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Development of a Pedestrian Demand Estimation Tool: a Destination Choice Model

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Background

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Why model pedestrian travel?

plan for pedestrian investments
& non-motorized facilities

mode shifts

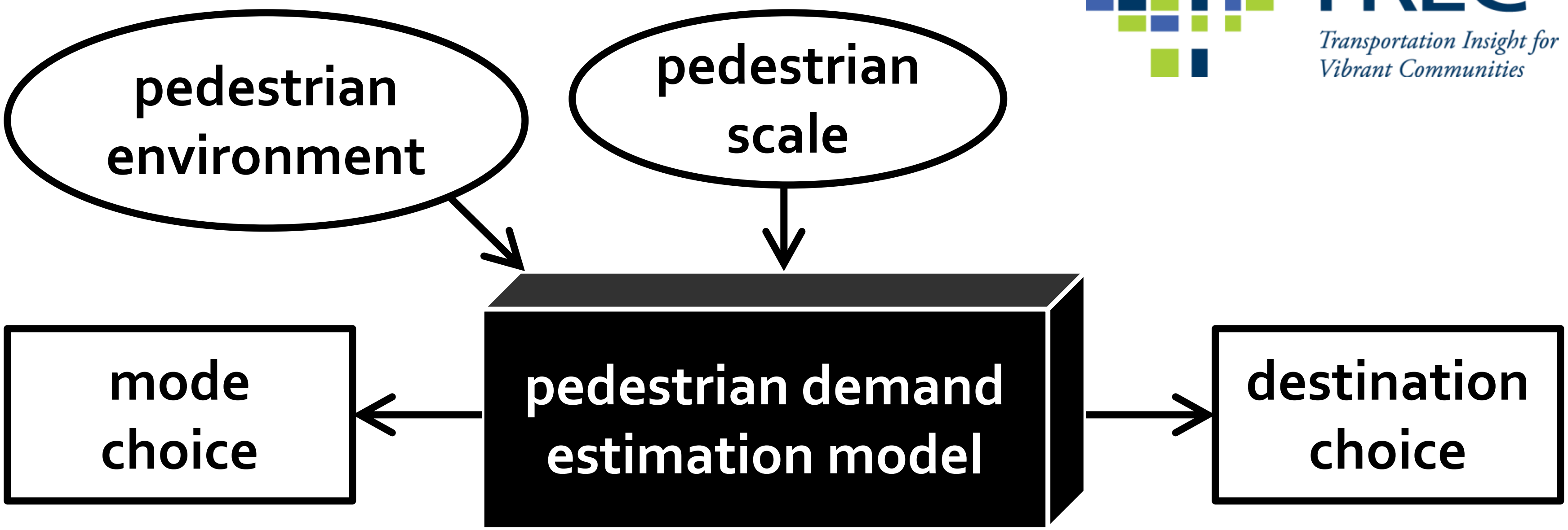
health & safety

greenhouse
gas emissions

new data

Project overview

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



Current method

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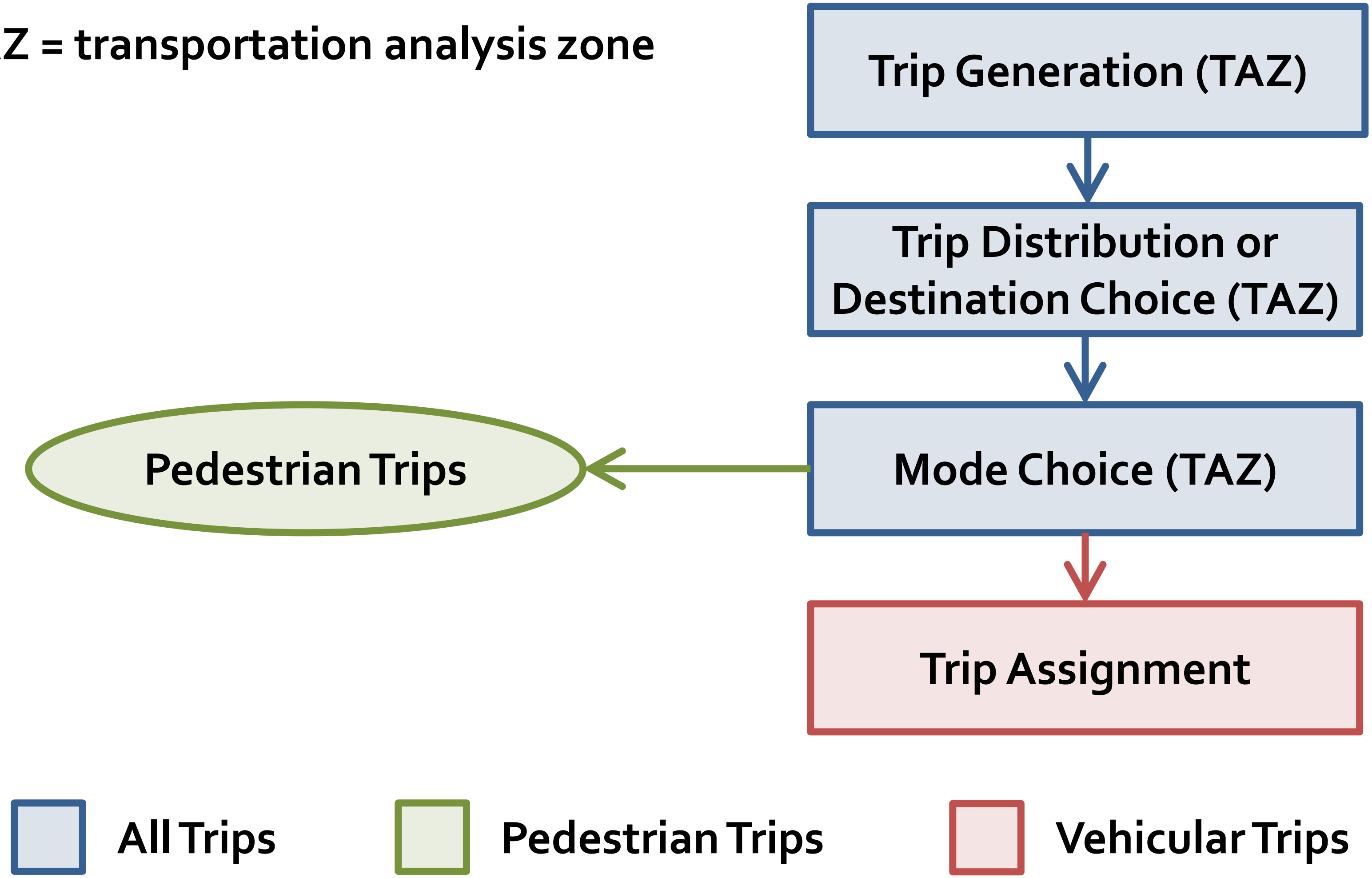
TAZ = transportation analysis zone



