



Jennifer Senick, PhD, is Executive Director of the Rutgers Center for Green Building at the Edward J. Bloustein School of Urban Planning and Policy Development, Rutgers University, and an instructor in the department.

An experienced urban planner, Dr. Senick received her PhD. in Planning and Public Policy from Rutgers, her M.A. in Political Science from UCLA, and her A.B. in Government from Bowdoin College.

Areas of expertise include sustainable development, resiliency planning, green building and environmental behavior.

Current appointments include Environmental Design Research Association (EDRA), co-chair Sustainable Planning Design and Behavior Network; American Planning Association (APA) International Division, coordinator International Health Planning and Impact Assessment Initiatives, American Planning Association-NJ, Chapter Board of Directors.



Heat Waves, Seniors, and Low-Income Housing: Organizational Factors in Individual Adaptive Behavior

**IFoU 12th Annual Conference
Beyond Resilience**

**Universitas Tarumanagara, Jakarta
27-29 June 2019**

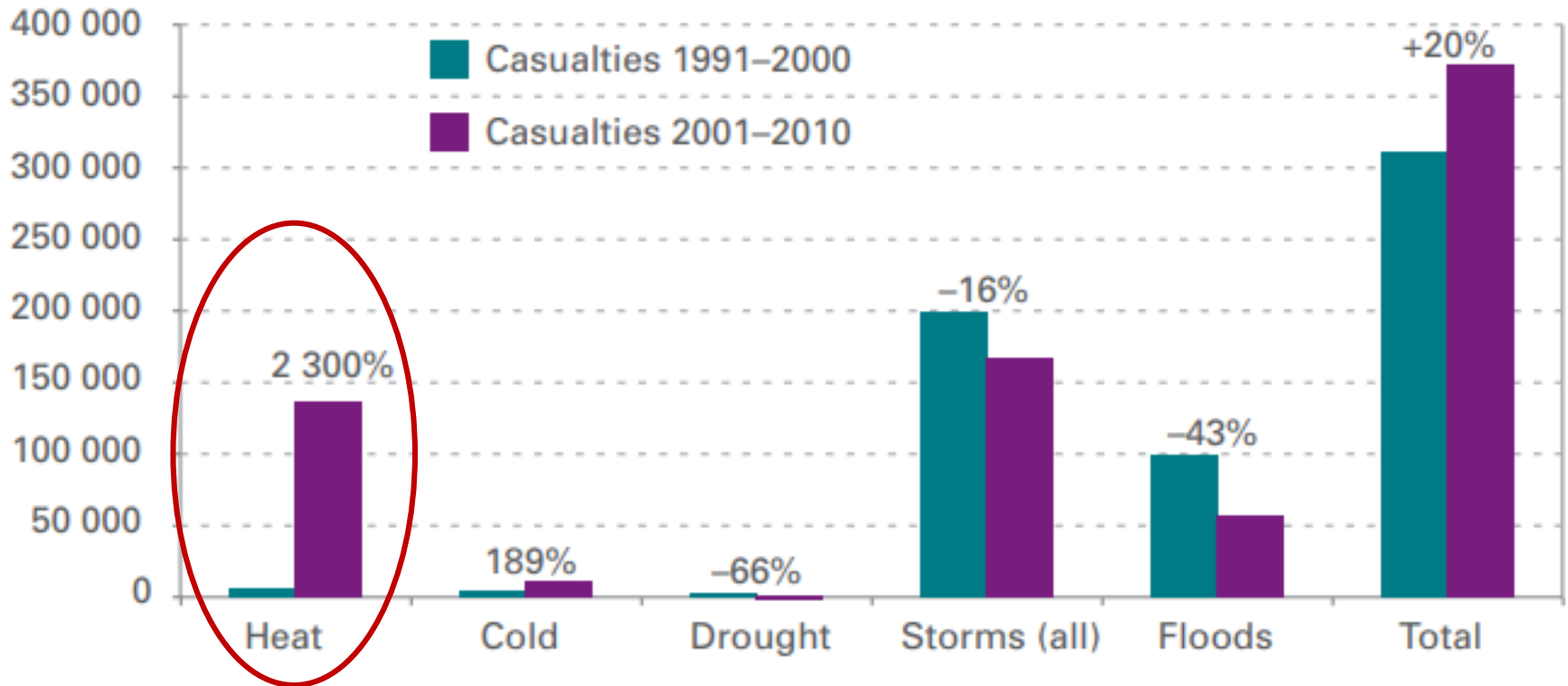
Jennifer Senick, Ioanna Tsoulou, Clinton Andrews,
Gediminas (Gedi) Mainelis, Ruikang He, Deborah Plotnik

Funded by NSF Grant AGS-1645786

Behavioral Inquiry: How do seniors living in public (low-income) housing cope with heat waves ?

- Cool drinks, wet clothes, open windows, use fans, leave apartment?
- Alternatives accessed through formal and informal group affiliations?
- Other adaptive actions?
- What is the nexus between air quality and building-level affordance?
- Between air quality and behavior?





Global Weather Fatalities

Dramatic increase in reported deaths, mainly due to 2003 and 2010 heat waves.



