Validating an Adaptive Capacity Composite Index Through Empirical Sensitivity to Climate

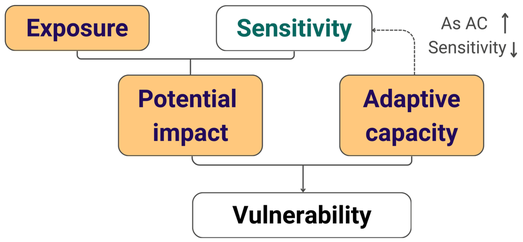
Denise Chavez, PhD Candidate[1*] · Katherine Nelson, PhD [1,2] · Sam Zipper, PhD [3,4]
[1] Kansas State University · [2] University of Missouri · [3] Kansas Geological Survey · [4] University of Kansas
*chavezd@ksu.edu

Problem:

Growing reliance on composite indicators to assess climate vulnerability, resilience, and adaptive capacity has raised concerns about their validity and real-world applicability. Many indices aggregate exposure, sensitivity, and adaptive capacity into a single measure, obscuring their distinct roles and theorized relationships.

Theoretical Framing:

Framework for assessing vulnerability to climate change adopted by the IPCC

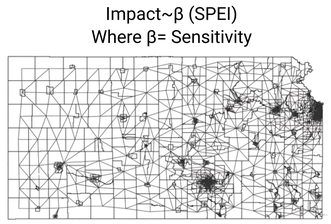


Source: Johnson & Welch, 2009

Objectives & Methods:

Obj 1: Estimate the sensitivity of observed impacts to drought conditions

Method: Geographically weighted panel regression (GWPR) established local effects (coefficients), accounting for spatial and temporal heterogeneity. Resulting coefficients represent the extent to which impacts, in terms of changes in the state of outcome variables, are associated with a unit change in exposure levels (sensitivity).



Obj 2: Explore the association between the adaptive capacity index and sensitivity estimates across space and time

(moving from theoretical causal links to characterization in real-world applications)

Method: Pearson Correlation & Bi-variate Map

Obj 3: Assess the construct validity of the adaptive capacity index

Method: Comparison between theoretical expectation and observed relationship

Where higher adaptive capacity should correspond to lower sensitivity while also incorporating confidence in the estimated sensitivity coefficients

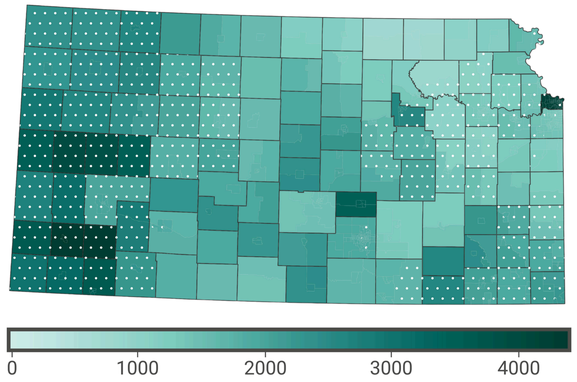
Data (source):

Exposure Data: 6-month Standard Precipitation Evapotranspiration Index (gridMET)
Impact Data: Crop indemnity data (USDA Risk Management Agency)
Adaptive Capacity Index: Details in paper (Chavez, Nelson, Zipper, 2026)

AC paper

Results:

Geographically weighted panel regression Crop Indemnity Sensitivity Coefficients



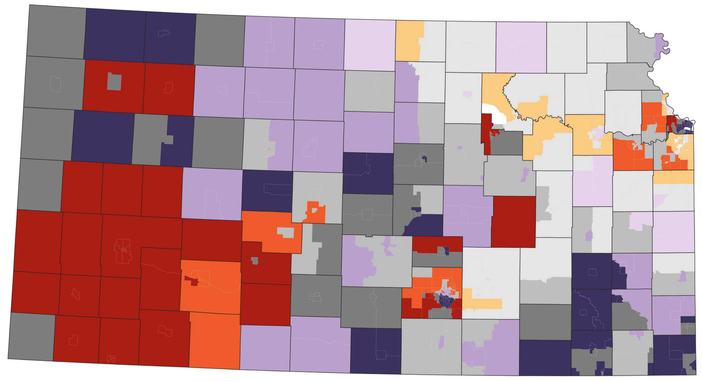
A **unit increase in the absolute value of SPEI-6** is associated with an **increase in crop indemnities** per planted acre ranging from $751 to $4,468, **depending on the county's agricultural landscape**.

Spatial visualization of geographically weighted panel regression coefficients capturing spatially heterogeneous sensitivity. White dots denote areas that had three or more drought years during the study period. The sensitivity coefficients for crop indemnity have been rescaled to indemnity per planted acress to aid interpretation.

Association between Crop Indemnity Sensitivity to |SPEI-6| and Adaptive Capacity

Correlations

State: -0.32**
Metro counties: -0.52**
Non-Metro counties: 0.44**
Farming counties: 0.59**
** p-values less than 0.001



Construct Validity of the Adaptive Capacity Index

By accounting for 1) the confidence in sensitivity coefficient (Expectation vs Observed), and 2) the theoretical expectation that higher adaptive capacity can reduce sensitivity (Theory vs Observed)

	Metro	Non-Metro	Farming
1. A unit increase deviation from normal climate (SPEI-6) would increase crop indemnities	✓	✓	✓
2. Higher adaptive capacity corresponds to lower sensitivity (negative correlations)	✓	✗	✗

Takeaways:

- Space matters, and sensitivity and adaptive capacity manifest differently across study areas.
- Localized sensitivity coefficients enable a place-based conceptualization vulnerability process.
- High adaptive capacity may coexist with high sensitivity, or be a response to high sensitivity, in systems that are deeply climate-dependent, such as agriculture.
- Challenges of validation as relationships are specific to not just exposure and outcome but also to context, and relationships can be bi-directional (sensitivity --> AC and AC --> sensitivity)