New method

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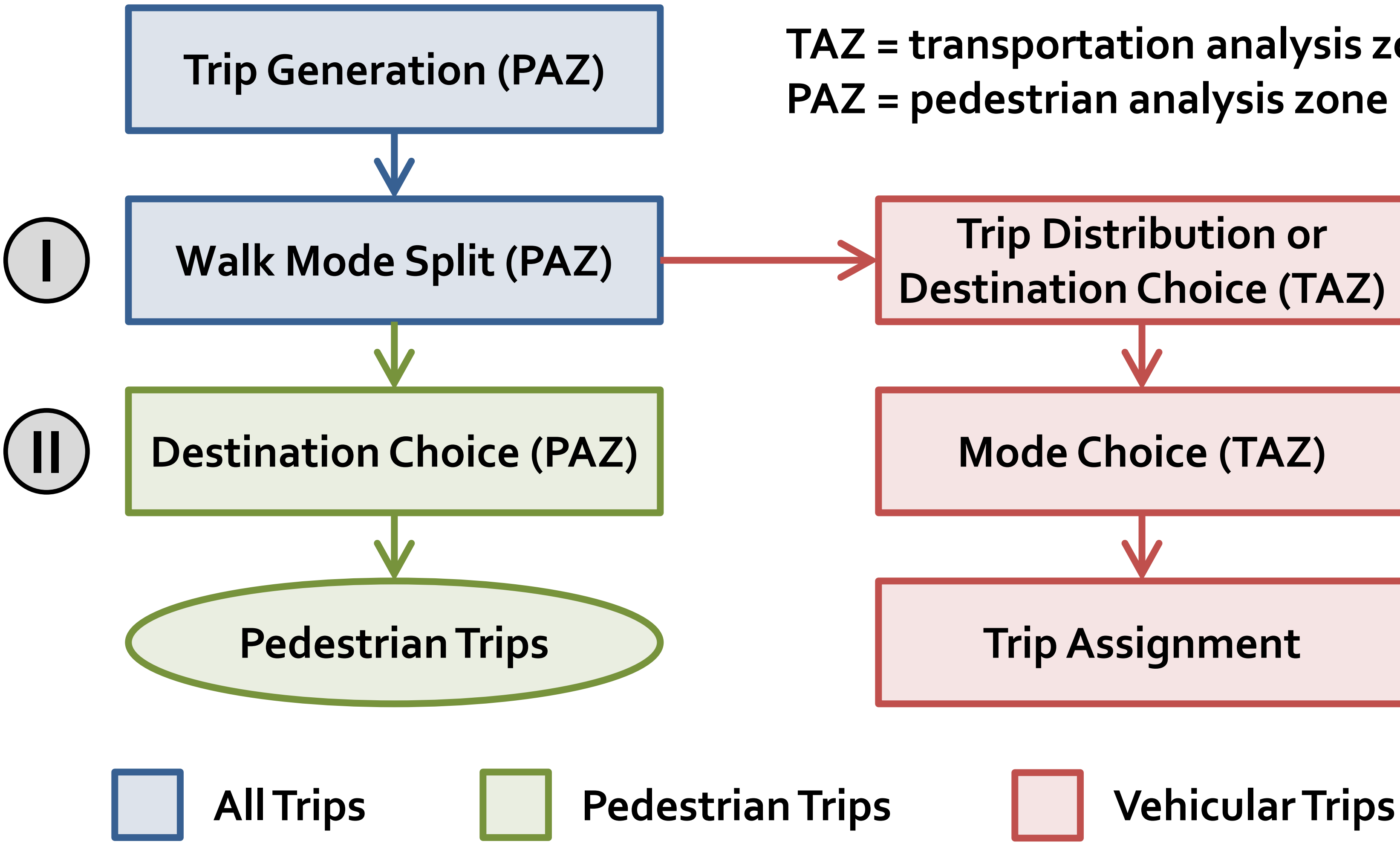
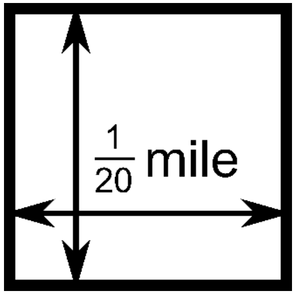
TAZ = transportation analysis zone
PAZ = pedestrian analysis zone



