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TRANSPORTATION RESEARCH BOARD

Straight to Recording for All: Methods to Measure Walkability: From Qualitative to Quantitative

Methods to Measure Walkability: From Qualitative to Quantitative

Organized by ANF10 – Standing Committee on Pedestrians

Measuring Walkability

Today's Webinar

Defining and Applying Walkability to Decision Making: Predicting Equity, Health & Economic Benefits of Land Use & Transportation Investments

Lawrence Frank, Urban Design 4 Health

Using Embodied Videos of Walking Interviews in Walkability Assessment

Geoffrey Battista and Kevin Manaugh, McGill University

The Pedestrian Index of the Environment (PIE)

Patrick Singleton, Portland State University

Defining and Applying Walkability to Decision Making: Predicting Equity, Health & Economic Benefits of Land Use & Transportation Investments

Presentation for TRB | Washington D.C. | July 27, 2017

Dr. Lawrence Frank, AICP, PhD
President, UD4H

Eric Fox, MScP
GIS Manager, UD4H

URBAN DESIGN 4 HEALTH

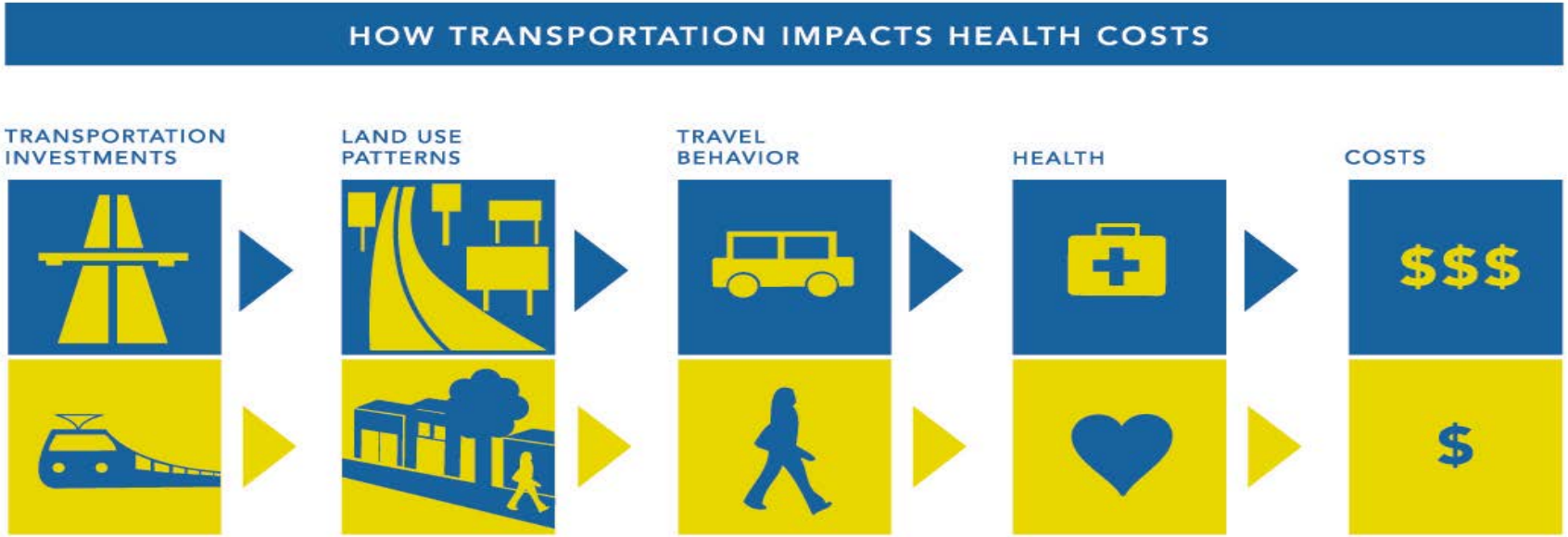
URBAN DESIGN 4 HEALTH (UD4H)

- Unique background and depth of experience in the modeling of health and built environment relationships
- UD4H and collaborators have led over $25 million in research linking transportation and land use development actions with health outcomes
- Among most published scholars on health and built environment globally
- Key Focus Areas:
    - Tool & Evidence Development
    - Objective Measuring & Surveying
    - Education, Outreach & Policy Development

ud4h

Core Expertise

- Measuring spatial phenomena including walkability, transit level of service, regional accessibility and pedestrian environments
- Developing predictive models of travel patterns for non-motorized, transit, private vehicle based demand
- Providing guidance for project-level programming and prioritization of active transport investments



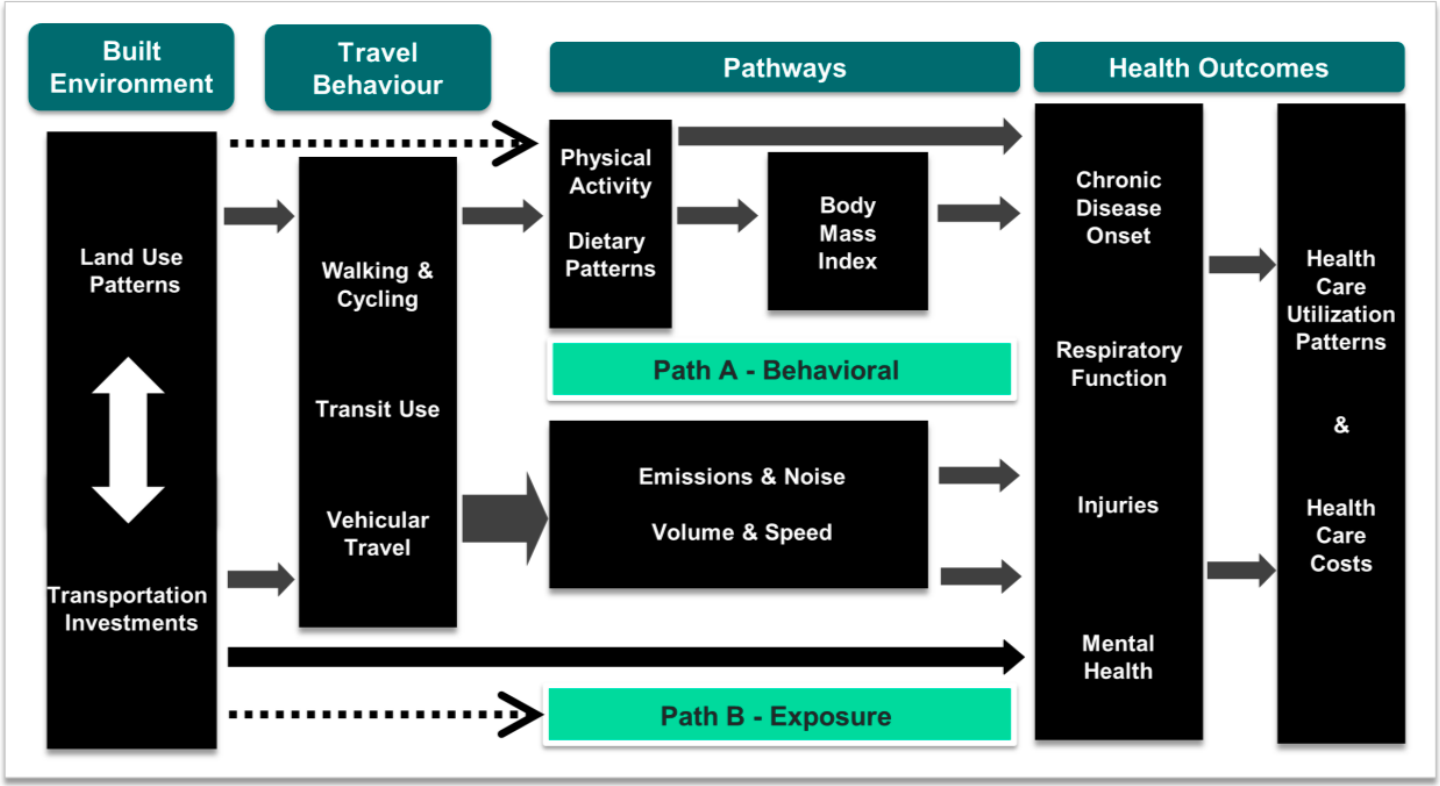
"The Hidden Health Costs of Transportation"

