Developing a GIS-based survey tool to elicit perceived neighborhood information for environmental health research

University Center for Social and Urban Research
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Jessie L. Carr,[1] Isaac Johnson,[1] Rob Keene,[2] Peter Landry,[3] Robert Gradeck,[2] Lauren Chubb,[1] Jim Lucht,[3] Scott Beach,[2] Jane E. Clougherty[1]

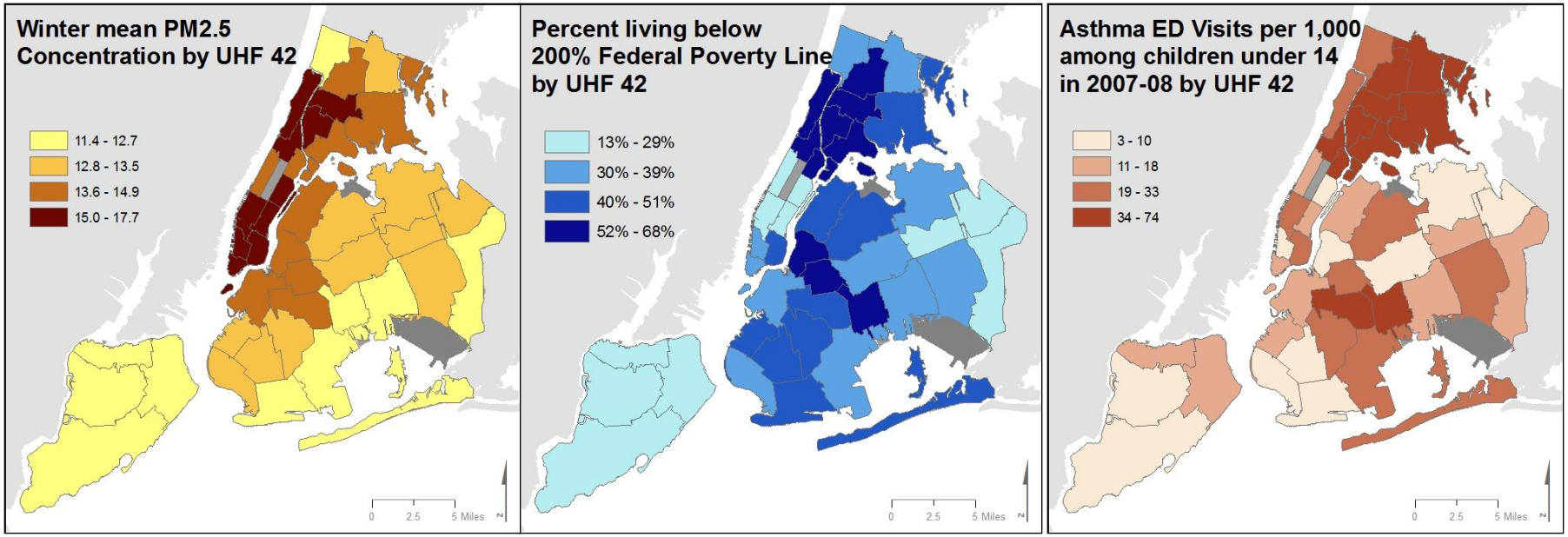
[1] University of Pittsburgh Graduate School of Public Health, Department of Environmental & Occupational Health

[2] University of Pittsburgh University Center for Social and Urban Research (UCSUR)

[3] The Providence Plan (ProvPlan)

Overall Goal:

To understand combined effects of environmental and social exposures on urban community health.



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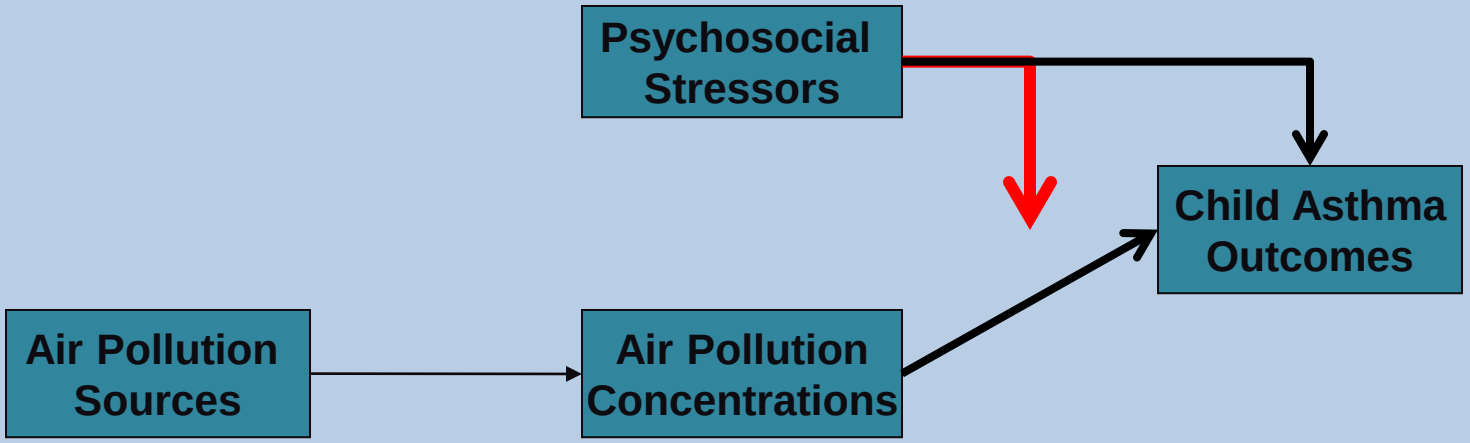
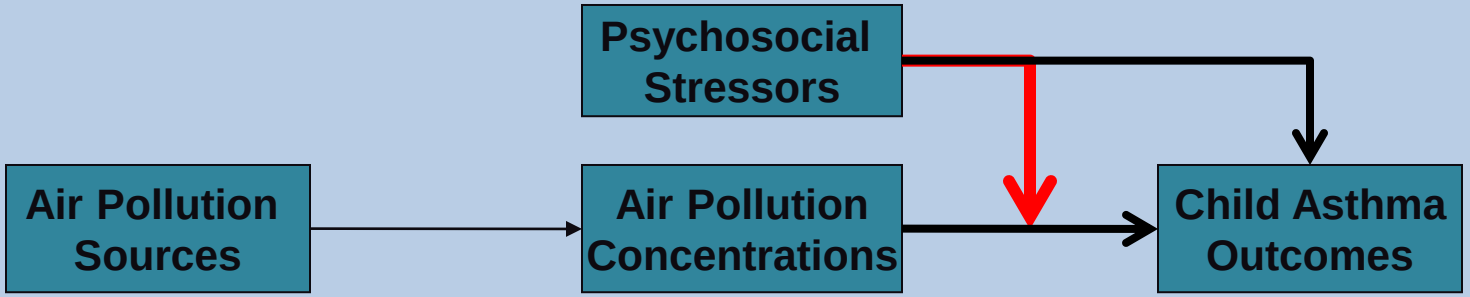


