



Image sources: NOAA, Telegraph, Boston.com, PBS

Impact of Hurricane Katrina:

Disaster resilience in New Orleans, Louisiana

Wen-Ching Chuang, Ph.D.;

Tarsha Eason, Ph.D; Ahjond Garmestani, JD, Ph.D.

US Environmental Protection Agency



Global Impacts of Natural Hazards

In 2016, 445 million people were affected worldwide by natural Hazards. (United Nations 2017)

The natural hazards have pushed 24 million people into poverty. (World Bank 2016)



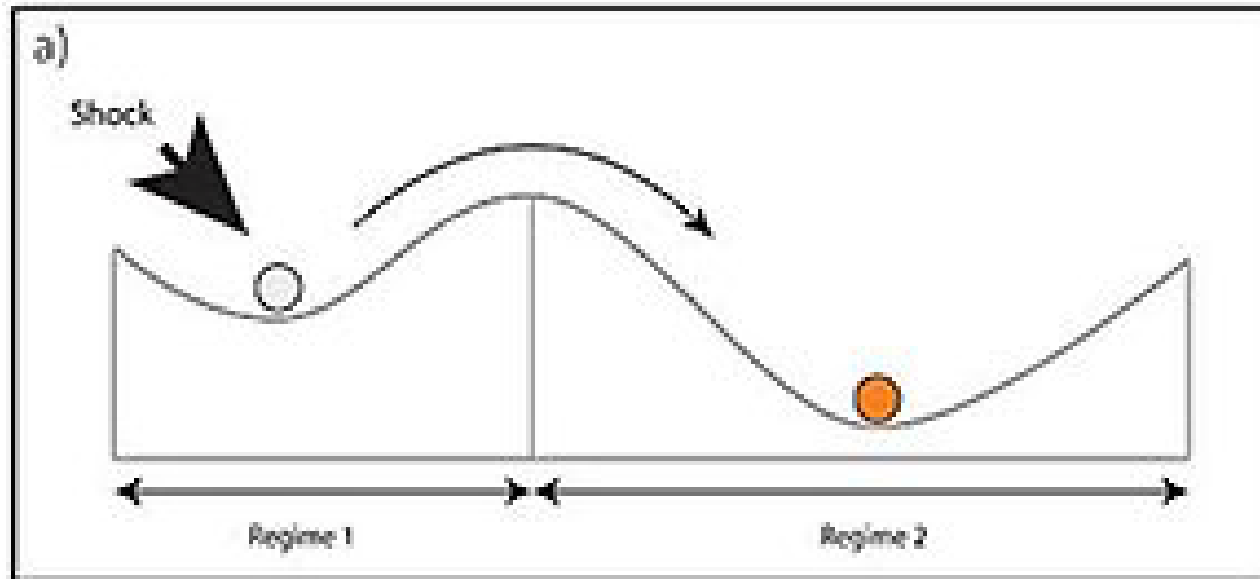
Image sources: UK Daily mail, Brookings



Resilience

Social-ecological resilience: the capacity of a social-ecological system to withstand change and retain its processes and structures without shifting to a new regime.

