The United States Drought Monitor Process:
History, What it is, and How is the map made?

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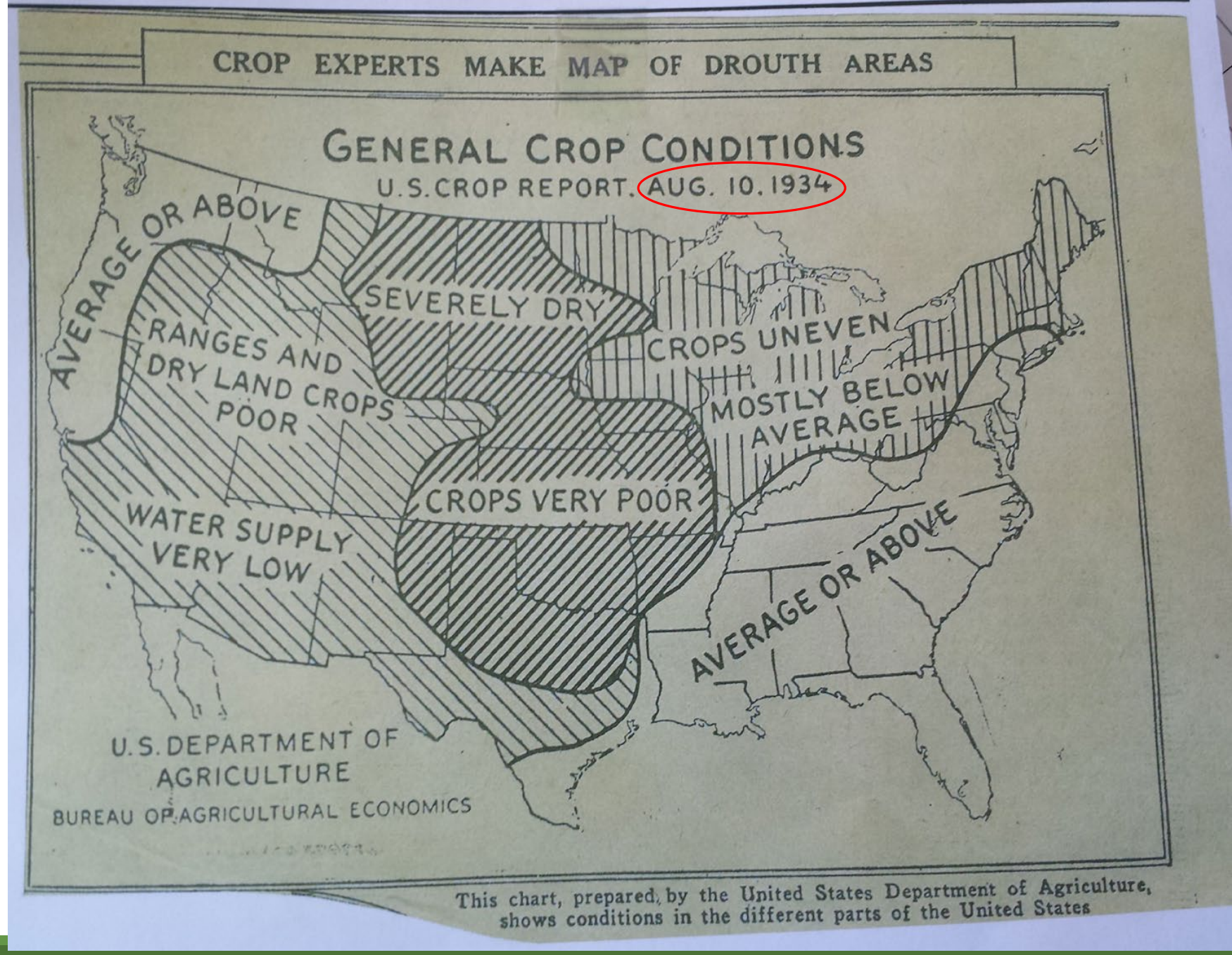
National Drought Mitigation Center
University of Nebraska-Lincoln
School of Natural Resources

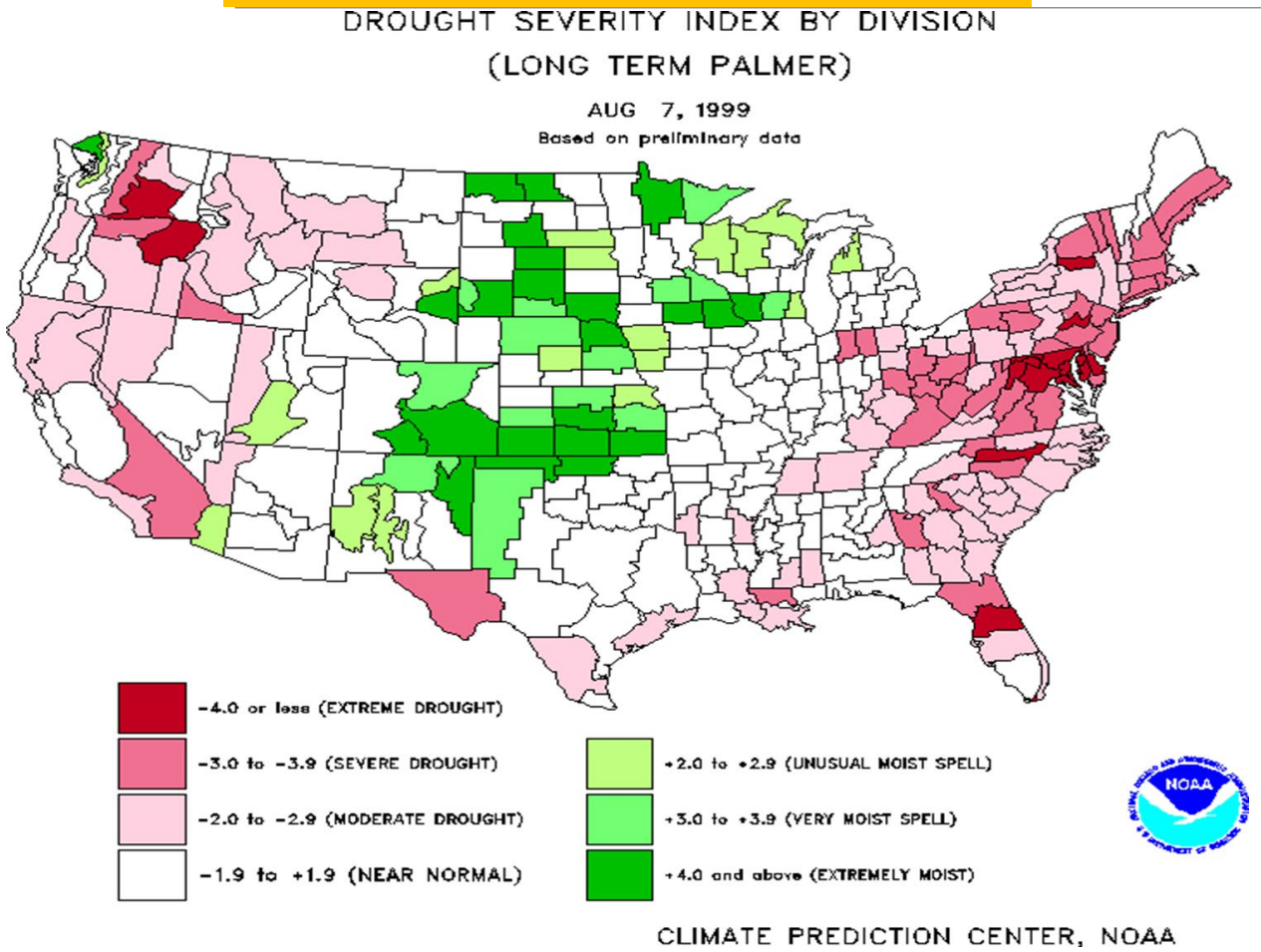
Southeast United States Drought Workshop
February 4-5, 2020

Scientists have been trying to monitor and map drought conditions for quite some time

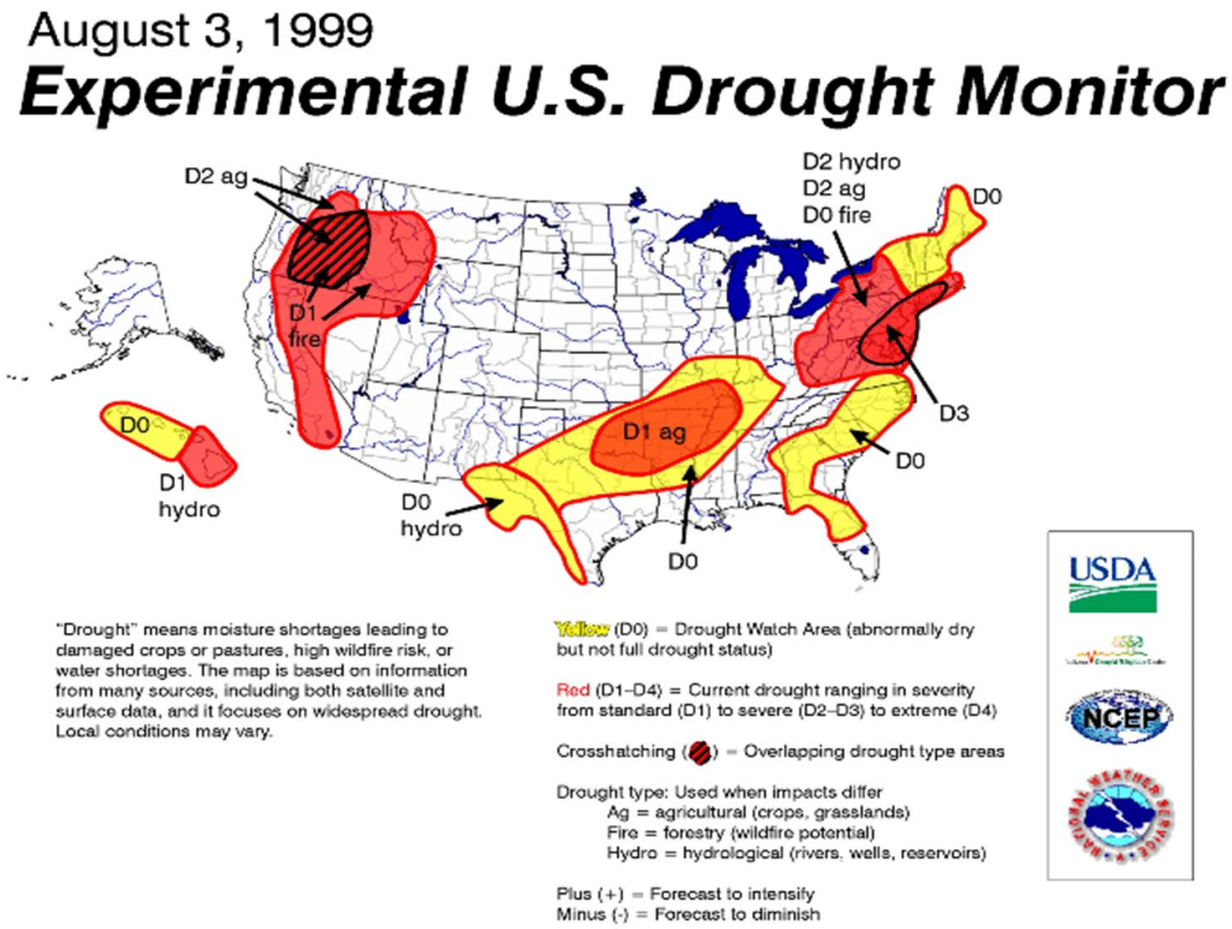


The USDM has continuously evolved from past efforts to monitor drought to early efforts of the USDM

Single Index/Indicator such as the PDSI



Hybrid Approach (made in Corel Draw)

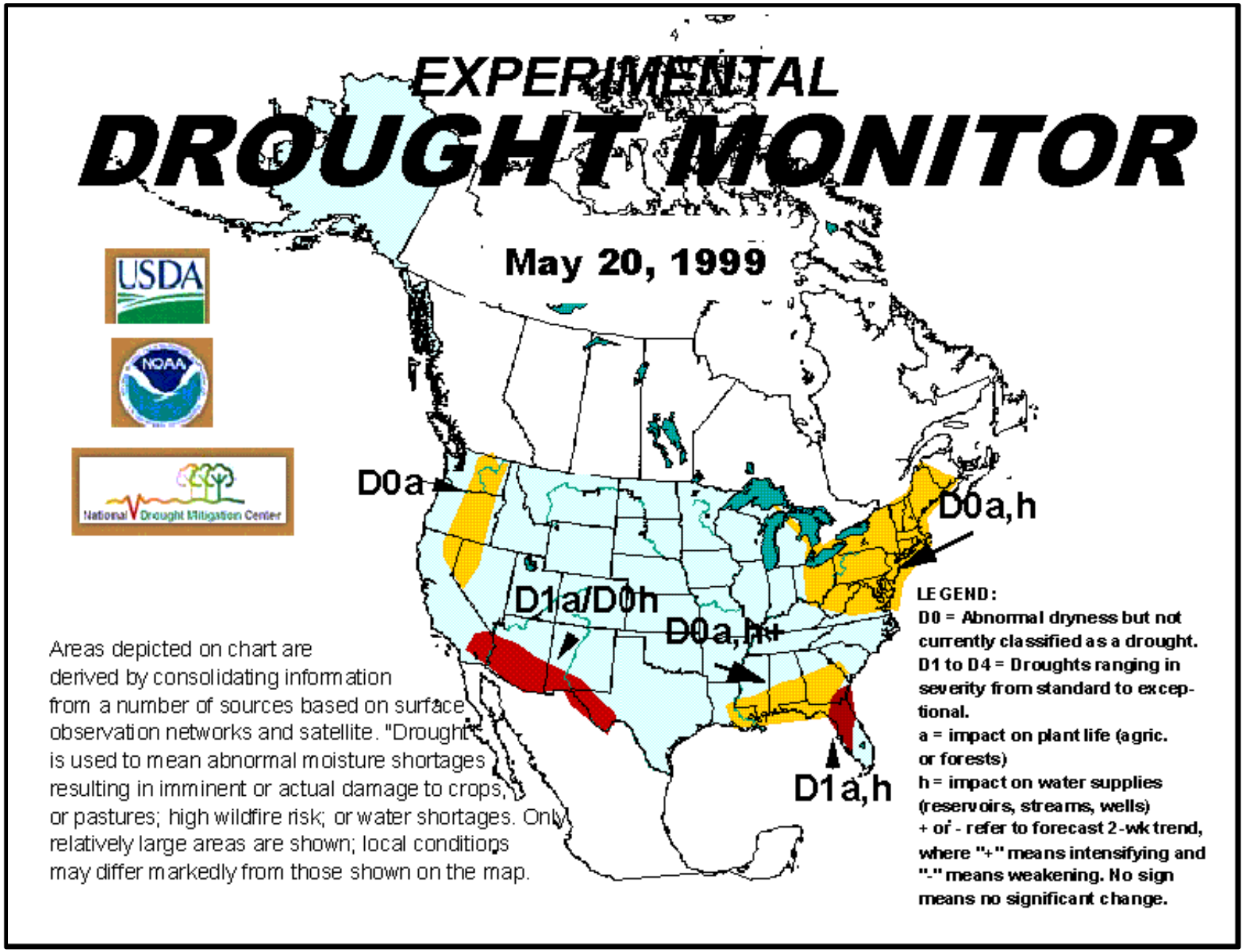


1999

The ***very first*** U.S. Drought Monitor!!

