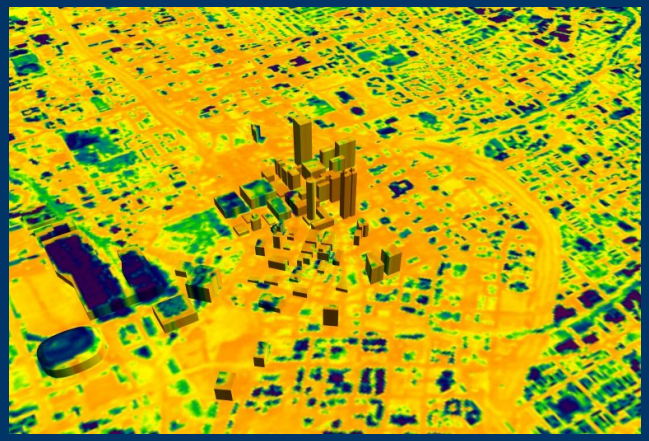
Knowledge Integration in Climate and Health Applications:
Integrated Modeling of Metropolitan Extreme Heat Risk



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IAI-NCAR Colloquium C2012 November 2012 Santo Domingo, Dominican Republic

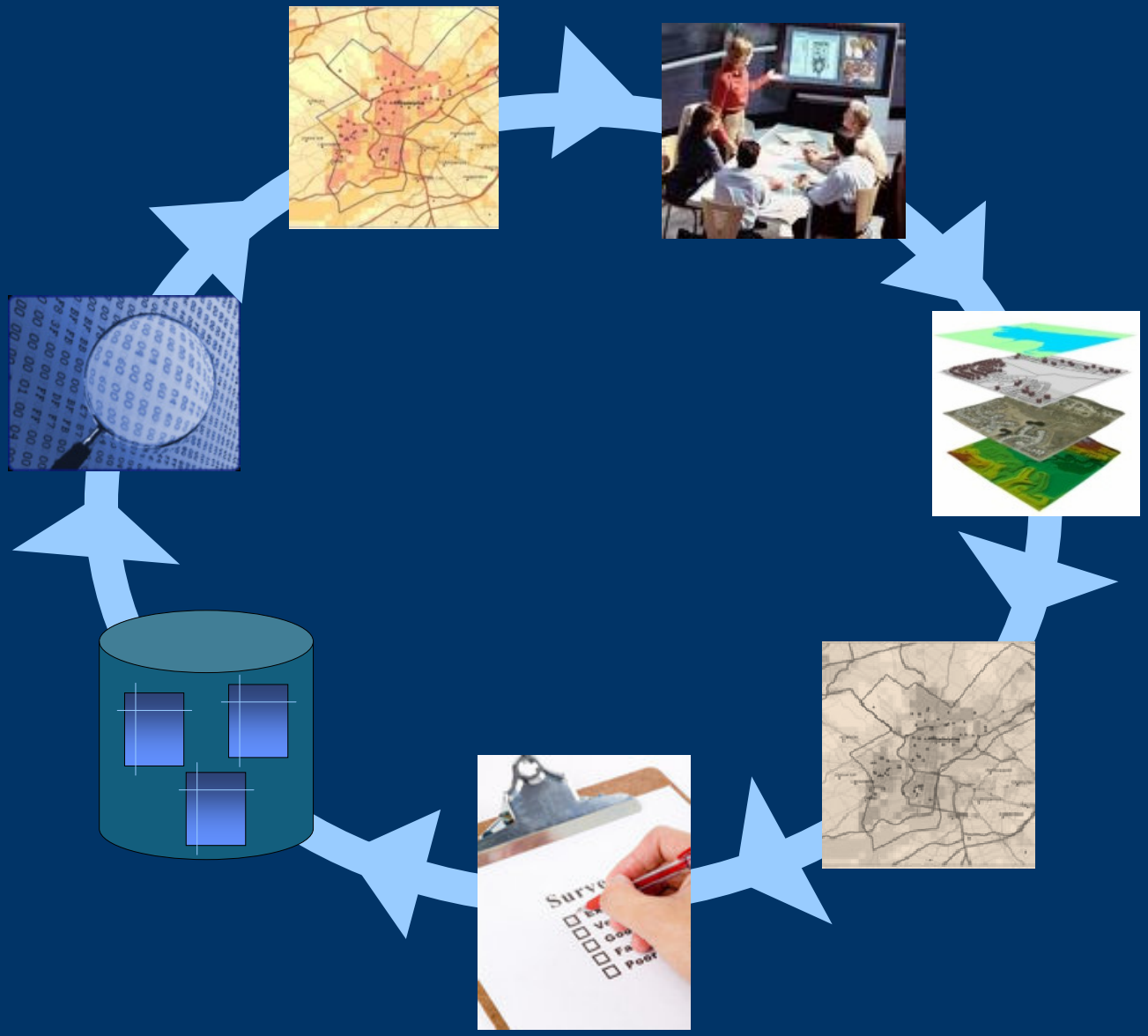
Overview

- Extreme heat and climate change are public health concerns
  - Observed impacts and projected changes in extreme heat events
- Heat waves can be deadly, especially in urban areas
  - Urban heat island
- Impacts (adverse health outcomes) are distributed unevenly
  - Societal vulnerability
- Relationship between human health and extreme heat is a complex medical, social and environmental issue
  - SIMMER project

