Changing the scope and scale of regional travel models to better estimate pedestrian activity: Applications for public health

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Moving Active Transportation to Higher Ground

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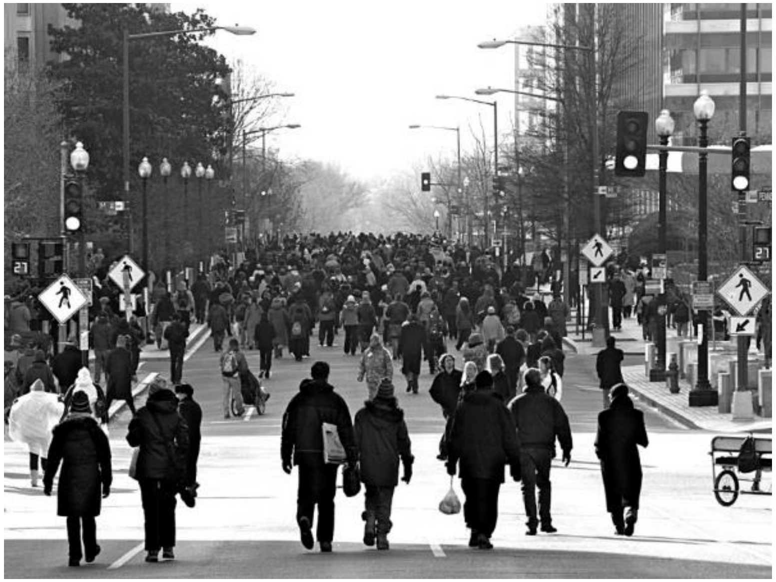
TREC Transportation Insight for Vibrant Communities

Metro

Outline

- Background
- Project & data
- Method & results
  - Trip generation
  - Walk mode split
  - Destination choice
- Summary, conclusions, & future work



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

Background

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Why model pedestrian travel?

plan for pedestrian investments
& non-motorized facilities

mode shifts

health & safety

greenhouse
gas emissions

new data

Background

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How can estimates of walking be used for health impact assessment?

walk trips, distances, locations

- Pedestrian crash risk & safety assessment
- Minutes walked → levels of physical activity
- Health impacts of projects / scenarios

Background

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How do travel models estimate walking?

- **Among 48 large MPOs:**
  - 38% did not estimate walking
  - 33% estimated non-motorized (walking + bicycling) travel
  - 29% estimated walking
- **Few used many BE measures or small spatial units**

Trip-based model sequence

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

Source: Singleton, P. A., & Clifton, K. J. (2013). Pedestrians in regional travel demand forecasting models: State-of-the-practice.

Background

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What are some challenges?

- ***Walking behavior data***:
  - difficult to obtain
- ***Built environment data***:
  - inconsistent/incomplete info on sidewalks, ...
- ***Travel demand models***:
  - large TAZs & coarse networks obscure BE variation
- ***Walking behavior research***:
  - determinants of walking were lacking

