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

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

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PSU Friday Transportation Seminar, 15 May 2015



Why model pedestrian travel?



plan for pedestrian investments
& non-motorized facilities



mode shifts



health & safety



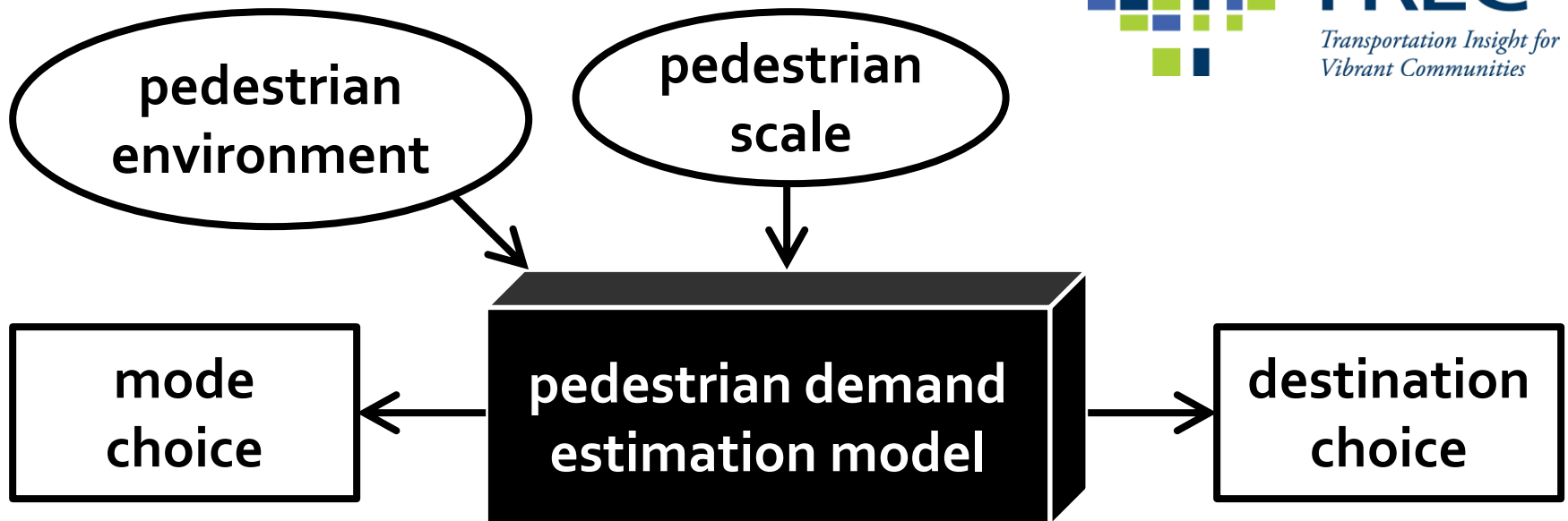
greenhouse
gas emissions



new data

