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Spatial analysis of return periods of hydrological drought of Nile River Basin

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The Nile River Basin has been vital source of water to Riparian countries in both upper and lower catchments of the Basin. However, the states in the lower catchment namely Sudan and Egypt have exploited this resource without significant competition from countries in the upper catchments in the past. Recently, due to population increase in the basin and climate change, there are some initiatives by Riparian States such as Ethiopia to use this vital water resource (e.g., for energy generation). Therefore, it is important to understand recurrent drought characteristics and its potential impacts on the water resource in the basin. Drought events in the Nile Basin have been extracted using run theory based on the Standardized Precipitation Evapotranspiration Index (SPEI) accumulated on the time scale of 12 months using CRU rainfall and evapotranspiration data, which covers the period 1901–2018. The drought events are characterized by four variables: duration, severity. Intensity and Inter-arrival time. The mean duration and severity of drought during the last 118 years over the Basin are generally short and moderate over upper catchments. Conversely, the mean duration various from 4 to 8 months and up to 14 months over the middle and lower catchments of the Basin respectively while the mean drought severity increases from -2 at upper catchment to -7 at lower catchment. Gamma, Weibull, Gamma and Exponential functions are then selected to describe the marginal distribution of severity, duration, intensity and inter-arrival time, respectively. The Gumbel–Hougaard Copula was used to construct the joint distribution of duration, severity, intensity and/or inter-arrival time. The results indicate that the return period is dependent on the location within the basin, variable type and the combination of variables. For extreme droughts with severity index of -10 and duration of 14 months, return periods are longer than 40 years over south parts of the Basin and it barely exceeds 25 years over northern parts of the Basin. Generally, the short return period is mainly distributed in lower catchments of the Basin. This study on the identification of spatial distributions of drought return periods across the Basin is therefore important for drought mitigation and strategic planning on the water resource.