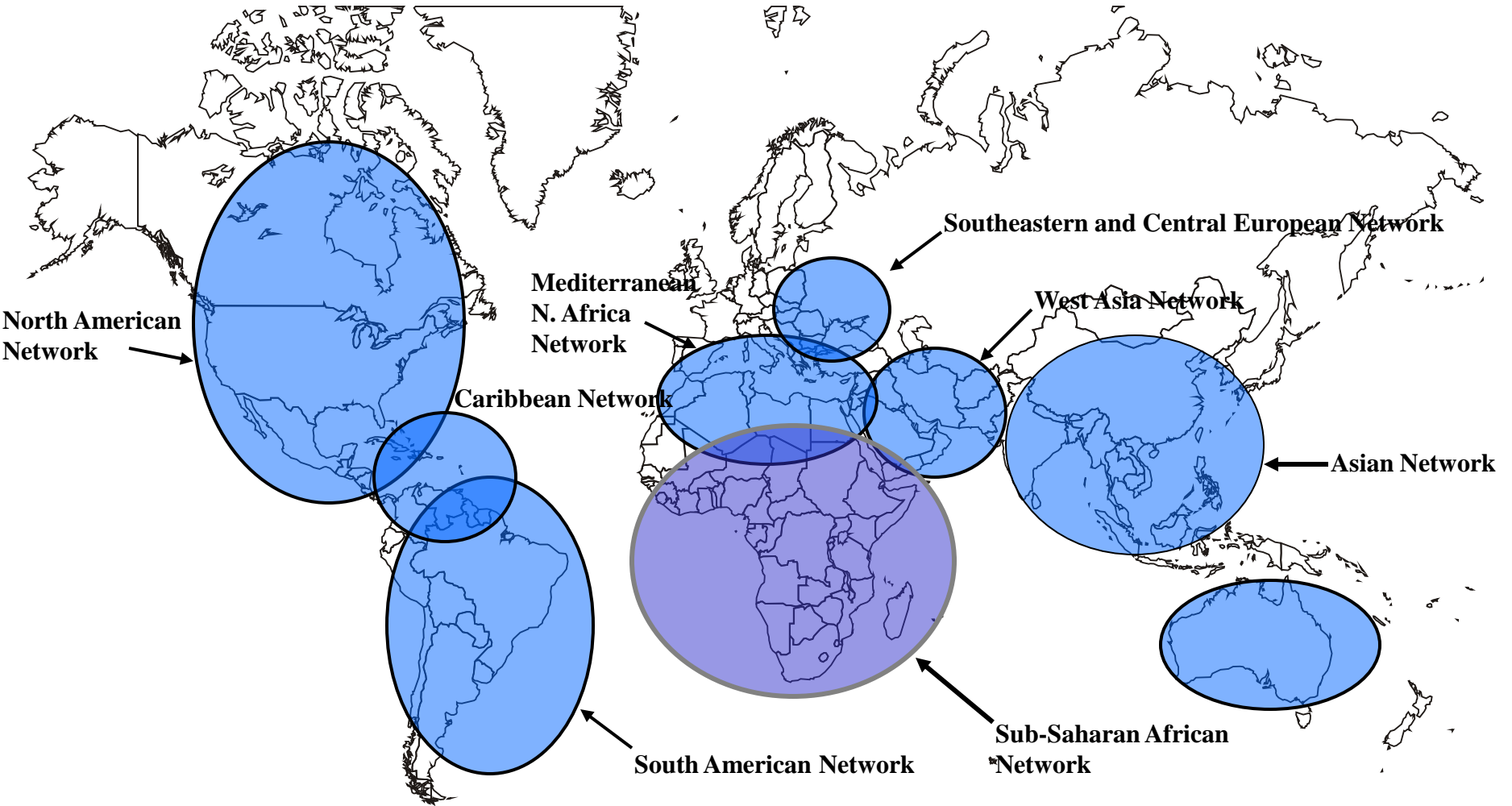
www.drought.gov

Global Drought Preparedness Network