Collaborative effort between the NDMC, NOAA and USDA

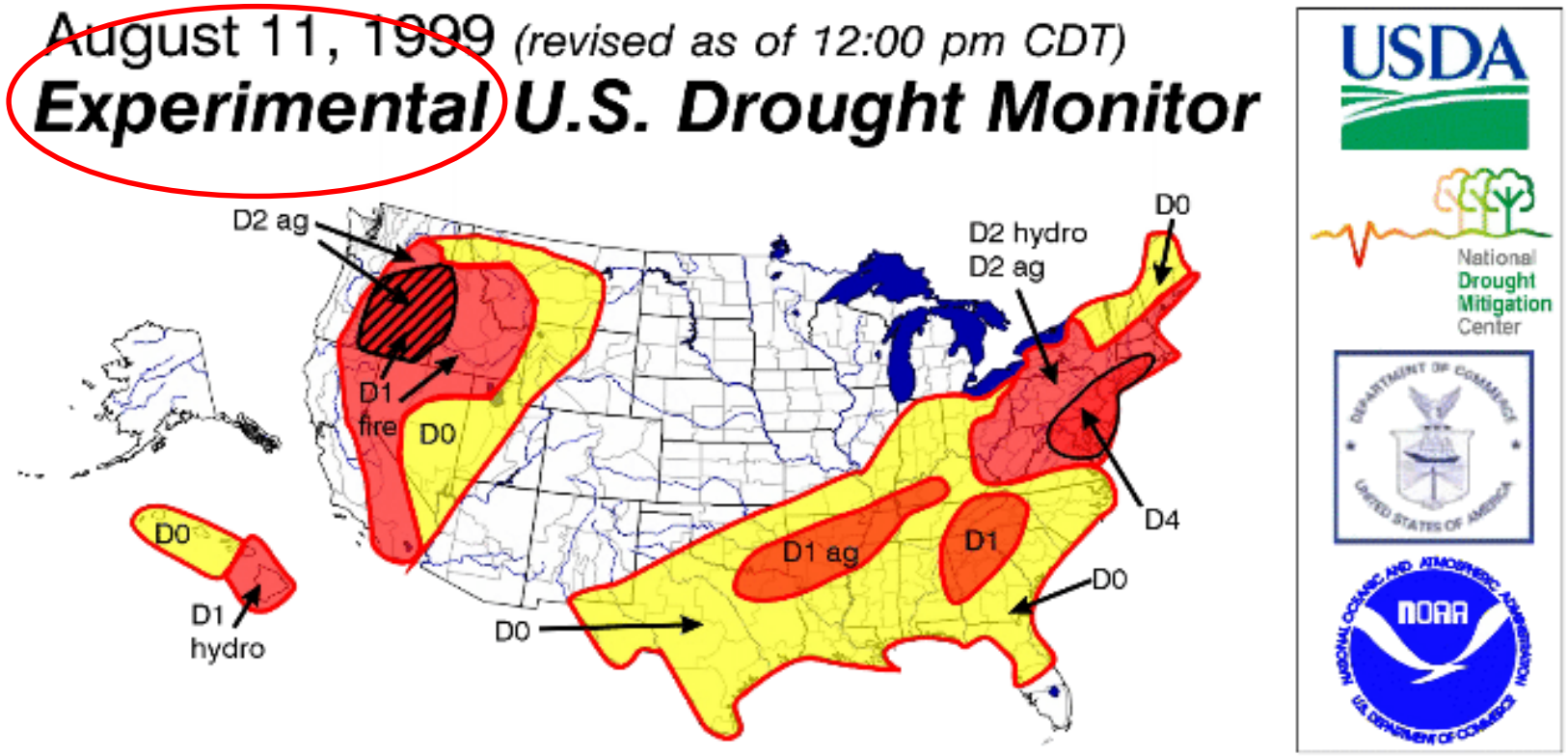
It was ***experimental***, and became operational, partially in response to intensifying dryness in the eastern U.S. and across portions of the West. **The map was created in CorelDRAW!** ☺



August 11, 1999

The revised map was presented to senior-level government officials at a **Secretarial White House Briefing**.

They liked it so much…



"Drought" means moisture shortages leading to damaged crops or pastures, high wildfire risk, or water shortages. The map is based on information from many sources, including both satellite and surface data, and it focuses on widespread drought. Local conditions may vary.

Yellow (D0) = Drought Watch Area (abnormally dry but not full drought status)

Red (D1–D4) = Current drought ranging in severity from standard (D1) to severe (D2–D3) to extreme (D4)

Crosshatching ( ) = Overlapping drought type areas

Drought type: Used when impacts differ
Ag = agricultural (crops, grasslands)
Fire = forestry (wildfire potential)
Hydro = hydrological (rivers, wells, reservoirs)

Plus (+) = Forecast to intensify next two weeks
Minus (-) = Forecast to diminish next two weeks

August 18, 1999

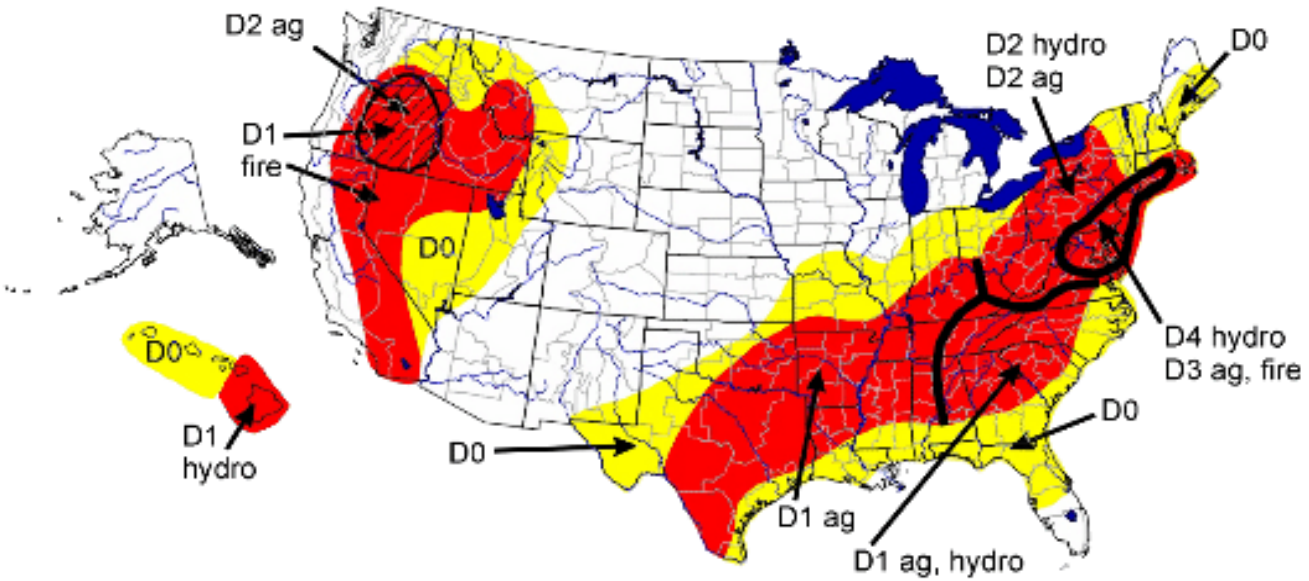
…the following week, it went operational, making this **the first "official" U.S. Drought Monitor!**

This might have been the ***fastest Experimental to Operational*** product in government history!

~24 experts make up the DROUGHT listserver

August 18, 1999 (scheduled release time Thursday a.m.)

U.S. Drought Monitor



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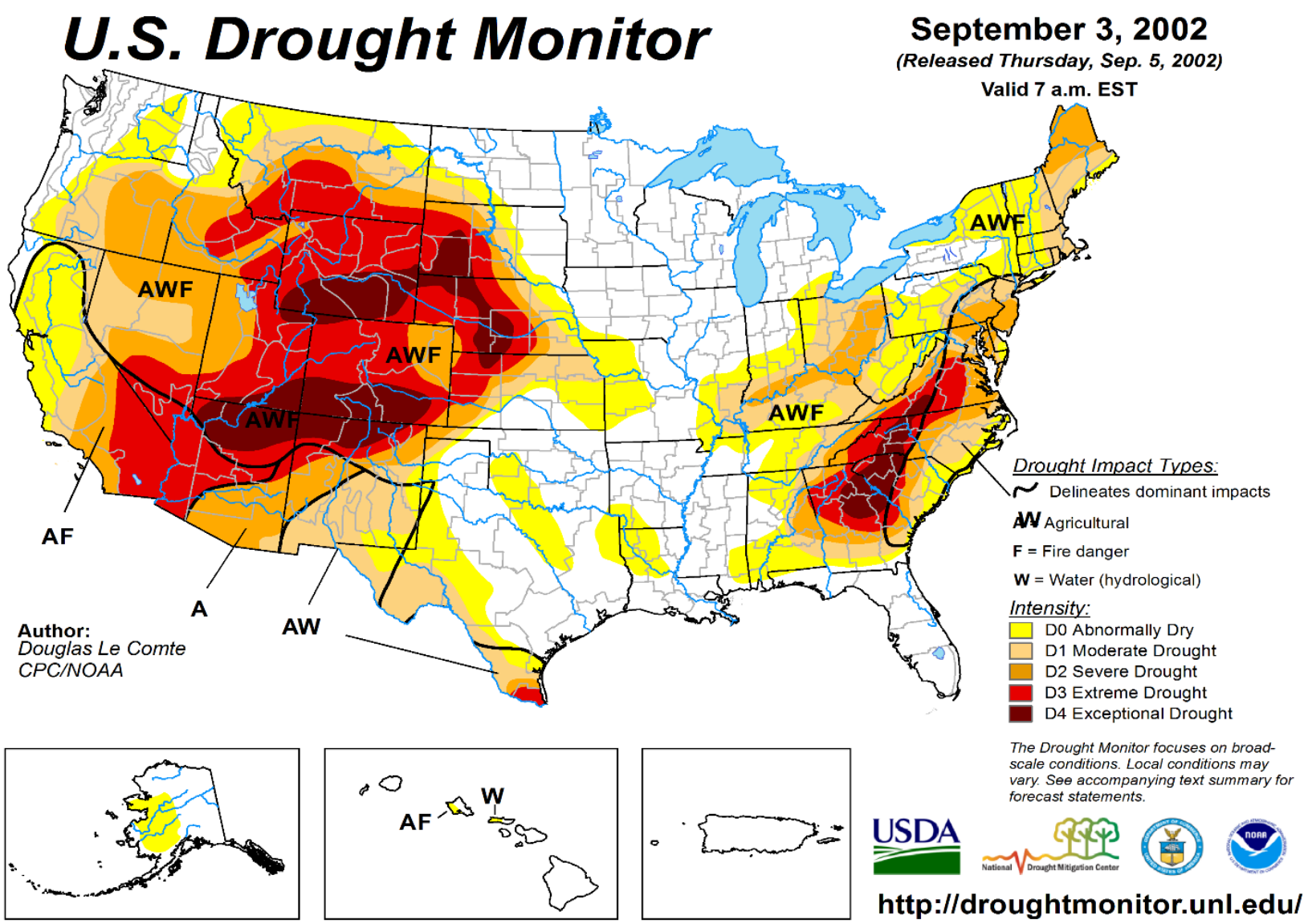
Summer/Fall 2002

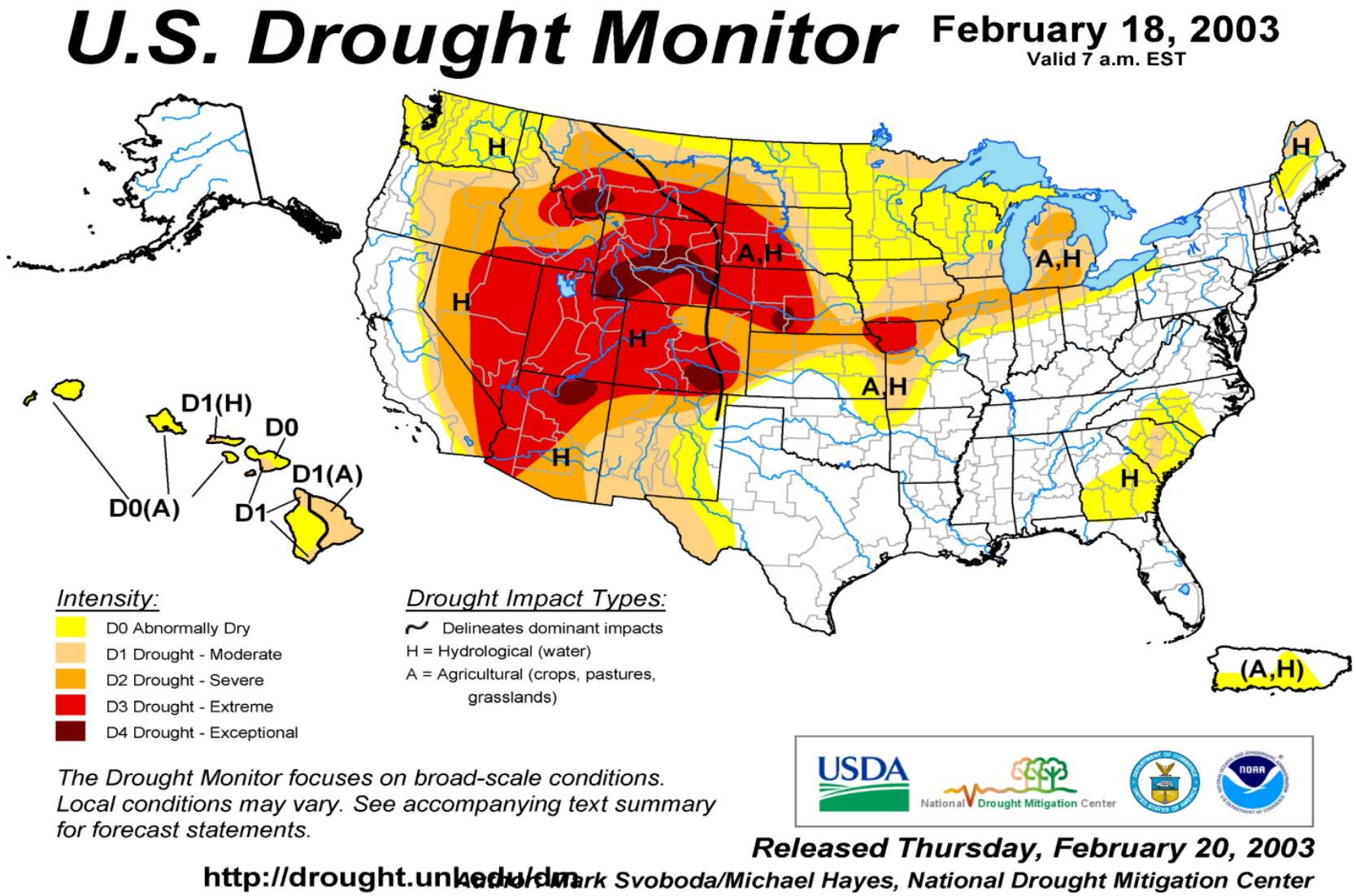
First federal use (USDA) of USDM as a trigger for drought response/relief (Dried Milk) for livestock.



