

Drought Early Warning and Risk Management Across the S2S Continuum

MARK SVOBODA, PH.D., DIRECTOR

NATIONAL DROUGHT MITIGATION CENTER

UNIVERSITY OF NEBRASKA-LINCOLN



NATIONAL DROUGHT MITIGATION CENTER
UNIVERSITY OF NEBRASKA

When the Rain Stops: Drought on Subseasonal and Longer Timescales
Aspen, CO September 10-14, 2018

National Drought Mitigation Center

Established by Don Wilhite in 1995 at the University of Nebraska-Lincoln (UNL).

Boundary organization based at UNL, national (and international) mission: ***To reduce vulnerability to drought***

Core expertise: Climatology, drought risk management planning and stakeholder engagement

Highly interdisciplinary group ~27 staff – including remote sensing, geography, anthropology, rural sociology, survey methodology, political science, environmental economics, history, journalism, community & regional planning, public engagement/facilitation, GIS, web & IT

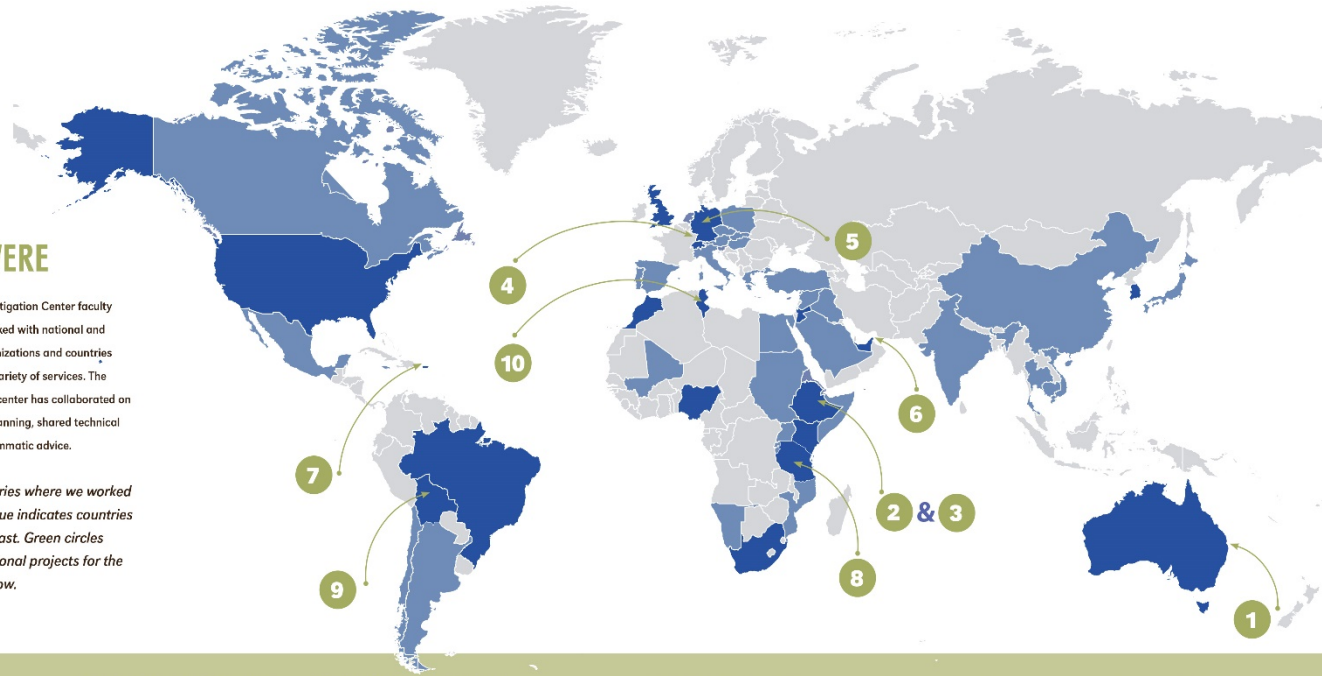


NDMC National/International Activities

WHERE WE WERE

National Drought Mitigation Center faculty and staff have worked with national and international organizations and countries around the world, providing a variety of services. The map shows where the drought center has collaborated on research, facilitated drought planning, shared technical knowledge, or provided programmatic advice.

Dark blue indicates countries where we worked in 2017, and the lighter blue indicates countries where we worked in the past. Green circles highlight our top international projects for the year; descriptions are below.



1 Tropical Ag Conference and University of South Queensland Visit

Location: Brisbane, Australia

NDMC's Mark Svoboda consulted with livestock producers at the University of South Queensland in Brisbane and spoke at the TropAg 2017 Conference.

2 Seasonal Prediction of Hydro-Climatic Extremes for the Greater Horn of Africa

Location: Addis Ababa, Ethiopia

NDMC and partners — NASA, Addis Ababa University, and Ethiopia's Meteorological

Society and National Meteorological Agency — presented a workshop on managing climate extremes.

3 International Conference on Agro-meteorology

Location: Addis Ababa, Ethiopia

NDMC's Tsigeaye Tadesse and remote-sensing experts were keynote speakers and presented information for Climate Resilient Agriculture and Smallholder Farmers in Ethiopia.

4 Integrated Drought Management

- **NOAA/NIDIS + USDA**
- **UN organizations: FAO, ISDR, UNDP and CCD**
- **World Meteorological Organization (WMO)**
- **USAID, World Bank**
- **Global Water Partnership (Integrated Drought Management Program)**
- **Various regional and national climate centers**
- **Numerous government agencies and universities in different countries**

5 Dubai Drought Vulnerability

Location: Dubai, United Arab Emirates

NDMC's Mark Svoboda and his colleagues presented at the Dubai Drought Vulnerability Conference.

6

Location: Addis Ababa, Ethiopia

NDMC's Tsigeaye Tadesse and remote-sensing experts were keynote speakers and presented information for Climate Resilient Agriculture and Smallholder Farmers in Ethiopia.

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Svoboda gave the keynote presentation at the Latin American and Caribbean Regional Conference on Drought Management and Preparedness.

10 Tunis, Tunisia, Meeting 2017

Location: Tunis, Tunisia

NDMC information technology and geographic information system experts led a hands-on capacity building workshop with their Tunisian counterparts to train them on a new operational drought early warning system and drought indicator built specifically for the country.



Drought as an analog: “a force for truth”

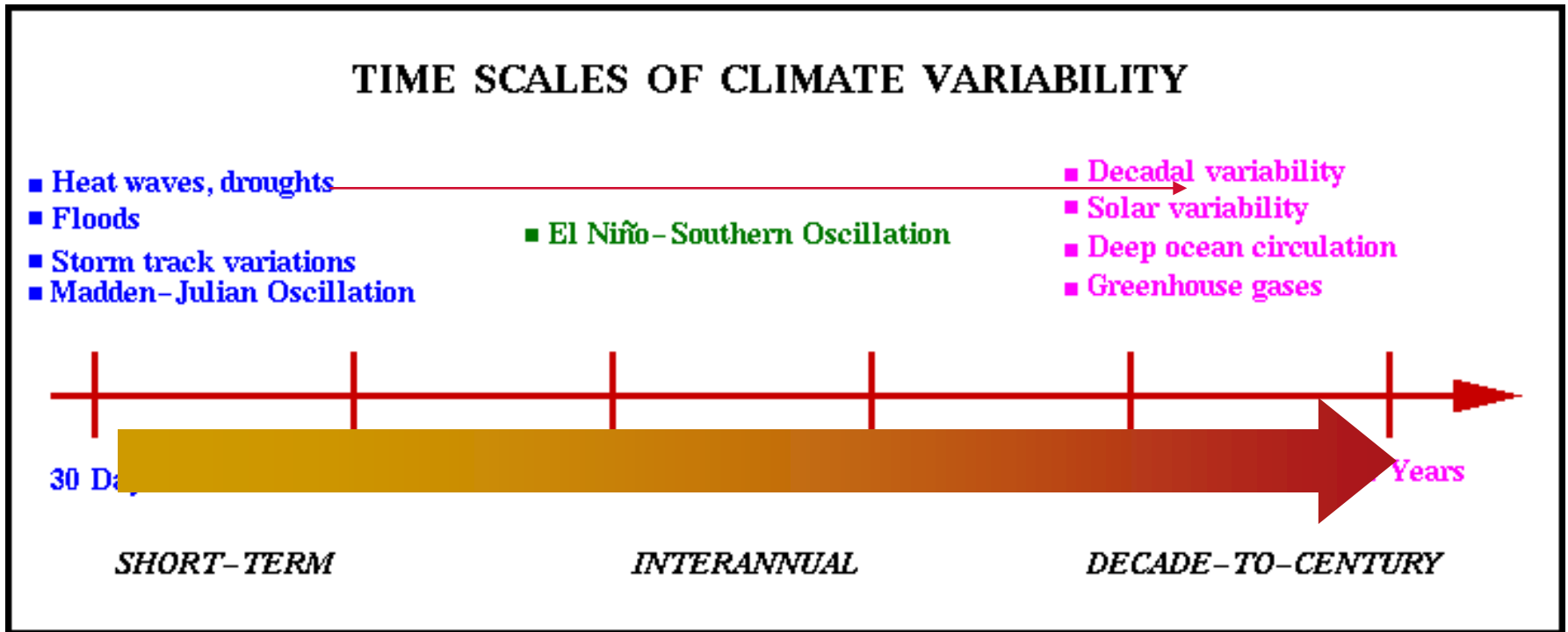
“Societies will manage climate change in the same way they will manage droughts (for better or worse)” (Daniel Connell, Australian National University, 2010)

