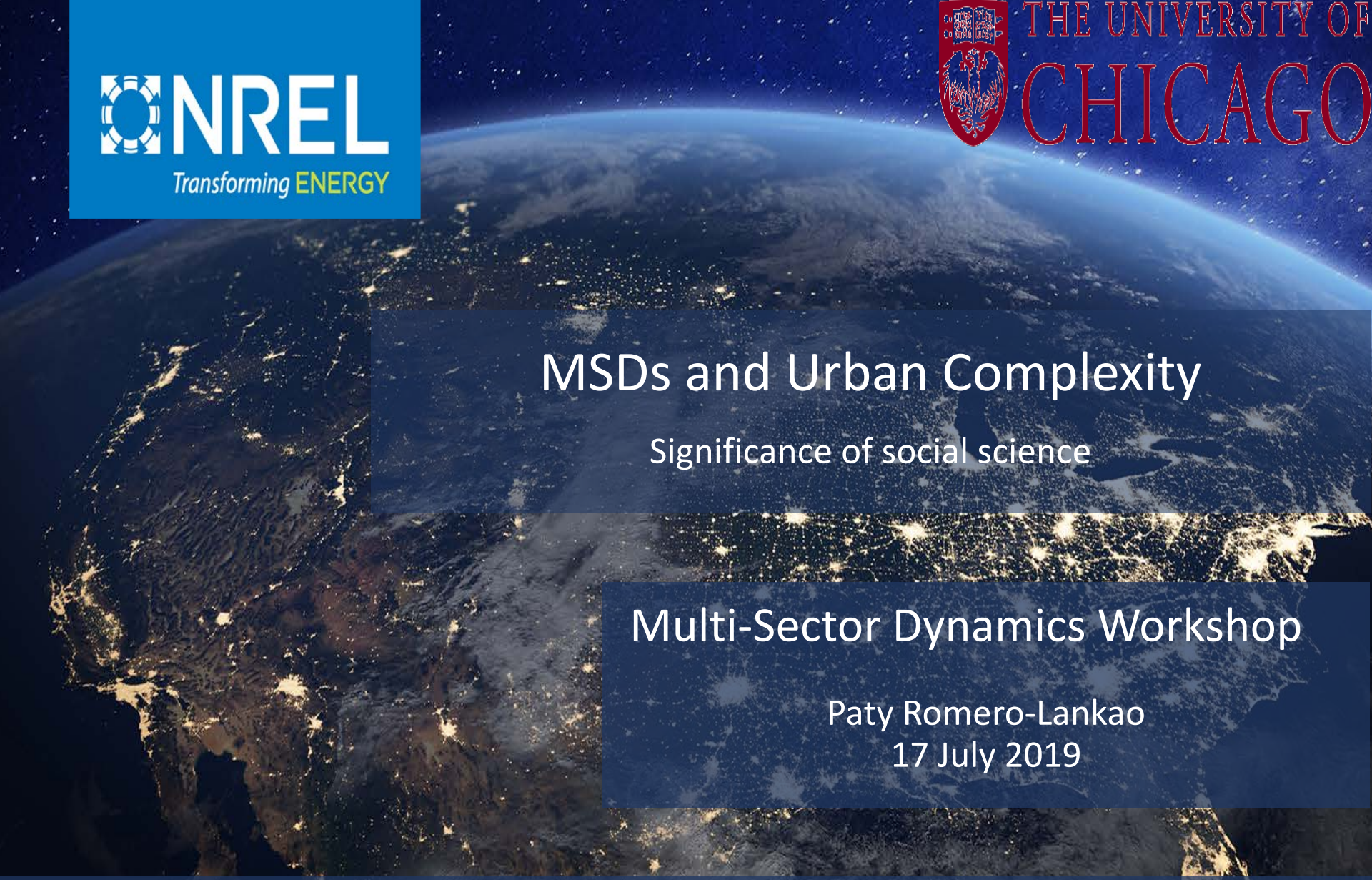


MSDs and Urban Complexity

Significance of social science

Multi-Sector Dynamics Workshop

Paty Romero-Lankao

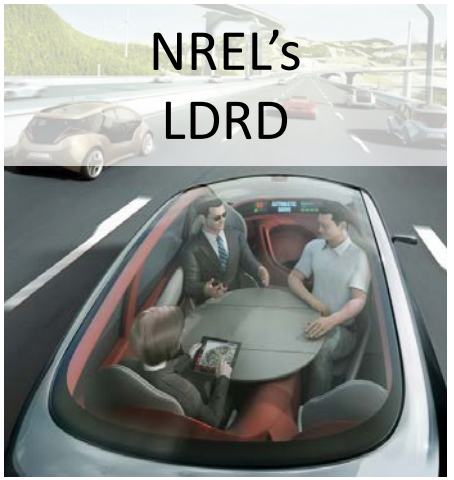
17 July 2019

Bill Livingood, Daniel Studer, Ben Polly, El Kontar Rawad*, Alana Wilson, Clement Rames, DanielZimmy-Schmidt, Caro Neri, Josh Sperling, Stanly Young, Andrew Duval (NREL), Douglas Nichka (Mines), Luis Betencourt (U. of Chicago), Rachel Norton (DU), Daniel Gnatz (ISUT)*

Significance of embedding science- and engineering-studies in behavioral science

I. **Interdependencies and cascading effects**

II. **Emerging technologies, ABMs and behavioral science**



III. **Urban typology patterns and variations in outcomes**

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SMARTMOBILITY
Systems and Modeling for Accelerated Research in Transportation

