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Walkability and pedestrian route choice

Studying walking behavior in Singapore's city centre

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10 July 2015

(FCL) FUTURE CITIES LABORATORY 未来城市实验室

(SEC) SINGAPORE-ETH CENTRE 新加坡-ETH研究中心





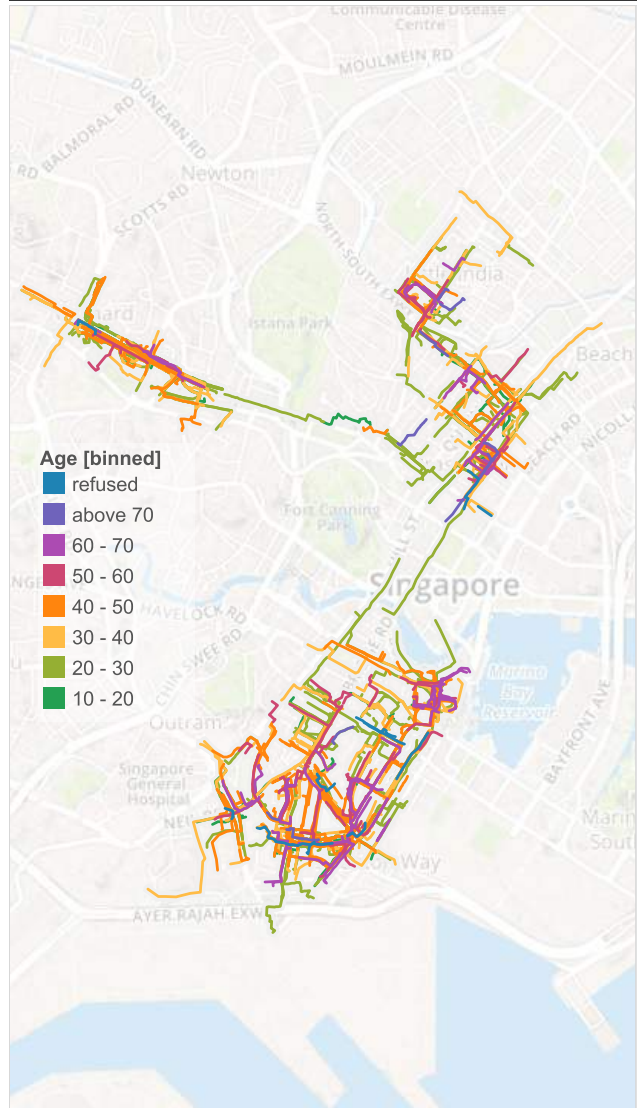
WHAT IS WALKABILITY?

Field survey

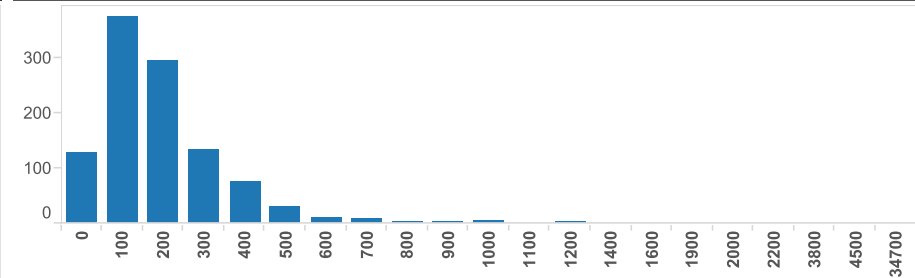
Tracking 1113 pedestrians in Singapore's city centre

Who walks where?

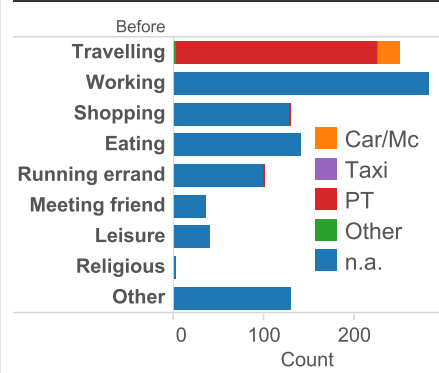
Pedestrian tracks



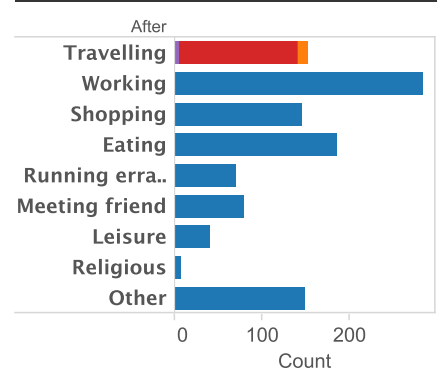
Distance [m]



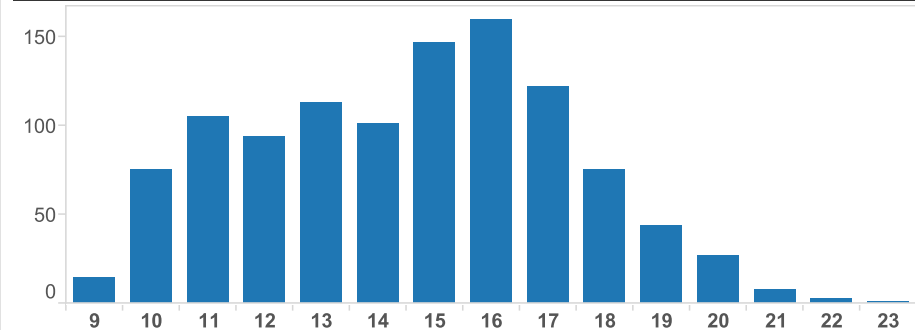
Activity before



Activity after



Time of day



Some basic facts

Number of valid tracks:	1077
Average walking distance:	259 m
Median walking distance:	210 m
Lower quartile:	143 m
Upper quartile:	305 m
Average walking duration	3.96 min
Media walking duration	3.23 min
Average walking speed	4.51 km/h
Median walking speed	3.98 km/h

Comparison of average walking distance in other cities:

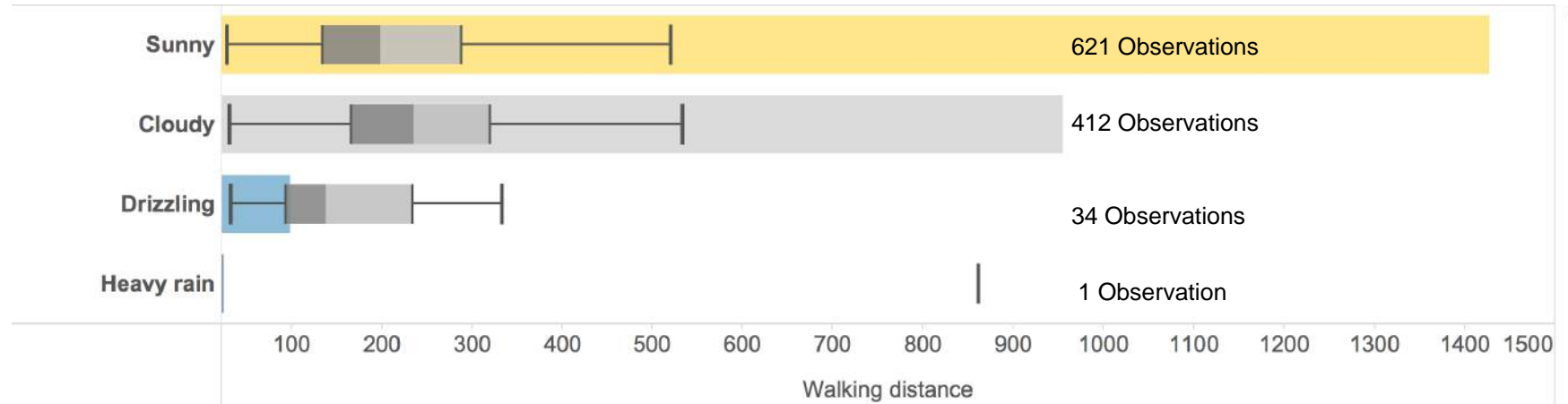
Calgary, city centre (1986):	330m
Portland, whole city (2014):	876m
San Jose / Portland, MRT stops (2012)	832m

Seneviratne, P. N. and J. F. Morrall (1985). 'Analysis of Factors Affecting the Choice of Route of Pedestrians', *Transportation Planning and Technology* 10(2): 147–159.

