SPI as an indicator of drought in South Bulgaria

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in

López-Francos A. (comp.), López-Francos A. (collab.).
Economics of drought and drought preparedness in a climate change context

Zaragoza : CIHEAM / FAO / ICARDA / GDAR / CEIGRAM / MARM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 95

2010
pages 113-115

SPI as an indicator of drought in South Bulgaria

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Abstract. During the last years an increase of the number of extreme natural events has been observed all over the world. Drought in Southeastern Europe is among the extreme events, which might have significant negative impacts on most socio-economic sectors. Drought in Bulgaria is in details assessed in the country, but being a problem of vital importance, is continuously considered with enhanced attention. 50 years time series of precipitation, collected from 20 weather stations located in the plain regions of South Bulgaria are used for SPI calculation with the purpose to detect drought periods and intensity. Some trends in drought frequency are analyzed. This study is implemented under the activities of the Drought Management Center for Southeastern Europe.

Keywords. Drought – SPI – Bulgaria – Precipitation.

Le SPI comme indicateur de sécheresse dans le Sud de la Bulgarie

Résumé. *Pendant des années on a observé partout dans le monde une augmentation du nombre d'événements naturels extrêmes. La sécheresse en Europe du Sud-Est est parmi les événements extrêmes, qui pourraient avoir une considérable influence négative sur les secteurs les plus socio-économiques. La sécheresse en Bulgarie est évaluée en détail, mais étant un problème d'importance essentielle, elle est toujours observée avec une attention grandissante. Des séries de précipitations pour une période de 50 ans, collectées pour 20 stations météorologiques situées dans les régions plates de la Bulgarie du Sud sont employées pour le calcul de SPI afin de détecter les périodes et l'intensité de la sécheresse. Quelques tendances de sa fréquence sont analysées. Cette étude est mise en place au titre des activités menées par le Centre de Gestion de la Sécheresse pour l'Europe du Sud-Est.*

Mots-clés. *Sécheresse – SPI – Bulgarie – Précipitations.*

I – Introduction

Drought in Southeastern Europe is among the extreme events that might have significant negative impacts on the most socio-economic sectors. Droughts occur as a result of precipitation deficit. Different definitions for drought are given in the literature with respect of their effects. Meteorological, agricultural and hydrological drought definitions are among the most common ones. McKee *et al.* (1993) developed the Standardized Precipitation Index (SPI) for the purpose of defining and monitoring drought. The nature of the SPI allows an analyst to determine the rarity of droughts or of anomalously wet events at a particular time scale for any location in the world that has precipitation records. Being located in Southeast part of Balkan Peninsula, Bulgaria is exposed to high risk of drought events occurrence.

A large number of drought periods were detected in the past by scientists using different methods. SPI is a possibility for assessment of anomalies using only precipitation records.

II – Materials and methods

Fifty eight years time series of daily precipitation amounts, collected from 20 weather stations located in the plain regions of South Bulgaria are used. The SPI was calculated daily for 1, 2 and 3 months time scale. The SPI was determined using daily precipitation data which was

adjusted to z Gamma probability distribution, a necessary condition for SPI calculation (McKee *et al.*, 1993). Gamma distribution is well explained in the literature, and is described by the following equation:

$$G(x) = \frac{1}{\beta \ \Gamma(\alpha)} \int_0^x x^{\alpha-1} e^{-x/\beta} dx$$

where: G(x): cumulative probability; β: scale parameter; α: shape parameter; x: random variable (daily precipitation); Γ(α): gamma function.

Parameters α and β are estimated by:

$$\alpha = \frac{1}{4A}\left(1 + \sqrt{1 + \frac{4A}{3}}\right)$$

$$\beta = \frac{\bar{x}}{\alpha}$$

where

$$A = \ln(\bar{x}) - \frac{\sum \ln(x)}{n}$$

being n the number of observations.

The cumulative probability calculated from Gamma distribution was transposed to the equivalent cumulative probability of the normal distribution (zero mean and unit standard deviation), with the resulting z value being the SPI (McKee *et al.*, 1993).

The SPI values correspond to a standardization of gamma-transformed total precipitation values, therefore a SPI equal to zero implies that there was no deviation from mean rainfall value at the chosen time scale for the analyzed period. Positive values of SPI indicate that the precipitation is above the mean value and negative values of SPI indicate that precipitation is below the mean value.

III – Results and discussion

Figures 1 and 2 present the most common results for long term SPI calculation series (stations Sadovo and Sliven). The period from 1995 to 2005 is detected as a dry one with increased number of severe drought events.