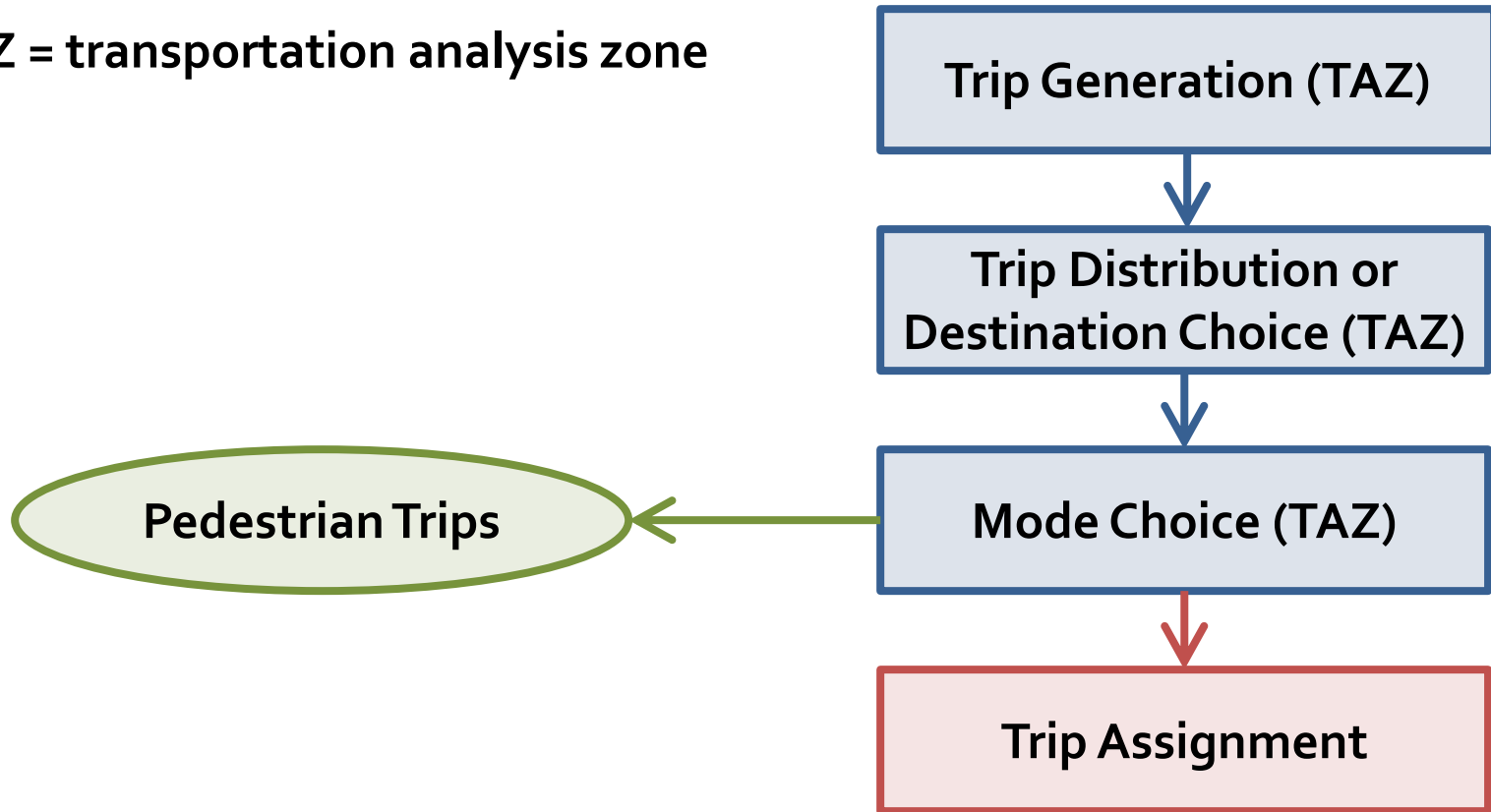
Project overview

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



Current method

TAZ = transportation analysis zone

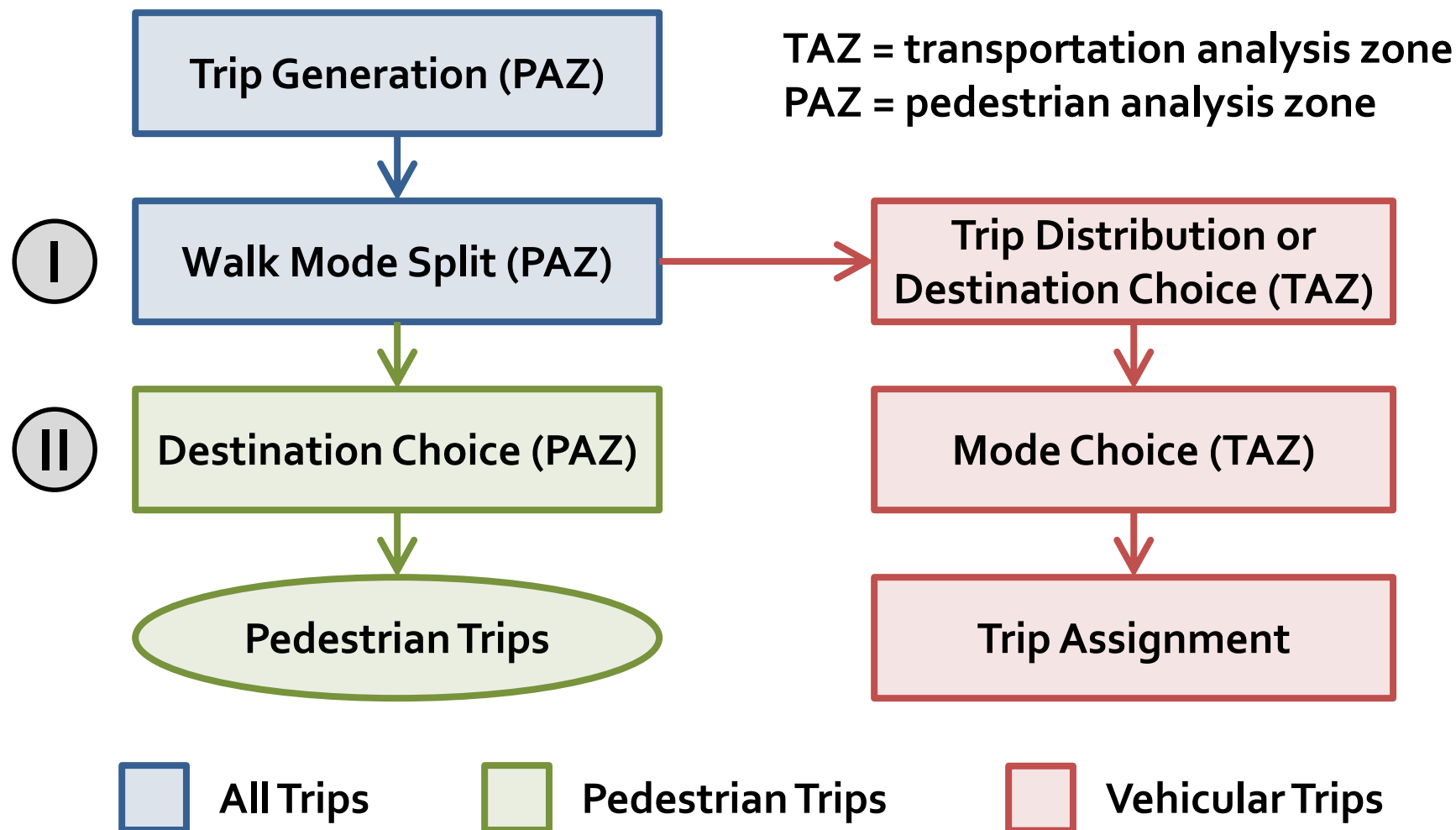


 All Trips

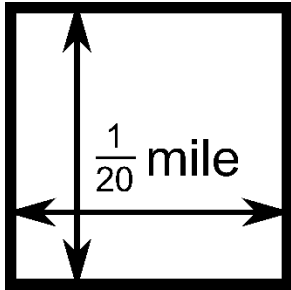
 Pedestrian Trips

 Vehicular Trips

New method



Pedestrian analysis zones



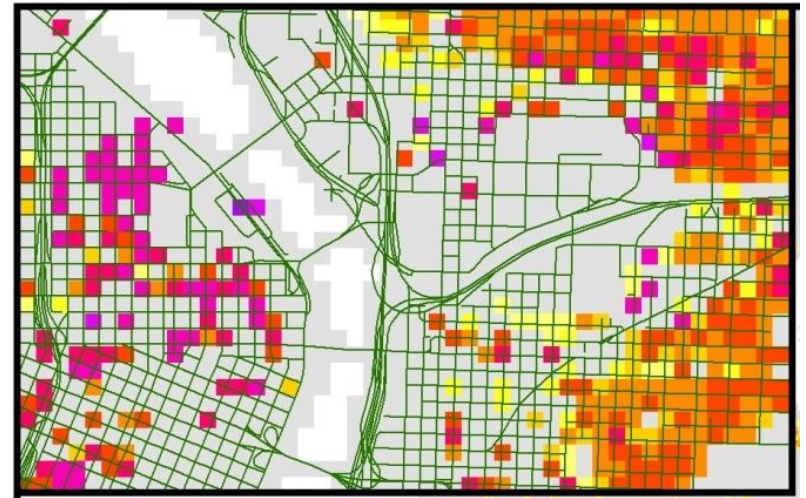
$\frac{1}{20}$ mile = 264 feet \approx 1 minute walk