Frank et al 2010

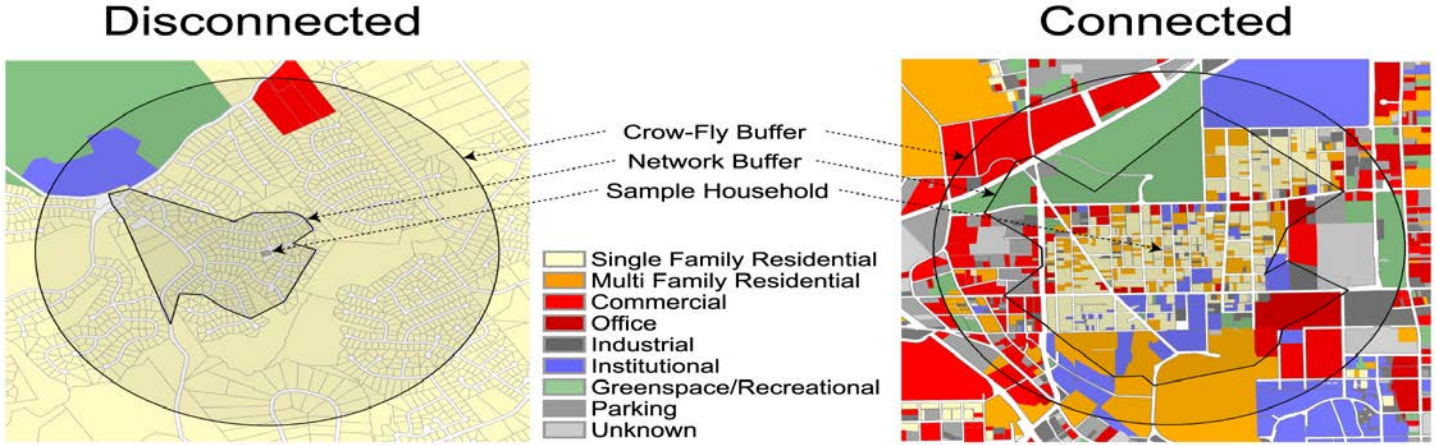
American Public Health Association

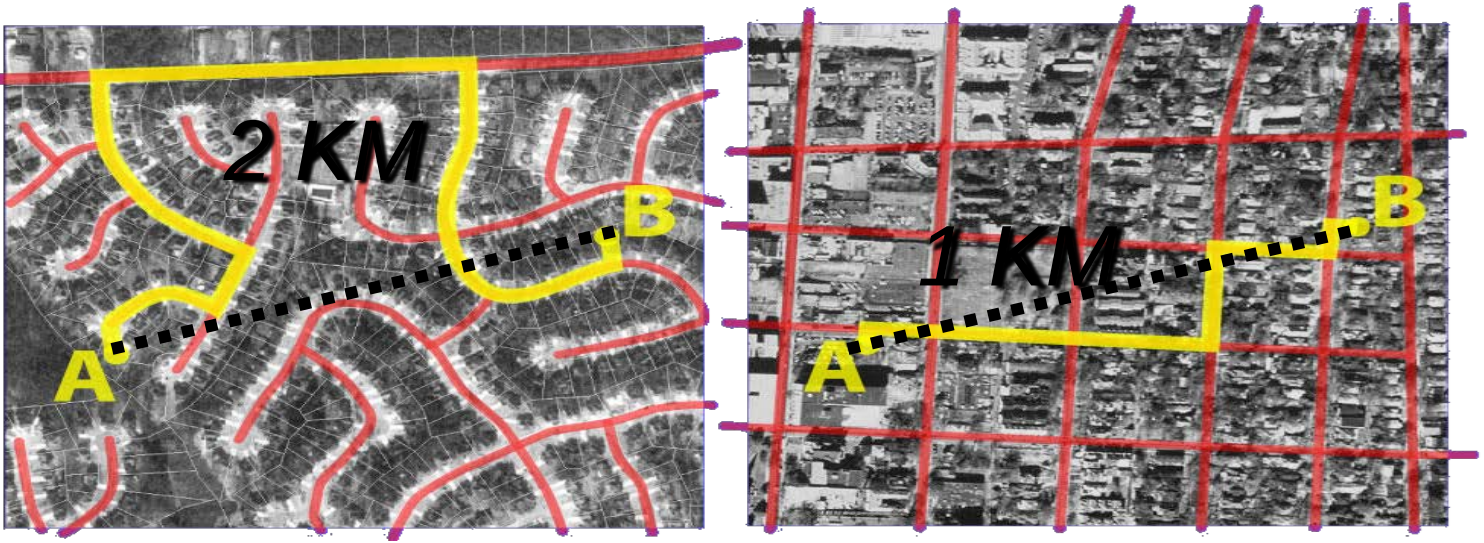

Monitoring & Feedback
Tracking Performance
Quality of Life
Environmental Quality
Air Quality and Greenspace
Human Behavior
Travel Patterns and Physical Activity
Built Environment
Transportation Investments and Land Use

