Drought Indices and Indicators in use around the World

National Drought Mitigation Center
University of Nebraska-Lincoln

Brian Fuchs

Caribbean Drought Workshop May 22-24, 2012
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
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

<table>
<thead>
<tr>
<th>Decile Classifications</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>deciles 1-2: lowest 20%</td>
<td>much below normal</td>
</tr>
<tr>
<td>deciles 3-4: next lowest 20%</td>
<td>below normal</td>
</tr>
<tr>
<td>deciles 5-6: middle 20%</td>
<td>near normal</td>
</tr>
<tr>
<td>deciles 7-8: next highest 20%</td>
<td>above normal</td>
</tr>
<tr>
<td>deciles 9-10: highest 20%</td>
<td>much above normal</td>
</tr>
</tbody>
</table>
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

Satellite Veg Health

SPI Drought Index

USDA Soil Ratings

Palmer Drought Index
U.S. Drought Monitor

Integrates Key Drought Indicators:

- Palmer Drought Index
- SPI
- KBDI
- Modeled Soil Moisture
- 7 Day Avg. Streamflow
- Precipitation Anomalies

Growing Season:

- Crop Moisture Index
- Sat. Veg. Health Index
- Soil Moisture
- Mesonet data

In The West:

- SWSI
- Reservoir levels
- Snowpack
- Streamflow

Created in ArcGIS

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!
Documenting Drought Impacts is Important

droughtreporter.unl.edu
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.
Any Questions?
Contact Information:

Brian Fuchs
bfuchs2@unl.edu
402-472-6775
National Drought Mitigation Center
School of Natural Resources
University of Nebraska-Lincoln