EGU22-2295
https://doi.org/10.5194/egusphere-egu22-2295
EGU General Assembly 2022

Two-dimensional analysis of the irrigation needs in Danubian Lowland in Slovakia

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A water shortage implies various adverse effects on agriculture and various other risks associated with the scale and duration of the rainfall deficit. Water scarcity and droughts directly impact the inhabitants and different economic sectors of a region that directly depend on water, such as agriculture, industry, energy, tourism, or transport.

Quantifying the expected probability characteristics of droughts assists in the planning and managing of water resources. The present work's authors described analyses from the perspective of irrigation system management and have performed a joint analysis of the severity and duration of the most important potential annual irrigation periods by a bivariate copula methodology. Basic climatic variables (temperature and precipitation) were used to determine the two derived variables that characterize dry and hot periods requiring irrigation in this work. Such a period is defined by its duration and the rainfall deficit with respect to the normal period (1960—1990). The hot and dry periods that lasted the longest for each year were identified. The duration was derived from the number of consecutive days with temperatures above 25°C. The hot period identified was extended by precipitation-free days before and after it. This variable is herein referred to as the maximum annual length of the potential irrigation period. The maximum yearly length of the potential irrigation periods and the corresponding rainfall deficit were inputs for a two-dimensional probability analysis by a copula methodology. The study was carried out on an agricultural area in Slovakia with a warm and relatively dry climate - the area of the Danubian Lowland around the municipality of Hurbanovo.

The results of this work indicate that in the context of the case study, the need for irrigation occurs very often. For example, every second year, a period can be expected in which temperatures above 25 °C occur. A dry period usually lasts one month with a moisture deficit of about 30 mm. Precipitation of 80 mm in such a period (which would be needed to maintain this limit) occurs with a probability in the upper quartile, i.e., it is scarce. Even more significant periods of drought can be expected, for example, with a five or 10-year return period. These phenomena result in considerable damage to agriculture yields, which, as is often declared in the domestic water management community, are more significant than the investment needed for the reliable maintenance or reconstruction of irrigation systems.