Dill, Jennifer (2015). *Where Do People Prefer to Walk?*, Active Living Research Conference, San Diego.

Agrawal, Asha Weinstein, Marc Schlossberg and Katja Irvin (2008). 'How Far, by Which Route and Why? A Spatial Analysis of Pedestrian Preference', *Journal of Urban Design* 13(1): 81–98.

Walking distance by weather

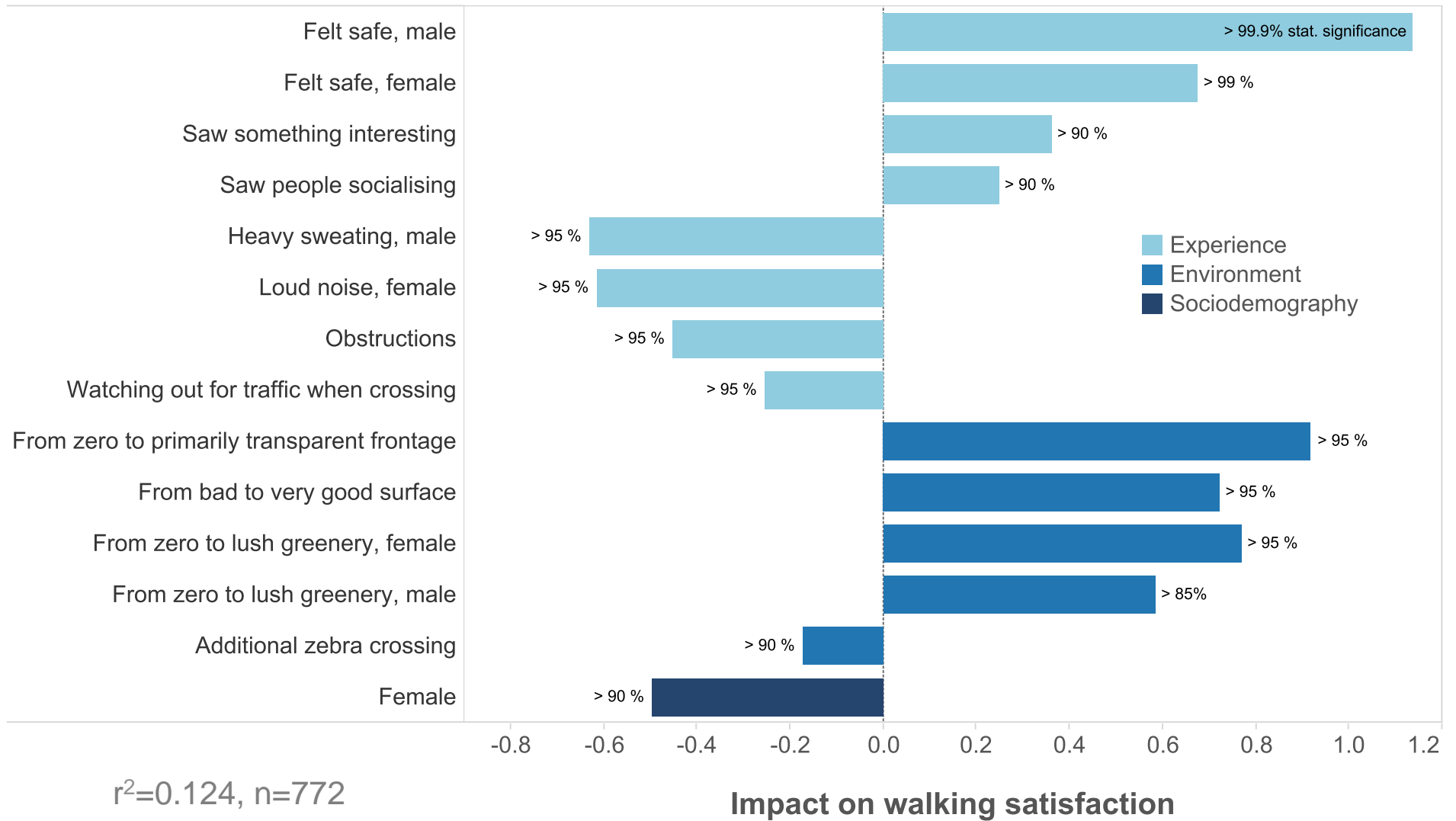


Compared to sunny conditions, people walk:

- 37 meters more, when it is cloudy
- 98 meters less, when it is drizzling

We have too few observation of walks in heavy rain condition to draw a valid conclusion.



What impacts walking satisfaction?



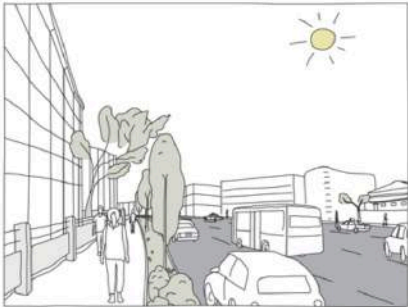
Web-based follow up survey

From actual to perceived distance

Which route would you prefer?



 sunny  1:00 pm


ROUTE 1




major road, no shops, no cover, with trees

6 min **2 min**

 walking  waiting


 overhead bridge


ROUTE 2



minor road, with shops, no cover, without trees

12 min

 walking

 no crossing required

Results of choice model

Parameters	Value	Sign.(>95%)
Walking time (through park, cloudy) [min]	-0.019	*
along major road	+59%	*
along minor road	+47%	*
cover	-18%	*
when rainy	-75%	*
when sunny	-51%	*
through block/underpass	-16%	*
when rainy	-66%	*
with greenery	-23%	*
with active frontage	-18%	*
Crossing 2-lane road	-0.015	*
Crossing 4-lane road	-0.094	*
Overpass	-0.082	*
Overpass with lift	-0.043	*
Trafficlight	-0.016	*

n = 2451, $\rho^2 = 0.131$

Numerical example

$$\begin{aligned} U &= -0.00193 \cdot 10 \cdot (\\ &\quad (1 + \mathbf{0.473} \cdot \text{minor} + \beta_{maj} \cdot 0 + \beta_u \cdot \text{under} \cdot (1 + \beta_{ur} \cdot 0)) \cdot \\ &\quad (1 + \mathbf{-0.228} \cdot \text{greenery}) \cdot \\ &\quad (1 + \mathbf{-0.175} \cdot \text{shops}) \cdot \\ &\quad (1 + \mathbf{-0.175} \cdot \text{cover} \cdot (1 + \mathbf{1.9} \cdot \text{sunny} + \beta_{cr} \cdot 0)) + \\ &\quad \beta_o \cdot 0 + \\ &\quad \beta_{ol} \cdot 0 + \\ &\quad \beta_{j_2} \cdot 0 + \\ &\quad \beta_{j_4} \cdot 0 + \\ &\quad \beta_{tl} \cdot 0 \\ &= -0.00193 \cdot 10 \cdot \mathbf{0.62} \end{aligned}$$