COMMUNITY STRESSORS AND SUSCEPTIBILITY TO AIR POLLUTION IN URBAN CHILDHOOD ASTHMA

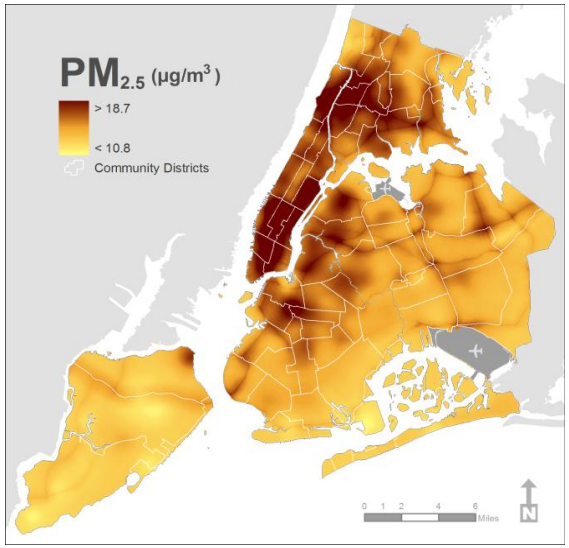


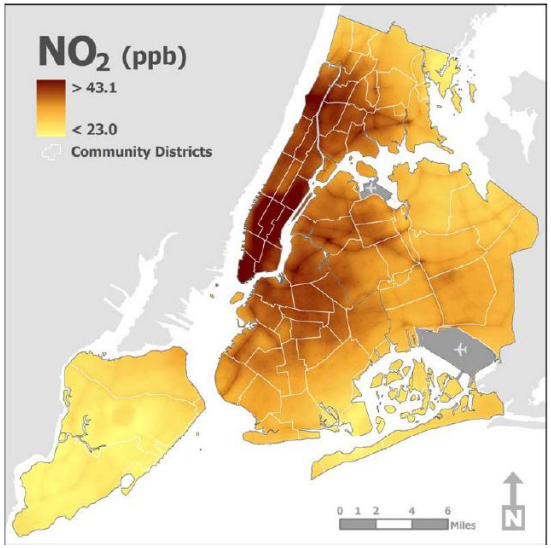
To examine combined effects of social stressors and air pollution on childhood asthma hospitalizations:

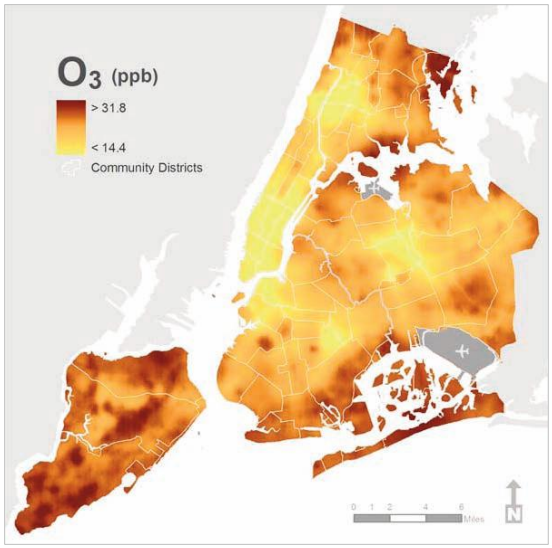
1) Leverage pollution maps from New York City Community Air Survey,
2) Identify and validate GIS-based chronic stressor indicators (e.g., violence rates).
3) Examine combined effects on childhood asthma hospitalizations across NYC, using multi-level spatio-temporal models.

US EPA STAR grant #RD-83457601-01 (PI: JE Clougherty)

New York City Community Air Survey (NYCCAS)





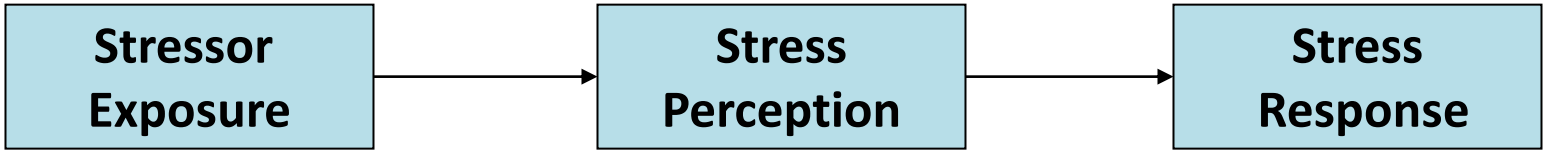


http://www.nyc.gov/html/doh/html/eode/nyccas.shtml

Matte et al., *JESEE* 2013

Clougherty et al, *JESEE* 2013

Measuring Chronic Stress

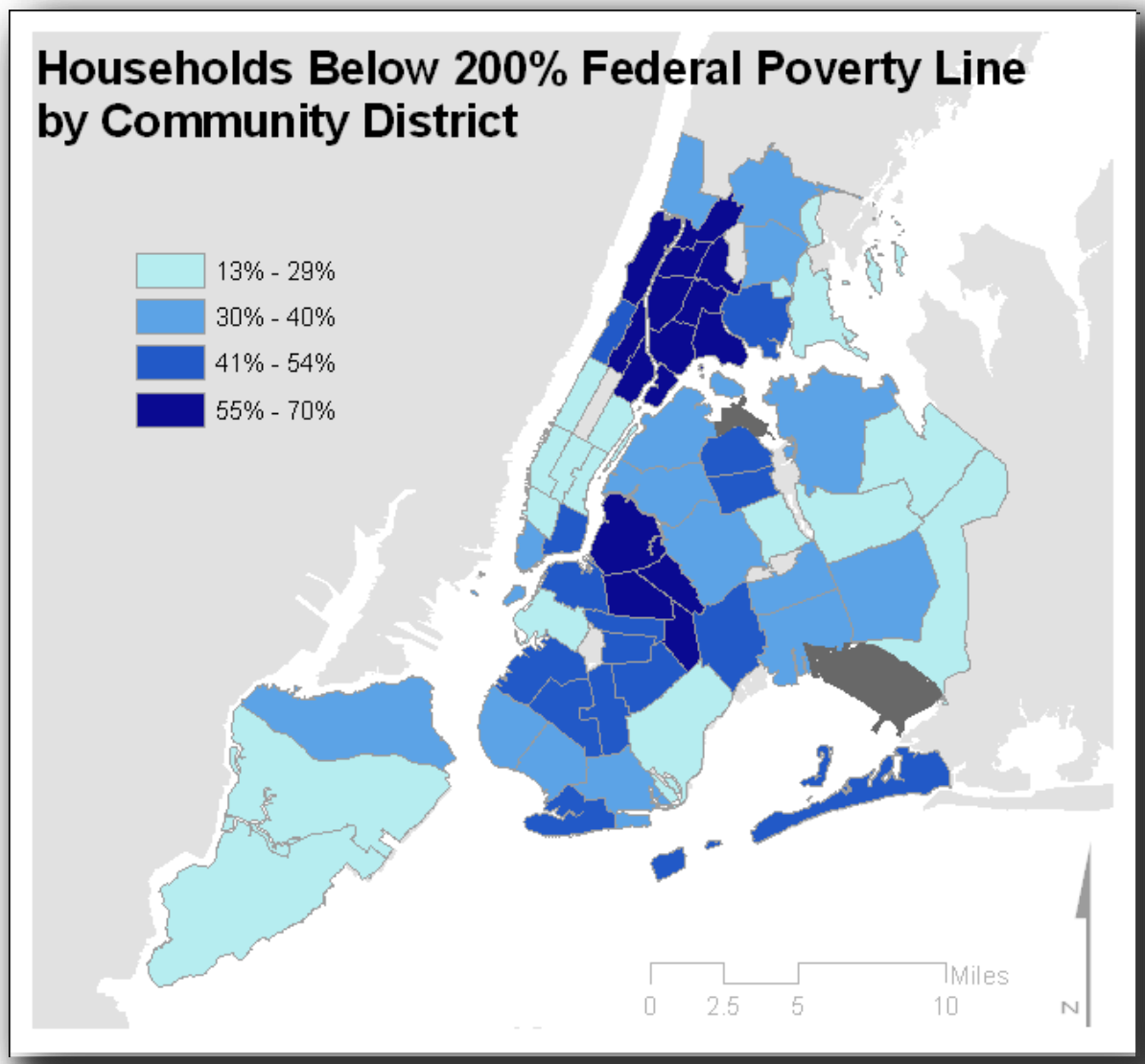


1. Public data on aggregate stressors (community-level)
   - Rates of violent crime
   - Physical dilapidation
   - Census indicators: poverty, demographics
2. Community-level validation
   - Focus Groups (key stressors by community)
3. Individual-level validation
   - Surveys: Link location to perceived stress