Conceptual Framework



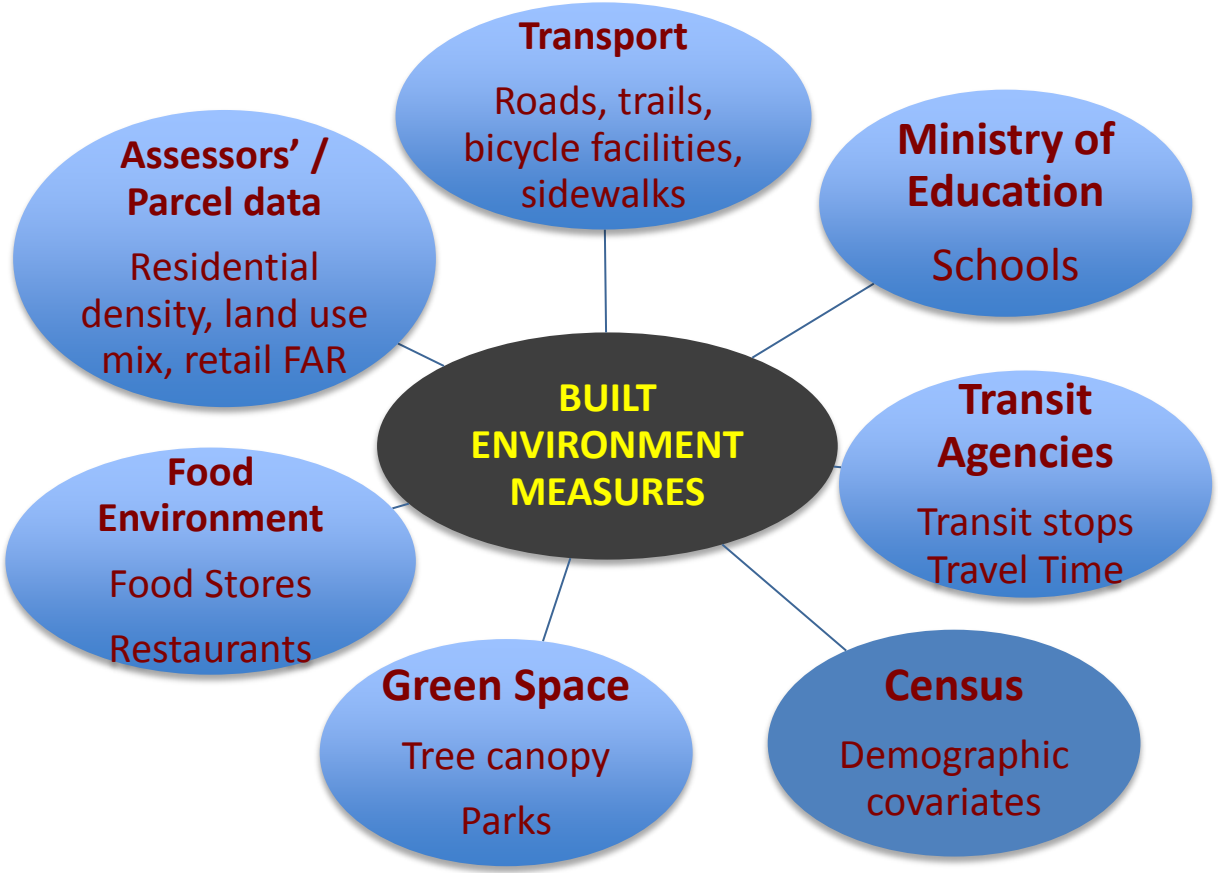
Proximity

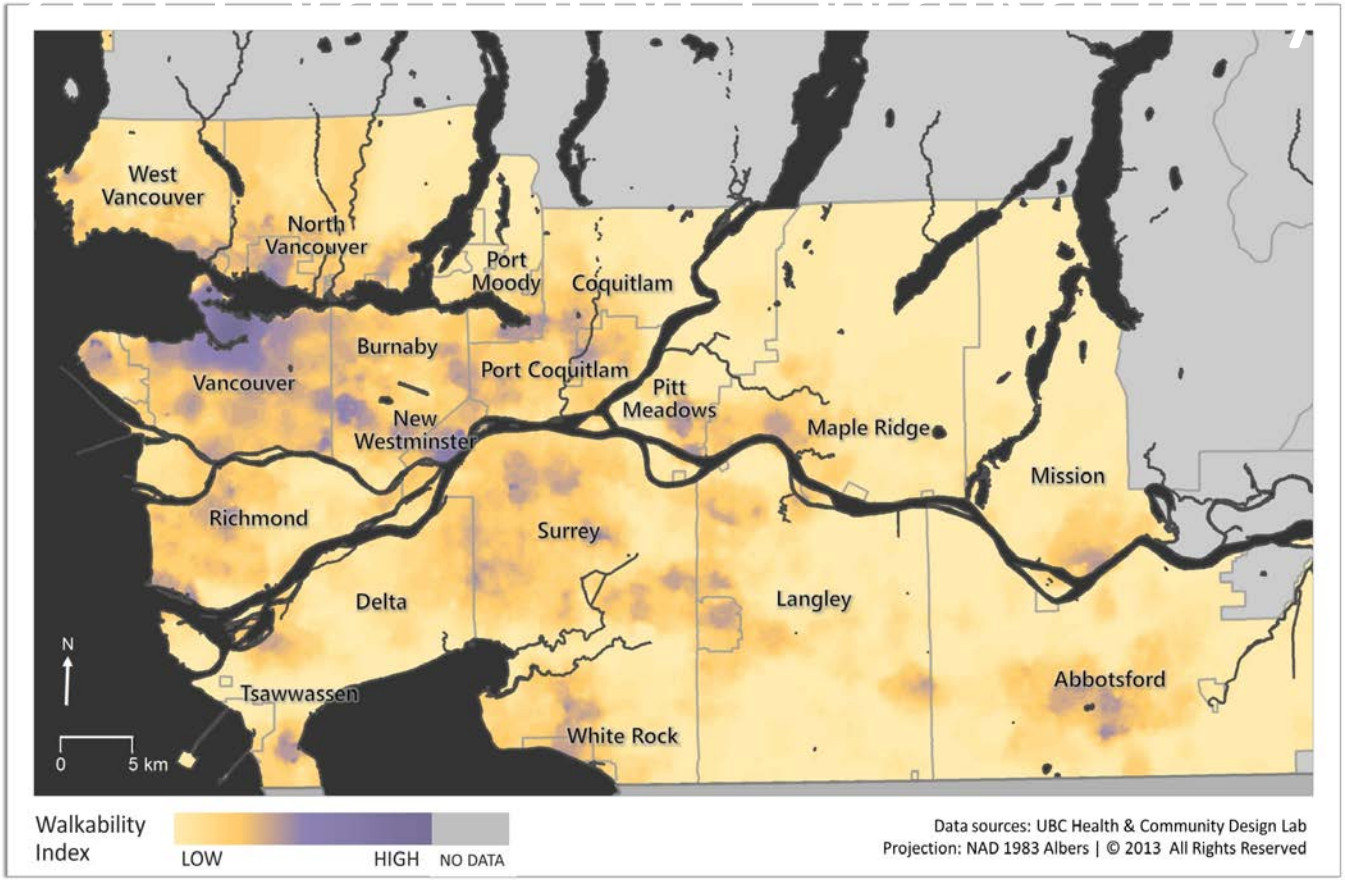




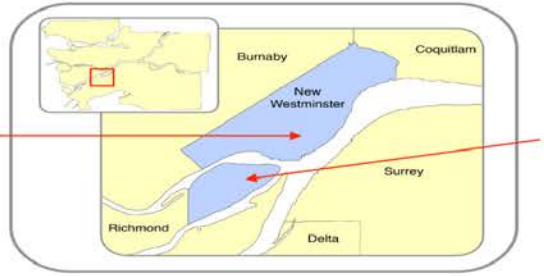
Connect-
ivity

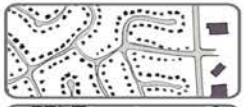
Built Environment Data Sources




West Vancouver
North Vancouver
Port Moody
Coquitlam
Burnaby
Vancouver
Port Coquitlam
Pitt Meadows
New Westminster
Maple Ridge
Mission
Richmond
Surrey
Delta
Langley
Tsawwassen
Abbotsford
White Rock
N
0
5 km
Walkability Index
LOW
HIGH
NO DATA
Data sources: UBC Health & Community Design Lab
Projection: NAD 1983 Albers | © 2013 All Rights Reserved

Local Walkability – “How”





	Uptown Moody Park	Queensborough
Net Residential Density (dwelling units/acre)	40.29	7.73
Mixed Use Index (range 0 – 1)	0.58	0.09
Intersection Density (per square km)	70.12	27.91
Retail Floor Area Ratio	0.64	0.30
Overall Walkability	4.26	-3.74

Scenario Planning Overview

- Scenario planning is a method for analyzing and comparing the impacts of various land use and transportation alternatives
- Typical impacts considered include financial costs, transportation accessibility & housing availability
- More recently health impacts are being added
- Results are used to inform decision-making about infrastructure investments, master planning, development proposals, etc.

Genesis of Tool Development

- **2005:** INDEX: Livable Community Initiative: Atlanta (SMARTRAQ)
- **2007:** I-PLACE3S: King County, added health module
- **2011:** UrbanFootprint: Vision California
- **2012:** CommunityViz: San Diego, & Toronto, Ontario & Surrey, BC—added health module
- **2015**: California Public Health Assessment Module (CPHAM) for Urban Footprint 2.0
- **2016**: National Public Health Assessment Model (NPHAM) supported by National Environment Database (NED)

San Diego County

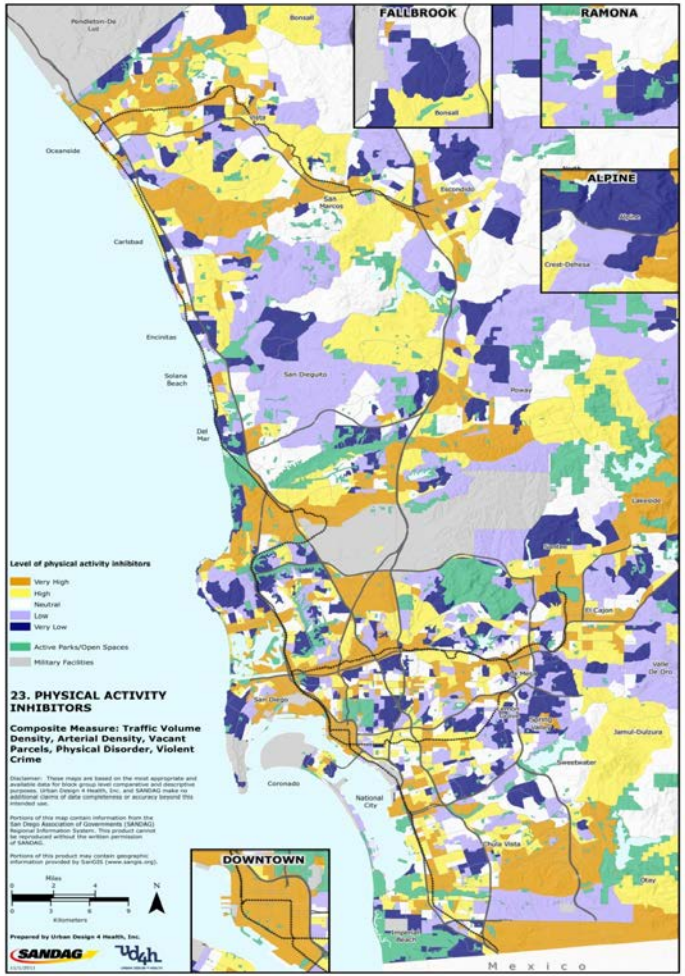
- San Diego Healthy Works
- Application– Palomar Gateway Development
- Data Sources:
  - Health Outcomes: California Health Interview Survey (CHIS) data from 2001-2009 for San Diego County (n = 18,044 adults, 1,368 teens, 2,715 children)
  - Travel Behavior: SANDAG Household Travel Survey (n = 5,974 adults, 1,589 children & teens)

Physical Activity Inhibitors: Composite Map Methodology

Made up of the following Base Maps:

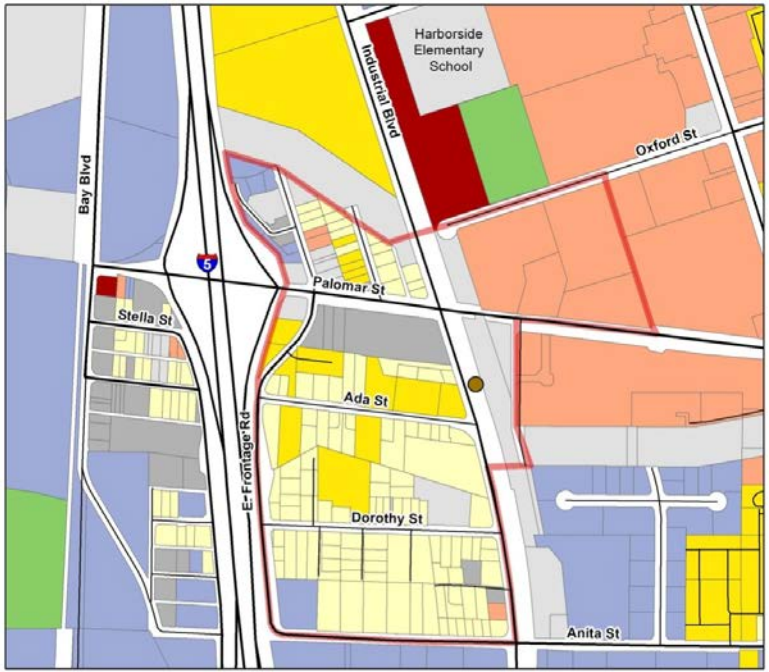
- Traffic Volume Density
- Arterial Density
- Vacant Parcels
- Physical Disorder
- Violent Crime

- To calculate the composite score:
- Each Base Map measure was given a standardized value (z-score) for each block group.
- The final composite score per block group is the average of the Base Map z-scores.
- Block groups were separated into quintiles (5 groups with equal numbers of block groups in each) based on their composite score.
- Although only the western third of the region is shown in the map, the analysis is based on all 1,762 block groups in the San Diego region.



SAN DIEGO

CASE STUDY: PALOMAR GATEWAY



Legend

Land Use Types

- Single Family Residential
- Multi-Family Residential
- Retail
- Office
- Industrial
- Vacant
- Other

Scale: 1:6,500

0 0.1 0.2 Miles

N W E S

- Palomar St. Station
- Palomar Case Study Area
- Parks & Open Space

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PALOMAR GATEWAY: BUILT ENVIRONMENT CHANGES

Variable	Base Scenario	Change Scenario	Units
Single Family DU	192	80	housing units
Multi-Family DU	155	1626	housing units
Total Population	884	3841	people
Residential Area	44.3	68.5	acres
Net Residential Density	7.8	24.9	units/acre
Retail Floorspace	370073	395221	square feet
Retail Area	15.7	7.3	acres
Retail FAR	0.5	1.3	
Office Floorspace	0	41238	square feet
Office Area	0	1.2	acres
Office FAR	0	0.8	
Civic and Education Floorspace	0	20035	square feet
Recreation and Entertainment Floorspace	0	68393	square feet
Park Area	1.2	1.2	acres
Number of Schools	0	0	
Number of Transit Stops	3	3	
Number of Grocery Stores	1	2	
Total Road Centerline Miles	4.2	4.2	miles
Total Sidewalk Miles	4.5	5.5	miles
Sidewalk Coverage	53%	66%	
Total Bike Miles	0.5	1.2	miles

Palomar Gateway Results Summary

- All adult health metrics improved in the change scenario, including
  - 68% increase minutes of daily transportation walking
  - 15.4% reduction in prevalence of high blood pressure
  - 9.6 % reduction in prevalence of type II diabetes
- Child/teen results were mixed
  - Physical activity predicted to increase for children/teens
  - Obesity prevalence for teens predicted to increase
  - Asthma prevalence for children/teens predicted to increase
- Collision risk factor increased