6.2 min

10 min

Interpretation of web-survey results



reference

10.0 min

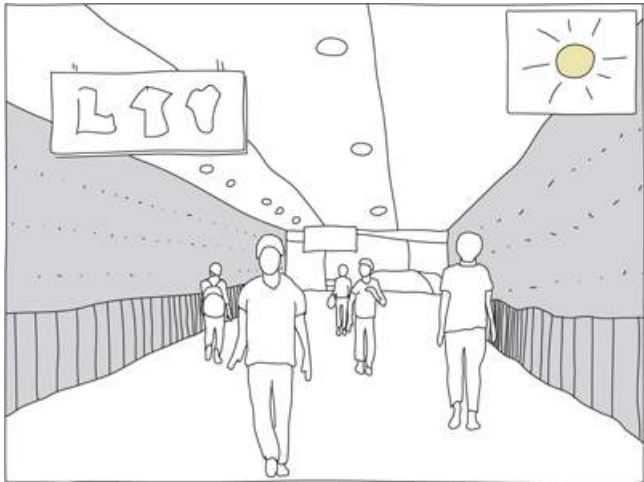


14.7 min

Reference case

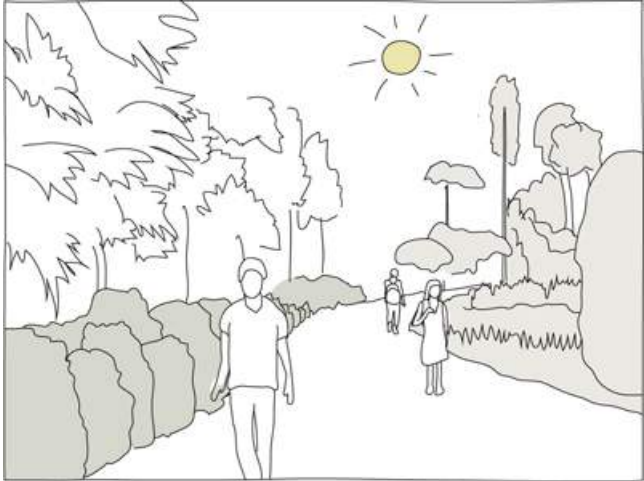


15.3 min

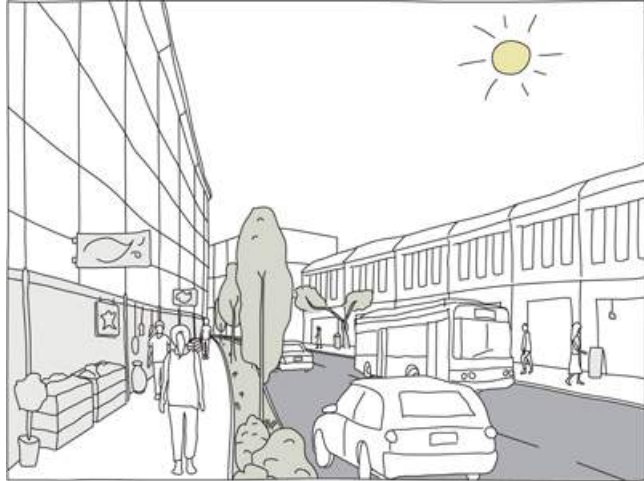


8.4 min

Interpretation of web-survey results

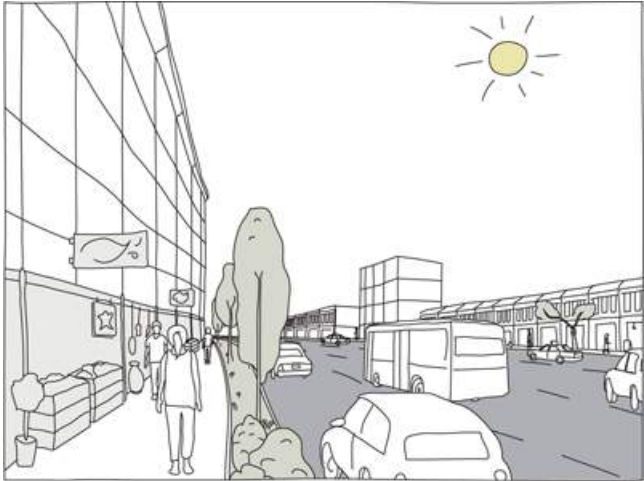


7.7 min



9.3 min

Add greenery (-23%) and shops (-18%)