Administrative indicators of community social stressors

Stressor Construct	Indicator and Administrative Scale	Data Source and Date
Crime & Violence	Felony Larceny Crimes per 10,000 (PP)	NYPD (FY 2009)
	Murder and non-negligent manslaughter per 10,000 (PP)	NYPD (FY 2009)
	Felonious Assault per 10,000 (PP)	NYPD (FY 2009)
	Robbery per 10,000 (PP)	NYPD (FY 2009)
	Burglary per 10,000 (PP)	NYPD (FY 2009)
	% Perceptions of Neighborhood Safety (self-report) (UHF)	DOHMH CHS (2010)
Mental Health	% Depression diagnosis ever (self-report) (UHF)	DOHMH CHS (2009)
	% Mental health treatment in past year (self-report) (UHF)	DOHMH CHS (2009)
Physical/Built Environment	% Small parks not acceptably clean (CD)	NYCP (FY 2009)
	% Sidewalks not acceptably clean (CD)	MOoO (FY 2009)
	Serious housing violations per 1,000 Rental Units (CD)	HPD (2009)
	Air Quality complaints per 10,000 residents (CD)	DEP (FY2009)
	% Crowding (>1 occupant/room) (USCT)	US ACS (2005-09)
Access to Healthcare	% With no type of insurance coverage (self-report) (UHF)	DOHMH CHS (2009)
	% Went without needed medical care (self-report) (UHF)	DOHMH CHS (2009)
	% Without a personal care provider (self-report) (UHF)	DOHMH CHS (2009)
	Public Health Insurance enrollment per 10,000 (CD)	MOO (FY 2009)
Noise disruption	% Frequent noise disruption (3+ times/wk over 3 months) (self-report) (UHF)	DOHMH CHS (2009)
	% Noise disruption, by sources (i.e. neighbors, traffic) (self-report) (UHF)	DOHMH CHS (2009)
Childhood-specific stressors	% Students in schools exceeding capacity (SD)	NYC DOE (SY 2006-07)
	% School buildings in good to fair condition (SD)	NYC DOE (SY 2006-07)
	% Average daily student attendance (SD)	NYC DOE (SY 2008-09)
	Substantiated cases of Child Abuse/Neglect per 10,000 (CD)	NYC ACS (2008)
Socioeconomic Position (SEP)	% Living below 200% federal poverty line (USCBG)	US ACS (2005-09)
	% Delayed rent or mortgage payment in past year (self-report) (UHF)	DOHMH CHS (2009)
	Food Stamp program enrollment per 10,000 (CD)	MOO (FY 2009)
	% Less than high school education (self-report) (UHF)	DOHMH CHS (2009)
	% Unemployed for less than 1 year (USCT)	US ACS (2005-09)

Administrative indicators of community social stressors



**All maps symbolized in quartiles.* Data Source: NYC HPD; NYC DOHMH CHS 2009; NYPD

Measuring Chronic Stress

*For GIS indicators, need validate content *and scale (MAUP).*

1) How to validate spatial scale?

2) Can we re-configure data to same spatial scale?

- Is there a smooth spatial surface for social stress?

Developing a GIS-based survey tool to elicit neighborhood information

1. Neighborhood Geography and Public Health
2. Online Survey tool
3. Pilot validation study
4. Future Directions

Neighborhoods and Health

Neighborhoods matter for health.

- PubMed ‘neighborhood’ in title = 2497 articles
- Multiple health outcome domains
- Independent of individual-level effects

However….

- Mismatch between available data and actual scale
- Definitions differ across individuals and space

Basta et al. 2010.

Neighborhoods, daily activities, and measuring health risks experienced in urban environments.

Space-Time Adolescent Risk Study (Philadelphia, PA)

> "daily activities are constrained in space and time, and create opportunities that can be either protective or harmful for health"

- Participants: n=55, 15-19 age adolescent (controls)
- Mapping exercise a "rapport building"
- Overlay hand-drawn neighborhoods on top of Census tracts
- Compare geographic overlap

Hand-drawn neighborhoods:

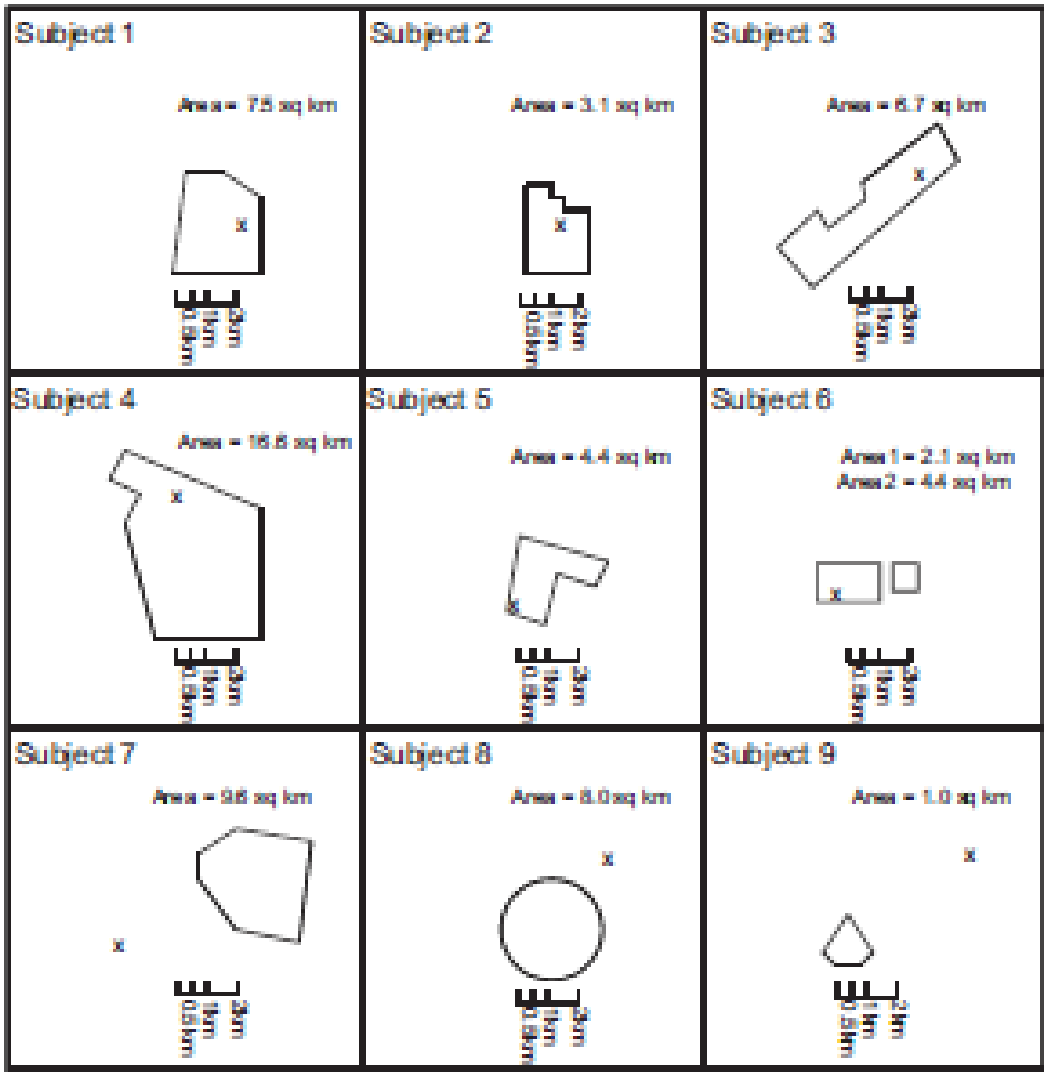


Fig 1. Basta et al. 2010

- Variable size and shape (1-17km^2)
- May not contain residence
- Intersected 10.8 census tracts, on average
- Density of alcohol outlets in census tract under-represent

Coulton et al. 2011

Finding Place in Community Change Initiatives:
Using GIS to Uncover Resident Perceptions of their Neighborhoods

Making Connections initiative

"failure to take residents' perceptions into account impedes key elements of the community change process and limits the degree to which residents will benefit from changes…"

- Household survey in target sites of 10 US cities
- Mapping task on paper maps
- Overlay resident maps, decomposed to block scale
- Identify consensus neighborhoods

Making Connections – Providence, RI:

FIGURE 2 Resident endorsed neighborhood boundaries, Providence.

- 3 official neighborhoods
- Disparate neighborhood names, sizes, shapes
- 2 "endorsed" neighborhoods
- Targets for employment services
- Practice implications for supporting collective action

Fig 2. Coulton et al. 2011

Online Survey Tool

1. Challenges of hand-drawn maps
   - small samples
   - data analysis
   - time and cost

2. Opportunities in GIS mapping tools
   - interact with online tools (e.g., Google.Maps)
   - online survey panels (difficulty of RDD)
   - Growing map and internet literacy

Objective:

To develop and validate a GIS-based mapping tool
to collect, aggregate, and analyze perceived neighborhood data.

1. Create a user-friendly mapping interface for online surveys.
2. Validate the accuracy of online map interface.
    - Compare narrative vs. online mapping neighborhood boundaries
    - “Digital Divide”
    - Inter- and intra-urban variability
3. Quantify geographic concordance between perceived neighborhoods and administrative areas, at individual and community levels.

Online Survey Mapping Tool

10. How easy was it for you to draw the outline of your neighborhood?

- ○ Very easy
- ○ Somewhat easy
- ○ Not at all easy

11. How accurate do you think the map was for drawing the outline of your neighborhood?

- ○ Very accurate
- ○ Somewhat accurate
- ○ Not at all accurate

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Save & Return Later

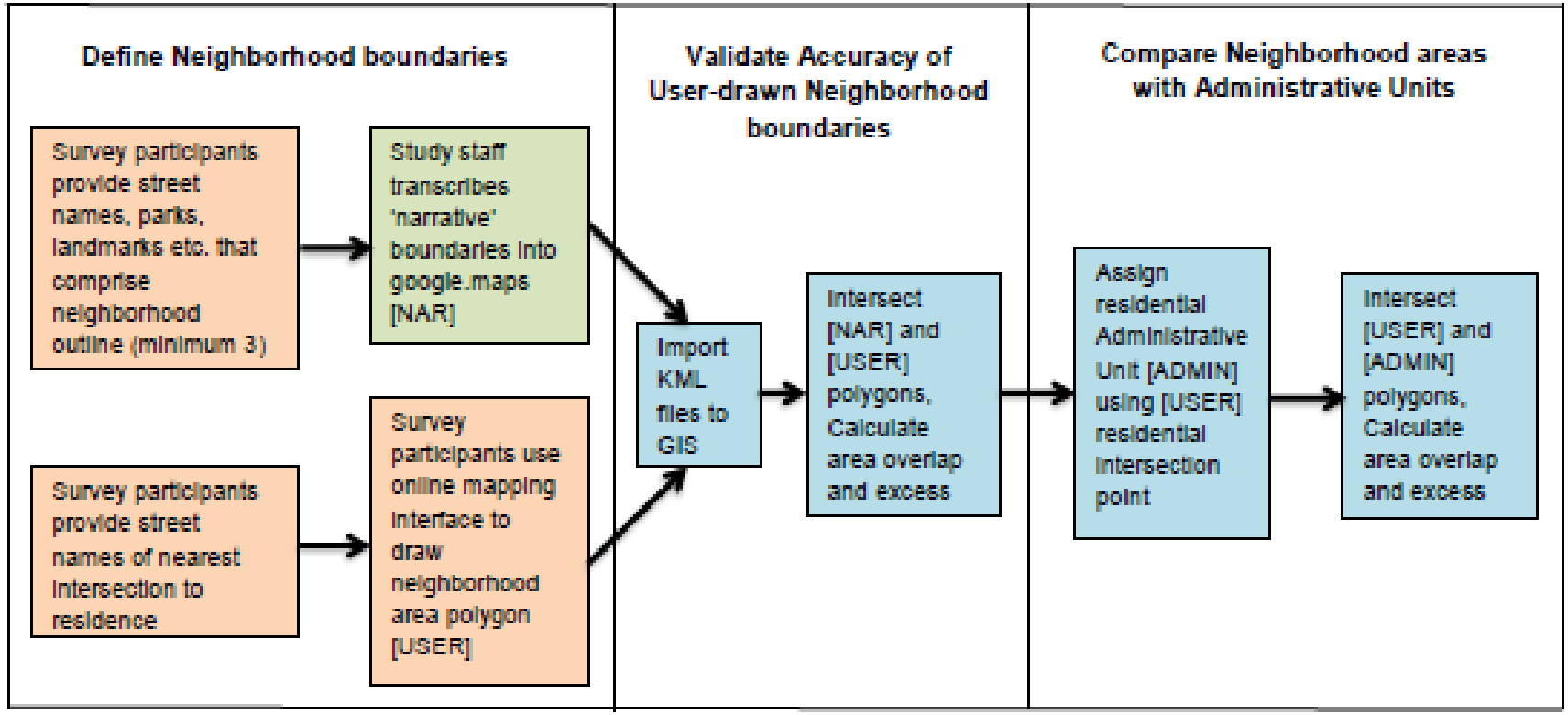
Please use these navigation buttons when using our survey. Please avoid using your Browser's 'Back' and 'Forward' buttons.