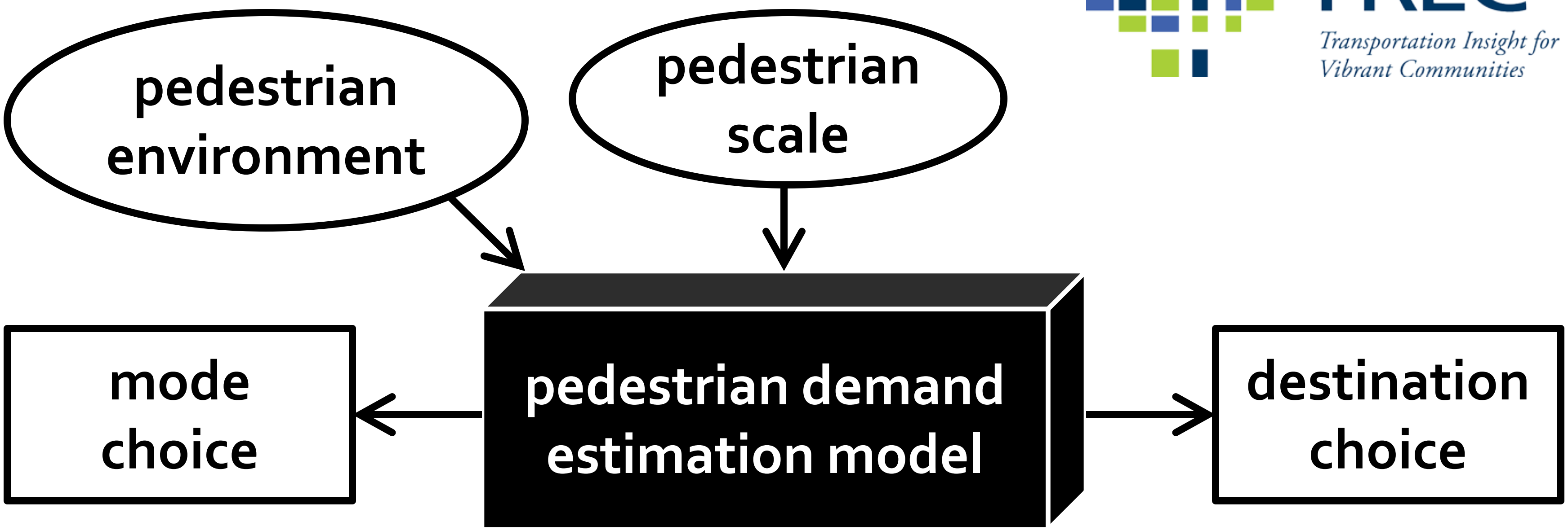
Background

What are some opportunities?

- ***Walking behavior data***:
  - improved travel surveys, ped. count data collection
- ***Built environment data***:
  - archived spatial datasets, GIS processing
- ***Travel demand models***:
  - smaller zones, complete networks, computer power
- ***Walking behavior research***:
  - more knowledge and studies