Figure 3 presents a comparison of the frequencies of severe and extreme events occurrence in the current climate period (1961-2008) and in the last decade (1999-2008). The comparison shows an increasing number of drought events in the end of winter and early spring.

IV – Conclusions

SPI refers precipitation to a common reference level. Therefore, one can compare precipitation excess or deficit in various regions differing in precipitation. Comparison of SPI calculations results for 20 stations located in South Bulgaria detect same or close drought periods for most of stations.

The comparison of annual courses of the number of occurred extreme and severe drought events in the current climate period (1961-2008) and in the last decade shows an increased number of drought events in winter and early spring.

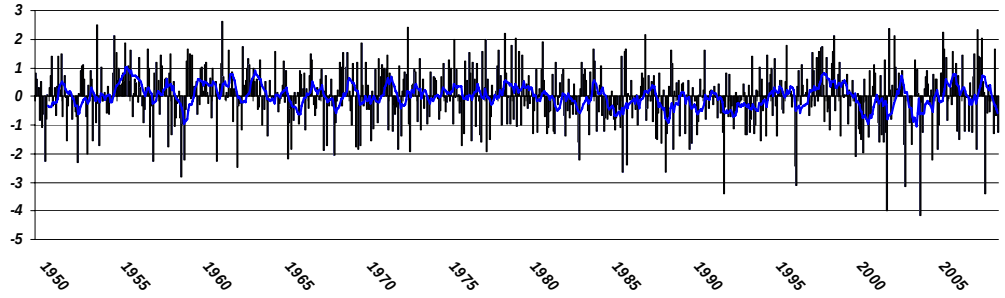

Fig. 1. Daily SPI for 1 month time scale. Station Sadovo.

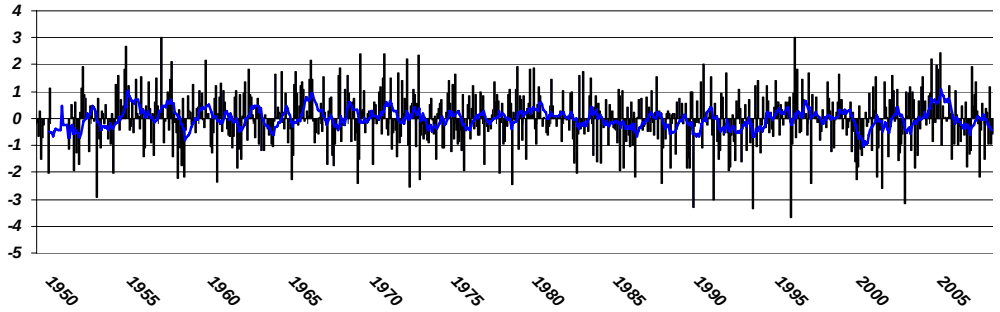

Fig. 2. Daily SPI for 1 month time scale. Station Sliven.

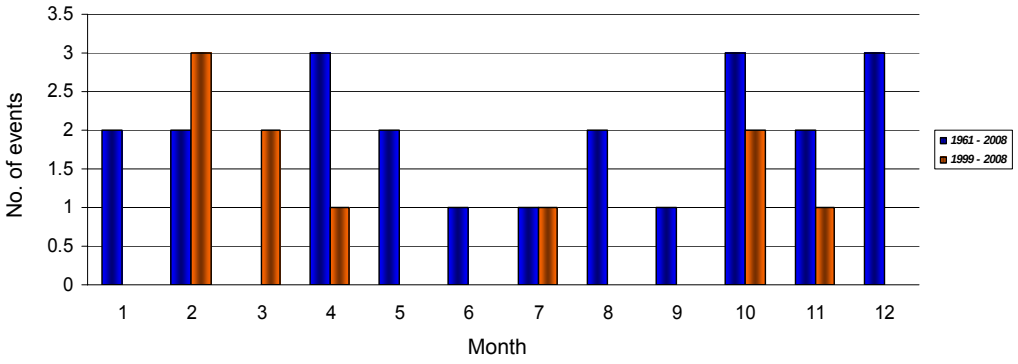

Fig. 3. Comparison of number of occurred severe and extreme drought event for the current climate period and the last decade. Station Kustendil.

References

McKee T.B., Doesken N.J. and Kleist J., 1993. The relationship of drought frequency and duration to time scale. In: *Proceedings 8th Conference of Applied Climatology*, Anaheim (CA), 17-22 January 1993, p. 179-184.