Narrative boundary transcription

- Two technicians with *local knowledge* of each city
- Protocols for boundary delineation consistency
  - include park areas or not
  - how to connect boundaries that do not meet

- Transcription of narrative boundaries from survey:
  - Search in google.maps for intersection of boundary #1 and #2
  - Locate boundaries 3, 4, etc.
  - Draw a closed polygon, following protocols
  - Assign participant ID
  - Export KML file

Data aggregation and GIS-based analyses



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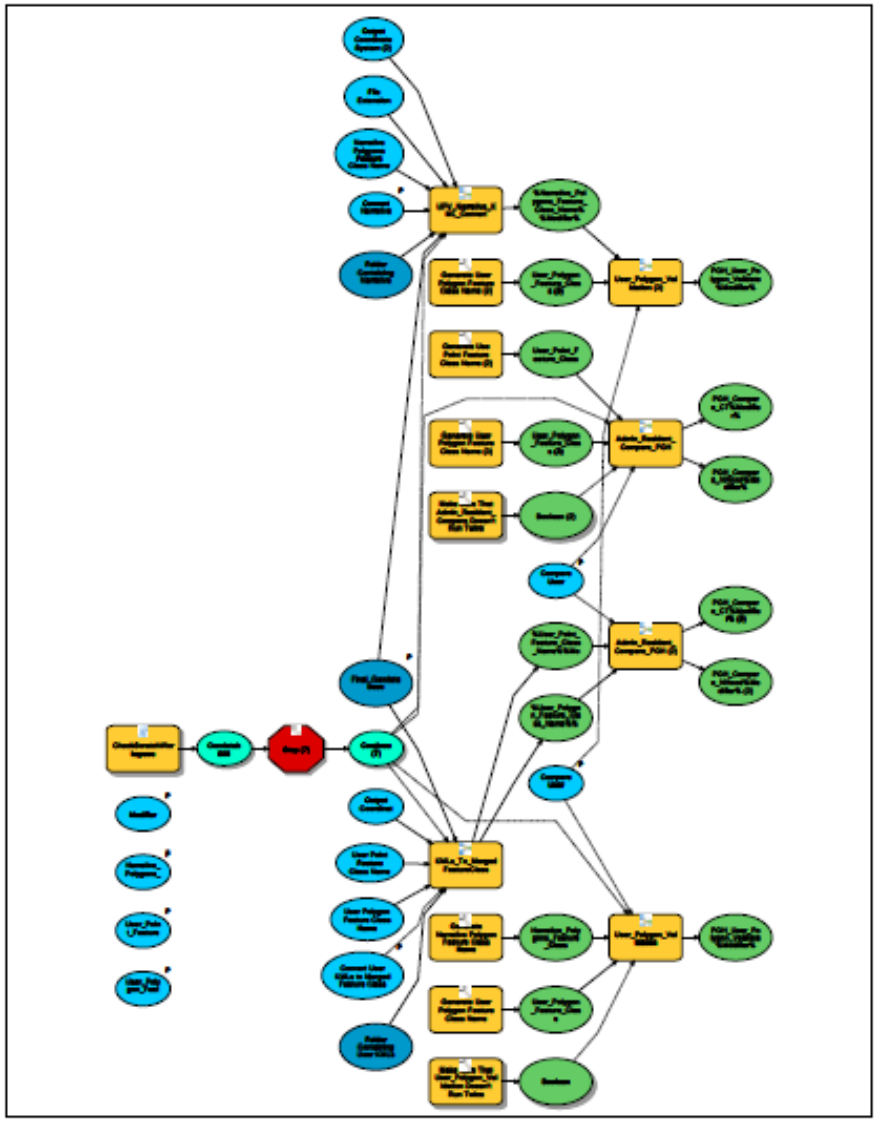


Multi-step, iterative processes in GIS

- Model Builder tool
- Simplified in python code

Survey Data Output

Figure 3: Visualization of individual participant neighborhood polygons shapefiles and spatial overlay layer

	Polygon area	Cross-street point		Administrative areas					Example Demographic information					
ID	AREA_sqmi	Lat	Long	UHF	CD	PP	SD	USCT	Age	Sex	Educ	Transpt	Parent	Race
1	2.624012	543	123	406	408	107	25	77902	45	1	2	1	2	4
2	4.631224	432	234	406	408	107	25	80900	23	2	2	2	1	2
3	1.66576	321	345	406	408	109	25	79300	47	1	3	2	2	1

Table 1: Example ArcMap attribute database table of survey output

Two-Stage Pilot Study Design

Pilot A (Winter 2011)

Aim: **Refine mapping instructions and interface**

- Friends & colleagues; n=21

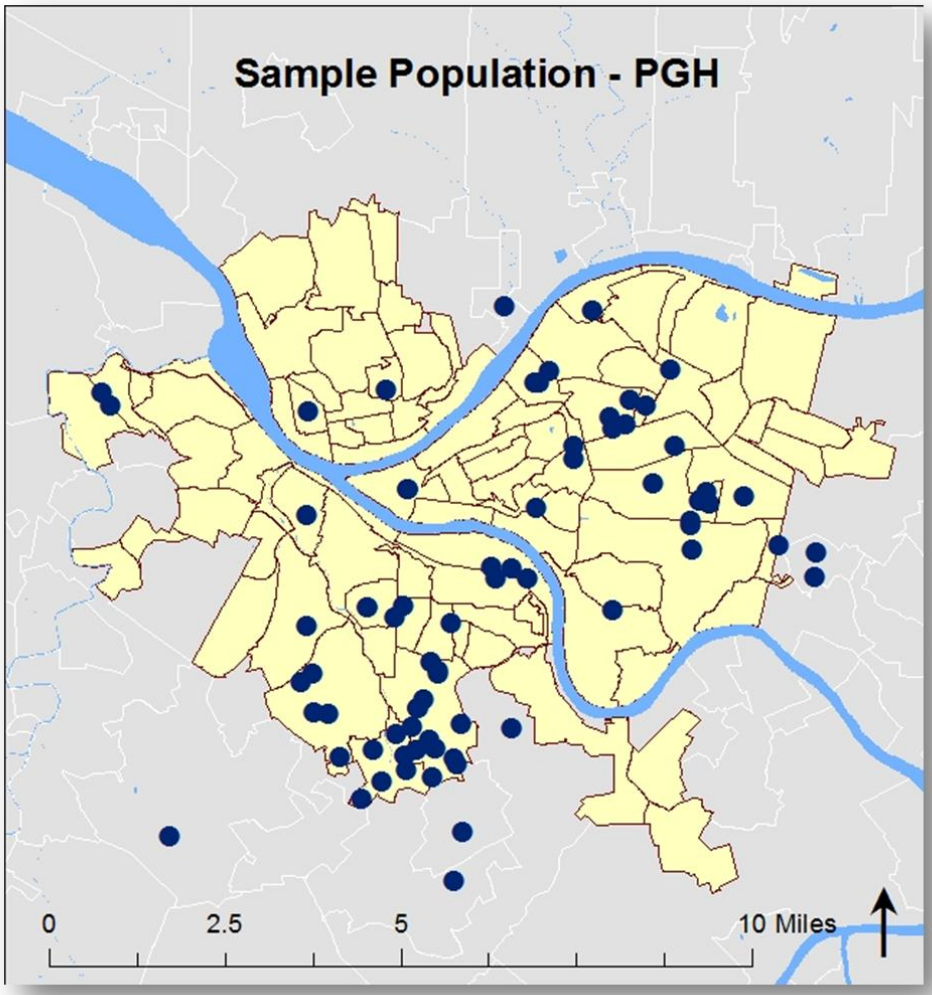
Pilot B (Spring-Summer 2012)