2003

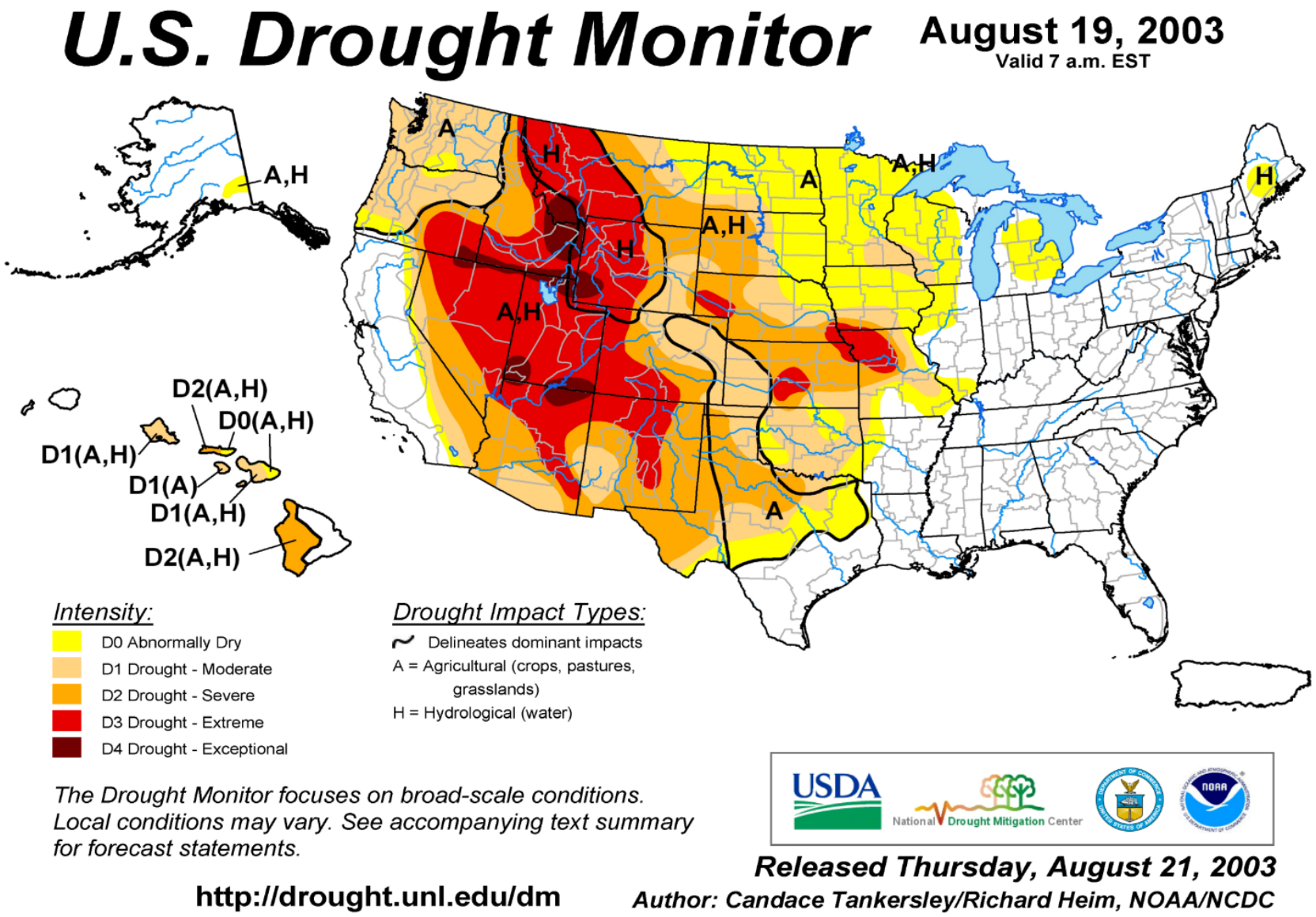
The Fire ("F") Impact type was dropped in early 2003 b/c there is always a fire season and it is hard to weigh the impact of drought on fire.

DROUGHT List Server grows to 150…



August 2003

USDM Authors make a transparent **switch from CorelDRAW to GIS** (Geographic Information System) to create the map. There was a steep learning curve, but it made the USDM a leader on the GIS front and would pay big dividends down the road in regards to timeliness and accuracy.



Are we making a difference?

No weeks missed in over 20 years!

Wordle of "*the most valuable aspects* of the USDM process or product"

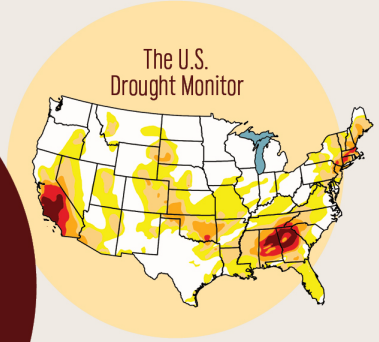
communication
collaboration
input
local
impacts
map
across
conditions
process
information
product
experts
agencies
stakeholders
Collaboration
ability
data
authors
listserve
message
discussion
knowledge
indicators
droughts
among
together
weekly
helps
wildfire
sharing
valuable
objective
effort
sectors
expertise
depiction
status
basis
areas
time
different
regional
ground
state
many
maps
people
monitoring
Drought
author
public
political
graphical
nationwide
coordination
Monitor
understand
Communication
Enhanced
feedback
conversation
assessment
changes
multiple
making
think
complexity
transparency
action
on-going
easy
helped
can
one
just
way
really
better
community
impact
discuss
direct
factors
Map
Characterization
folks
providing
provide
create
model
Coordination
Input
Seeing
something
understanding
climatologists
consensus
etc
occurrence
make
season
use
best
goes
come
learn
various
sources
issue
area
accurate
great
awareness
level
current
participating
Discussions
Cross-agency
Tacos
Educational
Feedback
Quick/easy
Comprehensive
Incorporate
Improved
Inclusion
Inspiring
Impacting
Impressive
Informative
Interesting
Interactive
Integrated
Innovative
Important
Information
Increasing
Implement
Implementation
Implementing
Implementing
Implementing

U.S. Drought Monitor Network

Improving drought early warning

Q WHAT IS THE U.S. DROUGHT MONITOR NETWORK?

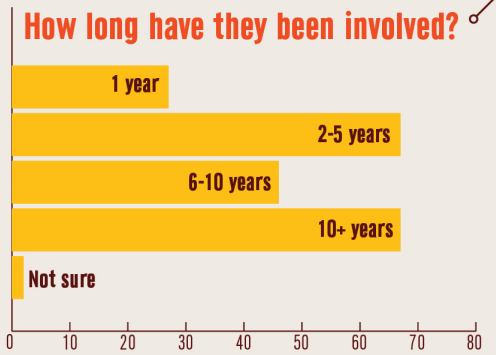
a A group of 425+ observers from across the country who supply input about local climate affects to the authors of the U.S. Drought Monitor map.



Q WHO PARTICIPATES?

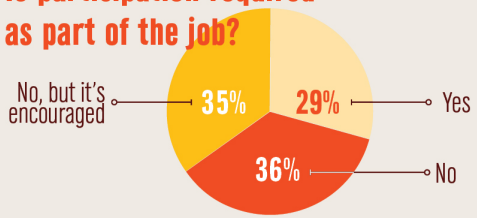
a
- Climatologists
- Meteorologists
- Hydrologists
- Biologists
- Natural resource scientists
- Agronomists
- Livestock producers
- Ag scientists
- Remote sensing specialists
- Social scientists

How long have they been involved?



*209 participated in this survey question

Is participation required as part of the job?

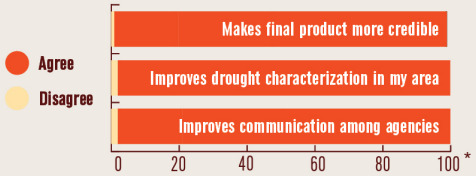


Q WHAT BENEFITS?

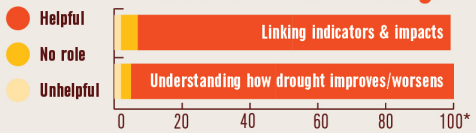
a
- The science of drought
- Awareness
- Communication
- Decision-making
- Credibility
- Validity
- Local characterization of drought
- Network member organization

89% say the USDM process has improved the ability to provide early drought warnings in the United States.

Benefits to the process



Benefits science of drought



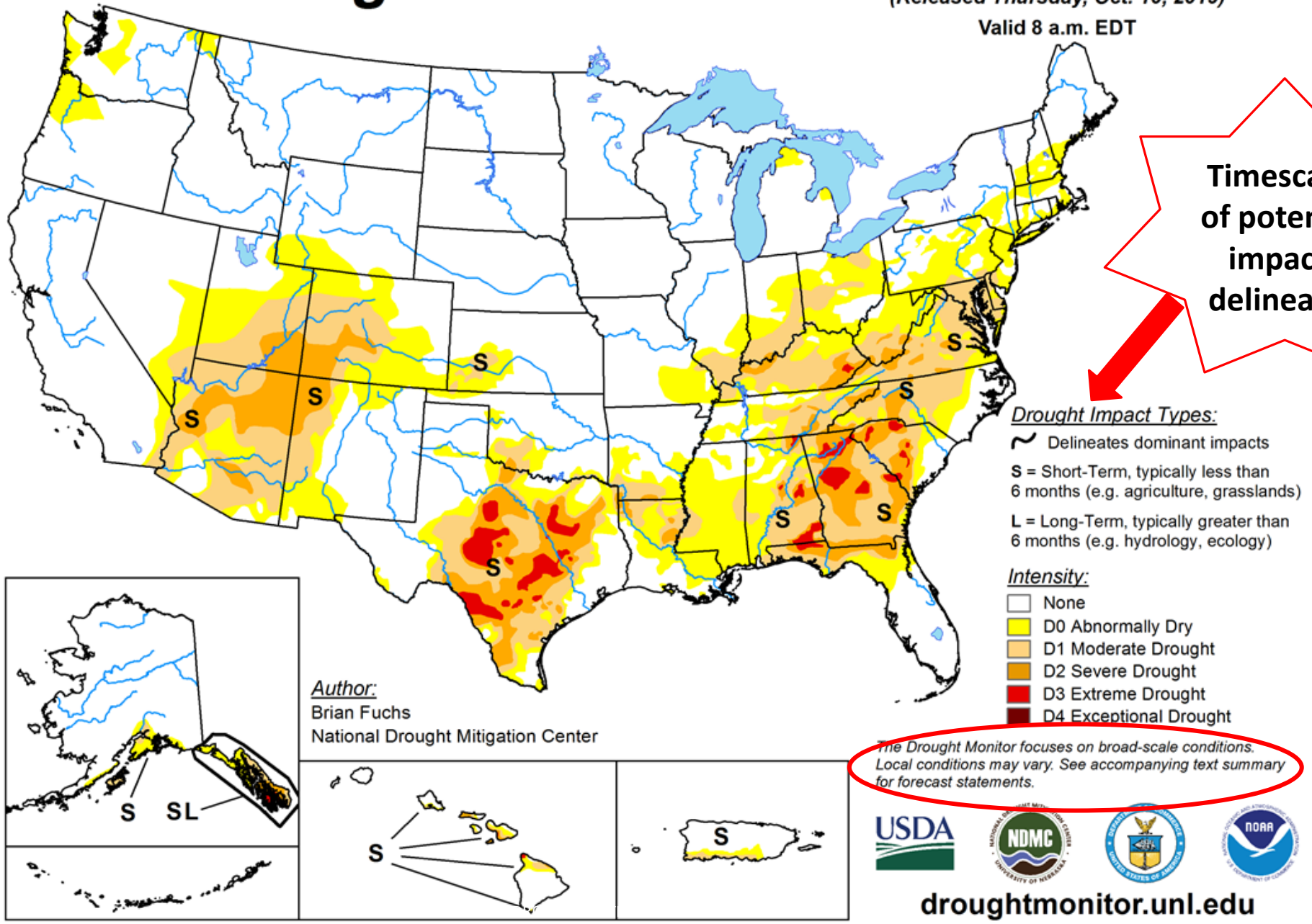
** Each graphic reflects 100 percent of responses; not every participant answered every question.*

U.S. Drought Monitor

October 8, 2019

(Released Thursday, Oct. 10, 2019)

Valid 8 a.m. EDT



Timescales of potential impacts delineated

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:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

Author:
Brian Fuchs
National Drought Mitigation Center

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

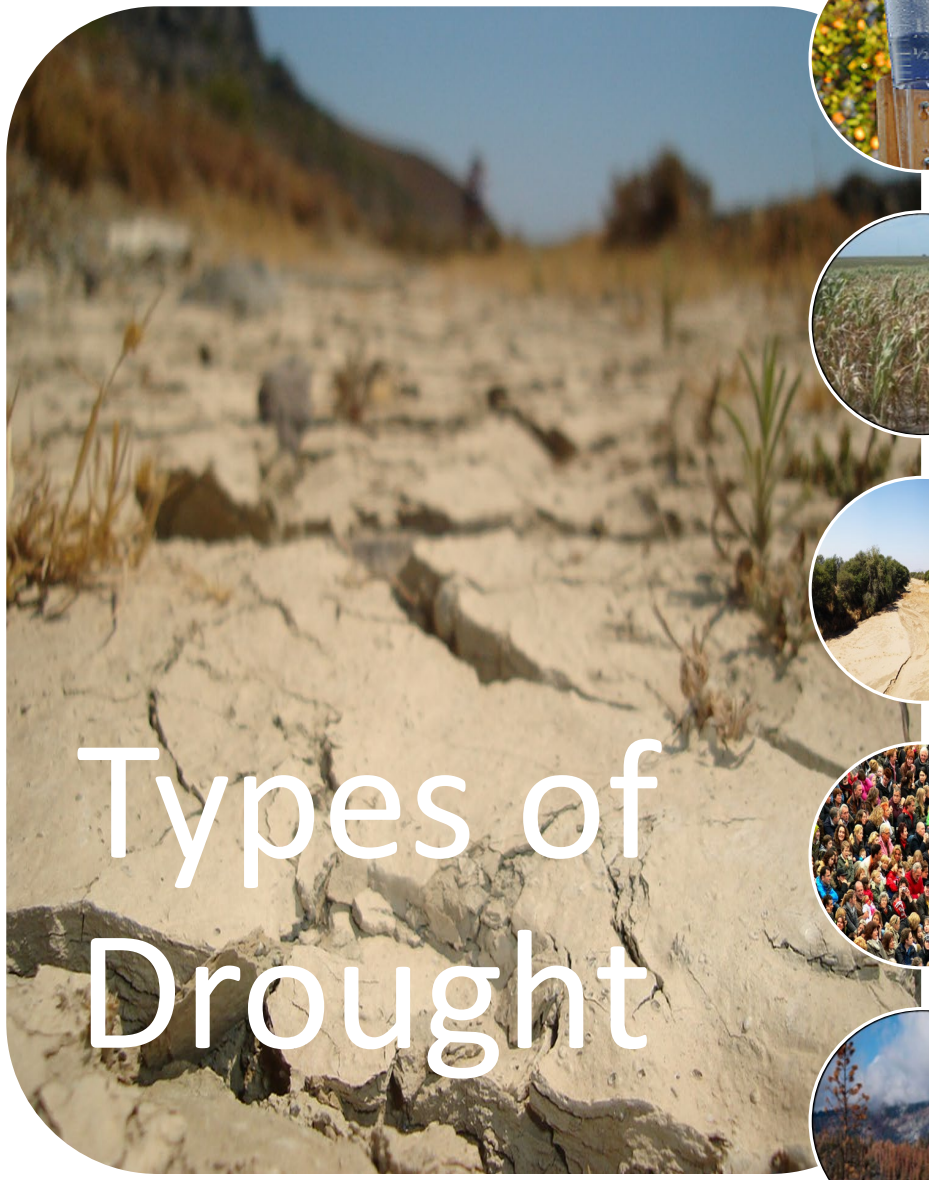
USDA NDMC NOAA

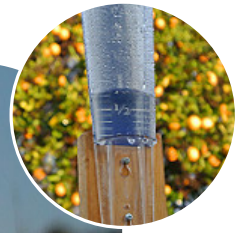
droughtmonitor.unl.edu

The map is…

An attempt to represent all the different types of drought on one map

Each one of us has a different perspective of what drought is as drought means different things to different people





