

# Quantitative approaches for assessing ecological and community resilience

Wen-Ching Chuang, Trisha Spanbauer, Tarsha Eason, Ahjond Garmestani

August 10, 2017

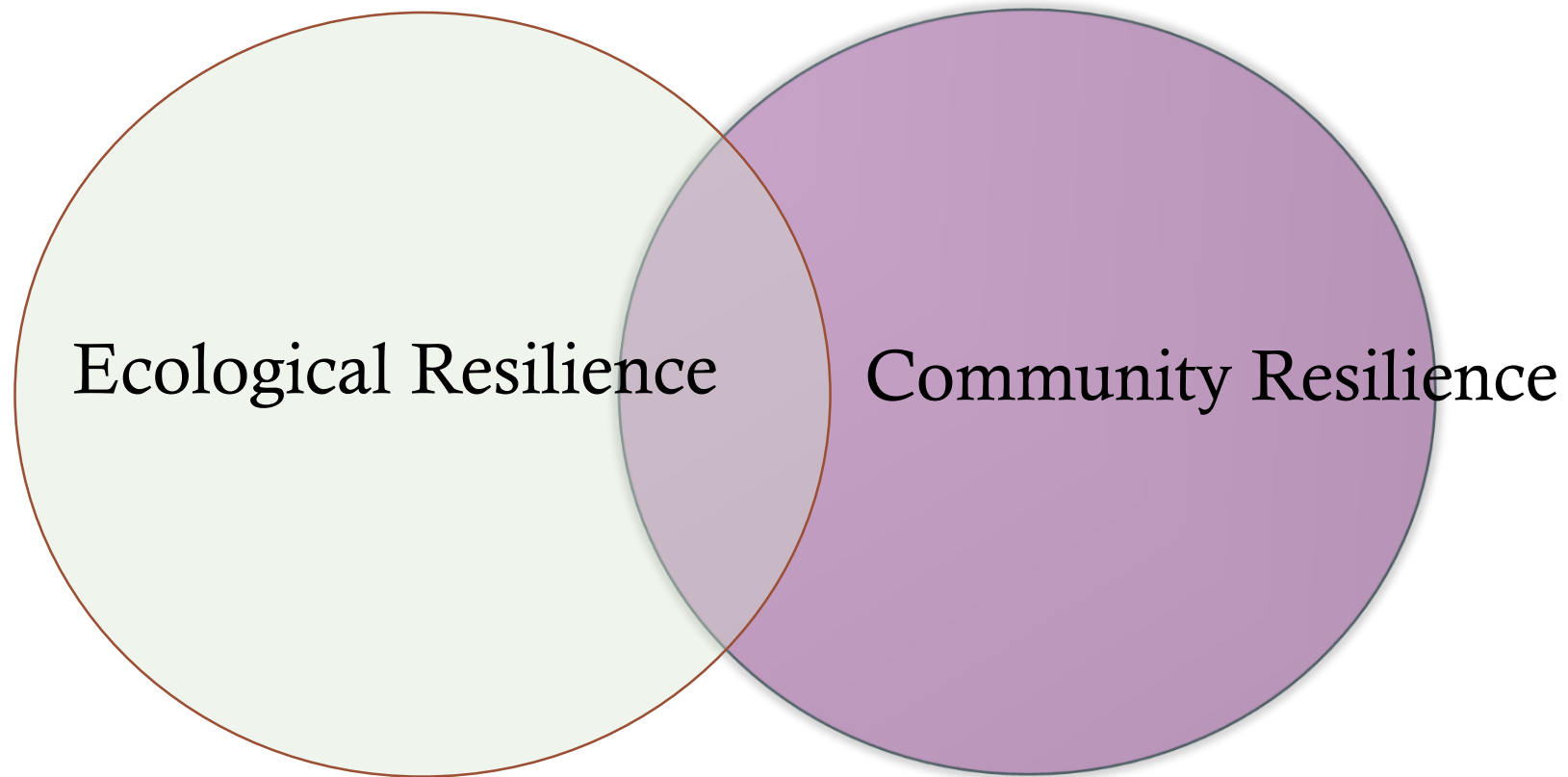
Ecological Society of America

# Talk format

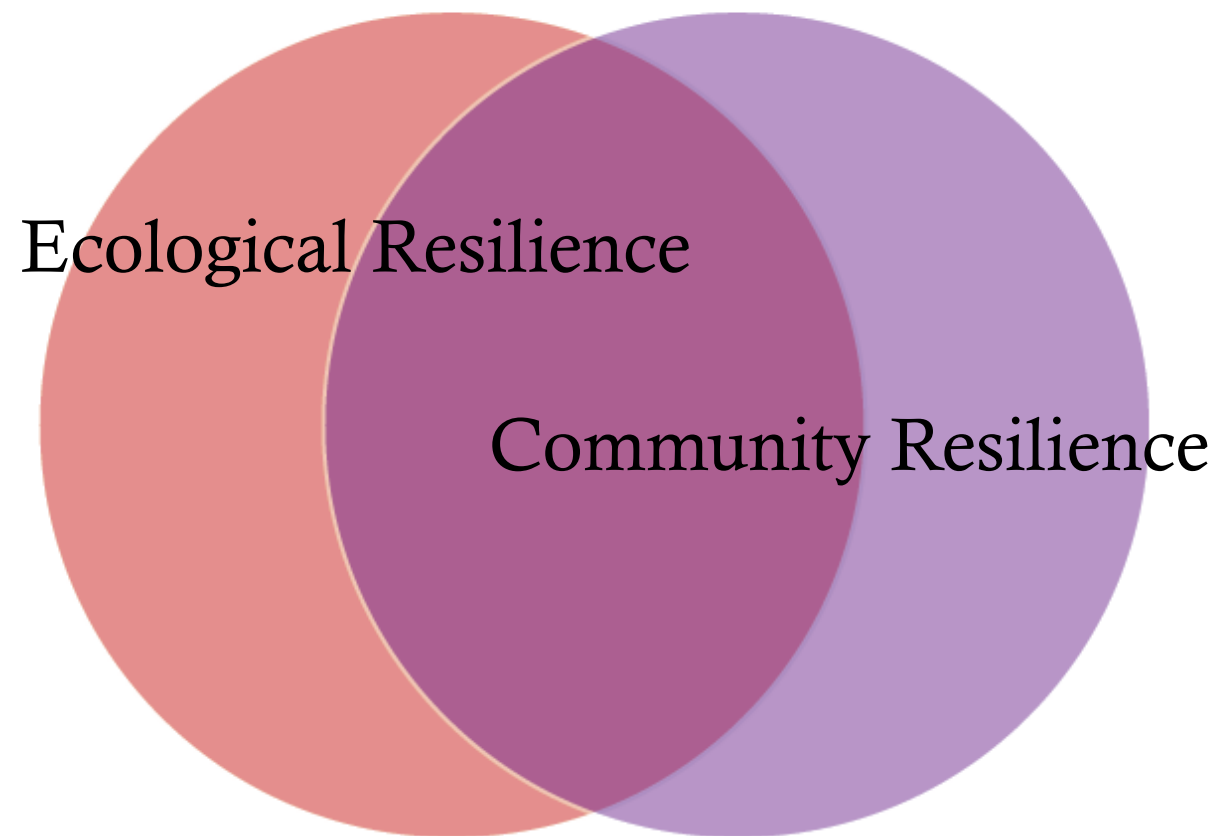
---

- Structure
  - Intro/Background
  - Ecological resilience
  - Community resilience
  - Discussion
  - Conclusion