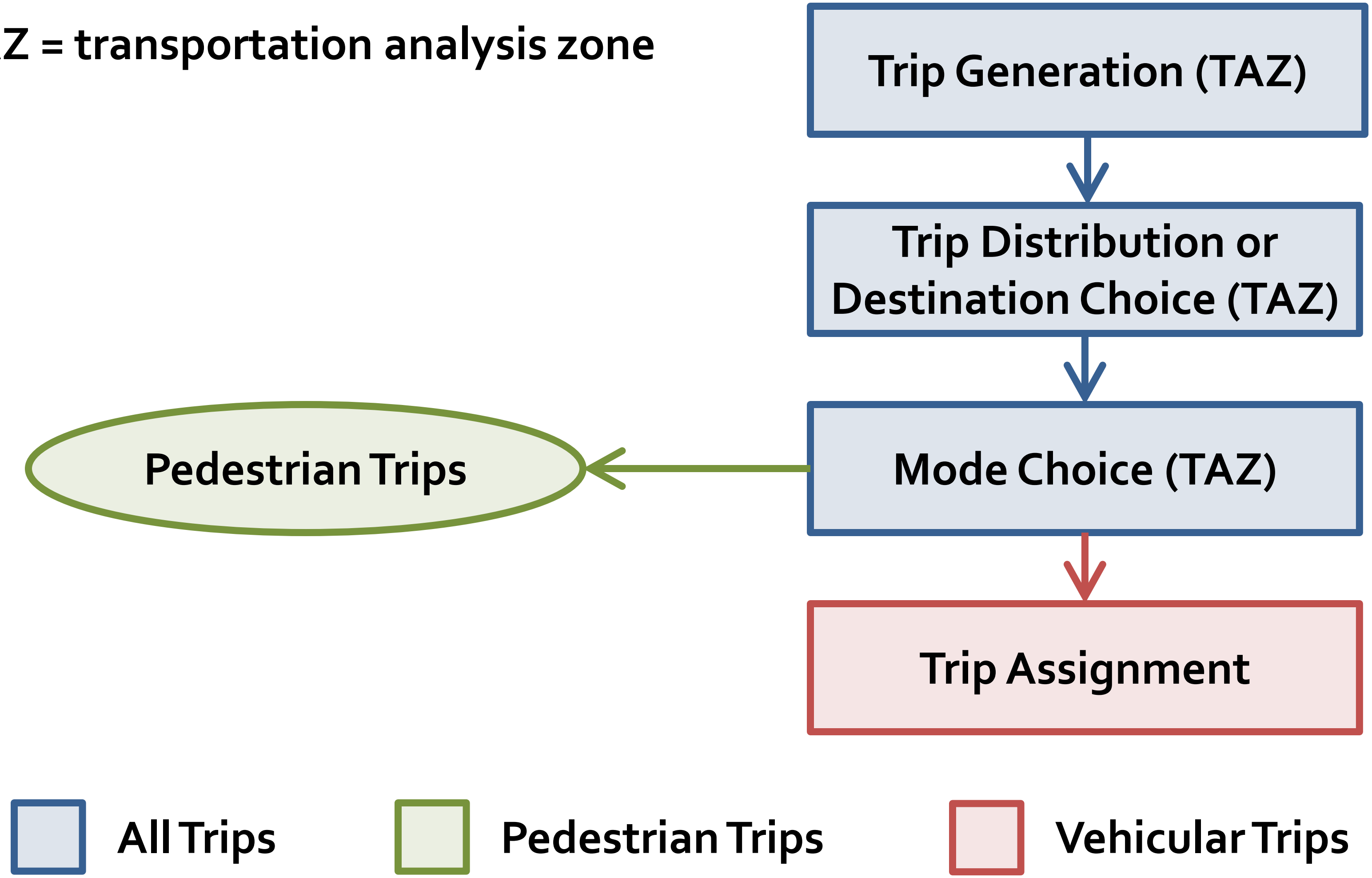
Project overview

- Metro: metropolitan planning organization for Portland, OR
- Two research projects