Pedestrian analysis zones

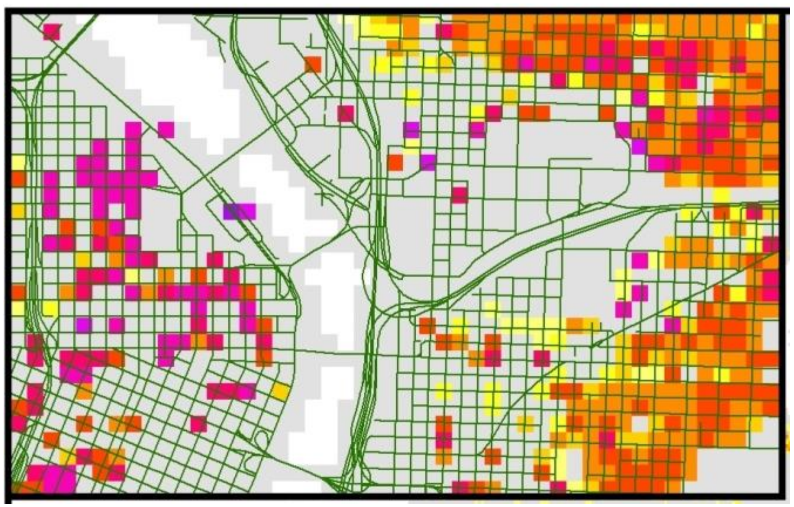


$^{1}/_{20}$ mile = 264 feet ≈ 1 minute walk

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

TAZs

PAZs



Home-based work trip productions

Pedestrian environment

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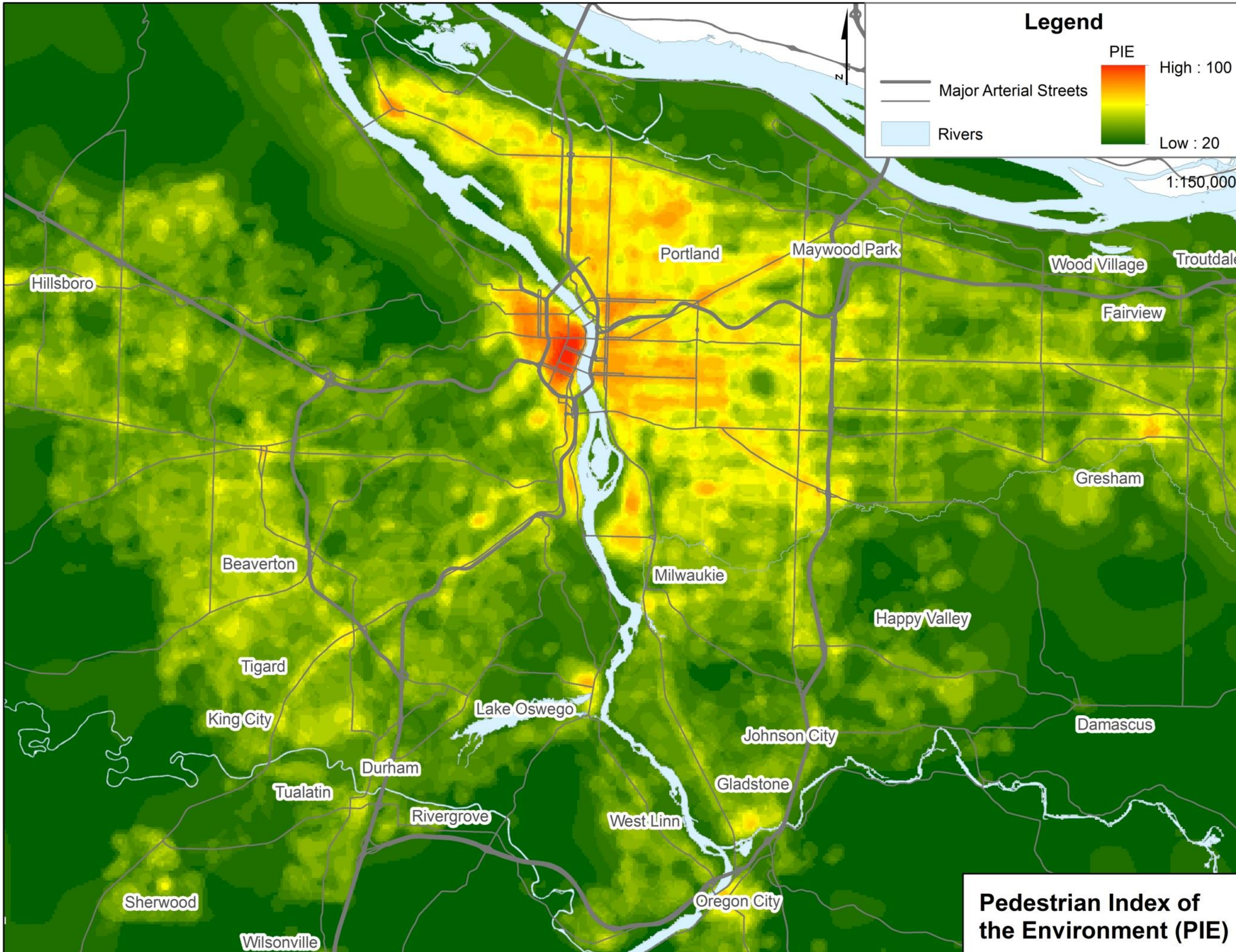
Pedestrian Index of the Environment (PIE)