Meteorological

Agricultural

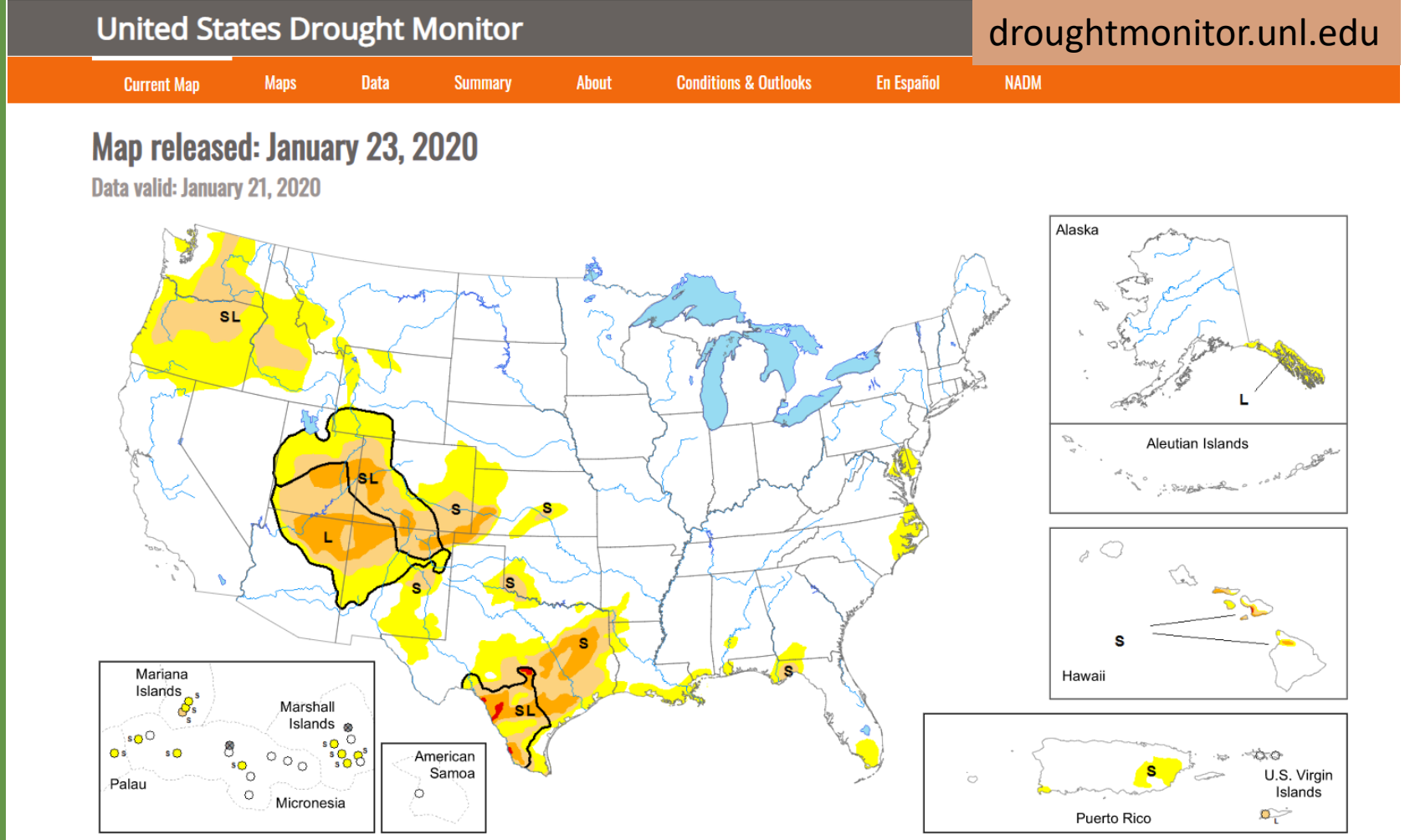
Hydrological

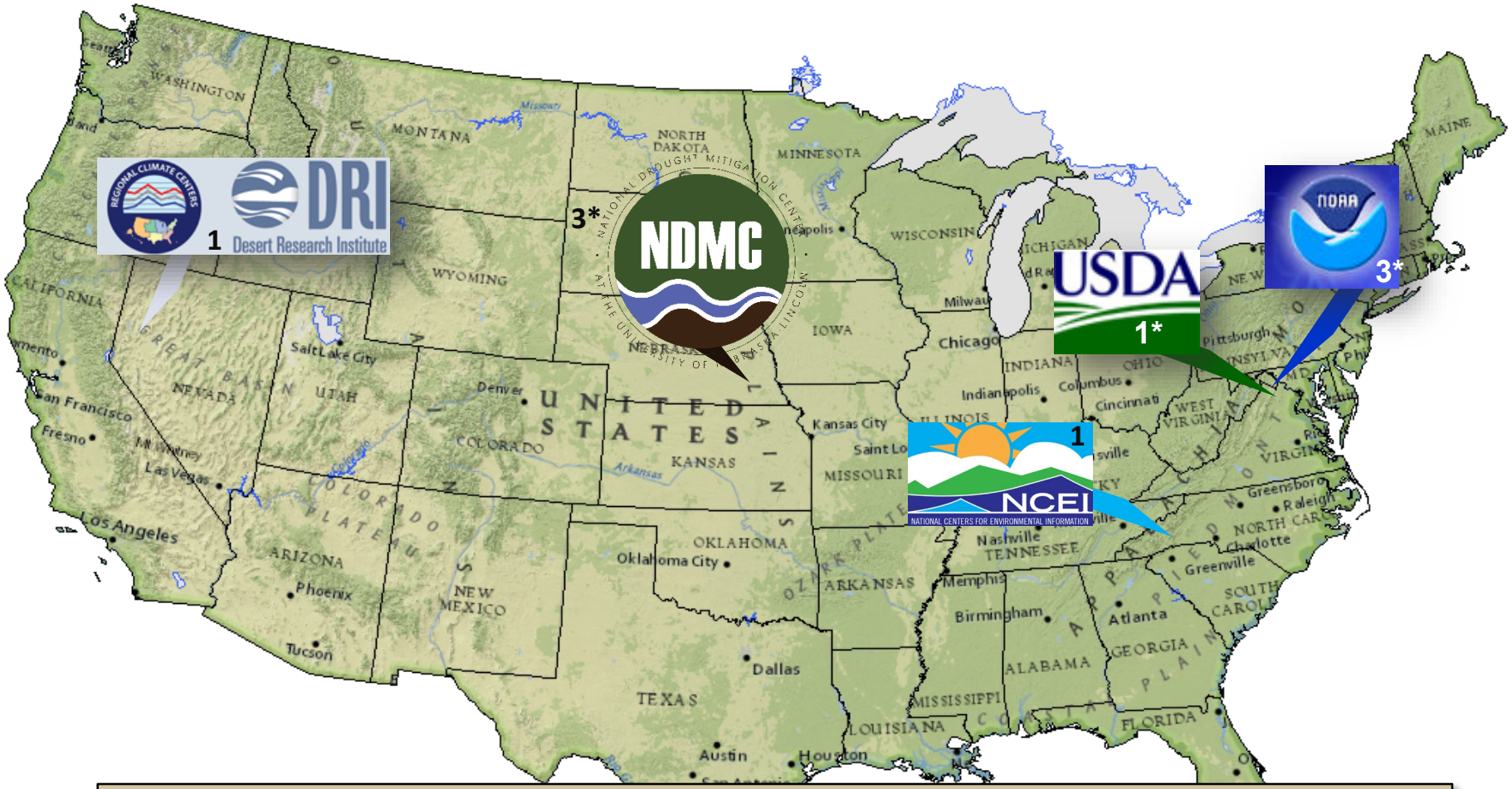
Socio-economic

Ecological

The United States Drought Monitor

- Hosted by the NDMC as part of a 3-way partnership with NOAA and USDA
- Over 12.5 million hits a year (more during significant drought events)
- Used in several USDA programs
- Used by the IRS for tax deferrals
- Many others !





Requirement: Authors <u>must</u> work at a regional or national "center", government or academia/research

There are currently 9* authors, and <u>all are volunteers</u>

US Drought Monitor Approach

Intensity:

- D0 Abnormally Dry } **Not Drought**
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

} **4 Drought intensities**

- Assessment of **current** conditions and **current** impacts for all types of drought
- Identifying **impacts** using "**S**" for short-term impacts and "**L**" long-term impacts or "**SL**" for a combination of both
  - "**S**"-generally 6 month time scales or less
  - "**L**"-generally greater than 6 month time scales
- Incorporate **local expert** input
  - Accomplished via email and impact reports
  - Validation of Objective Indicators
- Authors try to be as **objective** as possible (using the percentiles methodology) and the ***"Convergence of evidence"*** approach
  - The physical data, drought indices/ indicators ***must*** support the depiction on the map
  - Impact data validates physical data
  - The U.S. Drought Monitor has the final call on all decisions

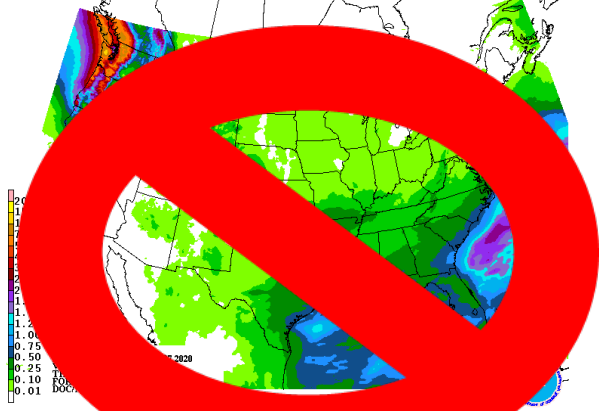
U.S. Drought Monitor Approach

"Convergence of Evidence"

- **Many types of drought "information" can be collectively analyzed for all types of drought, depicted on a single map**
  - ***Determining if the majority of information is 'converging' (telling the same story)*** about the accuracy, or inaccuracy, of the drought as depicted by the U.S. Drought Monitor
  - Several ***dozen*** inputs are considered **(equally)** in any given week
- **Authors need to *look at 100% of the data, BUT don't believe in any one piece of data input 100%* in making a decision**
  - No single input carries more weight than another, authors do not ***"cherry pick"*** the best or worst indicators to show the depiction
- ***Multiple indicators and many types of information are part of the analysis***
  - These data will identify different climatic and hydrologic parameters which are needed to understand the complete picture of a drought indicator's performance and how they interact in each part of the country
- ***Impacts are the "ground truth"***, yet are not monitored to the same extent in which other data are….**you can't measure what you don't monitor!**

The USD model

The USD ns when the created

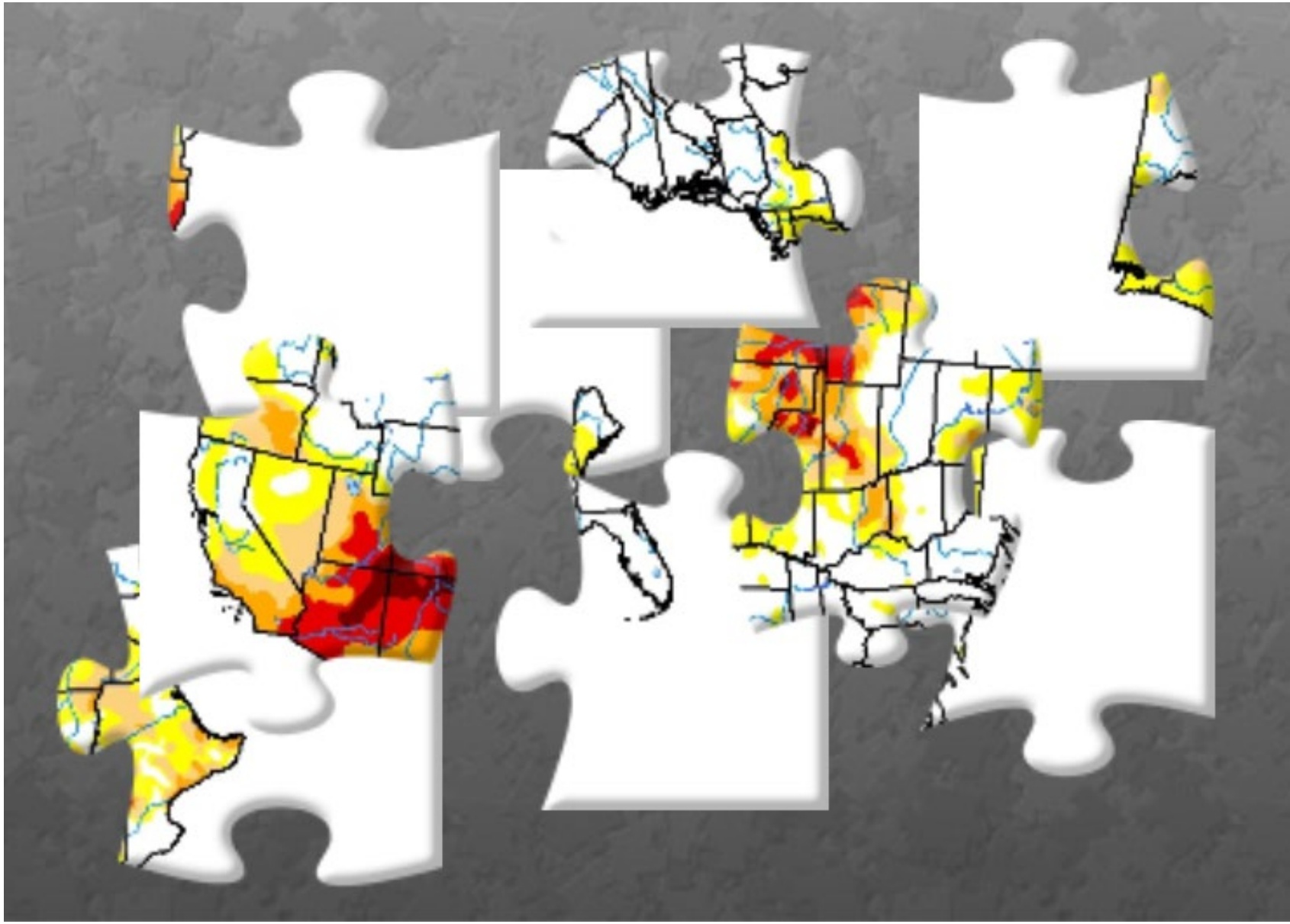


The USDM is a forecast

The USDM is a precipitation

The USDM declaration

USDM Data: All the pieces of the drought puzzle



Percentiles and the U.S. Drought Monitor

Every input can be put into percentiles to compare current data to historical records