# Introduction

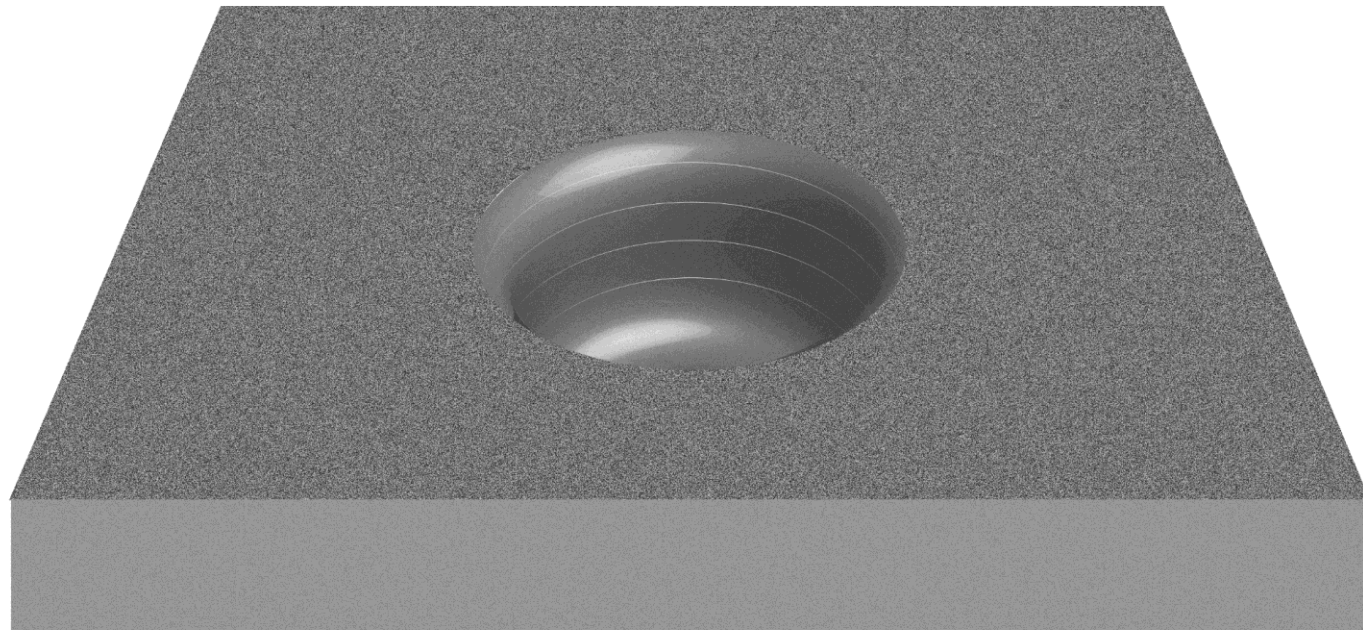


# Objectives



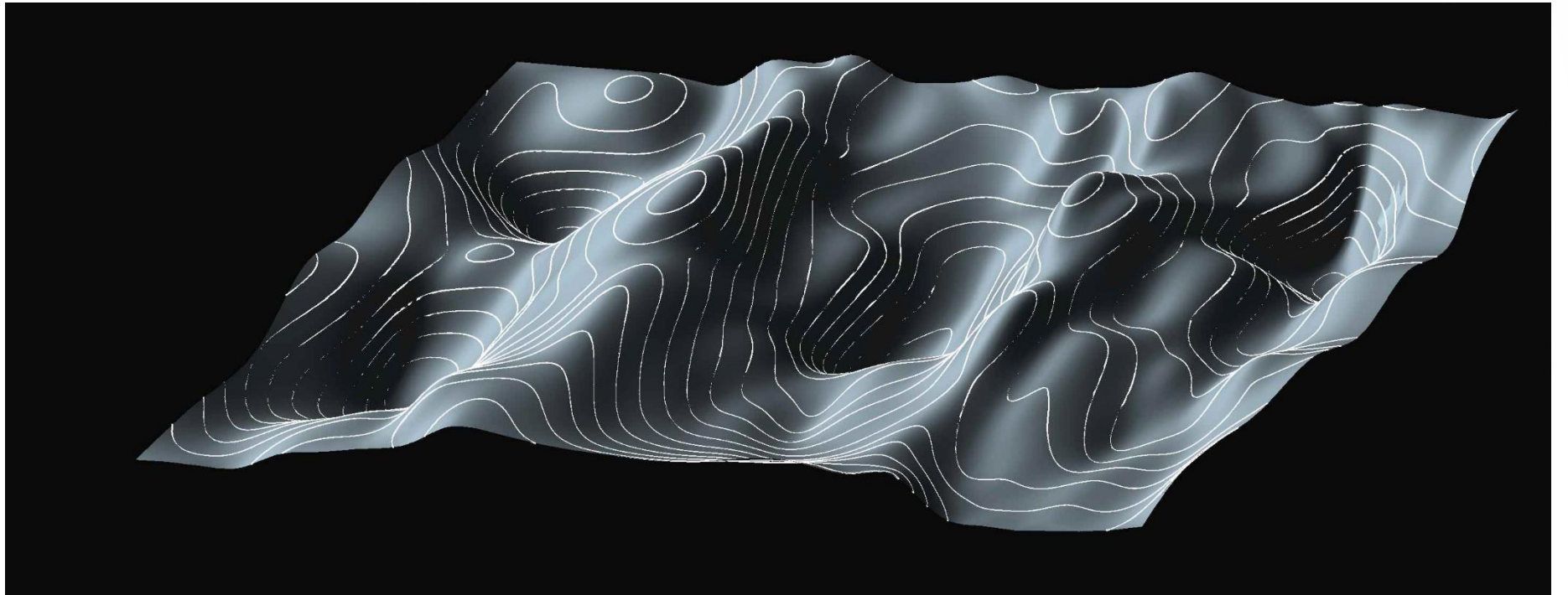
# Resilience

- Engineering resilience: Single basin



# Resilience

- Stability landscape



# Quantification of resilience

---

- Early warning signals (EWSs): CSD/Flickering