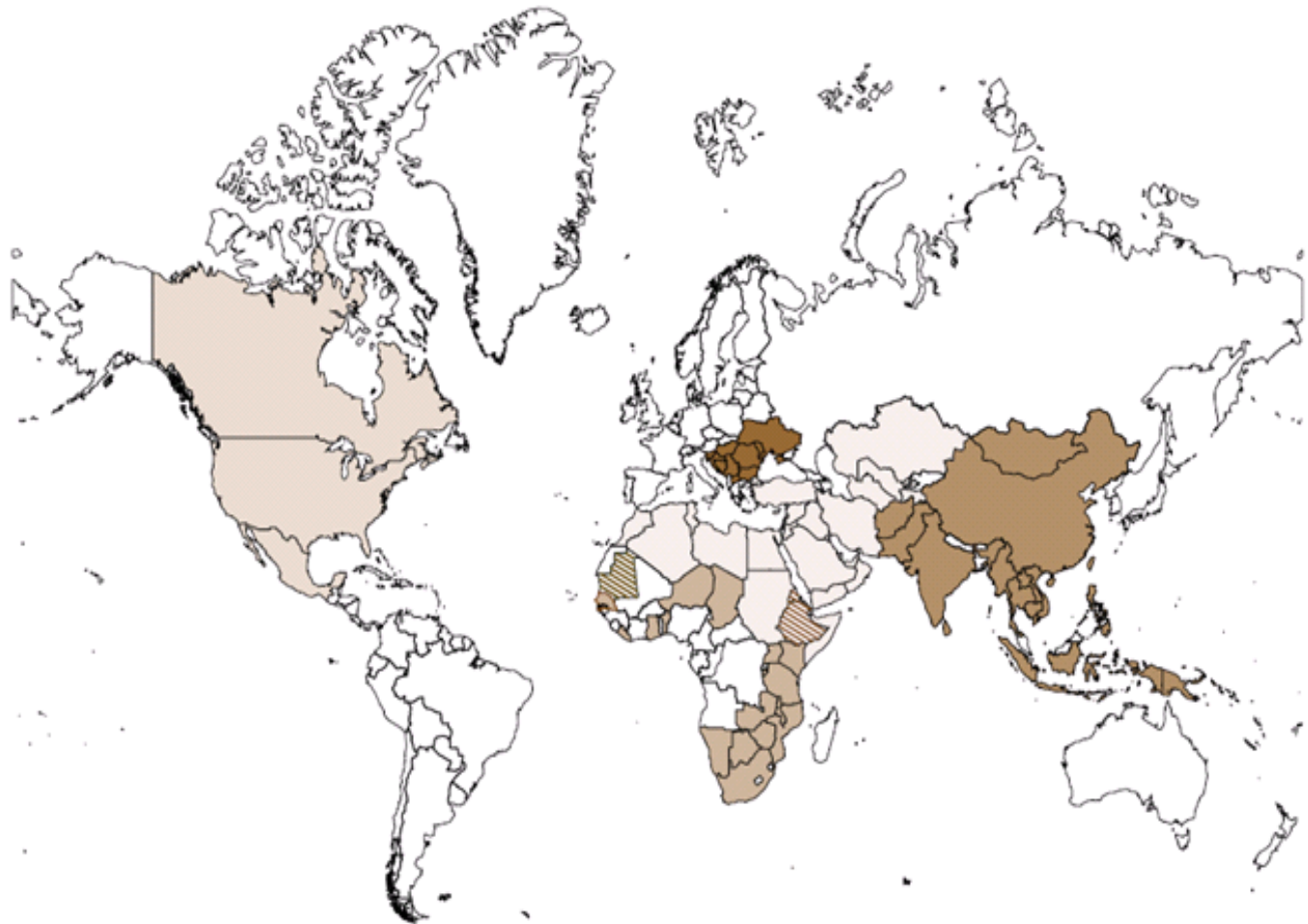
Individually, many nations will be unable to improve their drought coping capacity.