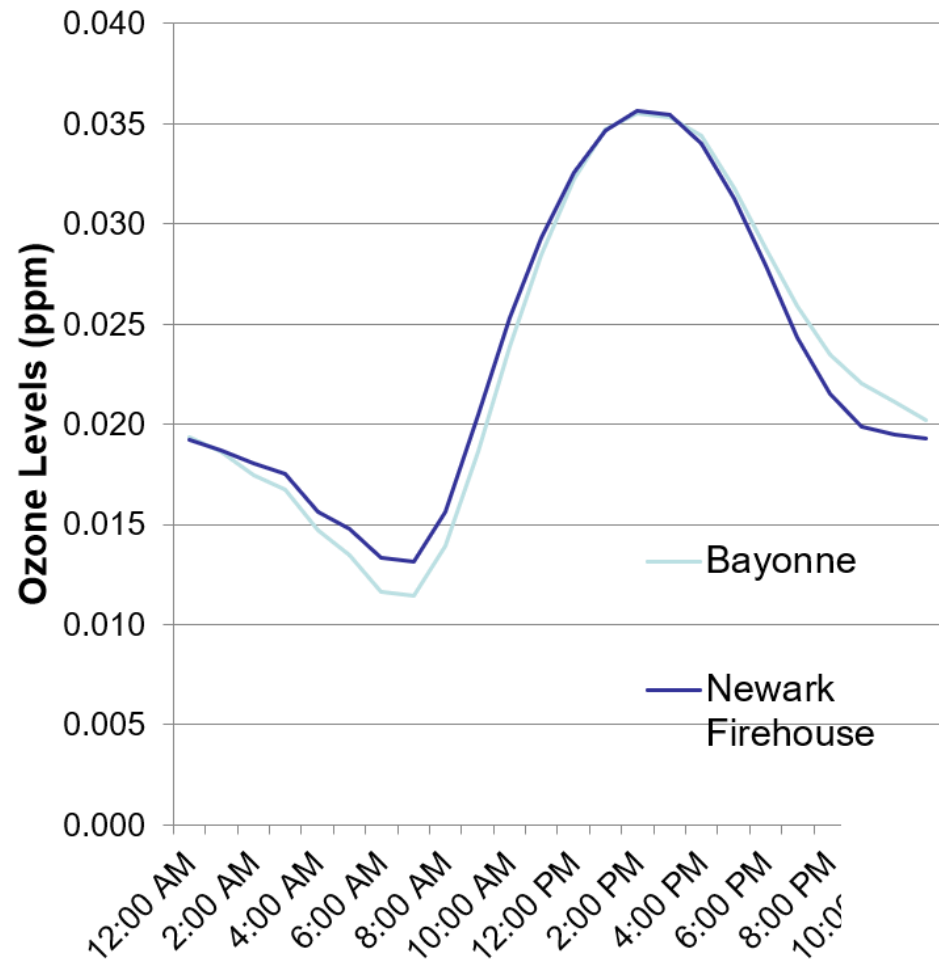
Heat in Urban Environments

Urban Heat Islands + Urban Air Pollution

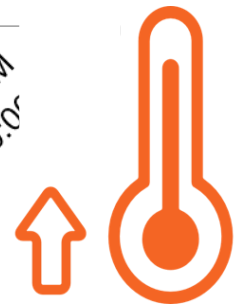
Heat Waves + Air Quality

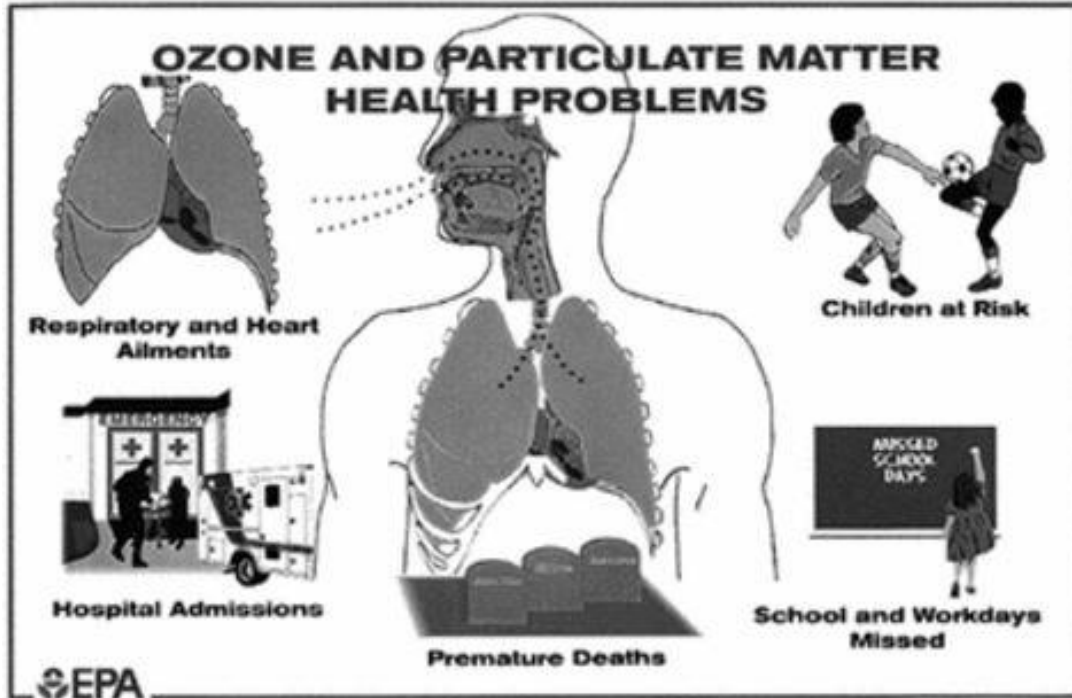
- High temperature associated with higher levels of ozone.
- Ozone, PM2.5, PM10, CO₂ + high temperature have negative effects on health.
- Vulnerable populations include seniors, children, health-impaired.

Average Hourly Ozone (2016)



Monitoring Stations





Air Quality Report 2015, NJ DEP

Indoor Air Quality & Health

- Indoor exposures to air pollutants also contribute to health effects (people spend 90% of time indoors).
- No standards for indoor PM.
- Indoor air quality \approx f (outdoor air quality, building design, occupant behavior).
- Individual health outcomes vary, even for similar exposures.

Heat and Vulnerable Populations

- Vulnerable populations include those with health conditions, the elderly, young children, socioeconomically disadvantaged individuals and racial or ethnic minorities (NCBI)
- Frequently, disadvantaged populations are housed in low resource communities with greater environmental threats including poor air quality

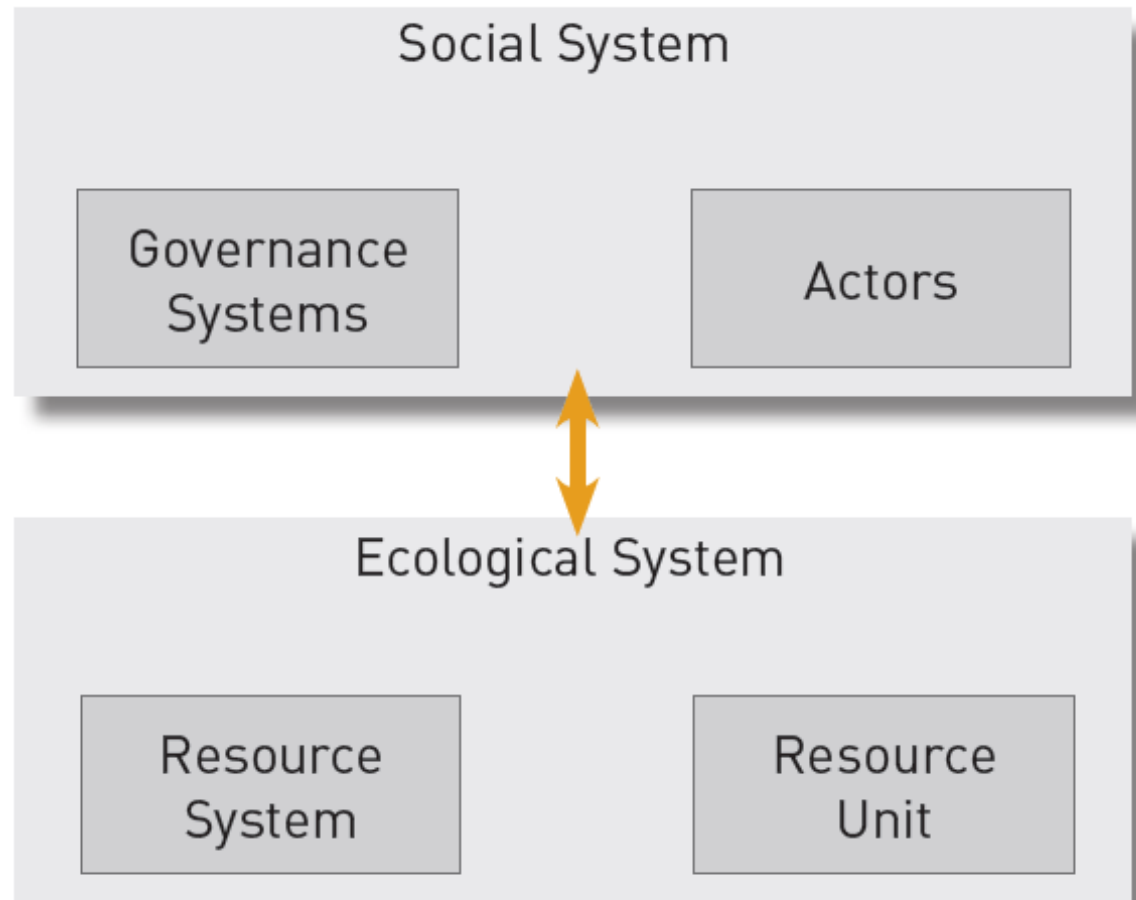


Research Framework Social- Ecological Systems

What is an SES

“Organized structure that includes human and non-human forms interacting with each other in a spatially determined geophysical setting.”

Halliday and Glaser, 2011



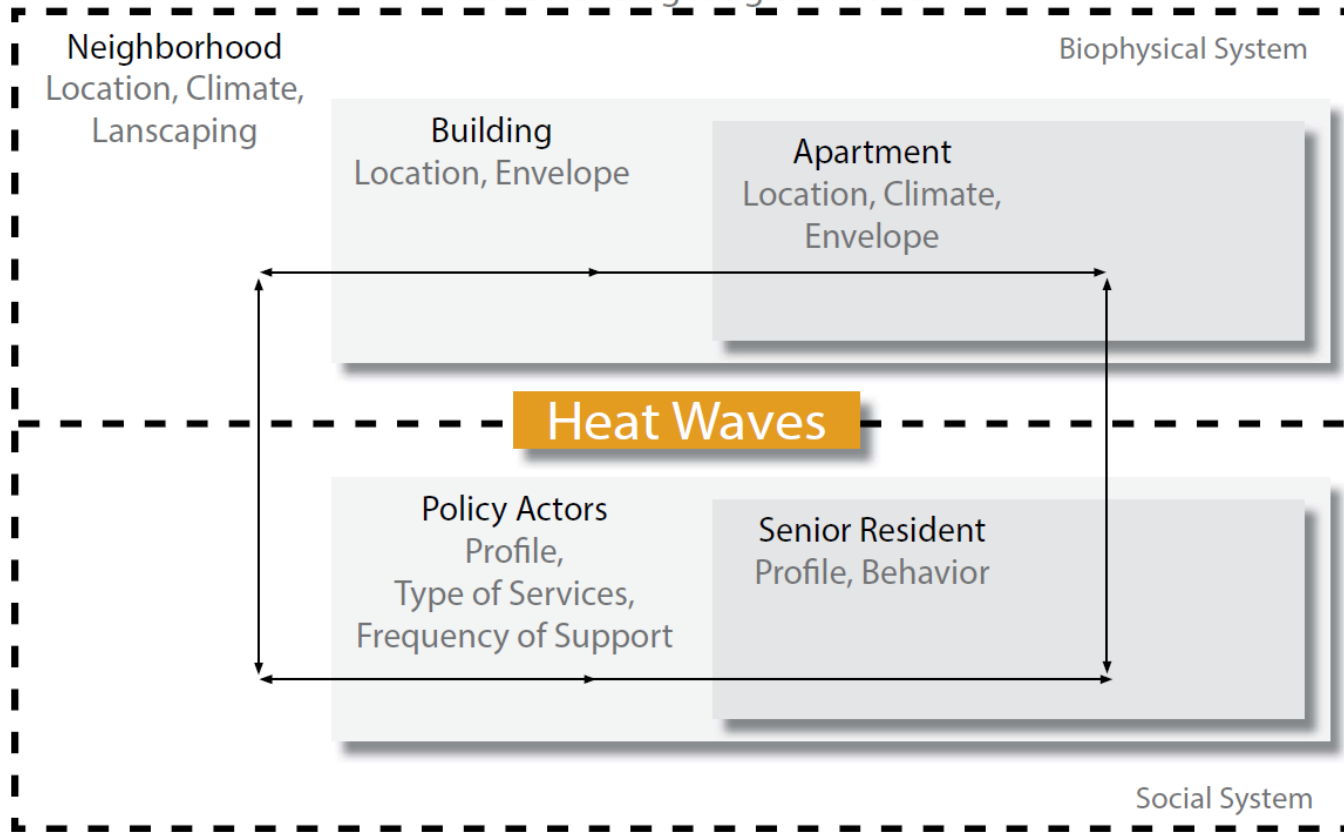
Ostrom (2009):