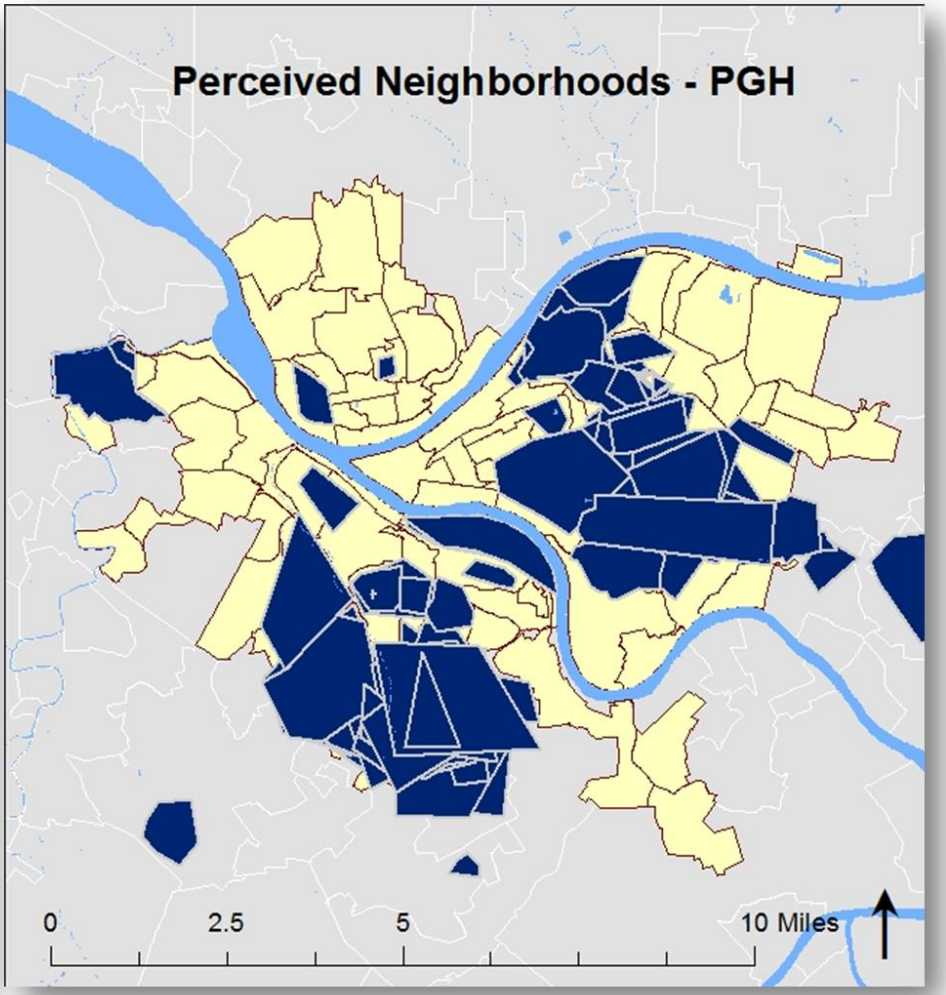
Aims: **Validate the online tool + Develop analytic models**

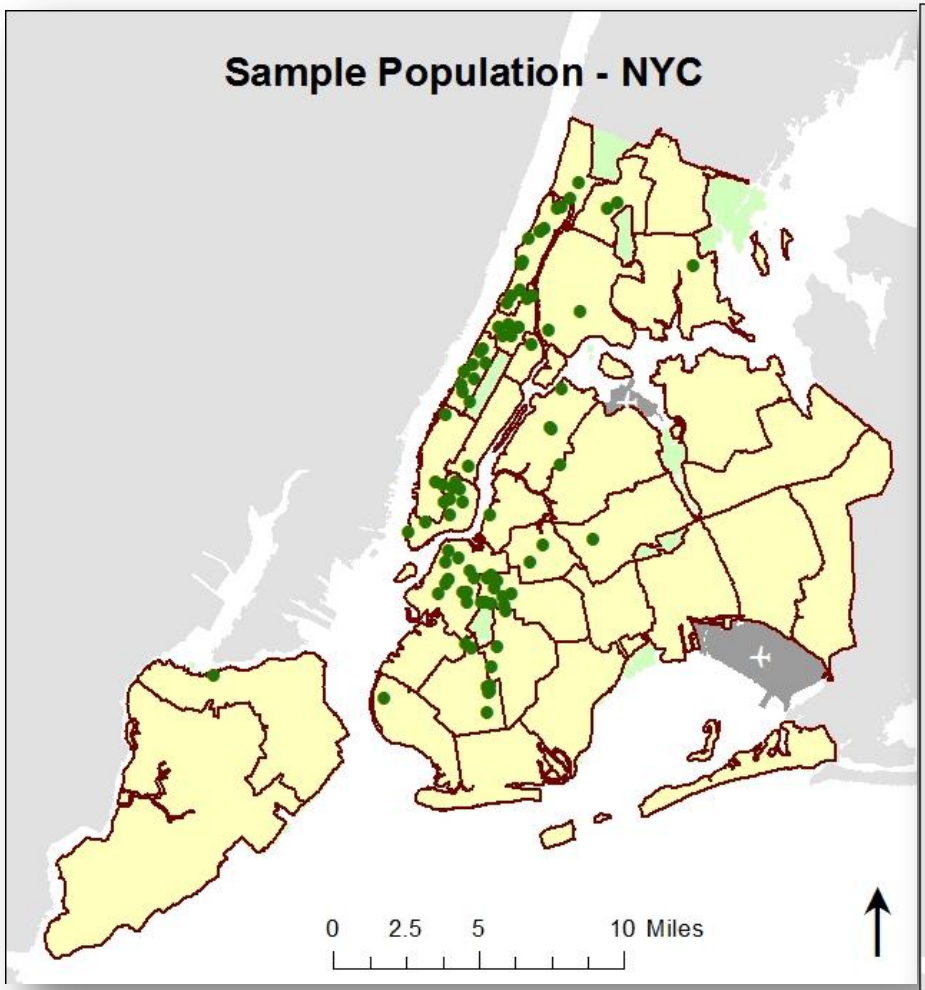
- Existing community organization and university networks
- NYC n=93; Pittsburgh n=81
- Domains of questions:
  - Socio-economic & demographic
  - Self-report ease of use and accuracy of mapping tool
  - Residential tenure
  - Day-to-day activities in and outside of neighborhood
- Focus group mapping exercise + discussion (EPA STAR)