- Discontinuity hypothesis, cross-scale resilience, and time series modeling

# Quantification of resilience.

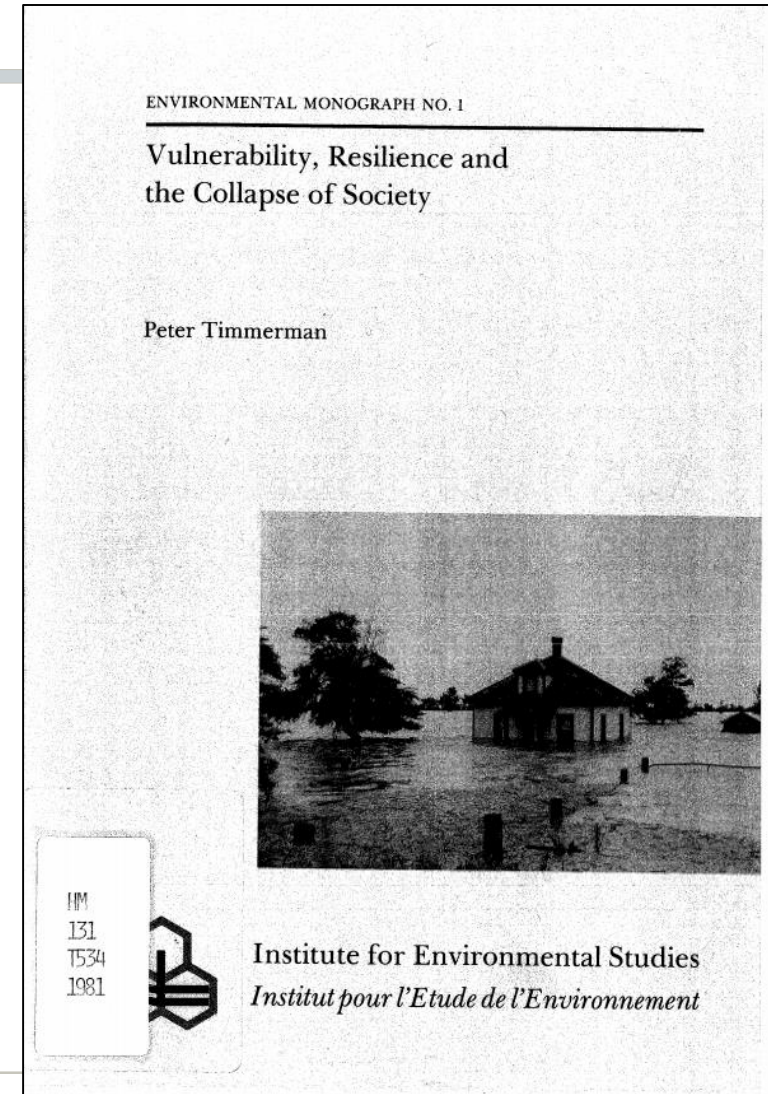
---

- Other
- Future



# Community resilience

“a system’s or parts of a system’s capacity to absorb and recover from the occurrence of a **hazardous event**”  
(Timmerman 1981)