California Public Health Assessment Module (CPHAM)

Funder: California Strategic Growth Council

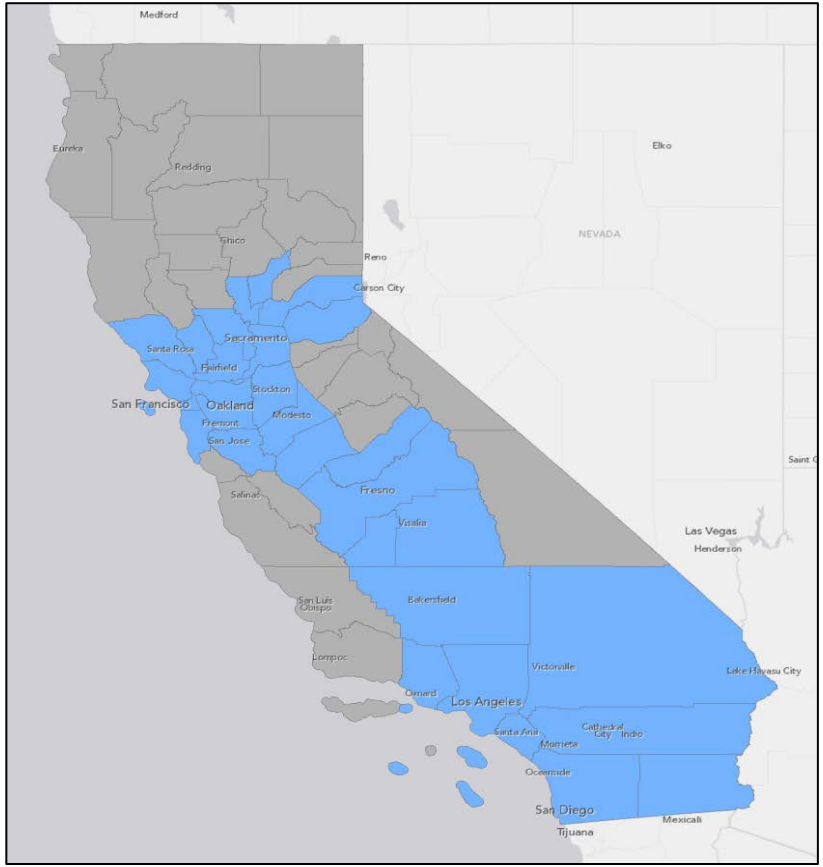
Key Elements:

- Quantitative statistical models of **built environment & health**
  - Outcomes include BMI, likelihood of being obese, likelihood of having high blood pressure/heart disease/type 2 diabetes
- Integrated into Calthorpe's UrbanFootprint

C-PHAM Study Region

30 counties across five California regions:

- San Francisco Bay Area
- Sacramento
- San Diego County
- San Joaquin Valley
- Southern California (including Los Angeles)



California Public Health Assessment Module (CPHAM)

Key Elements continued:

- **Data** from parcel level and address-level large, representative surveys
  - Parcel level built environment data (density, connectivity, etc) from UrbanFootprint
  - California Household Travel Survey (CHTS)
  - California Health Interview Survey (CHIS)
  - 5 MPO regions
- **Fine spatial scale** analysis and predictions
  - 1-km buffers around 150x150 grid cells

CALIFORNIA PUBLIC HEALTH ASSESSMENT MODULE (CPHAM)

Key Elements continued:

- Outcomes:

  Recreation Physical Activity - Minutes Daily

  Walking - Minutes Daily

  Biking - Minutes Daily

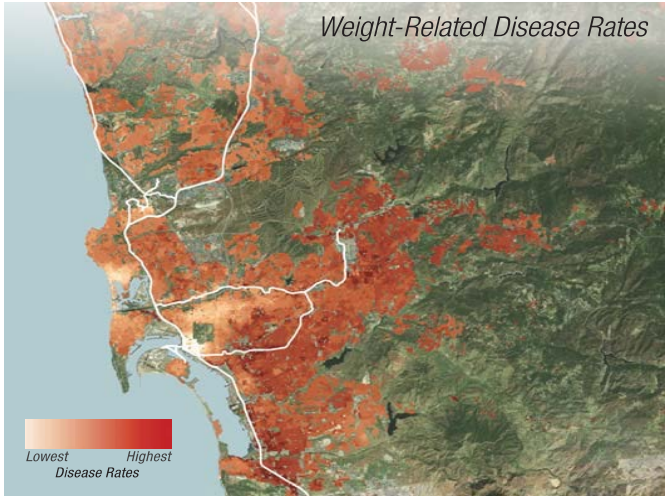
  Auto - Minutes Daily

  Obese Population (%)

  High Blood Pressure (%)

  Heart Disease (%)

  Diabetes - Type 2 (%)



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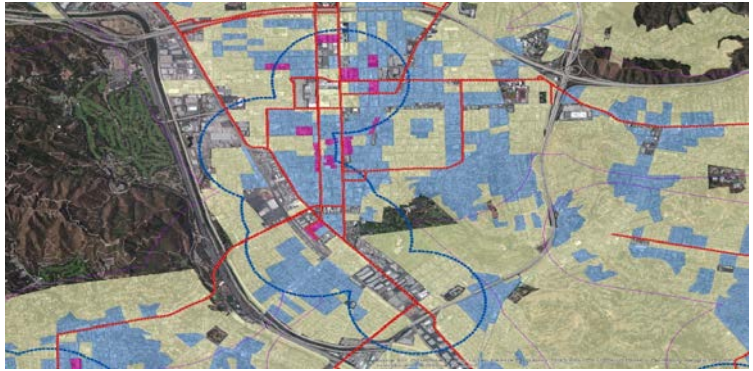
and demographic characteristics of scenarios.

Strength of Approach

- **Large sample sizes**
  - 53,733 California Household Travel Survey participants
  - 40,617 California Health Interview Survey participants
- **Cohort-specific model development**
  - 4 age groups (seniors, adults, teens, children)
  - For adults, three HH income groups (<$50k, $50-100k, >$100k)
- **California-specific evidence base**
  - CHIS and CHTS data were collected from a representative cross-section of Californians
- **Variability in built environment characteristics**
  - 30-county study area covers a broad range of built environments and travel behaviors across California

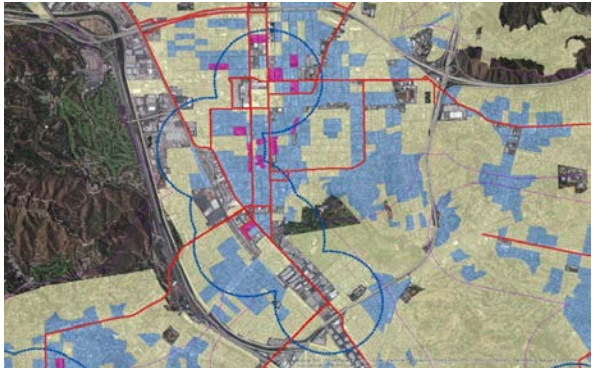
Applying Evidence to the Los Angeles Long Range Plan



Adults: Ages 18-65	Base Year 2012	Net Change: (2012 – 2040)
Recreation Physical Activity - Minutes Daily	13 min	+ 9%
Walking - Minutes Daily	23 min	+ 10%
Biking - Minutes Daily	3 min	+ 12%
Auto - Minutes Daily	55 min	- 6%
Obese Population (%)	21.5%	- 3%
Poor Health Population (%)	24.1%	- 13%
High Blood Pressure (%)	19.6%	- 1%
Heart Disease (%)	4.3%	0%
Diabetes - Type 2 (%)	5.6%	- 11%

Source: California Public Health & Activity Model – Scenario Planning for Southern California Association of Governments

C-PHAM IN SCAG PREDICTIONS



Adults: Ages 18-65	2040 Trend	Adopted Plan
Recreation Physical Activity - Minutes Daily	14.6 min	+ .4%
Walking - Minutes Daily	12.1 min	+ 33%
Biking - Minutes Daily	1.6 min	+ 26%
Auto - Minutes Daily	64.8 min	- 4.4%
Obese Population (%)	26.3%	- 1.3%
High Blood Pressure (%)	21.5%	- 1.2%
Heart Disease (%)	4.4%	- 1.0%
Diabetes - Type 2 (%)	6.1%	- 1.0%

Source: California Public Health & Activity Model –
Scenario Planning for Southern California Association of Governments

SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS

National Environmental Database (NED) & National Public Health Assessment Model (N-PHAM)

National Environmental Database (NED)

Goal: Develop a nationally consistent database of built, natural, and social environmental indicators

Funder: Robert Wood Johnson Foundation

Key Elements:

- Built, natural, and social environment
- Developed at block group geography
- National coverage

NED Database

- From 30+ national & region-specific databases
  - Government Agencies
  - Universities
  - Private Sector
- Contains over 200 variables
- Leveraging existing variables, developing new variables

Database Development

- Types of Variables
  - Existing nationwide variables (e.g. SLD, EnviroAtlas)
  - Composite measures
  - Variable weighting
  - Region-specific new variables at smaller spatial scale
- Frequent updates of variables at regular intervals where available

National Public Health Assessment Model (N-PHAM)

Goal: Develop a nationally applicable health impact tool that empower communities and developers to **quantify localized health impacts of alternative land use and transportation investment scenarios**

Funder: U.S. Environmental Protection Agency

Key Elements:

- Statistical regression models of **built, natural, and social environment effects on health**
  - Direct connection with modeled land use, walkability and health outcomes
- **Block group** level analysis and model predictions
  - Models developed from California statewide travel and health surveys

Pairing Data & Tools

National Database

(NED)

+

National Tool

(N-PHAM)

