CLC Street Network Modelling Project

SLA x NSCC Webinar

9th June 2021

- **Using spatial modelling as a bottom-up approach to analyse street accessibility**
- **How spatial analysis can inform and value-add planning processes and policies within govt agencies**

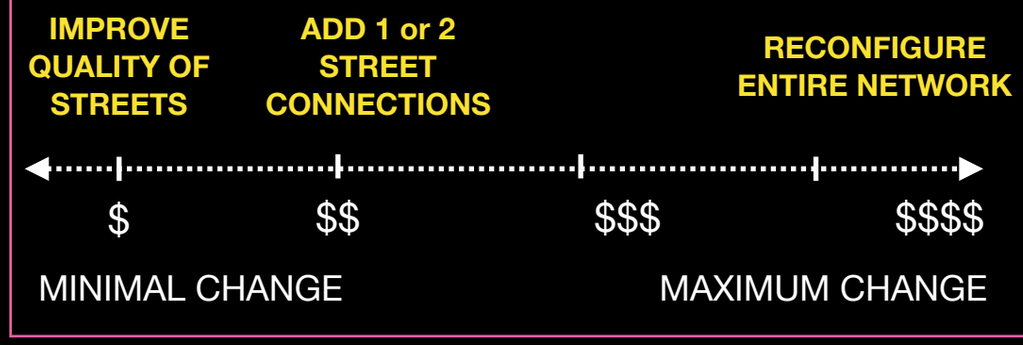
SPACE SYNTAX

Street Network Model

1. Measures accessibility of existing and proposed masterplans

2. Uncovers potential in active mobility routes and identifies missed opportunities

MINIMAL CHANGE TO ATTAIN MAXIMUM EFFECT



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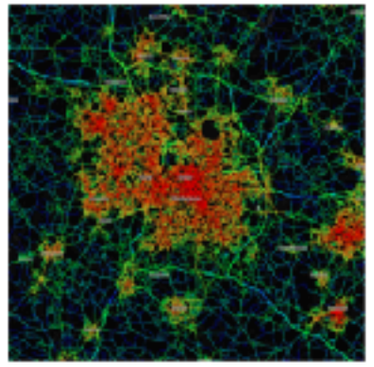
CityZen Explorer

A tool to improve the quality of life of older people living in urban areas.

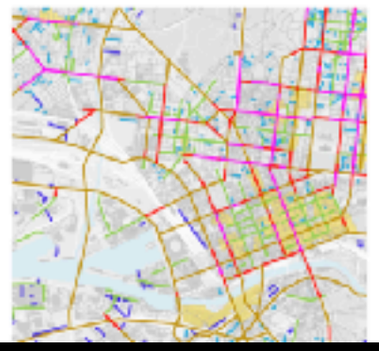
OpenMapping GB

A pre-processed spatial network model of Great Britain, published as an open dataset.



Urban Value modelling

A powerful modelling tool that measures the impact on land values of key urban design factors including spatial connectivity, land use attraction and transport infrastructure.



Walkability Index

A tool to benchmark existing places and test new proposals in terms of whether they deliver walkability or car-dependence.

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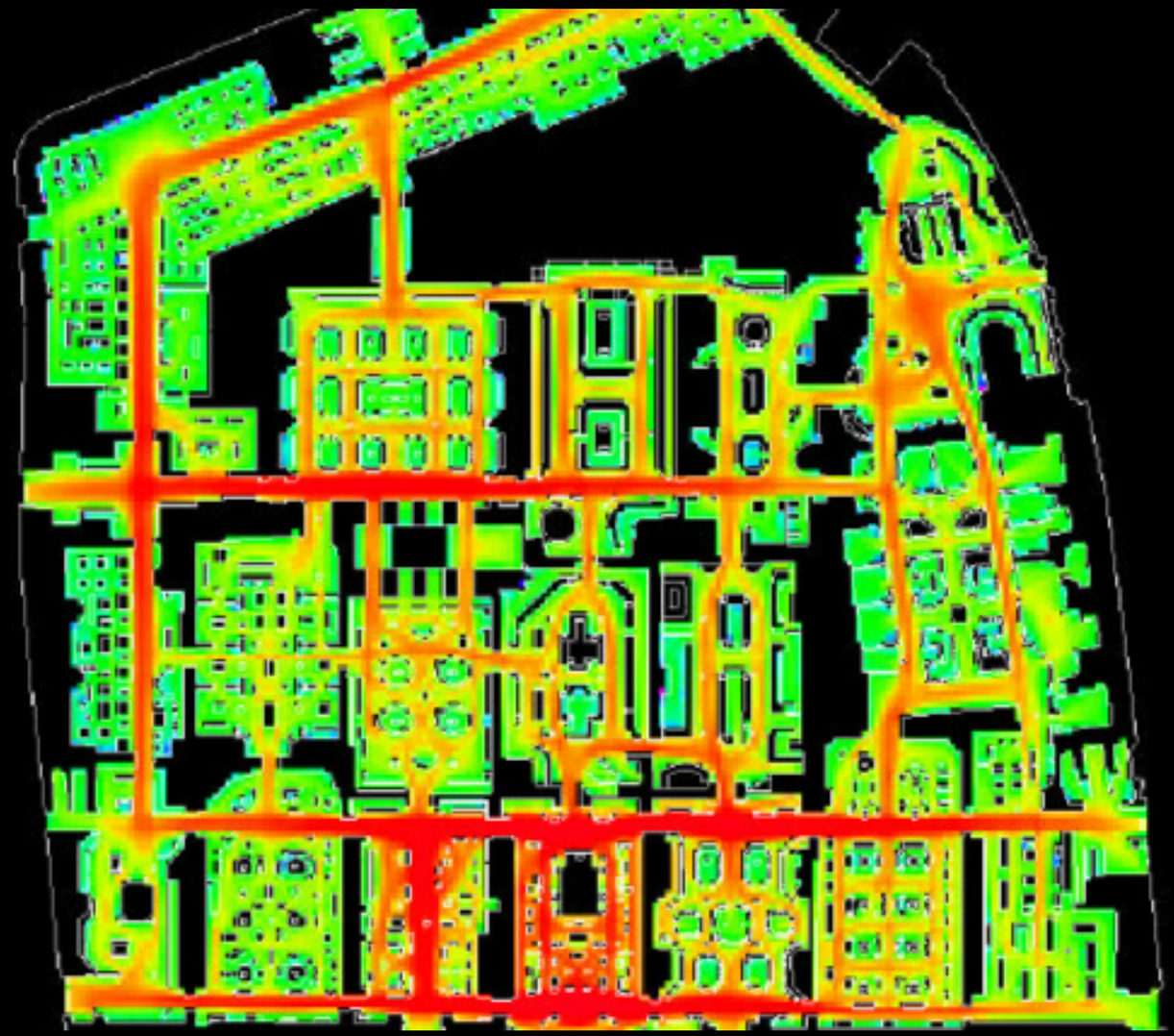
TRAFALGAR SQUARE, LONDON

