Quantifying Exposure to Extreme Weather Events Among Rural Communities and Agricultural Producers in Oklahoma

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Introduction

- Severe weather events pose several risks to the sustainability of communities, businesses, and institutions.
- Severe weather incident counts have increased in 2000-2020 as compared to the last 20 years of the 20th century.
- We aimed to explore the effects these events have on agricultural production and rural economies.

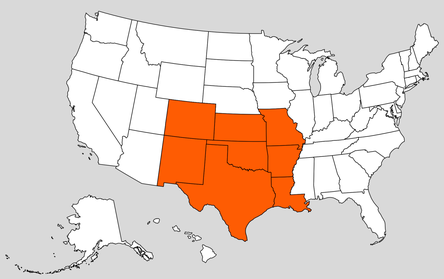
A first step is measuring the incidence and magnitude of severe weather hazards using a variety of data sources and approaches.

Data

- Years 2000 to 2021
- County level meteorological data was gathered from the NOAA's National Weather Service's (NWS) Storm Events Database.
- County level crop insurance data by loss type were obtained from the Cause of Loss (COL) Summary of Business available through the USDA Risk Management Agency's (RMA) website.
- RMA defines indemnity as "the total amount of the loss for the designated peril".[1]

Study Area

- Our eight-state study area consisted of Oklahoma, Texas, Kansas, Arkansas, New Mexico, Colorado, Missouri, and Louisiana.



Methodology

- Severe weather events were categorized as: **drought, excess moisture, heat and fire, spring and summer storms, and winter storms**.
- For each hazard category, weather events were quantified according to their meteorological severity and their impact on agricultural production.
- Loss severity was proxied by RMA Cause of Loss insurance indemnity amounts.
- We calculated an all-crops overall loss ratio by loss type and county, which was the indemnity amount over total premium.
- We multiplied each loss ratio by the total number of insured acres in that county and category to account for differences in production intensity across counties. Each measure was standardized to ensure comparability across indices.
- Z-score index values were calculated and visualized using geographic information systems (GIS) to visualize the highlight hazard exposure across counties within our eight-state study area.
- The end result is 10 indices. One for each of the five hazard categories and two hazard data sources (meteorology data and crop insurance loss data).

Finding 1: Data sources offer different measures of hazard damages and severity.

As shown in Figure 1 below, the two different data sources measure hazards differently. Each hazard index has unique potential applications depending on the question of interest. As seen on Figure 3, some counties are also *missing* data, which may affect the optimal source for a question.

Weather Event Types in "Winter Storms" Category

USDA RMA	NOAA Database	
• Cold Wet Weather • Cold Winter • Freeze • Frost • Ice Flow	• Winter Storm • Winter Weather • Heavy Snow • Extreme Cold/Wind Chill • Frost/Freeze • Blizzard	• Cold/Wind Chill • Ice Storm • Lake-Effect Snow • Sleet • Avalanche • Freezing Fog

Figure 1. Comparison of severe weather event categories between data sources

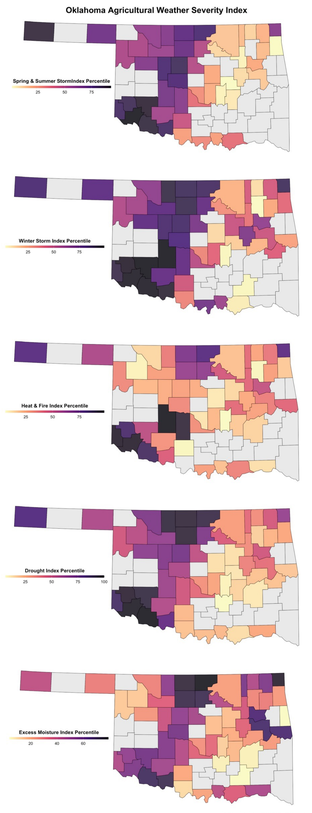


Figure 2. Z-score Percentiles for Five Hazard Categories

Finding 2. Some counties have greater weather hazard exposure across multiple categories.

In Figure 2, western Oklahoma counties have a greater vulnerability to most extreme weather events, but less expected are the pockets in the north-central and northeast part of the state.

Finding 3. Examining multiple indices illustrates the contrast between the agricultural and meteorological measures of hazard exposure.

In Figure 3, the two data sources offer different pictures of vulnerability. For example, in Map B urban areas are more prominently highlighted (using NOAA data), illustrating unintended statistical biases that arise from population density and measurement.

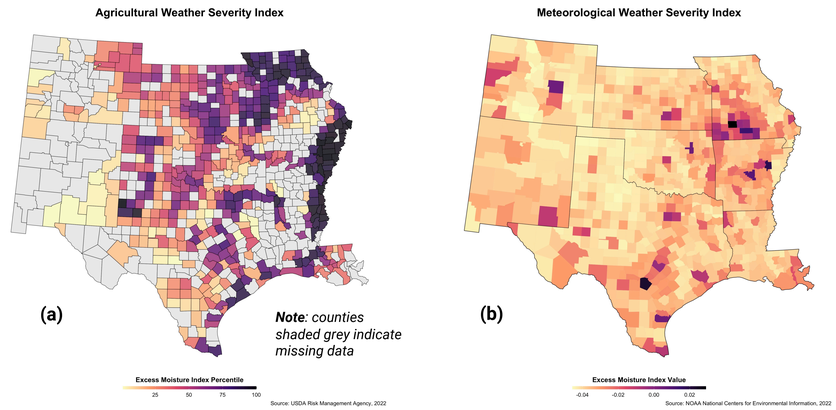


Figure 3. Z-score Percentiles Across all Hazard Types for COL data (a) and NOAA weather data (b)

Discussion and Future Research

- With a hazard index, studies of factors affecting vulnerability and resilience in rural community, business, and agricultural operations are possible. These two indices offer different types of information that can be used in vulnerability and resilience analysis.
- Future research will address factors affecting resilience in specific target counties in Oklahoma, based on the hazard index developed here.
- Additional studies on disaster program usage and crop insurance usage may also utilize these indices.

References

1. USDA Risk Management Agency. (2022). *Cause of Loss Historical Data Files: Cause of Loss Information – Summary of Business Data*. https://www.rma.usda.gov/-/media/RMA/Cause-Of-Loss/Summary-of-Business-with-Month-of-Loss/colsommonth_allyears-pdf.ashx.
2. NOAA National Centers for Environmental Information. (2022). *Storm Events Database*. https://www.ncdc.noaa.gov/stormevents/