→

Planners and public health officials can measure and optimize health impacts of transport and land use investment

Robert Wood Johnson Foundation

N-PHAM Connects With Existing Tools

- Connects to scenario planning software via end user API and software-specific plug-in
- Fully integrated with:
  - Envision Tomorrow (Fregonese Associates)
  - Urban Footprint (Calthorpe Analytics)
  - CommunityViz (City Explained, Inc., formerly Placeways)

envision tomorrow
a suite of urban and regional planning tools

communityviz®

UrbanFootprint

NPHAM Phase 1 - Outcomes

- Physical Activity:
  - Transport walking, transport biking, recreational PA
- Sedentary time:
  - Auto travel
- General health:
  - Prevalence of poor self-reported general health
- Obesity-related:
  - Average BMI, obesity prevalence, overweight prevalence
- Mental health:
  - Moderate to serious psychological distress prevalence

Diabetes and cardiovascular disease planned in Phase II

Contact Information

Dr. Larry D. Frank: ldfrank@ud4h.com

Mr. Eric Fox: efox@ud4h.com

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Visit our website: www.ud4h.com

Using Embodied Videos of Walking Interviews in Walkability Assessment

Geoffrey Battista
Ph.D. Candidate
McGill University
@GeoffBattista

Kevin Manaugh
Assistant Professor
McGill University
@KManaugh

Walkability: Measuring Physical Space

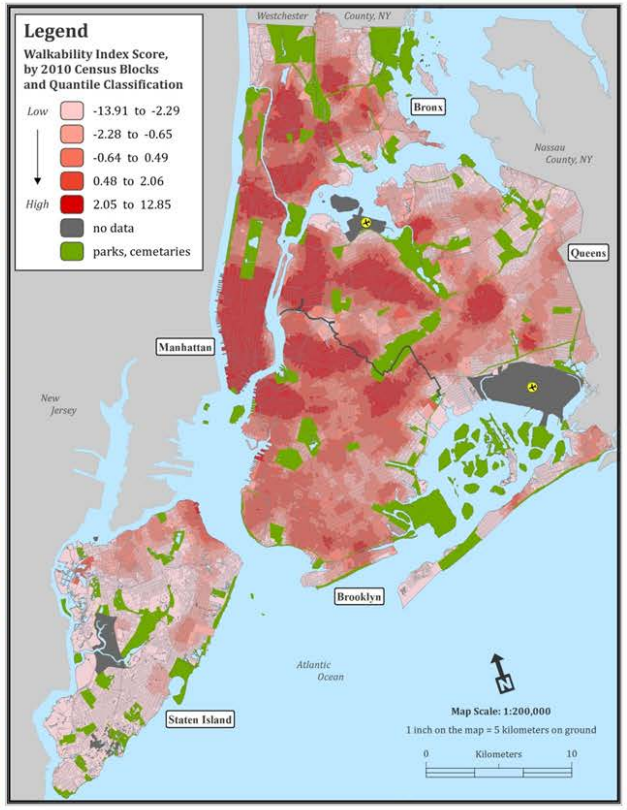
What is walkability?

Generalizable instruments

- Geospatial measures
- Audit-based measures

Shortcomings to date

- Locals' perceptions
  (Hajna et al., 2013)
- Socioeconomic factors
  (Manaugh and El-Geneidy, 2011)



Built Environment and Health Research Group at Columbia University (https://behcolumbia.files.wordpress.com/2015/11/walkability.png)

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Context Matters

The "Uncertain Geographic Context" Problem (Kwan 2012)

- How do complex areal attributes (e.g., land use mix) impact individual outcomes?
- How can we balance
  - generalizable processes and their particularities,
  - across space and among individuals,

to better understand the relationship between context and outcomes?

We propose that assessment *treats the pedestrian as* ***integral*** *to the geographic context of walkability.*


http://esoiesmarina.blogspot.ca/

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Toward Socializing Walkability

Rethinking walkable space

(Lefebvre, 1974/1991; Massey, 2005)

- Physical and social distances
- Complex and everchanging


http://www.pinkbike.com/
Spinney, 2011

Ways of understanding

- Embodiment and reflection
  (Middleton, 2010; Spinney, 2006; 2011)
- Walking interviews
  (Anderson, 2004; Evans and Jones, 2011)

http://www.toledoblade.com/
Evans and Jones, 2012

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Our Approach

Sedentary interview (1hr)

1. Start with personal history and neighborhood selection
2. Discuss routines and preferred amenities, e.g., shopping
3. Use amenities to discuss nearby streets, e.g., traffic, crime, and aesthetics
4. Flexibly pursue emerging themes

Walking interview (1hr)

1. Mount GoPro camera and begin participant-led tour
2. Prompt participant re: physical features, events, their feelings
3. Stop at key locations to discuss in greater depth, relating to previous statements
4. Debrief and solicit ideas for improving walking

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Generating new insights

Sample: 5 pilot-testing cases, followed by 30 residents of one neighbourhood

Our approach illuminates:

- ✓ Features in conventional tools
- ✓ Amenities and paths unique to locals
- ✓ Informal behavior by participants and others (and its impact on walking)
- ✓ Local knowledge of crime and traffic

Top: "I don't know why they don't redraw the lines. Does that mean they don't want it to be a crossing path anymore?" (Elena)
Bottom: Dodging a cyclist on the sidewalk

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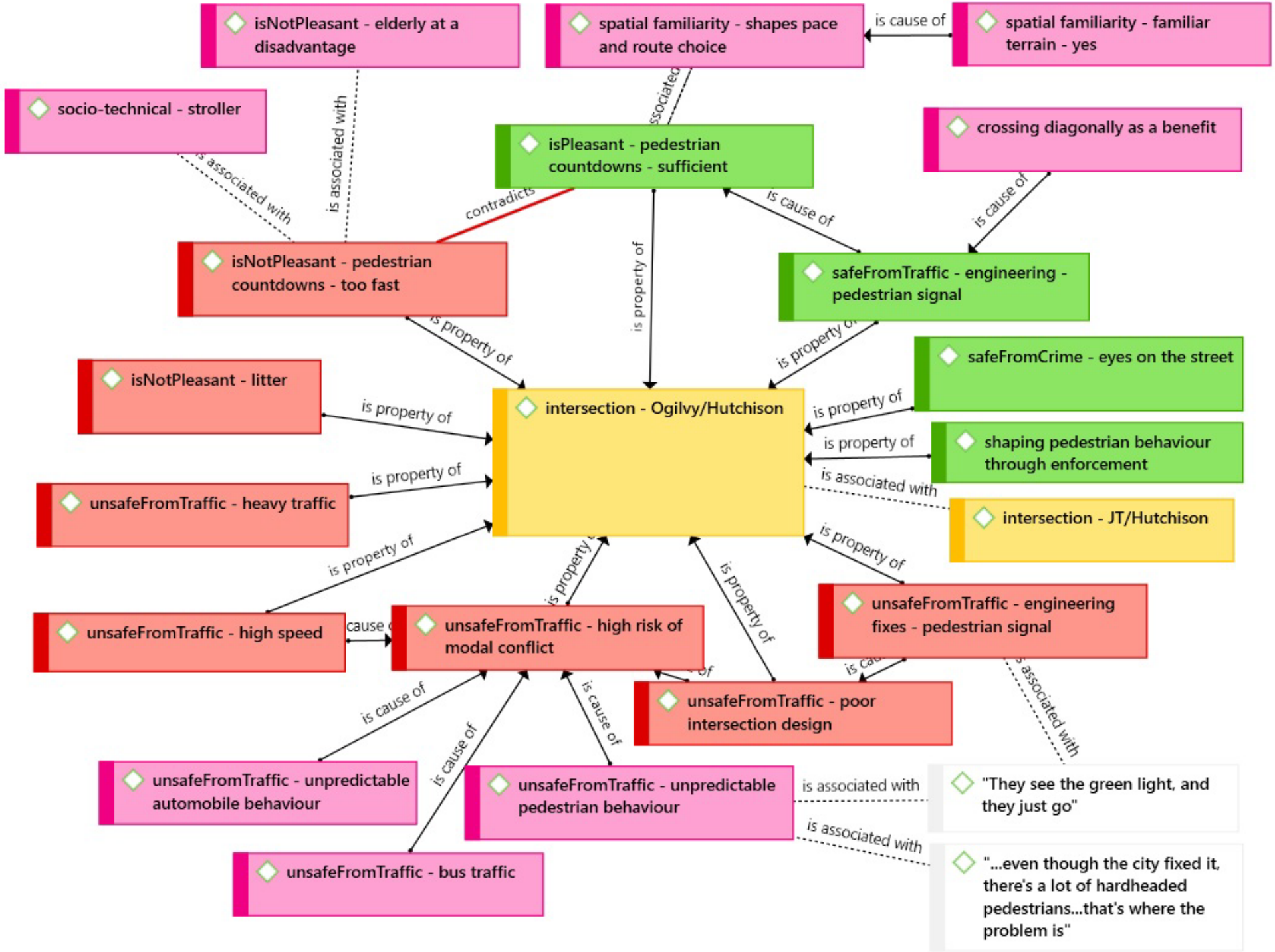
Cars turning very quickly from highway
Friend mugged outside temple
Pedestrian countdown very short, causing participant to run
Halfway house
Poor intersection design promotes jaywalking
Aggressive panhandler hangs out
Mafia firebombing
"Ogilvy is a sketchy street"
4 daycares, no crosswalks
KEY
Unsafe from traffic
Unsafe from crime
Google Earth
2004
Imagery Date: 9/17/2013 45°31'41.83" N 73°37'58.00" W elev 54 m eye alt 2.25 km