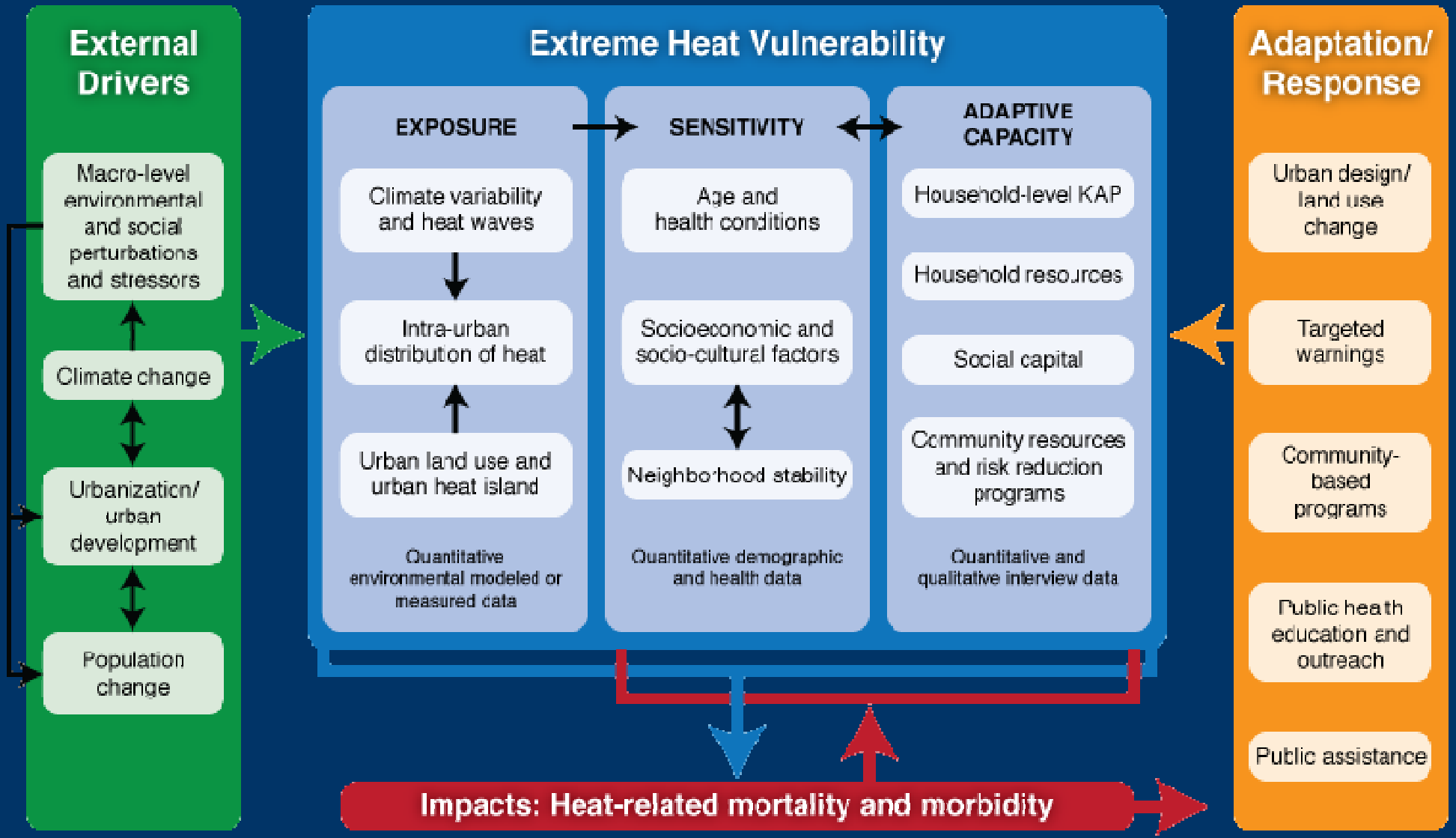
Climate adaptation and extremes

- Developing climate change adaptation strategies requires
  - Better understanding of impact of climate change and weather extremes
  - Better understanding and characterization of societal vulnerability
  - Context-specific extreme heat mitigation and response actions
- Engagement of stakeholders from both the top-down and the bottom-up allows the opportunity to better characterize health risks and develop policies for public health climate adaptation

Stakeholder engagement



Research framework



Wilhelmi and Hayden (2010, ERL)

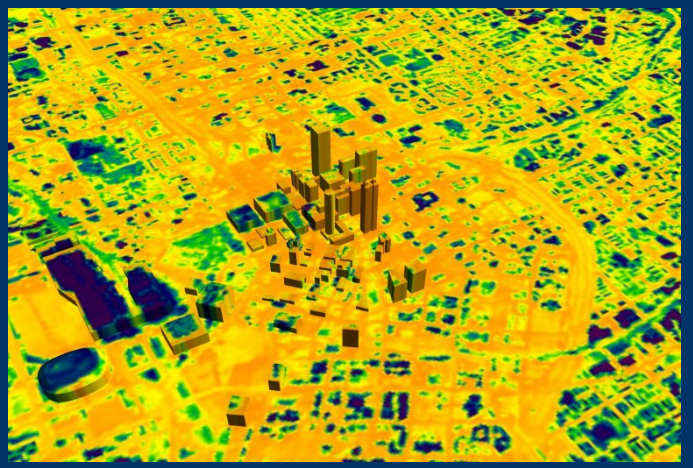
System for Integrated Modeling of Metropolitan Extreme Heat Risk (SIMMER)