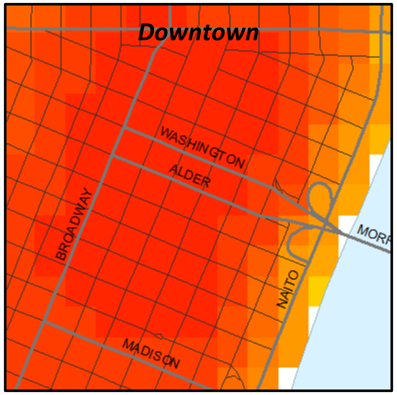
PIE is a 20–100 score total of 6 dimensions, calibrated to observed walking activity:

- People and job density
- Block size
- Transit access
- Sidewalk extent
- Urban living infrastructure
- Comfortable facilities

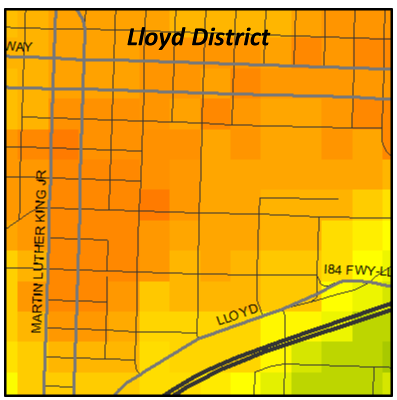

Legend
Major Arterial Streets
Rivers
PIE
High : 100
Low : 20
1:150,000
N
Portland
Maywood Park
Wood Village
Troutdale
Hillsboro
Fairview
Gresham
Beaverton
Milwaukie
Happy Valley
Tigard
King City
Lake Oswego
Damascus
Johnson City
Durham
Gladstone
Tualatin
Rivergrove
West Linn
Sherwood
Oregon City
Wilsonville
Pedestrian Index of the Environment (PIE)

