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Towards developing drought impact functions to advance drought monitoring and early warning

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In natural hazard analysis, damage functions (also referred to as vulnerability or susceptibility functions) relate hazard intensity to the negative effects of the hazard event, often expressed as damage ratio or monetary loss. While damage functions for floods and seismic hazards have gained considerable attention, there is little knowledge on how drought intensity translates into ecological and socioeconomic impacts. One reason for this is the multifaceted nature of drought affecting different domains of the hydrological cycle and different sectors of human activity (for example, recognizing meteorological – agricultural – hydrological – socioeconomic drought) leading to a wide range of drought impacts. Moreover, drought impacts are often non-structural and hard to quantify or monetarize (e.g. impaired navigability of streams, bans on domestic water use, increased mortality of aquatic species). Knowledge on the relationship between drought intensity and drought impacts, i.e. negative environmental, economic or social effects experienced under drought conditions, however, is vital to identify critical thresholds for drought impact occurrence. Such information may help to improve drought monitoring and early warning (M&EW), one goal of the international DrIVER project (Drought Impacts: Vulnerability thresholds in monitoring and Early-warning Research). The aim of this study is to test the feasibility of designing "drought impact functions" for case study areas in Europe (Germany and UK) and the United States to derive thresholds meaningful for drought impact occurrence; to account for the multidimensionality of drought impacts, we use the broader term "drought impact function" over "damage function". First steps towards developing empirical drought impact functions are (1) to identify meaningful indicators characterizing the hazard intensity (e.g. indicators expressing a precipitation or streamflow deficit), (2) to identify suitable variables representing impacts, damage, or loss due to drought, and (3) to test different statistical models to link drought intensity with drought impact information to derive meaningful thresholds. While the focus regarding drought impact variables lies on text-based impact reports from the European Drought Impact report Inventory (EDII) and the US Drought Impact Reporter (DIR), the information gain through exploiting other variables such as agricultural yield statistics and remotely sensed vegetation indices is explored. First results reveal interesting insights into the complex relationship between drought indicators and impacts and highlight differences among drought impact variables and geographies. Although a simple intensity threshold evoking specific drought impacts cannot be identified, developing drought impact functions helps to elucidate how drought conditions relate to ecological or socioeconomic impacts. Such knowledge may provide guidance for inferring meaningful triggers for drought M&EW and could have potential for a wide range of drought management applications (for example, building drought scenarios for testing the resilience of drought plans or water supply systems).