Collectively, through global, regional, and national **partnerships**, we can share information and experiences to reduce the impacts of drought.

Potential Regional Networks



Regional DEWS Networks



North American Drought Monitoring Network

NEMEDCA*

African Drought Risk & Development Network

Drought Monitoring Centre for SE Europe

Proposed Regional Drought Preparedness Network for Asia (under development)

NEMEDCA and African Drought Risk & Development Network

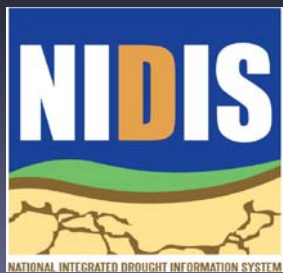
Global Drought Preparedness Network - UNISDR



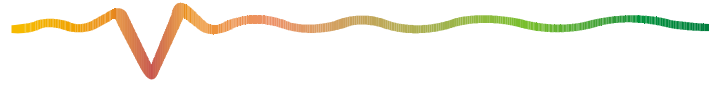
World Meteorological Organization
Working together in weather, climate and water



- ✓ The growing problem of drought and its impact on long-term sustainability of Earth's water resources has been recognized for many years. At a 2007 GEO Ministerial Summit, the event concluded with a U.S. proposal that technical representatives from participating countries build upon existing programs to work toward establishing a **Global Drought Early Warning System (GDEWS)** within the coming decade to provide:
 - A system of systems for data & information sharing, communication, & capacity building to take on the growing worldwide threat of drought
 - Regular drought warning assessments issued as frequently as possible with increased frequency during a crisis



Final Thoughts on DEWS



- All droughts are **LOCAL**
 - Monitoring local/regional/national/global (bottom-up or top-down or a combination of both)
 - Planning local/regional/national
- Collaboration
 - Leverage resources
 - Leverage skills/products
 - Data sharing (derivative and/or joint products)
- Ownership
- Attribution for all
- Communication/Transparency

DROUGHT: Future Challenges and Opportunities

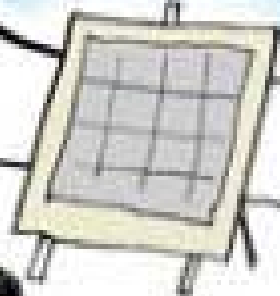
- **Climate change**
- **Public health issues**
- **Transboundary issues**
- **Food and water security**
 - Global Water Institute/Water for Food
- **Risk management**
 - Mitigation applications
 - Planning activities at all scales
 - Improved monitoring and prediction
 - Decision support
- **Global Integrated Drought Information System**
- **Global “Drought Services” (GFCS)**



CLIMATE SUMMIT

WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- ETC. ETC.



JOEL PITT
WITH GRACIA

Workshop Instructions: (How to use the “Sticky” Wall!)

- Please use the pens and post-it notes to formulate your thoughts and ideas and “post” them on the Sticky Wall at any time (break and after session). ***Please write large and include the Question #!*** 😊
- Any ***additional questions*** of the speakers you will hear in this session
- Ideas and thoughts as you listen to these talks

Workshop Instructions: (How to use the “Sticky” Wall!)

- #1: List your **Top 3 essential** climate/water/drought-related products or forecast **NEEDS** (list each one separately!)
- #2: What water sector **decisions** have you made **based on climate forecasts**?
- #3: What water sector **decisions** have you made **based on climate change**?
- #4: Any examples of **successful or unsuccessful decisions** made using climate information or forecasts?

Workshop Instructions: (How to use the “Sticky” Wall!)

- #5: How can climate information be ***mainstreamed*** into daily decision making?
- #6: How can ***we improve the linkages*** between meteorological, climatological and water communities at the international, regional, national and sub-national levels?
- #7: What ***new research questions*** would you like to ask the academic community about climate/water resources?
- #8: How can we ***improve communication***?

Please visit the NDMC website for more information: <http://drought.unl.edu>



Thanks!

Contact me at:
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402-472-8238
msvoboda2@unl.edu