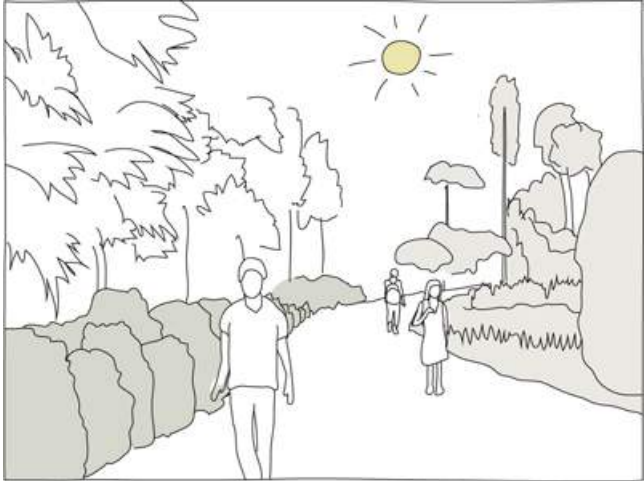


11.9 min



6.6 min

Interpretation of web-survey results

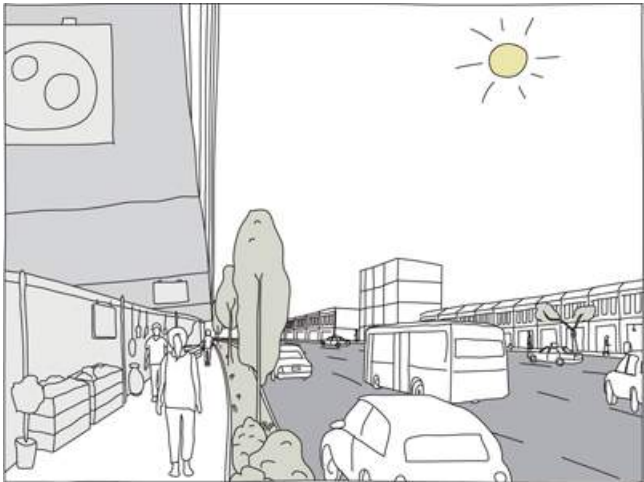


7.7 min



6.2 min

Add cover: -33% perceived walking time

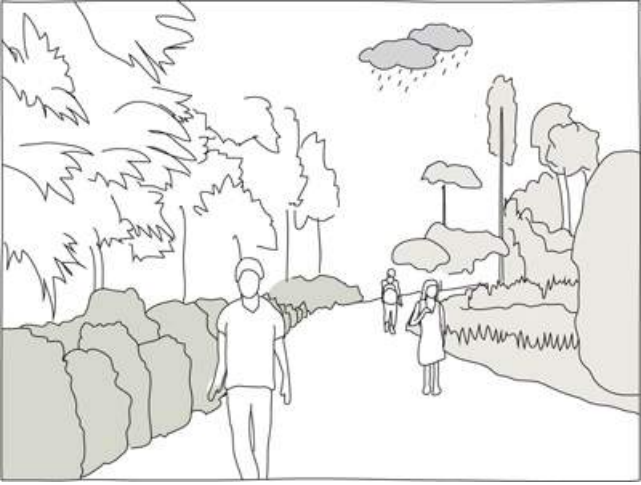


6.8 min



6.6 min

Interpretation of web-survey results



14.8 min

reference

5.6 min



Tropical rain sets in

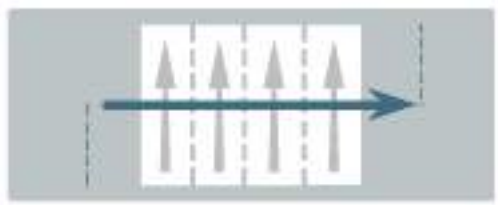


7.4 min

6.1 min



Crossings' equivalent of walking time



Jaywalking, 4 lanes

4.9 min

0.8 min



Jaywalking, 2 lanes



Overhead bridge

4.2 min

2.2 min



Overpass with lift



Traffic light

1 min

2.0 min*



Underground with stairs

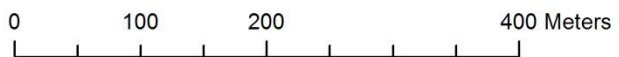
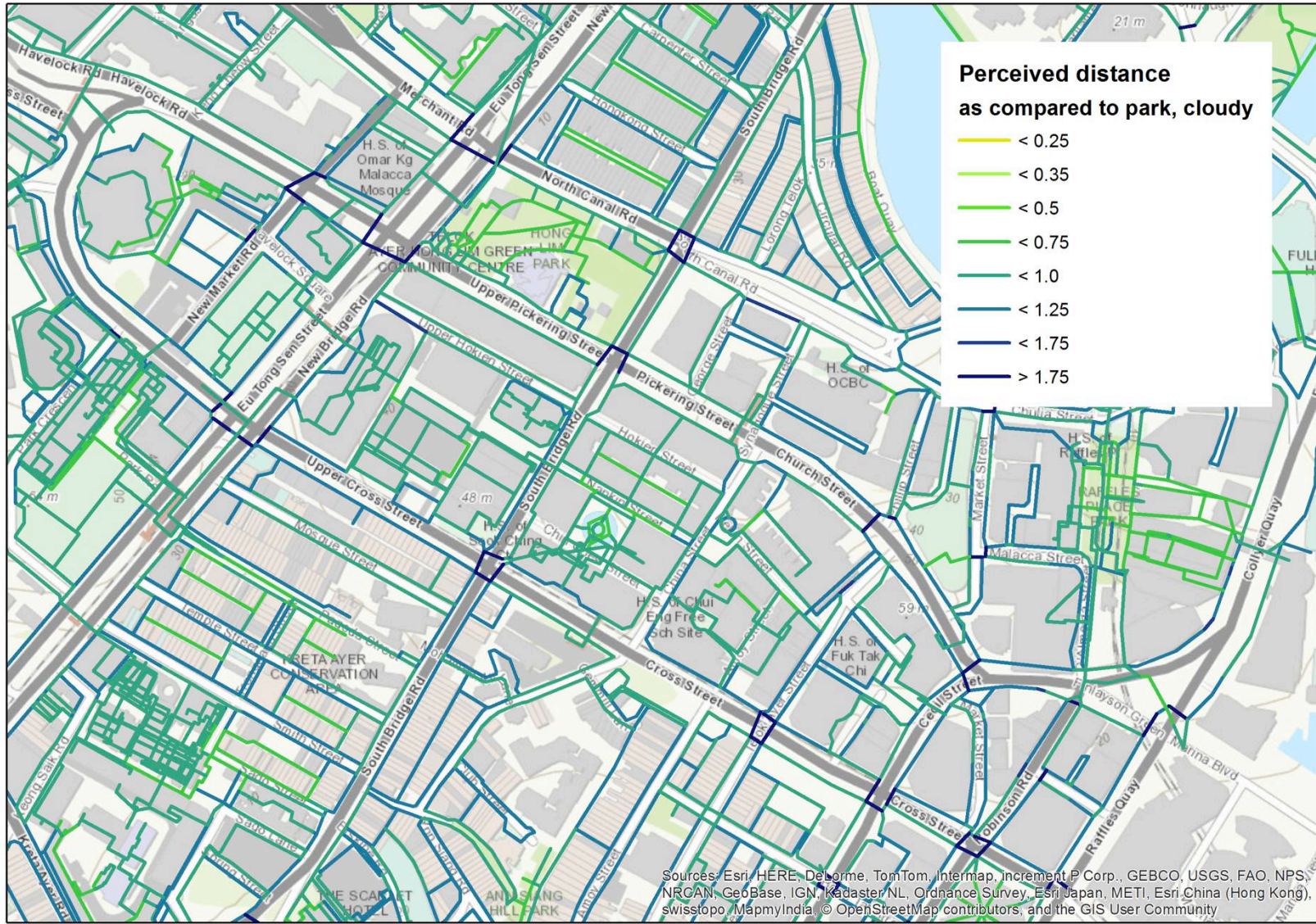
1 min*



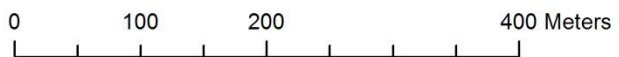
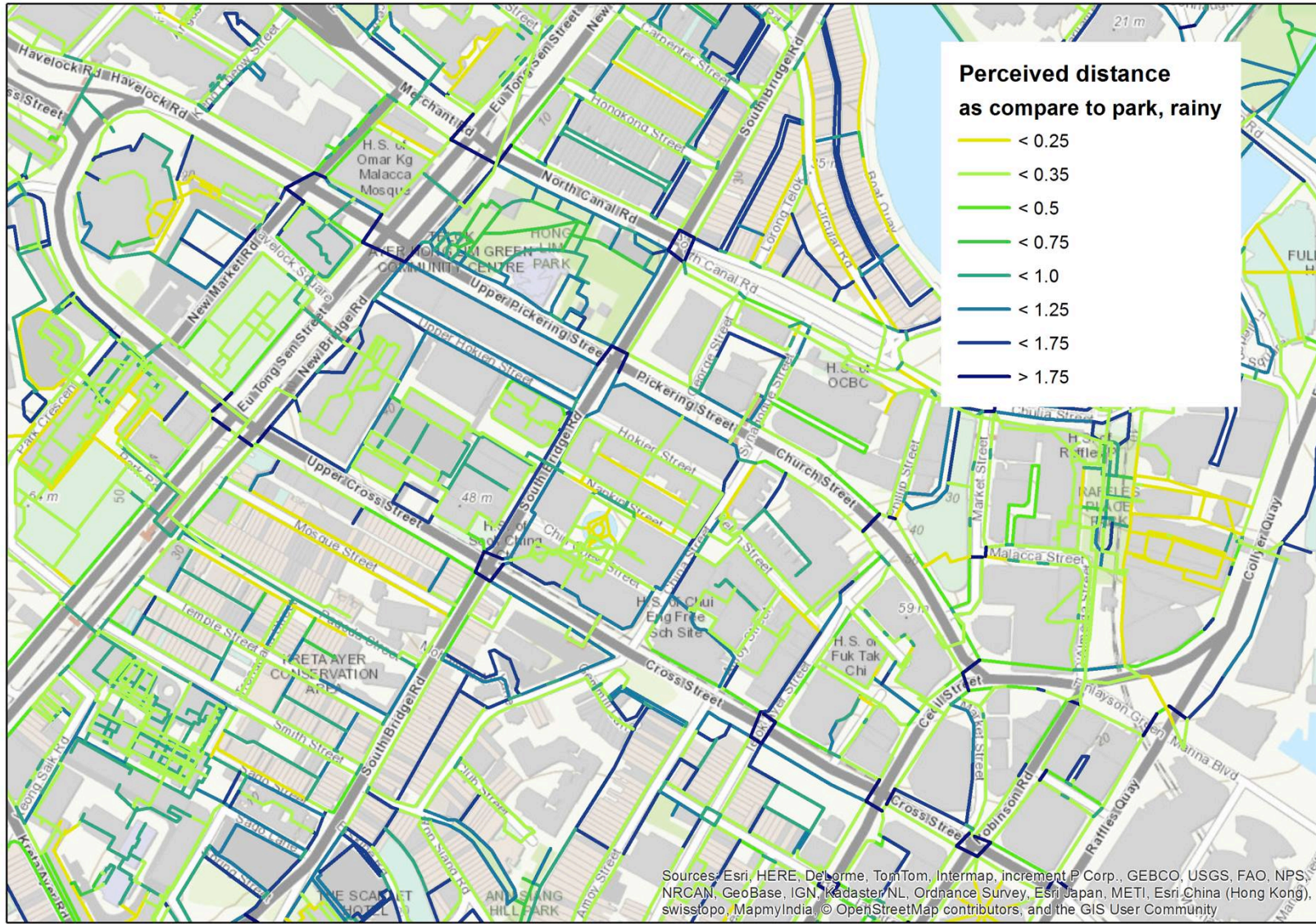
Underground with Escalator

