Standardized Precipitation Index tool for drought monitoring

- Examples from Slovenia -

Sabina Bokal

Drought Management Centre for Southeastern Europe, DMCSEE
Contents

- What is Standardized Precipitation Index?
- SPI characteristics
- SPI methodology
- Practical experience with SPI
- Is SPI appropriate tool for monitoring agricultural drought?
What is **Standardized Precipitation Index**?

- drought indices
- McKee – article in 1993
- most wide-spread use in practical drought monitoring
- “Lincoln Declaration on Drought Indices”
  (Workshop on indices and Early Warning Systems for Drought, University of Nebraska-Lincoln, December, 2009)

“SPI will characterize the **meteorological** drought around the world.”
SPI advantages / disadvantages

**ADVANTAGES**
- simple / input = precipitation
- describe drought on time scale
- standardization
- describe dry and wet periods in the same way
- independent from geographical position

**DISADVANTAGES**
- access to a long, reliable temporal time series
- meteorological drought
- short time periods (1,2 month) regions with low precipitations can give misleading SPI values
SPI - characteristics

amount of precipitation over a selected time period

- characteristics of specific drought event:
  - lead-time
  - duration
  - intensity

- different time scales
  - 1-month SPI:
    - short-term conditions
    - soil moisture
    - drought stress
  - 3-month SPI:
    - seasonal estimation of precipitation
    - overall crop yield
  - 6/12-month SPI:
    - impact on groundwater

<table>
<thead>
<tr>
<th>SPI value</th>
<th>Classification</th>
<th>Cumulative probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00 or more</td>
<td>Extremely wet</td>
<td>2.3</td>
</tr>
<tr>
<td>1.50 do 1.99</td>
<td>Very wet</td>
<td>0.4</td>
</tr>
<tr>
<td>1.00 do 1.49</td>
<td>Moderately wet</td>
<td>9.2</td>
</tr>
<tr>
<td>0 do 0.99</td>
<td>Mildly wet</td>
<td>34.1</td>
</tr>
<tr>
<td>0 do -0.99</td>
<td>Mild wet</td>
<td>34.1</td>
</tr>
<tr>
<td>-1 do -1.49</td>
<td>Moderate drought</td>
<td>9.2</td>
</tr>
<tr>
<td>-1.50 do -1.99</td>
<td>Severe drought</td>
<td>4.4</td>
</tr>
<tr>
<td>-2 or less</td>
<td>Extreme drought</td>
<td>2.3</td>
</tr>
</tbody>
</table>
SPI – methodology of SPI mapping

- Long, continuous time-series (at least 30 years)
- METEO office
- Data availability delay - in the middle of the following month
Use of SAGA GIS for spatial interpolation (kriging)

Technical instructions
Prepared for 1st DMCSEE-TCP training
Budapest, 25 February 2010
Environmental Agency of Slovenia

INTRODUCTION
SAGA (System for Automated Geoscientific Analyses) is free open-source software, designed for implementation of spatial algorithms and geospatial visualization. It was designed by University of Göttingen and further developed by University of Hamburg (see http://www.saga-gis.org). Although kriging algorithms, implemented within SAGA, lack some of features (flexible variogram fitting, cross validation) it can be used as tool for spatial interpolation of meteorological data, at least as first approximation. This document describes in practical manner steps to be taken in order to obtain maps of meteorological variables from point values (i.e. station measurements). As example, interpolation of Standardized Precipitation Index (SPI) is presented for Slovenia, however, procedure is not limited to this variable and can be implemented for any spatial unit and any cartesian coordinate system.

1. PREPARATION OF DATA
SAGA uses shapefile format for vector data (points, lines, polygons). Therefore, it would be easier if measurement data is prepared as shapefile that includes measurement values as point attributes. Since many database applications don’t support data output in shapefile format, easiest approach would be to prepare data in plain ASCII file. ASCII file should be organized in columns; among the columns, there have to be columns with X and Y coordinates; default is X as first column and Y as second column.

Another requirement is for columns to be separated with single TAB character. If that is not the case (i.e., if your file is comma delimited), you can use simple ASCII editor (such as Notepad) to replace commas with TAB character (easiest way to do so is to store TAB character on clipboard and paste it using Ctrl+V into Replace form of Notepad). First line should contain attribute names (please use X and Y for both coordinates)
Practical experience with SPI
Drought development in 2006

- 20,998 people involved
- 139 municipality
- 178,296.78 ha
- 25% of the area + two month
- Very intensive
- 42,395,720 € damage

Yearly structural damage due to natural hazards

Red areas = >90 €/ha

Yield damage
SPI development in 2006 (SPI calculated on 30.9.2006)

- SPI1 (sep)
- SPI2 (sep, avg)
- SPI3 (sep-jul)
- SPI6 (apr-sep)

SPI values and categories:

<table>
<thead>
<tr>
<th>SPI Value Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00 or more</td>
<td>Extremely wet</td>
</tr>
<tr>
<td>1.50 do 1.99</td>
<td>Very wet</td>
</tr>
<tr>
<td>1.00 do 1.49</td>
<td>Moderately wet</td>
</tr>
<tr>
<td>0 do 0.99</td>
<td>Mildly wet</td>
</tr>
<tr>
<td>0 do -0.99</td>
<td>Mildly wet</td>
</tr>
<tr>
<td>-1 do -1.49</td>
<td>Moderate drought</td>
</tr>
<tr>
<td>-1.50 do -1.99</td>
<td>Severe drought</td>
</tr>
<tr>
<td>-2 or less</td>
<td>Extreme drought</td>
</tr>
</tbody>
</table>
3-month SPI calculated on different dates

<table>
<thead>
<tr>
<th>SPI value</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00 or more</td>
<td>Extremely wet</td>
</tr>
<tr>
<td>1.50 do 1.99</td>
<td>Very wet</td>
</tr>
<tr>
<td>1.00 do 1.49</td>
<td>Moderately wet</td>
</tr>
<tr>
<td>0 do 0.99</td>
<td>Mildly wet</td>
</tr>
<tr>
<td>0 do -0.99</td>
<td>Mild wet</td>
</tr>
<tr>
<td>-1 do -1.49</td>
<td>Moderate drought</td>
</tr>
<tr>
<td>-1.50 do -1.99</td>
<td>Severe drought</td>
</tr>
<tr>
<td>-2 or less</td>
<td>Extreme drought</td>
</tr>
</tbody>
</table>
Is SPI appropriate tool for monitoring agricultural drought?

- water balance
- yield decrease
Water balance from 1.6. – 31.7.2006

2-month SPI (June – July)

**Water balance** = absolute values

**SPI** = in comparison with long-term average

Year with extreme dry areas
Drought analysis using SPI

Data available for drought verification:
- bulletin
- archive
- statistical reports
- yield reports
- agrometeorological reports
- damage estimation

Identification of drought severity

Red = more than 50% of all agricultural areas in municipality was damage

Share of damage agricultural areas

Spatial distribution of SPI

Temporal distribution of SPI
SO ... let’s now answer the question...

SPI is appropriate tool for monitoring agricultural drought ...

BUT ... in combination with other information: water balance, crop condition, ...