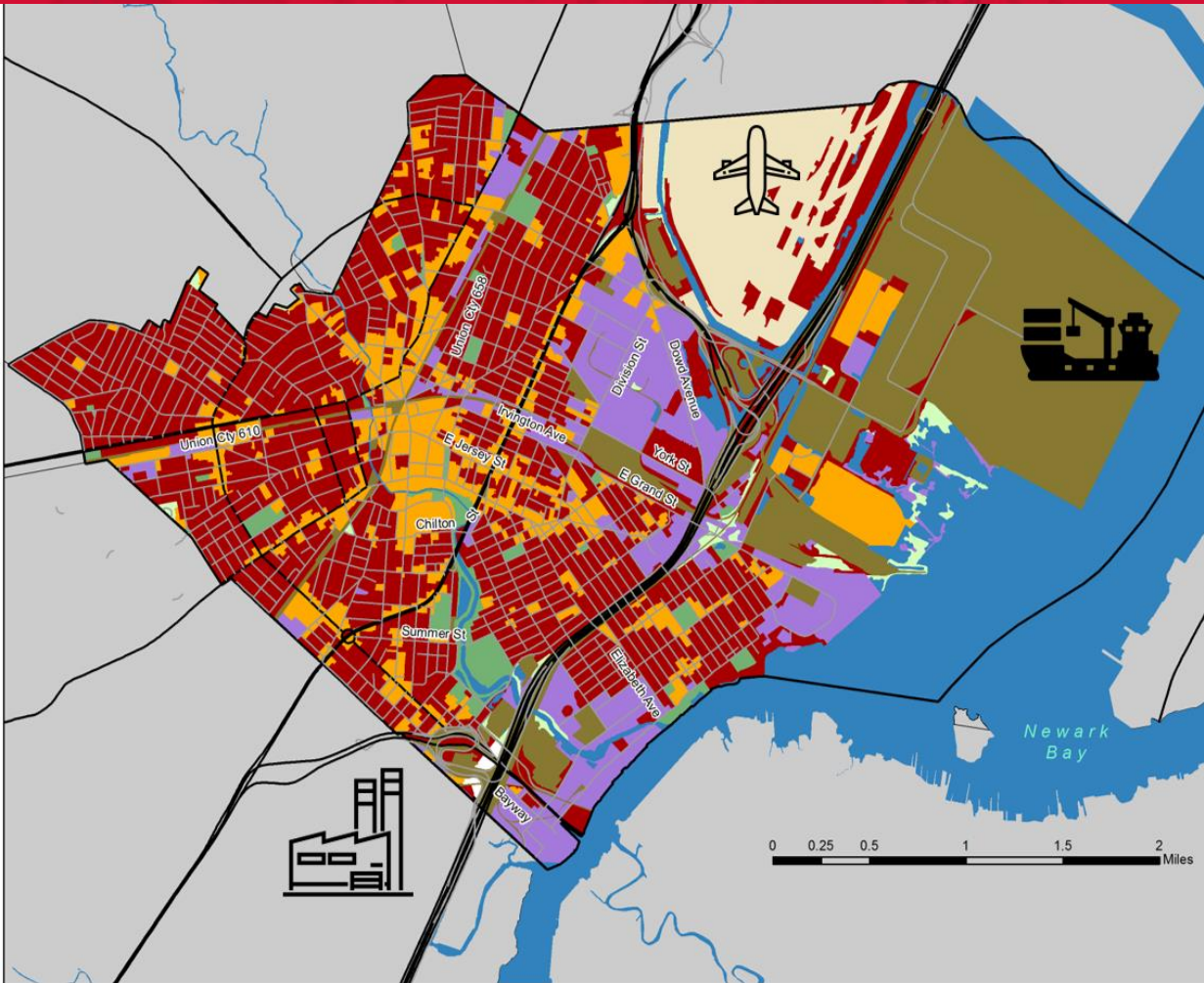
Successful integration among different perspectives:

A common framework.

The SES Framework of the Public Housing Community.

Source: Adapted from Ostrom (2005)
Public Housing Neighborhood

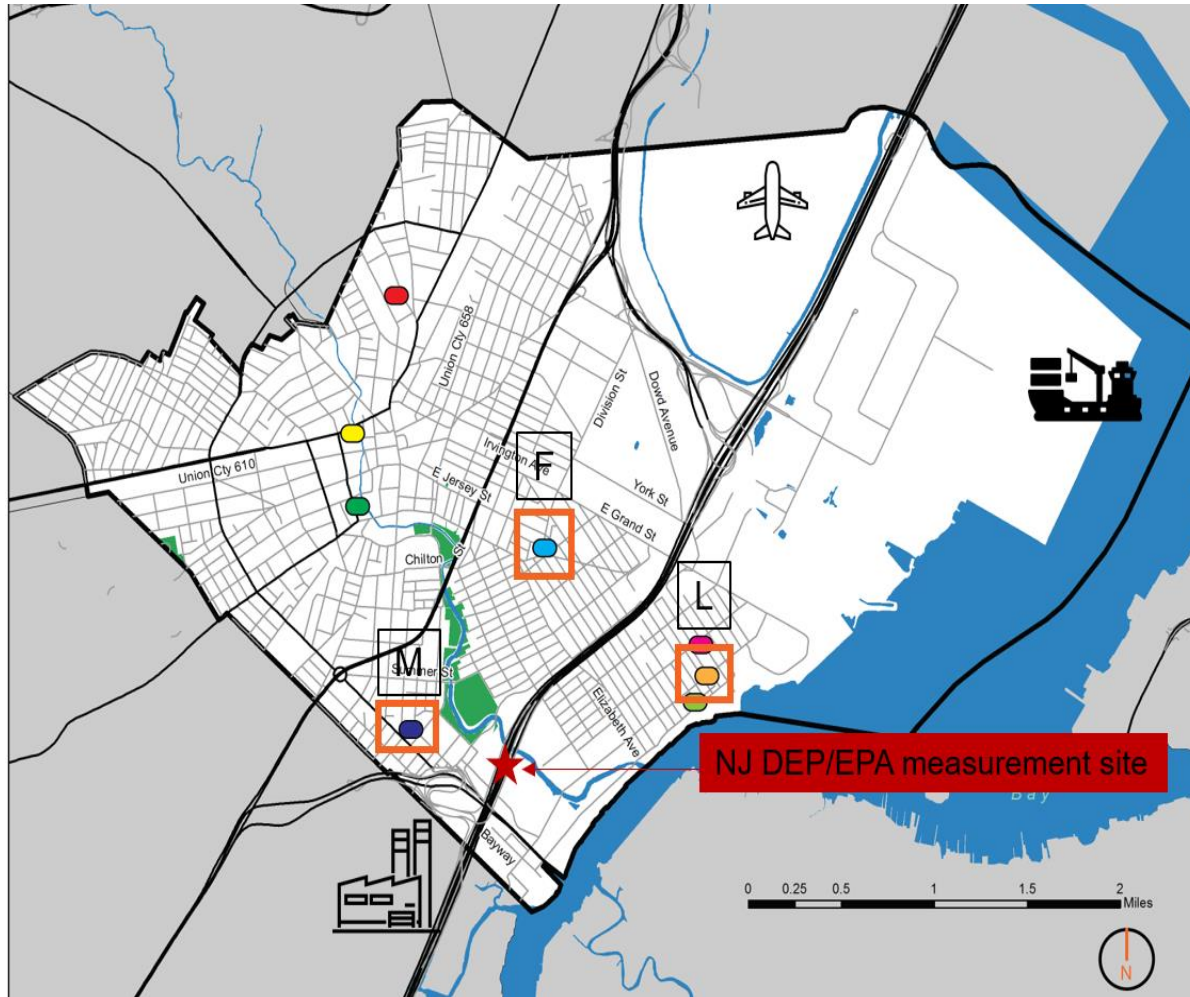




- Newark Airport
- Port Newark Marine Terminal
- Chemical refineries
- Highways



Biophysical Subsystem: Elizabeth, NJ



HACE Properties

- O'Donnell Dempsey Towers
- Kennedy Arms
- Farley Towers
- Ford Leonard Towers
- Mravlag Manor
- Heritage Village
- 205 1st St
- Marina Village

Resource Units: 3 Affordable Housing Sites owned by the Housing Authority of the City of Elizabeth, NJ

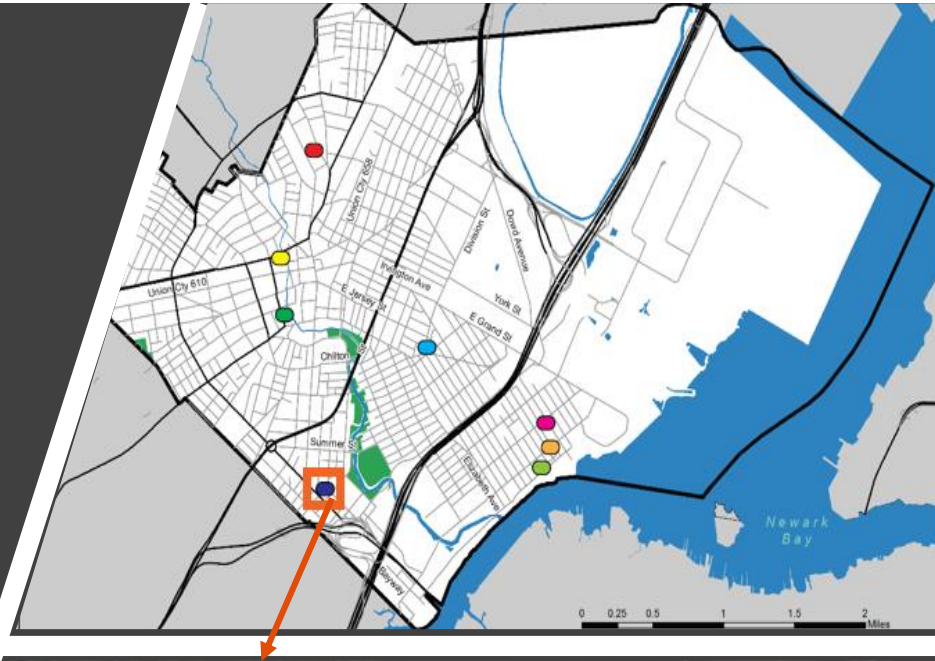


HACE:
Housing Authority of the
City of Elizabeth, NJ

- Formed in 1938.
- **Scope:** to meet the housing needs and improve the quality of life for its residents.
- Has successfully demonstrated its capacity to deliver a broad range of services ranging from social, economic, educational, and redevelopment.