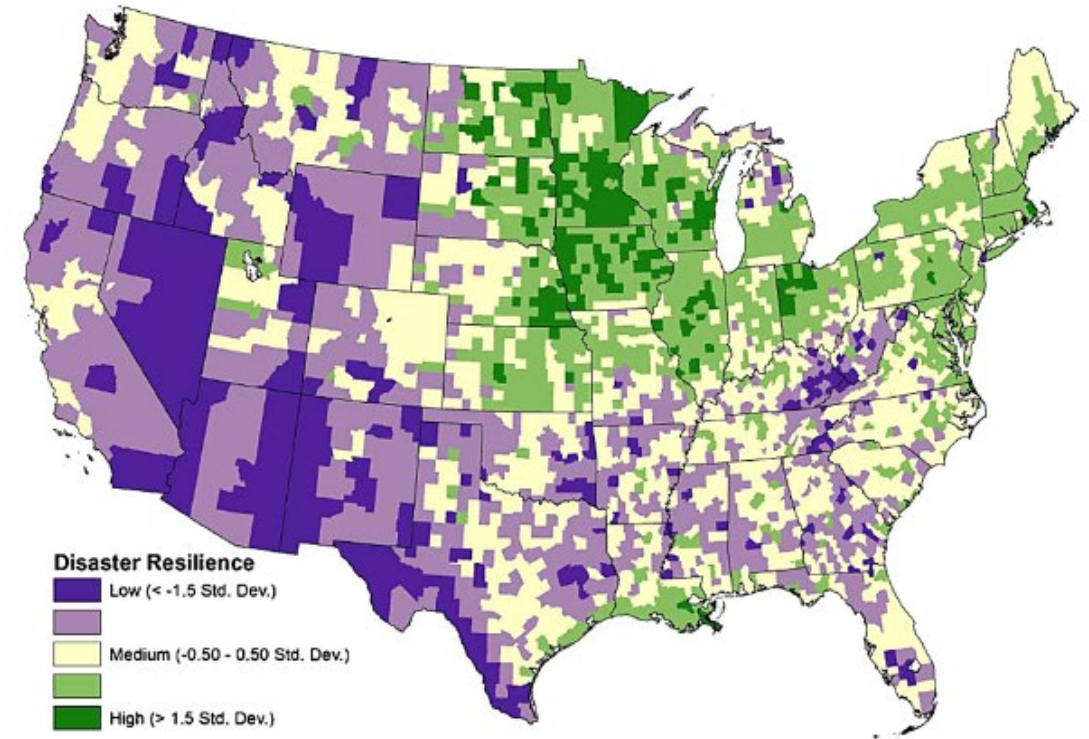
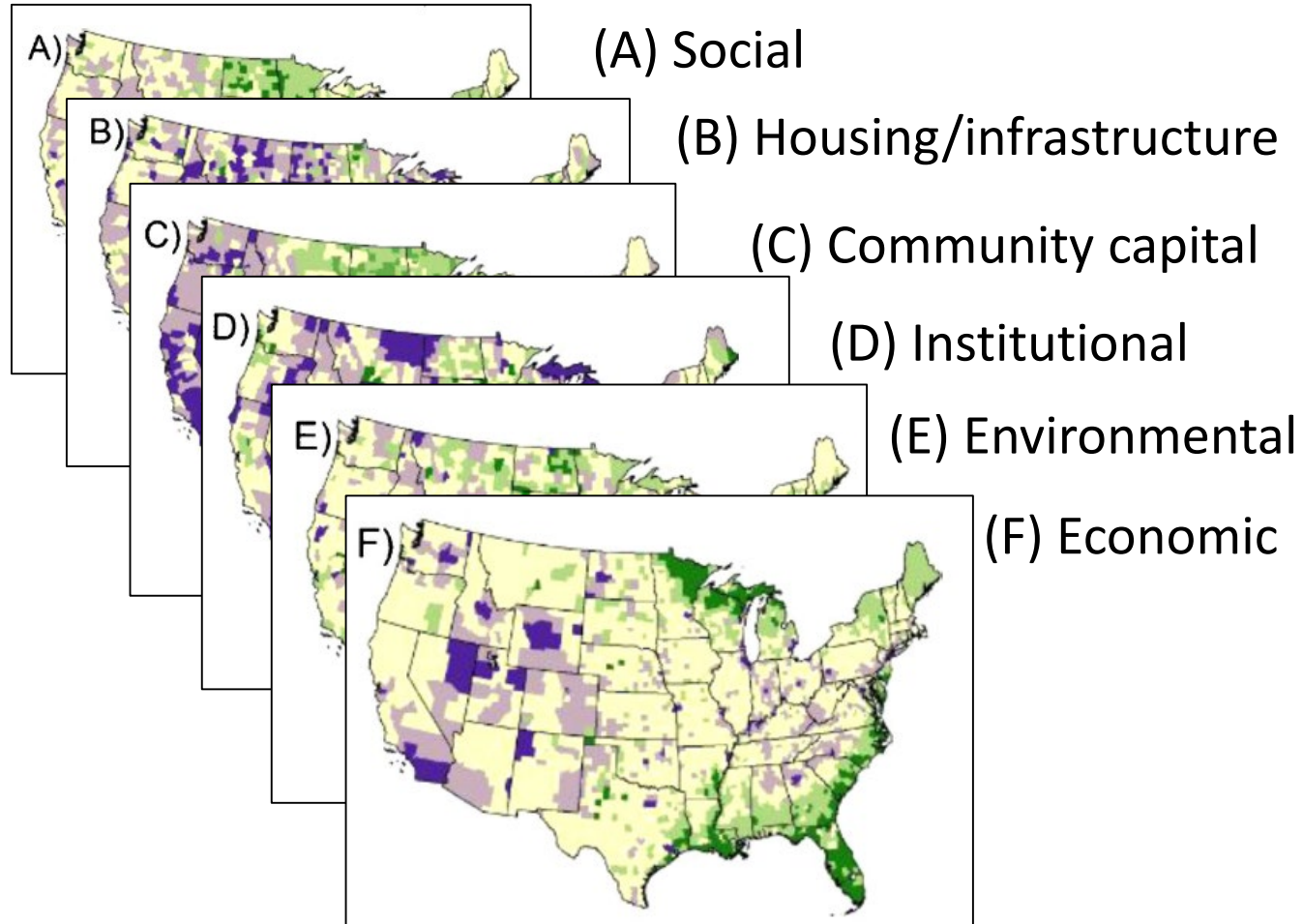
Disaster resilience: Qualities of a community, stemming from everyday processes, that might enhance or detract from its ability to prepare for, respond to, recover from and mitigate environmental hazardous events.



