

Abstract

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In the context of a changing climate, drought and its consequences are among the greatest climate challenges in Slovakia, but also in many other parts of the world. One of the most well-known and widely used meteorological drought indices is the Standardized Precipitation Evapotranspiration Index (SPEI). SPEI is based on the normalized difference between precipitation and reference evapotranspiration. When calculating this index, several aspects can be modified, such as the reference period of the index, the length of the index, the method of calculating reference evapotranspiration, and the statistical distribution used to describe the difference between precipitation and reference evapotranspiration. The first part of the dissertation aims to analyse the suitability of different approaches for calculating SPEI and subsequently propose the most optimal method. This method will then be applied in the next part of the dissertation to analyze expected future drought changes in Slovakia based on outputs from regional climate models. The choice of statistical distribution is of fundamental importance in calculating the SPEI index. If the difference between precipitation and reference evapotranspiration is fitted using a Generalized Extreme Value (GEV) statistical distribution, it may lead to an increased number of cases where it is impossible to determine the distribution parameters due to input conditions. On the other hand, in comparison with the commonly used log-logistic distribution, applying the GEV distribution results in more accurate outcomes, particularly in the representation of extreme values. Testing the final SPEI values for normality in reference period of index and subsequently removing time series that do not follow a normal distribution is a useful complementary tool to improve the quality of the SPEI index. The normality test of SPEI capture inappropriately estimated statistical distributions of the difference between precipitation and reference evapotranspiration, and by removing values that do not meet normality, incorrectly estimated indices (especially in the area of extreme values) are also removed from the data sample. If outputs from regional climate models are used as input data for SPEI calculation, normality tests may also help identify potential systematic

errors in the climate model. In the next part of the study, based on regional climate model outputs, we determine the expected changes in reference evapotranspiration, the water balance, the frequency and intensity of drought events, and shifts in the seasonal distribution of drought in Slovakia by the end of the 21st century. Our analysis suggests that the annual sum of reference evapotranspiration will increase across the entire territory of Slovakia. Nevertheless, in areas above 400–500 meters above sea level, the difference between precipitation and reference evapotranspiration will increase in favor of wetter conditions. On the contrary, we expect the most significant drying in the south of central Slovakia, where, compared to the period 1991 – 2020, the annual difference between precipitation and reference evapotranspiration by the end of the century may be lower by an average of 65 mm (in the case of the RCP4.5 scenario) or 90 mm (in the case of the RCP8.5 scenario). In the Danubian Lowland and lower-lying areas of the southern half of central Slovakia, by the end of the 21st century, the frequency of 6-, 12-, and 24-month drought episodes is expected to increase by 10–20% compared to 1991 – 2020. Drought intensity in these regions will also increase, with the most significant drying occurring in spring and summer.

Key words: meteorological drought, SPEI, regional climate models, statistical distribution of water balance, meteorological extremes