D4: Exceptional Drought		(*1st-2nd* percentile)
D3: Extreme Drought		(*3rd-5th* percentile)
D2: Severe Drought		(*6th-10th* percentile)
D1: Moderate Drought		(*11th-20th* percentile)
D0: Abnormally Dry		(*21st-30th* percentile)

Advantages of percentiles:

- Can be applied to any parameter used in the drought analysis
- Can be used for indicators of any length of data record
- Indicators of various periods of record can be analyzed side by side
- Puts drought in historical perspective:
  - **How many occurrences in a given period of time**

Intensity is based on historical likelihood

Data values ranked from highest to lowest

100	99	98	97	96	95	94	93	92	91
90	89	88	87	86	85	84	83	82	81
80	79	78	77	76	75	74	73	72	71
70	69	68	67	66	65	64	63	62	61
60	59	58	57	56	55	54	53	52	51
50	49	48	47	46	45	44	43	42	41
40	39	38	37	36	35	34	33	32	31
30	29	28	27	26	25	24	23	22	21
20	19	18	17	16	15	14	13	12	11
10	9	8	7	6	5	4	3	2	1

Normal

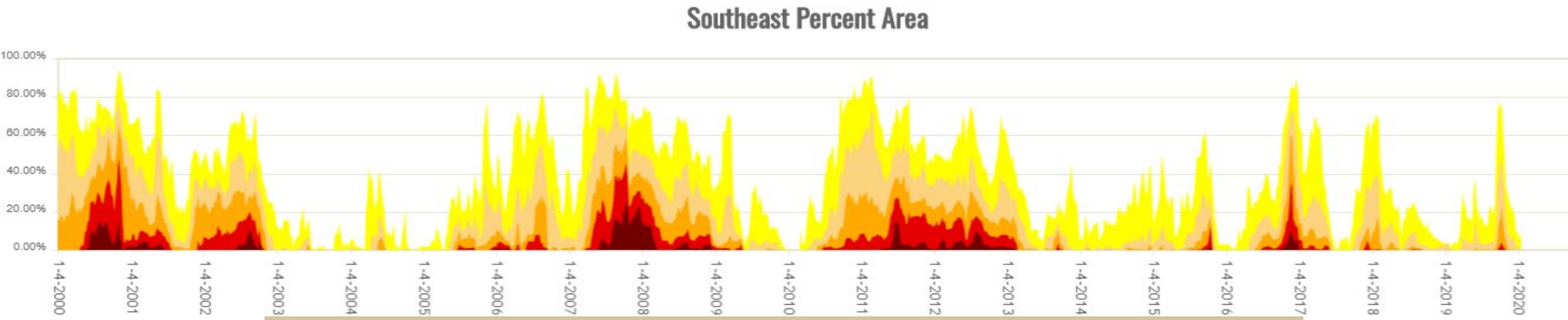
Unusually Dry

Moderate Drought

Severe Drought

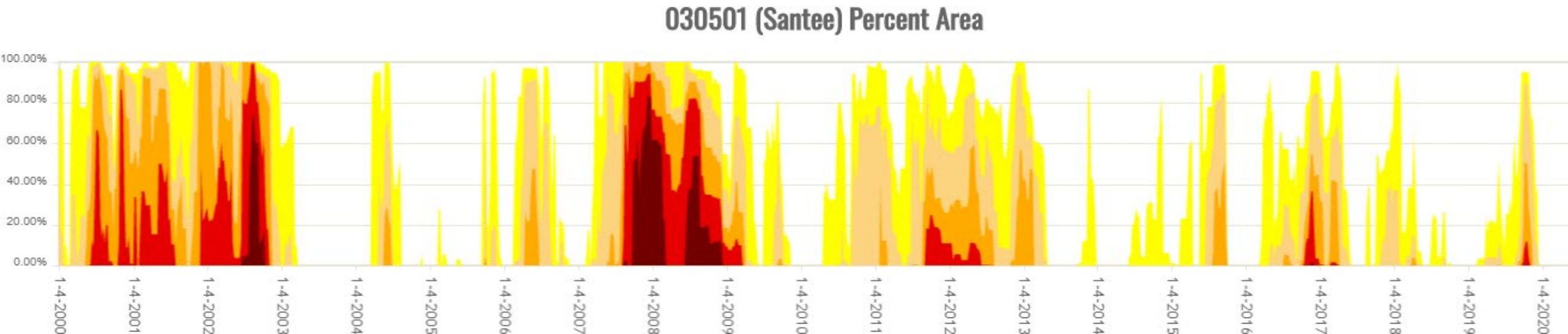
Extreme Drought

Exceptional Drought

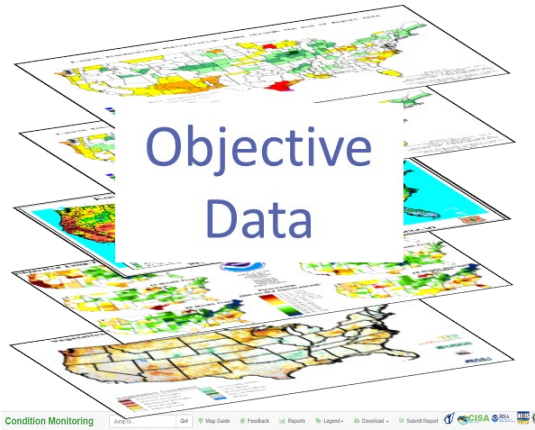


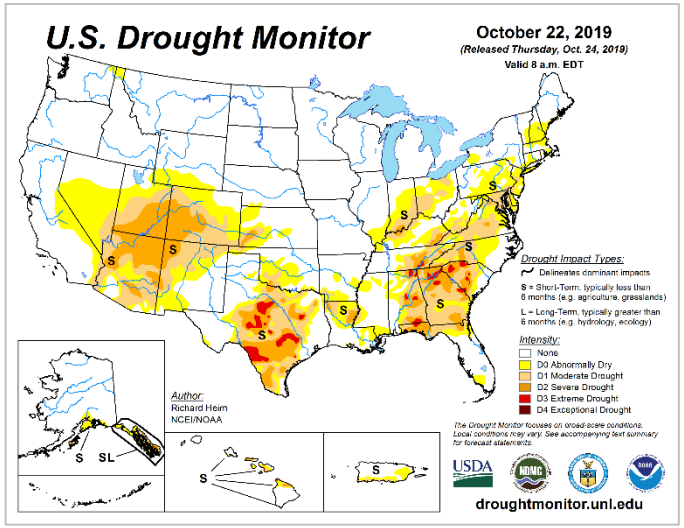
The drought categories are associated with historical occurrence/likelihood (percentile ranking)

It is not anecdotal or subjective, like "It's really, really dry!!" ….or, "I don't remember it ever being this dry, we have to be D3!!"



How is all of this done?

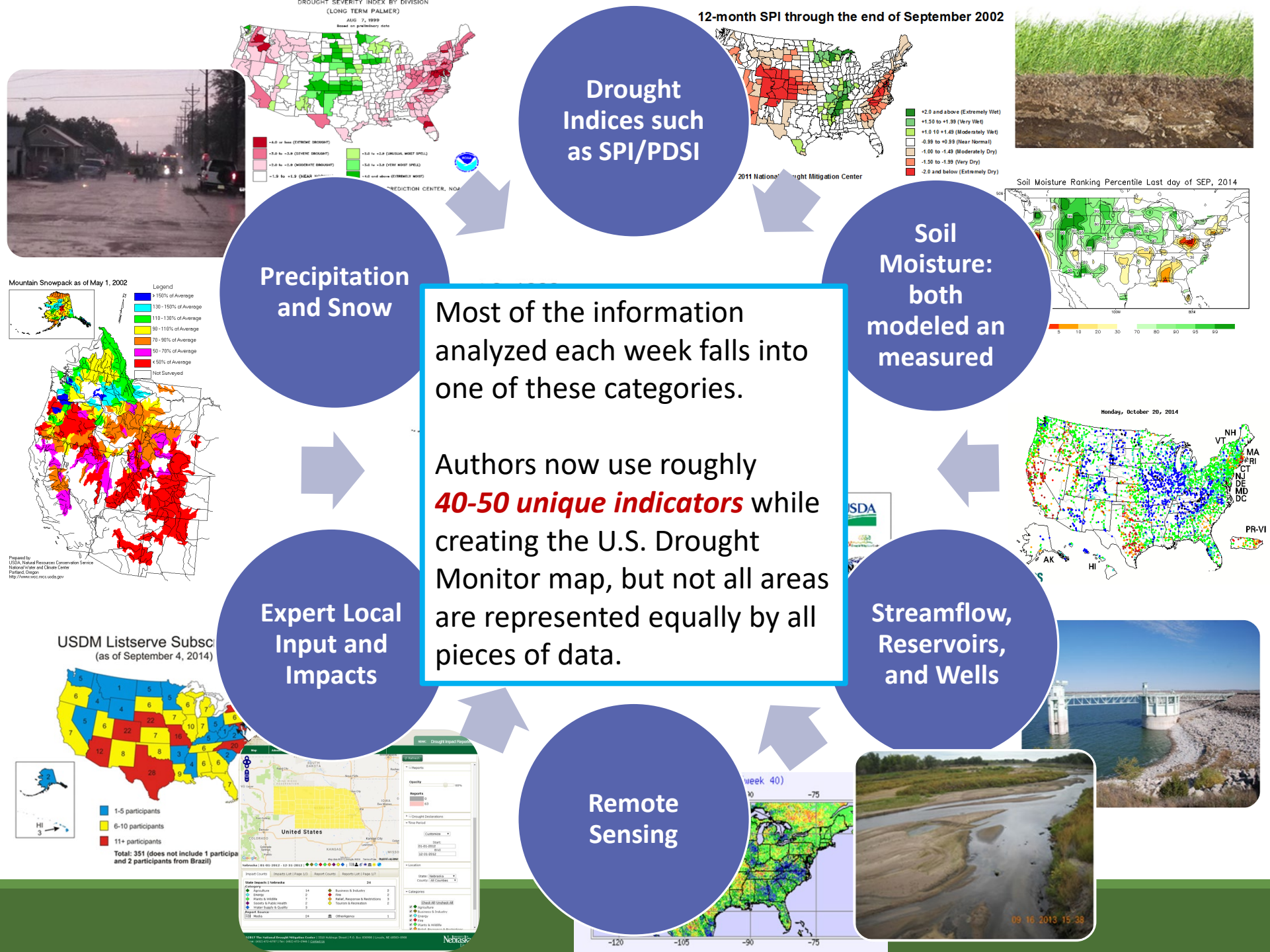




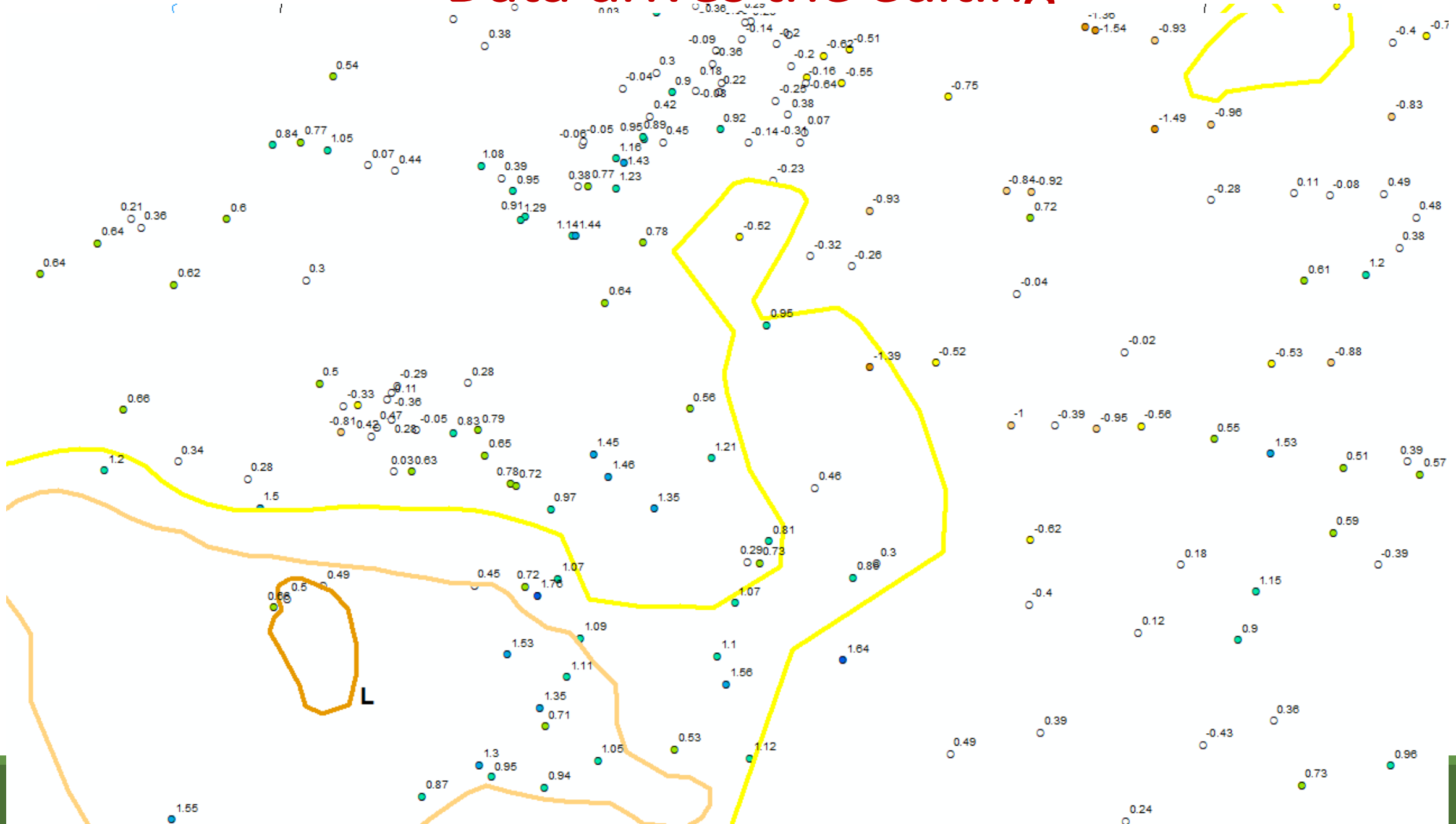
Methods & standards → Inputs → Production → Distribution of final map