# Community resilience: Multiple definitions



RESILIENCE MEANS *BOUNCING BACK*



**RESILIENCE** is the ability of communities to withstand and recover from disasters as well as to learn from past disasters to strengthen future response and recovery efforts.

## A RESILIENT COMMUNITY CAN

- 1 determine what it needs to reduce damage and to use its assets or resources wisely. The community is resourceful with what it has, no matter its condition or whether it has a lot of resources.
- 2 not only bounce back quickly, but take the opportunity to strengthen health, environmental, social and economic systems.
- 3 learn from past emergencies so that it can be better prepared for the next response.



relationships between organizations

Organizations are ready and prepared to respond and recover

There are enough volunteers to help in a disaster

People can rely on each other (neighbor to neighbor)

Individuals/families have the knowledge to prepare for and respond to disaster

Community resilience requires building neighbor to neighbor reliance and organizational connection

# Research approaches of community resilience

- Two research strands of human community resilience:
  - Psychological approach: psychological wellbeing at the individual level
  - Social-ecological approach: the capacity of a system to continually change and adapt, and yet remain within specific (desirable) regimes (Berkes and Ross 2012)



# Social ecological approach to community resilience

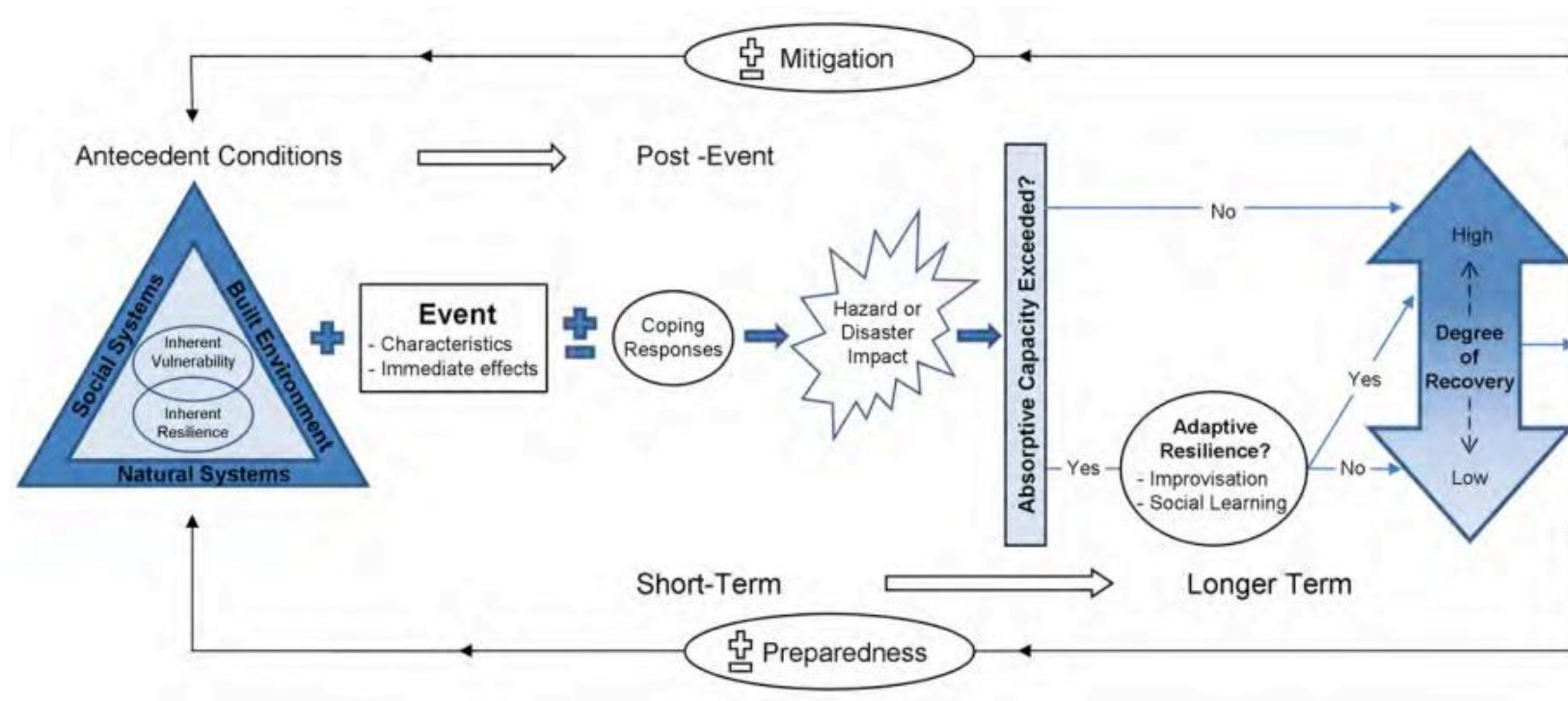
- “The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks.” (Walker et al. 2004)
- Social resilience: factors and linkages across organizational level that could damage, sustain, or promote a community’s livelihoods.
- Disaster resilience: a set of capacities and strategies for disaster readiness (Norris et al. 2008)

