Comprehensive Analysis of Drought Persistence, Hazard, and Recovery across the CONUS Indicators

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Results

Methodology

- Probabilistic features of agricultural drought in a given season are characterized by derivation of the conditional probability density function (PDF) of soil moisture values in a particular season given the soil moisture values in the previous season.
- Copula link univariate marginal distributions and construct a multivariate joint distribution. They offer the flexibility of generating a joint distribution with margins from different families of univariate distributions in addition to the flexibility in the selection of variables dependence structure.
- The resulting conditional pdf reveals the probabilistic characteristics of the hydrologic variable of interest at time \( t+1 \) given the its antecedent status at time \( t \).
- Copula functions are used in order to estimate the likelihood of the USDM drought severity classes.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Percentiles (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Normal/wet condition</td>
<td>31 to 100</td>
</tr>
<tr>
<td>D0</td>
<td>Abnormally dry</td>
<td>21 to 30</td>
</tr>
<tr>
<td>D1</td>
<td>Moderate drought</td>
<td>11 to 20</td>
</tr>
<tr>
<td>D2</td>
<td>Severe drought</td>
<td>6 to 10</td>
</tr>
<tr>
<td>D3</td>
<td>Extreme drought</td>
<td>3 to 5</td>
</tr>
<tr>
<td>D4</td>
<td>Exceptional drought</td>
<td>0 to 2</td>
</tr>
</tbody>
</table>

Study Area and Data

- Soil Moisture states are simulated using the Variable Infiltration Capacity (VIC).
- VIC was run with a spatial resolution of 1/8 over the CONUS at a daily time step over the period of 1979 to 2015.
- The VIC model is forced with surface meteorological data which were obtained from the Phase II North American Land Data Assimilation System (NLDAS-2) (Xia et al., 2012).

Discussion and Conclusion

- This study focuses its attention on probabilistic evaluations and aims at assessing the response of a watershed to an ongoing drought.
- This assessment is performed both in time, by studying the sensitivity of the responses to the season, and in space, by studying the sensitivity of the responses to the geographical location of the watershed.
- The droughts in the western US may persist (or become worse) while the eastern may retreat/recover.
- Exceptional droughts in the West may not retreat by the next season.
- Probability of drought recovery in the West in general is less significant than the East implying the potential of longer drought episodes in the West than the East.

Verification

- In order to verify the results, we assessed the performance of our method in detecting the CONUS historical drought of 2012 in the Great Plains, the US Drought Monitor reported that in the first week of July 2012, near 78% of the CONUS was under D0-D4 drought reaching to 80% by the end of July and remained around 77% for the rest of the summer.
- To investigate the potential of the proposed method in detecting this drought, the VIC soil moisture simulations were accumulated over Feb-Apr to initialize the bi-variate copula and estimate the probability of D0-D4 drought in May-July (figure 9a).
- As seen in figure 9b, US Seasonal Drought Outlook clearly misses the drought of the Great Plains while our results assign more than 90% drought probability to the area.

References


Acknowledgement

- We use the root-zone soil moisture percentile to characterize drought.
- Drought intensity classifications are adopted from the National Drought Mitigation Center (NDMC), United States Drought Monitor (USDM).