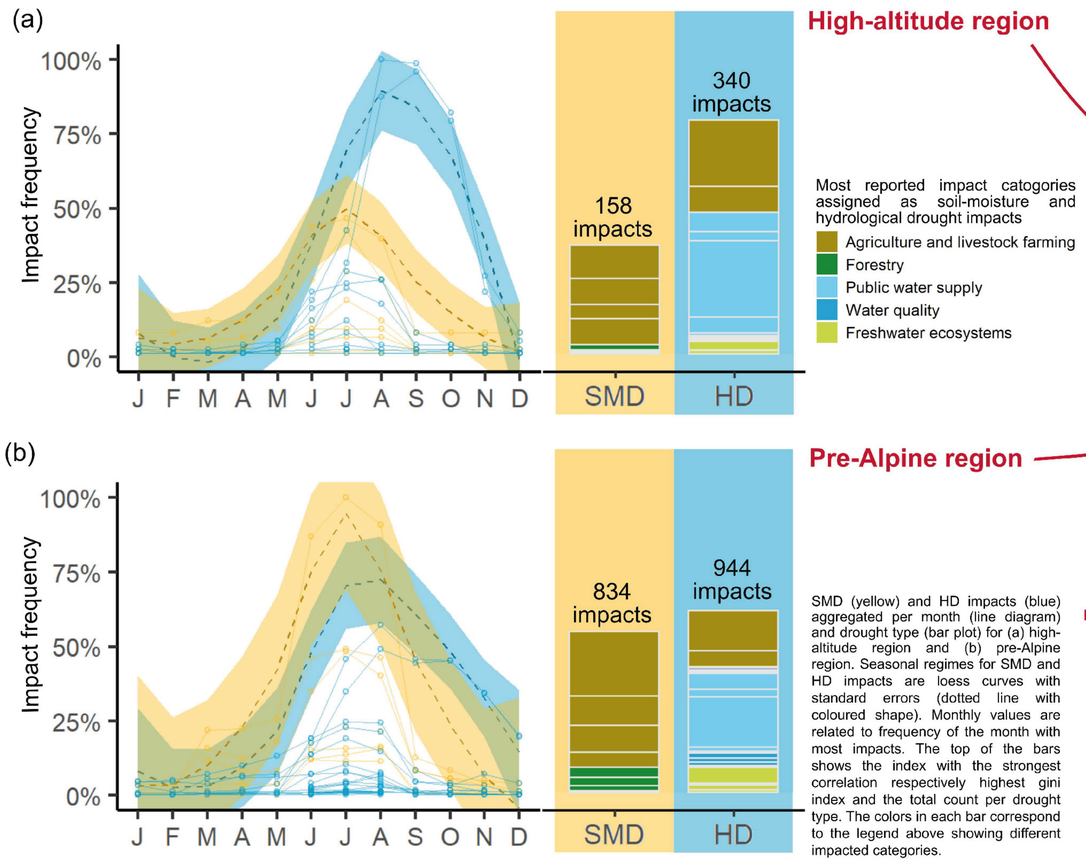
Delayed soil-moisture and hydrological drought impacts in mountain regions point to specific use of drought indices

UNI FREIBURG



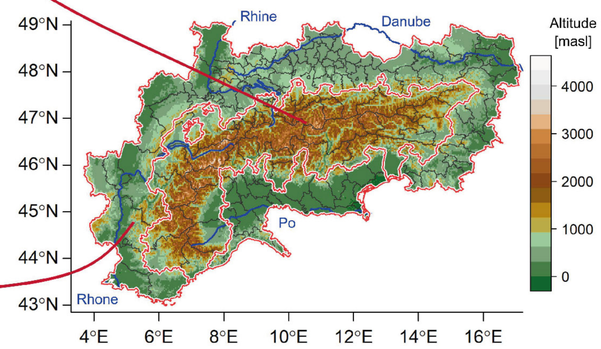
SMD (yellow) and HD impacts (blue) aggregated per month (line diagram) and drought type (bar plot) for (a) high-altitude region and (b) pre-Alpine region. Seasonal regimes for SMD and HD impacts are loess curves with standard errors (dotted line with coloured shape). Monthly values are related to frequency of the month with most impacts. The top of the bars shows the index with the strongest correlation respectively highest gini index and the total count per drought type. The colors in each bar correspond to the legend above showing different impacted categories.