# Approaches for Assessing Community Resilience

- Conceptual Frameworks/Models
- Quantitative approaches
- Mixed-method approaches

# Approaches for Assessing Community Resilience

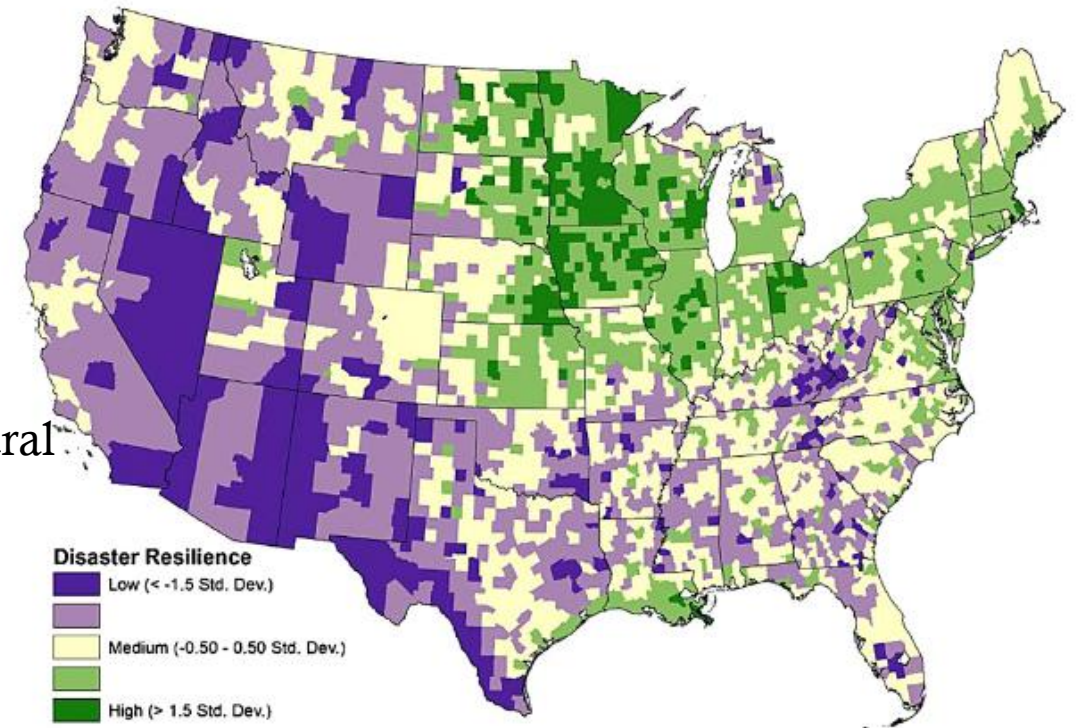
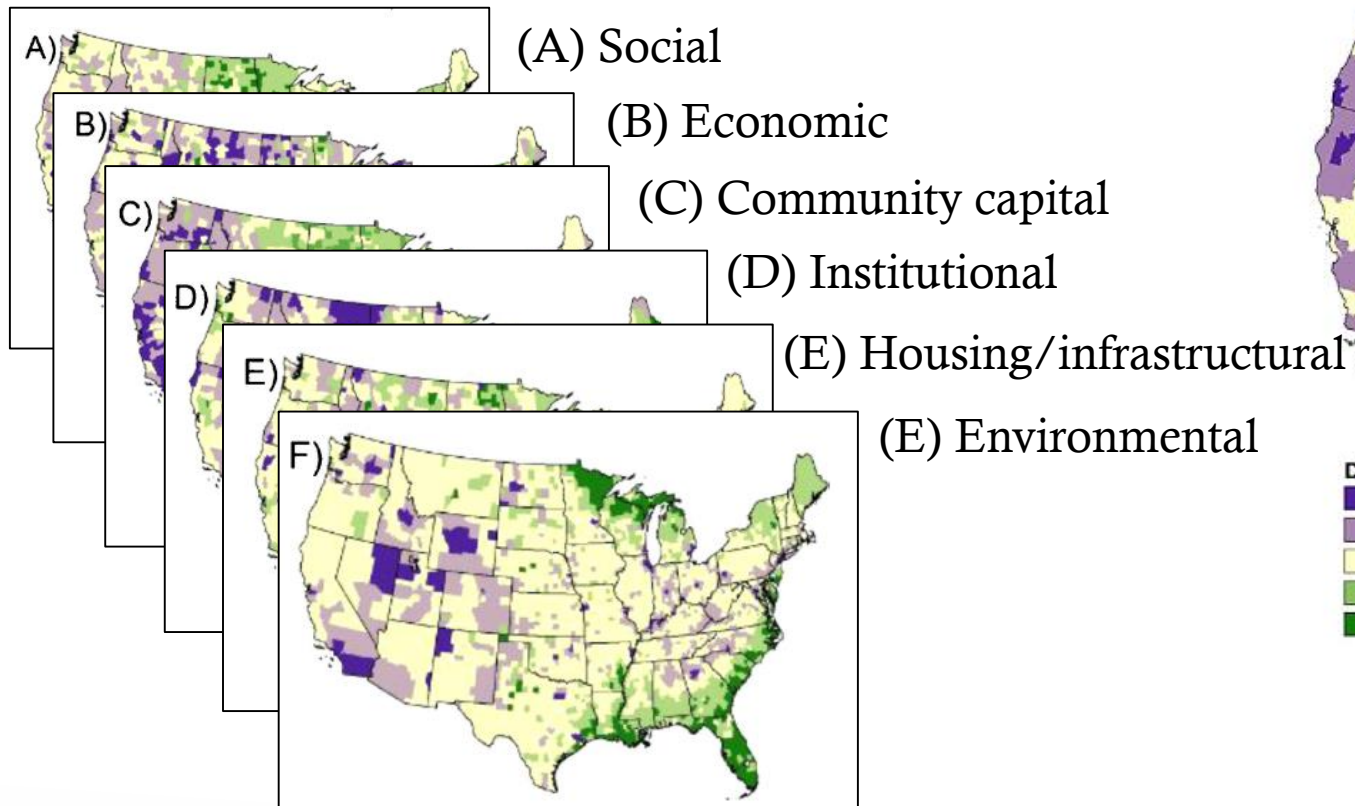
- Conceptual Frameworks/Models



Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18(4), 598-606. doi:10.1016/j.gloenvcha.2008.07.013

# Approaches for Assessing Community Resilience

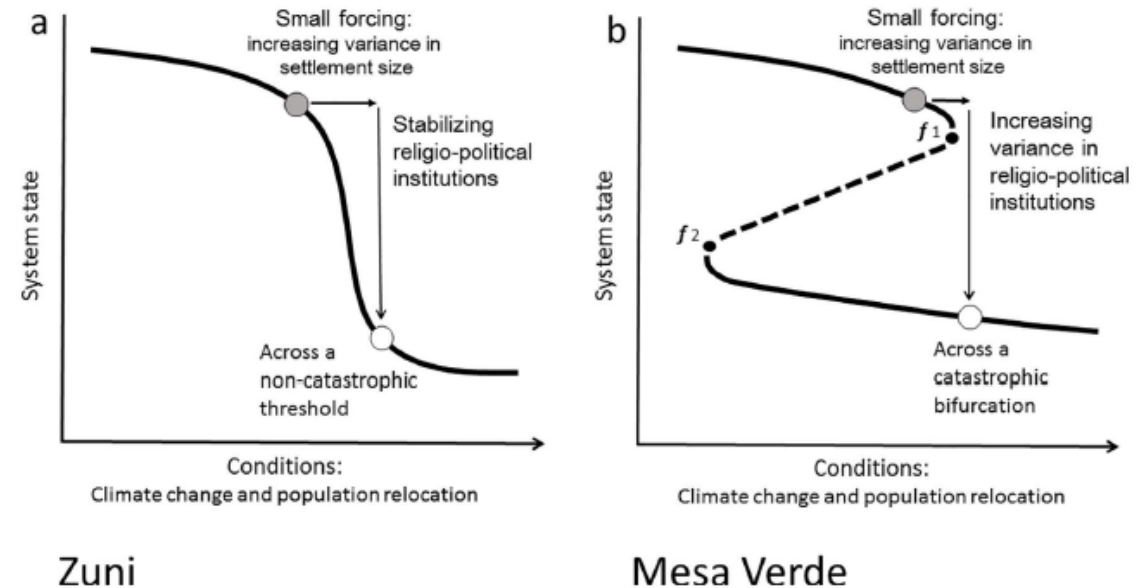
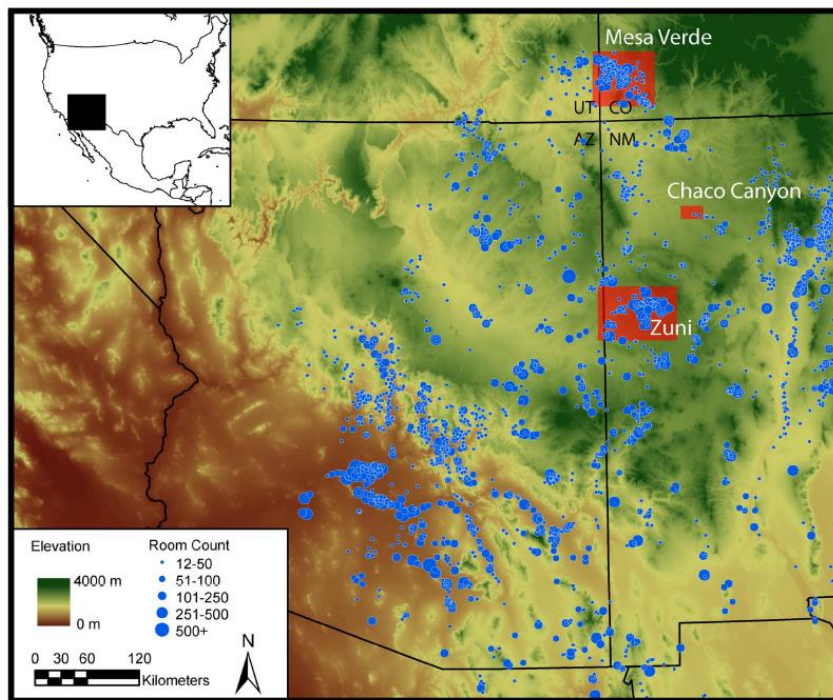
- Quantitative approaches