*stat. not significant as variable only available
in subsample-> assumed values

The barrier effect of the overhead bridge



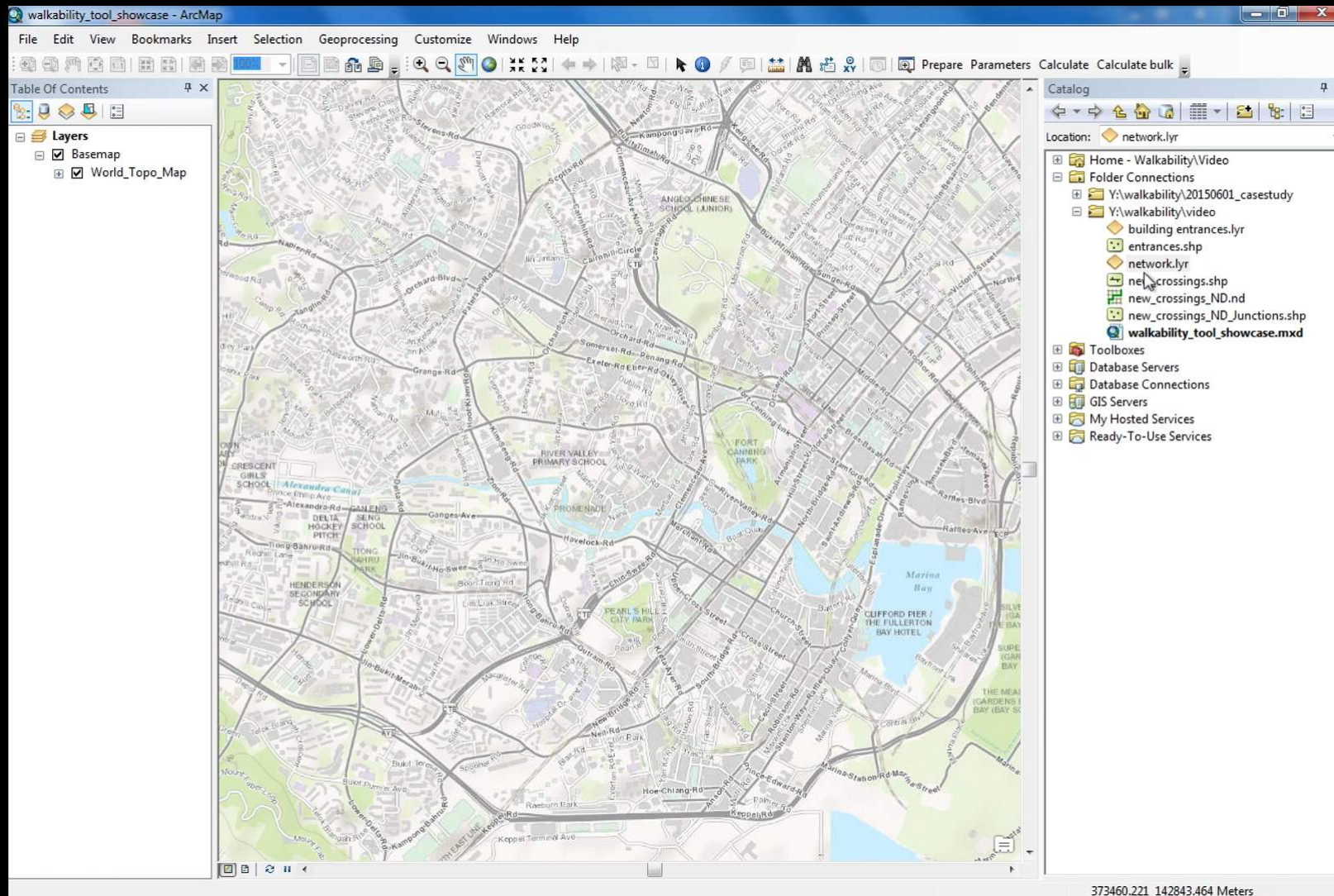
The barrier effect of the overhead bridge