Analysis of drought risk management is the starting point for a comprehensive institutional analysis

Stress from drought highlights:

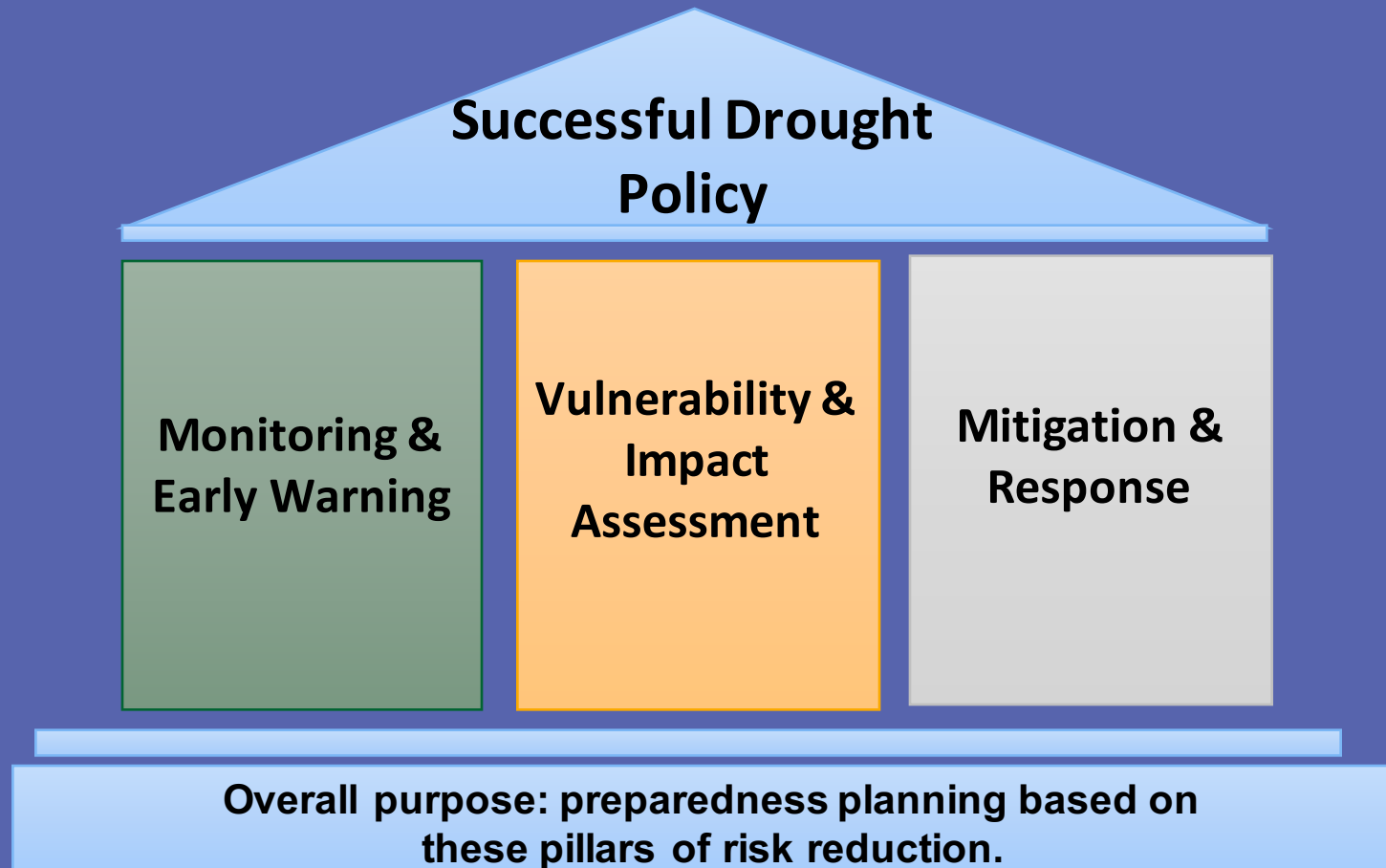
- Strengths and weaknesses that are usually hidden
- Political priorities and underlying cultural values revealed by difficult choices

Why Drought?



Droughts span an enormous range of temporal and spatial scales....not at all unlike the anticipated behavior of climate change.

Drought Risk Management: The Three Pillars



Current/Future Drought Risk Management Concerns

Past drought management efforts have been **reactive** (costly, untimely, ineffective & poorly coordinated).

Impacts are increasing and becoming **increasingly complex** across sectors, demonstrating increasing vulnerabilities...yet, impact assessments are lacking and/or no consistent methodology is present, therefore the **costs/losses of drought are not well documented**.

How do we tie together (e.g., **“triggers”**) the 3 pillars of Drought Risk Management elements?

Climate change is and will continue to alter the frequency, severity and duration of droughts for many regions— increasing costs and increasing recovery times. ***It’s a “fluid” thing!***

Given increased drought incidence and upward spiraling impacts, **how can we convince policy makers that drought preparedness and the application of the principles of risk management are worthy of upfront investments?**



Why is a Vulnerability Assessment Needed?

Assuming that drought occurs as part of the normal climate cycle, ***vulnerability is the key determinant of drought risk and the main driver of drought impacts and economic losses.***

An outstanding knowledge of drought monitoring and vulnerability itself does little to reduce drought impacts and economic losses ***unless the knowledge is implemented into practice*** (Ismail-Zadeh et al. 2017).



Drought Planning 101

Impacts & vulnerability: How does drought affect you? What do you need to protect?

Monitoring: How will you know when you are in a drought?

Response: What will you do during drought?

Mitigation: What can you do ahead of time to reduce impacts during the next drought?



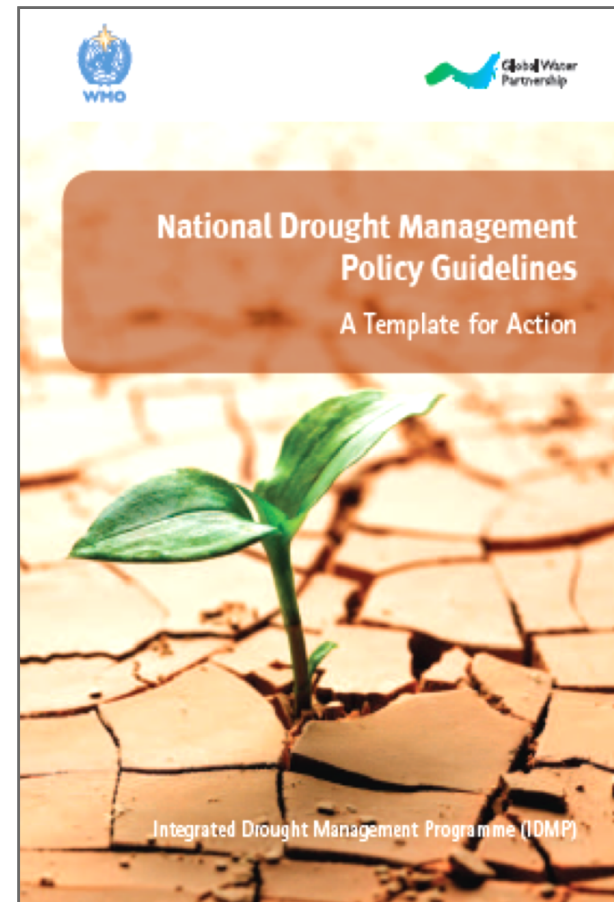
Integrated Drought Management Programme (IDMP) Outcome: National Drought Management Policy Guidelines

3 Pillars approach (NDMC roots)

Response to need articulated at the High Level Meeting on National Drought Policy