NASA ROSES (09-IDS09-34)
2010-2013

Goal: Advance methodology for assessing current and future urban vulnerability from heat waves through integration of physical and social science models, research results, and remote sensing data

SIMMER Research Components

- Improving representation of urban land cover and its accompanying radiative and thermal characteristics at local and regional scales
- Characterizing and modeling present and future extreme heat events at regional and local scales
- Characterizing societal vulnerability and the responses (i.e., mitigation and adaptation strategies)
- Determining the combined impact of extreme heat and the characteristics of urban environmental and social systems on human health
- Characterization and communication of uncertainty

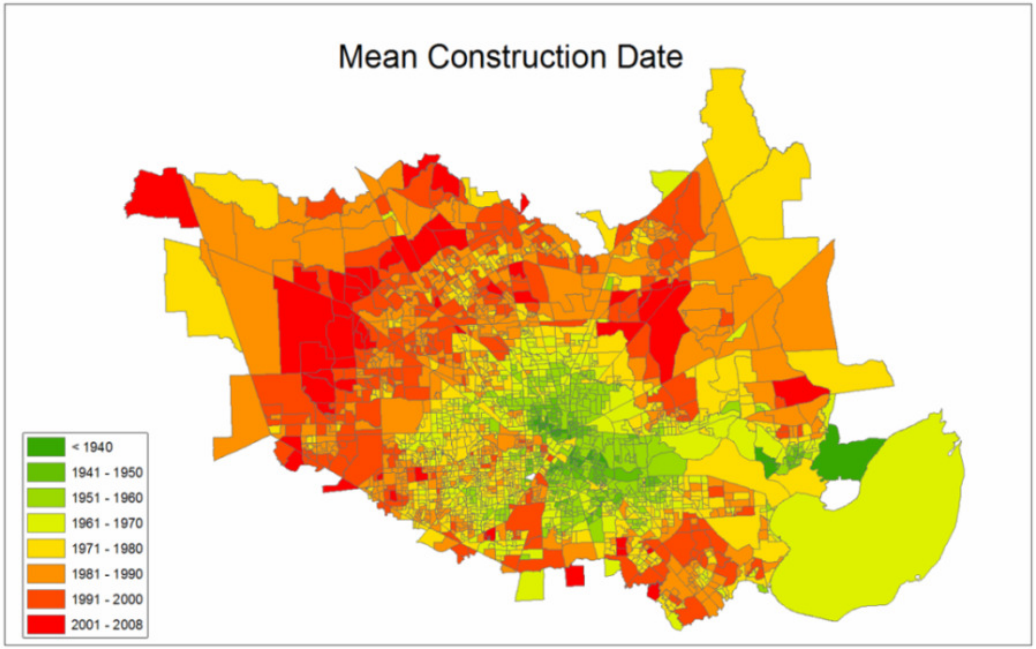


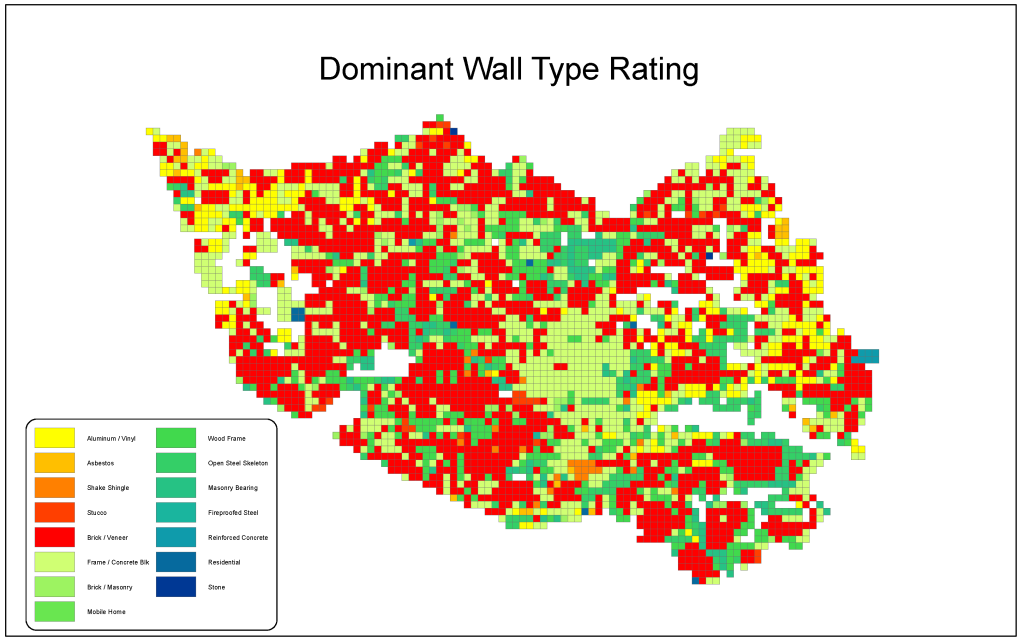
Improving representation of urban land cover

- **Building information from the Houston city housing database**
- **Use the database to determine the typical house properties by neighborhood (walls, roofs, windows)**

By Census Block Group

By WRF grid cell (~1km resolution)