Taking a closer look…



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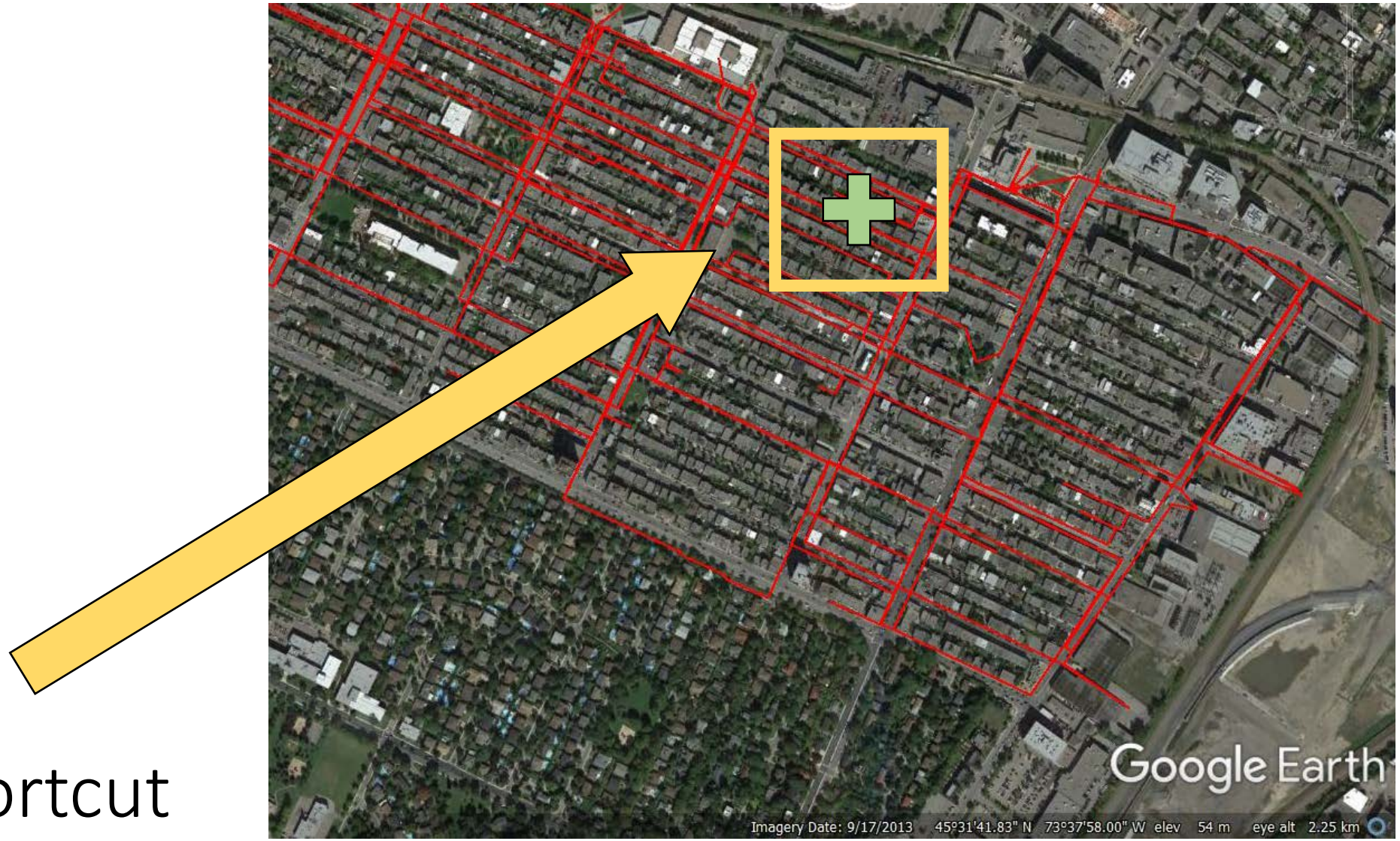
KEY
amenity – food – ephemeral
amenity – cafe/bar - old man
Google Earth
Imagery Date: 9/17/2013 45°31'41.83" N 73°37'58.00" W elev 54 m eye alt 2.25 km



Alleyway: Shortcut or amenity?

Implications for Practice

Complement existing walkability measures

- Compare local and technical knowledge
- Examine difference among different groups, e.g., people with disabilities, low-income
- Use multimedia as compelling evidence

As a stand-alone approach

- Gauge local needs at low cost, e.g., for cash-strapped advocacy groups
- Engage the community; people love to talk about themselves
- Tailor walkability audits and performance measures to local context

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Methodological Insights

A versatile, collaborative approach

- Reflect on physical and social spaces shaping walking behavior
- Inform design of pedestrian interventions **beyond built solutions**, e.g., law enforcement, social inclusion policies
- Relatively low-cost (camera, interviewing manual, compensation)

Acknowledging limitations

- Researcher should be familiar with walkability audits and interviewing
- Difficult to compare trajectories and assessments*

* We address this by grounding interviews in a qualitative GIS. See Battista, G.A. and K. Manaugh (2017). "Illuminating Spaces in the Classroom using Qualitative GIS". *Journal of Geography in Higher Education.* http://dx.doi.org/10.1080/03098265.2017.1339267

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Thank you!

Contact

Geoffrey A. Battista
Ph.D. Candidate
geoffrey.battista@mcgill.ca
@GeoffBattista

Kevin Manaugh
Assistant Professor
kevin.manaugh@mcgill.ca
@KManaugh

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The Pedestrian Index of the Environment (PIE)

Patrick A. Singleton
Portland State University

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  - Jaime Orrego
  - Joseph Totten
  - Christopher Muhs

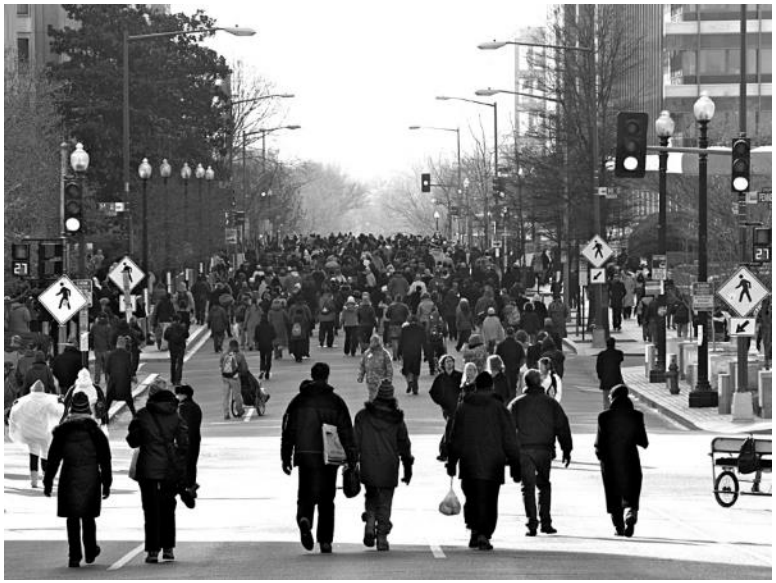
NITC NATIONAL INSTITUTE for TRANSPORTATION and COMMUNITIES

TREC Transportation Insight for Vibrant Communities

Portland State UNIVERSITY

Outline

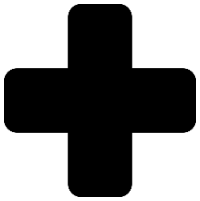
- Walkability
- Pedestrian Index of the Environment (PIE)
- Transferable PIE
- Comparing between & within regions
- Conclusions & future work



Adapted from: http://www.flickr.com/photos/takomabibelot/3223617185

Why walkability?

Pedestrian planning, infrastructure



Physical activity, health & safety

Mode shifts, emissions

Property values, neighborhood vitality

Walkability measures

- Pedestrian Environment Factor (PEF)[1]
- Walkability Index[2]
- Walk Opportunities Index[3]
- Walk Score®[4]

- **Pedestrian Index of the Environment (PIE)**[5]

1. Parsons Brinckerhoff Quade and Douglas, Cambridge Systematics, & Calthorpe Associates, 1993. LUTRAQ Volume 4A. http://www.friends.org/resources/reports
2. Frank, Schmid, Sallis, Chapman, & Saelens, 2005. https://doi.org/10.1016/j.amepre.2004.11.001
3. Kuzmyak, Baber, & Savory, 2005. https://doi.org/10.3141/1977-19
4. https://www.walkscore.com
5. Singleton, Schneider, Muhs, & Clifton, 2014. https://trid.trb.org/view.aspx?id=1289281

Original objectives

- Metro: Portland's metropolitan planning organization (MPO)
- Improving representation of the pedestrian environment in travel demand models
  - Four-step travel demand forecasting process
  - Finer spatial resolution
  - Research-based measures of the built environment
  - Behavioral sensitivity

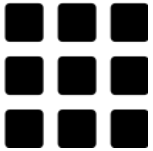
1. Generation
2. Distribution
3. Mode choice
4. Assignment

What is PIE?