Template that ***can be adapted to national realities and needs***

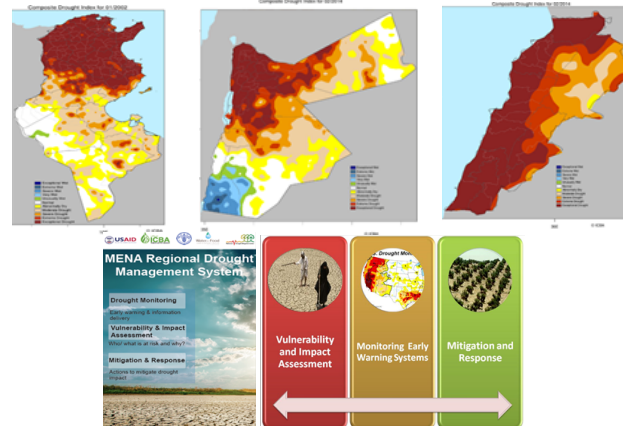
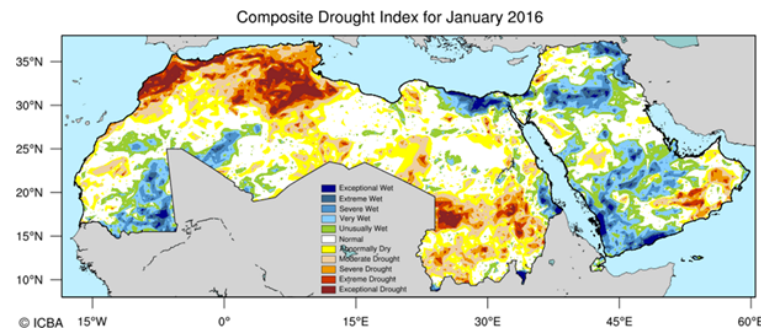
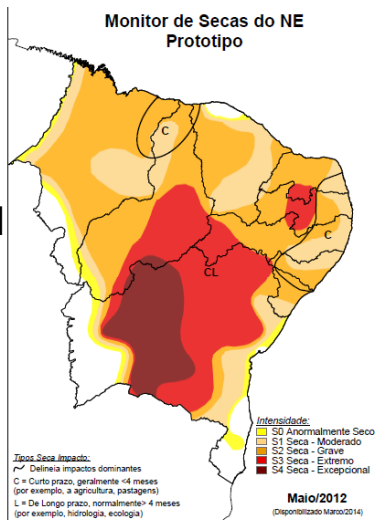
Building on existing risk management capacities



A variety of approaches aimed at tackling the 3 pillars...

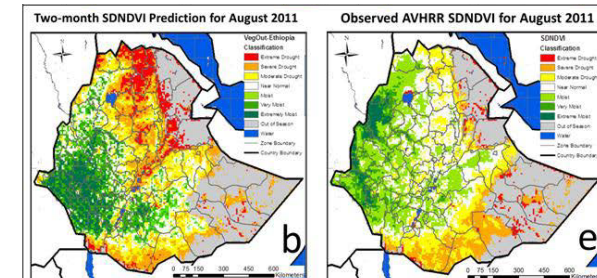


Caribbean



Czech Republic

Greater Horn of Africa



Types of Drought

There are *indices and indicators* used to identify *all* of these types of drought at various thresholds

There is *no single definition* of drought

Thus, in most cases, there is *no “one-size-fits-all”* drought indicator or index

Meteorological
Agricultural
Hydrological
Socioeconomic
“Ecological”
“Flash”
“Snow”



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FLASH DROUGHTS: A REVIEW AND ASSESSMENT OF THE CHALLENGE...

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FLASH DROUGHTS: A REVIEW AND ASSESSMENT OF THE CHALLENGES IMPOSED BY RAPID ONSET DROUGHTS IN THE UNITED STATES

Jason A. Otkin¹, Mark Svoboda², Eric D. Hunt³, Trent W. Ford⁴, Martha C. Anderson⁵, Christopher Hain⁶, and Jeffrey B. Basara^{7,8}

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<https://doi.org/10.1175/BAMS-D-17-0149.1>

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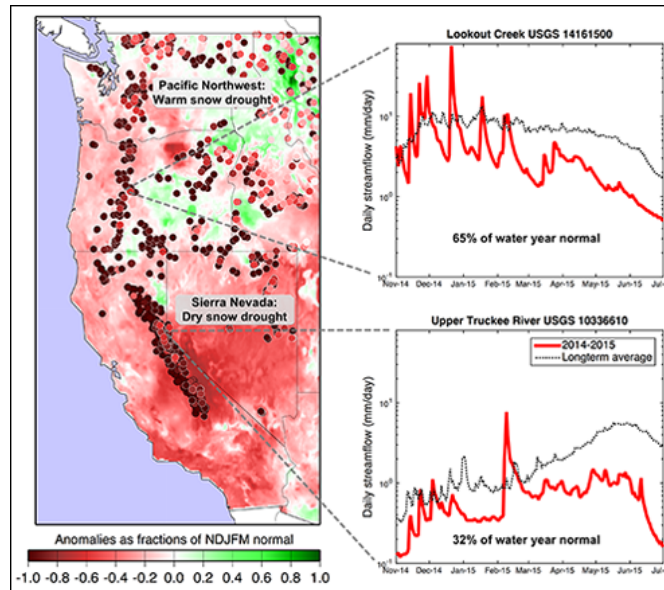
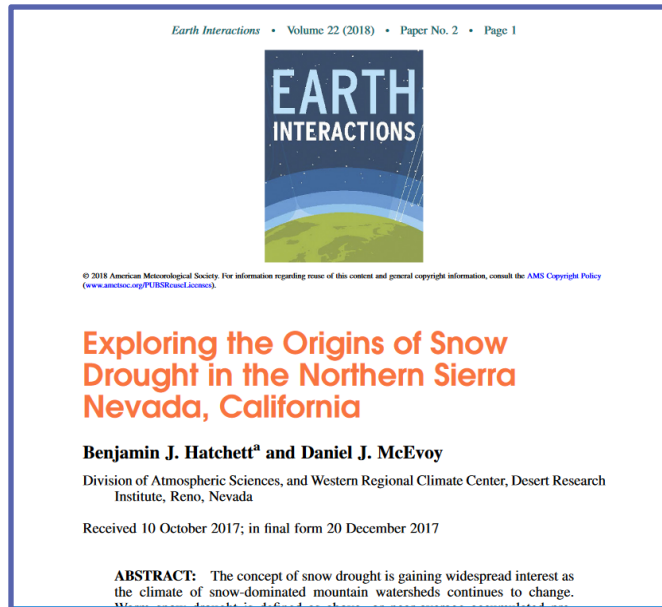
Flash Drought – Proposed General Definition

- We propose that “flash droughts” should be viewed as a subset of all droughts that are **distinguished solely by their rapid rate of intensification**
- This definition can be seamlessly **applied to all drought types**
- **Our proposed definition has two basic requirements:**
 - A given drought index must change much more rapidly than normal (e.g., the “flash” part of the definition)
 - Drought index must fall below the 20th percentile (e.g., “drought” according to the USDM classification scheme)
- Definition ***excludes short periods of anomalous conditions*** that do not lead to drought impacts

Snow Drought

What is Snow Drought?

Snow drought is defined as period of abnormally low snowpack for the time of year, reflecting either below-normal cold-season precipitation (dry snow drought) or a lack of snow accumulation despite near-normal precipitation (warm snow drought), caused by warm temperatures and precipitation falling as rain rather than snow or unusually early snowmelt. (*AMS Glossary of Meteorology*)



By Adrian A. Harpold, Michael Dettinger, and Seshadri Rajagopal 28 February 2017 (EOS)

Ecological Drought

They define the term **ecological drought** as “an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems.”

Defining Ecological Drought for the Twenty-First Century

Shelley D. Causby and Aaron R. Ramirez*

National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, Santa Barbara, California

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National Climate Change and Wildlife Science Center, U.S. Geological Survey, Reston, Virginia

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Lauren E. Hay

Denver Federal Center, U.S. Geological Survey, Denver, Colorado

Michael J. Hayes

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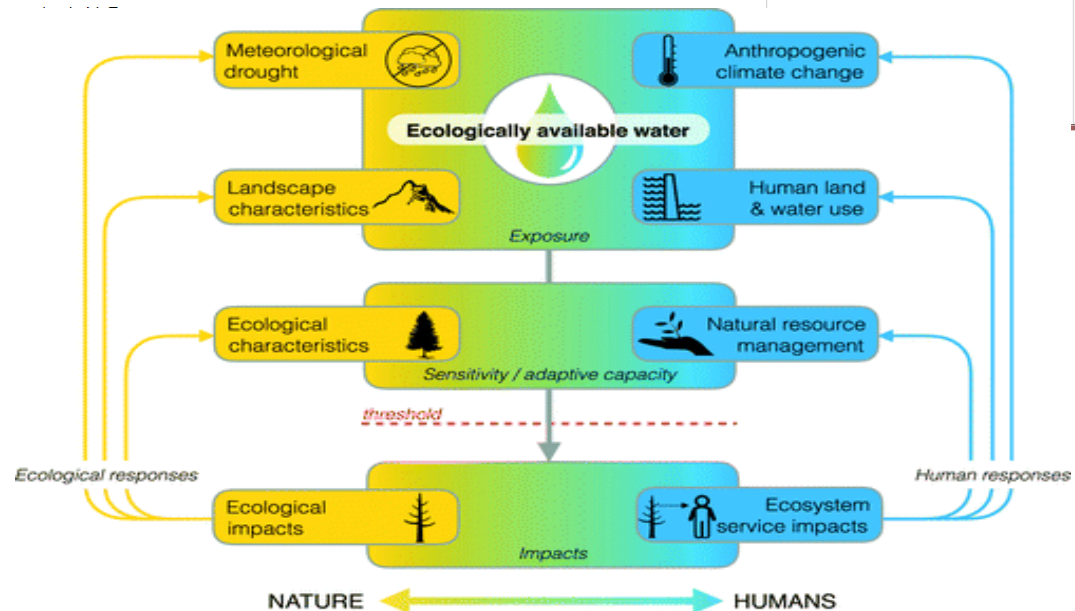


