

# Drought Indices and Indicators in use around the World



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# Types of Drought

- ▶ **Meteorological**
  - ▶ **Agricultural**
  - ▶ **Hydrological**
  - ▶ **Socioeconomic**
- 
- ▶ There are ***indices for all*** of these types of drought
  - ▶ There is ***no one definition*** of drought
  - ▶ Thus, there is ***no one-size-fits-all*** drought index or indicator



# What is a Drought Indicator versus a Drought Index?

- ▶ **Indicator:** a measure of a meteorological, hydrological, agricultural, or socio-economic variable that provides an indication of potential drought related stress or deficiency.
- ▶ **Index:** a method of deriving “value added” information related to drought by comparing current conditions to historical information based upon statistical calculations.

(Note: Indices are indicators as well)



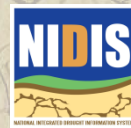
# Examples of Indicators

- ▶ Precipitation amounts
- ▶ River and Streamflow levels
- ▶ Soil Moisture information
- ▶ Evapotranspiration information
- ▶ Reservoir storage
- ▶ Impact information
- ▶ Crop status/yield estimation reports
- ▶ Temperature
- ▶ Vegetation Health/Stress
- ▶ Short and long-term/seasonal forecasts
- ▶ Ground water
- ▶ Snow pack



# Examples of Indices

- ▶ Standardized Precipitation Index (SPI)
- ▶ Palmer Drought Severity Index (PDSI)
- ▶ Surface Water Supply Index (SWSI)
- ▶ Percent of Normal/Departure from Normal Precipitation
- ▶ Deciles
- ▶ Standardized Precipitation-Evapotranspiration Index (SPEI)
- ▶ Effective Drought Index (EDI)
- ▶ Many others !



# What “defines” an Index

- ▶ The World Meteorological Organization (WMO) defines a drought index as “an index which is related to some of the cumulative effects of a prolonged and abnormal moisture deficiency”



# Criteria for a Drought Index

- ▶ The timescale should be appropriate to the problem at hand
- ▶ The index should be a quantitative measure of large-scale, long-continuing drought conditions (**intensity, duration, spatial extent**)
- ▶ The index should be applicable to the problem being studied
- ▶ A long accurate past record of the index should be available or computable
- ▶ The index should be able to be computed on a near real-time basis to be used operationally



# 2009 WMO Meeting

**The Lincoln workshop highlighted that a DEWS (Drought Early Warning System) can contain the following components:**

- ▶ Data-monitoring networks (for the multiple and varied collection of climate, hydrological, and environmental observations, remote sensing, impacts, etc.)
- ▶ Data retrieval and storage [quality assurance (QA) and quality control (QC)]
- ▶ Derivative interpretation and value-added deliverables (products/tools)
- ▶ Integration and application of various models, such as Land Data Assimilation Systems (LDAS), potential evapotranspiration, soil moisture, groundwater, etc.
- ▶ Translation from data to information, which is critical
- ▶ Dissemination (accounting for user needs, mediums of delivery, timely information, and data sharing) of the information and status of conditions.





# “Lincoln Declaration on Drought Indices”

**Inter-Regional  
Workshop on Indices  
and Early Warning  
Systems for Drought**

**Lincoln, Nebraska, USA  
8-11 December 2009**



**Recommends that the SPI be computed and used by Met/Hydro Services as the common meteorological drought index globally (WMO)**



Inventory of **Indicators** (data)  
available and reporting  
frequency



Identify appropriate **Indices** to use  
based upon the local climate and  
data availability. Designate **triggers**  
tied back to a response plan.



Compute Indices, gather  
drought impact information,  
and consolidate these data into  
a Drought Early Warning  
System



# Drought Triggers

➤ **Triggers**: Specific values of an indicator that initiate and/or terminate each level of a drought plan, and associated management responses.

- **Who is accountable to do what and when?**
- **Ties back to the plan!**

Example: precipitation below the 5th percentile for two consecutive months → Level 4 Drought.