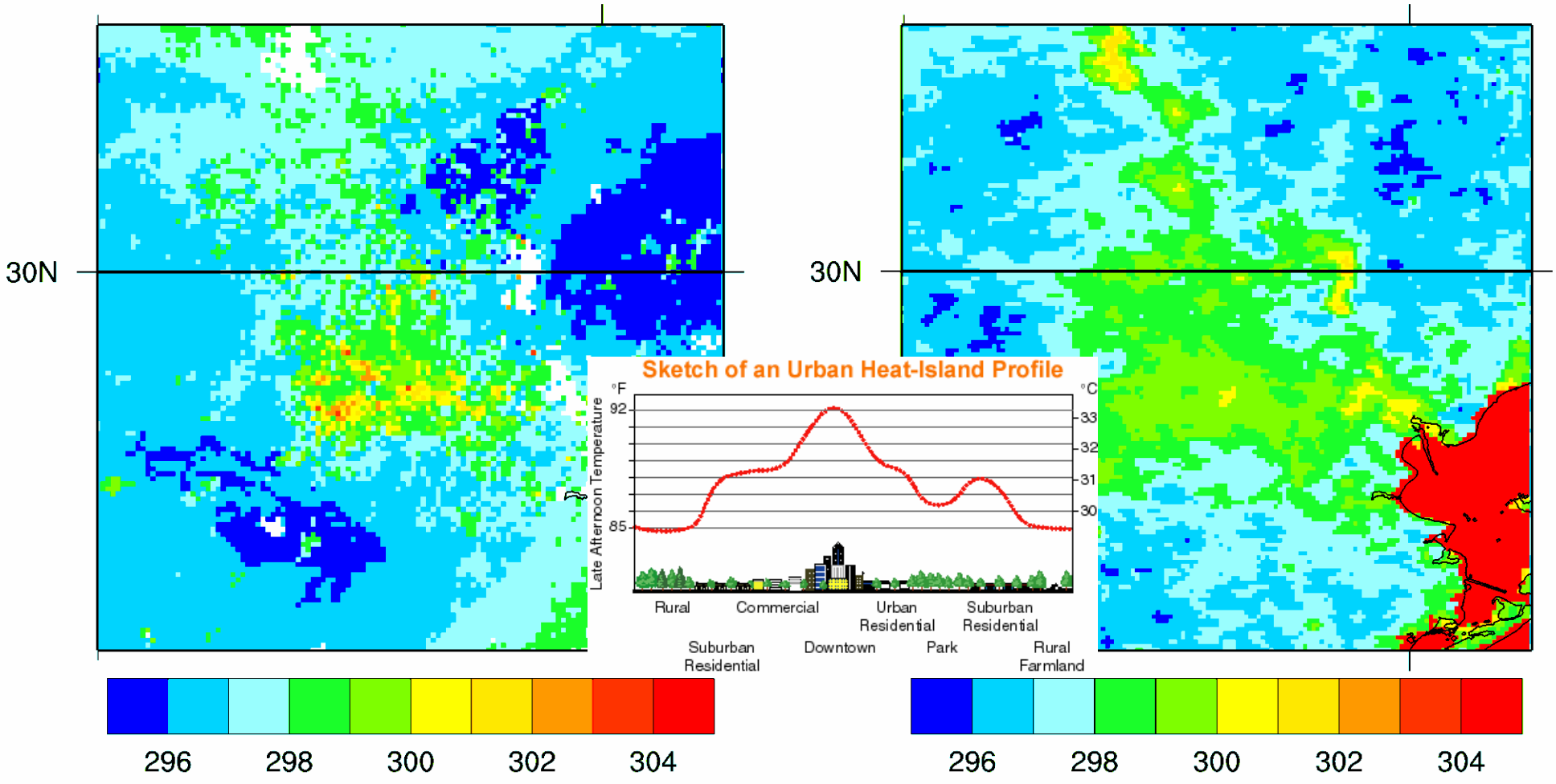




Johannes Feddema, U. Kansas

Land Cover and Urban Heat Island

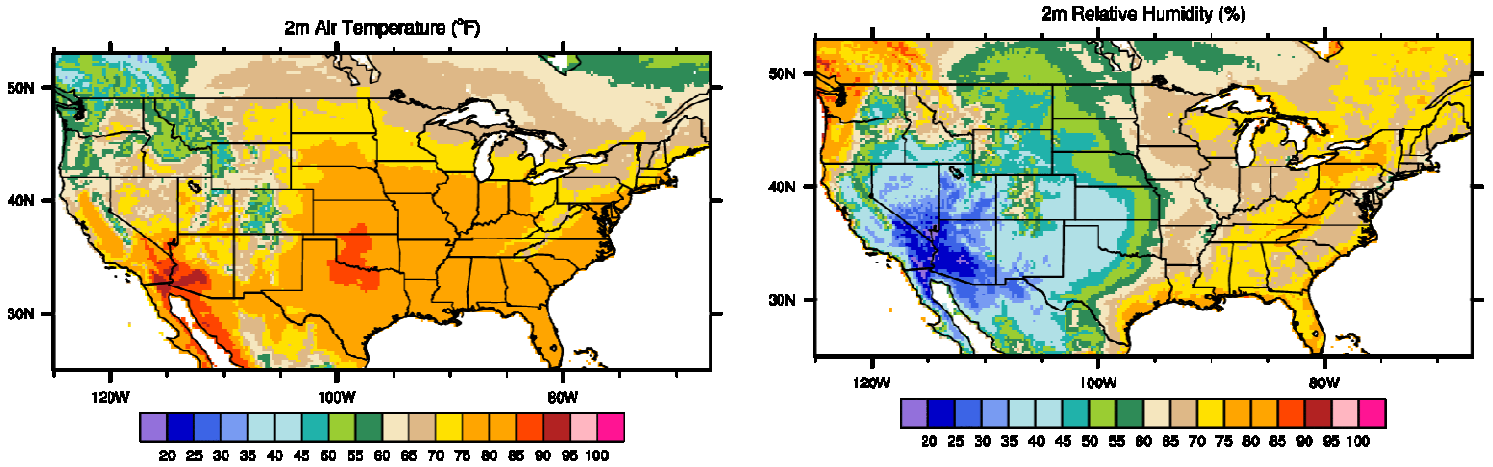
HRLDAS (MODELED) MODIS



Nighttime UHI: 2006-08-21

“Heat” Modeling

- **Regional simulations of heat waves using Community Land Model - Urban at 25 km**
- **Heat measures and future climate projections**