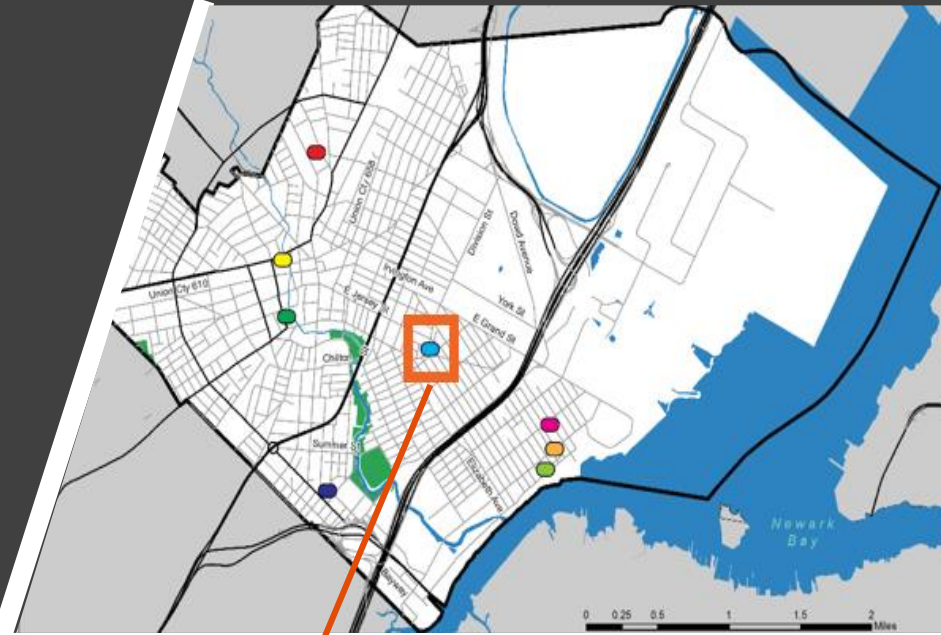
Mravlag Manor (Site M)

- 421 Units in 15 buildings, 3-story walk-ups
- New roofs, fire escapes, heaters + bathrooms
- On-site community room and event space
- Social + financial support services on-site
- No central air conditioning



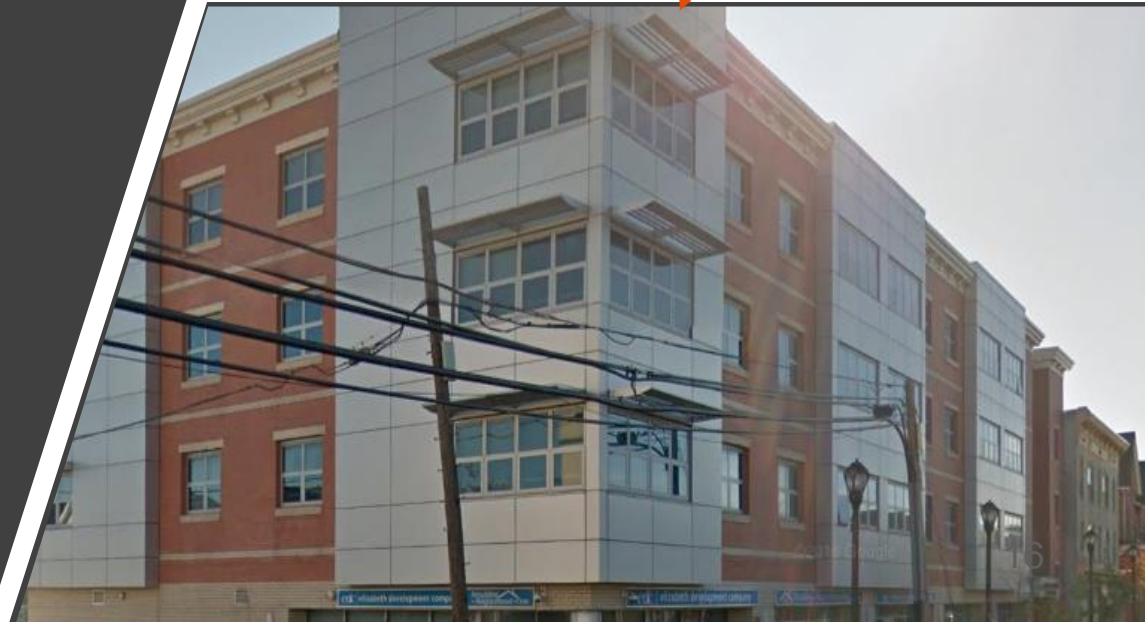
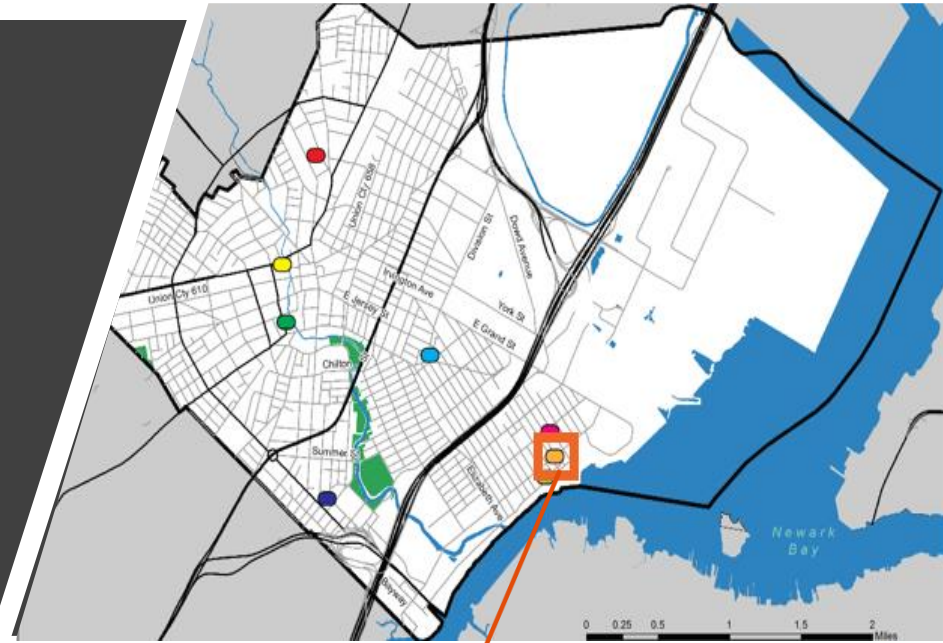
Ford Leonard Towers (Site F)

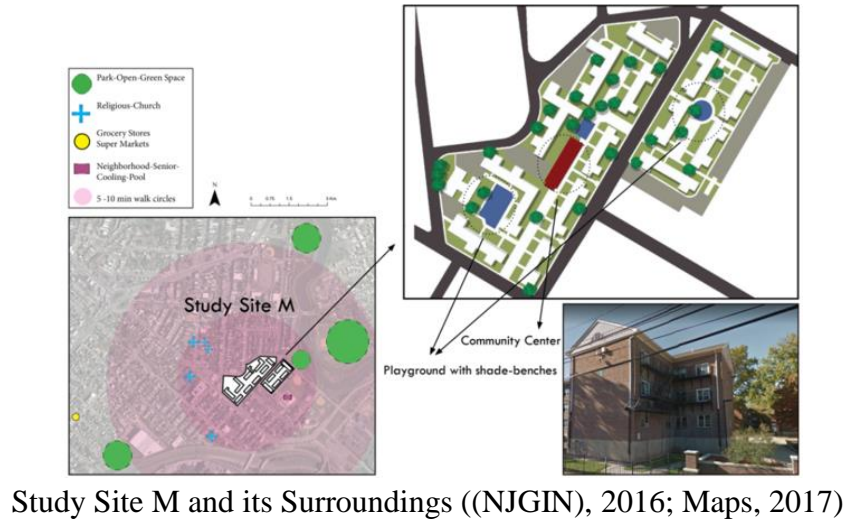
- 121 Units
- 11-stories (1 building)
- Extensive upgrades
- Community Space
- No central air



205 First Street (Site L)

- 30 Senior-only units
- Newest HACE property
- LEED Gold
- All units have access to central air





Physical characteristics of the study sites

Question	Answer	% of responses
Gender	Female	84%
	Male	16%
Age	55-64	34%
	65-74	45%
	75-84	21%
Education	Elementary school	4%
	Secondary school	21%
	High school	63%
Income	< 10,000	80%
	10,000-19,999	16%
	20,000-39,999	4%