Walkability Tool

A new ArcGIS add-in to compute walkability

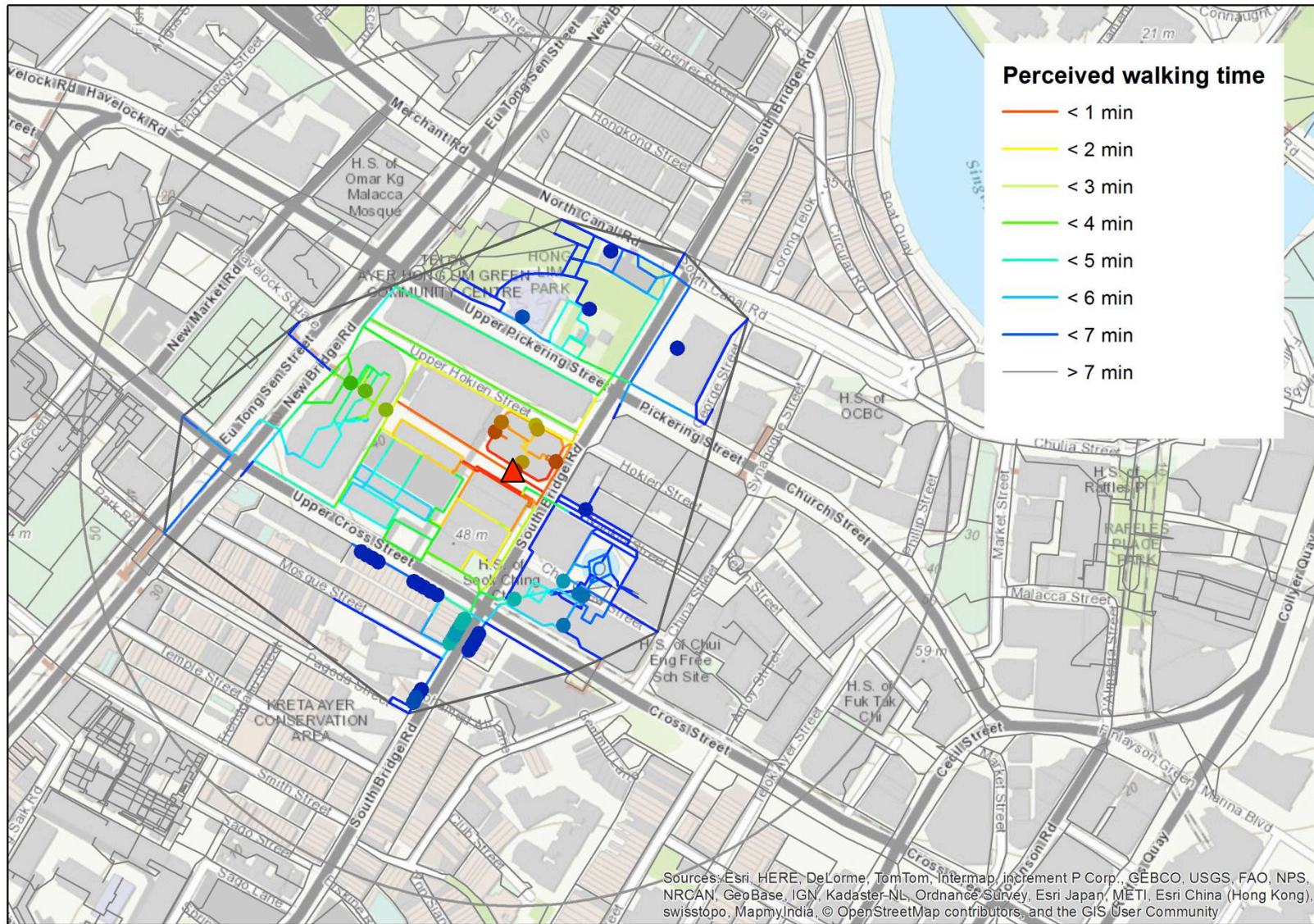
New ArcGIS add-in for planners



Connecting Hong Lim complex with Nankin Road

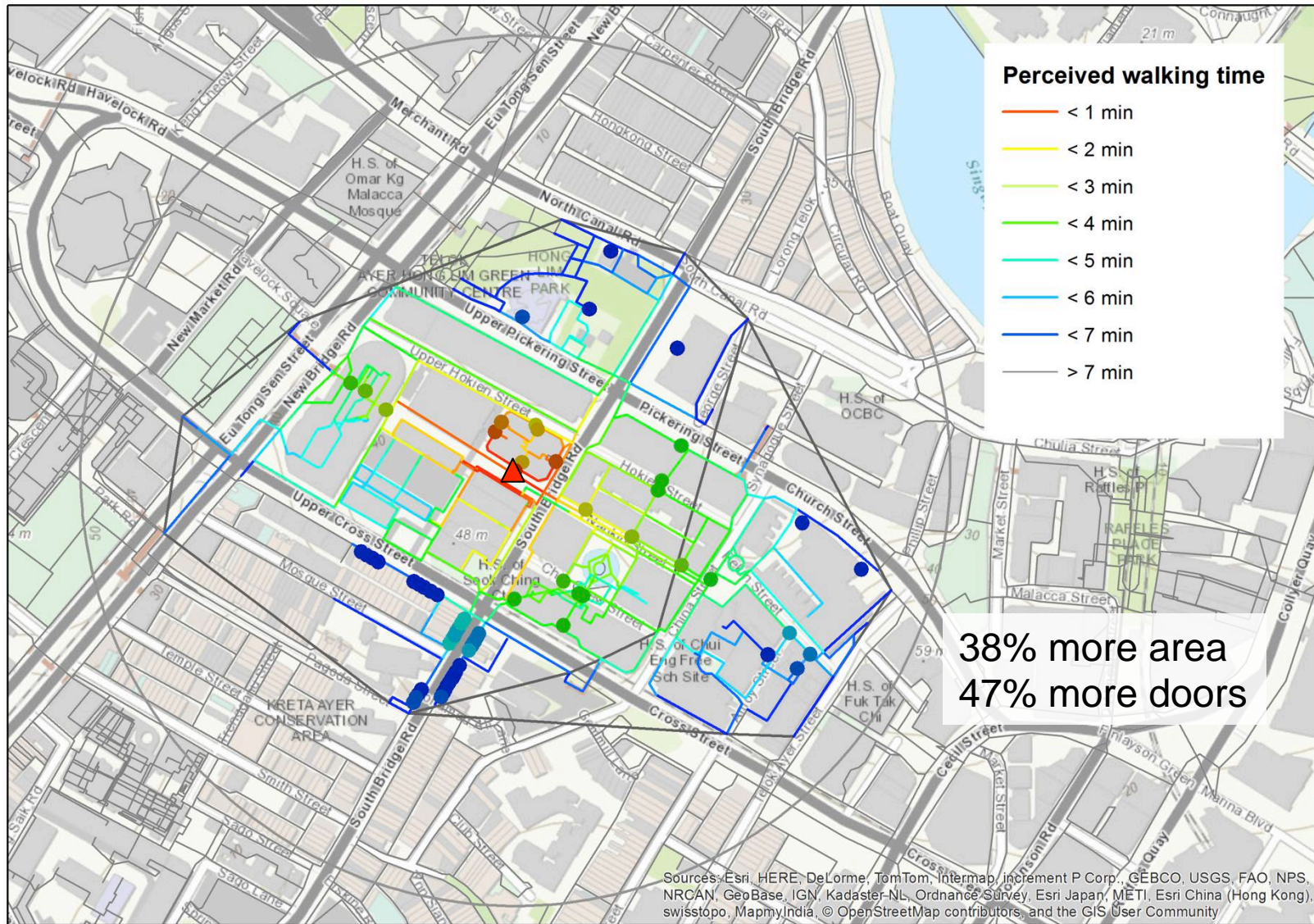


The barrier effect of the overhead bridge

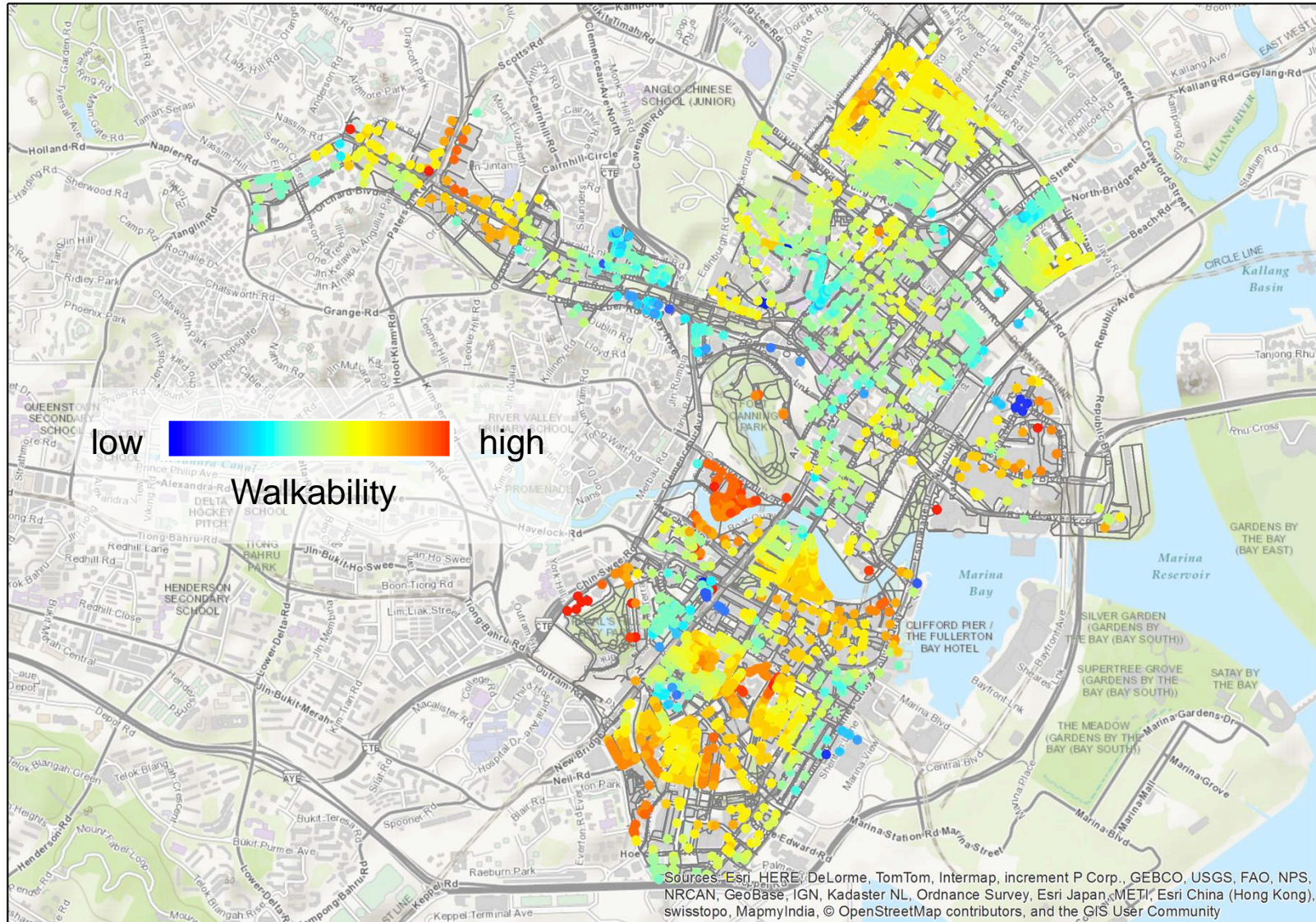


0 100 200 400 Meters

The barrier effect of the overhead bridge



Walkability in Singapore



0 500 1,000 2,000 Meters

What's next

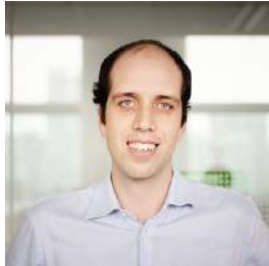
Model pedestrian route choice to better understand influence of:

- Influence of turns, wayfinding
- Traffic lights
- Distance vs built environment based on actual behavior