I. Interdependencies mediating risks of cascading effects

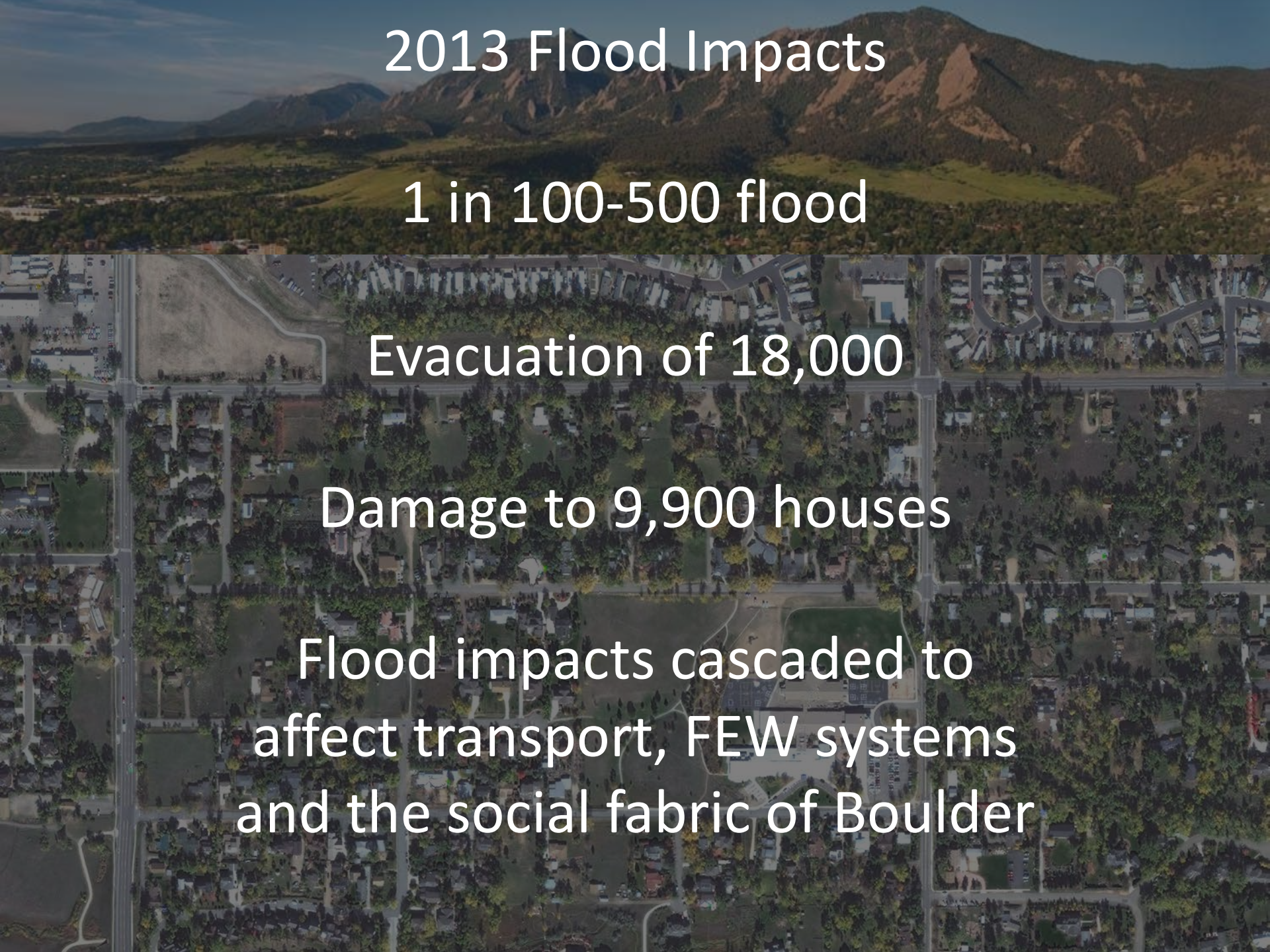
Participatory research based on

- Identification of gaps in engineering
- Integration of social science's approaches

I. Understanding of interdependencies that amplify or mitigate these effects

II. Options/barriers for learning & action

Jamestown: picsant.com



2013 Flood Impacts

1 in 100-500 flood

Evacuation of 18,000

Damage to 9,900 houses

Flood impacts cascaded to affect transport, FEW systems and the social fabric of Boulder

Methods

Interviews/Fuzzy Cognitive Maps co-created with 17 respondents

- Food-energy-water, 4 cities, local to state jurisdictions, mountains to plains

Jurisdictional Level and Sectoral Representation of Respondents

Level	**Sectors**							
	Other	Food	Energy	Water	Emergency Response	Infrastructure	Public Health	Flood Recovery
Local	#5	#12, #16	#16	#6,#11 #16	#16	#10		#14
County	#8, #10	#3, #15		#2	#1, #4, #17	#9	#1	#7
State					#13			

Source: Romero-Lankao & Norton (2018) Earth's Future

Infrastructural interdependencies

Transportation was the foundation of interdependency amplifying flood risk

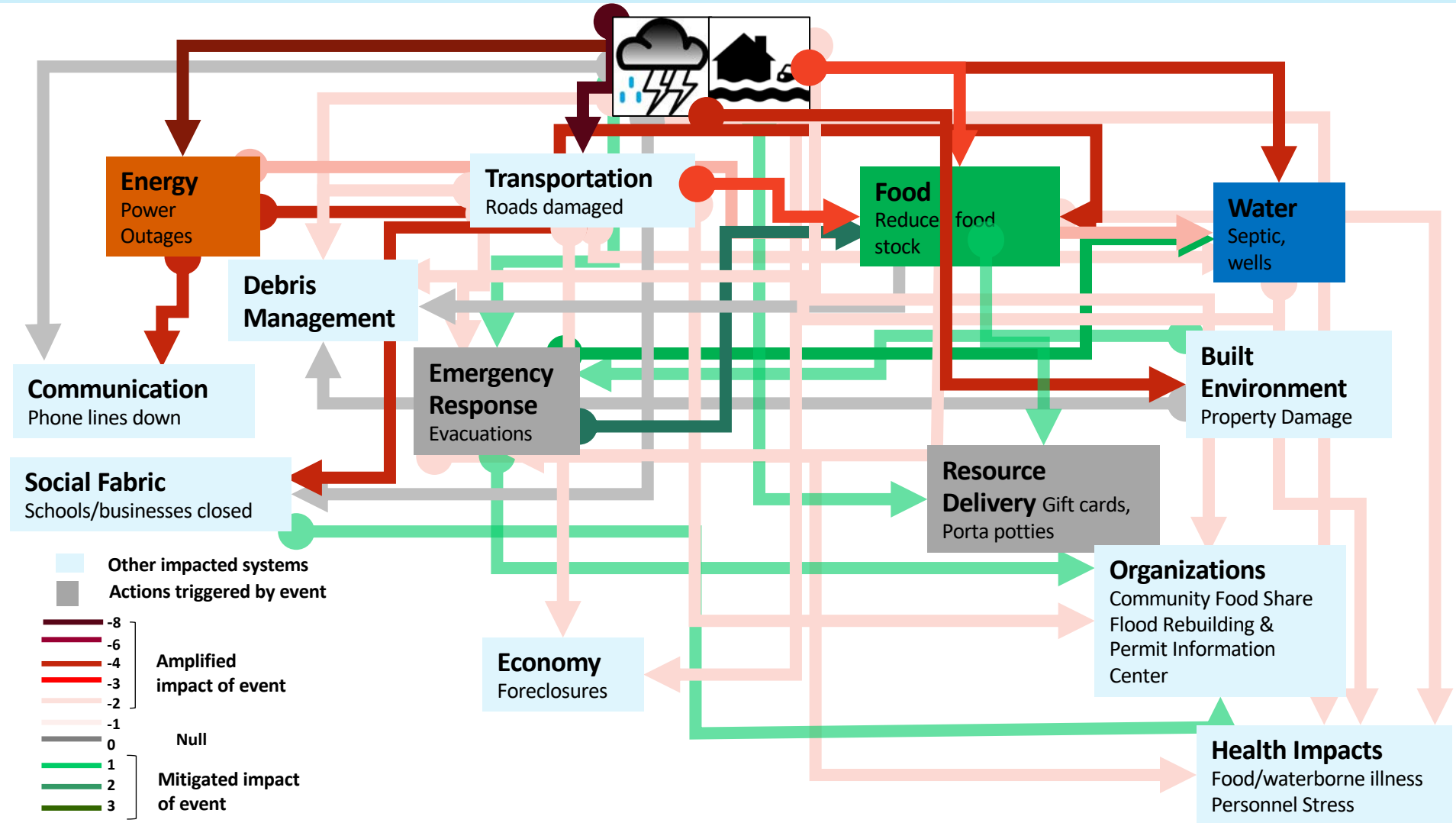
In many sectors, actions and policies mitigated the negative impacts of the floods