Question	Answer	% of responses
Overall Health	Very Poor	4.25%
	Fair	54%
	Good	37.5%
	Somewhat good	4.25%
Chronic Condition exacerbated by Heat	Yes	50%
	No	50%
Medical Care because of Heat	Yes	13%
	No	83%

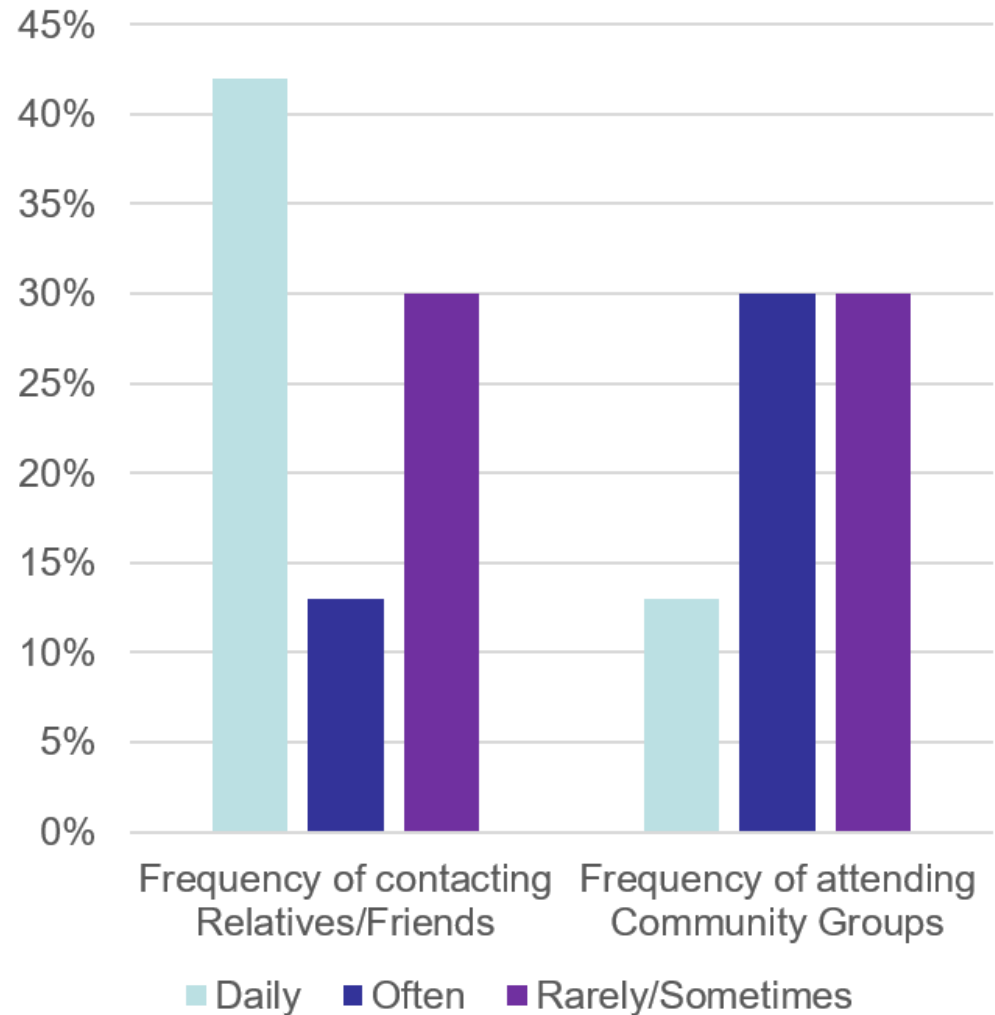
Baseline interview (n = 24)

Study Participants: Social, Economic and Health

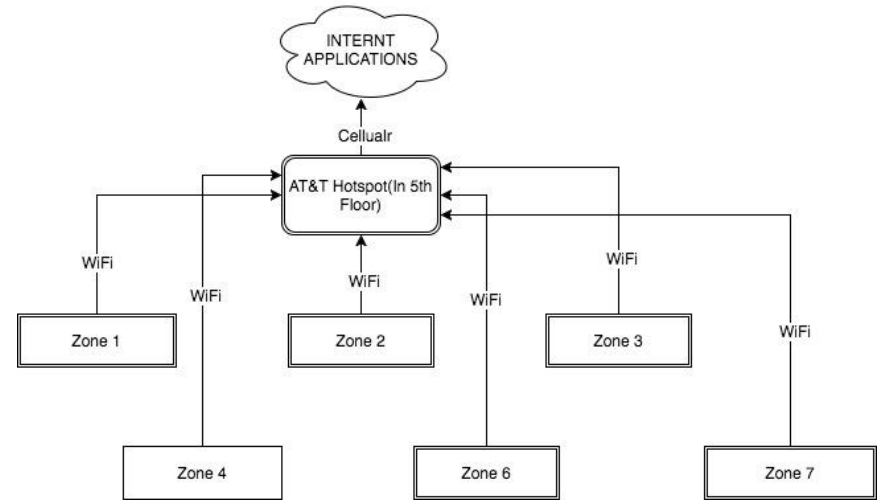
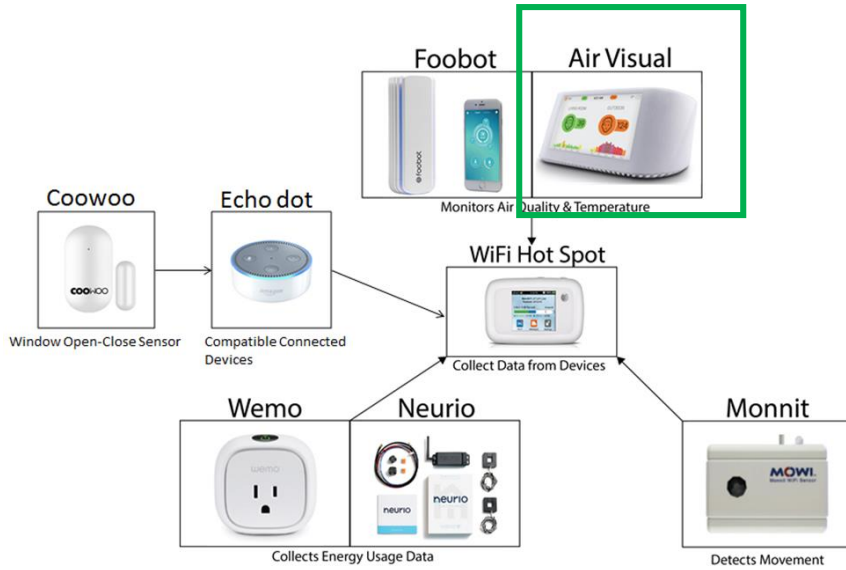
Social Behaviors of Residents (Baseline Conditions)

70% of respondents participate in Community Groups

Social Behaviors



Baseline interview (n = 24)



Consumer-grade sensors network for apartments (24)

Air Quality Measurements: Outdoor site



Findings: Air Quality Measurements

T higher on heat wave days, as expected

Highly variable PM2.5 and I/O ratios among apartments

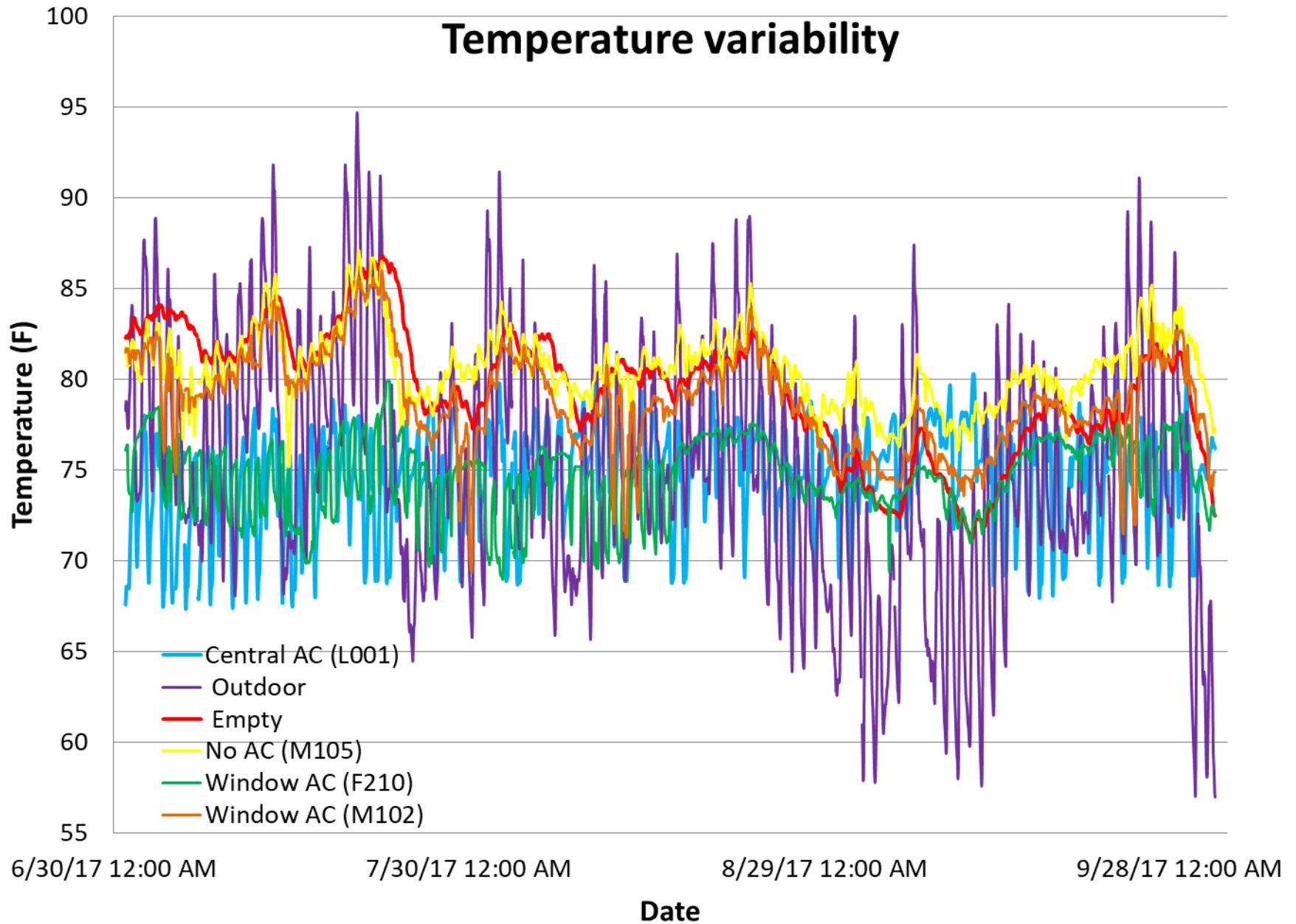
Clear role of smoking in indoor PM2.5 concentrations