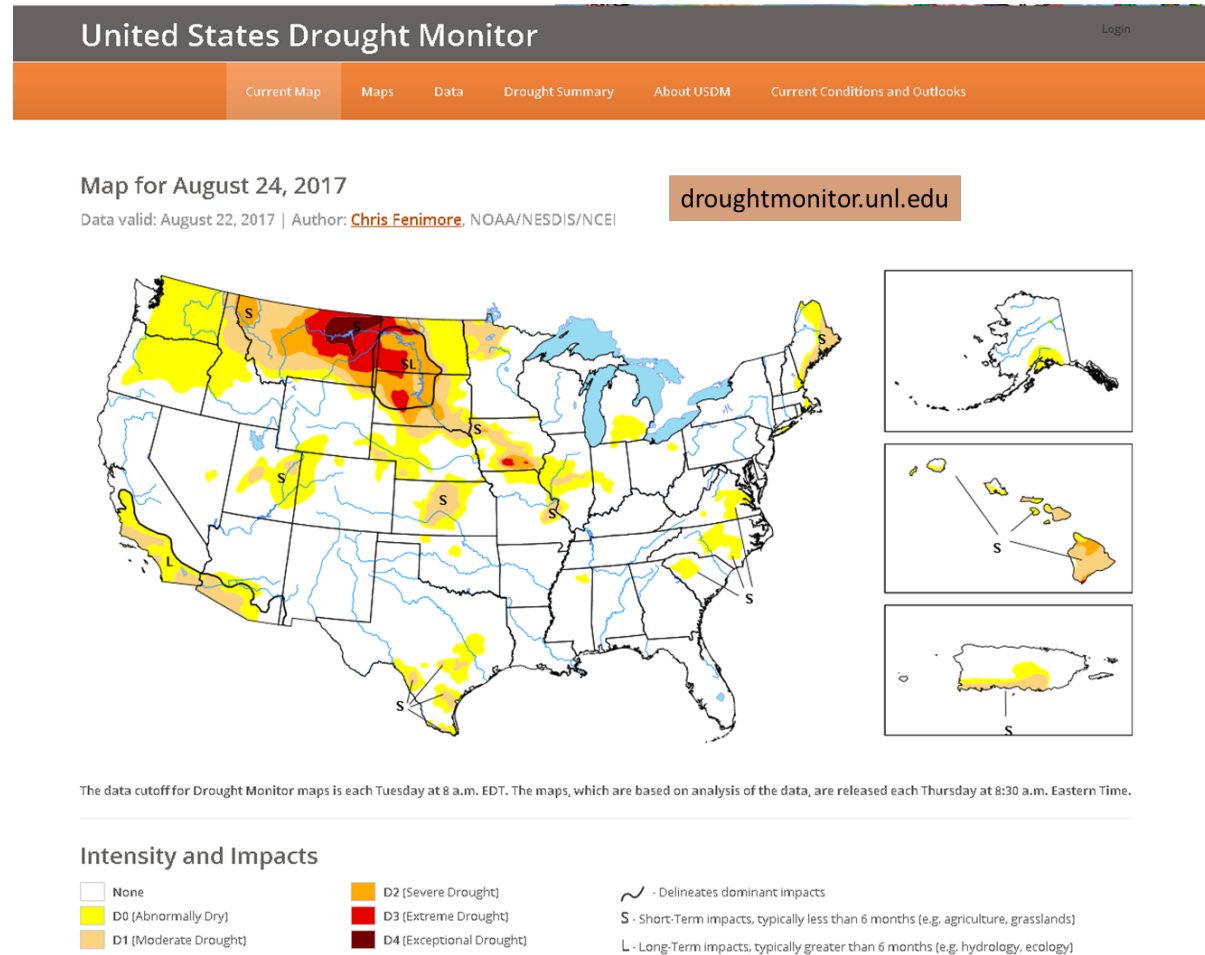
Fig. 1. Conceptual diagram of ecological drought in the twenty-first century. This diagram illustrates the key drivers of drought vulnerability and impacts in coupled natural-human systems. Vulnerability = exposure + sensitivity + adaptive capacity. Curved arrows indicate feedbacks where ecological responses and changes in human behavior or institutions can alter ecological drought vulnerability. The yellow-blue color gradient represents the continuum of coupled natural-human systems.

Components of a Drought Early Warning and Information System (DEWIS)

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

U.S. Drought Monitor (USDM)

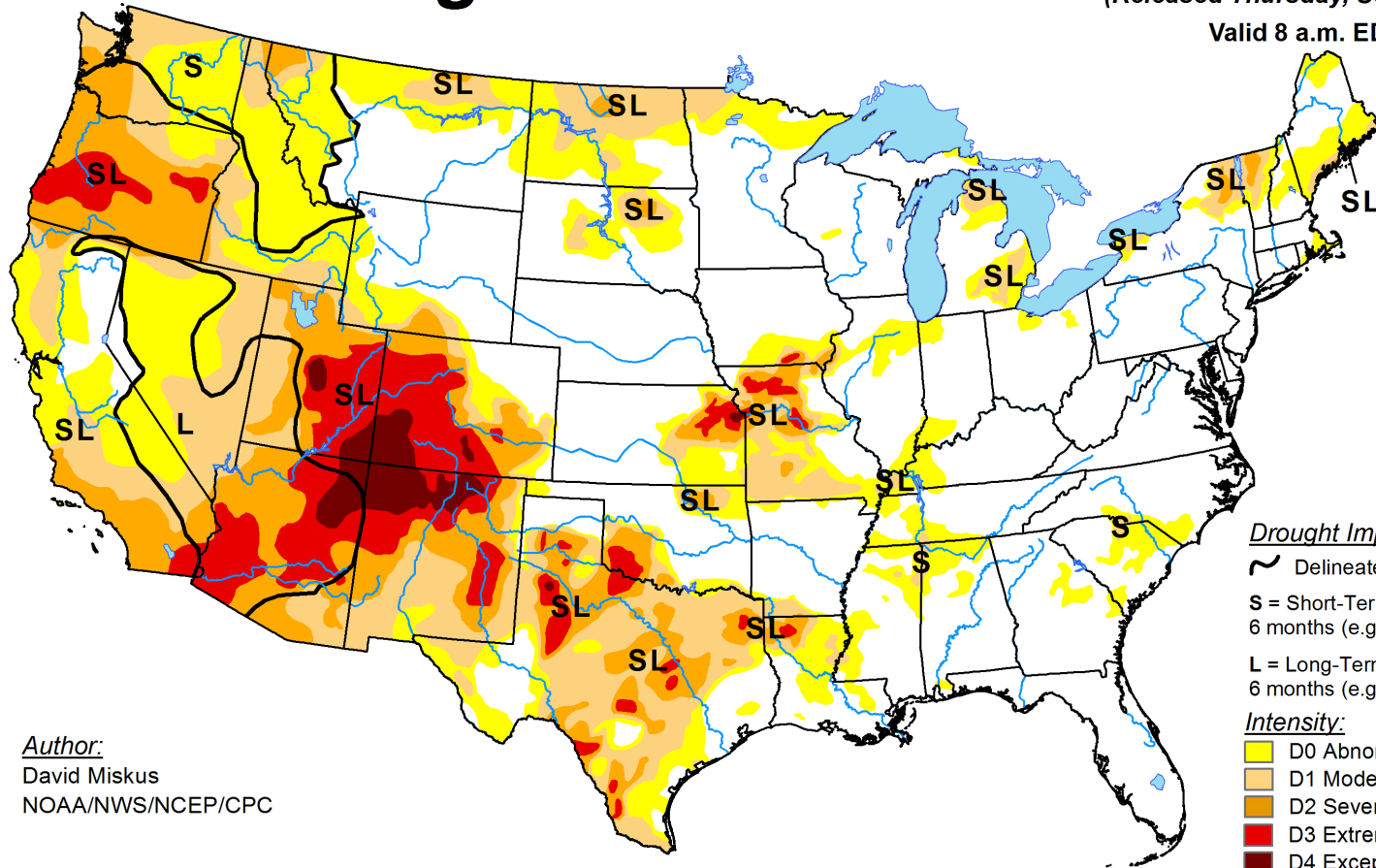
- **State-of-the-science** drought assessment in the U.S. since 1999
 - **Collaborative effort** between NOAA, USDA and NDMC
- **Composite** indicator blends objective indicators and indices with field input from over **~450 experts**
- **Policy implications** in Farm Bill (USDA), IRS, NOAA-NWS and several state drought plans and task forces
- **“Go to source”** for media and the public
 - ~12 million page views annually