Analysing pedestrian flow and activity

HARRODS, LONDON



Visibility Graph Analysis
Agent-based Modelling

Singapore Islandwide

Choice Accessibility

Global

Spatial Accessibility

High

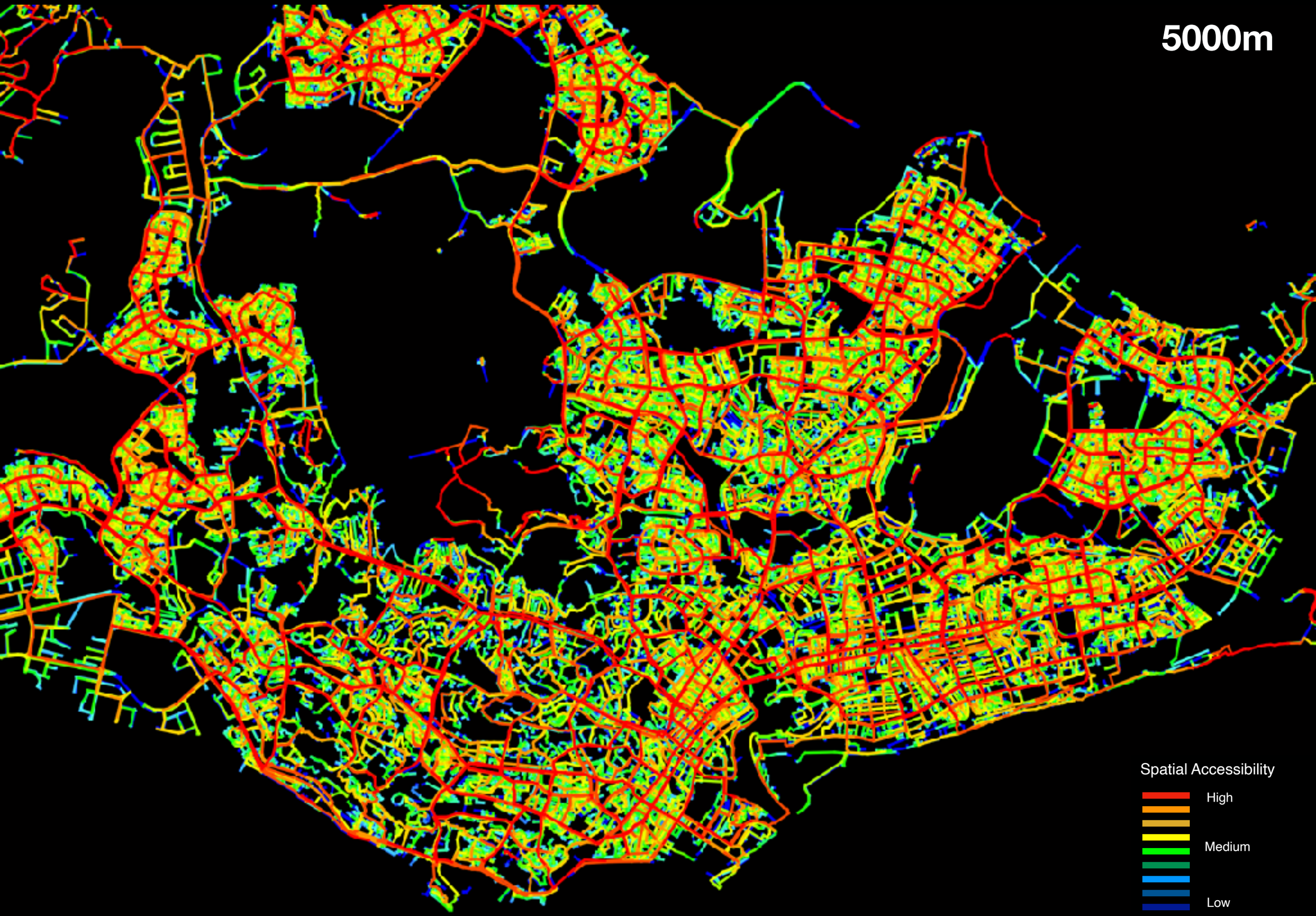
Medium

Low

Singapore Islandwide

Choice Accessibility

5000m



Singapore Islandwide

Choice Accessibility

3000m

Spatial Accessibility

High

Medium

Low

Singapore Islandwide

Choice Accessibility

2000m

Spatial Accessibility

High

Medium

Low

Singapore Islandwide

Choice Accessibility

1200m

Spatial Accessibility

High

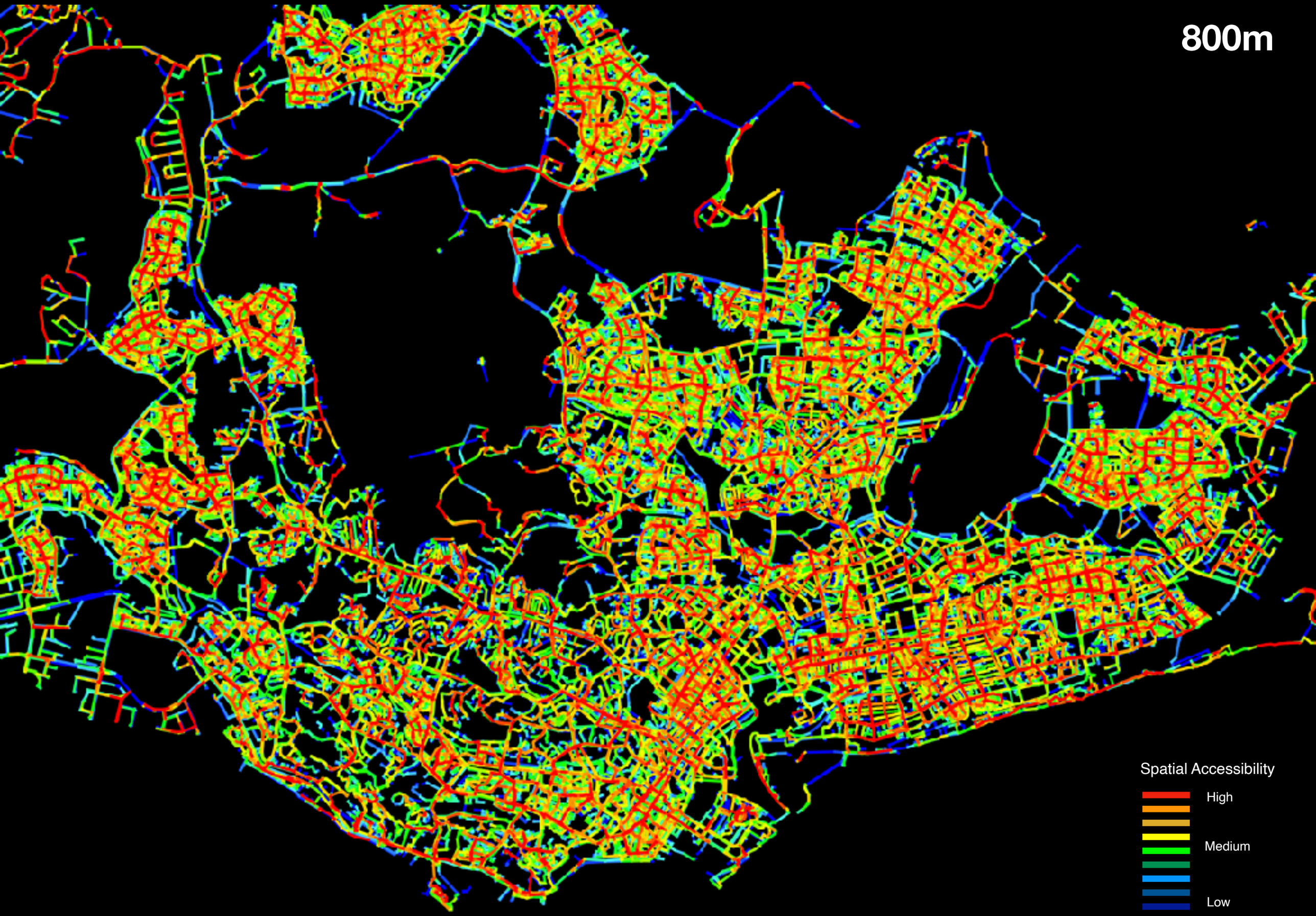
Medium

Low

Singapore Islandwide

Choice Accessibility

800m



Betweenness Centrality

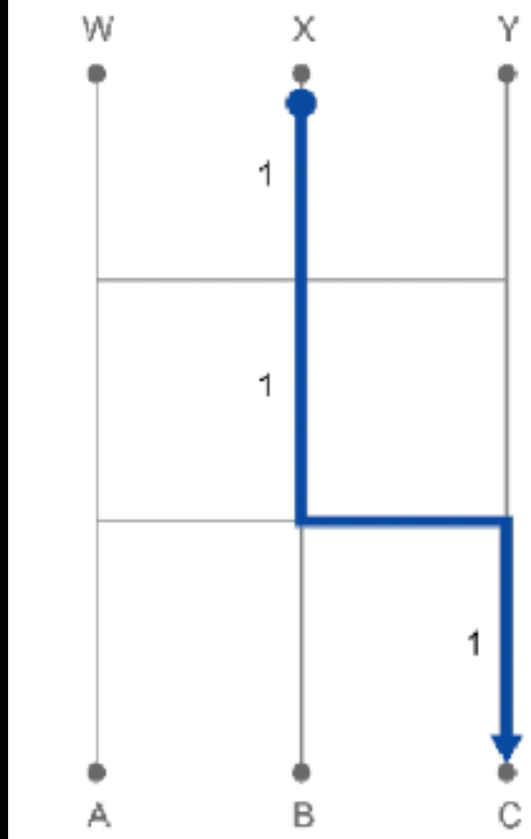
Choice / Through-Movement

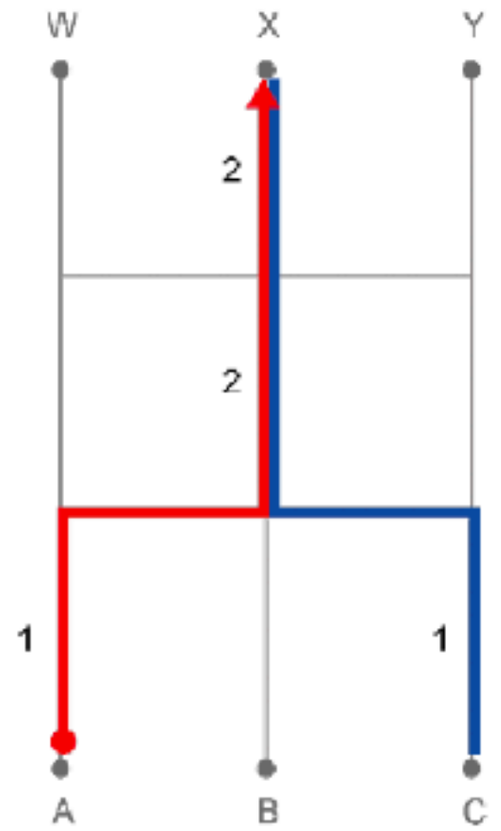
In graph theory, betweenness centrality is a measure of centrality in a graph based on shortest paths.