Visualizing PIE

100 – Downtown core

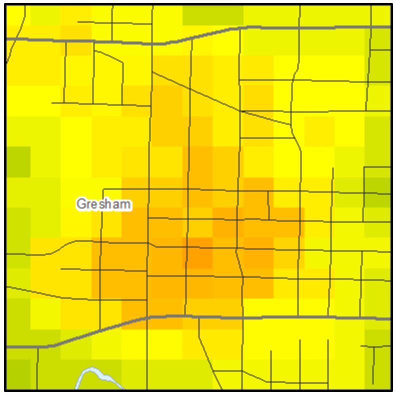


80 – Major neighborhood centers

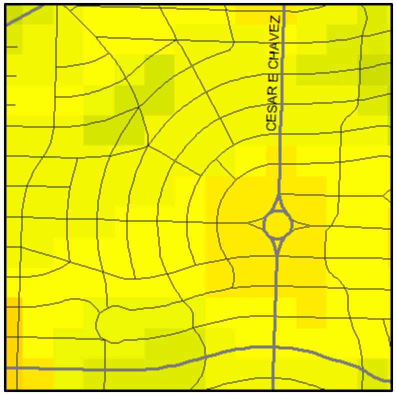


Visualizing PIE

70 – Suburban downtowns

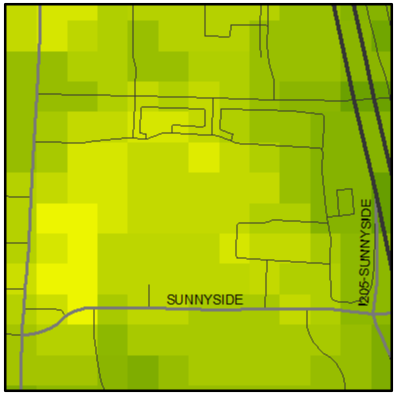


60 – Residential inner-city neighborhoods



Visualizing PIE

50 – Suburban shopping malls

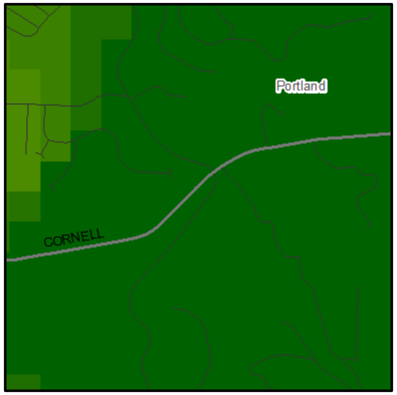


40 – Suburban neighborhoods/subdivisions

Visualizing PIE

30 – Isolated business and light industry

20 – Rural, undeveloped, forested



Ⓘ Walk mode split

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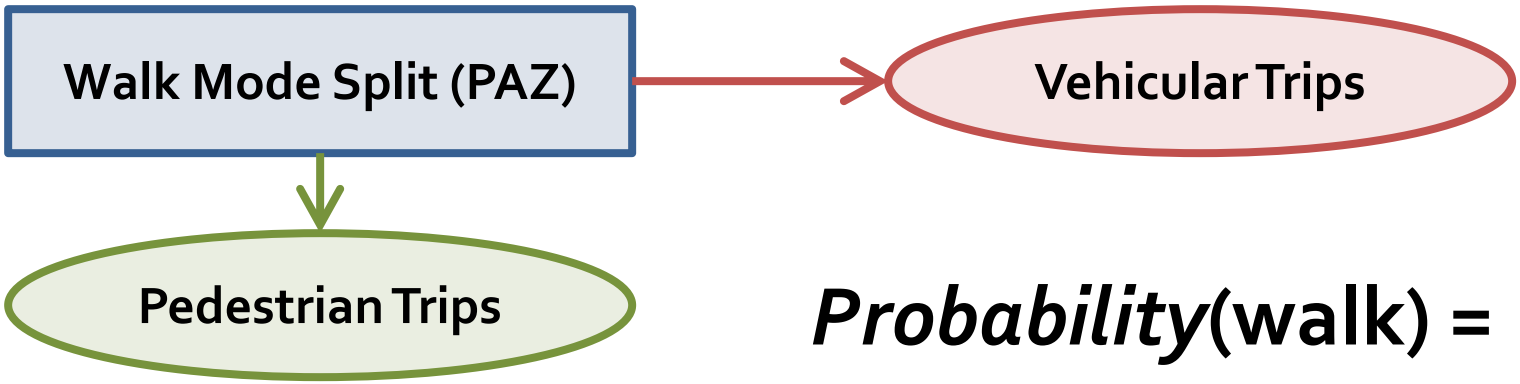

***Probability*(walk) =**
***f*(traveler characteristics,**
pedestrian environment)

- Data: 2011 OR Household Activity Survey: (4,000 walk trips) ÷ (50,000 trips) = 8% walk
- Model: binary logistic regression

Ⓘ Walk Mode Split Results

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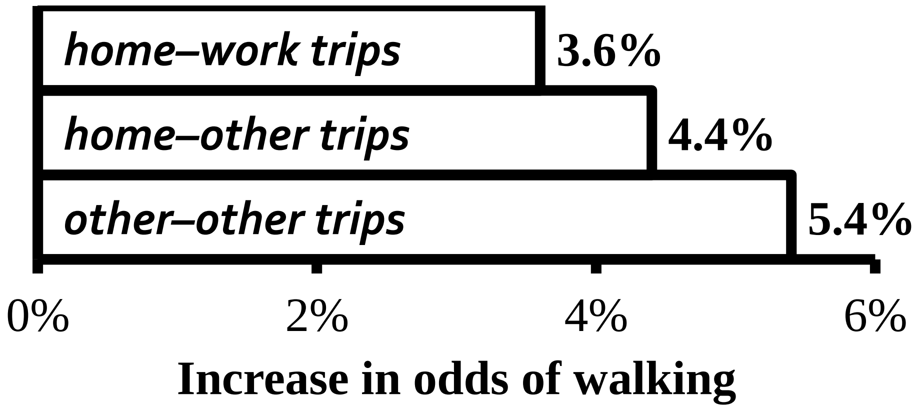
Household characteristics

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

Pedestrian environment

+ positively related to walking

+ 1 point PIE associated with:



Ⅱ Destination choice

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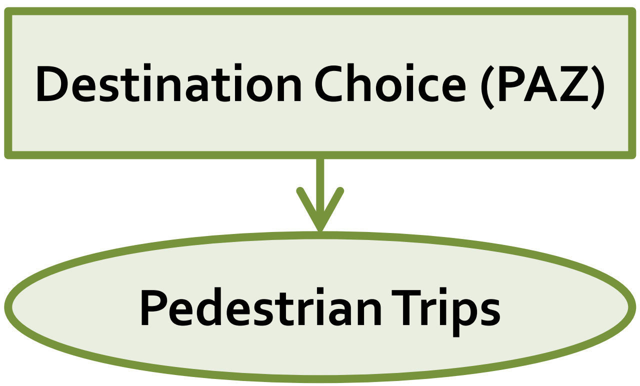
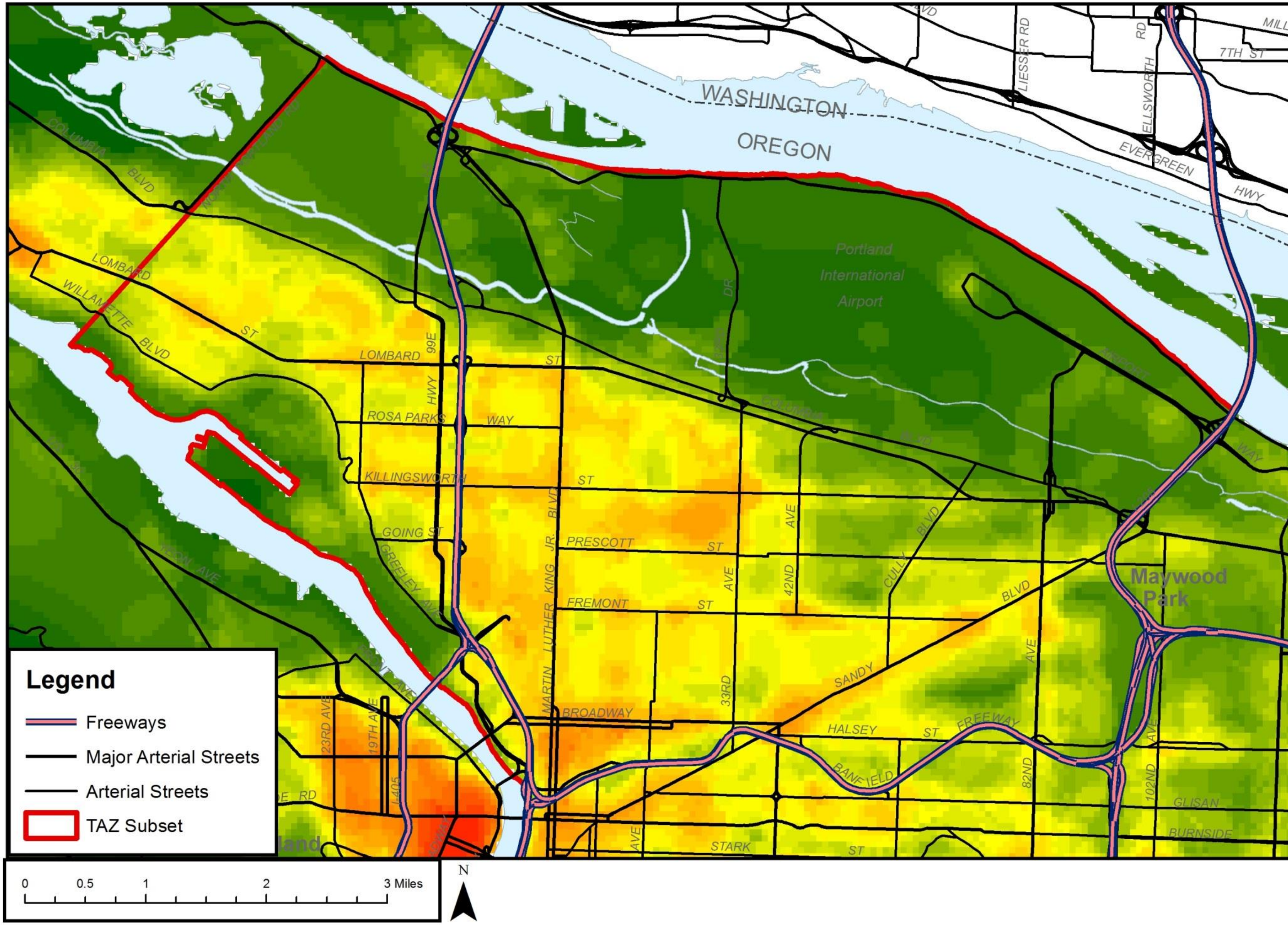


Prob(dest.) = *function of*…

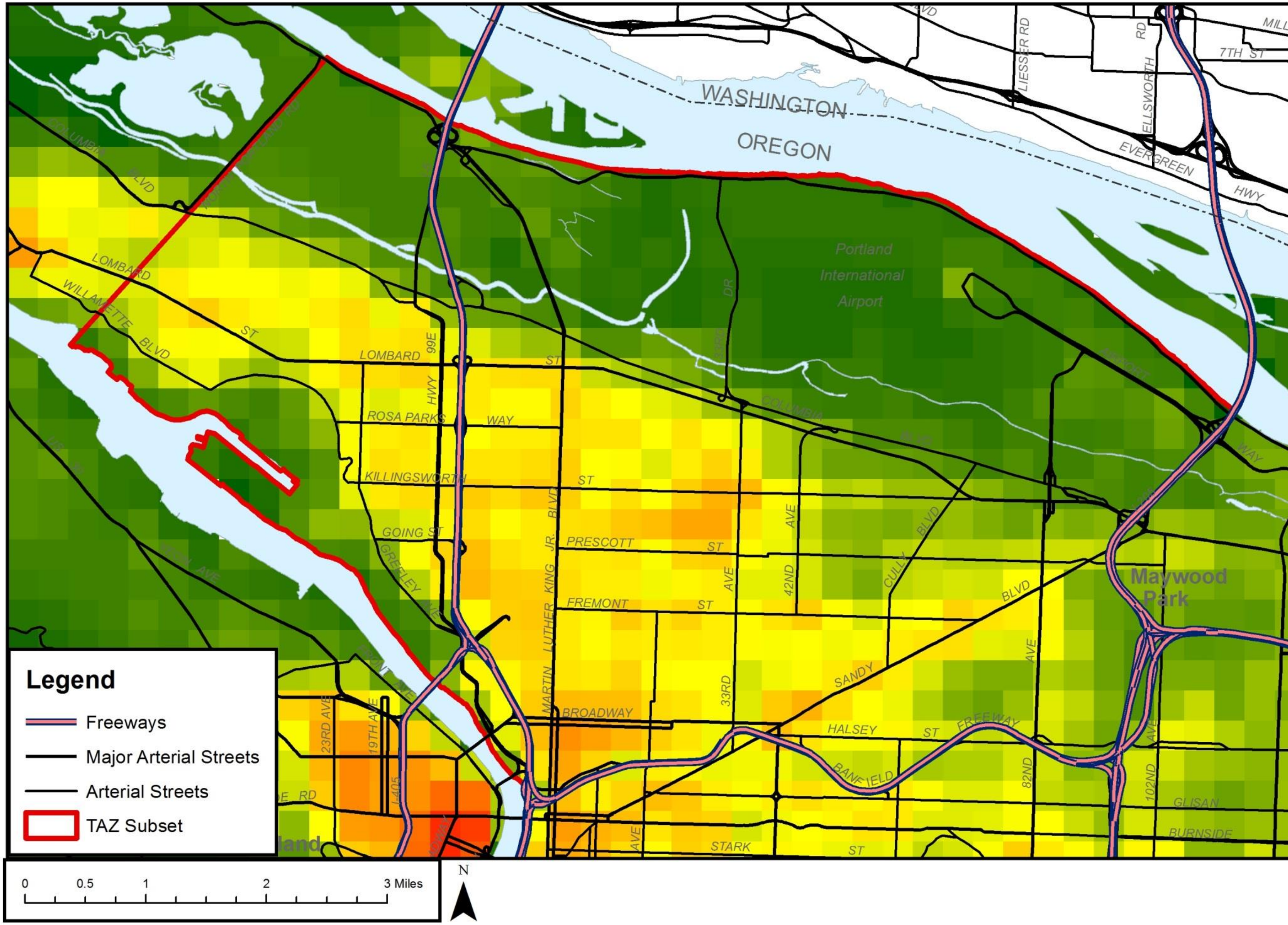
- network distance
- size (# of destinations)
- pedestrian environment
- traveler characteristics