# Drought **Indices** and **Indicators** Used around the World

- ▶ **Effective Drought Index (EDI)**: The EDI is an attempt to more accurately determine the exact start and end of a drought period. The EDI is a function of '*precipitation needed for a return to normal*' conditions (or to recover from the accumulated deficit since the beginning of a drought)



# Drought **Indices** and **Indicators** Used around the World

- ▶ **Deciles (Australia):** The technique developed divided the distribution of occurrences over a long-term precipitation record into *tenths of the distribution*. They called each of these categories a *decile*. The first decile is the rainfall amount not exceeded by the lowest 10% of the precipitation occurrences. The second decile is the precipitation amount not exceeded by the lowest 20% of occurrences. These deciles continue until the rainfall amount identified by the tenth decile is the largest precipitation amount within the long-term record. By definition, the fifth decile is the median, and it is the precipitation amount not exceeded by 50% of the occurrences over the period of record. The deciles are grouped into five classifications.



# Decile Classification

Decile Classifications	
deciles 1-2: lowest 20%	much below normal
deciles 3-4: next lowest 20%	below normal
deciles 5-6: middle 20%	near normal
deciles 7-8: next highest 20%	above normal
deciles 9-10: highest 20%	much above normal

National



# Drought **Indices** and **Indicators** Used around the World

- **SPEI(Spain)**: The SPEI combines the sensitivity of PDSI to changes in evaporation demand (caused by temperature fluctuations and trends) with the simplicity of calculation and the multi-temporal nature of the SPI. The new index is particularly suited to detecting, monitoring, and exploring the consequences of global warming on drought conditions.



# Drought **Indices** and **Indicators** Used around the World

- ▶ **RDI (Greece):** The Reconnaissance Drought Index is proposed together with the well known Standardized Precipitation Index (SPI) and the method of deciles. The new index exhibits significant advantages over the other indices by including apart from precipitation, an additional meteorological parameter, the potential evapotranspiration. It is concluded that although the RDI generally responds in a similar fashion to the SPI (and to a lesser extent to the deciles), it is more sensitive and suitable in cases of a changing environment.





# Putting all the Pieces Together



All the pieces may be a daunting task for a single person or group, but the task becomes easier if many contribute

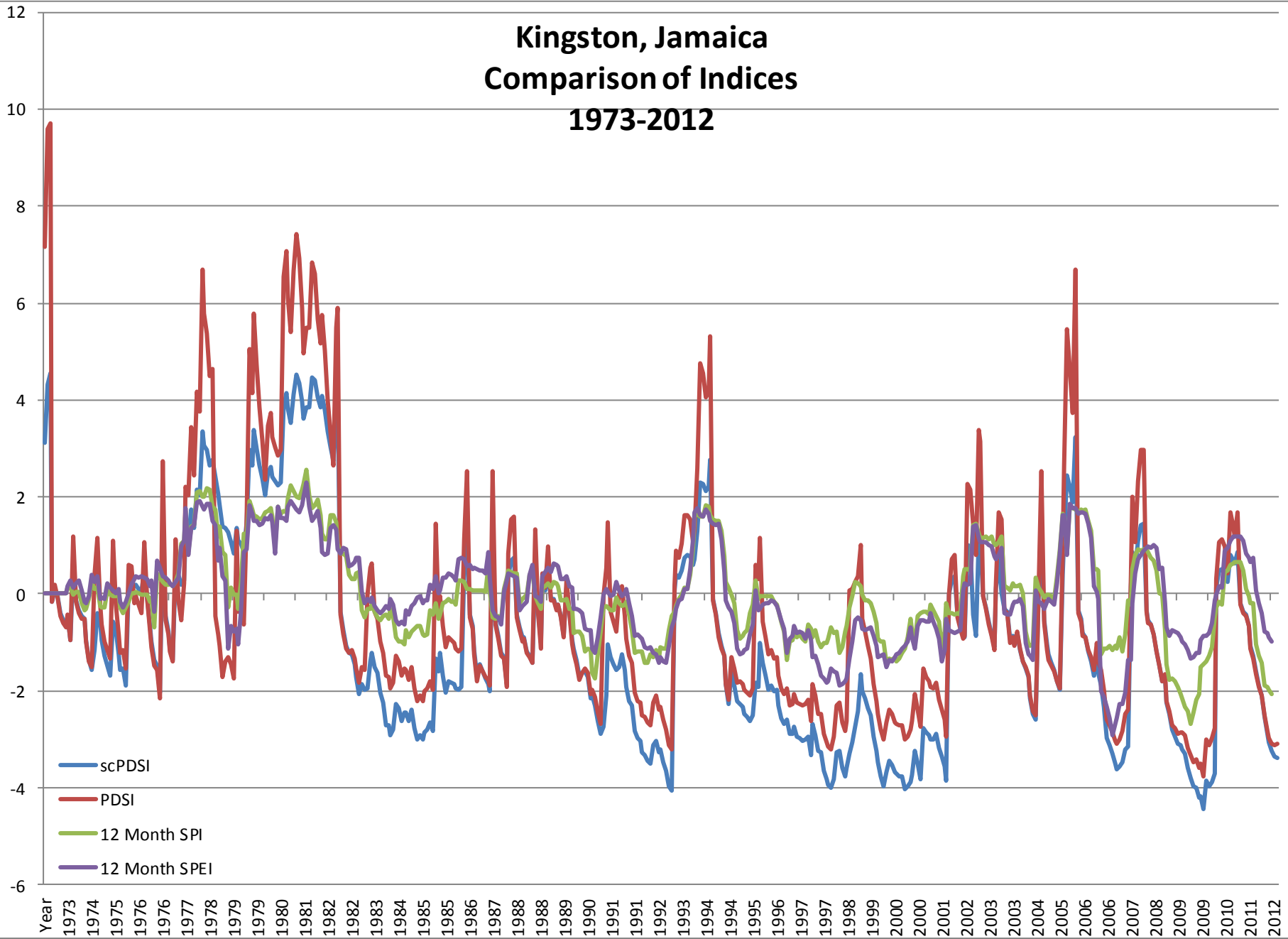
# Several Approaches to Drought Assessment