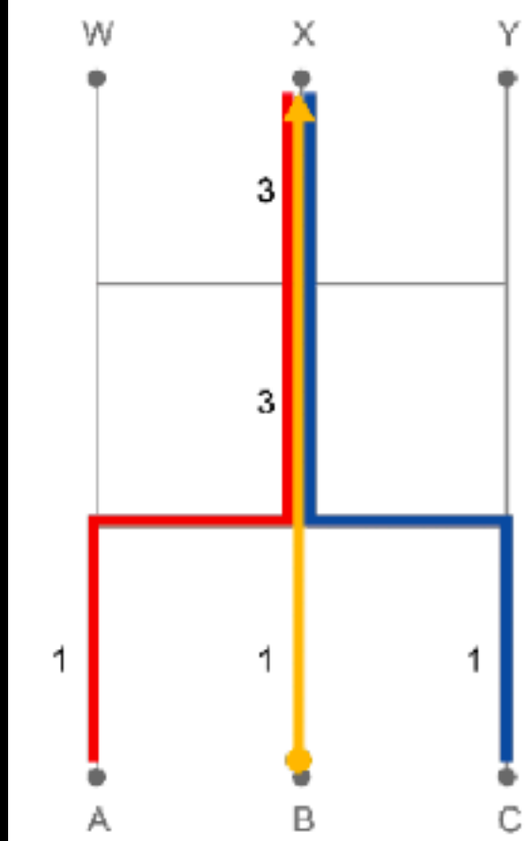
For every pair of vertices in a connected graph, there exists at least one shortest path between the vertices such that 1) and 2) are **minimised**

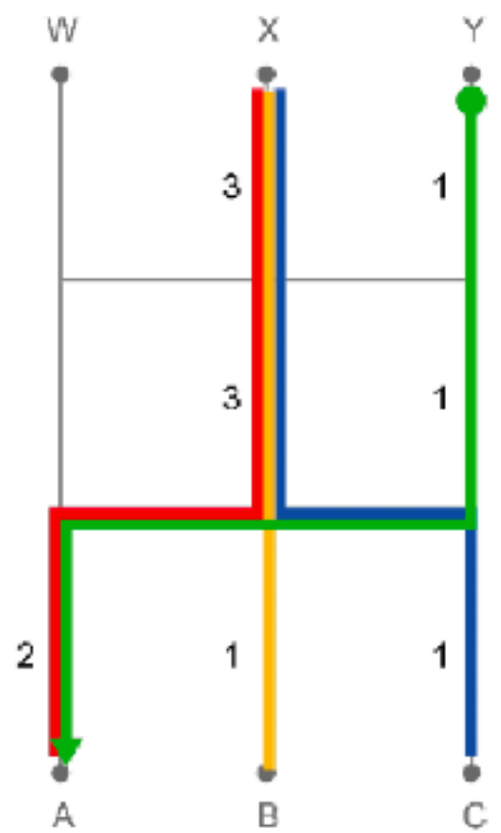
1) the number of edges that the path passes through (unweighted)

2) the sum of the weights of the edges (weighted)









Segment Angular Analysis

Angular Change

Angular change is the primary weighting for this model.

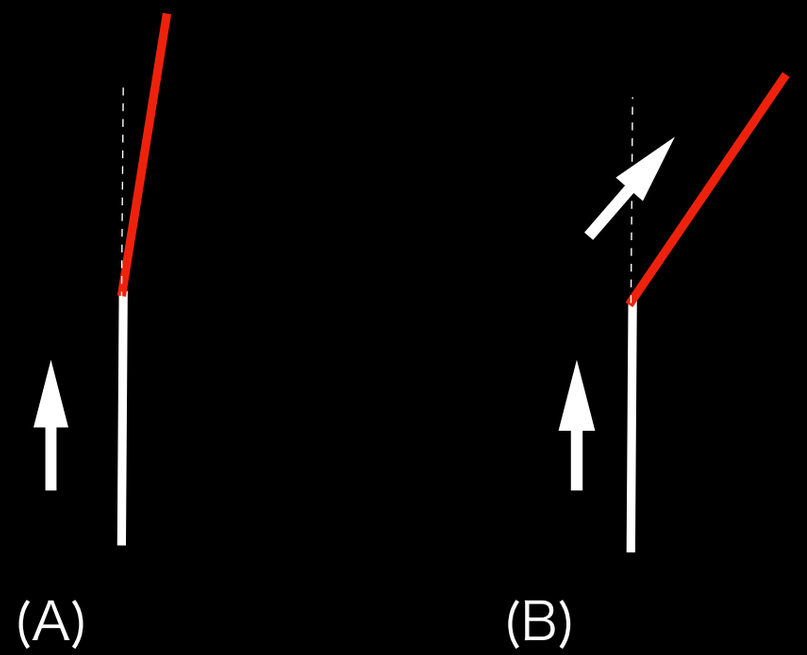
The higher the degree of angular change from line to line, the higher the weighting.