flood-co evac ng

Short-term responses were effective, but longer-term recovery is harder

Jamestown: picsant.com

Factors that amplified or mitigated cascading effects triggered by floods



Source: Romero-Lankao & Norton (2018) Earth's Future

Through our framework, participants learned to see FEW systems connections, however,

Most actions occurred within organizations, which focused on one system at a time

trib.com/business/energy/wyoming

II. Transformational Analysis through Behavioral Science:

Symbiotic Autonomous Systems (SAS) in Cities

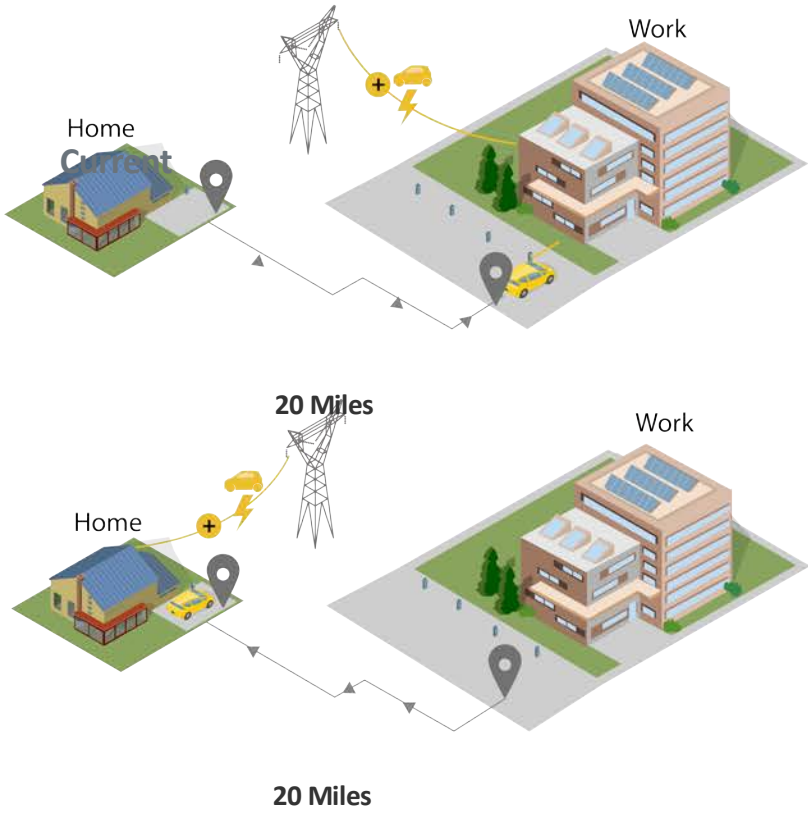
LDRD
Patricia Romero Lankao and Bill Livingood (PIs)

Symbiotic Autonomous Systems
Augmented Minds

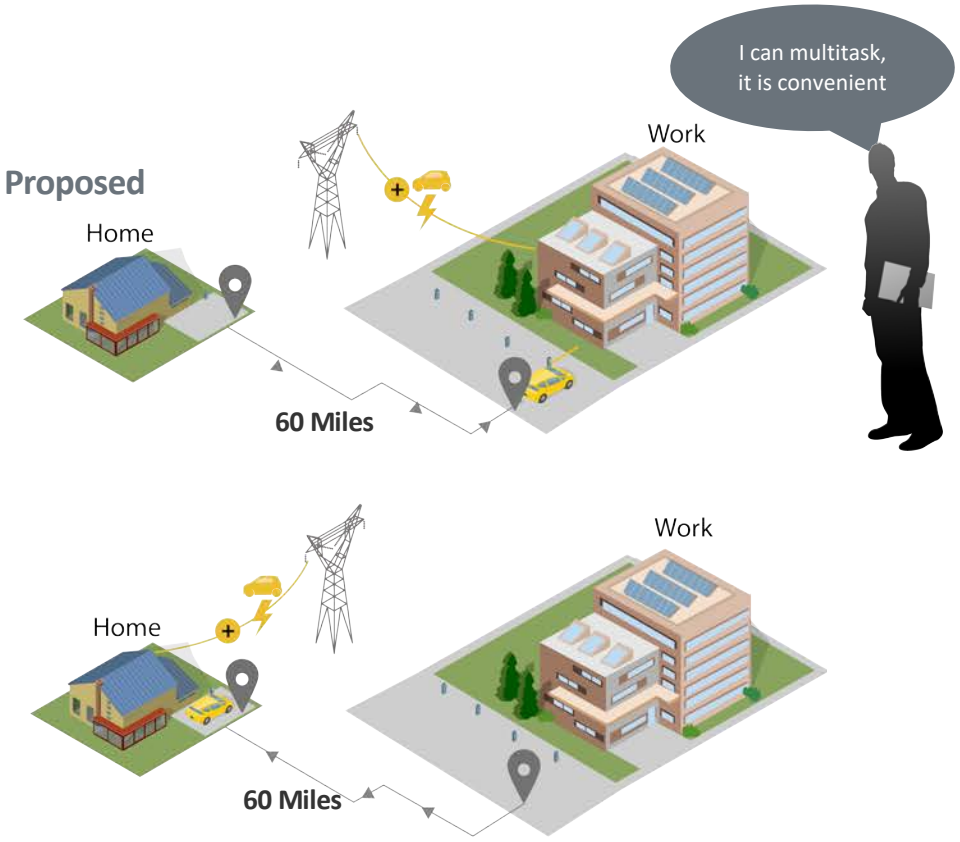
Advance machines will interact with humans and cities to transform our lives and the fabric of our cities