- ▶ Single Indicator or Index
- ▶ Multiple Indicators or Indices
- ▶ A “Composite” or “Hybrid” approach



# Why not just a single indicator?

Kingston, Jamaica  
Comparison of Indices  
1973-2012



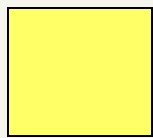
# The U.S Drought Monitor

- ▶ An example of several groups (govt and non-govt) working together to produce a single **"hybrid"** approach to drought monitoring
- ▶ Uses both *indicators* and *indices* in a **"Consolidation of Evidence"** approach based upon percentile rankings
- ▶ Continually **evolving** as inputs continue to develop and the use of technology is incorporated



# The U.S Drought Monitor

*Drought Intensity Categories based upon a  
“Percentile Ranking” methodology*



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



D1 Drought – **Moderate (20%tile)**



D2 Drought – **Severe (10%tile)**



D3 Drought – **Extreme (5%tile)**

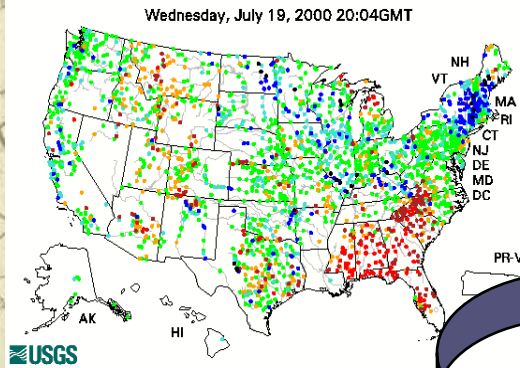


D4 Drought – **Exceptional (2%tile)**

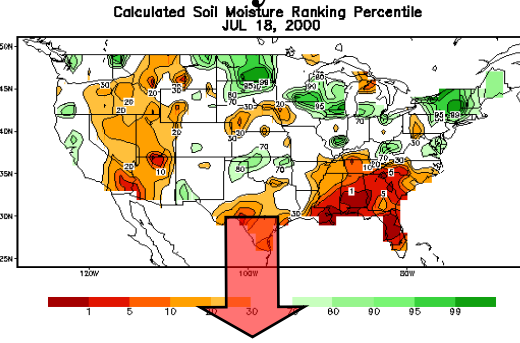


# Principal Drought Monitor Inputs

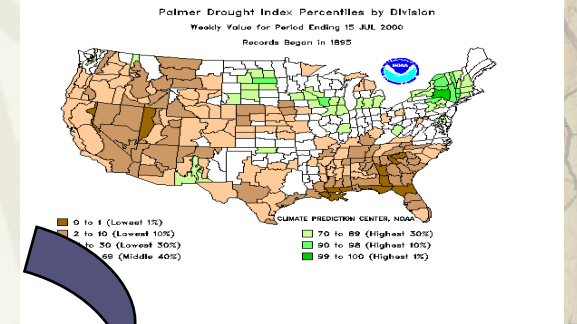
## USGS Streamflow



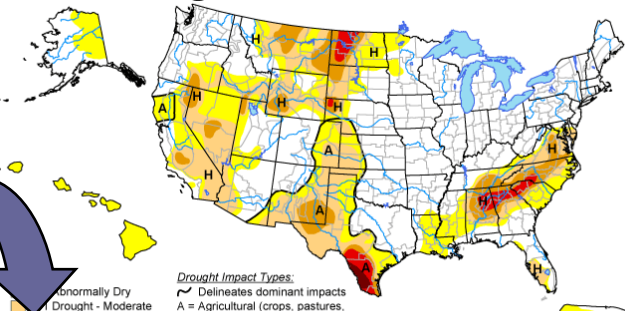
## CPC Daily Soil Model



## Palmer Drought Index



## U.S. Drought Monitor



**Drought Impact Types:**  
 ✓ Delineates dominant impacts  
 A = Agricultural (crops, pastures, grasslands)  
 H = Hydrological (water)

◻ Abnormally Dry  
 ◻ Drought - Moderate  
 ◻ D2 Drought - Severe  
 ◻ D3 Drought - Extreme  
 ◻ D4 Drought - Exceptional

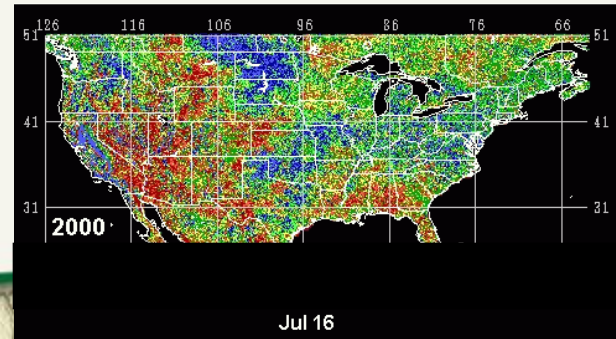
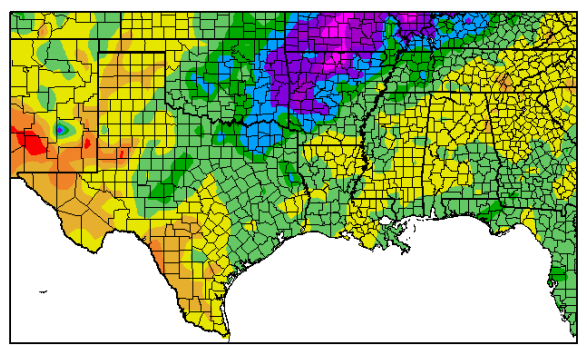
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>

Released Thursday, April 17, 2008  
 Authors: Jay Lawrence/Liz Love-Brotak, NOAA/NESDIS/NCDC

