Chair of Digital Agriculture
TUM School of Life Sciences

Munich RE

Master Thesis

Climate change impacts on return periods of extreme drought and rainfall events in the U.S. Corn Belt

This Master Thesis is announced in cooperation with Munich RE and the chair of Physical Geography and Nexus Research at LMU.

Background:
Extreme weather events such as droughts or excessive rainfall pose significant threats to agricultural producers, leading to reduced crop yields and financial instability. To mitigate these risks, many farmers (especially in the US) use agricultural insurances as a crucial risk management strategy.
For agricultural insurances to be sustainable and effective, (re)-insurers need detailed knowledge about current and future return periods of the insured extreme weather events. This knowledge allows (re)-insurers to set accurate premiums, ensuring coverage for claims and contributing to better risk management and resilience in the agricultural sector.

Start: Flexible, by agreement (From summer semester 2025 on)

Goals:
The goal of this master thesis is to identify historic return periods of one to two predefined extreme events:

- Large scale drought in the U.S. Corn Belt.
- Prevented planting event (due to excessive rainfall) in the U.S. Corn Belt.

Moreover, the goal is to assess the impacts of climate change on return periods of the above-mentioned events:

- What are the current best estimates of return periods?
- Are there trends indicating an increase or decrease in return periods historically?
- How are return periods projected to change in the future assuming a certain CO2 emission path, and how do they compare to current and historic return periods?

Recommended Research Approach

- Definition and identification of extreme events based on indices using e.g., temperature, precipitation, evapotranspiration, and soil moisture data (e.g., NOAA data). Events based on drought intensity comparable to the one of 2012 and rainfall intensity/amount comparable to the one of 2019.
- Analysis of correlations between extreme event definition and agricultural yield shortfalls.
- Analysis of the moment in time of an extreme event, as it is crucial to its potential harm for a crop (growing phase vs. pollination period of corn) based on literature reviews and data from Munich Re for most relevant crop types (e.g., corn and soybean).
- Sensitivity analysis regarding definition of extreme event and return period.
- Investigating different climate models (>3 ensemble) and emission scenarios (e.g., SSP 4.5) to derive current and future (specifically in 2030, 2040, and 2050) return periods of defined extreme events and their robustness.
- Identification of trends in historic, current, and future return periods.

Your profile:

- Proficient in analyzing empirical data, with expertise in data cleaning, statistical analysis, and graphical visualization using a scripting languages for statistical computing (e.g., Python, R, or MATLAB)Experience (or willingness to learn) working with geospatial data (e.g., NOAAdatasets) Strong interest in interpreting results within the context of agricultural insurance using beginner actuarial methods, such as distribution fitting and return period analysis
- Excellent verbal and written English communication skills, with a willingness to write the thesis in English
- Strong ability to prioritize tasks, manage deadlines, and work independently

Optional:

- Experience with insurance and risk modelling
- Experience with environmental/climate modeling

Contact person:

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