(Scheffer 2009)

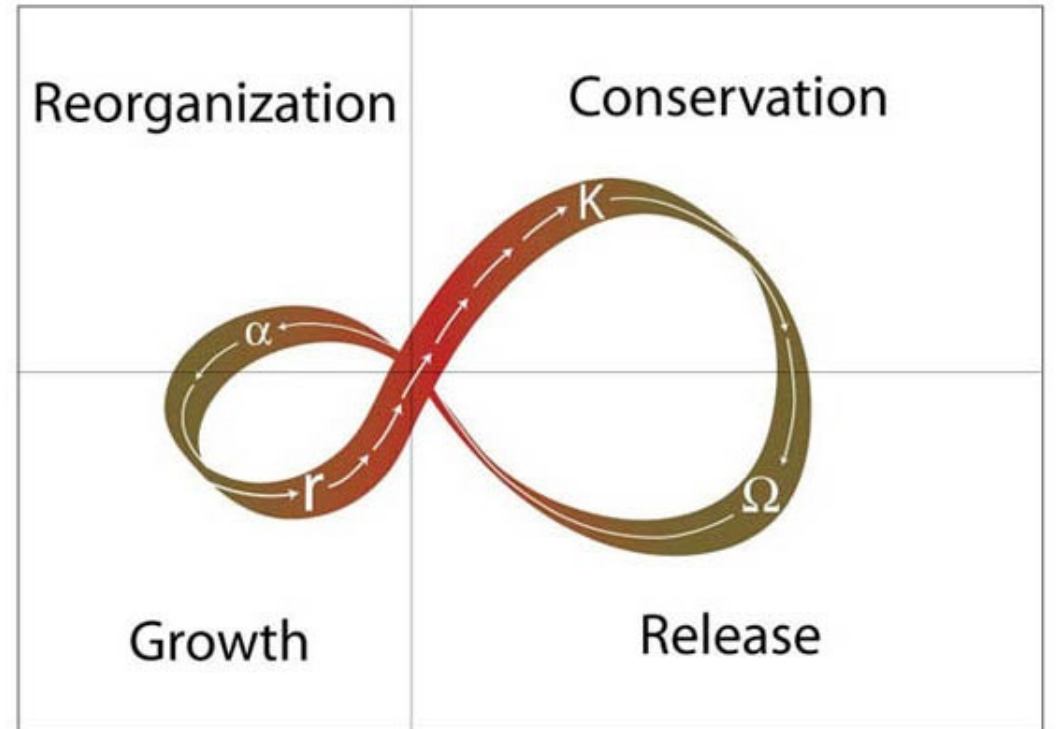
Approaches Quantify Disaster Resilience

Landscape of disaster resilience (Cutter et al. 2014)



Current Research Limitations

- Whose resilience to what?
- Little has focused on the **process of recovery, reorganization and change** of social-ecological systems.
- Four phases of adaptive cycle
 - Ω : Release
 - Υ : Growth
 - α : Reorganization
 - K : Conservation



(Holling 1986)

