Some Thoughts on Drought Indicators and Triggers

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NDMC Program Objectives

**Improve the science** of drought monitoring, planning, and mitigation

**Build awareness** of drought & 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

**Conduct and maintain** operational tools, research, outreach and training
The Cycle of Disaster Management

- Risk Management
  - Planning
  - Monitoring and Early Warning
- Mitigation
- Hazard Event
  - Impact Assessment
- Protection
  - Recovery
  - Response
  - Reconstruction

Crisis Management
What is Drought?
Droughts differ in terms of:

- **Intensity**
- **Duration**
- **Spatial Extent**
Types of Drought:

- Meteorological
- Agricultural
- Hydrological
- Socioeconomic

There are *indicators and indices for all* of these types of drought

There is *no one definition* of drought

Thus, there is typically *no one-size-fits-all* drought index or indicator
Monitoring the Drought Hazard: Many Parameters and Indices to Choose from:

**Parameters (Indicators) to measure:** temperature, precipitation, soil moisture, reservoir/lake levels, streamflow, groundwater, snow pack, ET, vegetation health/stress, short and long-term/seasonal forecasts, *impacts*!

**Assessing Drought:**

**Meteorological/Agricultural Indices**
- Percent of normal precipitation
- Standardized Precipitation (Evapotranspiration) Index (SPI/SPEI)
- Palmer Drought Severity Index (PDSI, scPDSI)
- Remotely sensed vegetation stress indices (VCI, VegDRI, ESI, EDDI…)

**Hydrologic Drought Indices**
- Palmer Hydrological Drought Index (PHDI)
- Surface Water Supply Index (SWSI)
Definitions: Indicators, Indices and Triggers

- **Indicators**: Variables or parameters used to describe drought conditions. *(NOTE: Indices are Indicators as well)*

Examples: precipitation, temperature, streamflow, groundwater, reservoir levels, snowpack, soil moisture, drought indices, etc.

- **Indices**: Typically a computed numerical representation of a drought’s severity/intensity using climatic or hydrologic inputs.
Definitions: Indicators, Indices and Triggers

- **Triggers**: Specific values of an indicator/indice 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!

**Examples**: 6-mo SPI below the 5th percentile for two consecutive months → Level 4 Drought

OR...

3-mo SPI above the 30th percentile for three consecutive months → No Drought
Importance of Drought Indices

- **Simplify** complex relationships and provide a good communication tool for diverse audiences/users
- **Quantitative** assessment of anomalous climatic conditions
  - Intensity
  - Duration
  - Spatial extent
- **Historical** reference (probability of recurrence)
  - Planning and design applications
Considerations for Choosing Indicators / Triggers

- Proper and Timely Detection of Drought
- Spatial and Temporal Sensitivity
- Supplies and Demands
- **Drought In / Drought Out**
- Composite and/or Multiple Indicators
- Data availability/stability, period of record, and validity
- Ease of Implementation
- **Validation**….do they match the impacts/reality of the situation on the ground?
Approaches to Drought Assessment

- Single index or indicator (parameter)
- Multiple indices or indicators
  - Assessed stand-alone
- Composite (or “hybrid”) Indicator
  - Blended approach
Advantages of percentiles:
- Can be applied to any parameter
- Can be used for any length of data record
- Puts drought in historical perspective

USDM Drought Intensity Categories:
- D4, Exceptional Drought: (2) once per 50+ years
- D3, Extreme Drought: (5) once per 20 to 50 years
- D2, Severe Drought: (10) once per 10 to 20 years
- D1, Moderate Drought: (20) once per 5 to 10 years
- D0, Abnormally Dry: (30) once per 3 to 5 years
U.S. Drought Monitor Approach

“Convergence of Evidence”

- Many types of drought “information” can be collectively analyzed to determine if the majority of information is ‘converging’ (telling the same story) about the accuracy, or inaccuracy, of the drought as depicted by the USDM.

- Need to look at 100% of the data, BUT don’t believe in any one piece of data input 100% in making a decision...

- Multiple indicators and types of information that describe different environmental parameters are needed to get a complete picture of a drought indicators performance.

- Impacts are the “ground truth”, yet aren’t monitored….you can’t measure what you don’t monitor!
U.S. Drought Monitor
West

July 14, 2015
(Released Thursday, Jul. 16, 2015)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

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<th>Current</th>
<th>None</th>
<th>D0-D4</th>
<th>D1-D4</th>
<th>D2-D4</th>
<th>D3-D4</th>
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<tr>
<td></td>
<td>25.49</td>
<td>74.51</td>
<td>61.37</td>
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<td>Last Week 7/7/2015</td>
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<td>61.14</td>
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<td>3 Months Ago 4/14/2015</td>
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<td>73.45</td>
<td>61.00</td>
<td>37.91</td>
<td>17.04</td>
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<td>Start of Calendar Year 1/1/2014</td>
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<td>65.24</td>
<td>54.48</td>
<td>33.50</td>
<td>18.68</td>
<td>5.40</td>
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<tr>
<td>Start of Water Year 9/30/2014</td>
<td>31.48</td>
<td>68.52</td>
<td>55.57</td>
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<tr>
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<td>60.35</td>
<td>46.65</td>
<td>23.56</td>
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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.

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http://droughtmonitor.unl.edu/
The Importance of Drought Early Warning and Information Systems (DEWIS)

- 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 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
- Efficient **dissemination/communication** (WWW, media, extension, etc.)
- Drought risk assessment and **planning**
- **Education** and Awareness
Drought Plan Components

- **Monitoring and early warning**
  - Integrate and distill information
  - 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...*
Lessons Learned

- Monitoring is the **foundation** of risk management planning
  - *Trigger to who does what and when!*
  - *One can not manage what is not monitored!*
- **Impact collection must be an integral part** of any drought early warning information system
- Tool development should be an **iterative process** in partnership with the users
- **Dissemination** is needed through a variety of media and educational materials in order to reach a variety of audiences
Critical Observations:

1) No single indicator/index is used solely in determining appropriate actions

2) Instead, different thresholds from different combinations of inputs is the best way to approach monitoring and triggers using a variety of indices and indicators

3) Decision making (or “triggers”) based on quantitative values are supported favorably and are better understood
Final Thoughts

- Seeing a *shift toward more development of remotely sensed, modeled, gridded and/or combined/composite indices* (e.g. NLDAS, MDSI, VegDRI, ESI, SMAP...) being integrated into USDM + DEWIS/GDEWIS...

- **Decision Support** Tools/Applications/Services help bridge the gap between monitoring/early warning, prediction and preparedness ("triggers" for decision support)
Thank You!

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