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Spatially representing socio-cognitive and biophysical aspects of vulnerability to climate change: A study of Midwestern farmers

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Introduction

Upper Midwestern United States produces 70 percent of all U.S. corn and soybean:

- More than one-third of the global corn supply
- In 2015, an approximate value of $68 billion of corn and soybean was farmed in this region

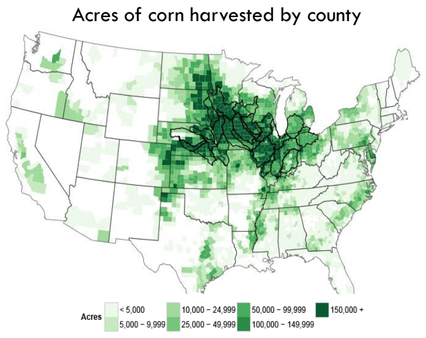
Climate change will increase heavy precipitation events, causing:

- Reduced crop productivity
- On-farm soil erosion and runoff
- Off-farm leaching of chemicals into streams and lakes

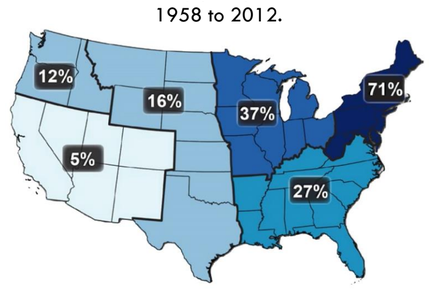
Given these projected trends, this research aims to explain:

- How biophysical and socio-cognitive elements can influence farmers' vulnerability to changes in the climate?
- How farm-level vulnerability can be aggregated to the county level? (useful for policy and planning purpose)

Acres of corn harvested by county



% increase in daily precipitation events from 1958 to 2012.

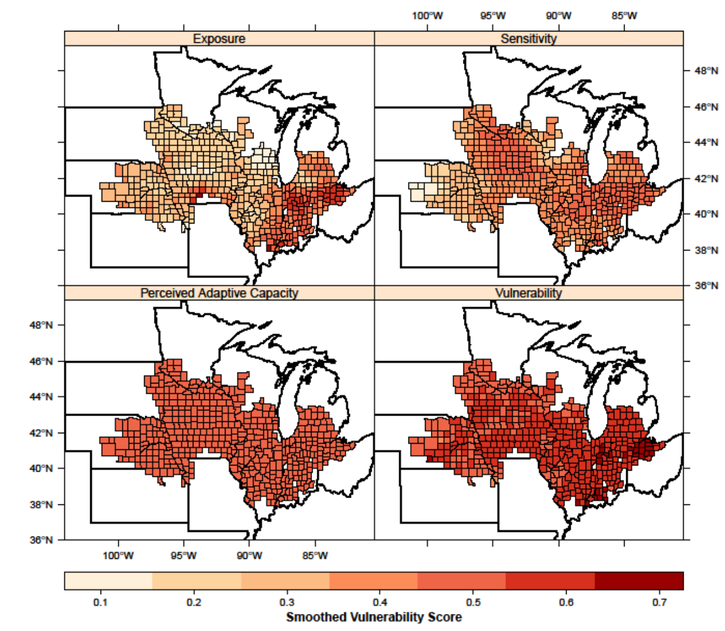


Source: NOAA, 2015

Source: USDA photo by Keith Weston

Results

Spatially Smoothed (a) Exposure, (b) Sensitivity, (c) Adaptive Capacity, and (d) Vulnerability



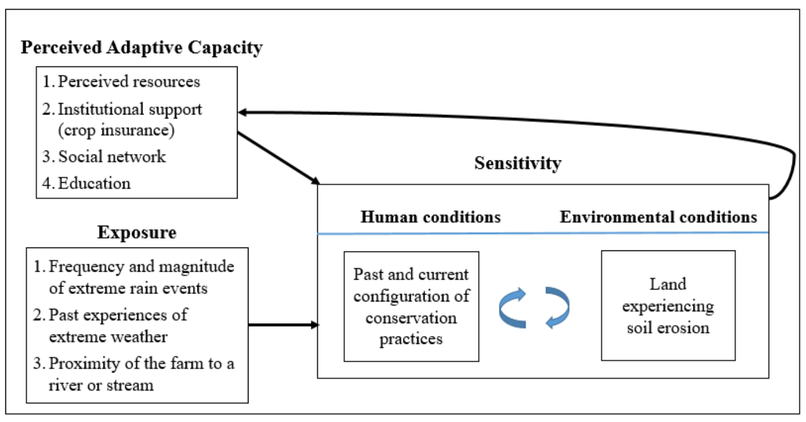
- Regional variations in landscape, with higher potential for soil erosion in some parts of the region.
- Fewer socio-cognitive differences between farmers within and between each county.

Materials and methods

Data:

- Survey: Stratified random sample mail survey of 4778 corn-soybean farmers from 11 Midwestern states.
- Soil: Soil Survey Geographic (SSURGO) database
- Climate Data: National Weather Service (NWS) Cooperative Observer (COOP)

Vulnerability = Exposure + Sensitivity – Adaptive Capacity



From farm to county-level measures of vulnerability:

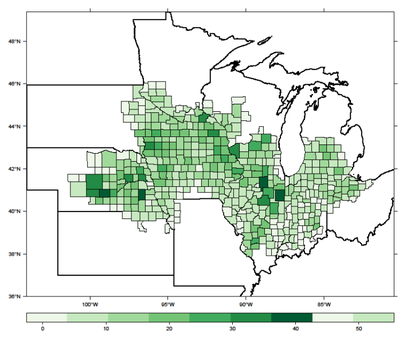
Problem:

- Geospatial coordinates not available (privacy reasons)
- Problem: Unequal sample size in county

Solution:

- Compute the county-level simple random sample variance
- Average, first quantile, and third quantile of vulnerability scores are calculated for each county, respectively
- Spatial smoothing using Conditional Autoregressive Modelling (CAR)

Study Sample (N = 4778)



Conclusions

- Constructing reliable estimates of vulnerabilities for small areas can allow policy makers and planners to spatially locate areas with low/high climate change vulnerabilities.
- Socio-cognitive elements are consequential for adaptation, especially if farmers systematically under-or-overestimate their own ability to adapt.
- Perceived climate risks should be understood in conjunction with objective risks.

Acknowledgements

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Literature cited

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