Strong correlation between outdoor T and indoor ozone, especially during hot days

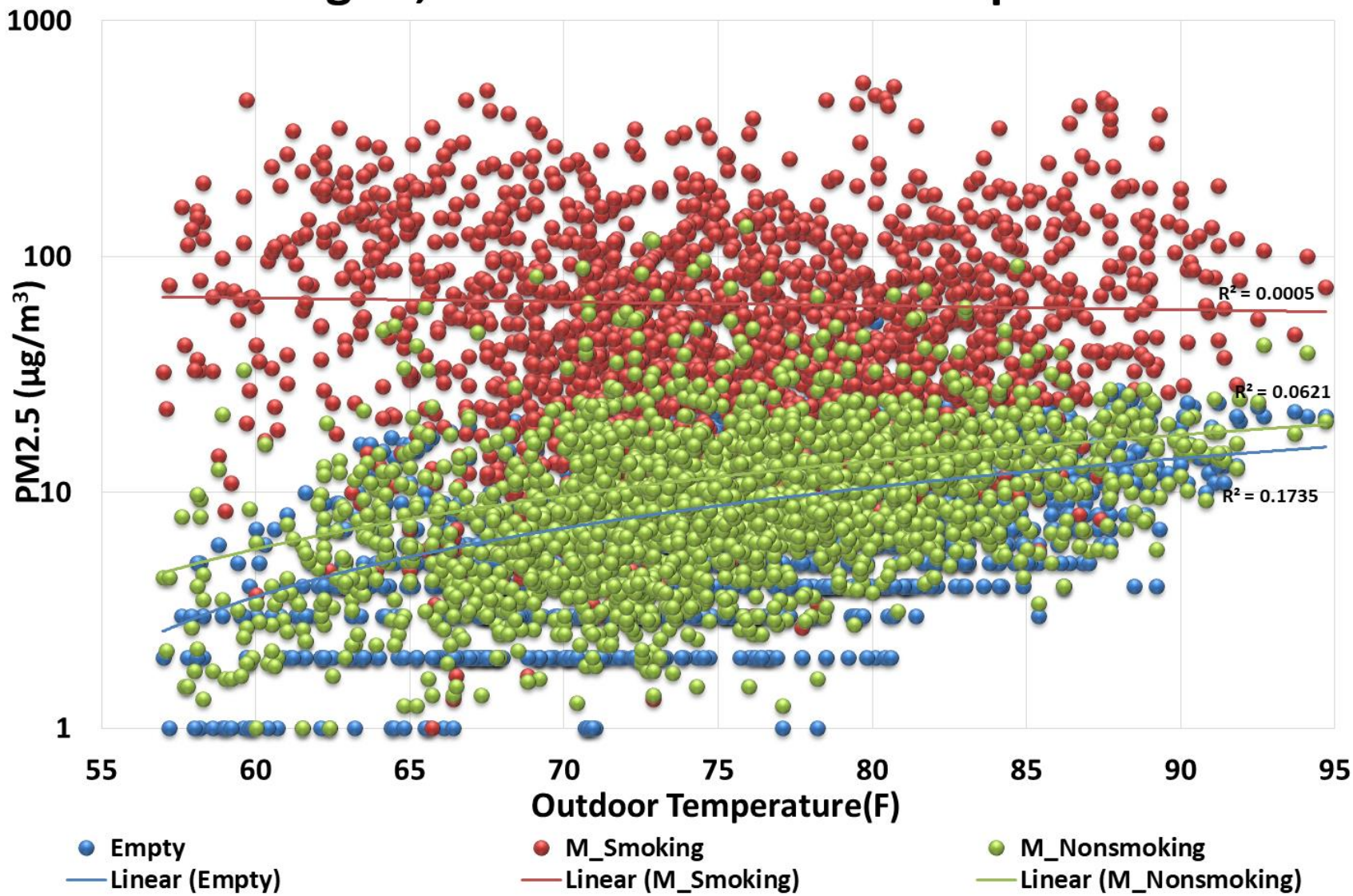
Hot days have beneficial effect on IAQ?!?

- If one can afford air conditioning, or rather air filtration option

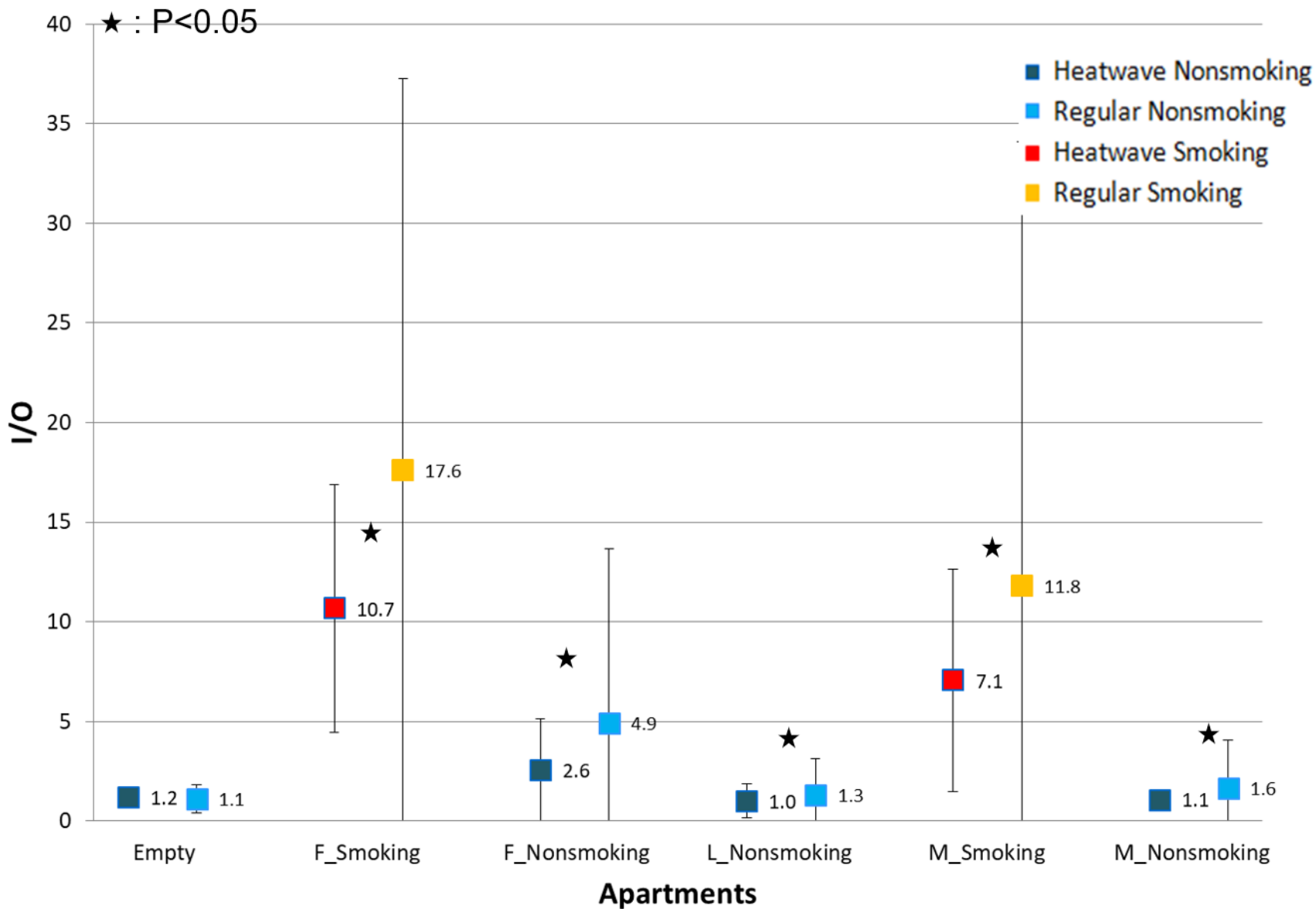
Temperature variability



Building M, PM 2.5 vs Outdoor Temperature



Heatwave and Regular Day, Avg. Indoor/Outdoor Ratio (Stdev)