METHODS

The Alpine Drought Impact Inventory ($EDII_{ALPS}$) compiles drought impacts across the *Alpine Space* from a variety of sources. $EDII_{ALPS}$ consists of more than 3,200 reported negative drought impacts georeferenced and classified in various categories. We split the *Alpine Space* in the high-altitude and pre-Alpine region in order to identify differences and assigned the impacts initiated by

- soil moisture drought (SMD) and
- hydrological drought (HD).

The gini index and spearmans' correlation were used to evaluate the drought impacts' association with meteorological drought indices.



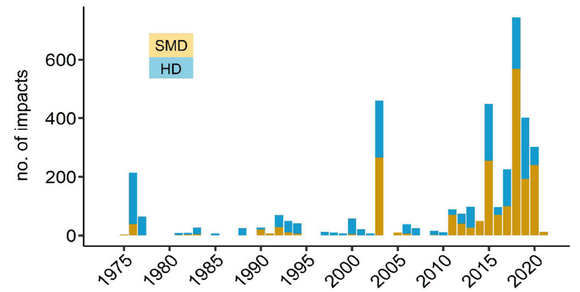
The *Alpine Space* study region within Europe for which $EDII_{ALPS}$ was developed showing the two subregions (a) high-altitude region and (b) pre-Alpine region.

RESULTS

A majority of SMD impacts were impacts on agriculture and livestock farming and a majority of HD impacts are impacts on public water supply. Whereas we found a similar amount of the two drought types' impacts in the pre-Alpine region, we present relatively more in the high-altitude region. Further, we identified different impact regimes over the year with a delayed increase and maximum of hydrological drought impacts for both regions.

The SPI and SPEI indices with the strongest correlation and the highest gini index are the ones with shorter accumulation periods for the SMD compared to the HD impacts - in both regions.

DISCUSSION



Total number of impacts from 1975 to 2020 for the whole Alpine Space assigned as SMD impacts (yellow) and HD impacts (blue).

The number of $EDII_{ALPS}$' impacts increased over time, especially after 2010. The drivers for this development have to be discussed. Are the records affected by an increasing occurence of drought or by the higher societal awareness? Or vice versa: Does the lack of reported impacts indicate no drought impacts or rather no reporting or collection of them? To better understand these effects on impact data respectively on the link to drought indices, we could test different counting methods and develop a parameter estimating general high awarness and reporting behaviour.

Further, other indices such as the *Soil Moisture Index* or *Vegetation Health Index* might explain better the drought impact occurrence as the applied meterological ones. Therefore, a broader set of indices needs to be tested.

Conclusion and Outlook

The $EDII_{ALPS}$' impacts can be assigned as soil-moisture drought and hydrological drought impacts showing seasonal and regional specifics of impact occurrence in mountain regions. The seasonality has to be adressed when using drought indices to predict different regional impacts. To obtain reliable predictors we need to understand societal effects on the impact data and include further indices that cover other aspects such as soil or plant conditions.

Ruth Stephan, Mathilde Erfurt, Kerstin Stahl

Environmental Hydrological Sytems, University of Freiburg
ruth.stephan@hydrology.uni-freiburg.de

*$EDII_{ALPS}$ Stephan et. al: *An Alpine Drought Impact Inventory to explore past droughts in a mountain region*, Nat. Hazards Earth Syst. Sci. Discuss. [preprint], in review, 2021, https://doi.org/10.5194/nhess-2021-24.

Interreg Alpine Space
Alpine Drought Observatory