Autonomous Electric Vehicles:
Transformed Urban Fabric

Using current tools, NREL analyses assume no change in behavior, or at best, bake in static assumptions



Some strain on urban and suburban grids; no change to rural grids or building loads.

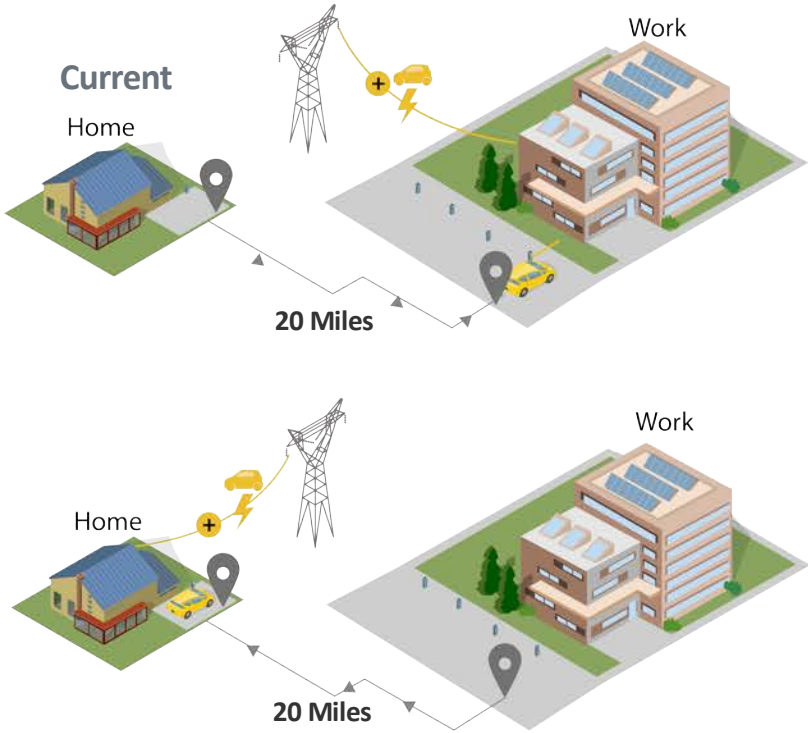


Large strain on urban and rural grids, but lower building load!

Problem: Accounting for autonomous EV adoption would look largely similar to current EV adoption

Example: Autonomous EV adoption increases:

More, in our agent-based approach, our female would react differently



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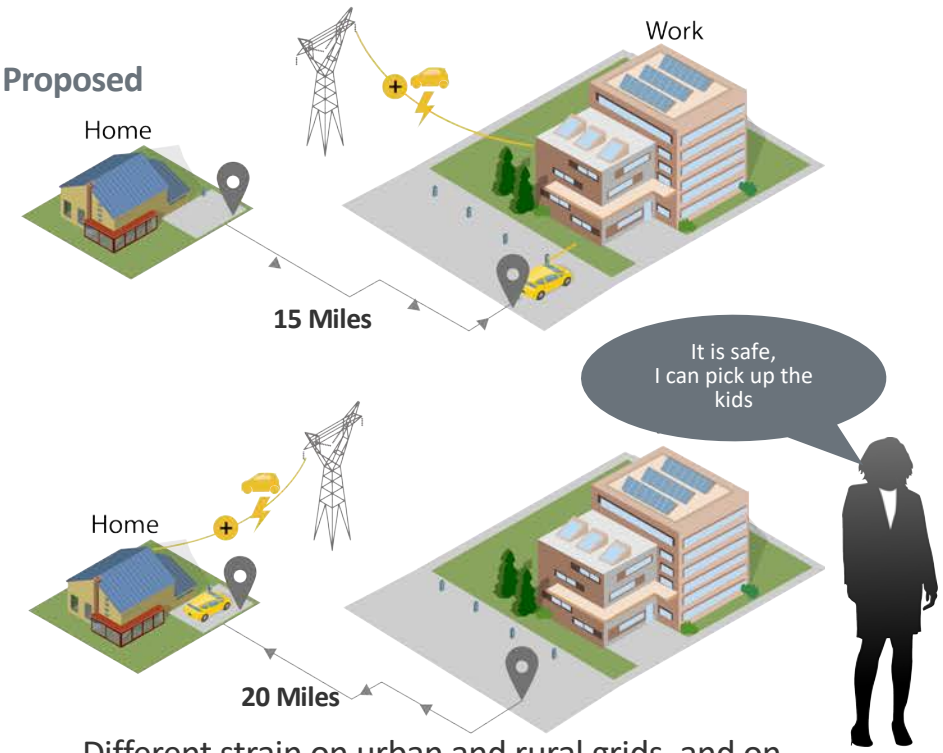


Different strain on urban and rural grids, and on building load!