U.S. Drought Monitor

September 4, 2018
(Released Thursday, Sep. 6, 2018)

Valid 8 a.m. EDT



Author:
David Miskus
NOAA/NWS/NCEP/CPC

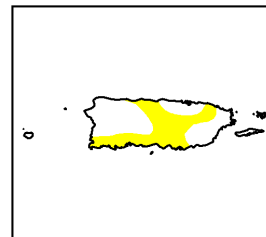
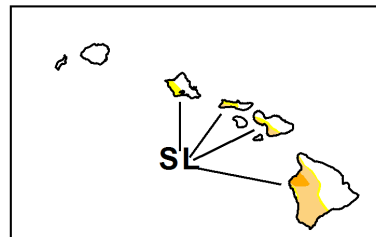
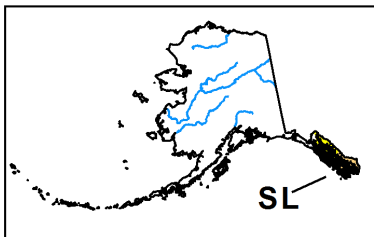
Drought Impact Types:

- ~ Delineates dominant impacts
- S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

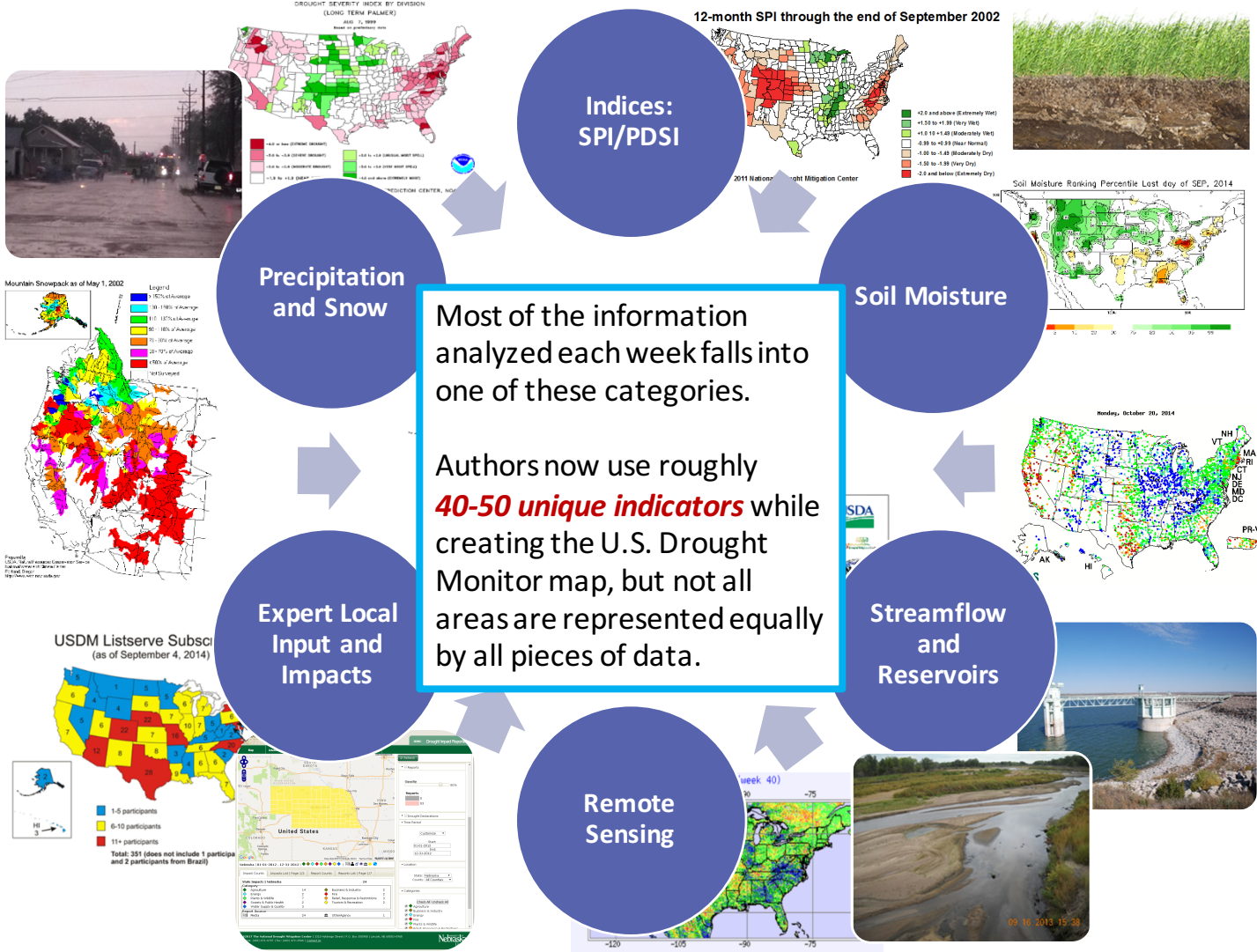
Intensity:

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

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



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



Some Examples of Decision Making and Policy Using the USDM

(Science before Policy)

Policy:

- **2008/2014 Farm Bill**
 - USDA Farm Service Agency, Natural Resources Conservation Service, Risk Management Agency
 - **~\$6.5 billion in payments** disbursed (through 2015) via the Livestock Forage Disaster Program (LFP) between 2011-2015
- **Internal Revenue Service**
 - Livestock tax deferral program
- **U.S. Department of Agriculture**
 - Secretarial *“Fast Track”* Drought Designations (USDM trigger since 2012)
- **NOAA National Weather Service**
 - Drought Information Statements
- **Environmental Protection Agency**
 - Water quality monitoring
- **Centers for Disease Control and Prevention**
 - Public health
- **Bureau of Land Management**
- **Several States use the USDM in their monitoring/early warning and in drought plans**





And now....BEYOND the USDM

Now What?

There is an **obvious need to systematically collect impact information** just as we do precipitation, temperature, ET, snowpack + SWE, reservoir levels, soil moisture, groundwater, etc.

In addition, we **need to better understand the relationships and lags between impacts and indicators**...both spatially and temporally.



Why track drought impacts?

Validation: ground truth models, indicators, satellite imagery/products, etc. (“reality check”)

Research: Improve our understanding of how biophysical indicators relate to social and environmental indicators. Need longitudinal data.

Response & Recovery: To know where to direct relief (input, regional representation for U.S. Drought Monitor)

Planning: Impacts point to underlying vulnerability. Tracking drought impacts can help decision makers figure out where to focus efforts to reduce vulnerability to the next drought.



What is a drought impact?

“An observable loss or change that occurred at a specific place and time because of drought.”