Assessing impacts of Katrina in New Orleans

Hurricane Katrina: August 23, 2005 – August 31, 2005

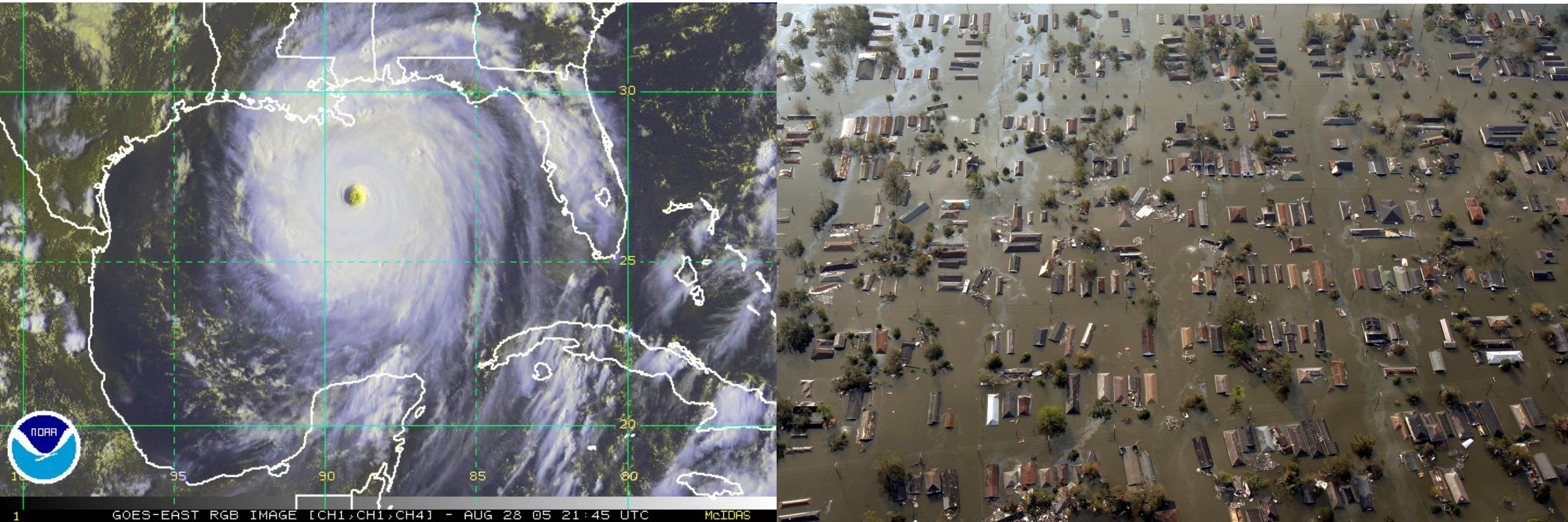


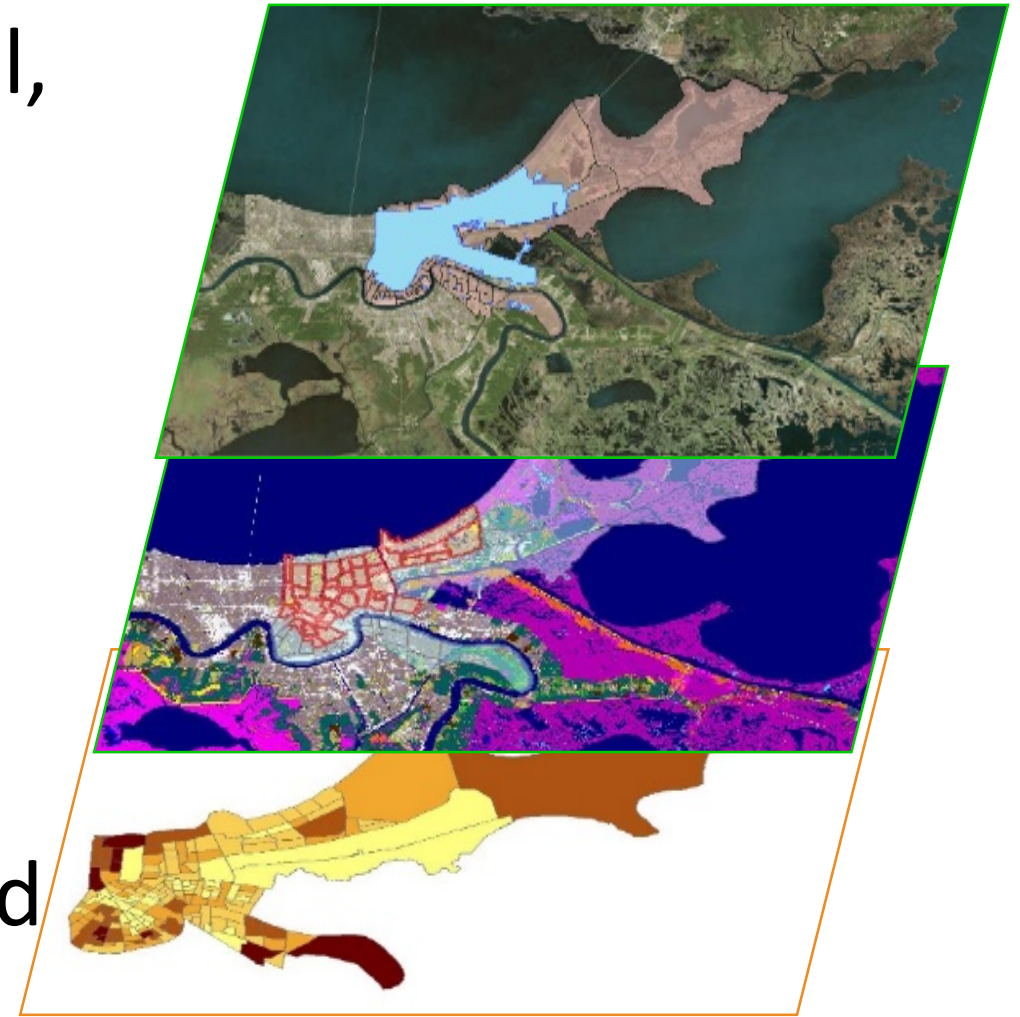
Image sources: NOAA, Telegraph

Research Approach and Data

Examine the spatial changes in social, economic, and environmental conditions before and after Katrina.

Use public data:

- US Census: 2000, 2009, 2014
- NOAA Coastal Change Analysis Program: 2001, 05-06, 2010
- USGS North American Breeding Bird Survey (BBS): 2000-2014