Planned Approach

Proven Methods Accounting for Complexity of humans, robots and cities

M1: Inventory

- Toolsets and methods
- Delphi technique

M2: Stakeholder Proving Ground

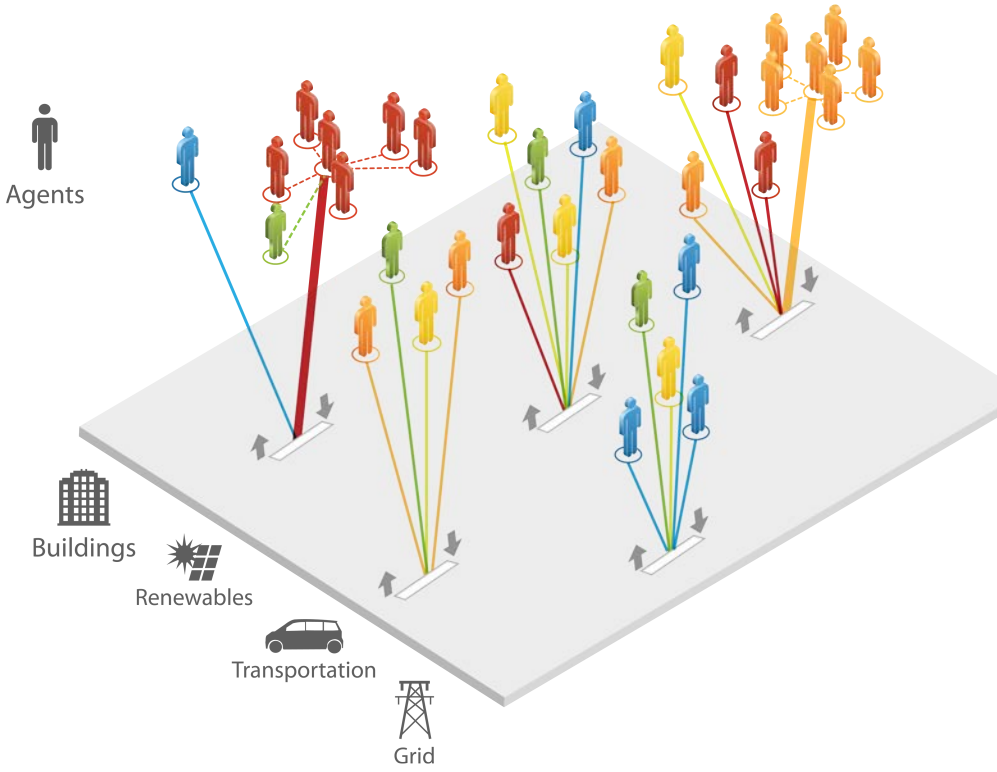
- Control scenario workshop
- Rank identified use cases

M3: Implementation

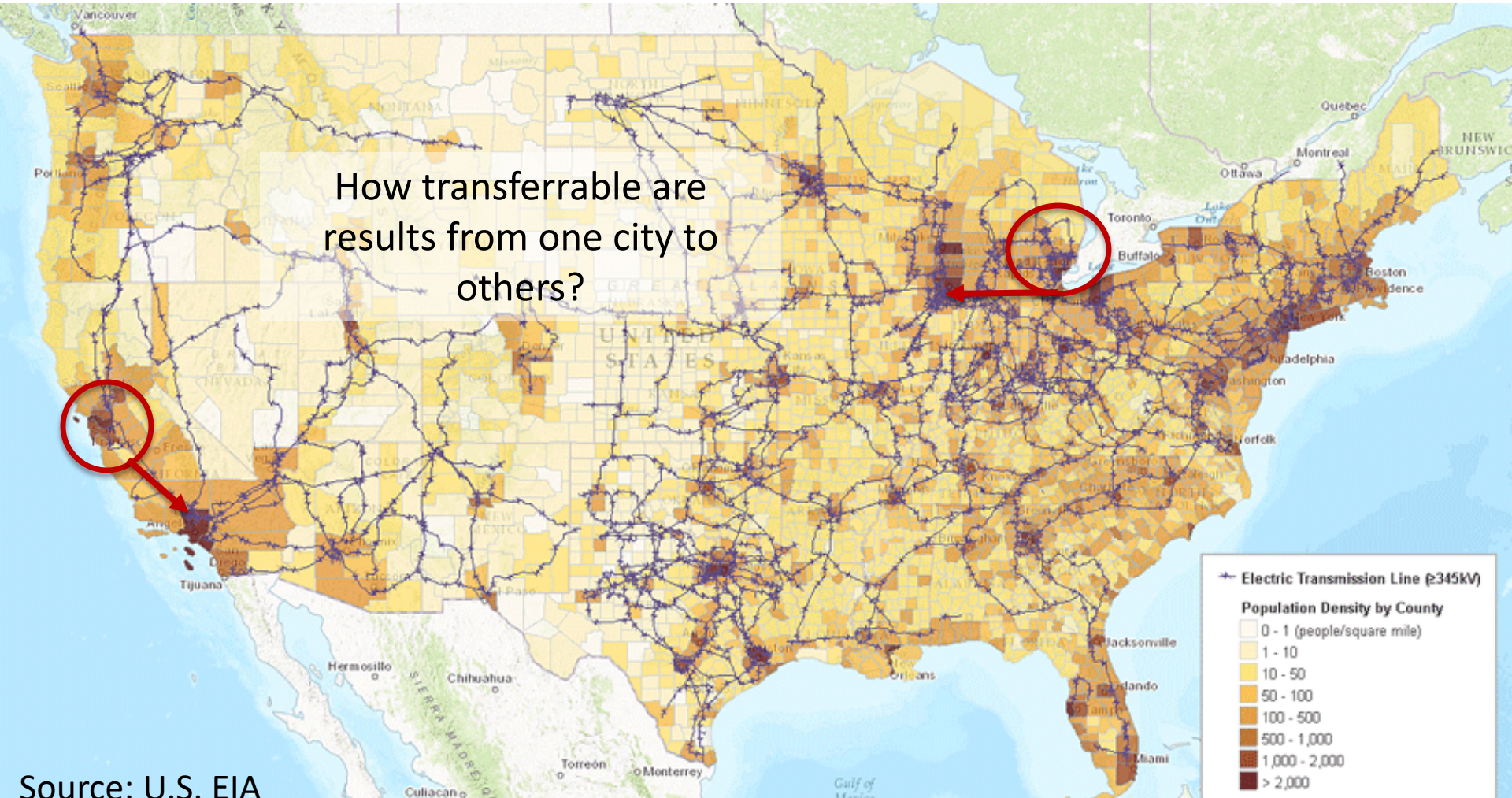
- Scope to incorporate AGM
- Design and implement

M4: Pilot Analysis

- Execute
- SAS workshop (results)
- Report (high impact journals)



III. Typology to identify clusters of features in emergent mobility behavior & energy use across settlement types & socioeconomic status groups