Current method

TAZ = transportation analysis zone



New method

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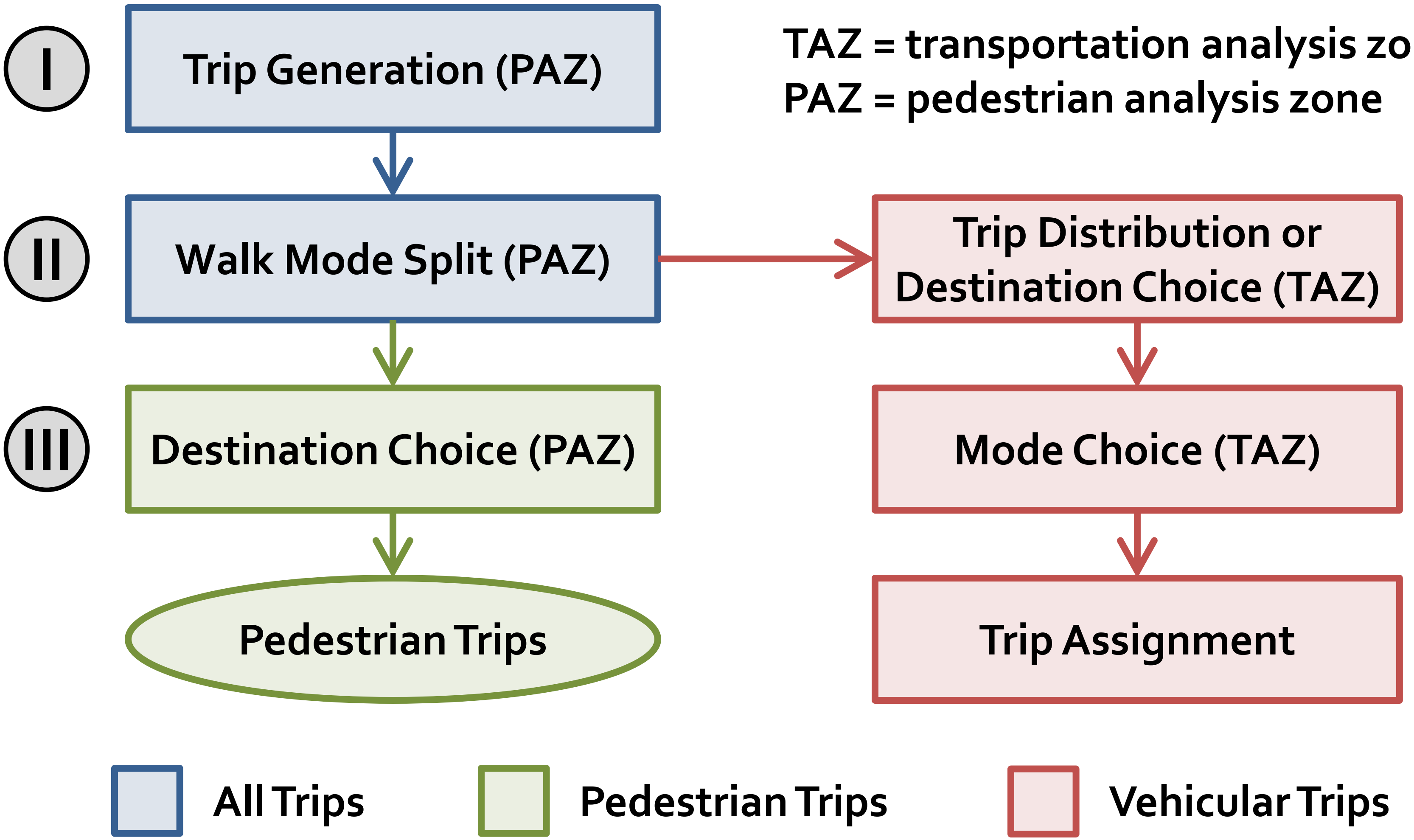
TAZ = transportation analysis zone
PAZ = pedestrian analysis zone



Travel survey data

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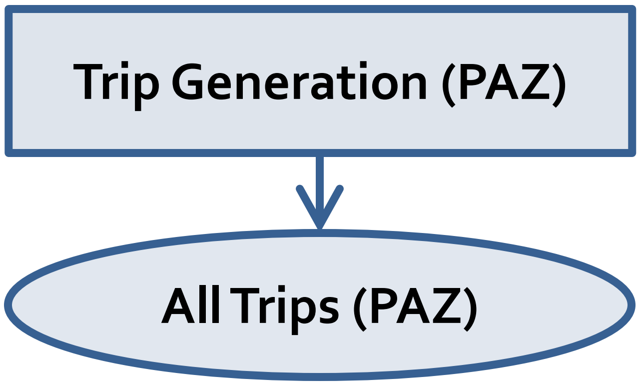
- **Oregon Household Activity Survey (OHAS)**
- **Portland region dataset (2011)**
  - **6,100 households**
  - **13,400 people**
  - **56,000 trips ÷ 4,500 walk trips ≈ 8% walk**
  - **90% sample* for estimation; 10% for validation**

Note: * The 90% estimation sample was stratified by trip purpose and walk vs. not-walk.