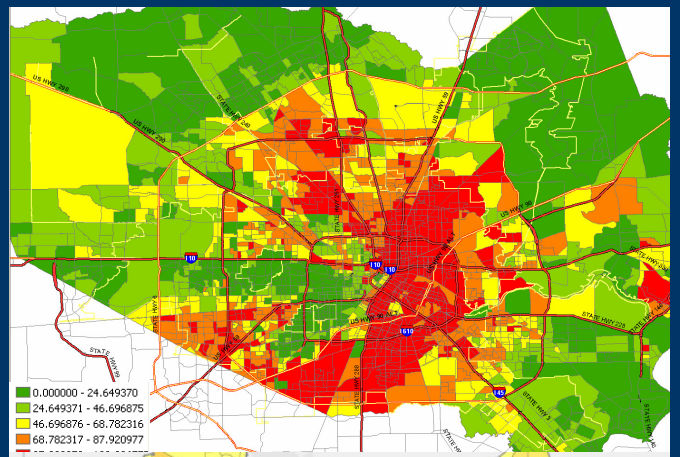


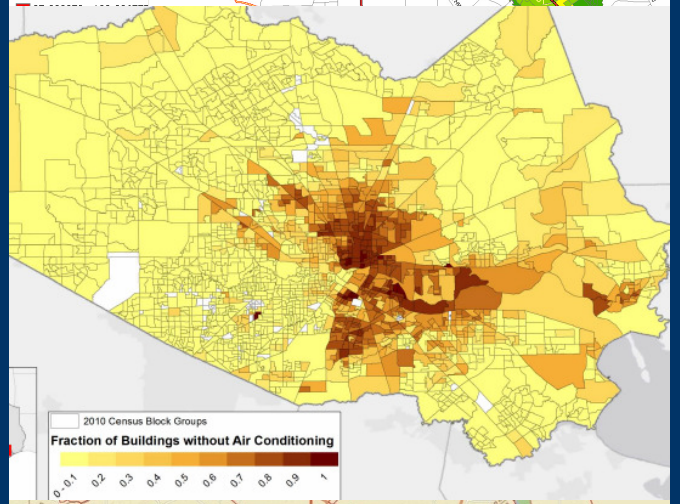
JJA 1986-2005

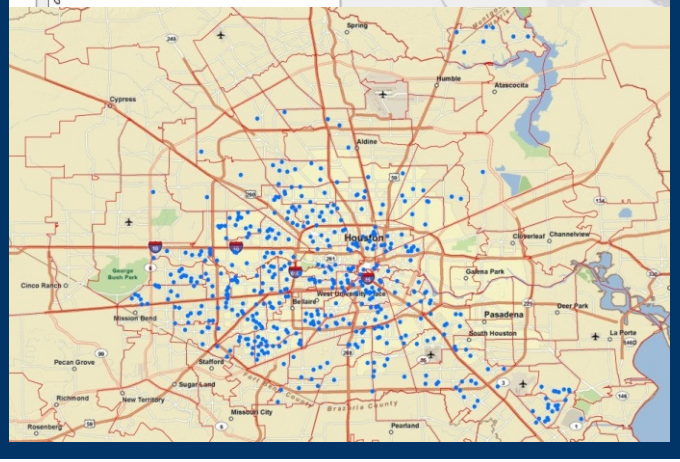
Keith Oleson, NCAR

Societal vulnerability and responses

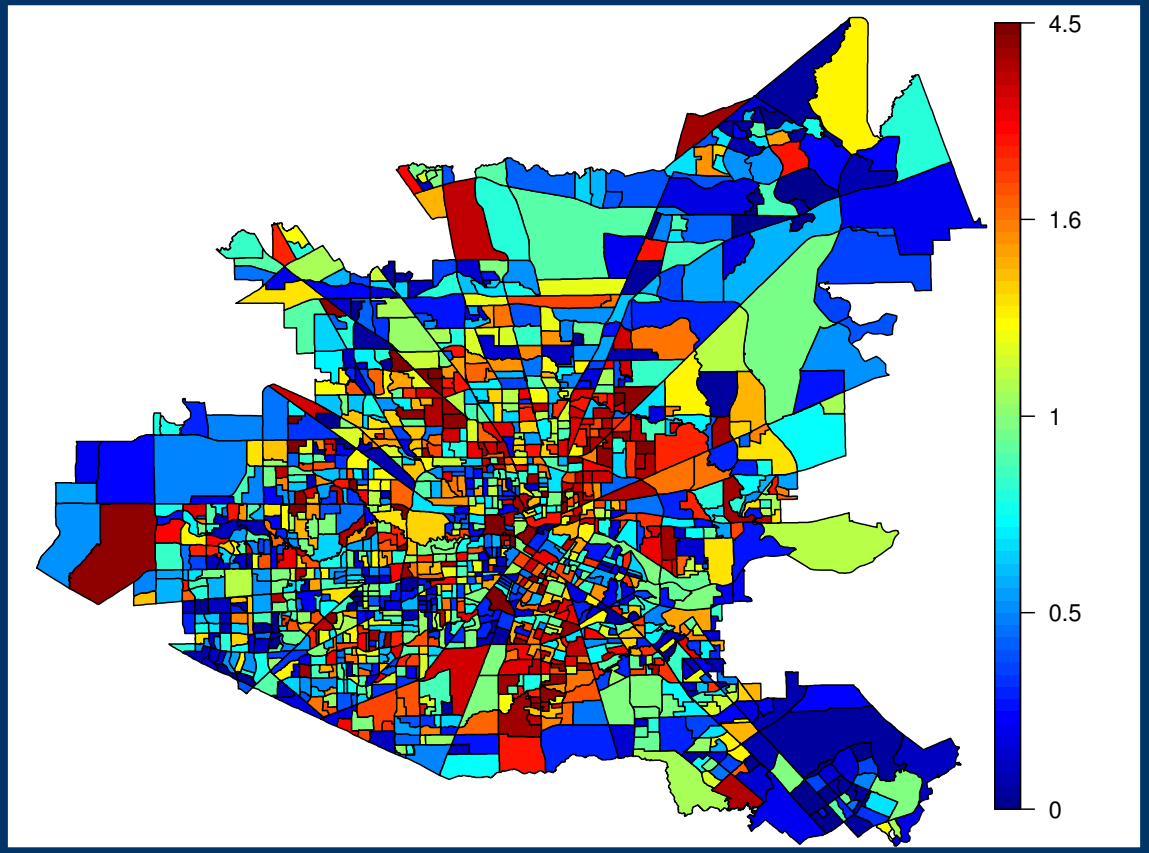
- **Spatial representation of sensitivity and adaptive capacity**
  - age, income, social isolation, education, pre-existing health conditions, location, household resources, access to cooling
- **Data sources:**
  - US Census (block groups)
  - American Community Survey
  - Parcel /building database
  - Household survey (2011)
  - Stakeholder survey (2012)