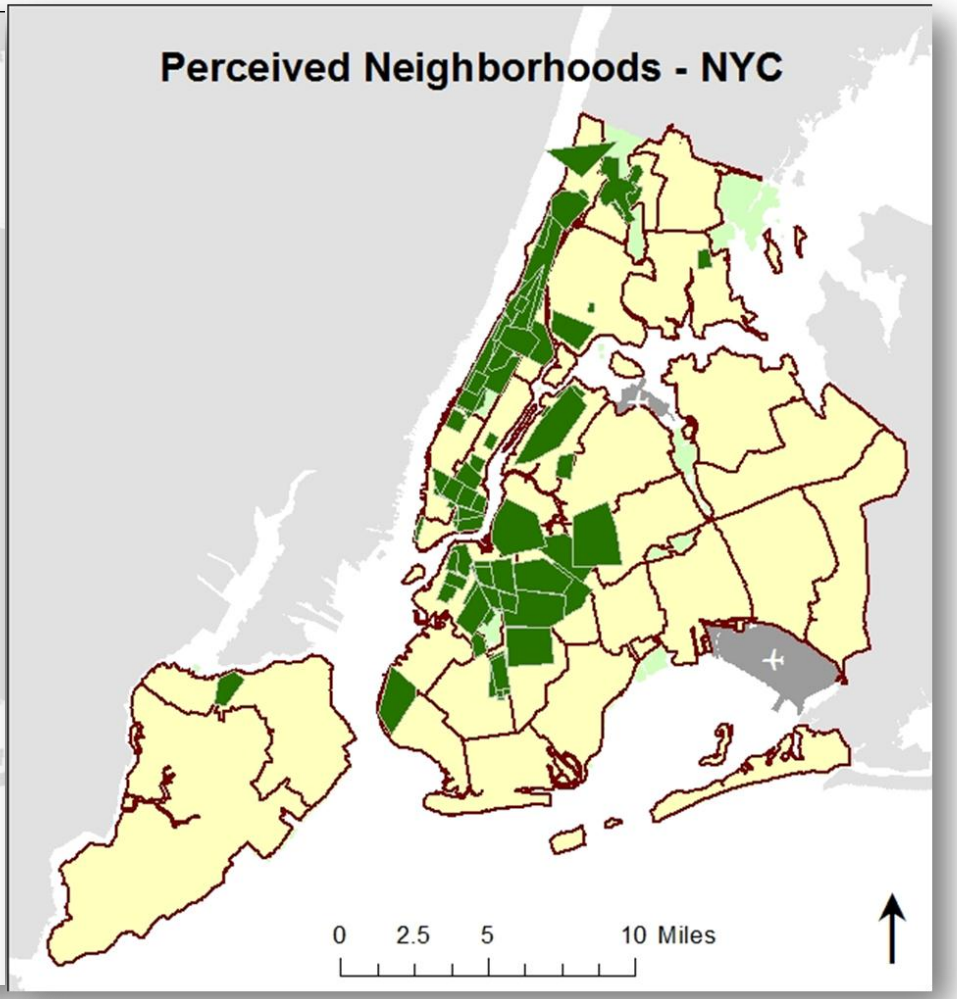
Sample Population Characteristics

	Pittsburgh (n=81)	New York City (n=93)
Age	Median=38 (23-69)	Median=33 (22-71)
Sex	68% Female	52% Female
Race & Ethnicity	83% white	80% white
Residential tenure	Median= 6-10 years	Median= 1-5 years
Household Income	Median= $46-70,000 (<3xFPL)	Median= $70-93,000 (<4xFPL)
Educational attainment	Median = College degree	Median = Graduate degree


Sample Population - PGH
0
2.5
5
10 Miles


Perceived Neighborhoods - PGH
0
2.5
5
10 Miles


Sample Population - NYC
0
2.5
5
10 Miles


Perceived Neighborhoods - NYC
0
2.5
5
10 Miles

Participant comments

“There are some parts of the neighborhood that I do not walk in because it's not by a main road and doesn't feel as safe… Perhaps; create a mapping survey that allows the user to put in the circles and then add connector lines in separate steps…”

“I love my neighborhood!”

“This made me realize how much I am able to do in my own neighborhood.”

Mapping Results

	Pittsburgh	New York City
Mapping Self-assessment*	Most common response (median) reported	
Ease	Very Easy	Very Easy
Accuracy	Somewhat Accurate	Very Accurate
Successful completion		
Narrative boundaries	n=59 (73%)	n=71 (76%)
Online mapping	n=79 (98%)†	n=93 (100%)
Neighborhood Area (km^2)	Mean (Min-Max)	
Narrative Area	**1.99** (0.09-7.04)‡	**1.68** (0.12-7.35)
Online mapped area	**2.31** (0.04-7.90)	**0.71** (0.04-3.05)
Concordance**	81%	73%

* 3-level scale (i.e., Very easy, Somewhat easy, Not at all easy)
† one implausible value removed (area=0.002 km^2)
‡ Paired t-test of Pittsburgh narrative and user boundaries are not statistically significantly different.
** Percentage overlap area within online mapped area.

Validation of Online Tool:
Explore differential results across population

1. Narrative boundaries vs. online mapping
    - Completion of boundary naming, Online mapping
    - Geographic concordance

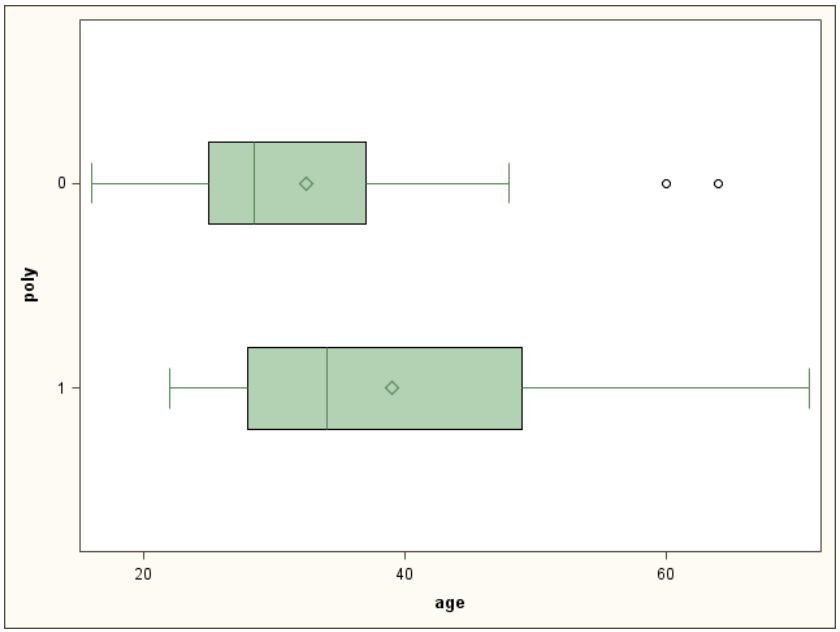
2. Perceived Boundaries vs. Administrative areas
    - Different administrative boundaries

Age	Gender
Household income	Residential tenure
Educational attainment	Self-rated mapping accuracy

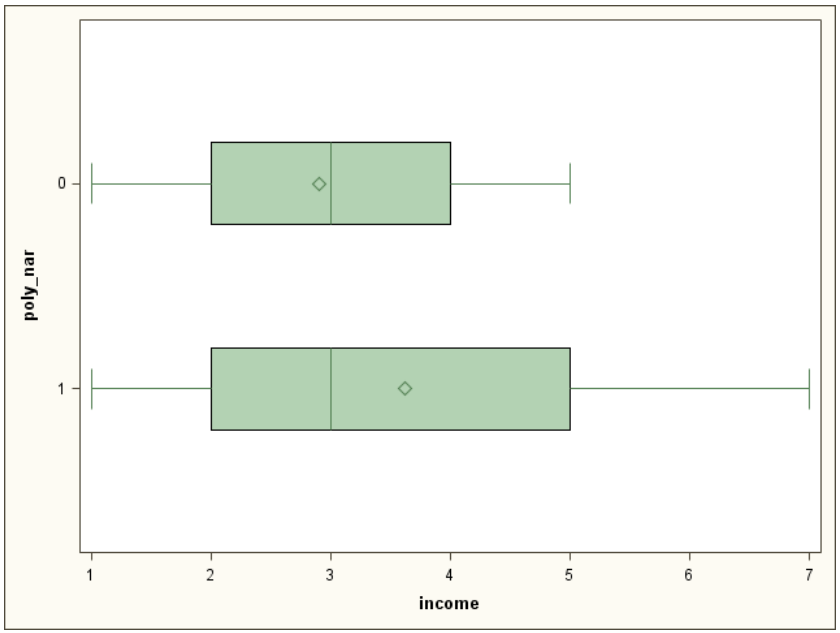
Narrative Boundary Completion

1. Did not provide any boundaries
2. Boundaries provided were insufficient for transcription

Age distribution in NYC



Income distribution in PGH



Agreement of Narrative and Mapped Areas

1. Quantified common geographic area
2. % Agreement = common area / mapped area
3. Compared groups with agreement in the top and bottom quartiles

- No differential agreement, good or bad!