- *Data*: 2011 OHAS (4,000 walk trips)
- *Method*: multinomial logit model, random sampling
- *Spatial unit*: super-pedestrian analysis zone
- Models estimated for 6 trip purposes

Example of PIE by PAZs in NE Portland Sub-area



Example of Avg. PIE by SuperPAZs in NE Portland Sub-area



DC Model Specification

Key variables

Impedance

Network distance btw. zones

Attractiveness

Employment by category (within ln)

Add'l variables

Ped supports

PIE

Ped barriers

Slope, x-ings, fwy

Traveler attributes

Destination choice results

	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
Sample size	305	405	643	1,108	732	705
Pseudo R^2	0.45	0.68	0.42	0.53	0.59	0.54

Results : key variables

	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
Distance (mi)				-1.94**	-1.43**	-1.45**
Distance * Auto (y)	-1.35**					
Distance * Auto (n)	-0.96**					
Distance * Child (y)		-2.29**	-1.76**			
Distance * Child (n)		-1.54**	-1.52**			
Size terms (ln)	0.50**	0.88**	0.05*	0.41**	0.36**	0.39**
(' = p < 0.10, * = p < 0.05, ** = p < 0.01)						

Results : key variables

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	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
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(‘ = p < 0.10, * = p < 0.05, ** = p < 0.01)						

- Distance has the most influence on destination choices
- Auto ownership and children in HH moderate effects

Results : key variables

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	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
Distance (mi)				-1.94**	-1.43**	-1.45**
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Size terms (ln)	0.50**	0.88**	0.05*	0.41**	0.36**	0.39**

((p < 0.10, * p < 0.05, ** p < 0.01)

- No. of destinations inc. odds of choosing particular zone
- # Retail destinations dominates shopping purpose

Results : ped variables

	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
PIE (avg)	0.03**	*n.s.*	*n.s.*	0.03**	0.02*	0.02**
Avg. slope (°)	*n.s.*	-0.20*	*n.s.*	-0.42**	-0.16**	*n.s.*
Major-major xing (y)	*n.s.*	0.60**	0.42’	*n.s.*	*n.s.*	*n.s.*
Freeway (y)	*n.s.*	-0.95**	*n.s.*	*n.s.*	*n.s.*	0.27’
% Industrial jobs	-1.00*	-1.82**	*n.s.*	-0.40’	-1.66**	*n.s.*

(‘ = p < 0.10, * = p < 0.05, ** = p < 0.01) n.s. = not significant

Results : ped variables

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% Industrial jobs	-1.00*	-1.82**	*n.s.*	-0.40’	-1.66**	*n.s.*
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Ped supports: PIE increases odds of dest choice for many trip purposes

Results : ped variables

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	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
PIE (avg)	0.03**	*n.s.*	*n.s.*	0.03**	0.02*	0.02**
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Ped barriers:

Slope, major crossings, and presence of freeways have mixed impacts

Results : ped variables

	HB Work	HB Shop	HB Rec	HB Other	NHB Work	NHB NW
PIE (avg)	0.03**	*n.s.*	*n.s.*	0.03**	0.02*	0.02**
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Freeway (y)	*n.s.*	-0.95**	*n.s.*	*n.s.*	*n.s.*	0.27’
% Industrial jobs	-1.00*	-1.82**	*n.s.*	-0.40’	-1.66**	*n.s.*