Metro: \sim 2,000 TAZs \rightarrow \sim 1.5 million PAZs

TAZs



PAZs



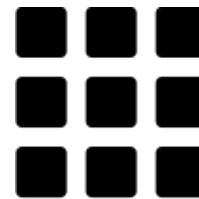
Home-based work trip productions

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



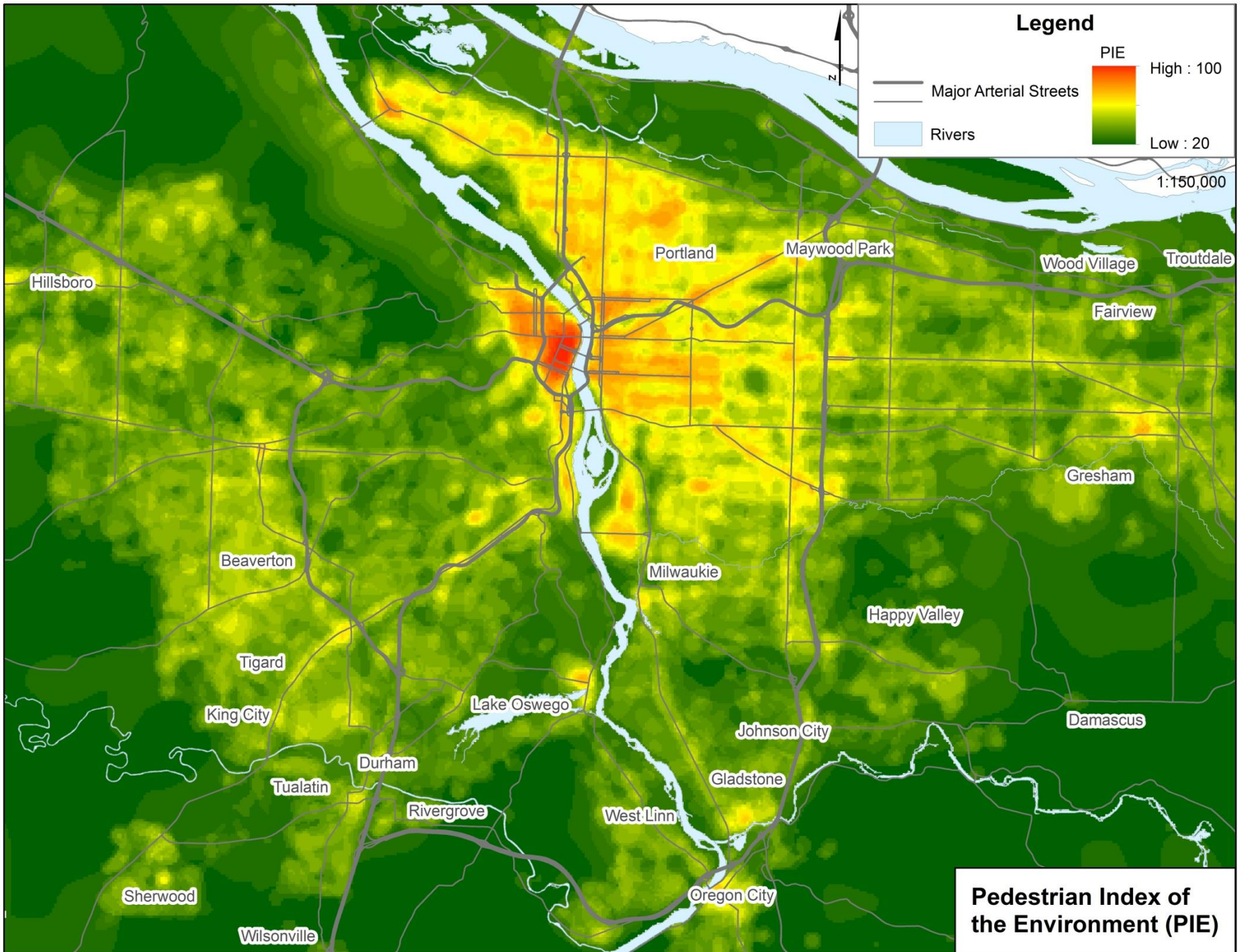
Sidewalk extent



Urban living infrastructure

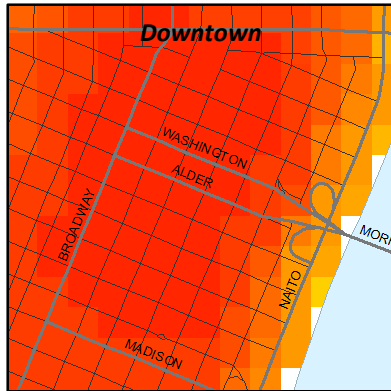


Comfortable facilities

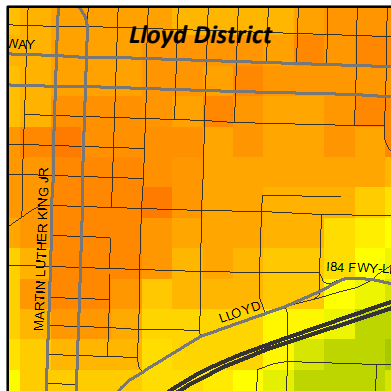


Visualizing PIE

100 – Downtown core

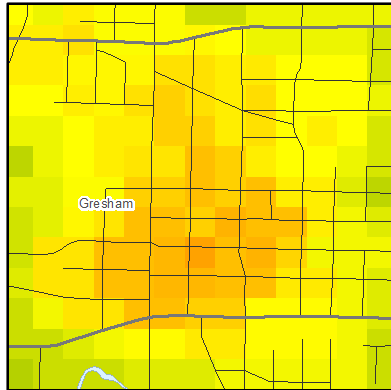


80 – Major neighborhood centers

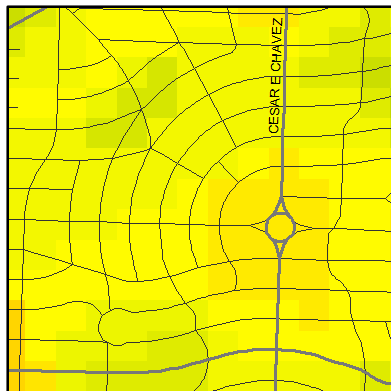


Visualizing PIE

70 – Suburban downtowns

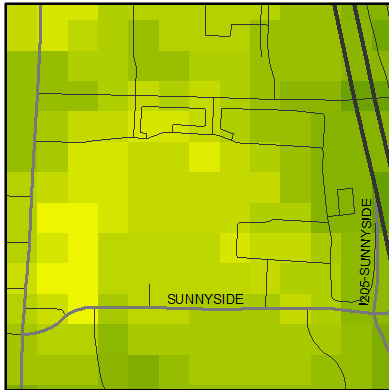


60 – Residential inner-city neighborhoods

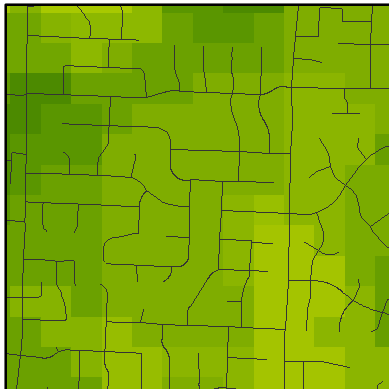


