

An Asymmetric Composite Index for Agricultural Drought Monitoring across Central Europe

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Abstract

Agricultural drought assessment in central Europe is increasingly challenged by climate driven compound events such as heatwaves and droughts. The non-linear interaction of heat-driven dryness with precipitation and vegetation is often overlooked by simple drought indices. From this perspective, our study proposed an asymmetric improvement in already existing Temperature–Vegetation–Precipitation Dryness Index (TVPDI). Monthly skin temperature (Ts) , precipitation sums (P) from ERA-5-Land, and Normalized Difference Vegetation Index (NDVI) from MODIS were normalized using long term (2001–2022) month-specific climatology and aggregated to a 1 km grid. The impact based asymmetric weightings were applied by predicting yield anomaly of wheat, maize, and barley at national scale using machine learning based ridge regression. Afterwards, the asymmetric TVPDI was spatiotemporally aggregated for the growing season of wheat, maize, and barley masked on high resolution crop specific agricultural land use. Research findings quantified droughts extent and severity using defined thresholds. Asymmetric TVPDI captured severe to extreme cyclic droughts across central Europe in 2003, 2015, 2018 to 2020, and 2022 with pronounced spatial heterogeneity at sub-national scale. Finally, spatial correlation of asymmetric TVPDI with ERA-5-Land volumetric soil moisture proved the robustness of composite index for improved drought's monitoring across central Europe.

Keywords: Asymmetric TVPDI, Ridge regression, Crop specific drought, Central Europe