Drought Indices - EO4SD CR SPEI index products
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Outline

1. Introduction to the service
2. Introduction to Drought Indices
3. EO4SD-CR Standardised Precipitation Evapotranspiration Index products
4. Interpretation of SPEI and Validation
1. Introduction
Introduction

- Drought can have a serious impact on health, agriculture, economies, energy and the environment
- An estimated 55 million people globally are affected by droughts every year
- Water scarcity impacts 40% of the world’s population, and as many as 700 million people are at-risk of being displaced as a result of drought by 2030
- The EO time-series data sets can build understanding about the scale of effects associated with different drought impacts
- Early food security assessments, contingency planning and emergency preparedness

Source: Pixnio
2. Introduction to Climate-based Drought Indices
Drought is a major cause of agricultural, economic and environmental damage.

Quantitative drought indices are the most widespread approach for drought analysis and monitoring.

Most of the early studies related to drought analysis and monitoring systems have been conducted using either:

- Palmer Drought Severity Index (PDSI)
- Standardised Precipitation Index (SPI)
Introduction to Climate-based Drought Indices

PDSI

- **Pros**
  - Based on the supply and demand concept of the water balance equation
  - Incorporates prior precipitation, moisture supply, runoff and evaporation demand at the surface level

- **Cons**
  - Fixed temporal scale
  - Autoregressive characteristic whereby index values are affected by the conditions up to four years in the past

Source: US National Oceanic and Atmospheric Administration (NOAA)
Introduction to Climate-based Drought Indices

SPI

- **Pros**
  - Comparable in time and space
  - Can be calculated at different time scales to monitor droughts with respect to different usable water resources

- **Cons**
  - Assumed that droughts are controlled only by the temporal variability in precipitation
  - Variation in temperature and potential evapotranspiration (PET) is not considered
Standardised Precipitation Evapotranspiration Index (SPEI)

- The SPEI combines
  - The sensitivity of PDSI to changes in evaporation demand (caused by temperature fluctuations and trends)
  - The multi-temporal nature of the SPI

- SPEI allows comparison of drought severity through time and space
- SPEI can measure drought severity according to its intensity and duration
- Multi-scalar characteristics enable identification of different drought types
- Statistically robust and easily calculated
SPEI

- The difference between the precipitation (P) and PET for the month $i$ is calculated:
  \[ D_i = P_i - PET_i \]

- Thornthwaite method used for estimating PET based on daily averaged temperatures and latitude.

- The latitude variable used to estimate the maximum amount of sunshine duration.

- $D_i$ provides a simple measure of the water surplus or deficit for the analysed month.
**SPEI**

- **Calculation steps**

Time series of $D_i$ values are obtained, aggregated at different time scales

Log-Logistic distribution is fit to $D_i$ time series for each grid point

The distribution PDF is transformed to Normal distribution and SPEI values are obtained as standardised values
3. EO4SD-CR Standardised Precipitation Evapotranspiration Index (SPEI) products
This service provides the monthly SPEI products from 1979 to 2020
- SPEI-6 (6 month time step)
- SPEI-9 (9 month time step)
- SPEI-12 (12 month time step)
- SPEI-18 (18 month time step)

Daily precipitation and temperature data obtained from the 5th generation of ECMWF atmospheric reanalyses (ERA5) 1979 to 2019

Spatial resolution: 0.25° × 0.25° Lat/Long

Spatial coverage: Global Land

Parameters:
- Log-Logistic distribution
- Thornthwaite method for PET
- Reference period 1981-2010
EO4SD-CR SPEI products

SPEI-18 visualisation on the EO4SD-CR platform explorer
EO4SD-CR SPEI products

SPEI time series for Mozambique, at 6 months and 18 months time scales
SPEI time series for Mozambique, at 6 months and 18 months time scales
EO4SD-CR SPEI products

SPEI-12 time series for Mozambique
4. Interpretation of SPEI and Validation
### SPEI classification

<table>
<thead>
<tr>
<th>Category</th>
<th>SPEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme wet</td>
<td>SPEI ≥ 2.0</td>
</tr>
<tr>
<td>Severe wet</td>
<td>1.5 ≤ SPEI &lt; 2</td>
</tr>
<tr>
<td>Moderate wet</td>
<td>1.0 ≤ SPEI &lt; 1.5</td>
</tr>
<tr>
<td>Normal</td>
<td>-1.0 &lt; SPEI &lt; 1.0</td>
</tr>
<tr>
<td>Moderate drought</td>
<td>-1.5 &lt; SPEI ≤ -1.0</td>
</tr>
<tr>
<td>Severe drought</td>
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</table>
Interpretation of SPEI and Validation

- **SPEI classification**

SPEI-18 time series for Mozambique (top) and Senegal (bottom)
Interpretation of SPEI and Validation

- Comparison with Global SPEI database

SPEI-12 time series for Mozambique, from EO4SD (top) and SPEIbase datasets (bottom)
Summary

- The SPEI combines the sensitivity of PDSI to changes in temperature with the multi-temporal nature of the SPI

- The SPEI fulfils the requirements of a drought index since its multi-scalar character enables identification of different drought types

- EO4SD-CR platform provides data access through explorer and API which enables integration into the stakeholders’ systems

- Copernicus data streams are free and open to the public and covered by an operational service guarantee for many years to come
References


