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Evaluation of the accuracy of drought-related seasonal forecasts using large-scale hydrological modelling and drought indices

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Drought is one of the most severe weather-induced natural hazards, causing significant economic and environmental impacts to water and water-related systems. Drought indices can be used to monitor, manage and anticipate drought events and their undesired consequences. In this regard, large-scale hydrological models can provide drought indices to assess drought risks under a harmonized and integrated view, including meteorological, soil and hydrological processes. Moreover, seasonal forecasting of droughts can provide longer anticipation times than the application of drought indices to current and near past records.

In this study we take advantage of seasonal forecasts from large-scale hydrological models and generate drought indices for the anticipation of meteorological, agricultural (soil moisture) and hydrological droughts. Seasonal forecasts from the pan-European E-HYPE hydrological model, forced by bias□adjusted ECMWF SEAS5 forecasts, are employed. The analysis period is 1993-2015. A sample of 617 sub-basins from E-HYPE was chosen taking into account the different hydroclimatic regimes found in Europe. The variables considered are: precipitation and precipitation less than potential evapotranspiration (meteorological drought); soil moisture (agricultural drought); and streamflow (hydrological drought). For each variable, different probability distributions are tested and the most suitable one is selected using a two-step automatic procedure programmed in Python. Firstly, the theoretical function for each variable with the best fit to the empirical distribution is selected using the sum of squares method, the Kolmogorov-Smirnov test and the QQ-plot. Afterwards, the fitting of the tails of the distribution is evaluated by the D'Agostino's K-squared, Shapiro and Wilcoxon tests. In case of a failure in fitting the tails, the fitting of the distribution is re-calculated. The selected probability distribution is further used to compute the standardized drought indices (SPI and SPEI for meteorological, SSMI for agricultural, and SSI for hydrological droughts) at the monthly scale, with temporal aggregations of 1, 3, 6 and 12 months for the historical period. Afterwards, seasonal drought index forecasts are calculated for each initialization month, lead month, and temporal aggregation.

The skill of these forecasts is evaluated with respect to the modelled variables using the Absolute Mean Error (MAE) and the Continuous Ranked Probability Score (CRPS). The results show how the predictability of droughts changes across drought type, hydroclimatic regime, temporal

aggregation and lead month.

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