(A) A turn of less than 22.5 degrees has **0** weighting

(B) A turn of 45 degrees is weighted by **0.5**

(C) A turn of 90 degrees is weighted by **1**

(D) The maximum is 180 degrees with a weighting by **2**



Choice Accessibility

Global

Choice Accessibility

- Betweenness Centrality
- Potential for Human Movement
- Multi-scale

Spatial Accessibility

High

Medium

Low

Choice Accessibility

Radius 5000m

Choice Accessibility

- Betweenness Centrality
- Potential for Human Movement
- Multi-scale

Dunman Road

Spatial Accessibility

High

Medium

Low

Choice Accessibility

Radius 3000m

Choice Accessibility

- Betweenness Centrality
- Potential for Human Movement
- Multi-scale

Spatial Accessibility

High

Medium

Low

Choice Accessibility

Radius 2000m

Choice Accessibility

- Betweenness Centrality
- Potential for Human Movement
- Multi-scale

Spatial Accessibility

High

Medium

Low

Choice Accessibility

Radius 1200m

Choice Accessibility

- Betweenness Centrality
- Potential for Human Movement
- Multi-scale

Spatial Accessibility

High

Medium

Low

Choice Accessibility

Radius 800m

Choice Accessibility

- Betweenness Centrality
- Potential for Human Movement
- Multi-scale

Dunman Road

Spatial Accessibility

High

Medium

Low

SLA 3D SANDBOX

VISUALIZING THE MODEL WITH 3D

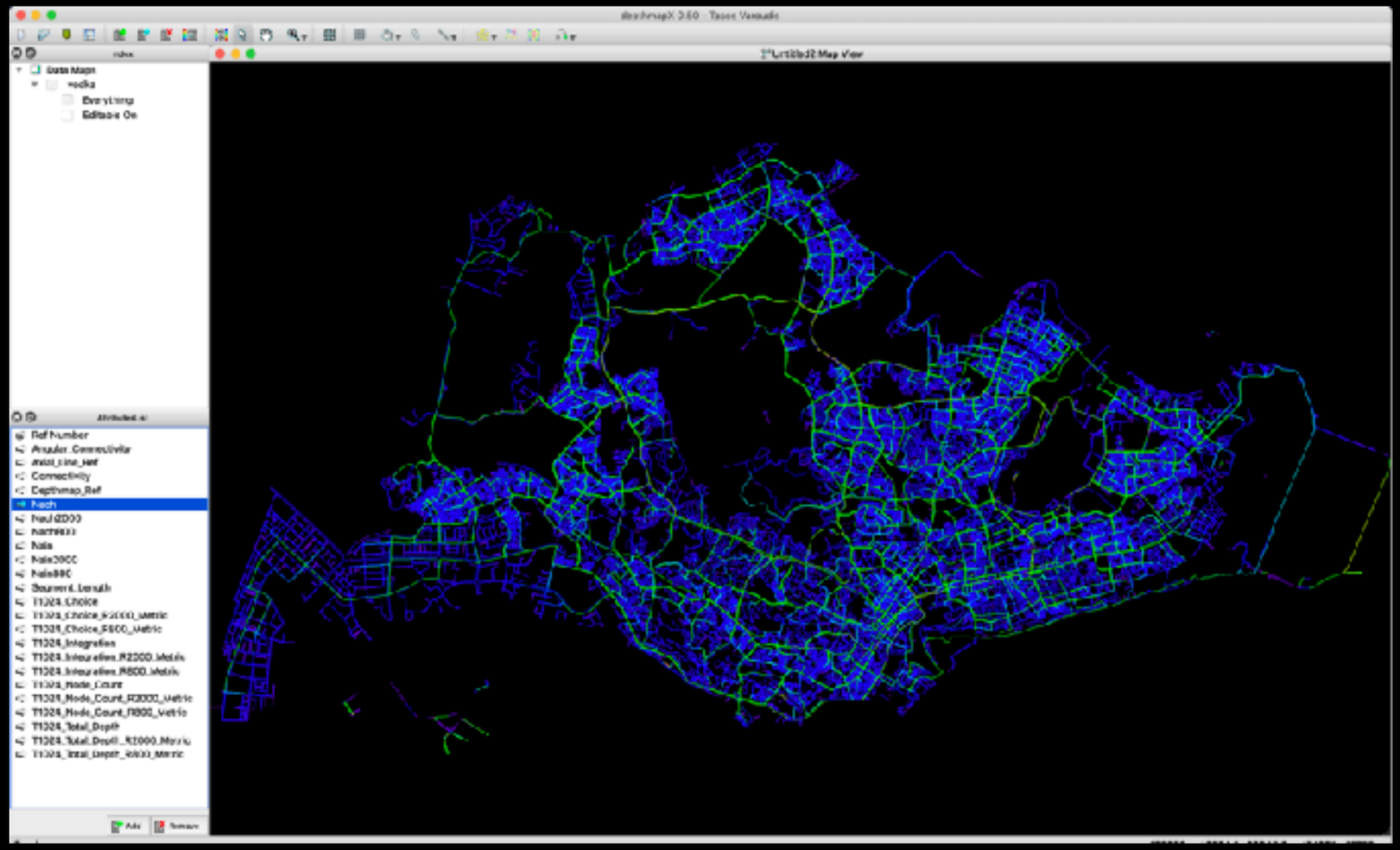
Typical workflow - Without HPC

NSCC

HIGH PERFORMANCE COMPUTING

depthmapX software

Running analysis using depthmapX software (open source)
Processing time: 24-48 hours



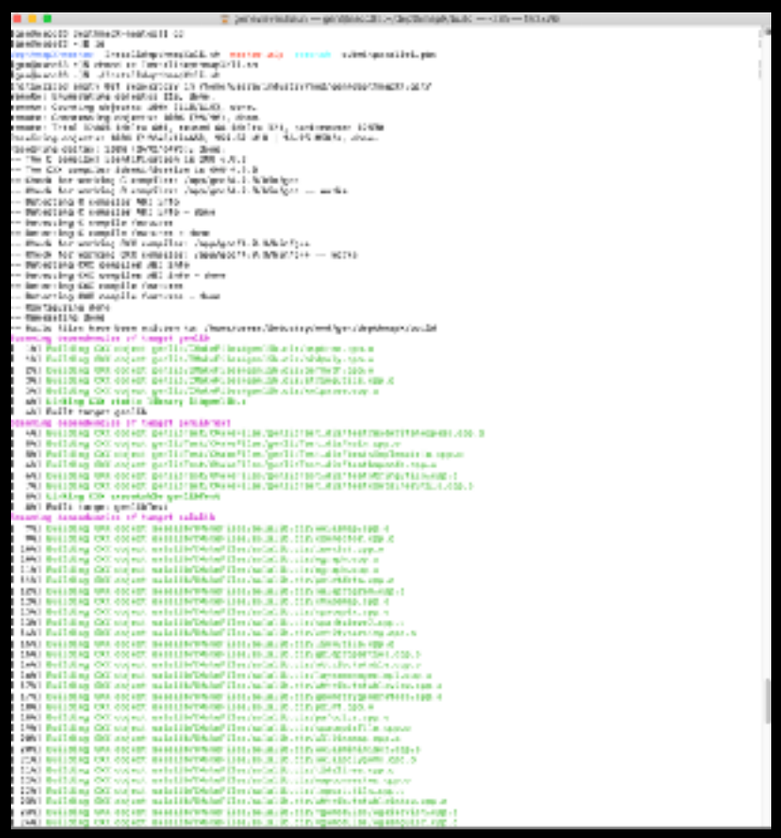
Typical workflow - With HPC

NSCC

HIGH PERFORMANCE COMPUTING

depthmapX software

1.
Building depthmapX onto NSCC's server



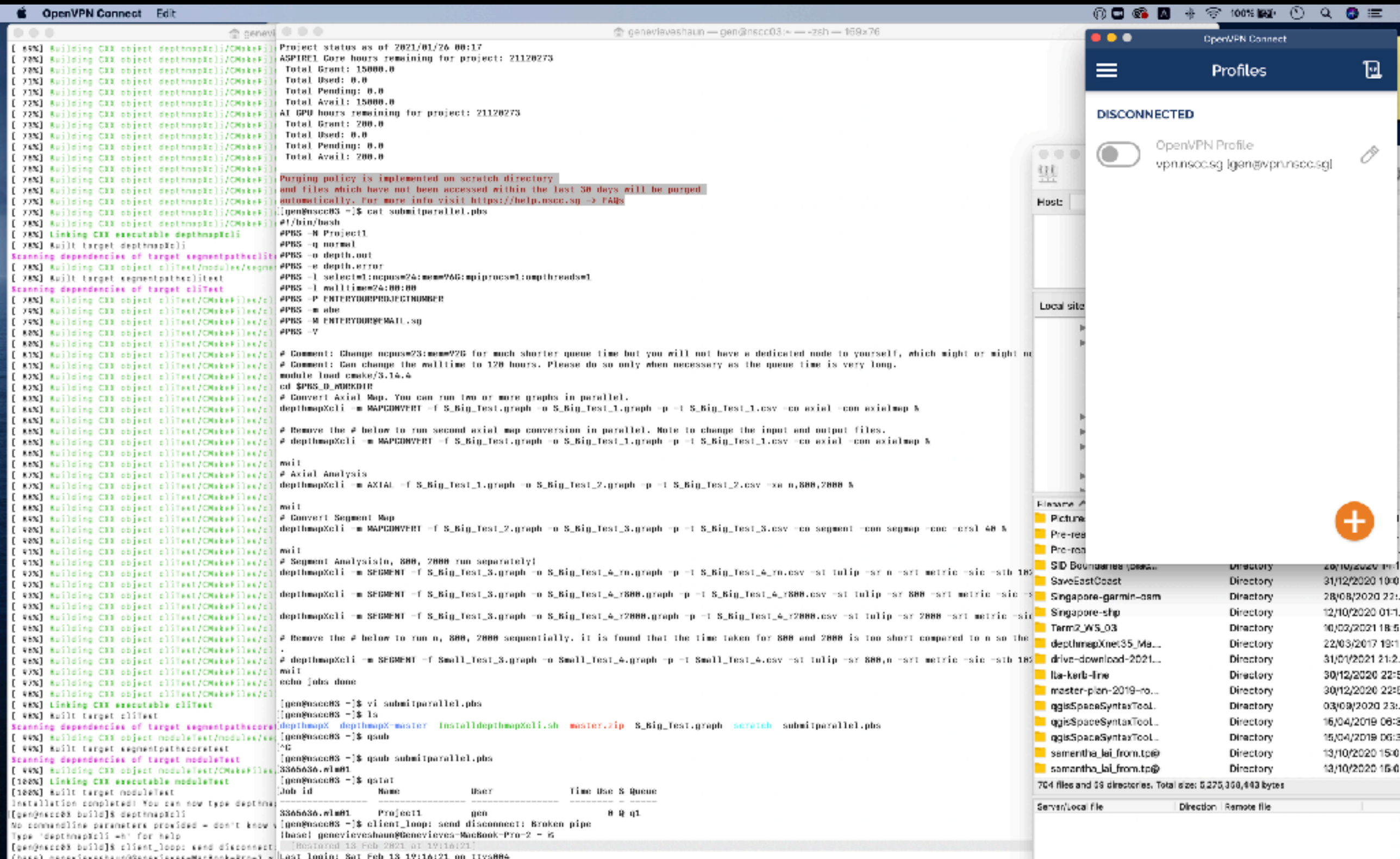
2.
Running DepthmapX on NSCC's server
Using DepthmapX CLI (Command Line Interface)