Ⓘ Trip generation

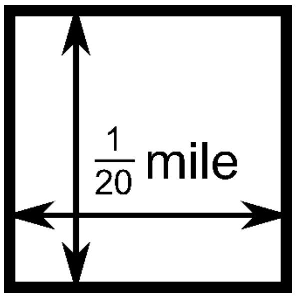


trips = *function of*…
- traveler characteristics
- average trip rates

- ***Data***: 2010 US Census pop. est.
- ***Method***: cross-classification model*
- ***Spatial unit***: pedestrian analysis zone

Note: * We did not estimate new cross-classification models; instead, we applied Metro's existing models to PAZ-level data.

Pedestrian analysis zones



$^{1}/_{20}$ mile = 264 feet ≈ 1 minute walk

Metro: ~2,000 TAZs → ~1.5 million PAZs

TAZs

PAZs

Home-based work trip productions

II Walk mode split

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Walk Mode Split (PAZ)

Vehicular Trips

Pedestrian Trips

Prob(walk) = *function of*…

– traveler characteristics
– pedestrian environment

- *Data*: 2011 OHAS
- *Method*: binary logit model
- *Spatial unit*: pedestrian analysis zone

Pedestrian environment

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Pedestrian Index of the Environment (PIE)

20–100 score = calibrated *sum*(6 dimensions)

- People and 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.

Visualizing PIE

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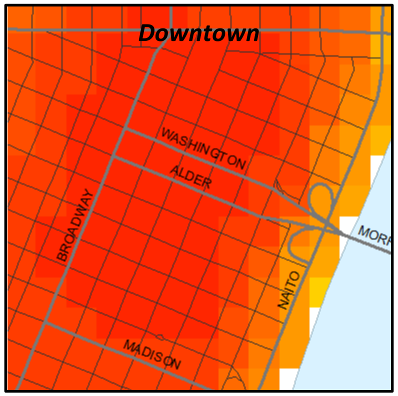
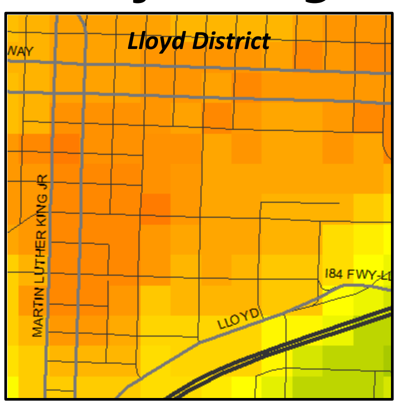
100 – Downtown core