Mapped vs. Administrative Areas

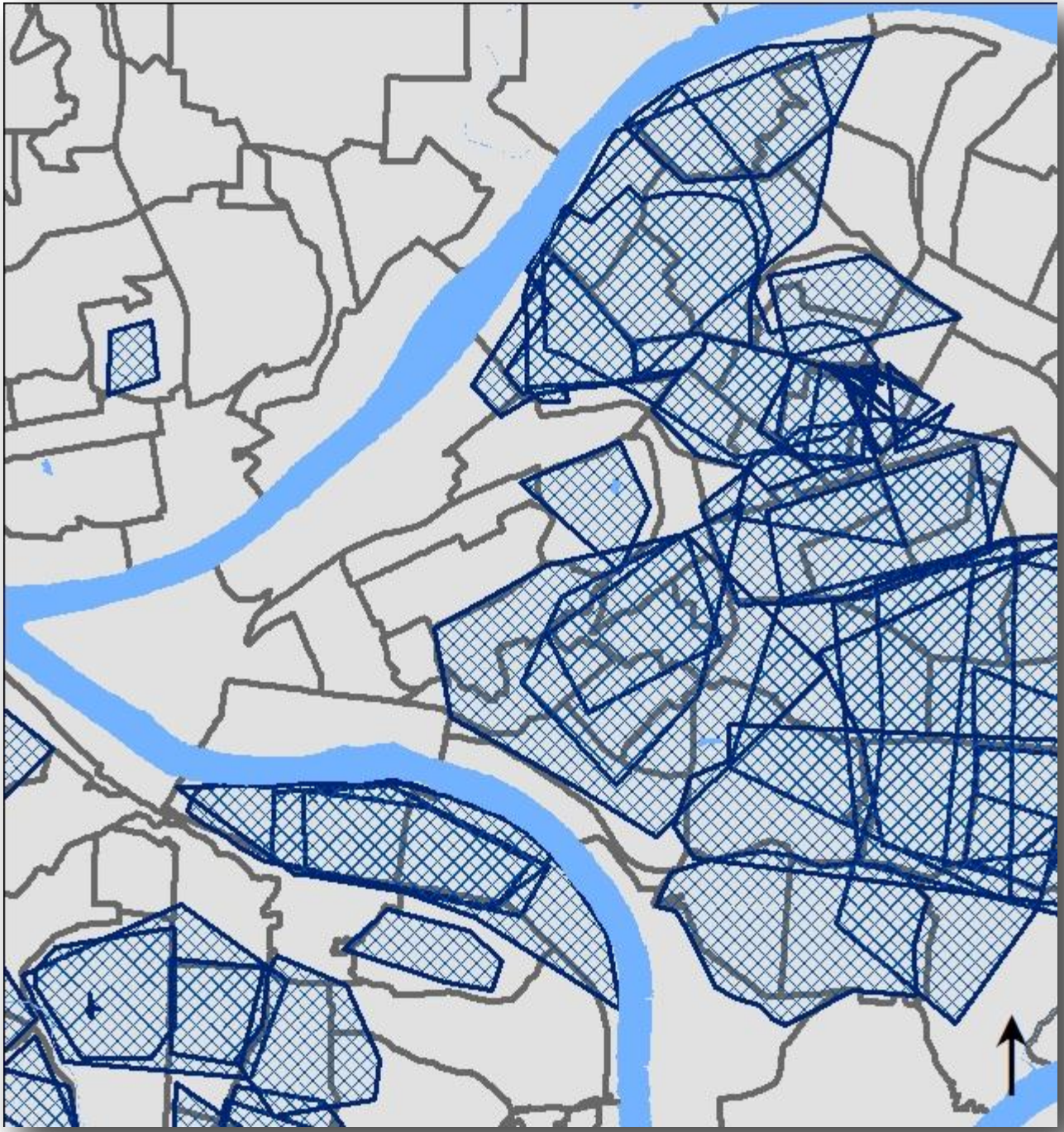
1. Assign Administrative area based on residential cross-street
2. Quantified common geographic area
3. % Agreement = common area / user mapped area

Pittsburgh:

- Census Tracts
- Neighborhood (DCP)

New York City:

- Census Tracts
- United Health Fund Areas
- Police Precincts
- School Districts
- Community Districts



Mapped vs. Administrative Areas

New York City (n=93)	Mean (Min-Max)
Census Tracts (n=2116)	12.8% (0-94.4%)
United Health Fund Areas (n-34)	79.1% (0-100%)
Police Precincts (n=78)	71.6% (0-100%)
School Districts (n=32)	76.5% (0-100%)
Community Districts (n=59)	78.3% (0-100%)
Pittsburgh (n=78)	
Census Tracts (n=X)	38.2% (0-99.9%)
Neighborhoods (n=X)	52.8% (0-100%)

- Additional information on administrative area outside of mapped neighborhood
- Look for differential “coverage” across populations and space

Pilot Strengths & Limitations

1. Two-stage pilot
2. Two unique cities
3. Explored multiple metrics in validation process
4. Interpretation -- Focus group mapping exercise and discussion about neighborhood definition and boundaries
5. Analysts with local knowledge
6. Multi-disciplinary team

1. Did not define neighborhood
2. Narrative boundary transcription is time-consuming
3. No gold standard metric
4. Quantitative models are complex
5. Findings may not be generalizable across populations or places, but the tool is….

Conclusions

- Online mapping interface can be a powerful survey tool across disciplines
  - Visual recognition of neighborhood areas may be more effective than narrative reporting

- Possible to assess 'optimal' administrative proxy for neighborhood, and quantify the bias induced

- Broadly, perceived neighborhood information allows for:
  - refined multi-level hypotheses
  - elucidation of mechanisms driving health effects on health

Next Steps

- Individual survey (online and RDD) of perceived neighborhood characteristics and experiences of psychosocial stress in NYC.
- Derive a continuous spatial surface of perceived stress across NYC, using Land Use Regression
  (Manners Award, UCSUR, 2012)
- Incorporate in exposure assessment for epidemiologic investigation of joint effects of air pollution and social stressors on childhood asthma.

Thank you!

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The University of Pittsburgh Institutional Review Board approved this survey protocol.

UCSUR Team:
Rob Keene, Bob Gradeck, Scott Beach

ProvPlan Team:
Peter Landry, Jim Lucht

University of Pittsburgh Team:
Lauren Chubb, Isaac Johnson, Jessie Carr, Jane Clougherty (PI)

EPA STAR Team:
WE ACT for Environmental Justice:
Ogonnaya Dotson Newman, Ana Parks, Evelyn Joseph, Charles Callaway, Peggy Shepard

New York University:
Kazuhiko Ito

Harvard School of Public Health:
Laura Kubzansky, Jack Spengler

Focus Groups Mapping Exercise