	Baseline (N=24)	Heat Wave Days (N=96)
Adjustable Fan	75%	75%
Open Windows	46%	67%
Close Windows	83%	91%
A/C	79%	81%
Clothing Adjustment	63%	48%
Avoid Oven	--	51%
Avoid Stove	--	22%
Avoid Candles	--	16%
Avoid Smoking	--	12%
Leave Apartment*	80%	63%

Findings: Frequencies of Adaptive Actions During Heat Waves

Baseline Interviews vs.
Actual Heat Waves
Summer 2017

*Not necessarily in
search for a cooler place
(only 5% left in search of
a cooler place)

	M (N=49)	F (N=7)	L (N=4)
Adjust Fan	82%	57%	50%
Close Windows	82%	100%	100%
A/C	91%	100%	50%
Clothing Adjustment	73%	29%	25%
Avoid Oven	91%	57%	25%
Avoid Stove	73%	14%	25%
Avoid Candles	45%	0%	0%
Avoid Smoking	45%	0%	0%
Leave	91%	71%	100%
Apartment*			

Reported during the heat wave of July 17-21, 2017 (n = 96)

*Not necessarily in search for a cooler place (only 5% left in search of a cooler place)

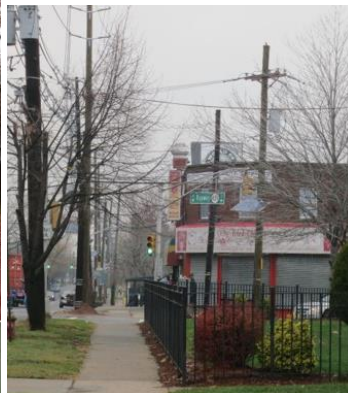
Adaptive Actions by Study Site

Gas stove at Building M



**Sample (N=96)
Outdoor Adaptive Actions**

Within HACE	Lobby/Community Room-Center
	Outdoor Yard
	Community Gardens
Outside HACE	Visit Relative/Friend
	Shopping Store
	Senior Center
	City Cooling Room
	Park Nearby
	Library
	Public Pool
	Movie Theater
	Church
	Doctor/Hospital/Nursing
	Home/Pharmacy
	Food Pantries
	Walks around the Block
Festivals	



**Adaptive Options --
Building Environs**

Use of amenities outside of HACE Comments			
Exit Interviews (N=24)			
	F	L	M
Parks	People rob and they need to be safer, but nice 3-4 small ones nearby.	Rosele Park	
Churches	Baptist in the corner	At East Jersey	
Libraries	A nice one in the area		Some library in the area would be good.
Senior Centers	Have nice activities	Senior Center Presbyterian, Steve Sanson Center, Ana Center, it is also a Cooling Center	Jefferson Square Town
Groceries	Nice and plenty within 5 min walk. New one in the division strt, Casablanca, Super-Super, also Walmart, IKEA, Jersey Gardens Mall, Super Market in Old Bridge. But more and bigger super markets would be nice.	ShopRite at Linden and Elmore, Jersey Gardens Mall	Colmado, Shop Rite in Elizabeth and Linden and Emerald Ave in Elizabeth, Jersey Gardens, Supremo, BJ's, Sam's, Walmart in Linden, Twin City, DDonuts
Pharmacy	Nice one in the corner when needed.		

Resident preferences and suggestions for improvements

Use of Indoors (apartments) and Outdoors (within HACE boundaries) Comments from Exit Interviews (N=24)			
	F	L	M
Apartments	Need better A/C, more windows, too much dust,		Better windows; there is too much air draft. Heaters in winter do not warm up the apt, summer inside is very hot, too much asbestos work in the buildings, sanding in preparation to get new windows,
Yards	Nice gardens, smoking, interacting, more flowers, sitting spaces and greenery would be good. Good when it is hot, but some people every day is boring and they get nosy and need bigger space		Shady areas are nice and used, but more trees and greenery are needed, also crazy mentality of people in the area scares a lot. But gardens are nice
Lobby/Cooling/Community Center	They close it early; it is the same as staying in the apartment.		It is for people without families and without A/C, or it is outside the buildings and needs walking. Community center is nice when it has food events.

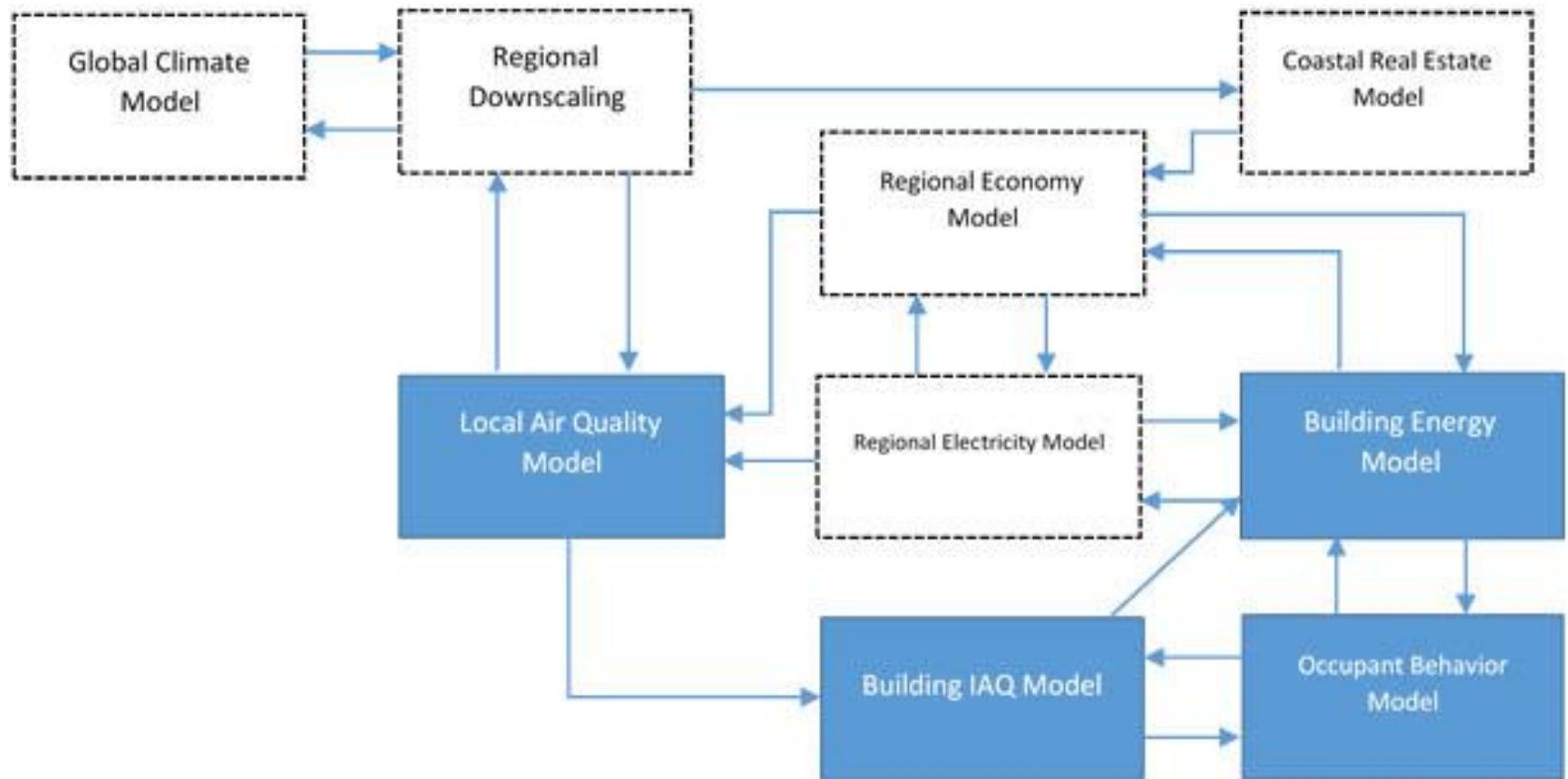


Resident preferences and suggestions for improvements

Hypothesis	Finding
1. Heat waves push residents to act and change key behaviors.	Supported <i>All residents changed activity patterns during heat waves.</i>
2. Background physical and social conditions constrain residents' actions.	Partially Supported <i>Increased outdoor temperatures push residents to act, however, considering limited funds, mobility issues and others, they cannot go far, making them highly dependent on the few nearby amenities and on other people for transportation.</i>
3. Apartment and building systems constitute the primary choice environment within which residents live and operate, and it is constraining.	Supported <i>The majority of residents reported staying indoors for most of the heat wave day, using A/C and closing windows. However, not all study sites have the same characteristics, with some supplying central A/C and others not, and with quite different building envelopes.</i>
4. Supportive social networks may offset possible infrastructure inadequacies.	Supported <i>Organizations such as Proceed played a very important role since they installed A/C units in apartments that didn't have them. Friends and families checked on each other.</i>
5. Residents are the primary agents in a heat wave situation. They pick their actions from a list of available options dependent on infrastructural systems, supportive networks, and nearby amenities, however they may not always act towards adaptation.	Supported <i>The residents themselves initiated most or all activity. Their actions defined how well or not they adapted, and was seen, they sometimes smoke inside, light candles, or house pets without caring or even realizing the health consequences.</i>