3.
Split the different radius analysis as different tasks to make use of HPC parallel computing

Typical workflow - With HPC

NSCC

HIGH PERFORMANCE COMPUTING



SPACE SYNTAX

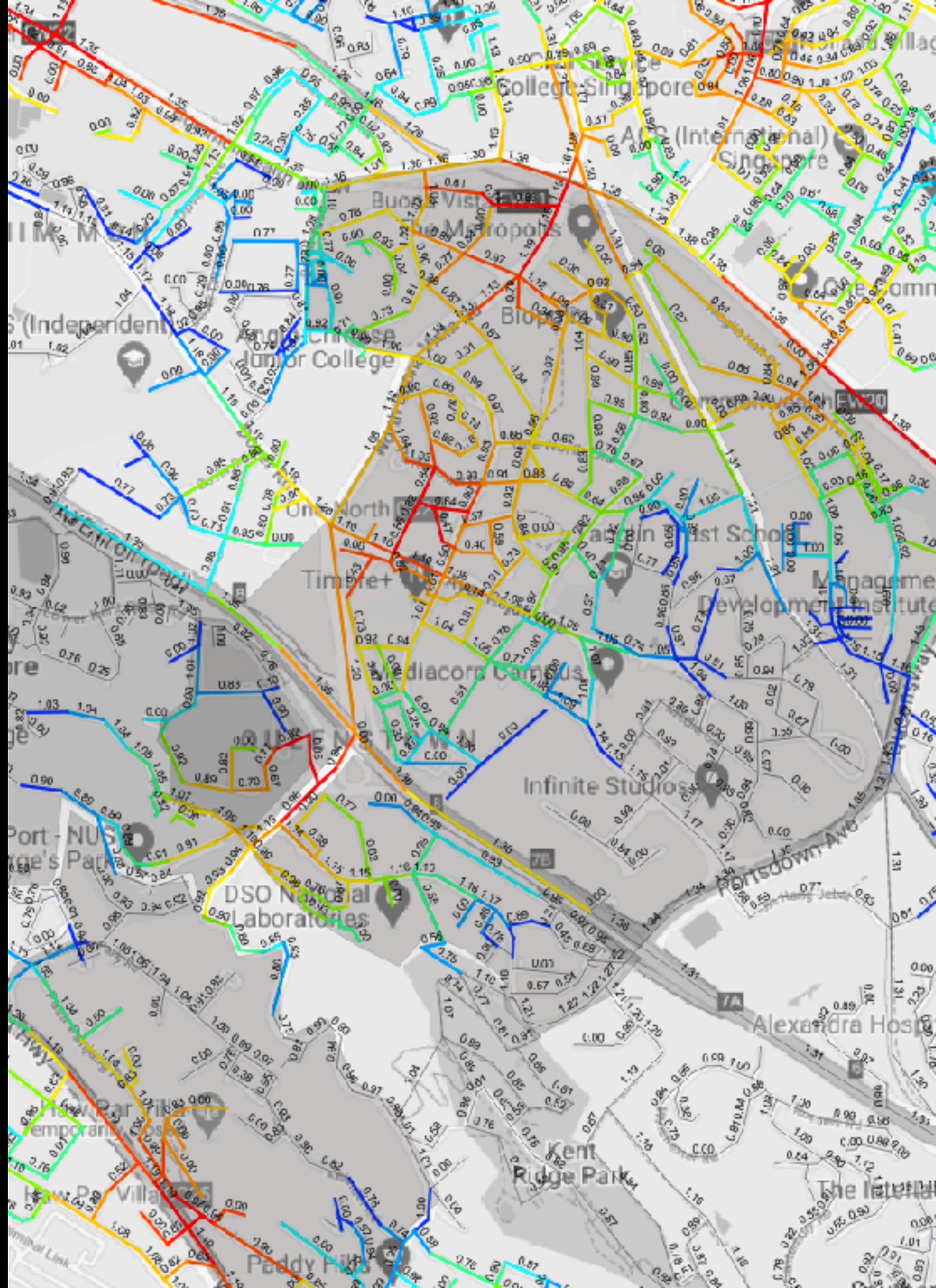
Benefits of a street network model as a baseline analysis

- Conducting preliminary studies before making a case to stakeholders

- Simple analysis can help in engaging stakeholders and develop deeper ideas

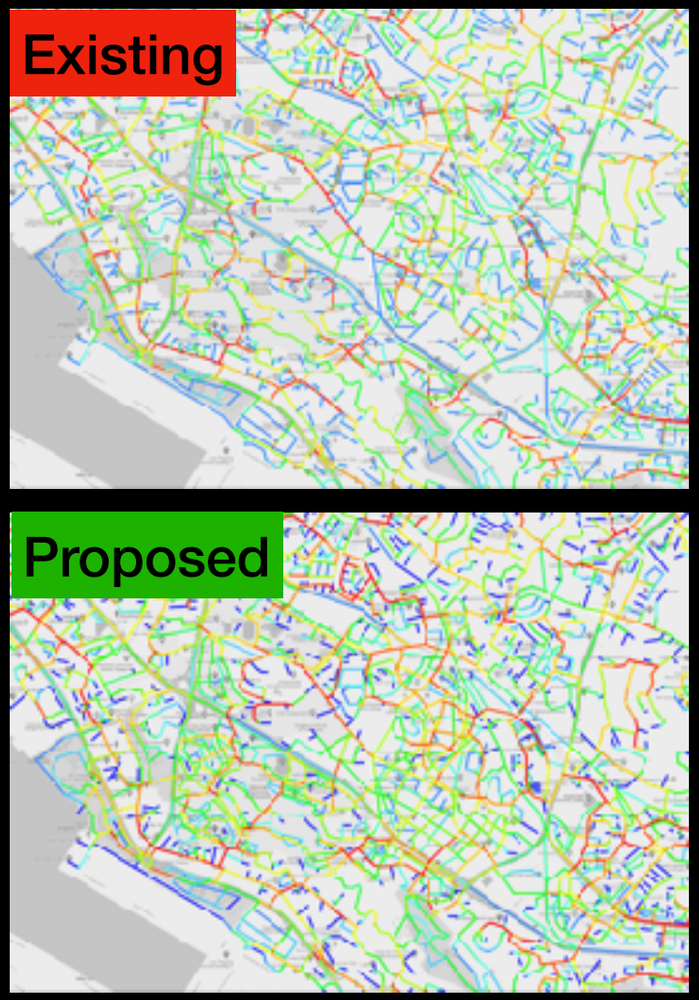
- Avoid guesswork between various stakeholders and govt agencies

- These ideas can be tested through the model, to examine its effectiveness



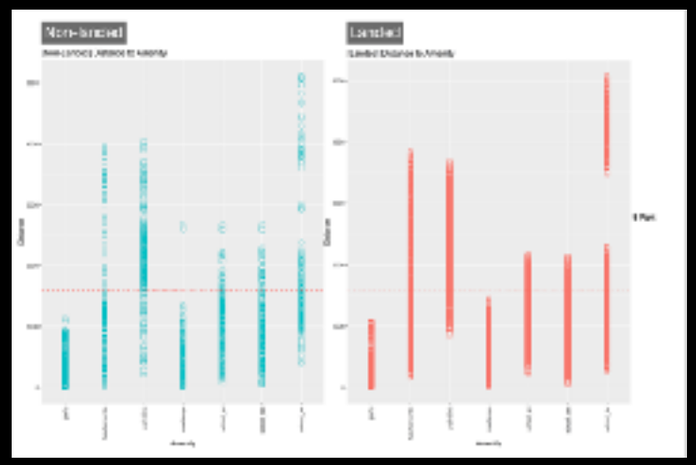
case 01

impact assessment (one-north)



case 02

20-min city (east coast grc)