Visualizing PIE

50 – Suburban shopping malls



40 – Suburban neighborhoods/subdivisions

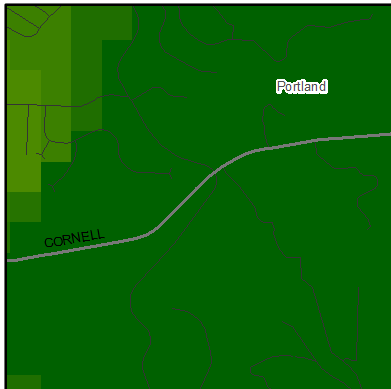


Visualizing PIE

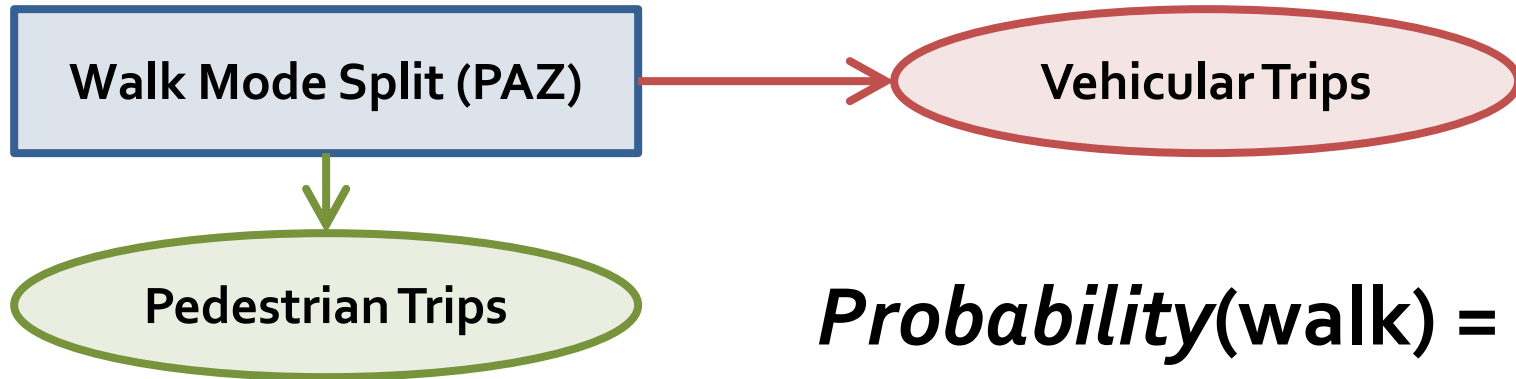
30 – Isolated business and light industry



20 – Rural, undeveloped, forested



① Walk mode split



***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

I Walk Mode Split Results

Household characteristics

+ positively related to walking

number of children

- negatively related to walking

age of household

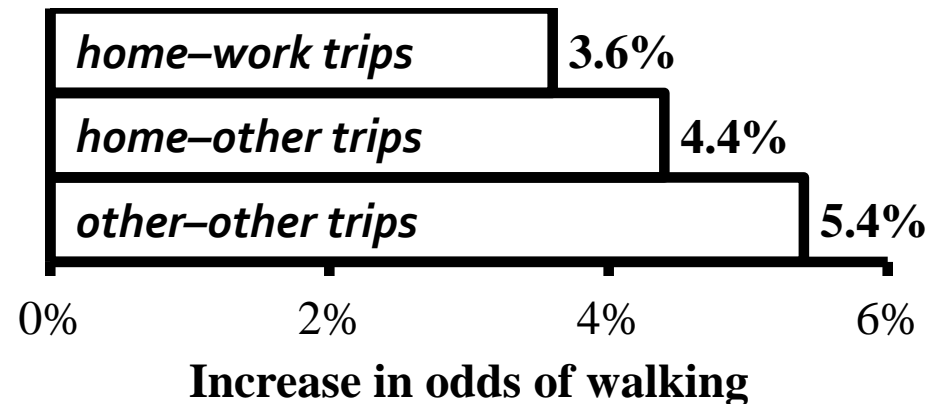
vehicle ownership

Pedestrian environment

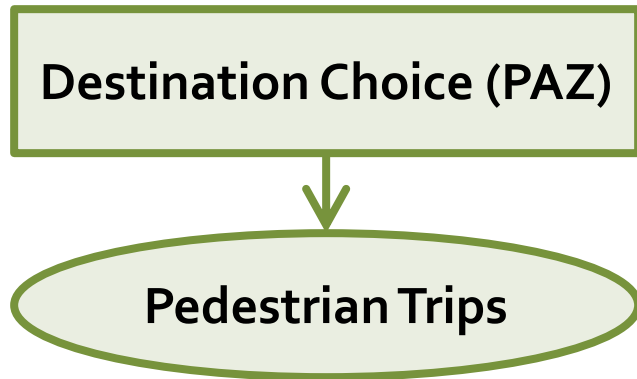
+ positively related to walking

+ 1 point PIE

associated with:



