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Assessment of bio-physical drought hazards. A case study of Karkheh River basin in Iran

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Iran has been affected by frequent droughts. Climate change is expected to intensify the situation in the future. Extreme drought events have had serious impacts on hydrological and agricultural sector. Thus, identification of bio-physical drought hazard is critically important for formulating effective adaptive measures to improve water and food security. This study aims to investigate temporal and spatial pattern of drought hazards in meteorological, hydrological, and agricultural (inclusively biophysical) sectors in the Karkheh River Basin of Iran in the historical and future climate change context. To do so, drought hazard indices were built based on the severity and frequency of standardized precipitation index (SPI), standardized runoff index (SRI), and standardized soil moisture index (SSMI), which represent the three aspects of drought hazards. Variables required for calculating these indices were obtained from SWAT (Soil and Water Assessment Tool) model constructed for the basin. The model was calibrated based on monthly runoff using the Sequential Uncertainty Fitting (SUFI-2) algorithm in SWAT-CUP. Based on the climate variability and drought analysis, three drought hazard classes, namely low, medium and high, were defined. This help identify how agricultural and hydrological sectors are related to meteorological droughts. Additionally, the bio-physical drivers of drought hazards were identified for each class. Comparing the results during historic and future scenarios revealed that the frequency of high- severity hazards will increase, whereas the same is not predicted for the area with medium hazard intensity. Inferred from findings of this study, the combined application of the SWAT model with bio-physical drought hazard concept helps better understanding of climate risks to water and food security. The developed approach is replicable at different scales to provide a robust planning tool for policy makers.