Deployment of Walkability Tool

- Developed in collaboration with URA, but to be shared
- Training session in August, please contact me if you are interested

The team to make it happen



Michael van Eggermond
Spatial database,
methodology



Sergio Ordonez
PhD student
App, ArcGIS add-in



Prof. Dr. Kay Axhausen
PI



Dr. Alex Erath
Survey, modelling,
methodology



Kim Helmersen
Piloting



Atizaz Ali
Survey support,
Network cleaning



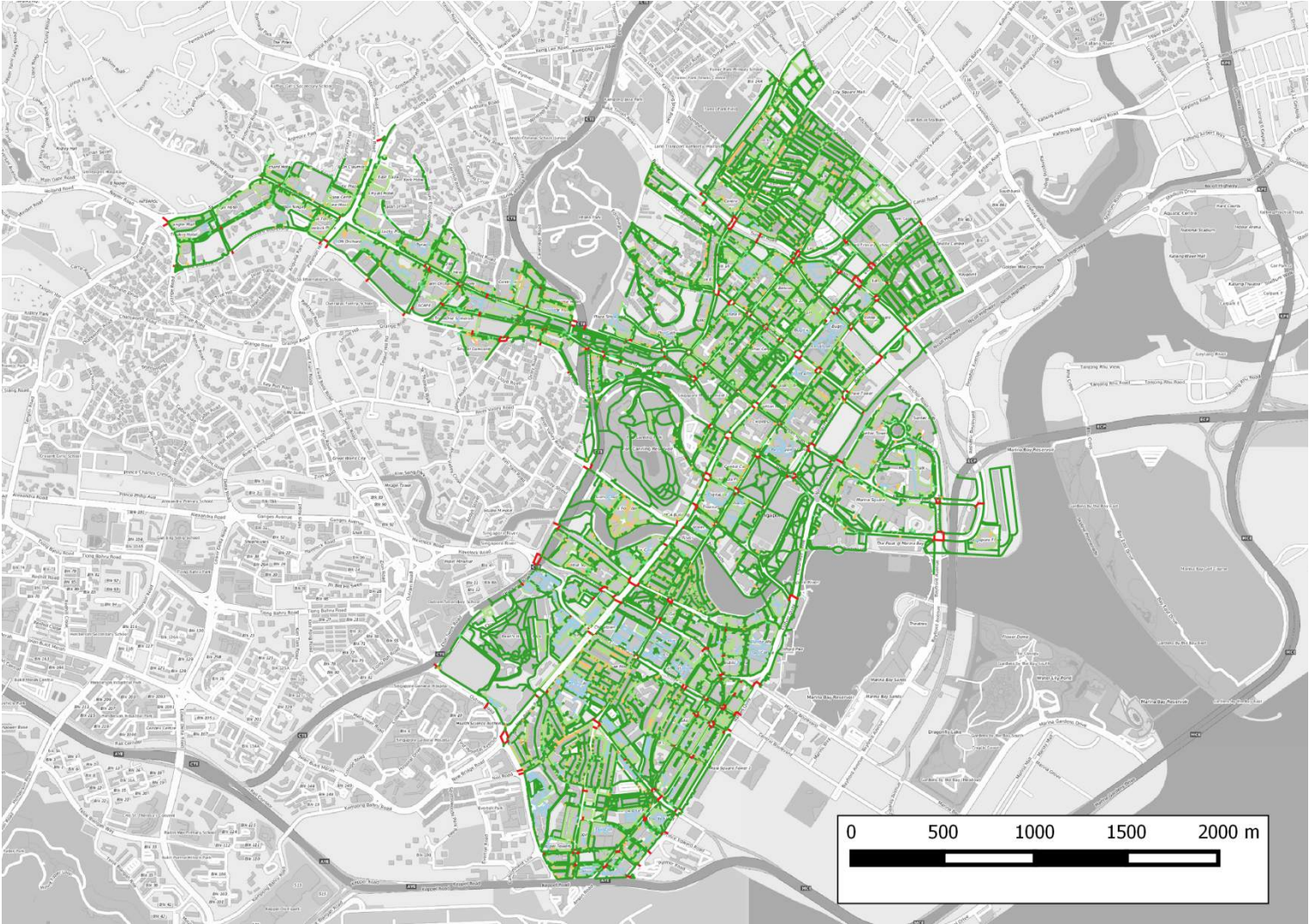


Appendices

Pedestrian network survey

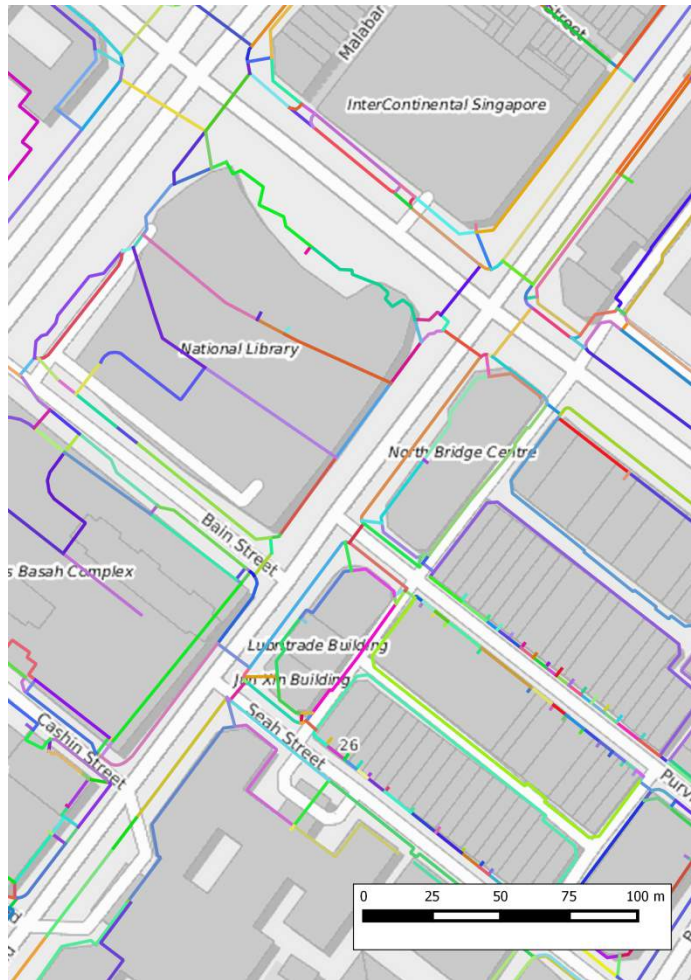
Collecting information for 43km walkways