Integrating diverse data into empirical heat-health models: relative risk

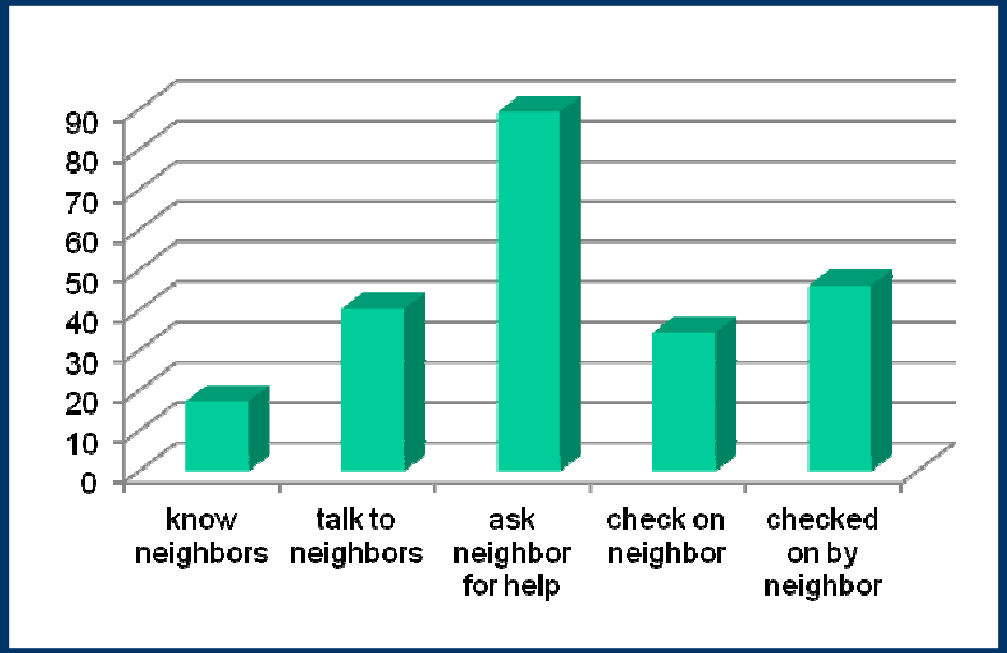


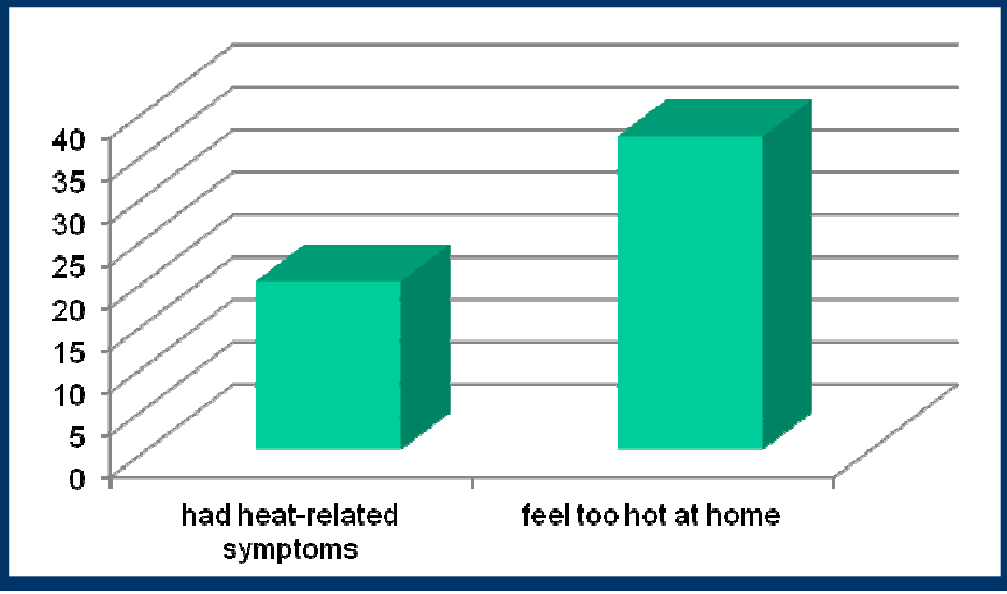
- **Multi-level statistical model**
- **Response variable: heat-related mortality**
- **Covariates: factors of exposure and sensitivity**
- **Which populations are at higher risk from heat-related health problems?**

Variable	Post. Mean	95% CI	Pr(>0)
% >65	4.06	(3.95, 4.24)	1
% NOAC	0.29	(0.07, 0.51)	1
% Black	0.53	(0.36, 0.7)	1
% <5	-3.43	(-3.62, -3.23)	0
% >65 White Alone	0.71	(0.51, 0.87)	1

Adaptive capacity: household survet

- Critical component in climate adaptation
- Use survey to explain low/high risk so we can differentiate how high risk in one block group is different from high risk in another
- Houston: 2011 household survey (n=901); 2012 stakeholder survey and 2012 focus groups (8)
- ~ 60 questions about Knowledge, Attitude, Practices (KAP), Social capital, Household Resources and Community/Government Programs