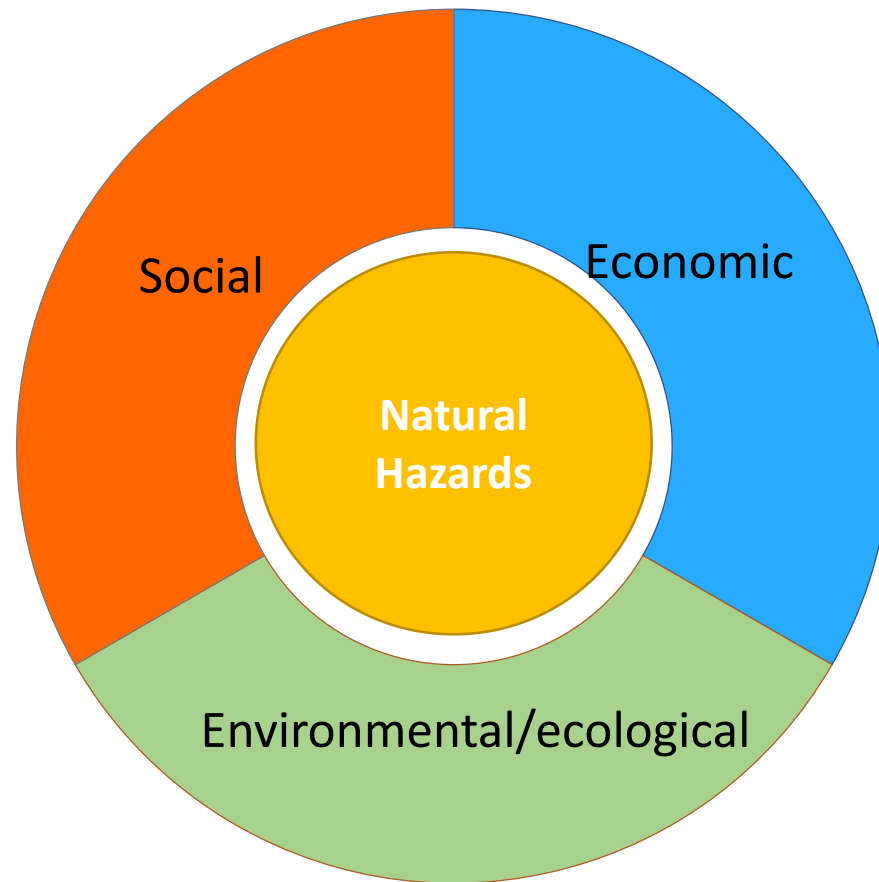
Study Variables of Disaster Resilience

Social

- Race/Ethnicity
- % Vacant units
- % Renter occupancy
- % Owner occupancy

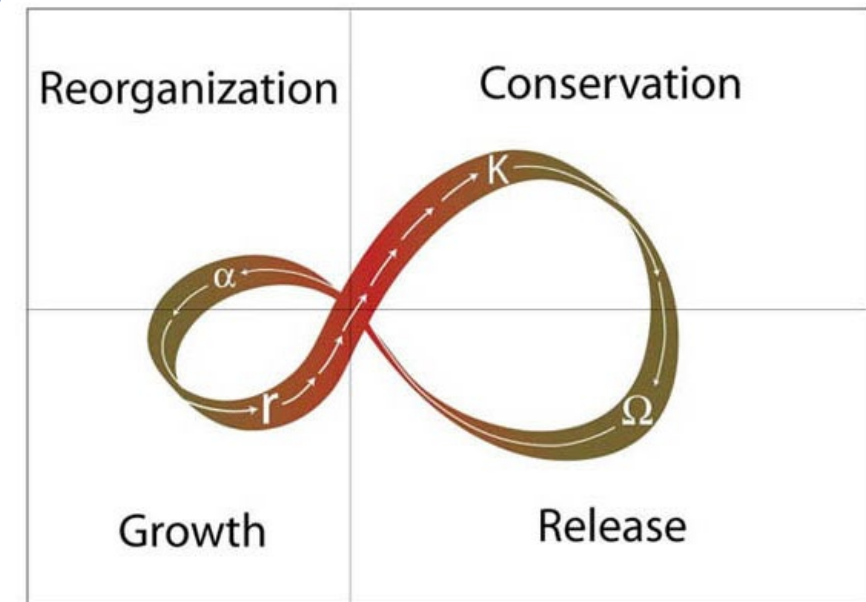
Environmental

- Bird diversity
- % Wetlands
- % Vegetation
- % High intensity development



Economic

- Median home value
- Median household income
- % Unemployment



(Holling 1986)

Research Method: Geospatial Analysis

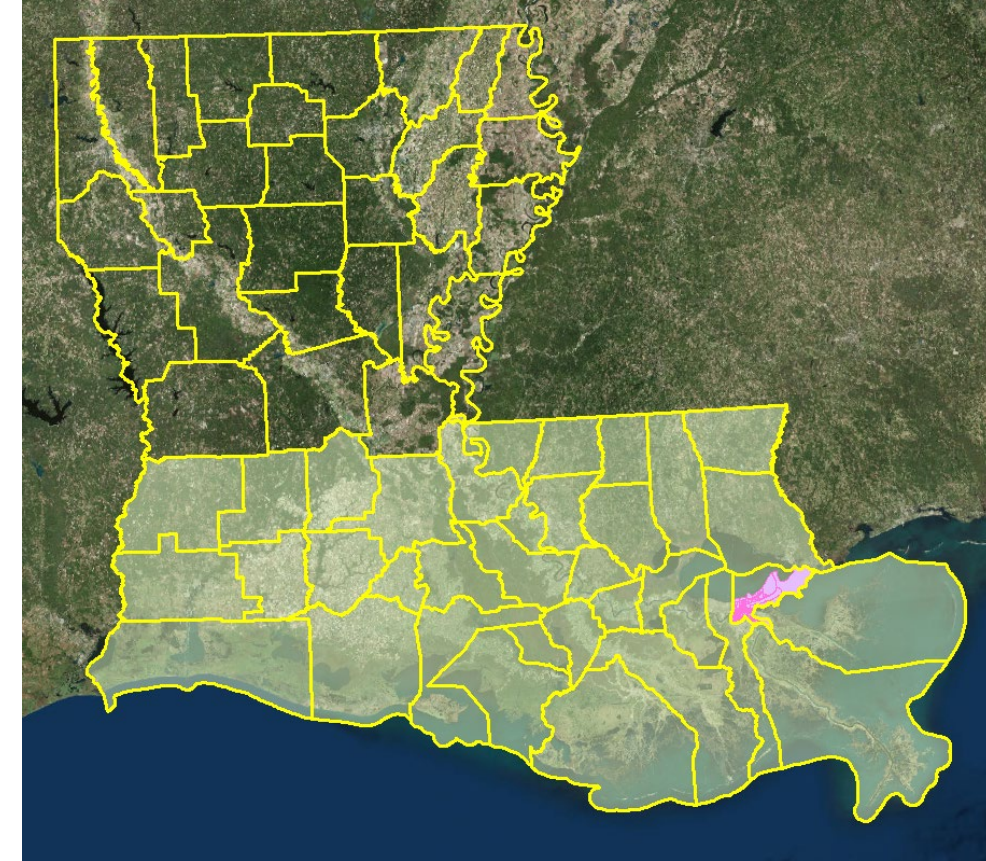
- Zonal statistics
- Local spatial autocorrelation, Moran's I, a calculation to identify local clusters and spatial outliers
- Shannon's diversity index: $-\sum_{i=1}^s (p_i * \ln p_i)$
 - p_i = proportion of the population made up of species i
 - s = number of species in sample
- Principal component analysis