Source: U.S. EIA

Sustainable TRANSPORTATION

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

1. **Create a multi-dimensional typology of adoption and outcomes**

   - E.g. on mobility & energy use

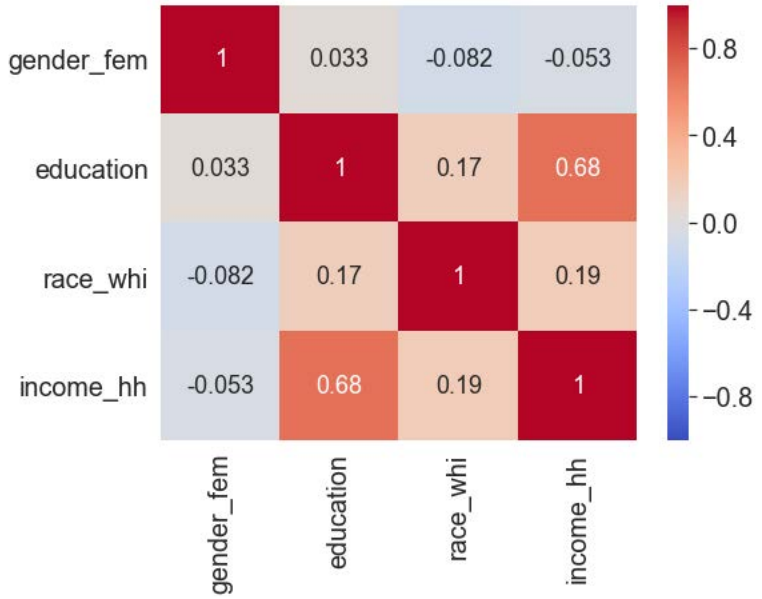
2. **Engage social science with engineering science**

II. Methods and data

1. Social, economic, technological environmental, governance (SET*E*G) indicators (for 10 US states)

2. Standard statistics, factor analysis and cluster analysis

3. Analysis of patterns and variations across population & settlement clusters



Dataset Typology

INDICATOR	SETEG	DEP/IND	RESOLUTION	AVAILABILITY
MEP metric	Mobility	DEP	Grid cells	Six cities
Gallons gasoline sold	Energy	DEP	County	Two cities
EV adoption %	Adoption	DEP	Zip code	US
Transit trips/capita	Mobility	DEP	Transit agency	US
Fleet averaged mpg	Energy	DEP	Zip code	US
Gender (female)	S	INDEP	Block group	US
Education (level)	S	INDEP	Block group	US
Race (white)	S	INDEP	Block group	US
Household income	E	INDEP	Block group	US
Employment Access	E	INDEP	Block group	US
House Tenure (own)	E	INDEP	Block group	US
Population Density	T	INDEP	Block group	US
#Vehicles/household	T	INDEP	Block group	US
GHG/MWh electricity	T	INDEP	Block group	US
HTA Index (CNT)	T	INDEP	Block group	US
PM 2.5	*E*	INDEP	Block group	US
Cancer Hazard	*E*	INDEP	Block group	US
Respiratory Hazard	*E*	INDEP	Block group	US
Intersection Density	G	INDEP	Block group	US
Non SOV commuters	G	INDEP	Block group	US