Drought Impact Questions & Challenges

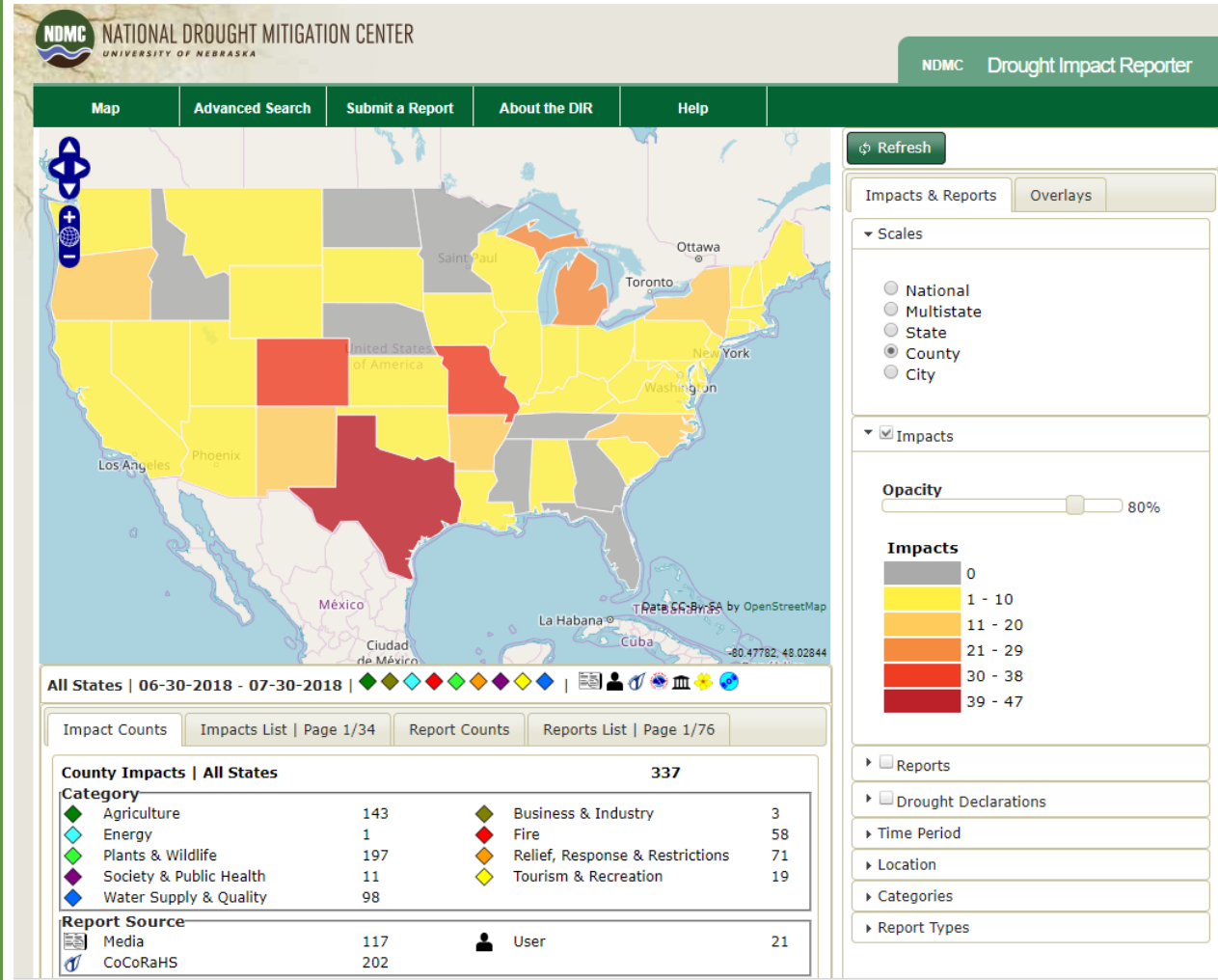
- No universal methodology for quantifying drought impacts
 - Even in agriculture (crop vs. range vs. livestock)
- No units
- Easier to list than to summarize impacts
- “Angst index” (pulse of concern/perception)
- Disincentives to sharing some info
 - Proprietary
 - Competitive/Economic
 - Privacy



Drought Impact Reporter

- Launched in **2005**, in response to calls for a comprehensive archive of drought impacts
- **Reports** from media, individual observers ("Users," CoCoRaHS), agencies
- **>72K** reports/**>25K** impacts in our database
- **Searchable** by time, place, scale, category, term
- **Moderated** @ NDMC

Wilhite, Donald A., Mark D. Svoboda, and Michael J. Hayes. "Understanding the complex impacts of drought: a key to enhancing drought mitigation and preparedness." *Water resources management* 21.5 (2007): 763-774.
<http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1042&context=droughtfacpub>



Inventory of drought impact data

BY SECTOR

Agriculture

Hydropower

Tourism & Recreation

Ecosystems: plants & animals

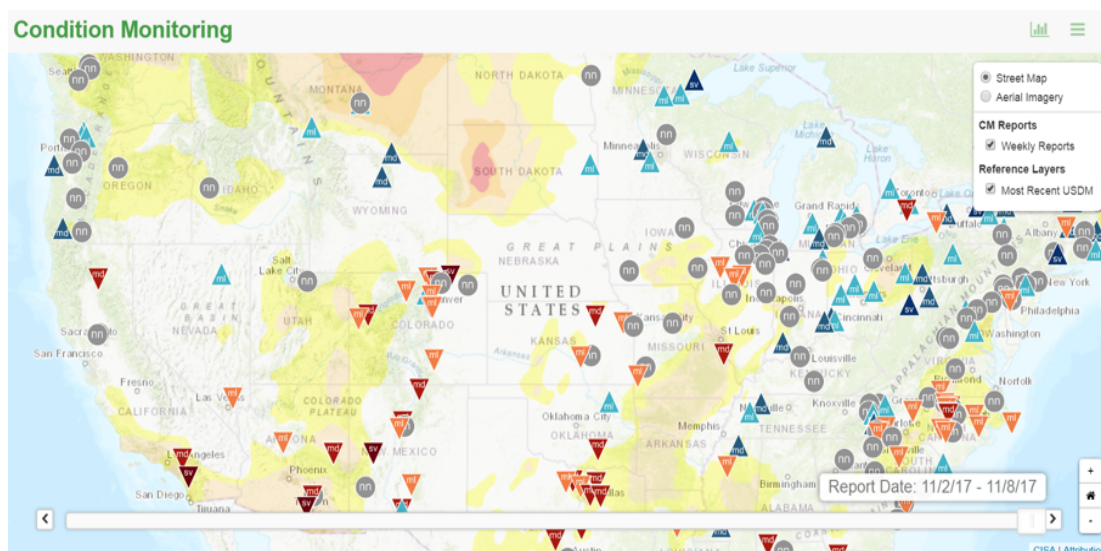
Public health

- Domestic wells
- Environmental health

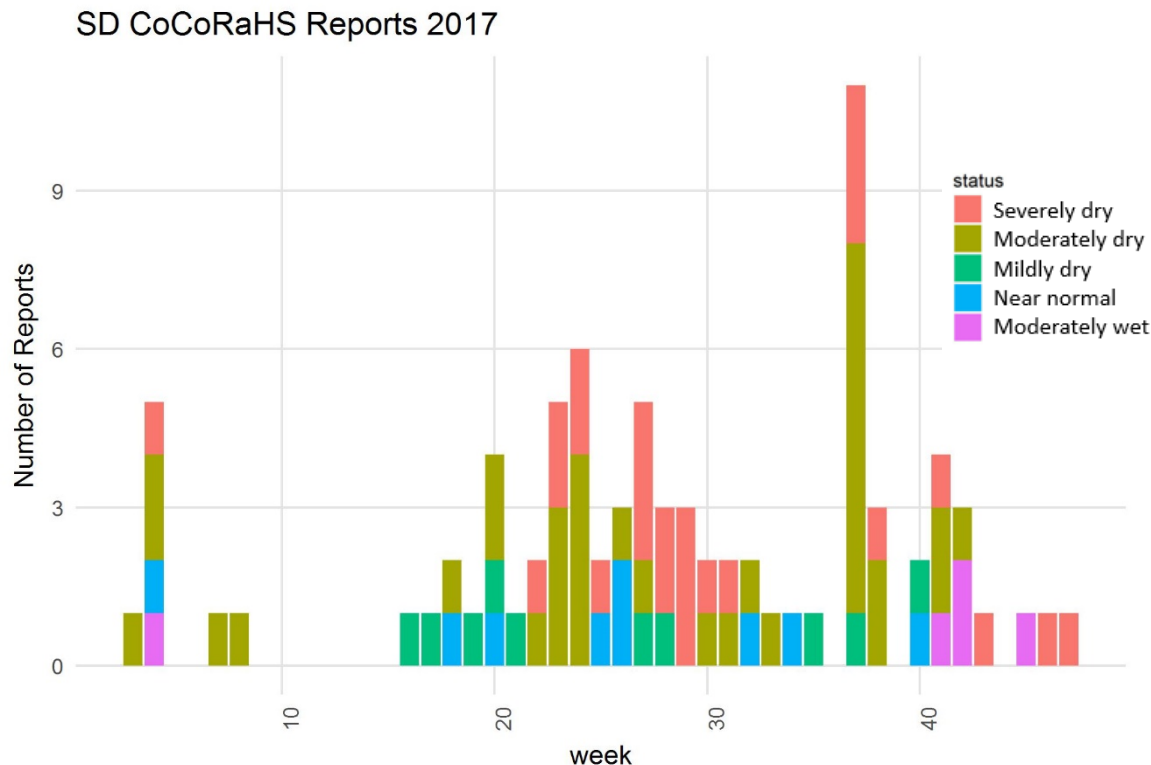
BY TIME

Cumulative, end-of-season vs.

Real-time, “condition-monitoring”



Number of CoCoRaHS condition reports from SD, by week, for 2017



CoCoRaHS Report from Station #Newell
6.5 ENE on 10/22/2017

Report Type: CoCoRaHS

Publication Date: 2017-10-22

Dates of Report: 2017-10-22 to 2017-10-22

Source Name: Newell 6.5 ENE

Summary: No rain since the first week of October. Grass has dried off - palatability has decreased for cattle, soil moisture is nonexistent. Dust blows and drifts like snow where there is bare ground. Windy and hot conditions over the past week have exacerbated conditions.