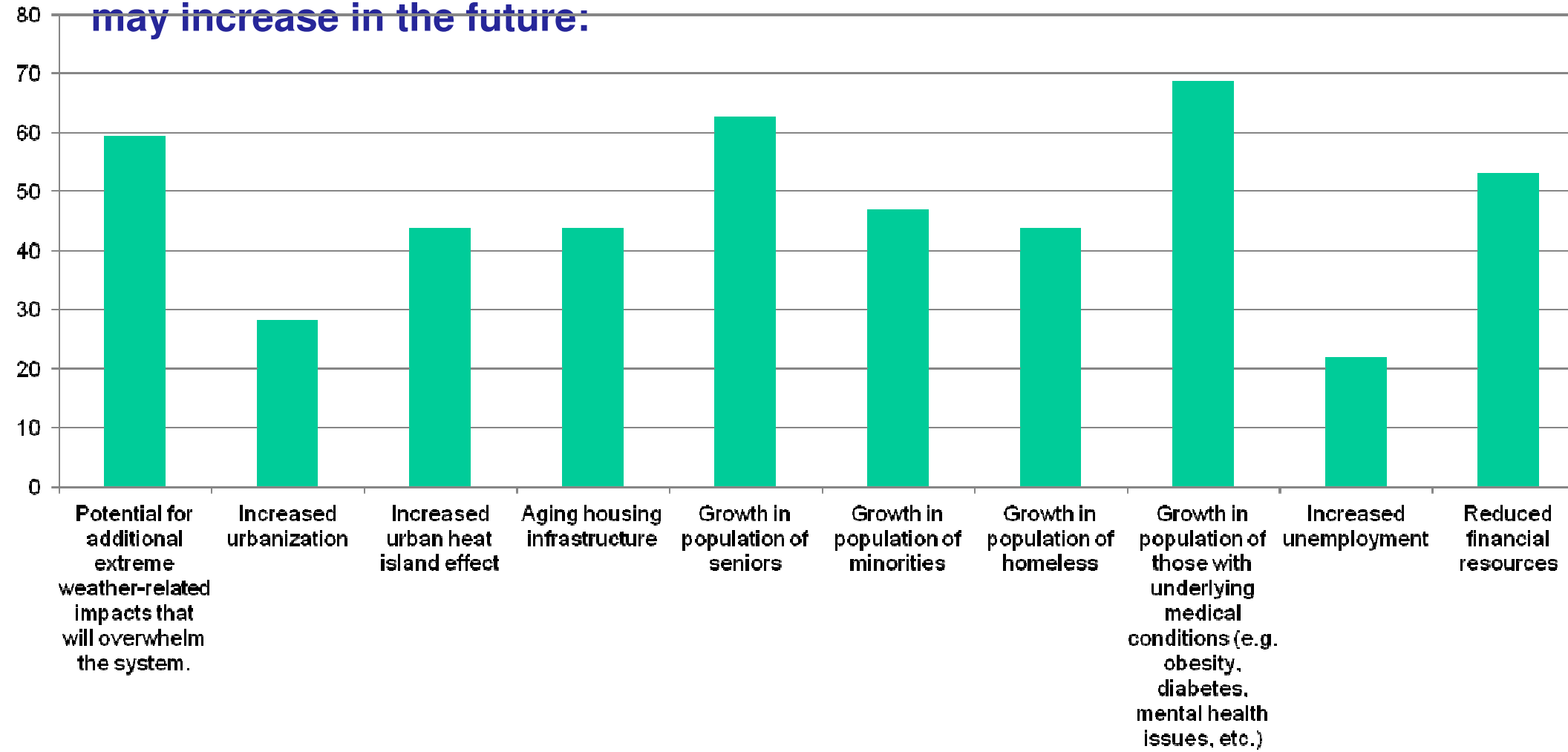




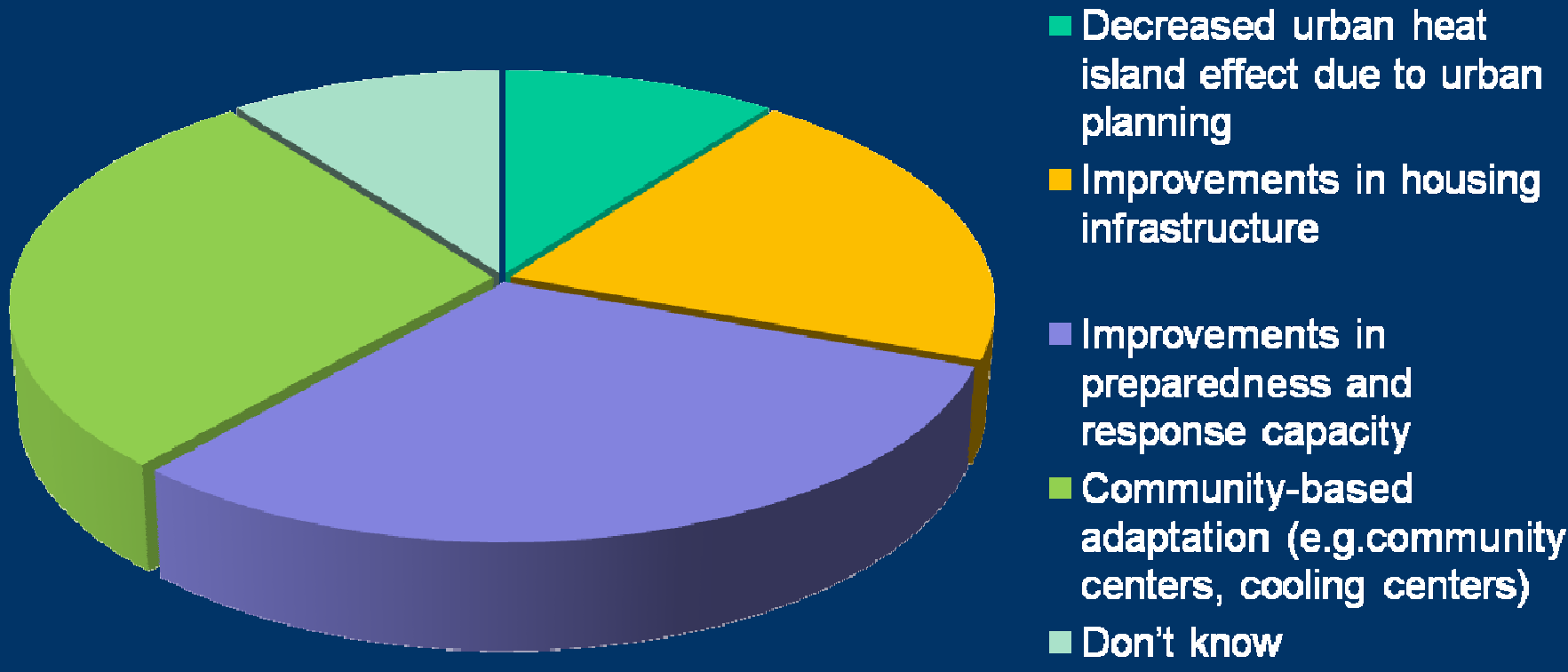
Stakeholder survey

- **Stakeholders (33) identified increasing heat-health risks**

Describe how you think the vulnerability to health risks from extreme heat may increase in the future:



Houston stakeholder survey: Describe how you think the vulnerability to health risks from extreme heat may decrease in the future



- **60 percent of survey respondents (local stakeholders from governmental, non-governmental, public and private organizations highlighted *non-structural* ways for reducing urban vulnerability to extreme heat**

Summary

- **The relationship between human health and extreme heat is a complex medical, social and environmental issue (Interactions between exposure, sensitivity and adaptive capacity)**
- **In assessing vulnerability, we need to focus on "*where?*" "*who?*" and "*why*?"**
  - Quantitative and qualitatve
- **Involvement of stakeholders (departments health) as project partners**
- **Analysis may be *complex* but the output (or product, e.g., integrated modeling system) needs to be *simple:***

  GIS map that shows factors of vulnerability and possible interventions, neighborhood by neighborhood.

Thank you!

- **SIMMER project participants:**
  - NCAR (O. Wilhelmi, (PI), A. Monaghan, M. Hayden, S. Sain, K. Oleson, M. Barlage, C. Uejio (now at CDC), J. Boehnert, M. Heaton, T. Greasby, K. Sampson, J. Pelzman)
  - University of Kansas (J. Feddema and N. Brunsell)
  - Houston Department of Health and Human Services (D. Banerjee and V. Nepal)
  - Health Canada, Climate Change and Health Office (A. Yagouti and C. Simpson, K.-L. Clarke)
  - Toronto Public Health (C. Mee and S. Gower)
  - Toronto Environment Office, City of Toronto (C. De Jong)
  - CIESIN, Columbia University (A. de Sherbinin)
  - Ryerson University (C. Rinner)
  - University of Georgia (M. Shepherd)
  - HARC (R. Harriss)