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Delayed soil-moisture and hydrological drought impacts in mountain regions

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Droughts are among the most damaging natural hazards leading to a wide range of impacts also in the water-rich mountain regions. In recent years, drought conditions and impacts have been reported frequently in the European Alpine region, possibly because climate change affects mountain environments more rapidly than others. However, in mountain regions the propagation of drought signals through the hydrological cycle and into different environmental and societal impact occurrence are poorly understood, especially regarding the impacts' seasonal patterns and delayed effects. This study aims to improve the understanding of the droughts' characteristics and their impacts from the high elevation headwater regions down to plateau and foothill areas. Specific climate conditions in high elevation regions determine an alpine environment, economy and society that differs from the pre-Alpine regions. Subsequently, impacts are expected to vary as well and indices for drought monitoring may have to be selected specifically for such a region. The European Drought Impact Report Inventory (EDII) compiles text-reports on negative drought impacts across Europe and classifies them into 15 categories with 108 subtypes. An updated version focusing on the 'Alpine Space' released as $EDII_{ALPS}$ V1.0 contains more than 3,200 reports about drought impacts. The most relevant categories are Agriculture and livestock farming and Public water supply. This data allowed an analysis of the seasonal patterns of drought impacts in several categories for four sub-regions in the Alpine Space: pre-Alpine vs. high-elevated region, Northern vs. Southern region. Assigning the impacts subtypes to drought type, soil-moisture drought (SMD impacts) and hydrological drought (HD impacts) allowed the derivation of smoothed seasonal "impact regimes". The peak of HD impacts occurred later in the year than the SMD impact peak, most clearly in the high-elevation region, with the latest increase of HD impacts in May and strongest decrease between November-December. This pattern is less clear for the Southern region. SMD indices and HD indices that may be used for monitoring and early warning need to be targeted to and tested for capturing these delays.