The map is a participatory process

A hybrid approach of combining the attributes of dozens of inputs to tell the “story” about drought in a region


Drought Indices such as SPI/PDSI
12-month SPI through the end of September 2002
Soil Moisture: both modeled an measured
Soil Moisture Ranking Percentile Last day of SEP, 2014
Streamflow, Reservoirs, and Wells
Remote Sensing
Expert Local Input and Impacts
Precipitation and Snow
Mountain Snowpack as of May 1, 2002
Most of the information analyzed each week falls into one of these categories.
Authors now use roughly 40-50 unique indicators while creating the U.S. Drought Monitor map, but not all areas are represented equally by all pieces of data.
USDM Listserve Subsc
(as of September 4, 2014)
1-5 participants
6-10 participants
11+ participants
Total: 351 (does not include 1 participa
and 2 participants from Brazil)
Monday, October 20, 2014

Data drives the editing

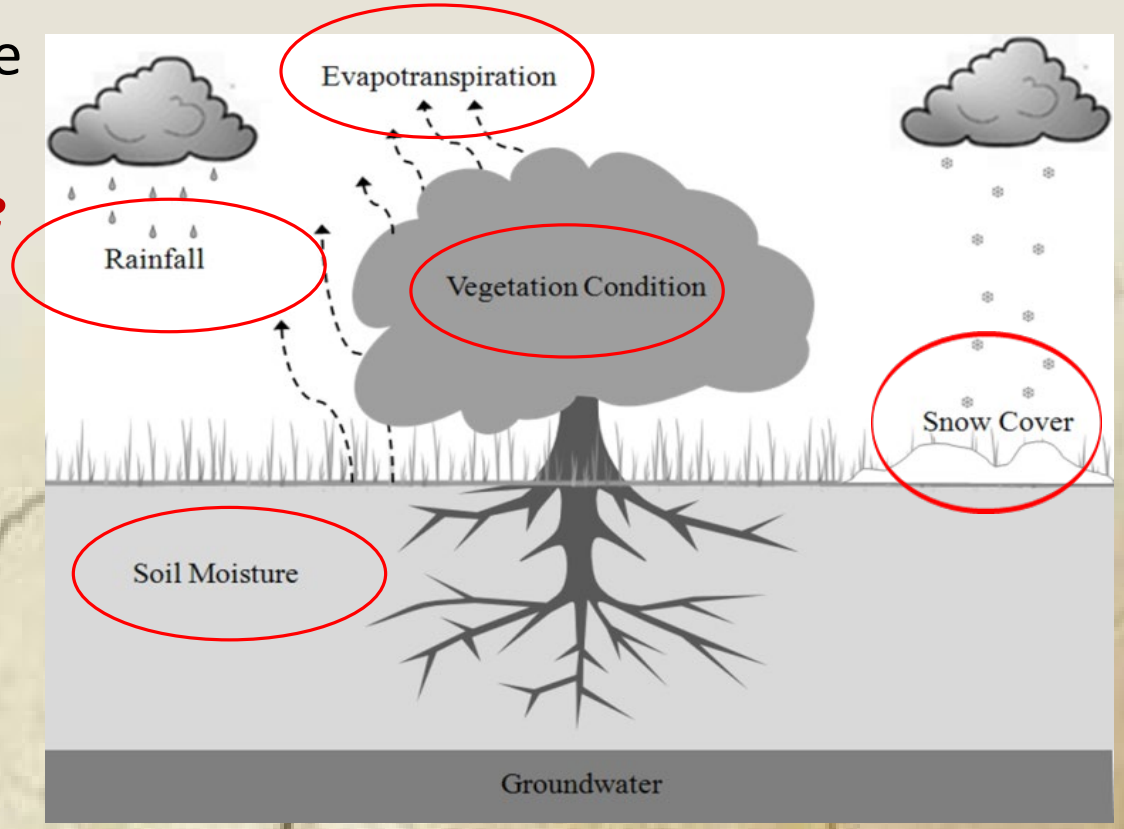


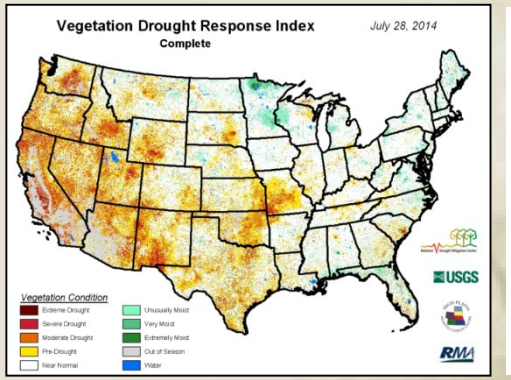
Emerging Satellite-based Observations and Products

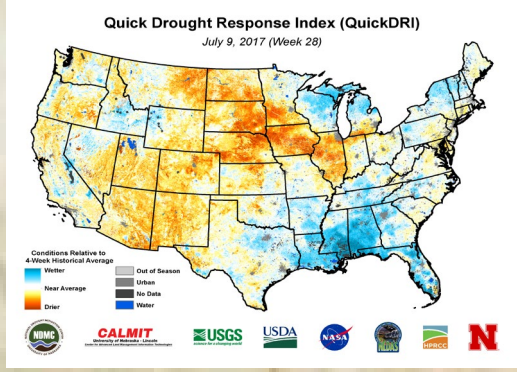
Over the past 10+ years, a number of satellite remote sensing-based tools and ***products characterizing different parts of the hydrologic cycle that influence drought conditions*** allowing new composite drought indicators to be developed.

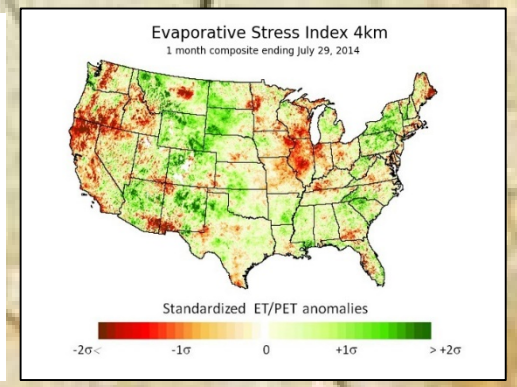
Examples

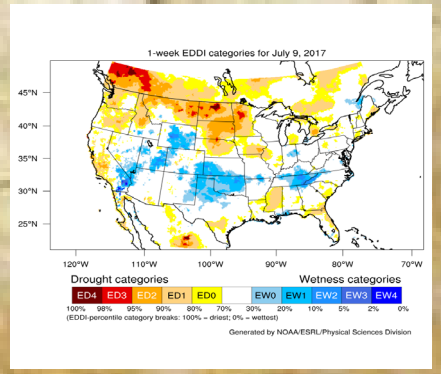
- Evaporative Stress Index (ESI)
- Quick Drought Response Index (QuickDRI)
- Evaporative Demand Drought Index (EDDI)
- GRACE soil moisture and groundwater anomalies
- Vegetation Drought Response Index (VegDRI)