Preliminary Results

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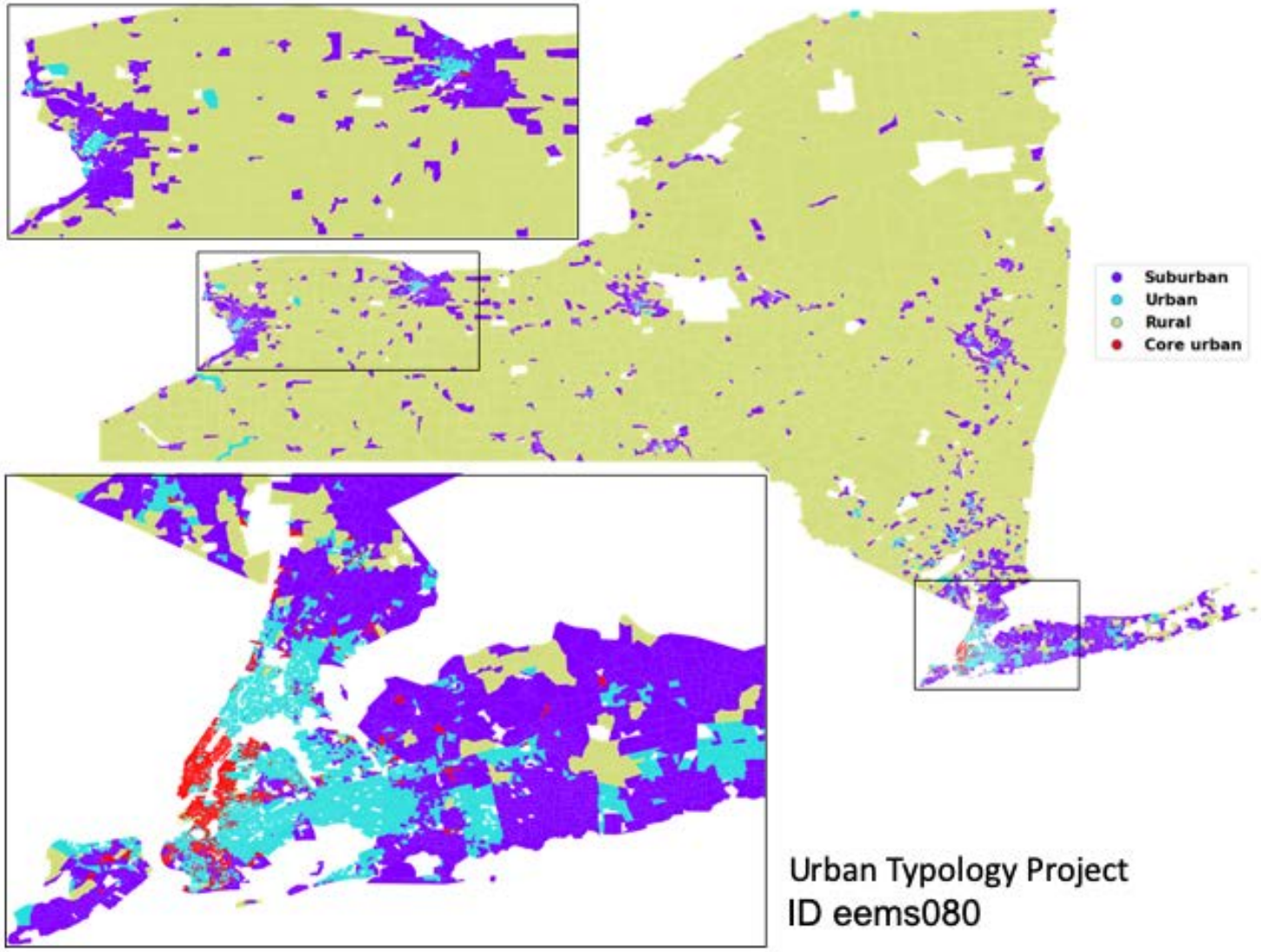
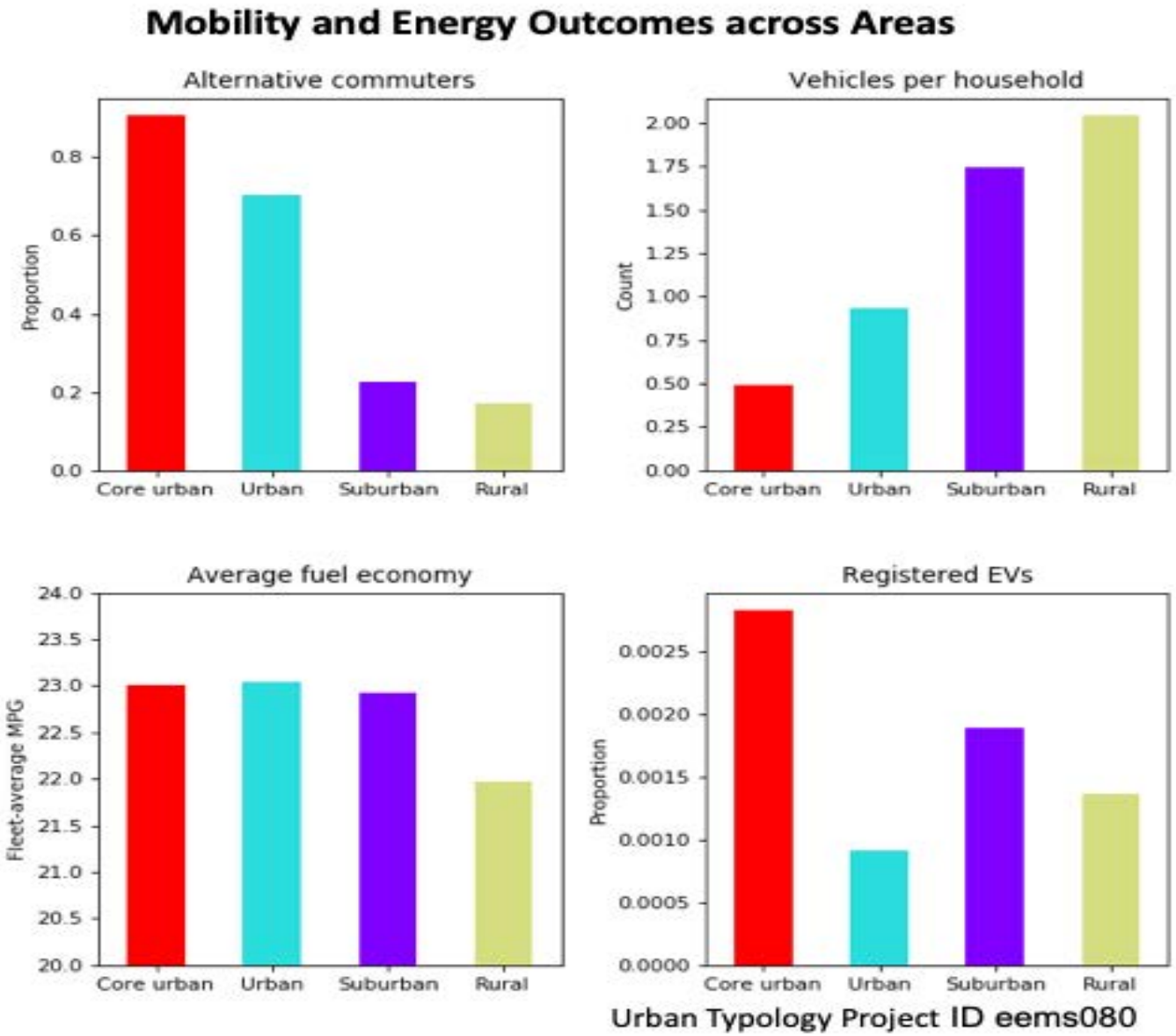
Areas in New York State Using a Typology Approach