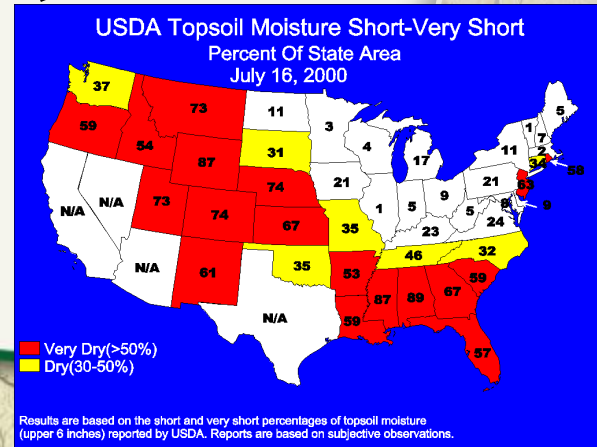
## SPI Drought Index

90 Day SPI  
1/16/2008 - 4/14/2008



## Satellite Veg Health

## USDA Soil Ratings



# U.S. Drought Monitor

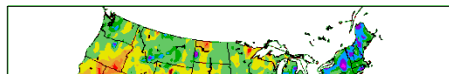
Integrates Key  
Drought Indicators:

- Palmer Drought Index

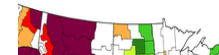
Several “newer” indicators also being considered:

- Mesonet data
- VegDri
- NWS Precipitation Analysis Tool
- NLDAS Soil Moisture
- VIC Soil Moisture
- Texas SPI Hybrid
- CRN Soil Moisture
  
- Plus many others !

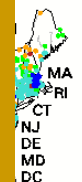
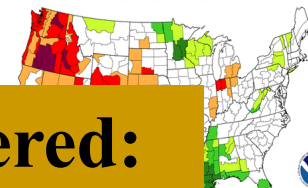
Water Year SPI  
10/1/2006 - 4/19/2007



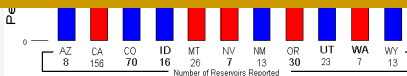
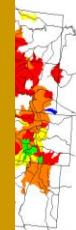
Palmer Drought Index  
Long-Term (Meteorological) Conditions  
October 21, 2001 - October 27, 2001



Standardized Precipitation Index  
Six Months  
June-November 2002



PR-VI



Prepared by: USDA, Natural Resources Conservation Service, National Water and Climate Center, Portland, OR  
<http://www.wcc.nrcs.usda.gov>



# Documenting Drought Impacts is Important

droughtreporter.unl.edu

The screenshot displays the 'Drought Impact Reporter' web application. At the top, there is a navigation menu with options: Map, Advanced Search, Submit a Report, About the DIR, and Help. The main content area features a map of the United States where states are color-coded based on drought impact levels. A legend on the right side of the map provides the following scale:

- 0 (Grey)
- 1 - 7 (Light Orange)
- 8 - 14 (Orange)
- 15 - 21 (Dark Orange)
- 22 - 28 (Red-Orange)
- 29 - 35 (Dark Red)

Below the map, there are several interactive elements: a 'Refresh' button, tabs for 'Impacts & Reports' and 'Overlays', and a 'Legend' section. A summary table titled 'Total Impacts | All States' shows a total of 133 impacts. The table is organized by category and report source.

Total Impacts   All States				133	
<b>Category</b>					
	Agriculture	53		Business & Industry	5
	Energy	2		Fire	33
	Plants & Wildlife	40		Relief, Response & Restrictions	48
	Society & Public Health	9		Tourism & Recreation	12
	Water Supply & Quality	49			
<b>Report Source</b>					

At the bottom of the application, there is contact information for The National Drought Mitigation Center and the University of Nebraska-Lincoln logo.



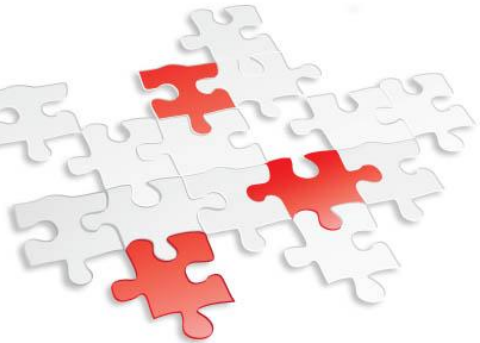


# Putting the Pieces Together

Inventory of **Indicators** (data) available and reporting frequency

Identify appropriate **Indices** to use based upon the local climate and data availability. Designate **triggers** tied back to a response plan.

Compute Indices, gather drought impact information, and consolidate these data into a Drought Early Warning System



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# Any Questions ?



# Contact Information:

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