



Comparison of the performance of SPI, STI and SPEI for agricultural drought monitoring in Vojvodina region

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Drought is a complex phenomenon that can be a result of one or combination of interacting physical processes and its intensity and spatial extent is usually quantified by drought indices (DI). Numerous developed DI are based on one or multiple indicators, and it is a complex task to determine which index is the most appropriate and accurate for one particular region and certain type of drought.

Agricultural drought is the most complex of all types of drought and could be considered as a compound event of multiple variables such as temperature, precipitation, evapotranspiration, etc. Main consequence of agricultural drought is reduction of crop yields. Adequate monitoring and quantification of agricultural drought is of major importance especially for regions such as Vojvodina (North Serbia), whose economy is strongly depends on agriculture. Drought analyses should take into account all relevant meteorological variables that contribute to the development of the agricultural drought.

Drought monitoring in Vojvodina is often based on univariate indicators that consider precipitation or temperature alone. On the other side, numerous literatures suggest that univariate analysis may not be sufficient because drought phenomena are related to multiple variables and should be analyzed using multivariate indices.

Bearing in mind that the performance of DI varies according to the application and region, in this study we investigated and compared the performance of three well known DI (Standardized Precipitation Index-SPI, Standardized Temperature Index-STI, Standardized Precipitation Evapotranspiration Index-SPEI) in order to select the most suitable one for agricultural drought monitoring in Vojvodina. SPI is based only on precipitation, STI only on temperature, while SPEI is based on precipitation and temperature (evapotranspiration is calculated using Thornthwaite equation). In this study we compared DI with the average yields of some of the main crops in Vojvodina (cover nearly 60% of all arable land): maize, soybeans, sugar beet and alfalfa.

SPI/STI/SPEI indices were calculated at 1, 2 and 3 month lags during the main crop growth stages (May-August) in Vojvodina from 1971 to 2016. Series of indices were calculated based on data from 9 meteorological stations in the region and aggregated.

Besides climate, a change of crop yields over time depends on advances in agricultural technology. In order to eliminate the bias due to non-climatic factors, the yield was de-trended using linear regression and residuals of the de-trended series of the crop yields were used for analysis. Multiple regression analysis was used to estimate the drought-yield relationships, and de-trend yield series of crops were modeled as a function of four SPI/STI/SPEI series (May-August) at 1-3 month lag.

Results show that SPEI correlates better with de-trend yields than SPI and STI. The SPEI explained 40%-74% of de-trend yield variability and had stronger association with yields of analyzed crops during critical growth stages compared to SPI and STI. According to the obtained results, multivariate index SPEI is recommended for monitoring drought and the assessment of drought impact on agricultural production in Vojvodina region.

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