Summary Results: Behaviors of Seniors in Affordable Housing Settings

Research Framework: Next Steps



Multi-Level (Urban Metabolism) Modeling Framework

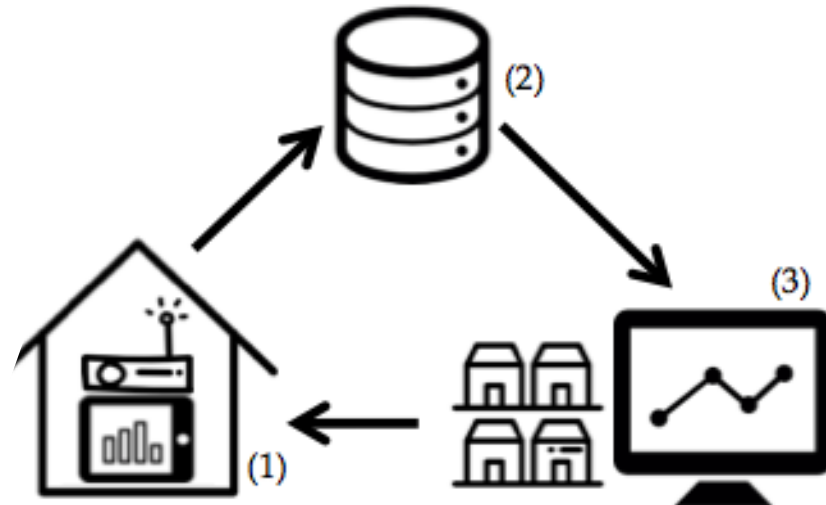
Light dotted boxes are in previous project, dark solid boxes are current tasks



Jennifer Senick, PhD
Executive Director, Rutgers Center for Green Building
Rutgers, The State University of New Jersey
jsenick@rutgers.edu
<http://greenbuilding.rutgers.edu>

Related Research: (1 of 2)

- Coupling of persuasive technology with community support mechanisms. Focus is on children.
- Figure 1. A structure for a proposed system: (1) a real-time IEQ monitoring & visualization station for a low-income household; (2) database to store and distribute IEQ data; and (3) a visualization platform for community organizations
- Figure 2. An educational tutorial session



Related Research: (2 of 2)

- Coupling of US EPA Air Quality Flag Program with community support mechanisms via a STEM-based summer camp.
- Figure 1: Activity: 'Environmental Bingo'



AirNow Local Air Quality Conditions

Air Quality Flag PROGRAM
Know Your Air Quality to Protect Your Health

Which Flag Do I Fly?

Today's Air Quality Forecast	Tomorrow's Air Quality Forecast
07/30/2015	07/31/2015
<input type="radio"/> Good <input type="radio"/> Moderate <input type="radio"/> Unhealthy	<input type="radio"/> Good <input type="radio"/> Moderate <input type="radio"/> Unhealthy

Learn about the [Air Quality Flag Program](#)

Use what [you know](#) to help us make color-coding more community-able.

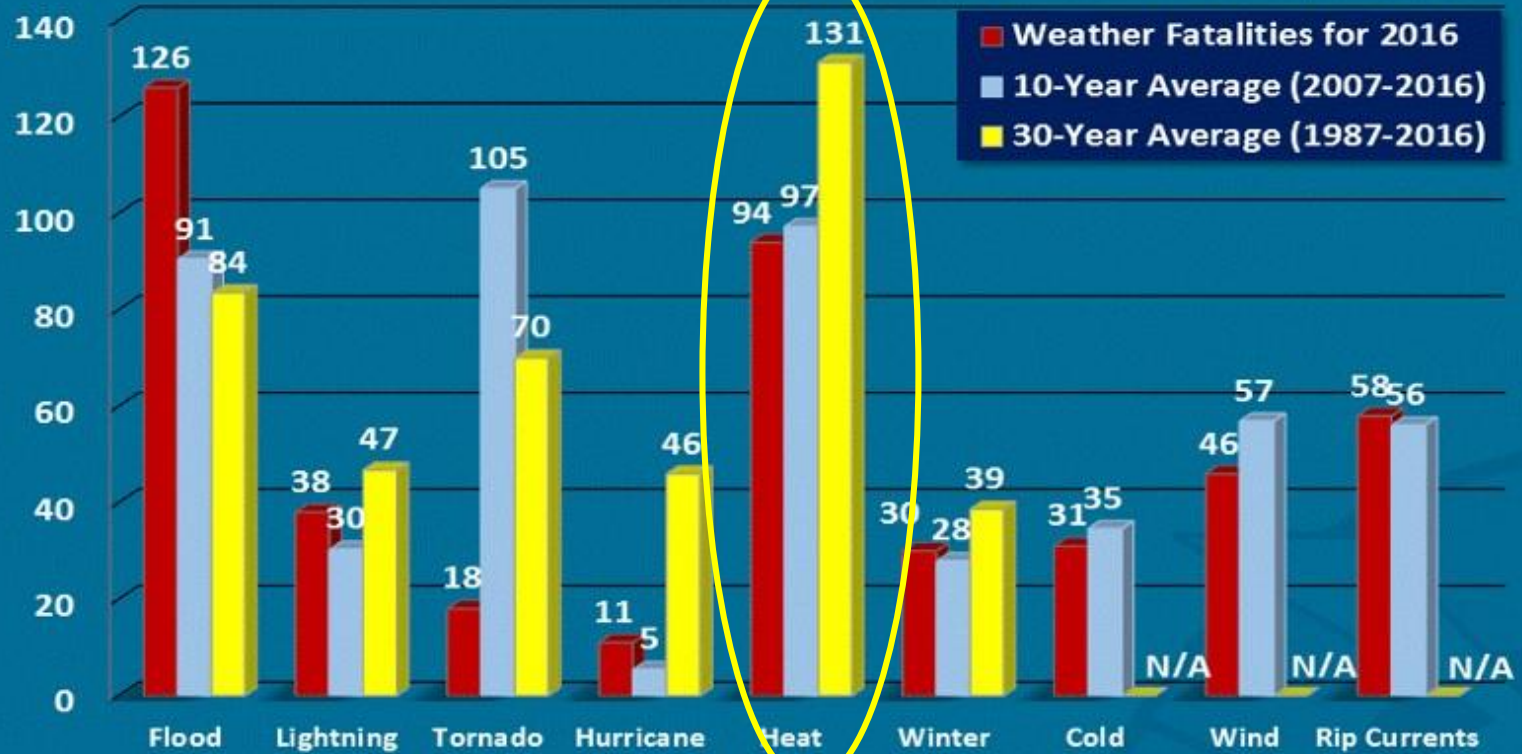
EPA

[Home](#) [About](#) [Air Quality](#) [Health](#) [Policies](#) [Partners](#) [Publications](#)
[Air Quality Action Plan](#) [Health](#) [Partners](#) [Publications](#) [Air Quality](#)
[Air Quality Calculator](#) [Links to International Air Quality Sites](#) [Learn More](#)
[Partners](#) [Air Quality](#) [Health](#) [Policies](#) [Partners](#) [Publications](#)

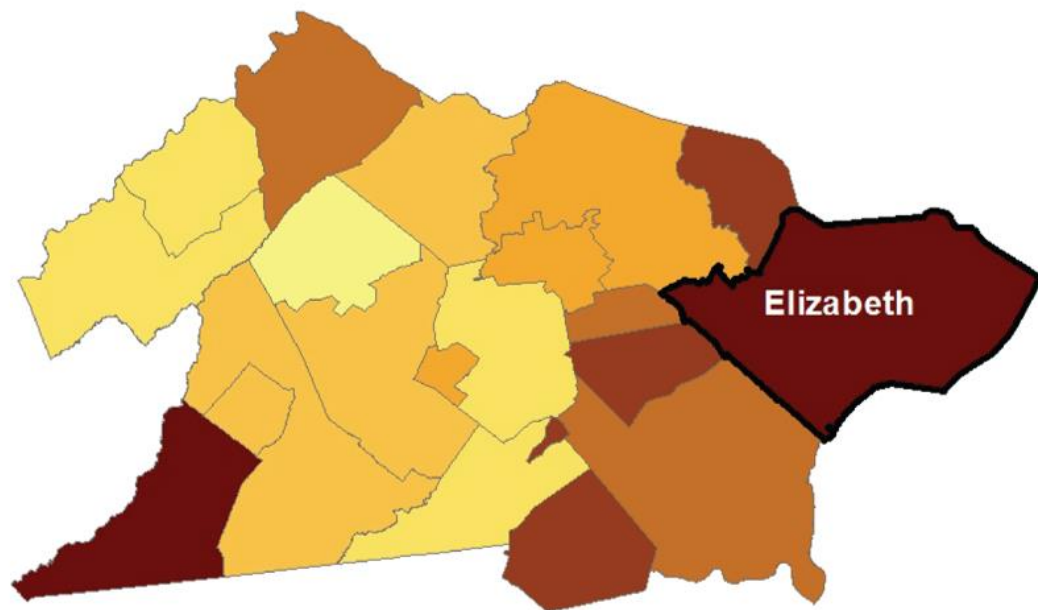
Back up slides



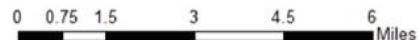
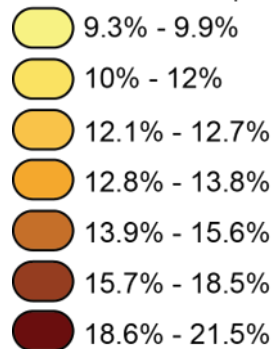
Weather Fatalities 2016



Union County, NJ (2008-2015)



% of Asthma Hospitalizations



Source: NJSHAD <https://www26.state.nj.us/doh-shad/home/Welcome.html>