The Pedestrian Index of the Environment (PIE)
= ∑ (6 dimensions)

weighted by association with walking

People & job density



Block size

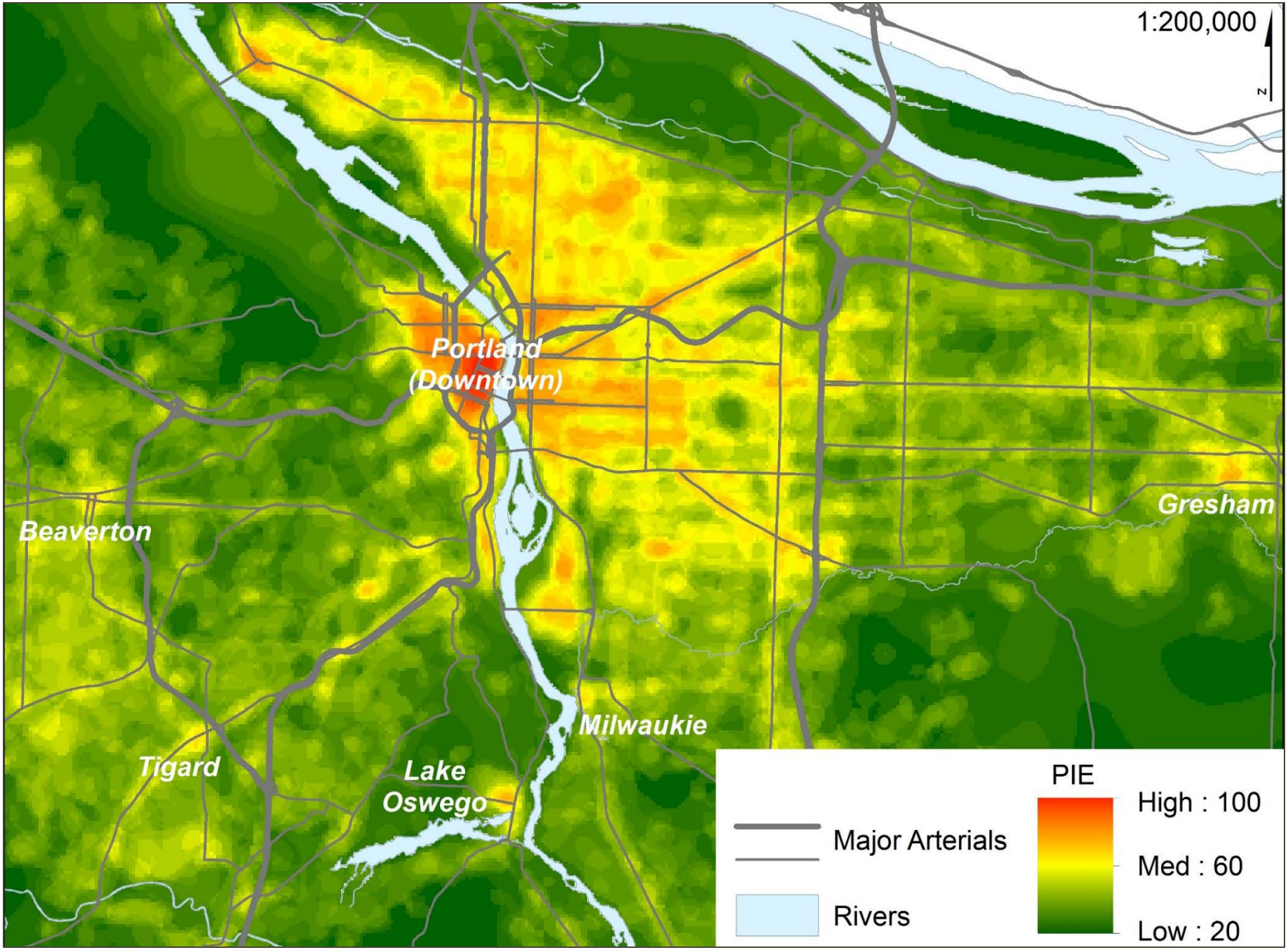
Transit access

Sidewalk extent

Urban living infrastructure

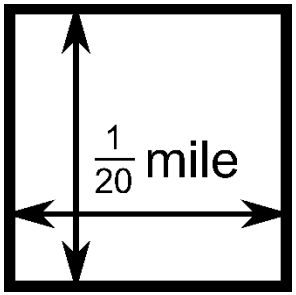
Comfortable facilities

ULI = Urban Living Infrastructure: pedestrian-friendly shopping and service destinations used in daily life.


1:200,000
N
Portland
(Downtown)
Beaverton
Gresham
Milwaukie
Tigard
Lake
Oswego
Major Arterials
Rivers
PIE
High : 100
Med : 60
Low : 20

PIE's unique contributions

- Calibrated to walking behavior
- Grid cells: pedestrian analysis zones (PAZs)

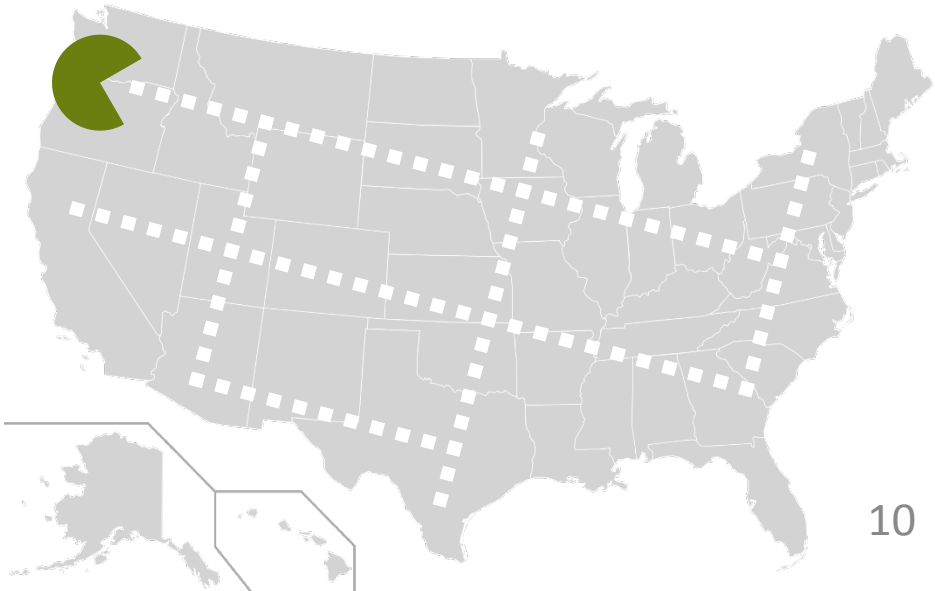


- Fine-grained built environment data

Adapted from: https://www.flickr.com/photos/65478477@N06/6063689338/

New objectives

- Transferability and forecasting of the PIE for modeling and planning applications
  - Retain unique aspects: small scale, behavioral
  - Use nationally-available built environment data
  - Evaluate transfer to different regions and urban contexts
  - Examine issues & needs when forecasting PIE



PIE 2.0

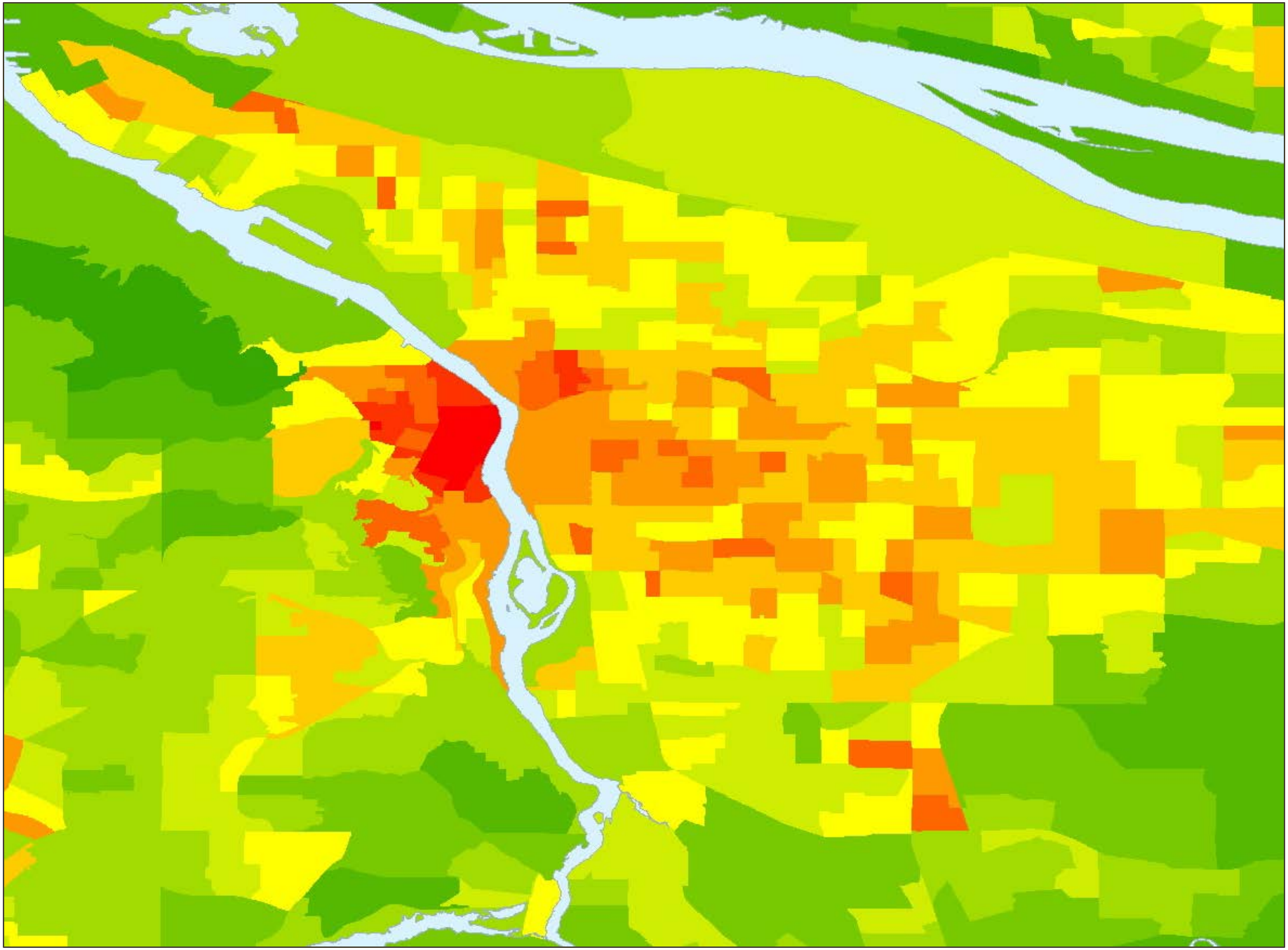
- EPA's Smart Location Database (SLD)
  - Census block groups