II Destination choice

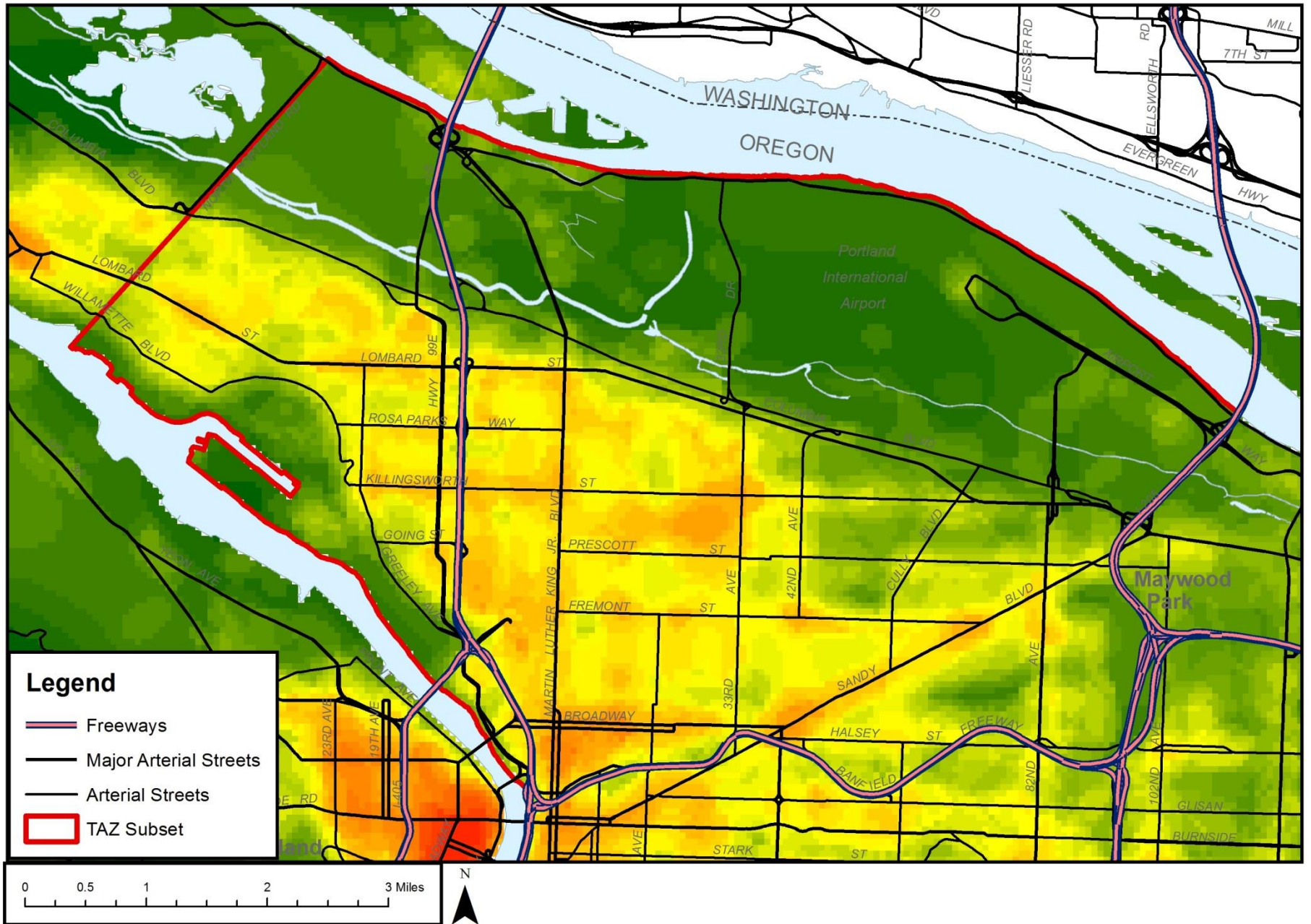


Prob(dest.) = function of...

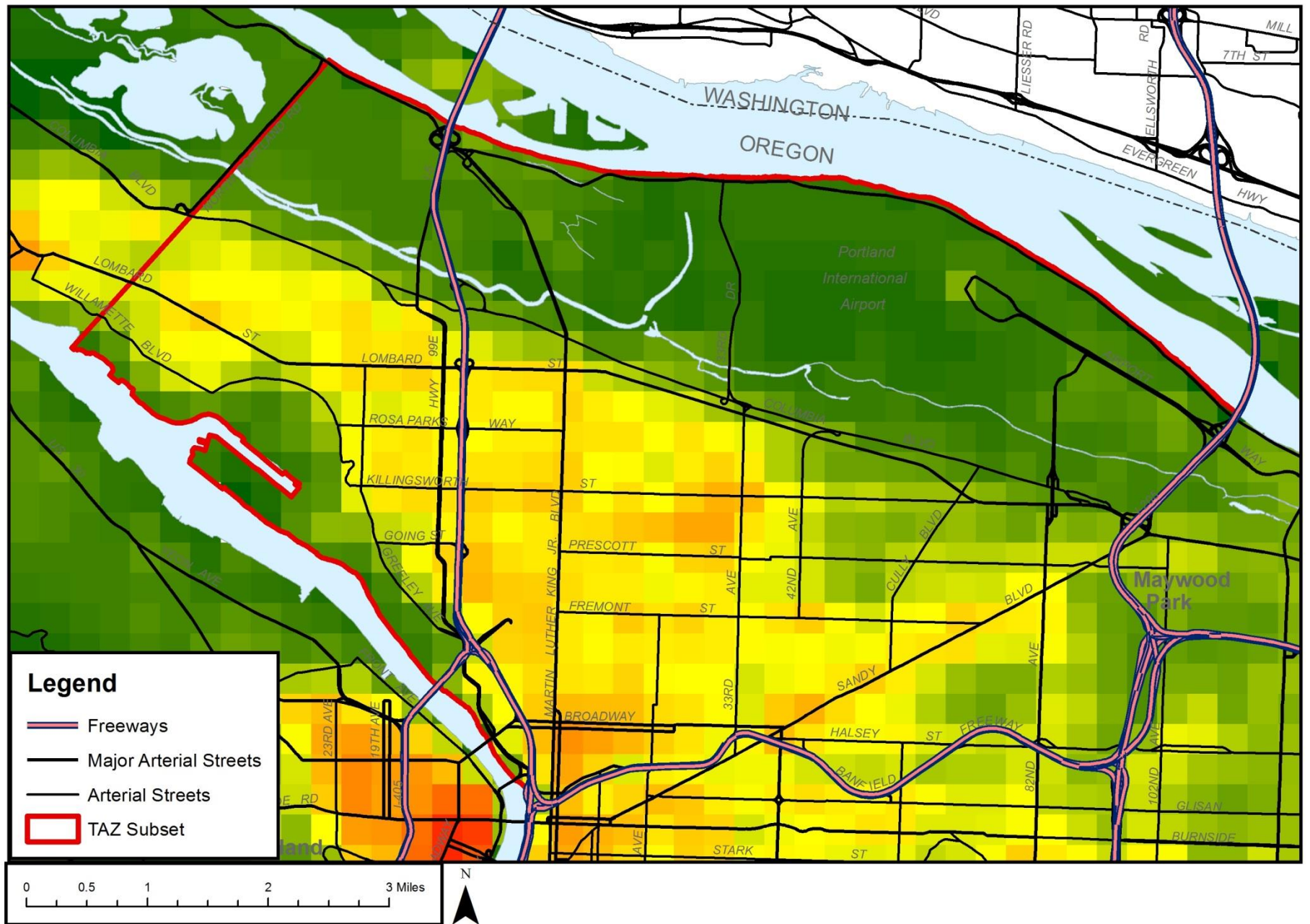
- network distance
- size (# of destinations)
- pedestrian environment
- traveler characteristics