Land-cover Change Over Time

% of land cover in southern Louisiana (% of total area)

Land Use, Year, (%)	2001	2005 (pre-Katrina)	2010 (post-Katrina)
Developed, High Intensity	0.31	0.37	0.45
Developed, Medium Intensity	0.58	0.61	0.66
Developed, Low Intensity	3.25	3.24	3.27
Developed, Open Space	0.60	0.66	0.70
Cultivated Crops	12.23	12.36	12.24
Pasture/Hay	5.86	5.46	5.26
Grassland/Herbaceous	1.85	1.92	1.31
Deciduous Forest	0.86	0.83	0.79
Evergreen Forest	6.06	5.70	5.22
Mixed Forest	1.19	1.12	0.99
Scrub/Shrub	4.11	4.87	5.98
Palustrine Forested Wetland	16.77	16.56	16.09
Palustrine Scrub/Shrub Wetland	1.30	1.27	1.87
Palustrine Emergent Wetland	6.07	5.95	5.96
Estuarine Scrub/Shrub Wetland	0.04	0.03	0.03
Estuarine Emergent Wetland	9.23	9.16	8.72
Unconsolidated Shore	0.49	0.50	0.49
Bare Land	0.15	0.14	0.28
Open Water	26.48	26.65	27.01
Palustrine Aquatic Bed	0.18	0.18	0.24
Estuarine Aquatic Bed	0.28	0.28	0.31

Urban



Chuang et al. (in review)

Land-cover Changes

Changes before and after Katrina in New Orleans

2005-2006

1. Wetland loss (1.07%)
2. Urban (-0.12%)

2001-2010

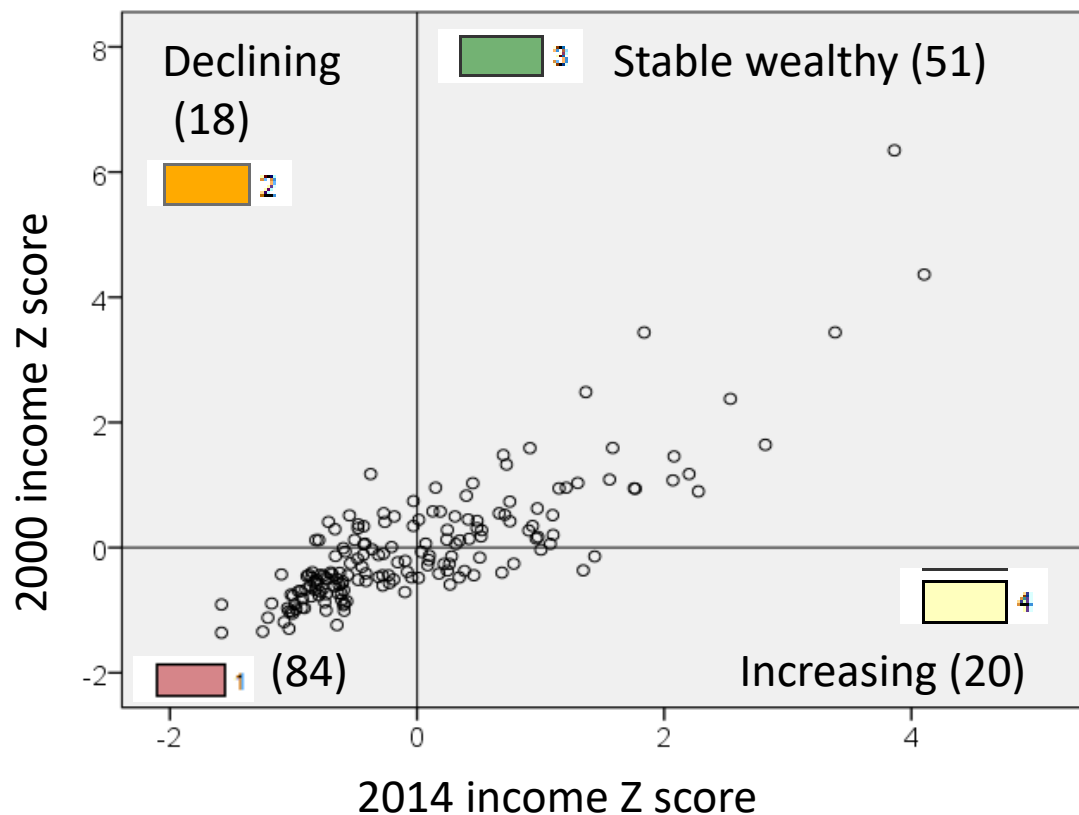
1. Wetland loss (1.86%)
2. Urban (2.83%)