case 03

east coast park accessibility

case 01

impact assessment

street connectivity btw plots of land by various stakeholders

- **mapping out new masterplan proposals**

- **calculating percentage increase / decrease in accessibility**

Measures accessibility of existing and proposed masterplans

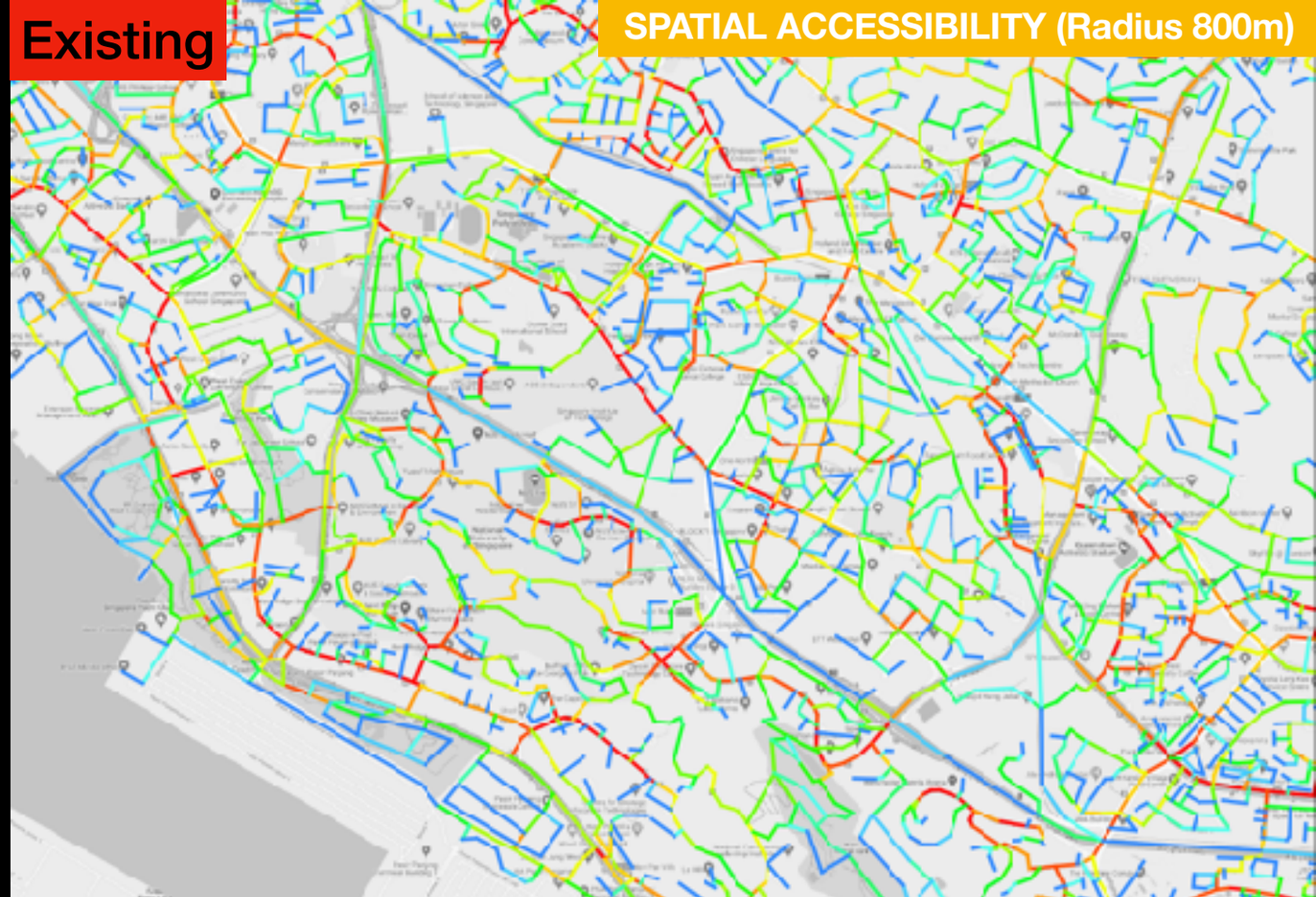
What it can do for SID:

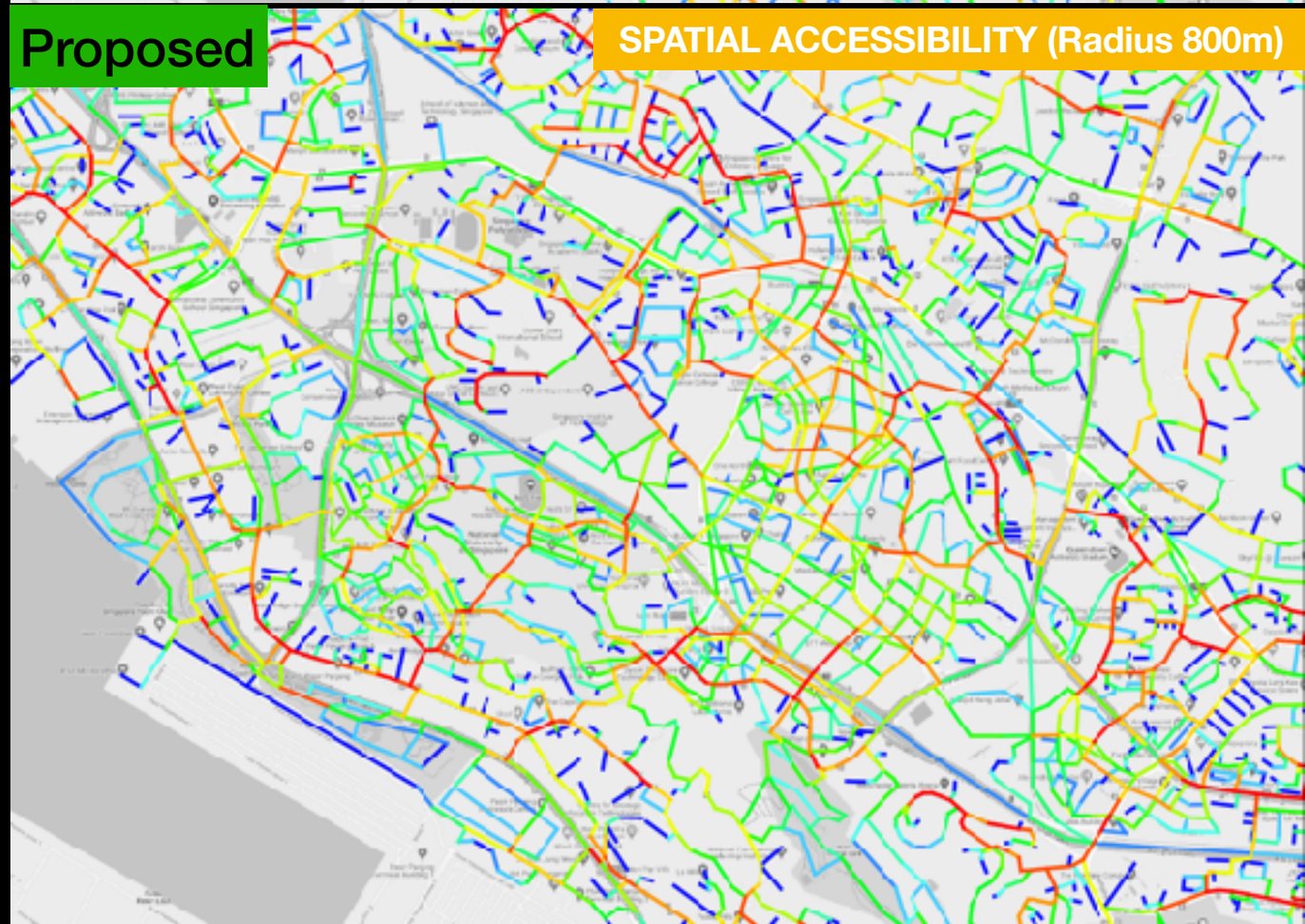
A. Analysing connections *between* the various plots of land

B. Analysing connections within the various plots of land

Methodology:

1. Process and evaluate existing street network model, calculate global, local & multi-scale accessibility
2. Geo-reference masterplans. Digitise proposed network to stitch it into the street network model.
3. Run analysis on the proposed network. Evaluate the differences in accessibility between existing and proposed.
4. Identify missed opportunities in connections, or better placement of connects. Run tests.





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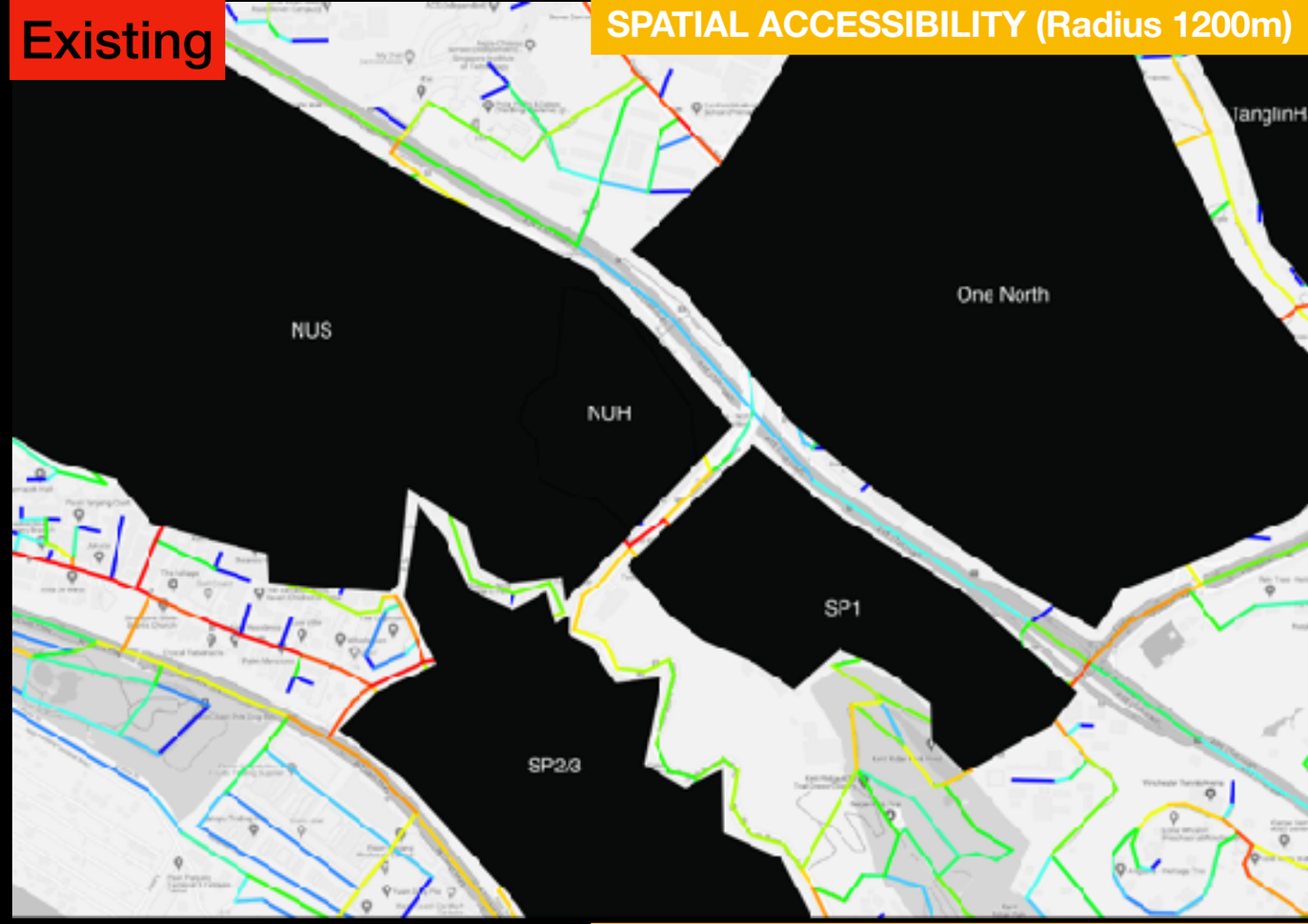