# Quantitative Approaches for Assessing Community Resilience

- Quantitative approaches (coefficient of variation)

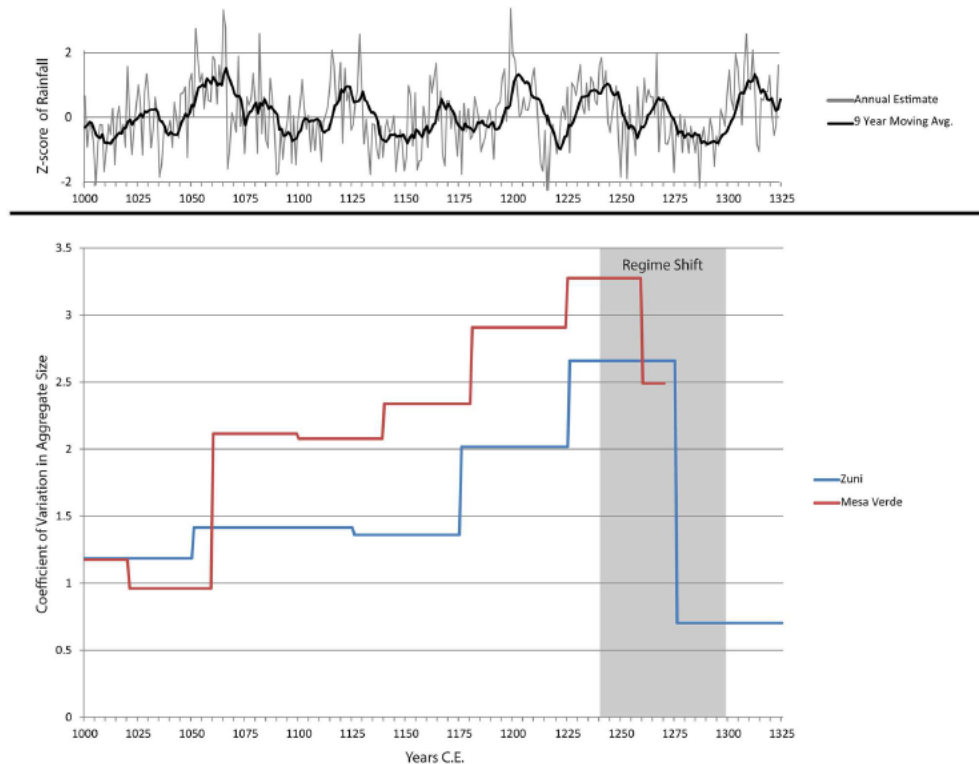


**Fig 4. Non-critical and Critical Transformations in the US Southwest.** In 4b:  $f_1$  and  $f_2$  are fold bifurcation points where a small forcing can cause a sudden qualitative change in a system.

doi:10.1371/journal.pone.0163685.g004

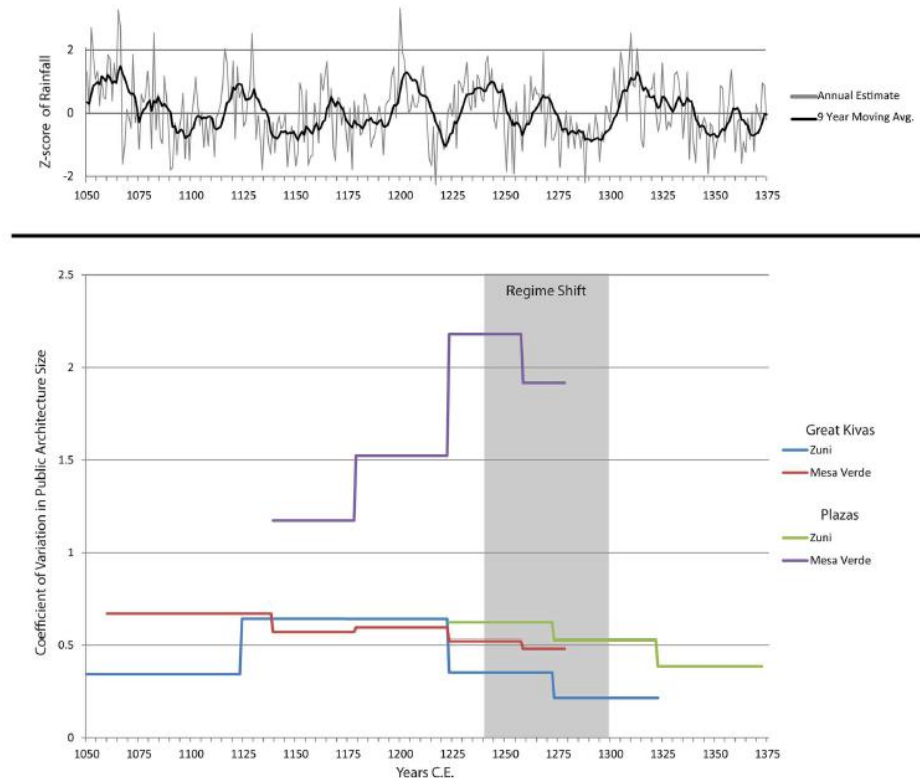


# Quantitative Approaches for Assessing Community Resilience



**Fig 6. Coefficients of Variation in Settlement Size for Zuni and Mesa Verde Region Sites over Time.** Plots of the El Malpais annual precipitation reconstruction and of the 9-year running mean are provided at the top of the figure to illustrate climate trends during this period.

