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Spatial analysis of extreme precipitation deficit as an index for atmospheric drought in Belgium

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The growing concern among the climate scientists is that the frequency of weather extremes will increase as a result of climate change. European society, for example, is particularly vulnerable to changes in the frequency and intensity of extreme events such as heat waves, heavy precipitation, droughts, and wind storms, as seen in recent years [1,2]. A more than 50% of the land is occupied by managed ecosystem (agriculture, forestry) in Belgium. Moreover, among the many extreme weather conditions, drought counts to have a substantial impact on the agriculture and ecosystem of the affected region, because its most immediate consequence is a fall in crop production. Besides the technological advances, a reliable estimation of weather conditions plays a crucial role in improving the agricultural productivity. The above mentioned reasons provide a strong motivation for a research on the drought and its impacts on the economical and agricultural aspects in Belgium. The main purpose of the presented work is to map atmospheric drought Return-Levels (RL), as first insight for agricultural drought, employing spatial modelling approaches. The likelihood of future drought is studied on the basis of precipitation deficit indices for four vegetation types: water (W), grass (G), deciduous (D) and coniferous forests (C) is considered.

Extreme Value Theory (EVT) [3,4,5] as a branch of probability and statistics, is dedicated to characterize the behaviour of extreme observations. The tail behaviour of the EVT distributions provide important features about return levels. EVT distributions are applicable in many study areas such as: hydrology, environmental research and meteorology, insurance and finance. Spatial Generalized Extreme Value (GEV) distributions, as a branch of EVT, are applied to annual maxima of drought at 13 hydro-meteorological stations across Belgium. Superiority of the spatial GEV model is that a region can be modelled merging the individual time series of observations from isolated sites and using a common regression model based on climatological/geographical covariates. The behaviour of the fitted spatial GEV-distribution is heavy-tailed with $\gamma \approx 0.3$ over Belgium. A comparison between the RL-maps using GEV model and the ones obtained from Universal Kriging (UK) confirms the reliability of the spatial GEV model in explaining atmospheric drought in Belgium.

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