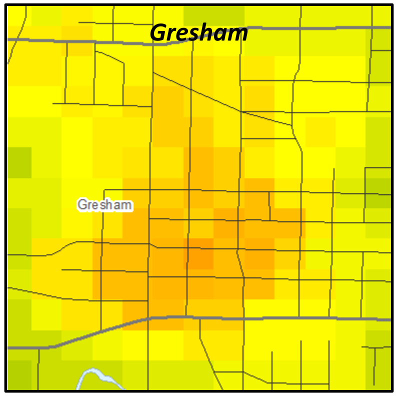


80 – Major neighborhood centers

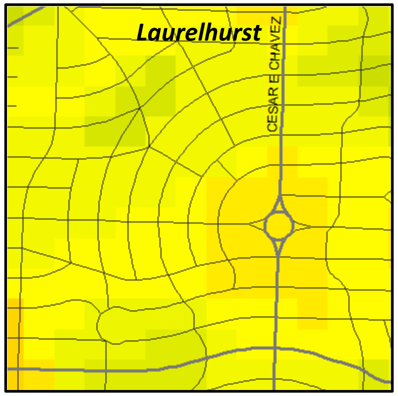


Visualizing PIE

70 – Suburban downtowns

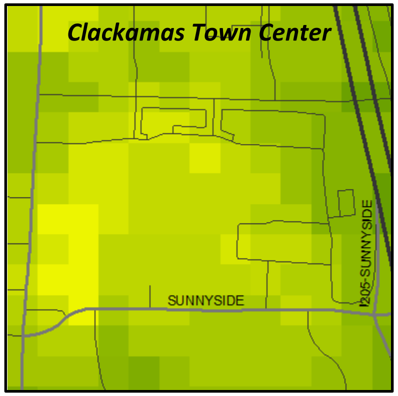


60 – Residential inner-city neighborhoods

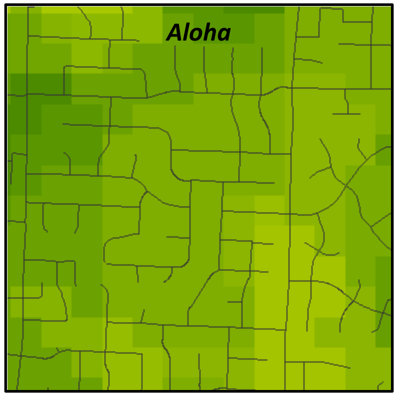


Visualizing PIE

50 – Suburban shopping malls

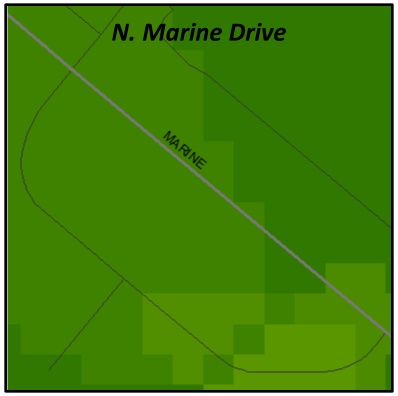


40 – Suburban neighborhoods/subdivisions

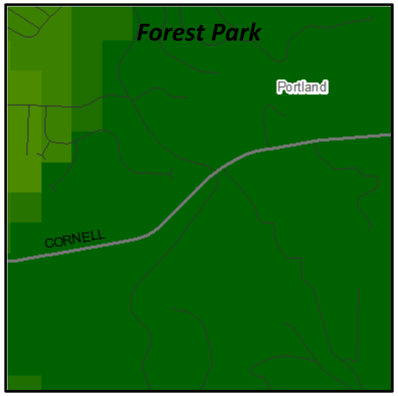


Visualizing PIE

30 – Isolated business and light industry



20 – Rural, undeveloped, forested



II Walk model results

- **Traveler characteristics**

+ positively related to walking	*– negatively related to walking*
number of children in HH	age of household head
	HH vehicle ownership

- **Pedestrian environment**

+ positively related to walking	*Δ odds of choosing to walk*
+ 10 points PIE associated with:	43% increase (HBW) 54% increase (HBO) 67% increase (NHB)
Pseudo R^2	0.137 (HBO) – 0.253 (NHB)

(III) Destination choice

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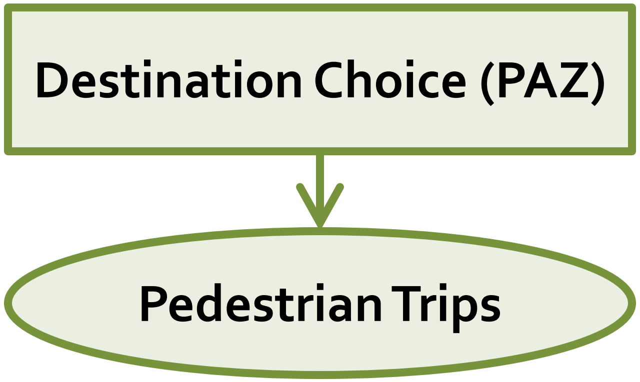