Population density

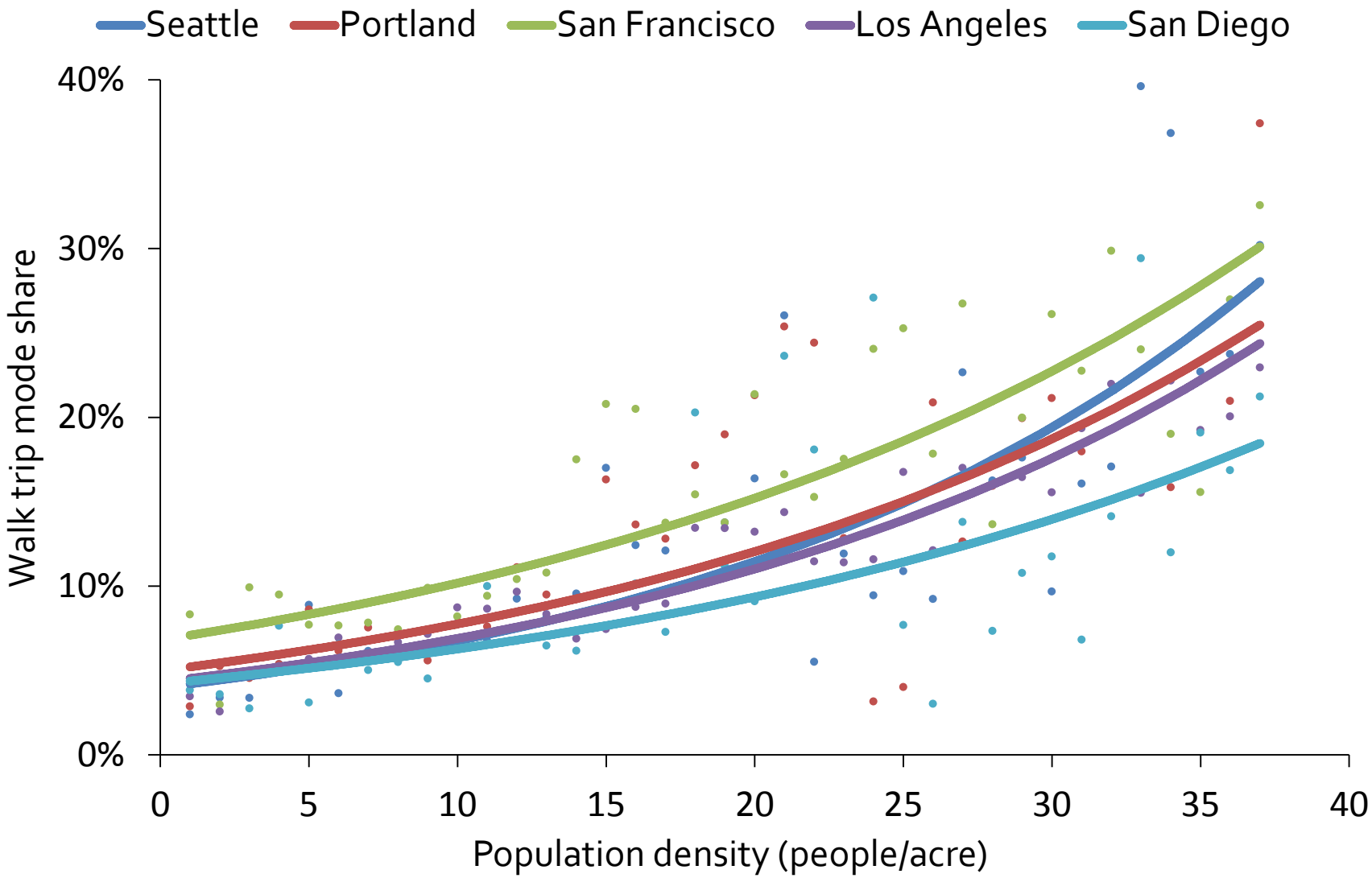
Transit frequency density

Employment density
(retail + entertainment)

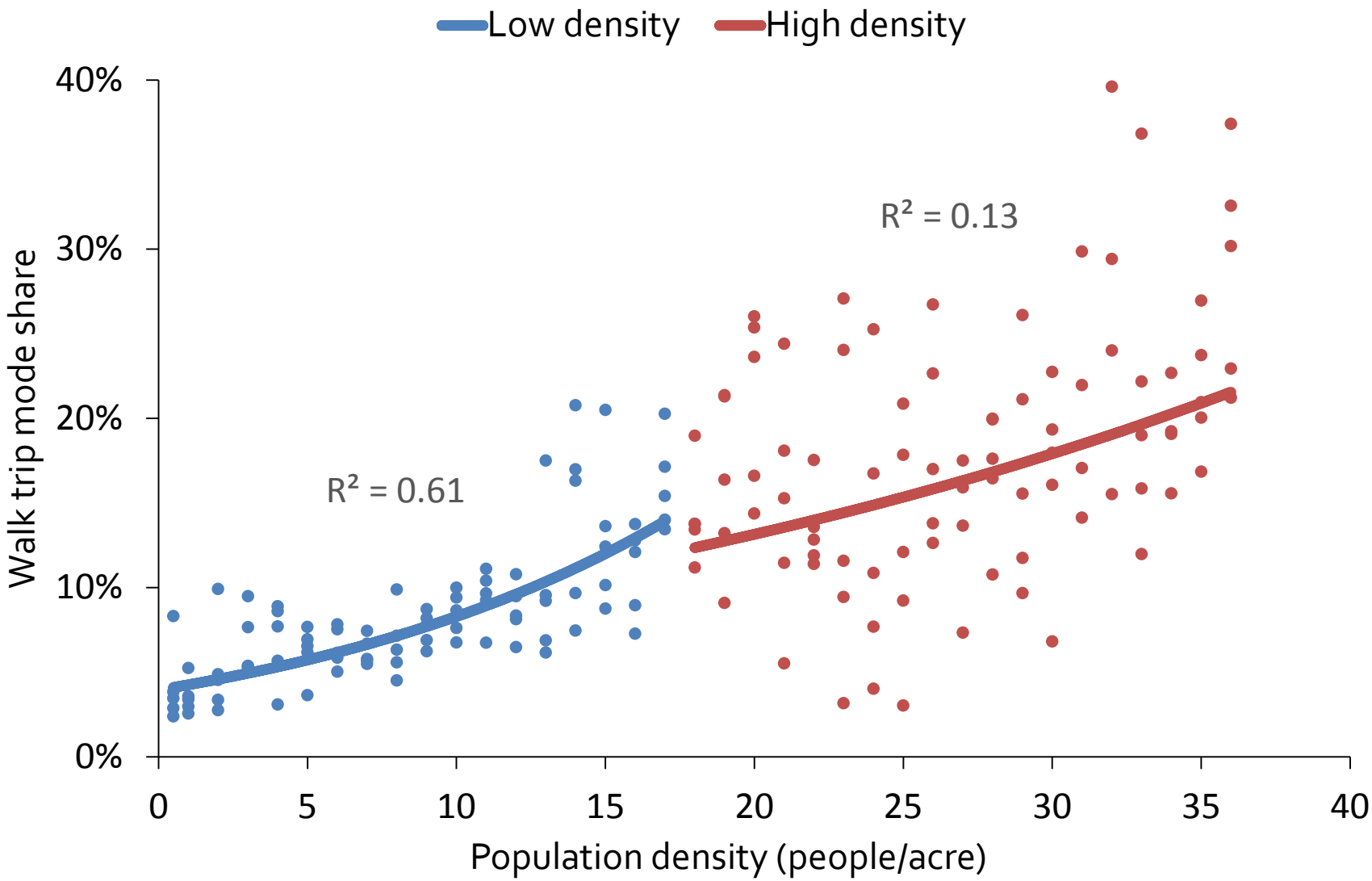
Intersection density (pedestrian-oriented)



Variations between regions

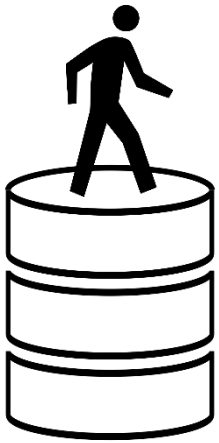


Variations within regions

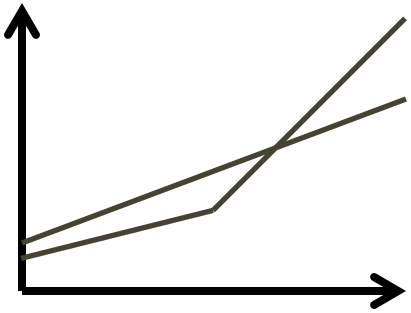


Challenges

- Data availability
  - Behaviorally-relevant measures of the built environment
  - Small spatial scale of walk trips



- Variations in behavioral relationships
  - Between or among regions
  - Within regions: non-linear?



Conclusions

- Increasing behavioral and environmental data
- Calibrated walkability measures for…
  - Behaviors
    - Utilitarian/recreational walking, public activity
  - Applications
    - Travel demand, residential location, health, safety
- Networks, connectivity, accessibility
- Future work:
  - Spatial scale
  - Forecasting

Thank you!

- Learn more

  http://trec.pdx.edu/research/project/510
  http://trec.pdx.edu/research/project/677
  http://trec.pdx.edu/research/project/1028

- Pedestrian Modeling Workshop

  Transportation & Communities Summit
  September 12, 2017 – Portland, OR

- Questions?

Patrick A. Singleton

PhD Candidate
Portland State University
patrick.singleton@pdx.edu