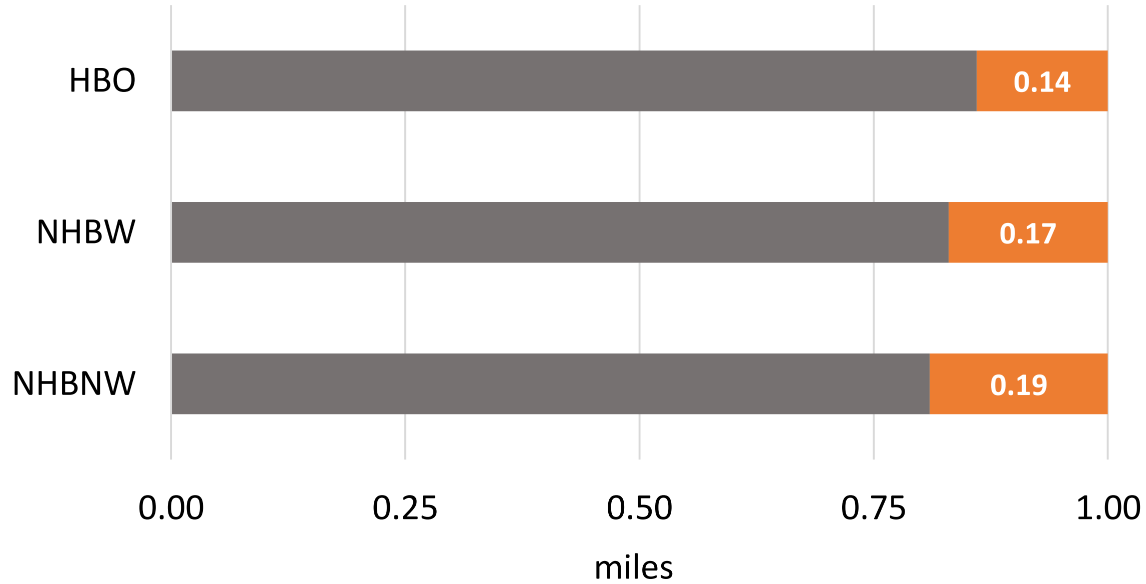
(‘ = p < 0.10, * = p < 0.05, ** = p < 0.01) n.s. = not significant

Ped barriers:

Ratio of industrial jobs to total jobs suggests industrial uses deter ped destination choices

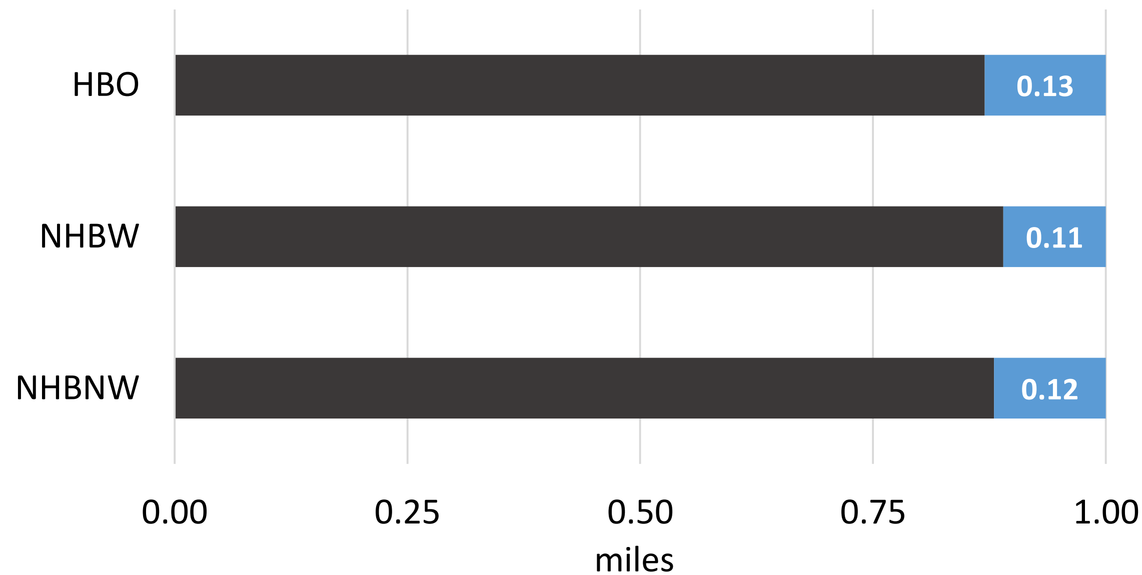
Some Interpretation

Equivalent distance reductions from
2 * (# destinations)



Some Interpretation

Equivalent distance reductions from
PIE + 10



Conclusions

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- One of the first studies to examine destination choice of pedestrian trips
- Pedestrian scale analysis w/ pedestrian-relevant variables
- Distance and size have the most influence on ped. dest. choice
- Supports and barriers to walking also influence choice
- Traveler characteristics moderate distance effect

Future work

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- Model improvements
  - Choice set generation method & sample sizes
  - Explore non-linear effects & other interactions
- Model validation & application
- Predict potential pedestrian paths
- Test method in other region(s)
- Incorporation into Metro trip-based model

Questions?

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Project report/info:

- http://otrec.us/project/510
- http://otrec.us/project/677

TREC
Transportation Insight for Vibrant Communities

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Size terms (ln)	0.50**	0.88**	0.05*	0.41**	0.36**	0.39**
Retail Jobs (#)		+	+		+	+
Finance Jobs (#)					+	
Gov't jobs (#)			+			+
Retail + gov't jobs (#)				+		
Ret + fin + gov't jobs (#)	+					
Other jobs (#)	+	+	+	+	+	+
Households (#)			—	—		+
Park in zone (y)			0.48**	n.s.		
PIE (avg)	0.03**	*n.s.*	*n.s.*	0.03**	0.02*	0.02**
Avg. slope (°)	*n.s.*	-0.20*	*n.s.*	-0.42**	-0.16**	*n.s.*
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Coefficients with #s are significant (' = $p < 0.10$, * = $p < 0.05$, ** = $p < 0.01$), others are not significant ($p > 0.10$).