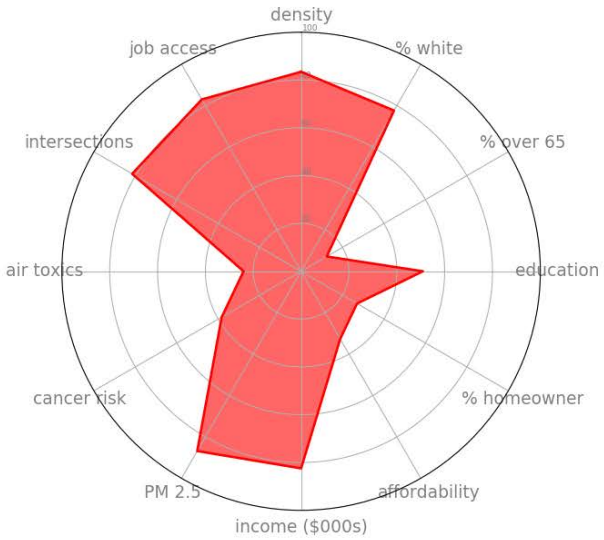


Urban Typology Project
ID eems080

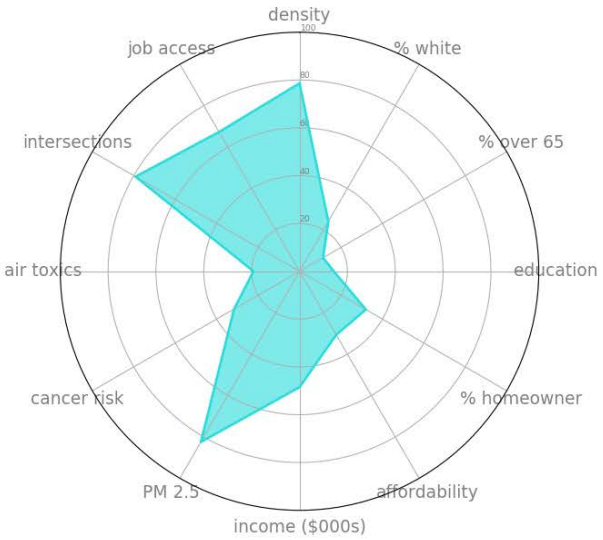
Preliminary Results



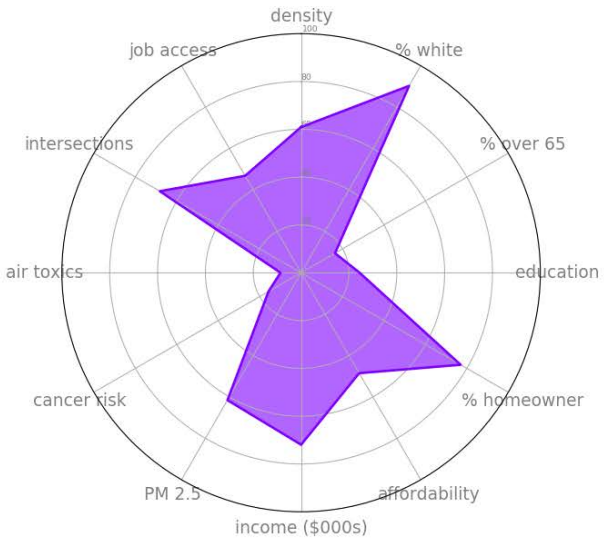
Core urban



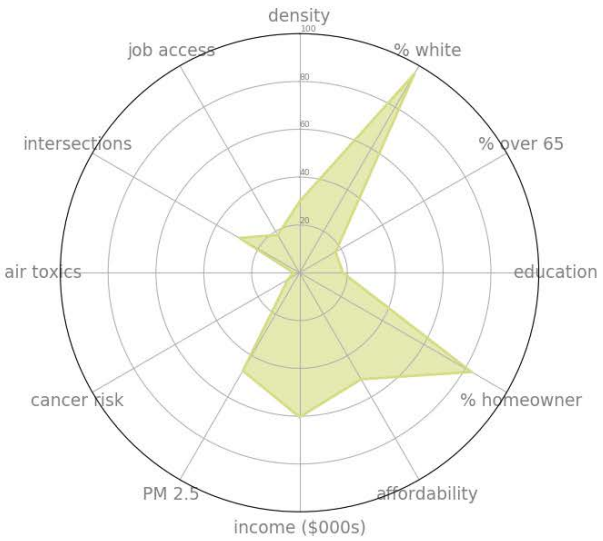
Urban



Suburban

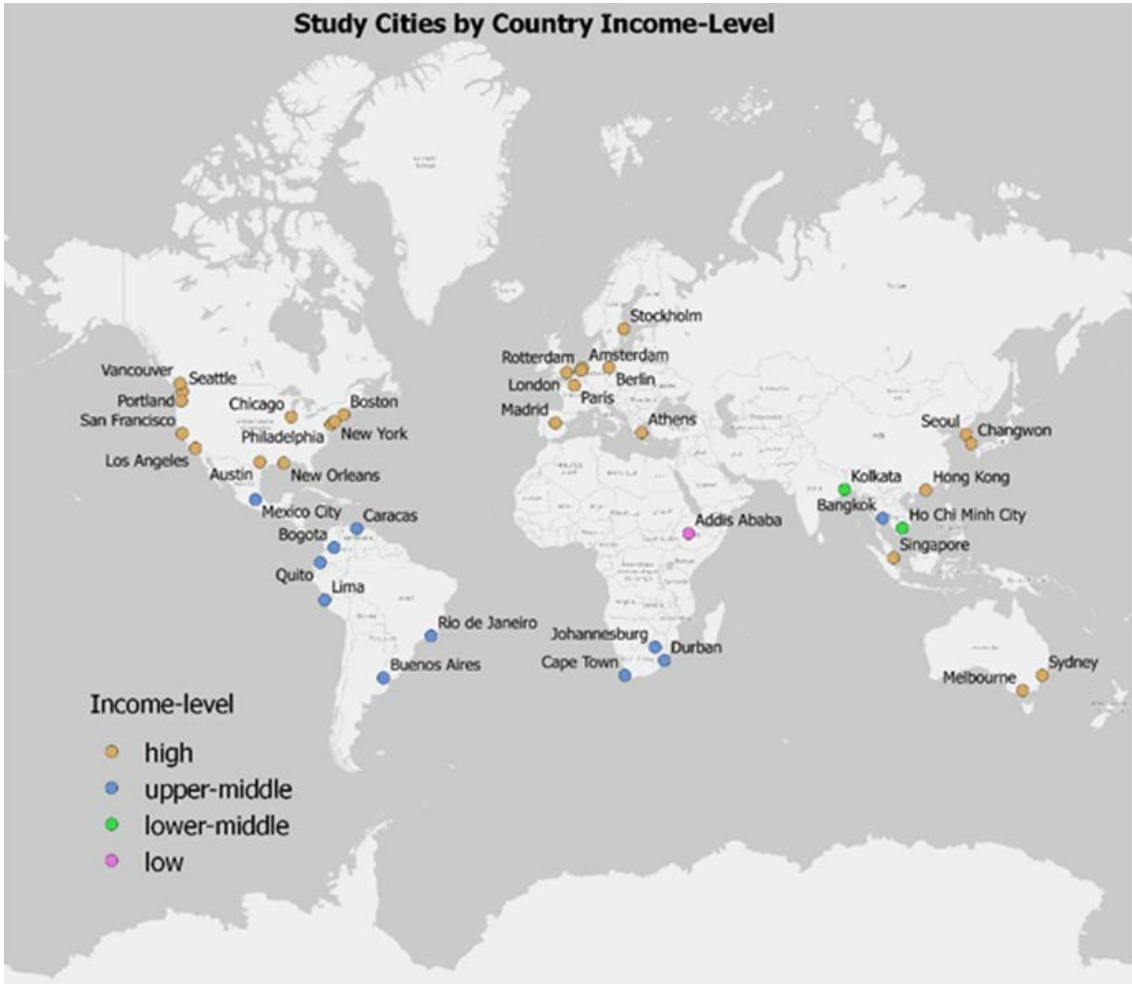


Rural



Other relevant outcomes

- White paper on urbanization, electrification and urban areas (draft)
- Meta-analysis of Risk Inequality and FEW Nexus: A Study of 43 City Adaptation Plans (published in Frontiers)

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CHICAGO
Thanks!
Paty Romero-Lankao