doi:10.1371/journal.pone.0163685.g006



**Fig 7. Coefficients of Variation for Zuni and Mesa Verde Great Kiva and Plaza Space over Time.** Plots of the El Malpais annual precipitation reconstruction and of the 9-year running mean are provided at the top of the figure to illustrate climate trends during this period.

doi:10.1371/journal.pone.0163685.g007

# Quantitative Approaches to Assessing Community Resilience

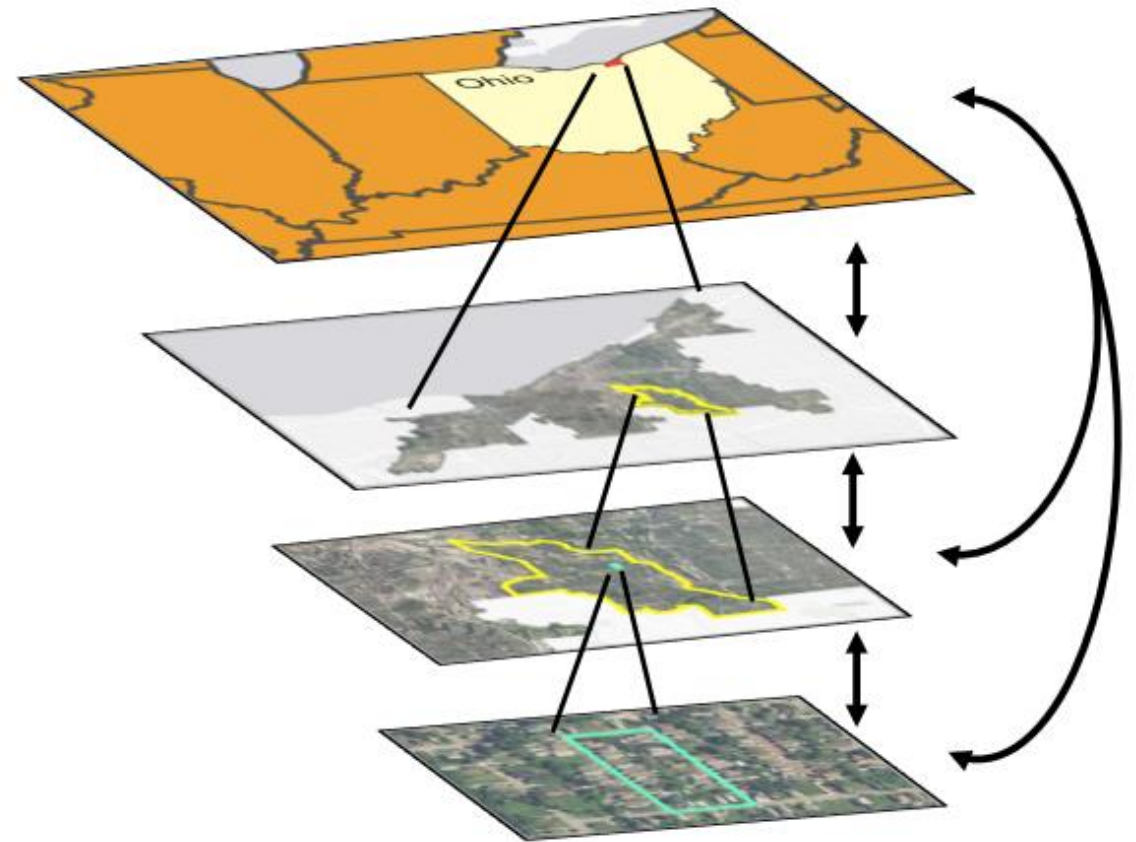
- Mixed-method approaches

# Discussion

Theme	Characteristics	Focus on	Context	Approaches and example references
Ecological resilience	Diversity, variability, <b>modularity</b> (scales), <b>cross-scale interactions</b>	Multiple regimes, multiple scales, adaptive and transformative capacity	Alternative regimes, ecosystem change	EWS, regime detection, discontinuity analysis
Community resilience	Diversity, variability, maintaining system functions, <b>vulnerability</b>	Recovery of human systems, sustainable livelihoods, disaster preparedness, the ability to cope with change	Disaster management, global environmental change, collapse of societies	Agent-based modeling, conceptual frameworks; coefficient of variation, economic simulations

# Filling the gap

- Little efforts made to integrate both ecological and community resilience (or view them in the context of each other).
- From single equilibrium-based analysis toward non-equilibrium approaches



# Conclusion: connecting ecological and community resilience

- The interaction between ecological and social factors is key to understanding the resilience of coupled systems of human and nature.
- Applying integrated approaches that move away from the traditional equilibrium-based models of disciplines and toward a more dynamic and non-equilibrium analysis.

# Thank You

---

Acknowledgements:

US EPA

NRC RAP

University of Nebraska-Lincoln

Complexity team members at UNL