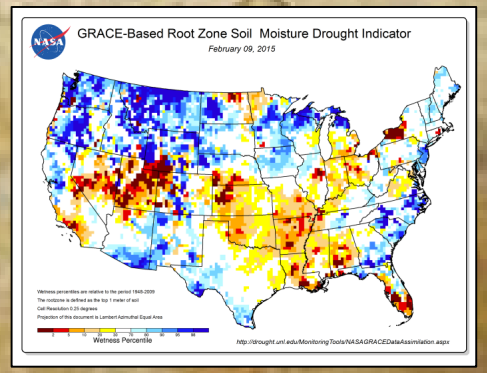




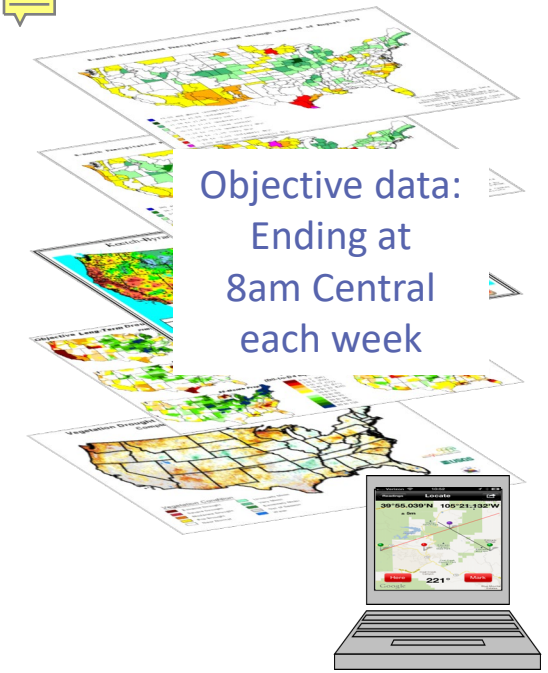




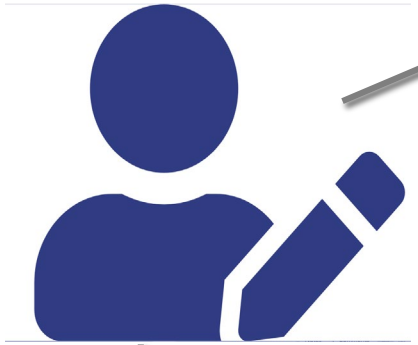


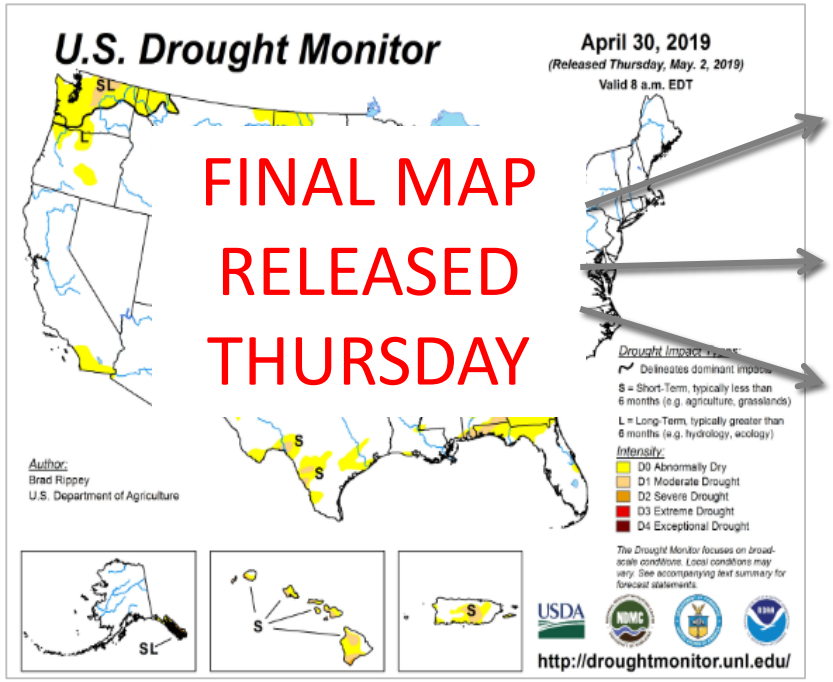


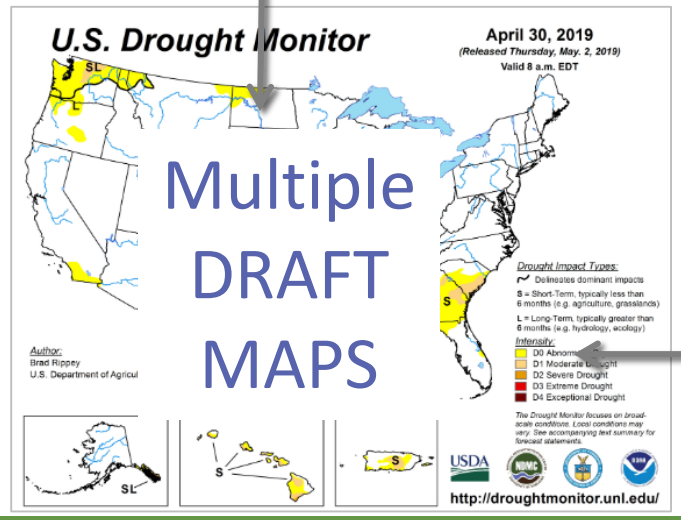
USDM
Convergence of Evidence

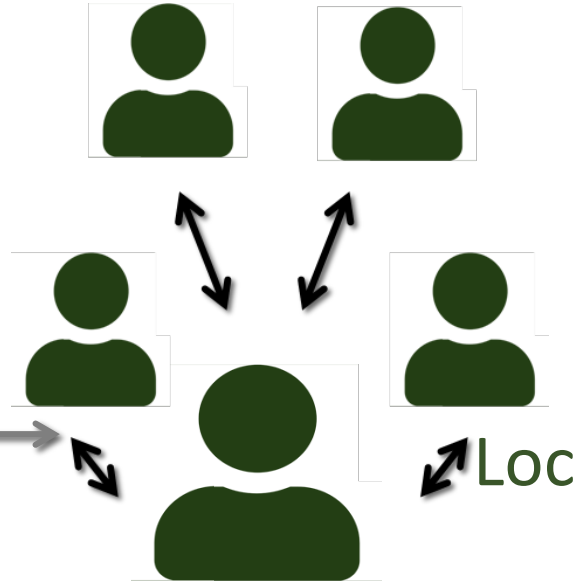


Author's rotate
every 2 weeks



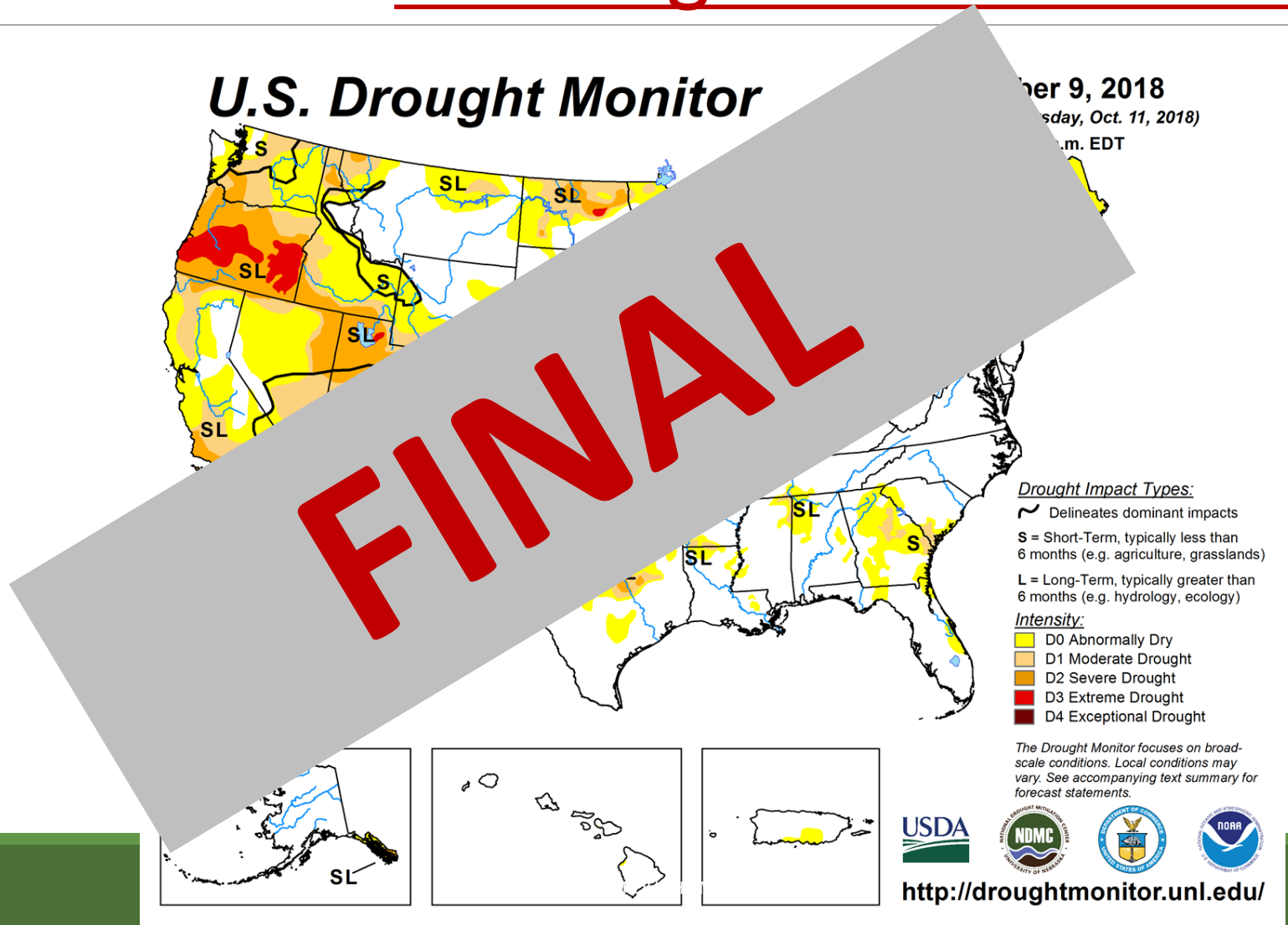






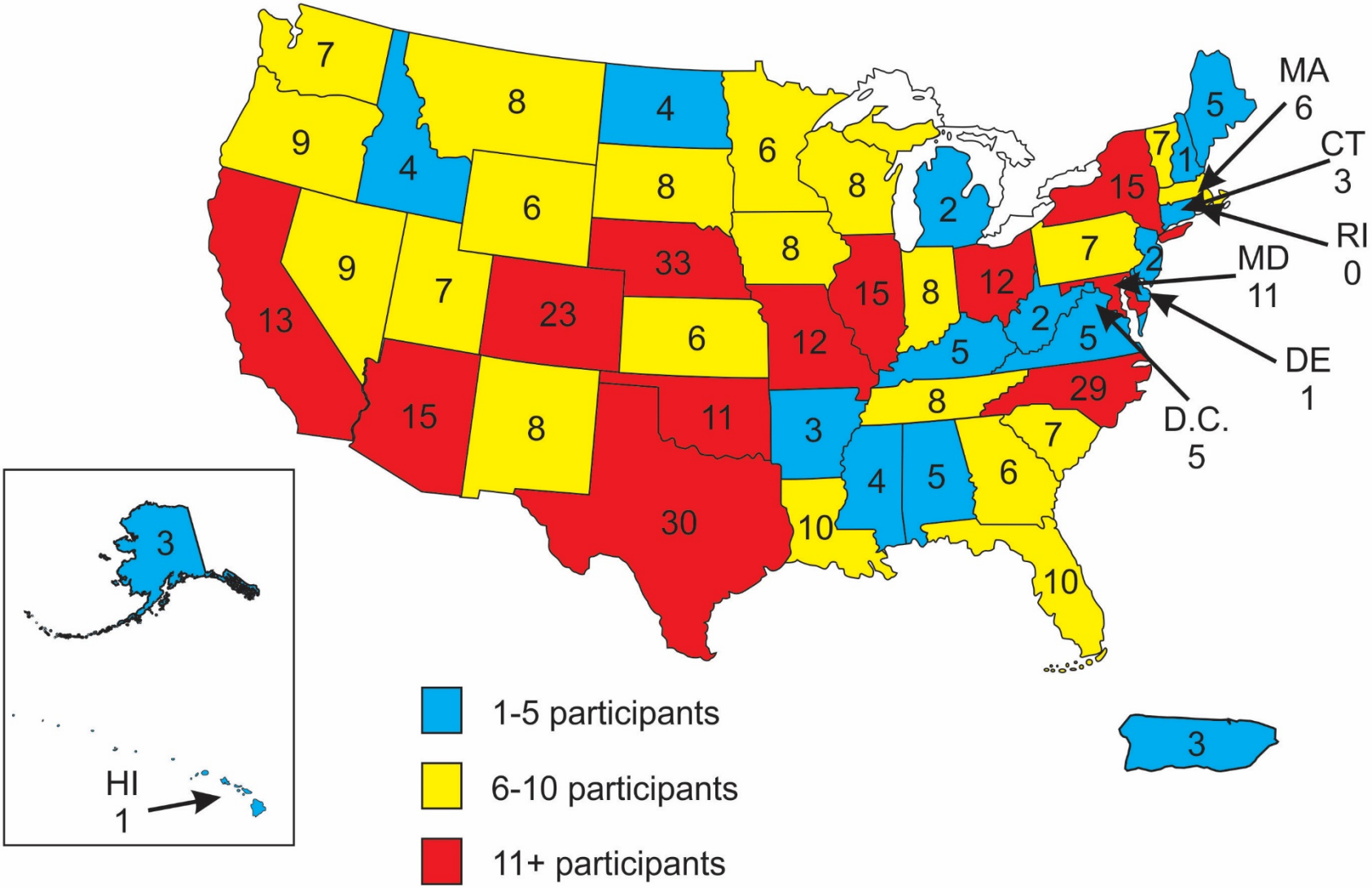
Local experts

Once the map is completed and published for the week, the map is final and **no changes will be made retroactively!**



USDM Listserv Subscribers

(as of September 13, 2019)

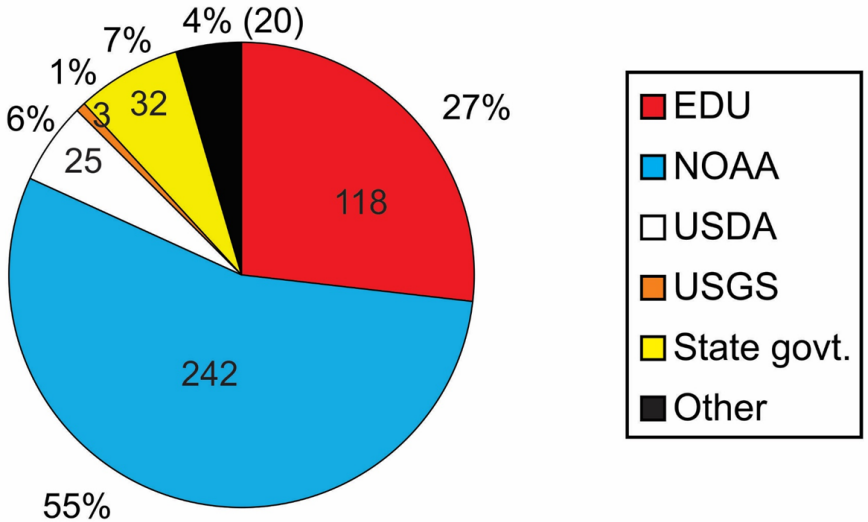


Total: 440 (does not include 2 participants from Canada and 2 participants from Brazil)

We want YOU !

USDM Listserv Subscribers

(as of September 13, 2019)

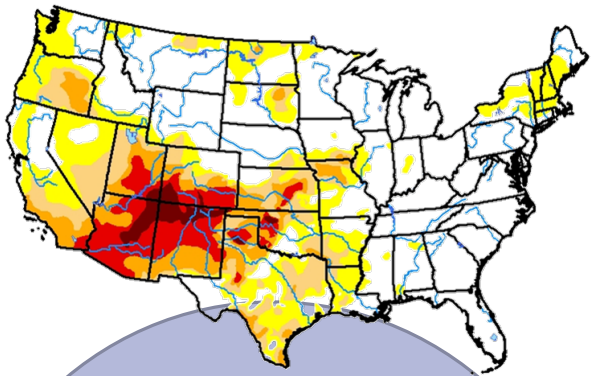


Some Examples of Decision Making and Policy Using the USDM
(Science before Policy)

Policy:

- 2008/2014 Farm Bill
  - USDA Farm Service Agency, Natural Resources Conservation Service, Risk Management Agency
- Internal Revenue Service
  - Livestock tax deferral program
- U.S. Department of Agriculture
  - Secretarial ***"Fast Track"*** Drought Designations
  - Livestock Forage Disaster Program (LFP) **$7.2 Billion in payouts so far**
- 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 in their monitoring/plans
- Many others

The map is **NOT**…. created for any one policy or use.



SCIENCE

Research based
Established methods
Peer-review

Trust

Service

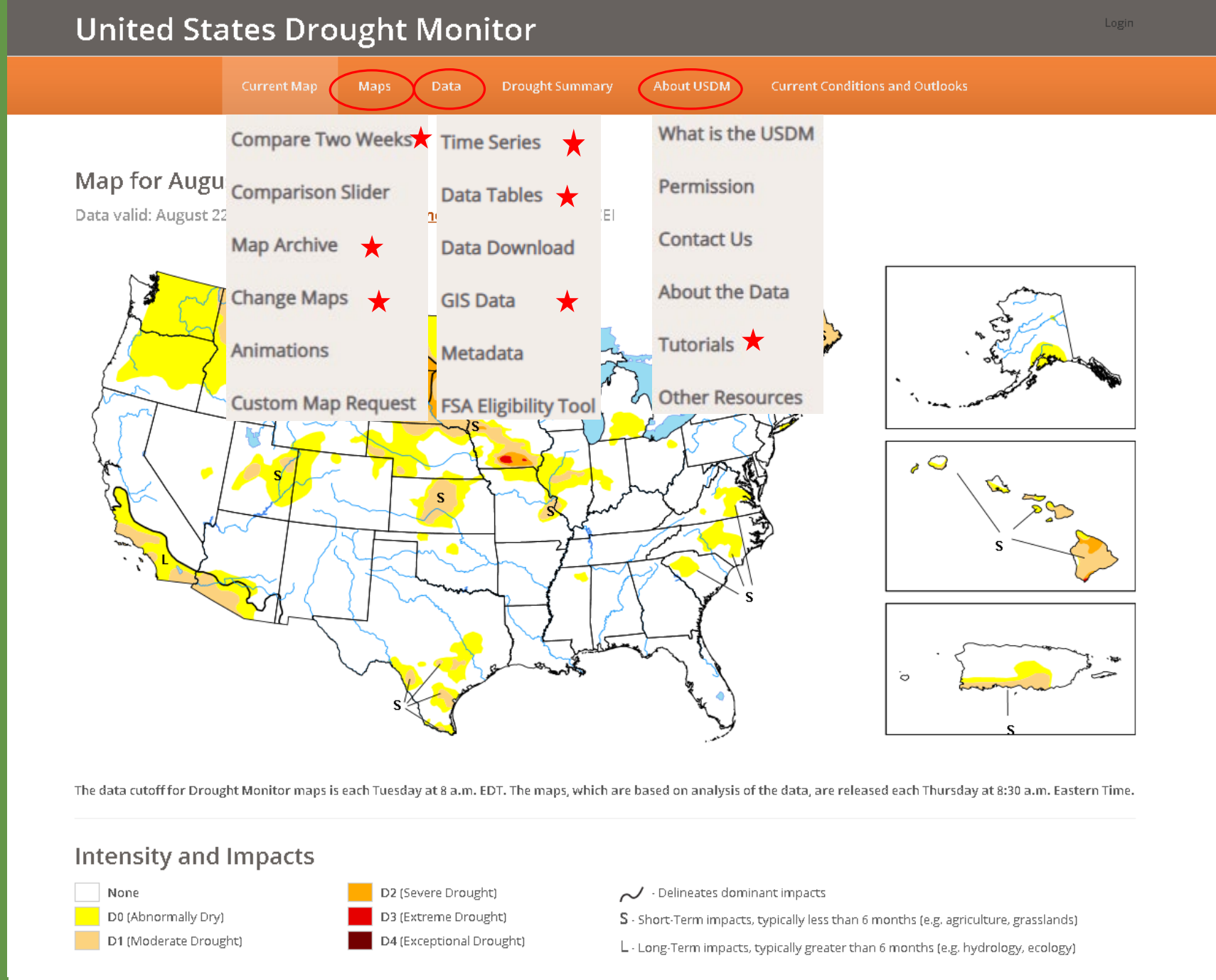
Decision support
Product development

Policy

Drought declarations
Aid & relief payments

The United States Drought Monitor website

A summary narrative of changes made each week, by region, can be found in the **"Drought Summary"**



Compare Two Weeks

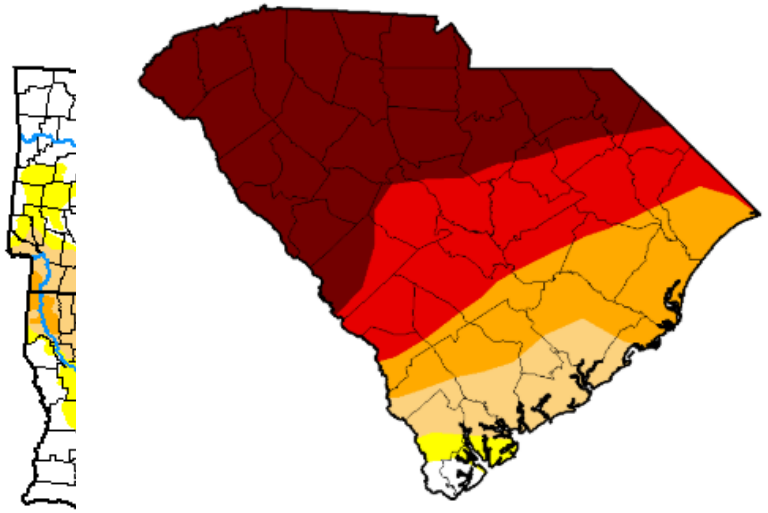
Maps > Compare Two Weeks

US

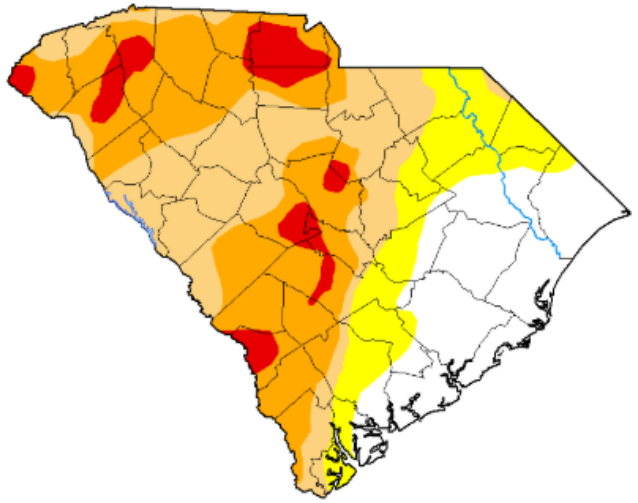
Area type: State | **Area:** South Carolina | **Statistics type:** Cumulative Percent Area

