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Meteorological risks are drivers of environmental innovation in agro-ecosystem management

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Agricultural crop production is to a great extent determined by weather conditions. The research hypothesis is that meteorological risks act as drivers of environmental innovation in agro-ecosystem management. The methodology comprised five major parts: the hazard, its impact on different agro-ecosystems, vulnerability, risk management and risk communication.

Generalized Extreme Value (GEV) theory was used to model annual maxima of meteorological variables based on a location-, scale- and shape-parameter that determine the center of the distribution, the deviation of the location-parameter and the upper tail decay, respectively. Spatial interpolation of GEV-derived return levels resulted in spatial temperature extremes, precipitation deficits and wet periods. The temporal overlap between extreme weather conditions and sensitive periods in the agro-ecosystem was realised using a bio-physically based modelling framework that couples phenology, a soil water balance and crop growth. 20-year return values for drought and waterlogging during different crop stages were related to arable yields. The method helped quantify agricultural production risks and rate both weather and crop-based agricultural insurance.

The spatial extent of vulnerability is developed on different layers of geo-information to include meteorology, soil-landscapes, crop cover and management. Vulnerability of agroecosystems was mapped based on rules set by experts' knowledge and implemented by Fuzzy Inference System modelling and Geographical Information System tools. The approach was applied for cropland vulnerability to heavy rain and grassland vulnerability to drought. The level of vulnerability and resilience of an agro-ecosystem was also determined by risk management which differed across sectors and farm types. A calibrated agro-economic model demonstrated a marked influence of climate adapted land allocation and crop management on individual utility.

The "chain of risk" approach allowed for investigating the hypothesis that meteorological risks act as drivers for agricultural innovation. Risk types were quantified in terms of probability and distribution, and further distinguished according to production type. Examples of strategies and options were provided at field, farm and policy level using different modelling methods.