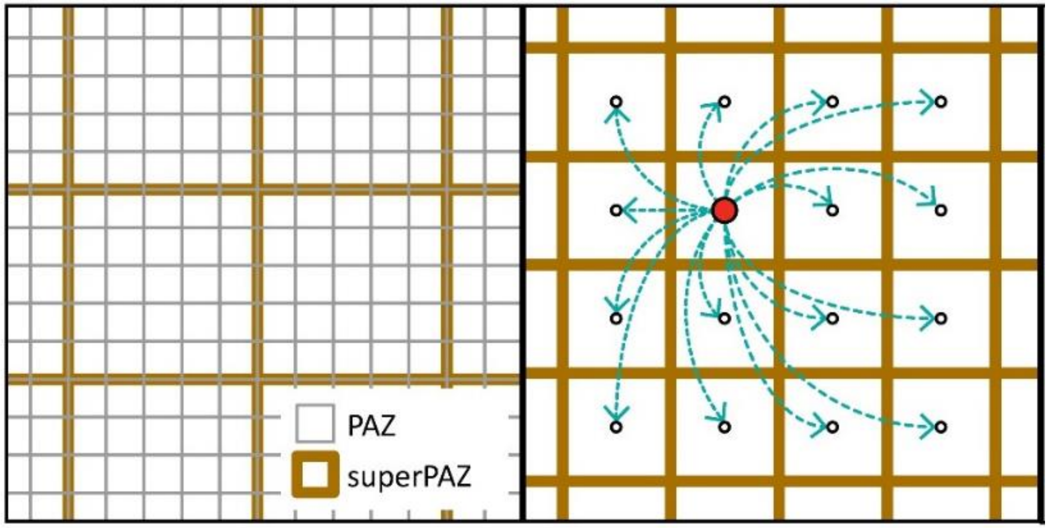
Prob(dest.) = *function of*…

- network distance
- size / # of destinations
- pedestrian environment
- traveler characteristics

- ***Data***: 2011 OHAS
- ***Method***: multinomial logit model
- ***Spatial unit***: super-pedestrian analysis zone

Destination choice

- **superPAZ:**
  - a grid of 5 × 5 = 25 PAZs



- **Choice set generation:**
  - Random sample of 10 superPAZs within 3 miles (99% of OHAS walk trips < 3 miles)

III Dest. choice results

Preliminary results:

	Δ odds of walking to destination
+ 1 mile of distance	72–85% decrease
2 × # destinations	32–39% increase
	4% increase (HBrec)
	92% increase (HBshop)
+ 10 points PIE	15–46% increase*
Pseudo R^2	0.417 (HBrec) – 0.668 (HBshop)

Note: * Except for HBshop.

Summary of results

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(II) **Walk mode split model:**

+ 10 point PIE → +45% to +65% odds of walking

(III) **Destination choice model (preliminary):**

+ 1 mile distance → –75% odds of walking to dest.

2 × #destinations → +33% odds of walking to dest.

+ 10 points PIE → +15% to +45% odds of walk to dest.

+ 10 points PIE ≈ –450 to –1600 ft (–0.08 to –0.30 mi)

Applications for health

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- Walking demand impacts of projects, policies, programs, or suites of scenarios
  - Δ sidewalk/off-street path network, or Δ land use density/diversity → Δ PIE → Δ pedestrian travel demand
- Crash analysis / safety assessment
  - # walk trips across / along a street, or distances walked in an area → denominator in a crash rate calculation

Applications for health

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- **Health impact assessment / model**
  - distances walked by location/neighborhood
    → minutes walked by location/neighborhood
    → levels of physical activity

- **Health & transportation equity analysis**
  - # walk trips & distances walked:
    by neighborhood,
    by categories of age, income, etc.

Future Work

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- Continue destination choice modeling
- Refine and verify PIE
  - Compare PIE to other walkability measures (e.g., WalkScore)
  - Construct with widely available data sources (e.g., EPA's Smart Location Database)

Future Work

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- Test method in other region(s)
  - Examine relationships in contexts beyond those in Portland, OR
  - Assess PIE's transferability (whether other regions prefer different "flavors" of PIE)
  - Construct full pedestrian modeling tool
  - Provide agency guidance for making pedestrian enhancements to urban travel demand models

Questions?

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Project info & reports:

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

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

TREC
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