Drought Classification

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No Data



December 25, 2007



October 8, 2019

Statistics Comparison

Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4	DSCI
2007-12-25	1.01	98.99	97.62	88.69	70.46	45.86	402
2019-10-08	22.04	77.96	62.98	36.84	7.03	0.00	185
Change	21.03	-21.03	-34.64	-51.85	-63.43	-45.86	-217

19

10, 2019)

Percent Area)

-D4	D3-D4	D4
.76	2.57	0.00
.50	1.36	0.00
36	0.00	0.00
00	0.00	0.00
.50	1.36	0.00
00	0.00	0.00

Severe Drought

Extreme Drought

Exceptional Drought

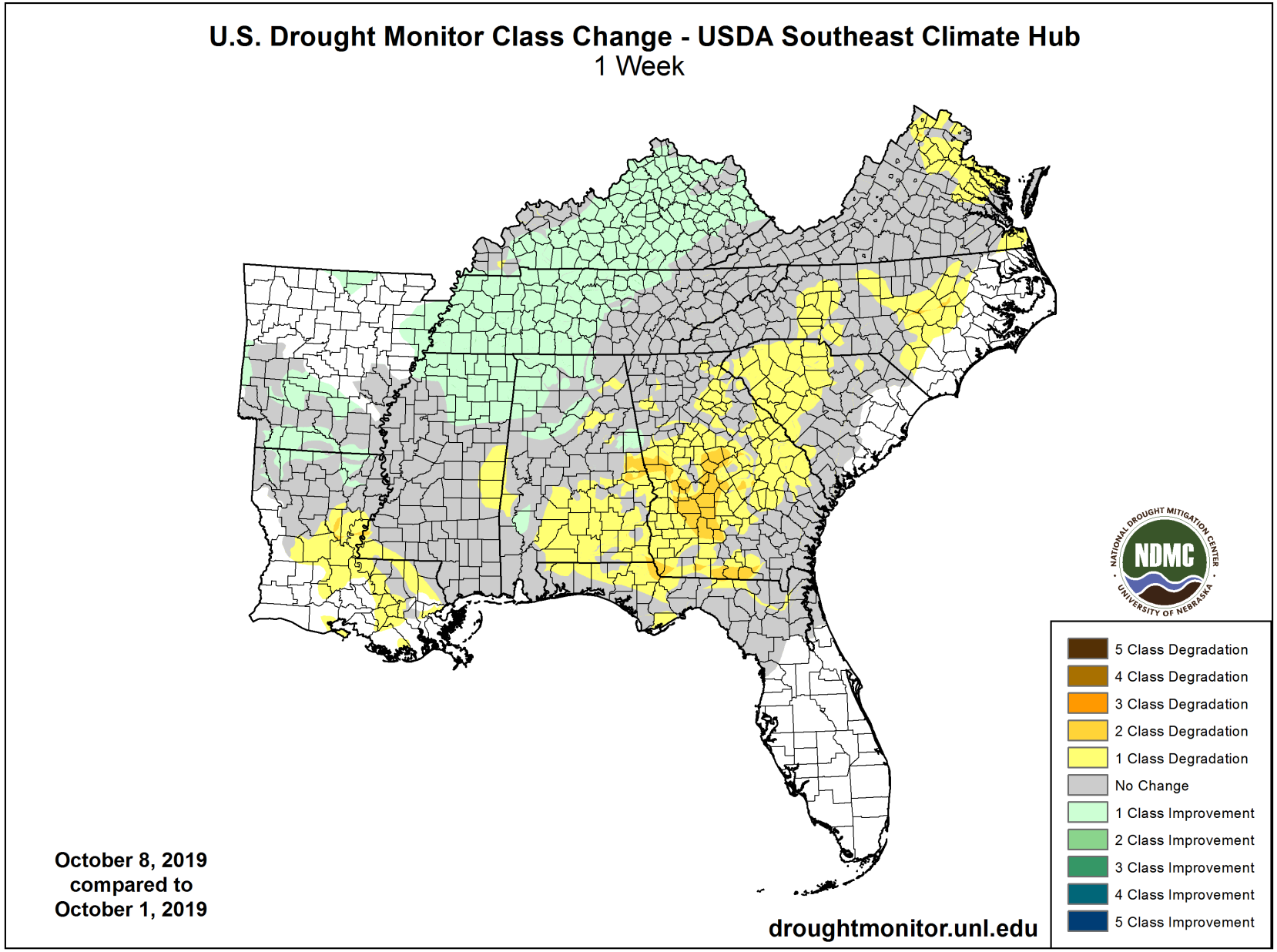
e conditions.
ng text summary

nl.edu

U.S. Drought Monitor Change Maps

At various time-scales of:

1 week
4 weeks
8 weeks
12 weeks
24 weeks
1 year
Calendar year
Water year



What is next……

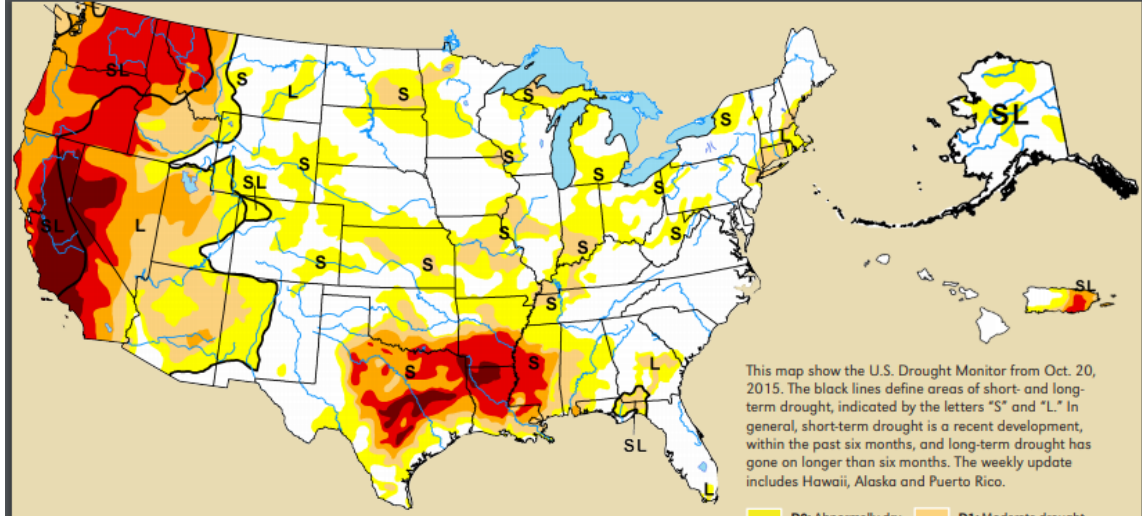
- We will continue to listen to users
- Continue to work with partners o
- USDM change maps services will
- Transition to operational "Objecti what CPC is currently doing with c
- Transition to an on-line ESRI base map
  - First for the Authors
  - Next for the USDM community
- New "potential impacts" tables b data collected in the Drought Impa
- Continue to develop tools, maps, funding allows
- Allow the USDM to change as dat

South Carolina

Category	Impact
D0	Row crop growth is stunted, irrigation begins early
	Brush fires increase
D1	Peach size is reduced; non-irrigated corn shows severe stress
	Fire risk increases; tree pests increase
	Water use is high; creeks, streams, and lakes are low
	Voluntary conservation of water and energy is requested
D2	Cattle are lighter, producers are selling calves early and feeding cattle earlier
	Number of fires increases, and fires are more intense
	Fisheries are impacted; duck hunting areas close
	Boating recreation is compromised
	River and lake levels are low; saltwater intrusion occurs; hydroelectric power production is reduced
D3	Hay is scarce and expense; owners are giving away horses
	Soil moisture is low, winter crops are slow to germinate
	Burn bans begin
	Small aquatic species are stressed
	Mandatory water restrictions are implemented, violators are fined; lake outflow is low
D4	Producers are hauling water for cattle; auctions see record number of cattle
	Trees are stressed; fish are dying
	Daily life is compromised
	Wells are contaminated or running dry; lakes are extremely low with hazards exposed

US Drought Monitor Brochure

Also available in Spanish



This map show the U.S. Drought Monitor from Oct. 20, 2015. The black lines define areas of short- and long-term drought, indicated by the letters "S" and "L." In general, short-term drought is a recent development, within the past six months, and long-term drought has gone on longer than six months. The weekly update includes Hawaii, Alaska and Puerto Rico.

D0: Abnormally dry
D1: Moderate drought
D2: Severe drought
D3: Extreme drought
D4: Exceptional drought

What is the U.S. Drought Monitor?

Maybe you've seen it in the media: that map of the U.S. painted with blobs of yellow, orange and red. It shows drought — but how do we know which colors go where? Who decides? What does it mean for you?

A USDM Q&A

The U.S. Drought Monitor is a map released every Thursday, showing parts of the U.S. that are in drought. The map uses five classifications: abnormally dry (D0), showing areas that may be going into or are coming out of drought, and four levels of drought: moderate (D1), severe (D2), extreme (D3) and exceptional (D4).

What agencies or organizations are responsible for the USDM?

The Drought Monitor has been a team effort since its implementation in 1999, produced jointly by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the National Oceanic and Atmospheric Administration, and the U.S. Department of Agriculture. The NDMC hosts the web site of the drought monitor and the associated data, and provides the map and data to NOAA, USDA and other agencies. It is freely available at droughtmonitor.unl.edu.

Who uses it, and what do they do with it?

The USDA uses the drought monitor to trigger disaster declarations and eligibility for low-interest loans. The Farm Service Agency uses it to help determine eligibility for their Livestock Forage Program, and the Internal Revenue Service uses it for tax deferral on forced

How does drought affect the country?

Drought is a normal part of the climate cycle. It is a slow-moving hazard, which causes people to underestimate the damage it can do, but losses from drought are as substantial as those from hurricanes, tornados and other faster-moving disasters. Drought causes losses to agriculture; affects domestic water supply, energy production, public health, and wildlife; and contributes to wildfire, to name a few of its effects.

No single federal agency is in charge of water or drought policy; response and mitigation fall to an assortment of federal authorities. The USDA leads response efforts; NOAA, through the National Integrated Drought Information System (drought.gov), leads monitoring; agencies such as the U.S. Geological Survey and NASA contribute data; and the Environmental Protection Agency regulates water quality. The National Drought Resilience Partnership, launched in the aftermath of widespread drought in 2012, is an effort to unify federal drought response and policy. Drought response efforts, planning, and water law vary from state to state.

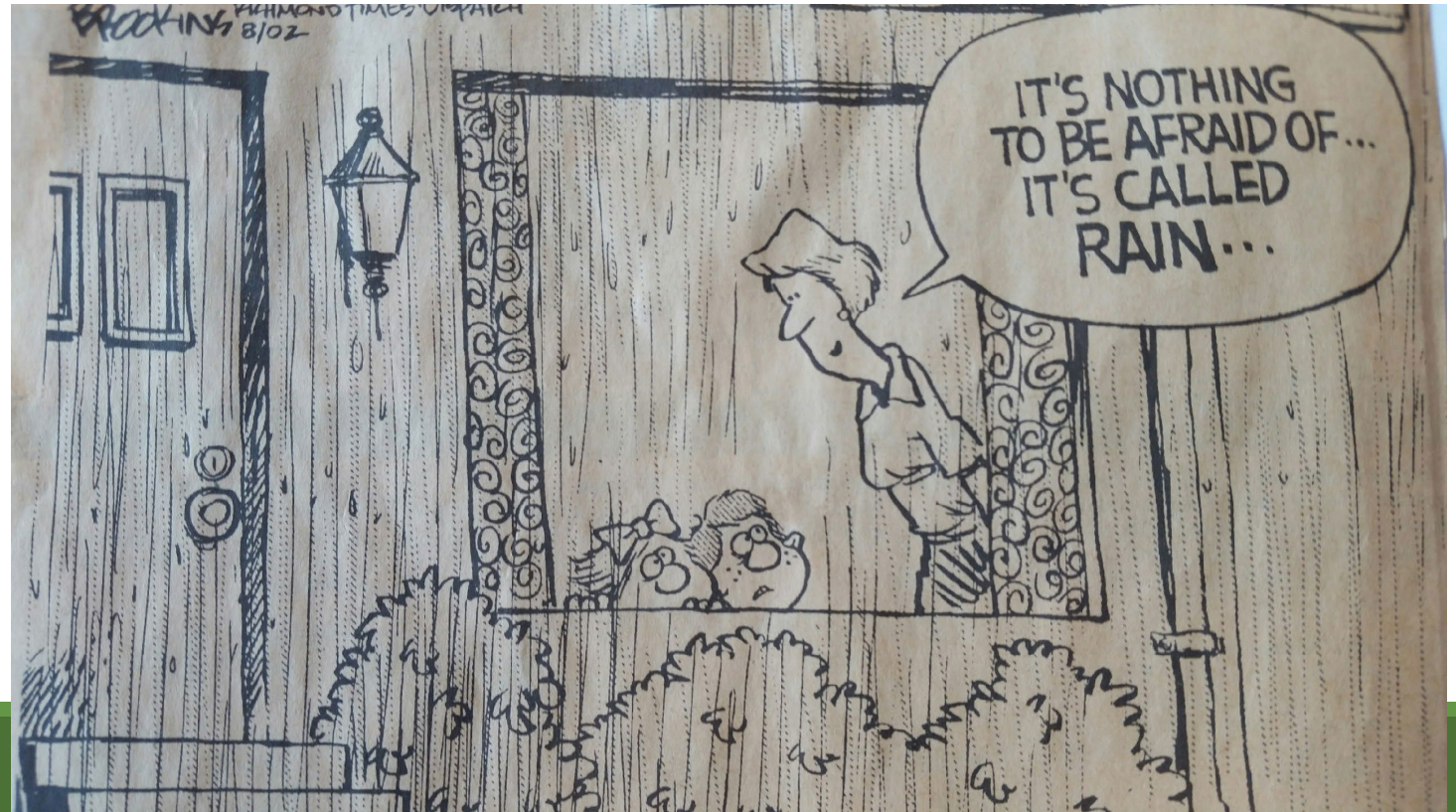
How do we know when we're in a drought?

Recognizing drought before it intensifies can reduce impacts and save money. How you recognize it depends on how it affects you. Traditional ways to measure drought are by comparing observed

NATIONAL DROUGHT MITIGATION CENTER

https://droughtmonitor.unl.edu/data/docs/what_is_usdm.pdf

OUR PARTNERS



Any Questions ?

DROUGHT.UNL.EDU e | ndmc@unl.edu /NationalDroughtMitigationCenter @droughtcenter

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bfuchs2@unl.edu

402-472-6775

National Drought Mitigation Center
School of Natural Resources
University of Nebraska-Lincoln