Drought Indices in Decision-making Process of Drought Management

Ekaterina Altman
Master of Earth and Environmental Resources Management
University of South Carolina
Carolina Climate Resilience Conference
April 28, 2014
Charlotte, NC
Drought and Drought Indices

- Devastating phenomenon, affects water supply and other resources.
- Hard to measure due to various temporal and spatial scales; can be measured by rainfall deficit as well as impacts.
- Drought indicators are used to measure and assess droughts.
- **Drought index** value is typically a single number and is more useful than raw data for decision-making.
- All drought indices have + and −, some sector-specific.
Proactive Drought Management

- Proactive (risk management) vs. Reactive (crisis management) approaches.
- Proactive drought management strategies can reduce and virtually eliminate drought impacts (Wilhite, 2000).
- Evaluation of drought conditions by decision-makers is important issue.
- Previous research (Mizzell, 2008) identified how decision-makers in water systems and power companies use drought indices.

This research studies use of drought indices in decision-making process by the SC’s Drought Response Committee.
Number of Triggers used in State Drought Plans

Legend

- 0
- 1-2
- 3-4
- 5-6
- 7-9

Svoboda, NDMC, 2011
SC Drought Policy

- SC has proactive drought monitoring and management program.
- The state was among the first to formulate drought management plan in 1982.
- The Drought Response Act (DRA) was first enacted in 1985 and amended in 2000.
- The South Carolina Department of Natural Resources (DNR) moderates work of the Drought Response Committee (DRC).
- DRC consists of statewide (state agencies) and local committee members.
- Indicators are not anticipated to be a perfect match.

Research Objective

- How the information from different drought indices (PDSI, PHDI, Z-Index, CMI, SPIs, KBDI, USDM) relates to DRC drought status declaration through considering measures: **onset, duration, severity and recovery**.*

* Drought Response Committee (DRC) – South Carolina drought decision-making body; PDSI - Palmer Drought Severity Index; PHDI - Palmer Hydrological Drought Index; Z-Index - Palmer Z-Index; CMI - Crop Moisture Index; SPI - Standard Precipitation Index; KBDI - Keetch-Byram Drought Index; USDM - U.S. Drought Monitor.
Hypothesis

- Overarching: DRC is not consistent with any single index as measured by correspondence with onset, duration, severity and recovery.

- Sub-hypotheses:
  A) DRC lags behind entering drought.
  B) DRC and indices identify different duration.
  C) DRC and indices have different drought severity.
  D) DRC lags behind in drought recovery.
Methodology


South Carolina counties
- Charleston
- Florence
- Edgefield
- Richland
- Oconee
Methodology

- Data collection:
  - SC Department of Natural Resources,
  - U.S. Drought Monitor (USDM),
  - Dynamic Drought Index Tool for Basins of North and South Carolina.

<table>
<thead>
<tr>
<th>Database</th>
<th>Time Coverage</th>
<th>Frequency</th>
<th>Data Points for the Study Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRC Reports</td>
<td>Jul. 1998 – Jul. 2012</td>
<td>Every 4-6 week when drought</td>
<td>31</td>
</tr>
<tr>
<td>DM data</td>
<td>May 1999 – Sep. 2012</td>
<td>Weekly</td>
<td>468</td>
</tr>
</tbody>
</table>
Methodology

- **Data calibration/coding**
  - Weekly and daily to monthly values.
  - Monthly data then into drought categories *incipient, moderate, severe and extreme*.

- **Data analysis**
  - Visual analysis of figures and descriptive statistics.

- **Limitations**
  - Nine years of data, but includes two drought periods.
## Results

<table>
<thead>
<tr>
<th></th>
<th>DRC</th>
<th>USDNM</th>
<th>PDSI</th>
<th>PHDI</th>
<th>Z Index</th>
<th>SPI1</th>
<th>SPI3</th>
<th>SPI6</th>
<th>SPI9</th>
<th>SPI12</th>
<th>CMI</th>
<th>KBDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Drought Status:
- **Green**: No Drought
- **Yellow**: Incipient
- **Red**: Moderate
- **Dark Red**: Severe
- **Brown**: Extreme

* - Drought Response Committee drought status update

Drought periods measured by the DRC
Results for Charleston, Edgefield, Florence, Oconee and Richland counties.
As it was expected, no index measured drought onset, duration, severity and recovery the same way as the DRC.

**Onset:** DRC changes less frequently than indices, in most cases DRC lagged to detect drought by at least 2-3 months.

**Duration:** DRC values change less frequently than other indicators.

**Severity:** DRC tends gradually change drought severity and stays on conservative side.

**Recovery:** DRC consistent with indices in measuring drought recovery and lagged less than in measuring onset.
Other Results

- Charleston County experienced the least number and Edgefield County the largest number of drought months for study period.

- **USDM** demonstrated the highest drought severity among drought indices.

- **SPIs** good measure for developing drought conditions, however, in most cases, showed lower severity than USDM, PDSI and PHDI.

- **CMI** and **KBDI** measure shorter drought duration than other indices, but DRC tends to consult these indices because direct link to agriculture and fire risk impacts on the ground.
Conclusion: Significance

- Complexity of drought measurement and evaluation in decision-making process.

- Highlights the need for multiple indices, some of them sector-specific, link indices with impacts on the ground.

- South Carolina drought management program is a valuable examples of an assessment of drought indicators for policy purposes.
Ultimate Goal – Drought Resilience

- Effective use of indices
- Proactive drought management
- Reduced drought impacts
- Drought resilient societies
Thank you for your attention. Questions or Comments?

Ekaterina Altman
altmane01@gmail.com

@altmane01

http://bit.ly/1nCHJTX

www.linkedin.com/in/ekaterinaaltman/