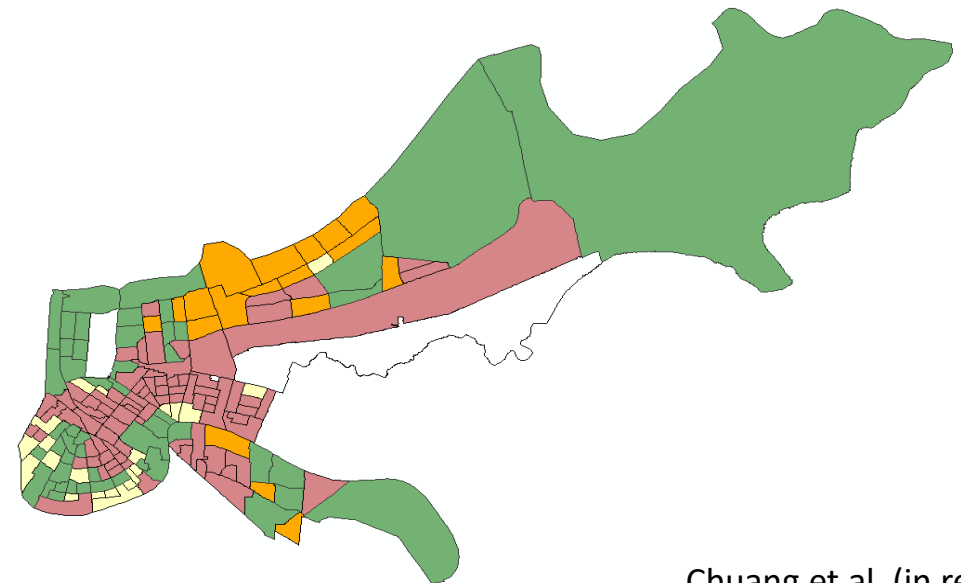
Income Change

Between 1990 and 2000, only 5 neighborhoods had increasing wealth.

Between 2000 and 2014 (after Katrina), 20 neighborhoods had increasing wealth.