- *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



Key variables

Impedance

Network distance btw. zones

Attractiveness

Employment by category (within In)

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)						

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

Results : key variables

	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)

- 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**	<i>n.s.</i>	<i>n.s.</i>	0.03**	0.02*	0.02**
Avg. slope (°)	<i>n.s.</i>	-0.20*	<i>n.s.</i>	-0.42**	-0.16**	<i>n.s.</i>
Major-major xing (y)	<i>n.s.</i>	0.60**	0.42'	<i>n.s.</i>	<i>n.s.</i>	<i>n.s.</i>
Freeway (y)	<i>n.s.</i>	-0.95**	<i>n.s.</i>	<i>n.s.</i>	<i>n.s.</i>	0.27'
% Industrial jobs	-1.00*	-1.82**	<i>n.s.</i>	-0.40'	-1.66**	<i>n.s.</i>

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Ped supports: PIE increases odds of dest choice for many trip purposes

Results : ped variables

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Ped barriers:

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

Results : ped variables

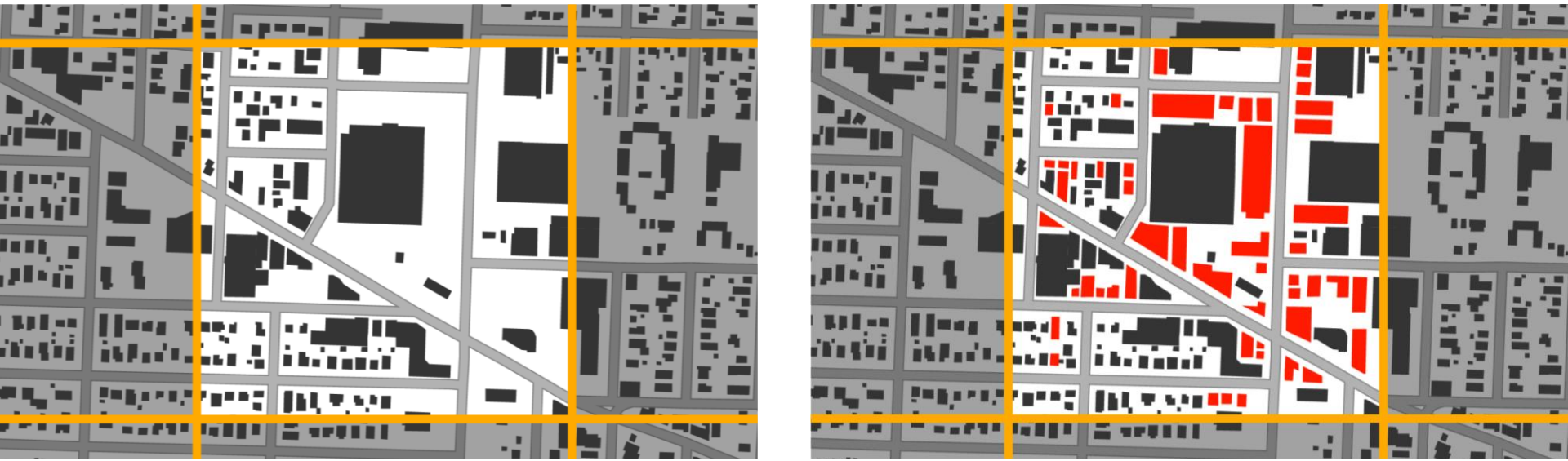
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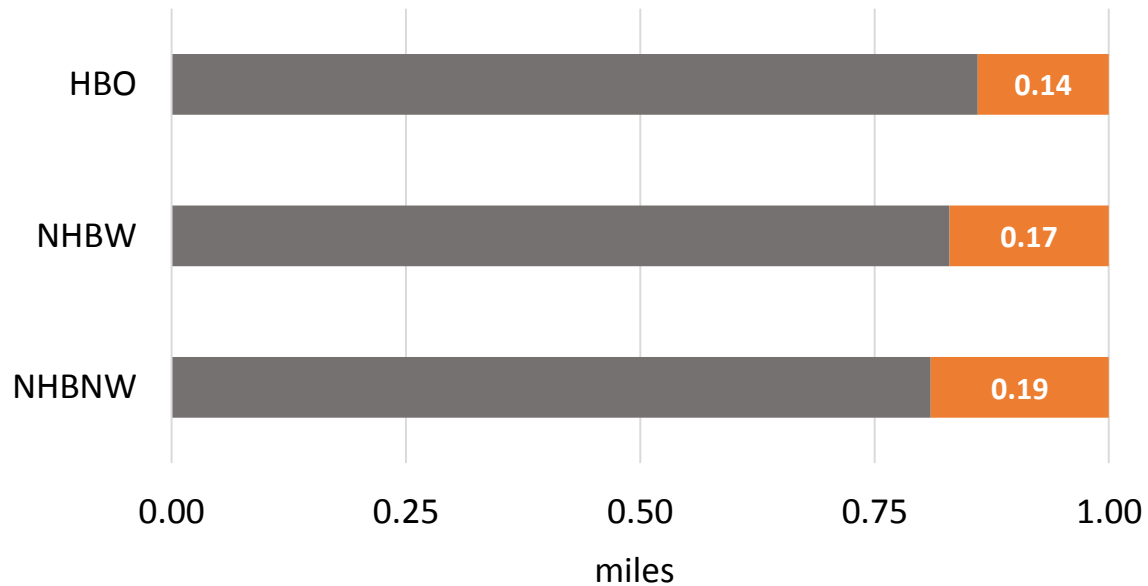
Ped barriers:

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

Some Interpretation



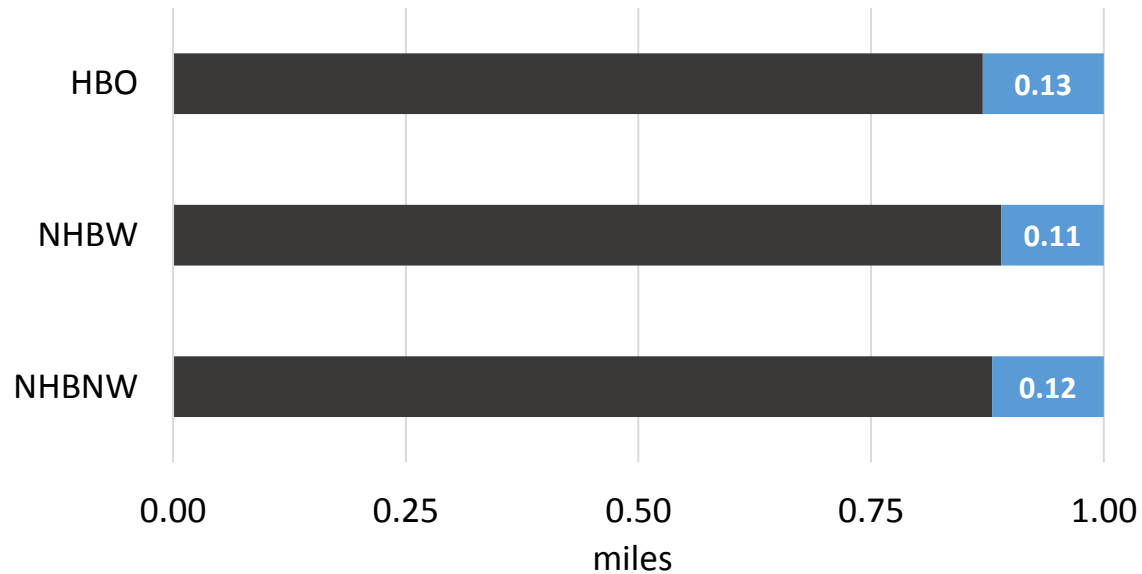
Equivalent distance reductions from
 $2 * (\# \text{ destinations})$



Some Interpretation



Equivalent distance reductions from
PIE + 10



Conclusions

- 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

- 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?

Project report/info:

<http://otrec.us/project/510>

<http://otrec.us/project/677>



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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**	<i>n.s.</i>	<i>n.s.</i>	0.03**	0.02*	0.02**
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Pseudo R^2	0.45	0.68	0.42	0.53	0.59	0.54

Coefficients with #s are significant (' = $p < 0.10$, * = $p < 0.05$, ** = $p < 0.01$), others are not significant ($p > 0.10$).