Url:

Affected Area(s): Butte County, SD

Categories:

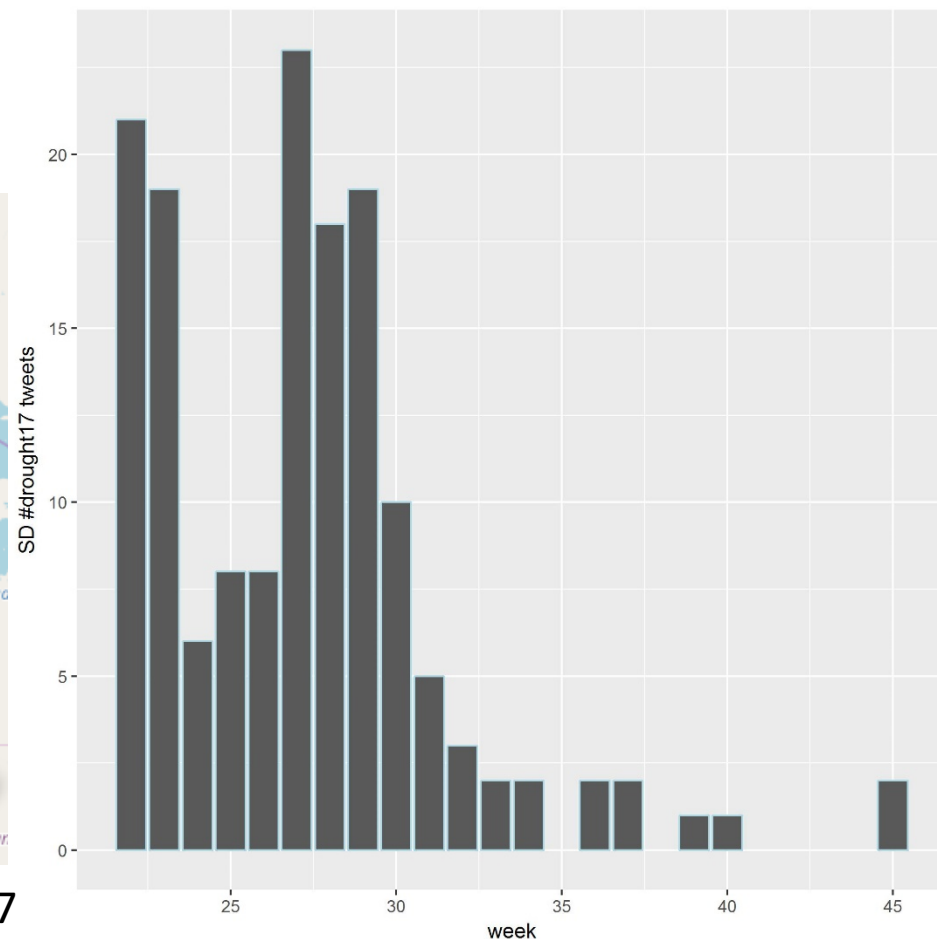
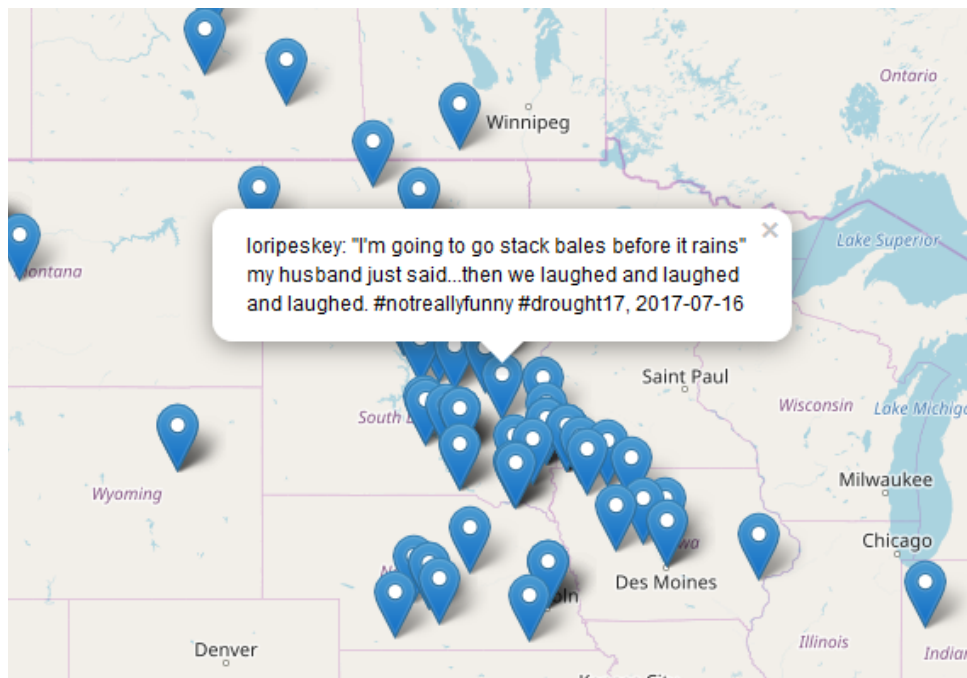
Agriculture

General Awareness



SD “#drought17” tweets

Note that they start abruptly in June – chart only shows weeks 22-45



#drought17 tweets for week ending July 24, 2017

Developing a Framework to Link Drought Impacts and Severity State-by-State

MARY NOEL AND THE NDMC TEAM



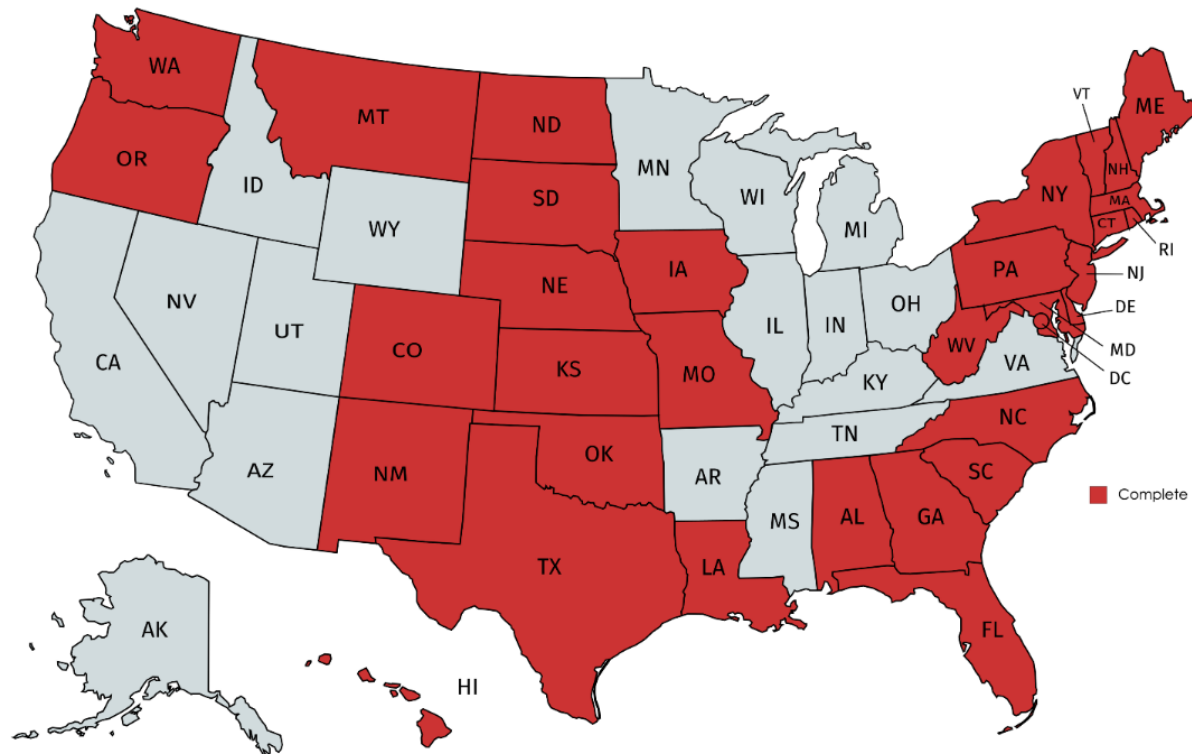
Current Drought Classification Table on USDM

Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures Coming out of drought: some lingering water deficits pastures or crops not fully recovered	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	Some damage to crops, pastures Streams, reservoirs, or wells low, some water shortages developing or imminent Voluntary water-use restrictions requested	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	Crop or pasture losses likely Water shortages common Water restrictions imposed	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	Major crop/pasture losses Widespread water shortages or restrictions	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses Shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

Purpose:

- Update the USDM national classification table schema state by state.
- Link multisector qualitative impacts reported in the DIR to drought severity monitoring as defined by USDM at a state level.
- Raise awareness about the importance of drought impact reporting to improve drought planning, preparedness, and mitigation.
- Incorporate state impact tables on the NDMC website for public availability.