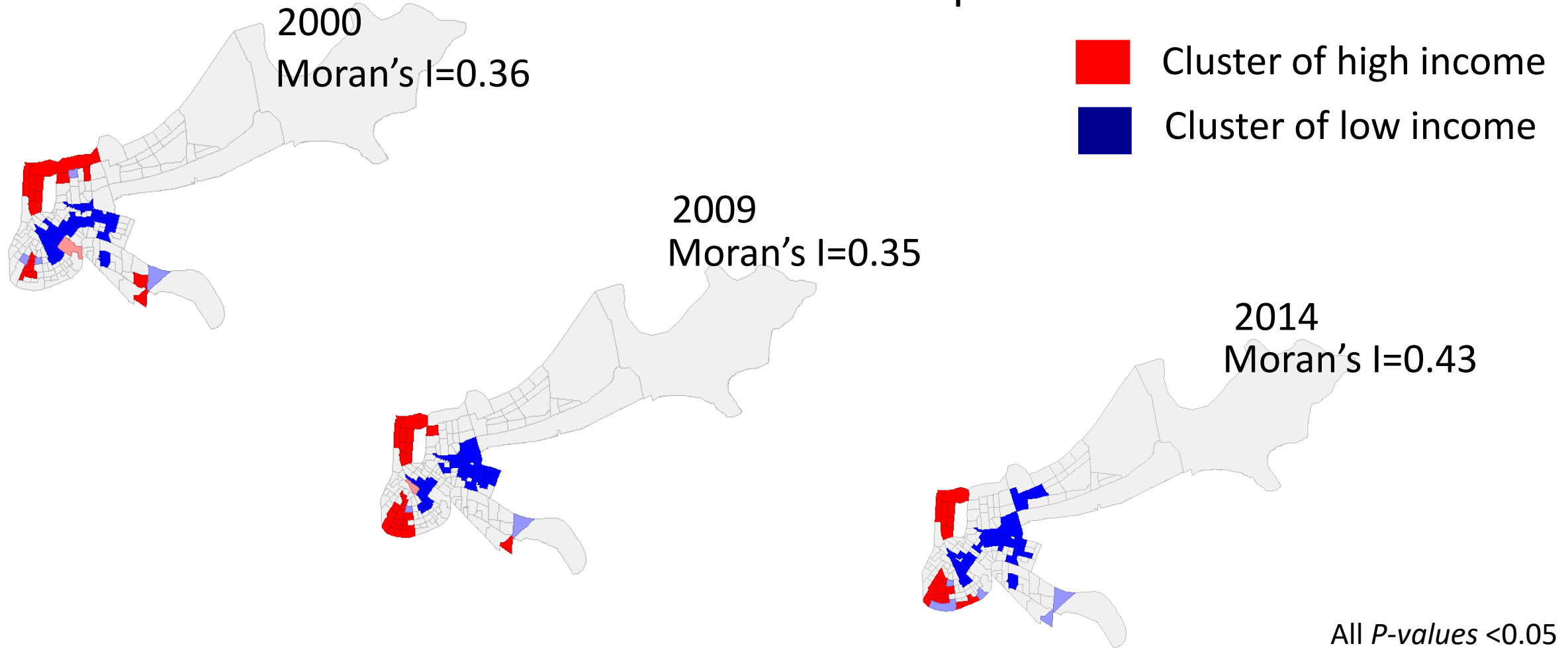


- 1 Remained relatively low income
- 2 Decreasing wealth
- 3 Remained wealthy
- 4 Increasing wealth



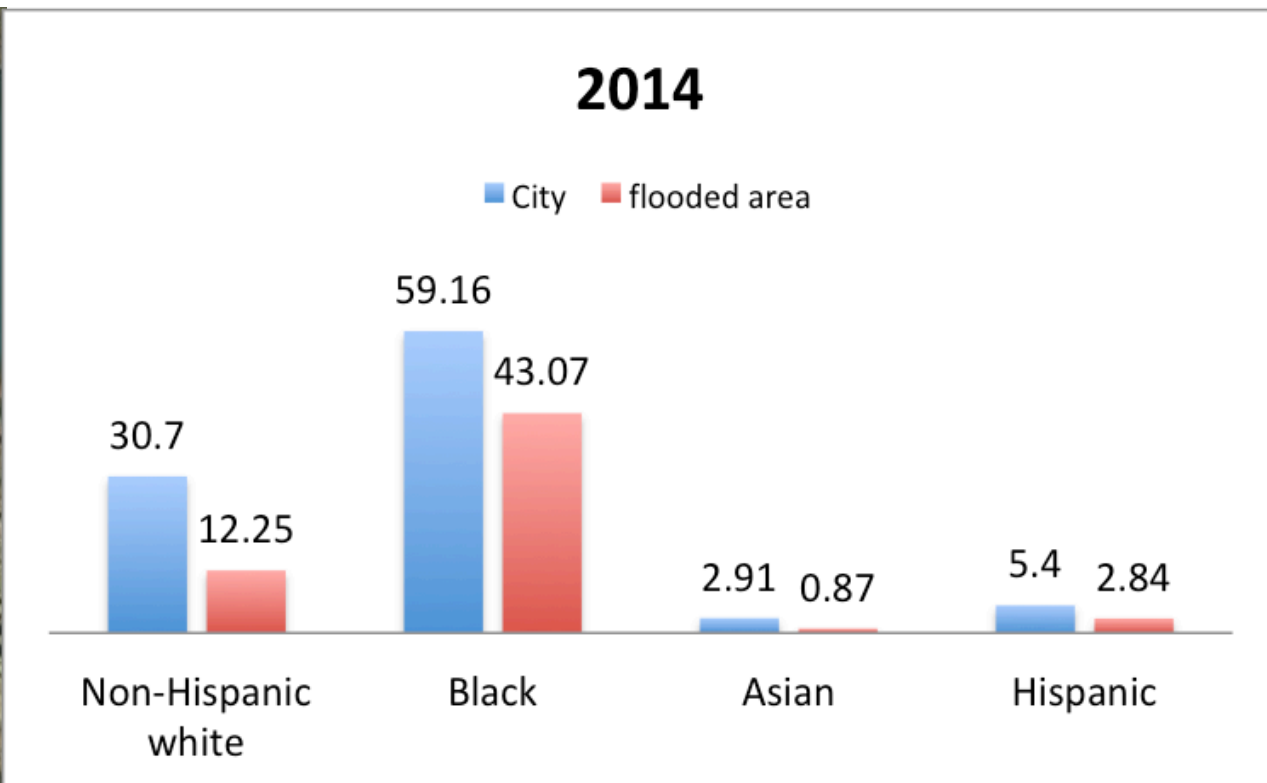
Income Inequality Increase

Cold and Hot Spots



Race/Ethnicity in Flooded Areas

African Americans are the majority population of the city, and a large portion of them live in the flooded area.



Discussion

Both social and environmental changes intertwine to amplify social inequality

Not only quantity but also quality of ecosystem services are important for the resilience

Equality \neq Equity



Conclusion

Resilience to natural disasters: It should not be measured by only the outcomes, but also the processes.

Natural disasters create a need to transform and develop new policy interventions.

Spatiotemporal considerations are critical for managing resilience of social-ecological systems.

Thank you

Q&A

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