Extent of the pedestrian network

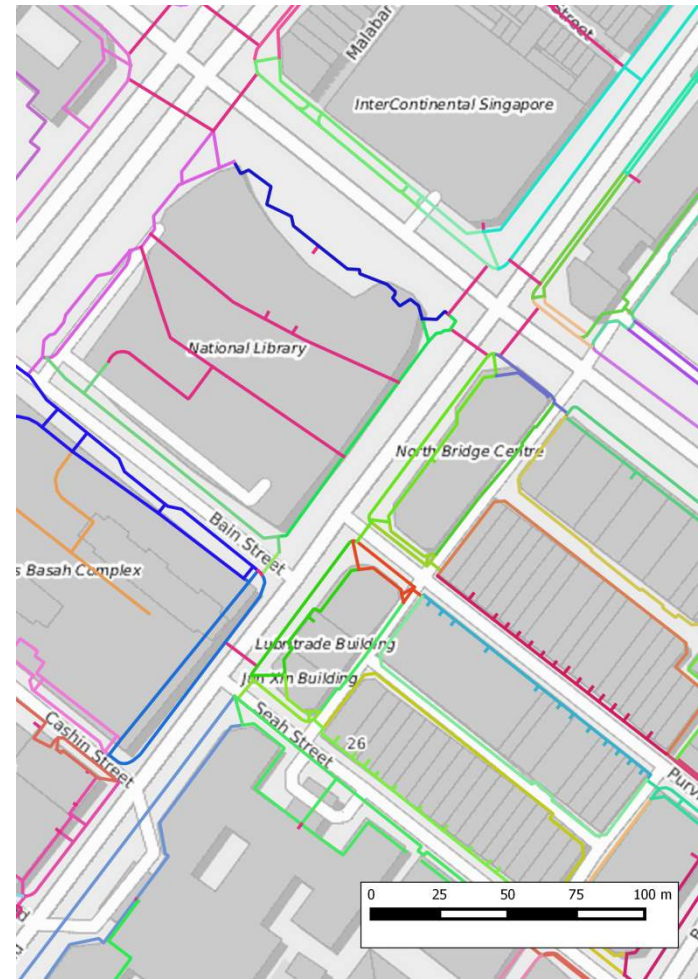


Simplification of network to collect characteristics


At grade network (27311 features);
Each color represents a feature



Link clusters (2833 features); ;
Each color represents a cluster



Developing a survey manual



Walkability in Singapore Pedestrian Network Survey Manual

Greenery

Step 1
Walk along the entire length of the link cluster.


Step 2
As you walk, note the level of greenery on your side of the road. Assess the total level of greenery composed of lawns, hedges, trees, potted plants and vertical planted greenery.

Step 3
Record the level of greenery using your tablet on a scale from 1 to 5.
If there are considerable differences in the level of greenery within a link cluster, use a weighted average and round it to an integer: if about 40% of the area has no greenery at all, and the other 60% features lush greenery this would result in the following calculation: $(0.4 * 1 + 0.6 * 5) = 3.4 \rightarrow 3$


Note
Figures 1 to 5 show examples of the different levels of greenery. The figures show the scope of different types of greenery that you may encounter. Bear in mind that the different types don't directly correspond to a particular level, i.e. level 4 does not necessarily require a hedge and trees. The figures are rather to give you an indication of the amount of greenery that refers to each level.

Urban design qualities


Outdoor links




Level 1: No greenery



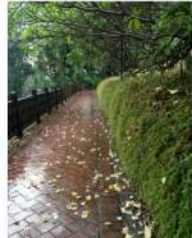
Level 2: Little greenery



Level 3: Some greenery



Level 4: Considerable amount of greenery

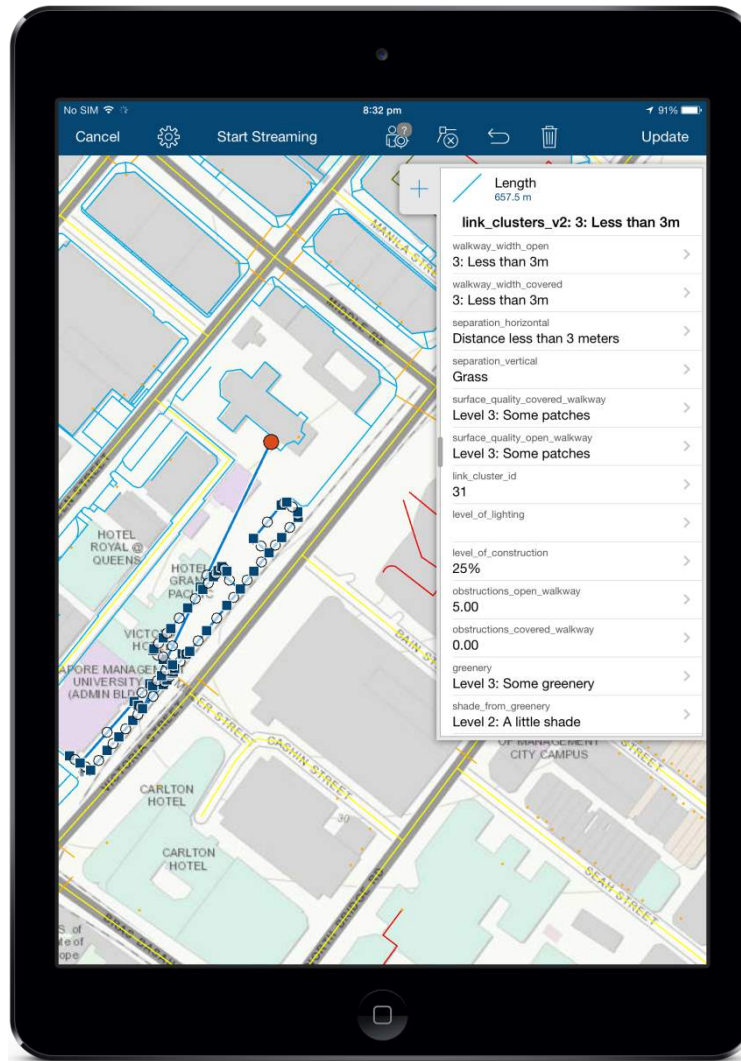


Level 5: Lush greenery

Collector for ArcGIS

Use your smartphone or tablet to collect and update information in the field, whether connected or disconnected.

Your update can include modifying the feature's attributes and location, as well as adding and deleting photos.



Beach road



Width open walkway	1-2m
Width covered walkway	n.a.
Separation horizontal	1-3m
Separation vertical	medium high hedge
Noise level	69db
Noise source	Mainly from street
Maintenance	5/5 – no rubbish in sight
Slipperiness	No, no tendency to slipperiness
Greenery	5/5 – lush greenery
Shade from greenery	4/5 - clearly shaded
Obstructions	0 – no obstructions in sight
Construction	0%
Imageability	1 feature
Human scale	1 feature
Enclosure	4/5
Transparency	0/100
Level of lighting	2/5 – small amount
Number of persons	5
Wheelchair	fully accessible
Date	6. July 2014

Sultan Gate



Width open walkway	2 – 3 m
Width covered walkway	1 – 2m
Separation horizontal	1-3m
Separation vertical	grass
Noise level	60db
Noise source	Mainly from street
Maintenance	4/5 – a little rubbish in sight
Slipperiness	No, no tendency to slipperiness
Greenery	3/5 – some greenery
Shade from greenery	1/5 - no shade from greenery
Obstructions	0 – no obstructions in sight
Construction	0%
Imageability	2 features
Human scale	13 features
Enclosure	4/5
Transparency	40/100
Level of lighting	2/5 – small amount
Number of persons	4
Wheelchair	fully accessible
Date	8. July 2014