Two-thirds of the country now has an individualized drought impact table



Materials and Methods:

- DIR media and CoCoRaHS impact reports
- DIR sectors
- USDM drought severity at a county level
- **Drought emergence**

	A	D	F	K	M	N	U
1	Impact ID	Start Date	Description	Agriculture	Fire	Place	Drought Severity
2	22021	10/20/07	A burn ban is in effect for the Great Smoky Mountains National Park backcoun	No	Yes	Haywood County, NC	D4
3	19735	3/19/07	Residents of North Carolina are asked to not burn yard materials and fallen tre	No	Yes	North Carolina	D1
4	21656	9/27/07	Fewer trout will be stocked in the mountain streams of North Carolina becaus	No	No	Alexander County, NC	D3
5	21656	9/27/07	Fewer trout will be stocked in the mountain streams of North Carolina becaus	No	No	Cherokee County, NC	D4
6	21656	9/27/07	Fewer trout will be stocked in the mountain streams of North Carolina becaus	No	No	Surry County, NC	D2
7	21524	3/1/07	The following report was submitted.Partial to complete loss of value for many	Yes	No	Graham County, NC	D1
8	22138	10/31/07	Water use in excess of 11,250 gallons per month will be billed at twice the nor	No	No	Guilford County, NC	D2
9	23118	10/31/07	Mandatory water restrictions went into effect for Wilmington in October. The	No	No	New Hanover County, NC	D2
10	23897	10/31/07	Wilmington residents must abide by mandatory restrictions that specify when	No	No	Brunswick County, NC	D2
11	22097	10/30/07	Lock service in the Dismal Swamp Canal ended at 3 pm due to low water levels	No	No	Camden County, NC	D1
12	22098	10/30/07	In North Carolina, 117 of the water systems are experiencing mandatory restri	No	No	North Carolina	D4

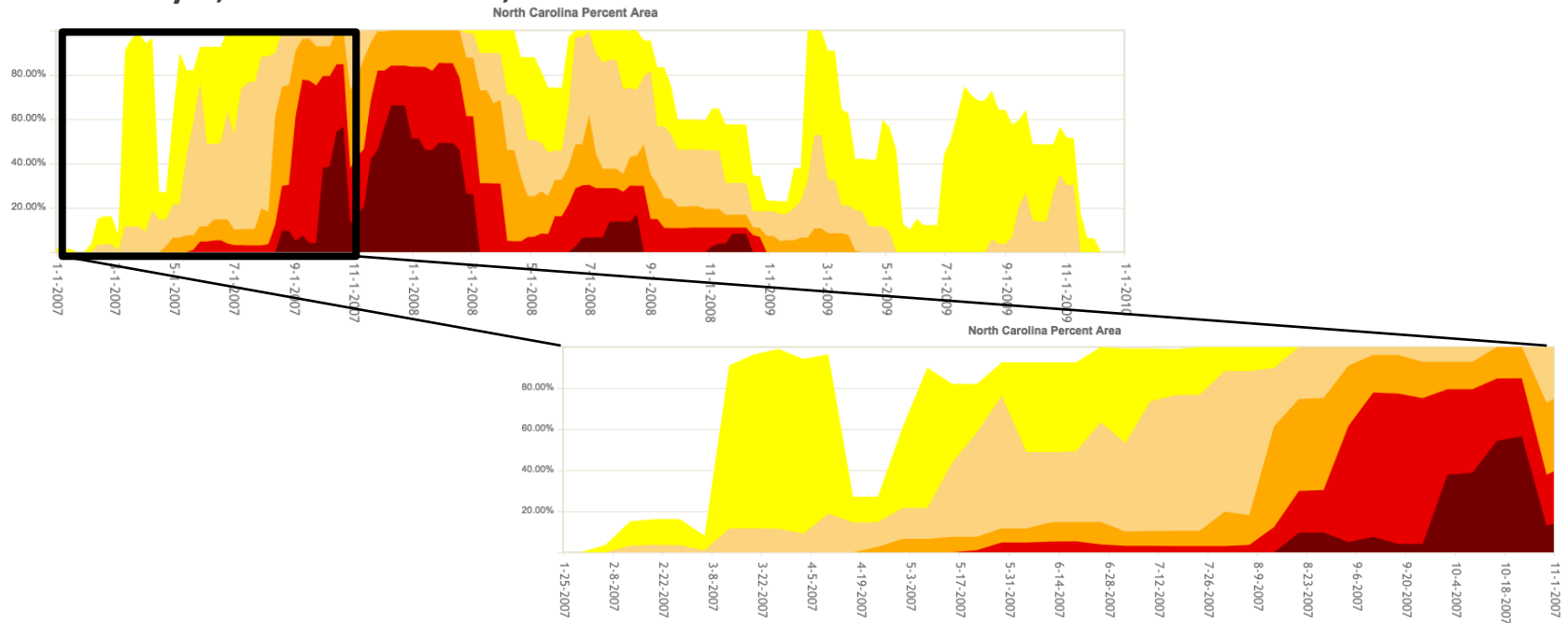
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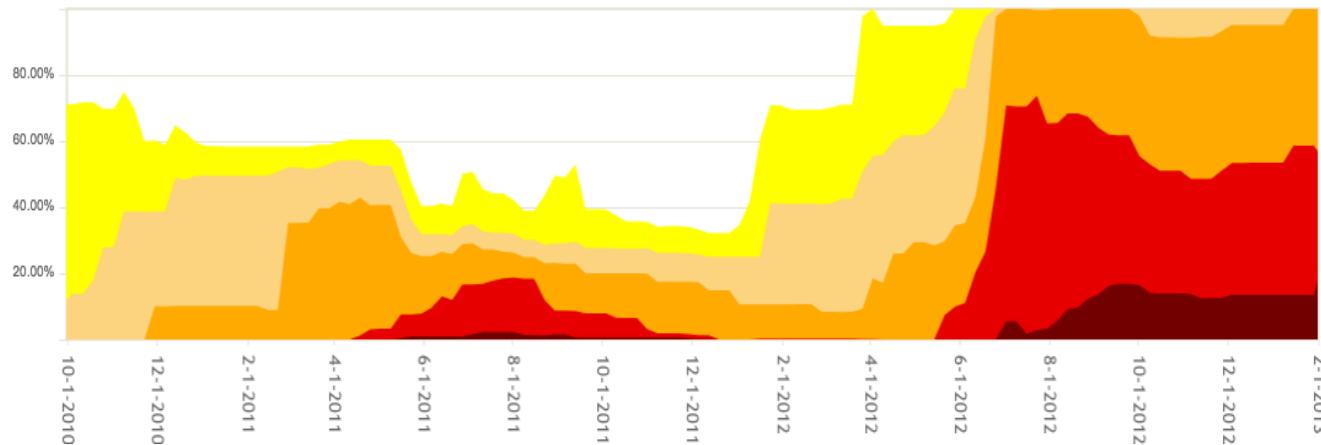
Analyze impacts *reported during onset*

February 1, 2007- October 31, 2007



Colorado State Impacts

Colorado Percent Area



Impacts	Count
Agriculture	150
Plants and Wildlife	71
Water Supply and Quality	71
Total	258

DIR Reported Impacts - CO (Oct 1, 2010 -Dec. 31, 2012 drought)

Hay production decreases, some cattle sold

Irrigation begins sooner

Rangeland brown and no growth, very little hay, selling more cattle

Dryland commercial row crops suffering

Wildfires increase

Pheasant population lower, ski resorts closing earlier

CRP lands suffering

Farmers reduce planting

Fire season early

Low snowpack, snow melt early, low surface water levels, reduced river flow, increased water temperature

Natural disaster areas declared

Pasture conditions worsen

Disaster program assistance begins

City landscapes dying

Fish kill

Reduction in rafting, fishing, pheasant hunting, skiing

Grasshopper and insect infestation

Reservoirs extremely low, mandatory water restrictions

Dust storms, widespread topsoil removal

Large agricultural and recreational economic loss

Lessons Learned...

Early Warning and Risk Management Relationship: *A cycle forms...*

- As monitoring and early warning systems improve, **the need** for better drought risk management strategies (planning and mitigation) increases
- As planning and mitigation strategies are implemented, **the need** for improved drought monitoring and early warning increases
- **Information delivery** drives this cycle

Final Thoughts

- Drought Early Warning System (DEWS) = **Monitoring AND Forecasting**
- ***Due Diligence (e.g., monitoring)*** needed (“even if we had a perfect forecast”***now what?***)
- Monitoring is the ***foundation*** of risk management planning
- ***Triggers are needed to coordinate*** who does what and when....they are the bridge between the science and the policy
- ***Need BOTH*** drought planning/policies and appropriate triggers
- Build political will for a ***paradigm shift*** to risk management.....drought needs to be very much a part of any water, food and national security conversation
- ***Don't forget the impacts!!***

**Thank You!
Questions?**

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