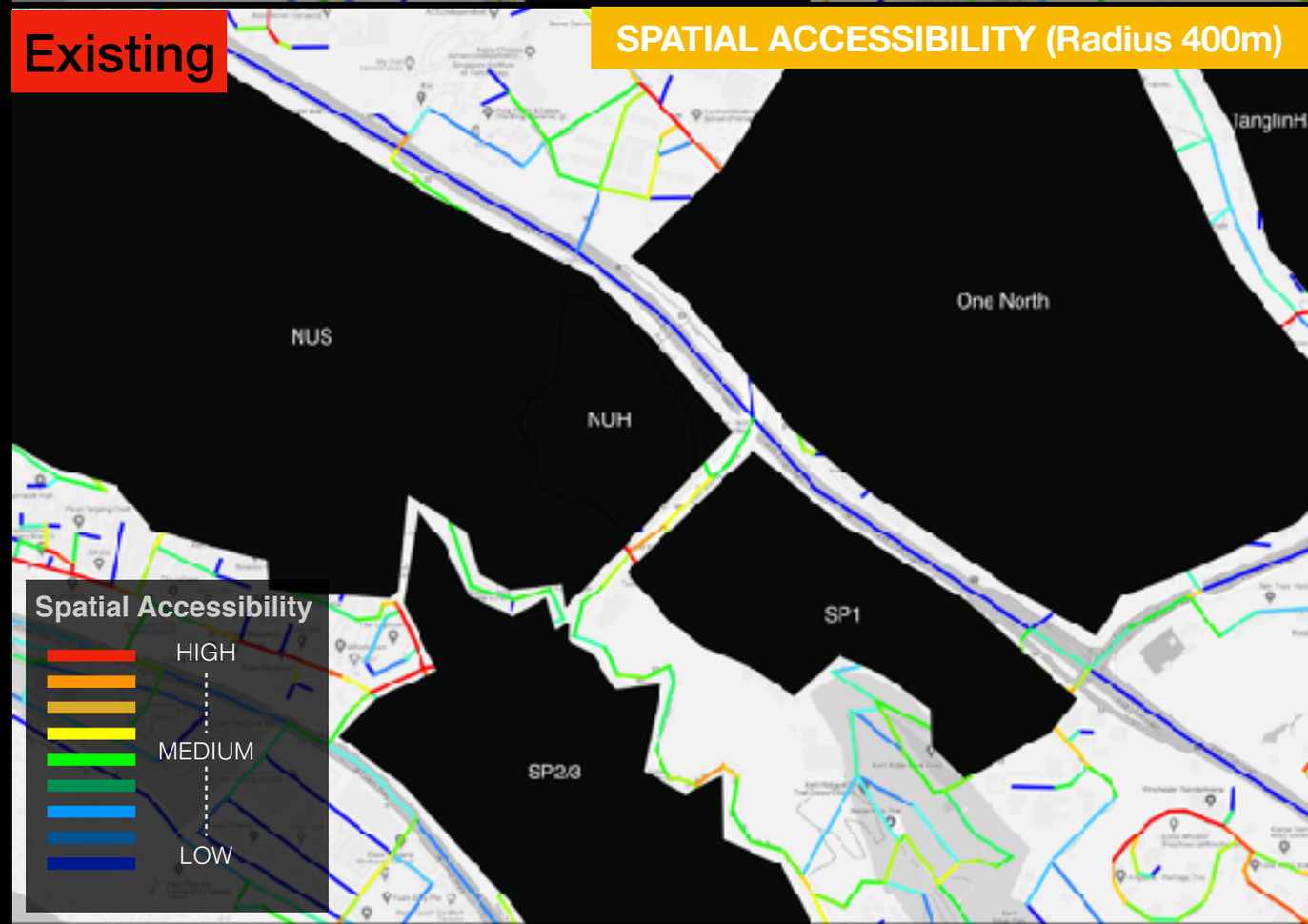

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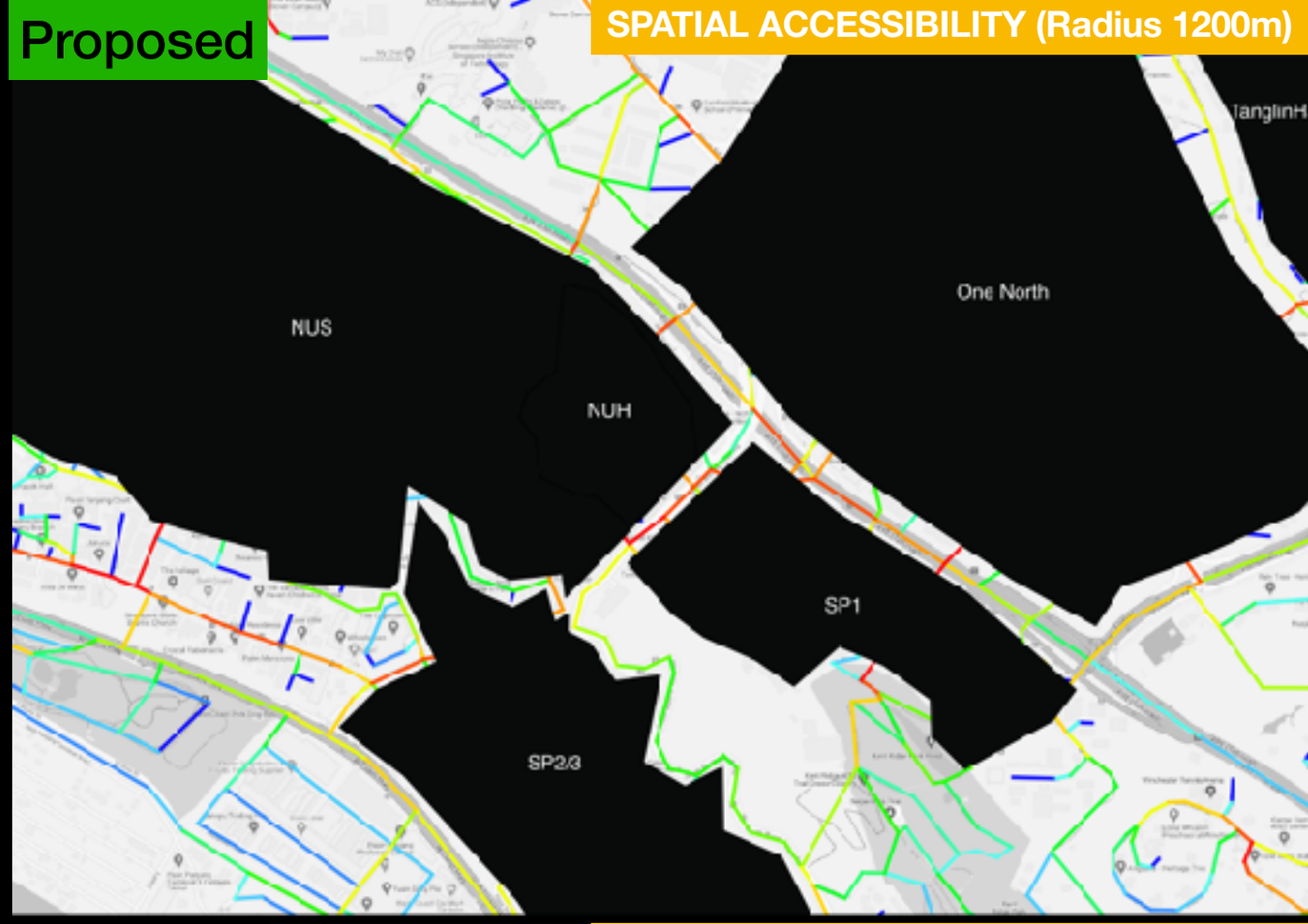
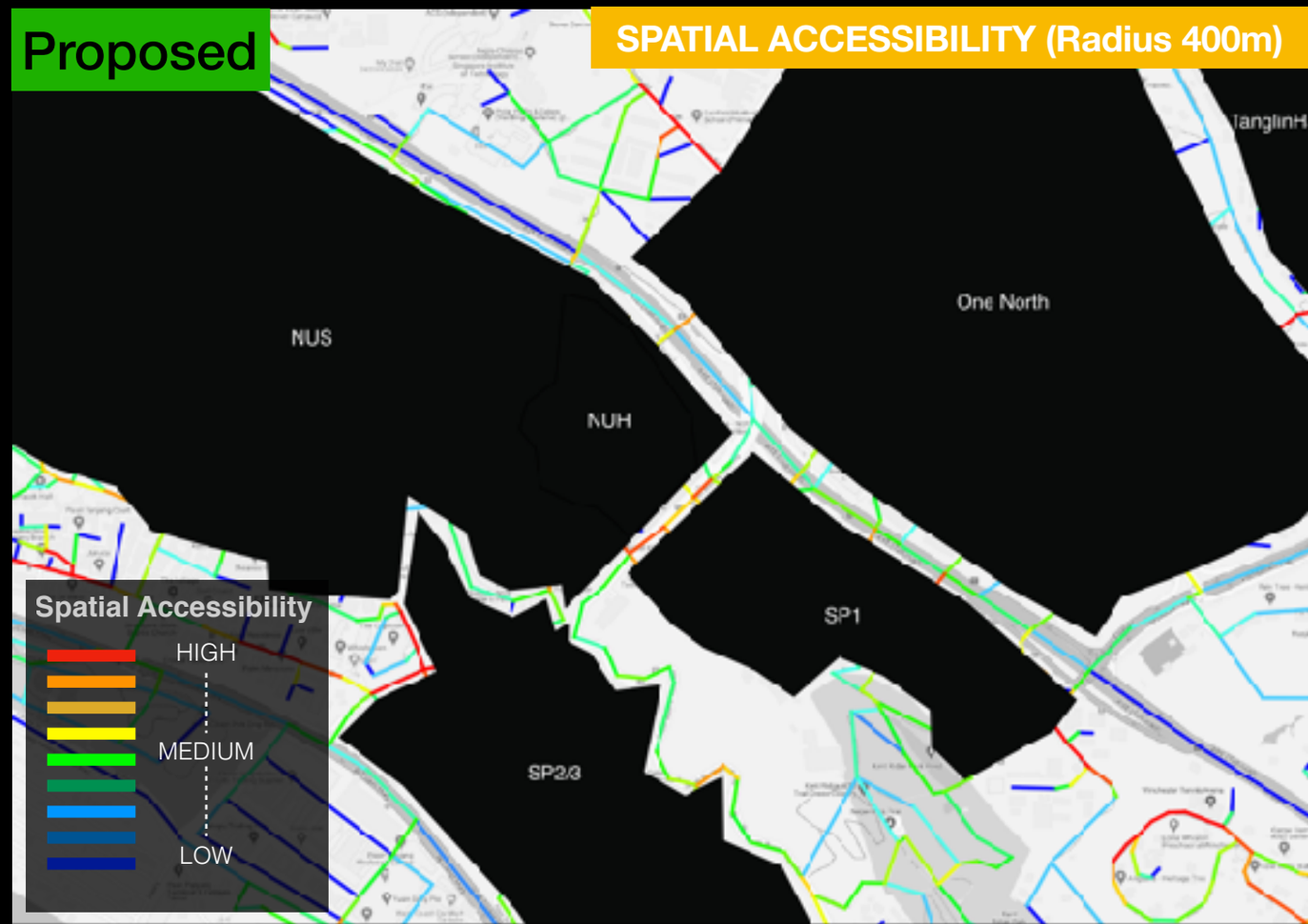




case 02

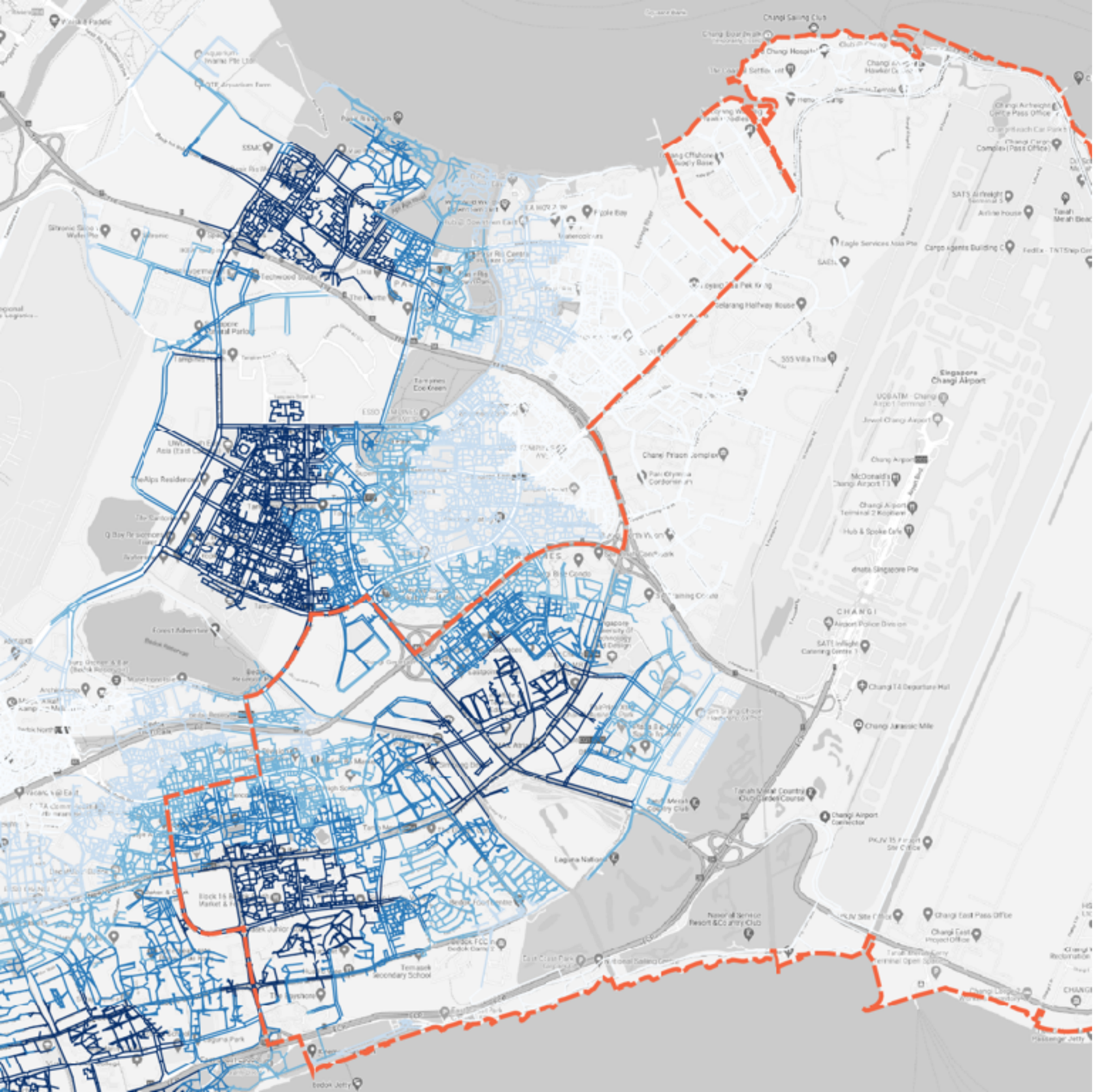
accessibility studies

homes to various amenities

20 minute city - East Coast GRC

baseline data sources for POI:

schools (primary, secondary, tertiary) - OSM & cleaned
polyclinics - OSM & cleaned
hawker centres - data.gov.sg
parks - URA landuse masterplan
retail shops - OSM & cleaned



schools tertiary

0-1600m (20 min walk)

baseline data sources for POI:

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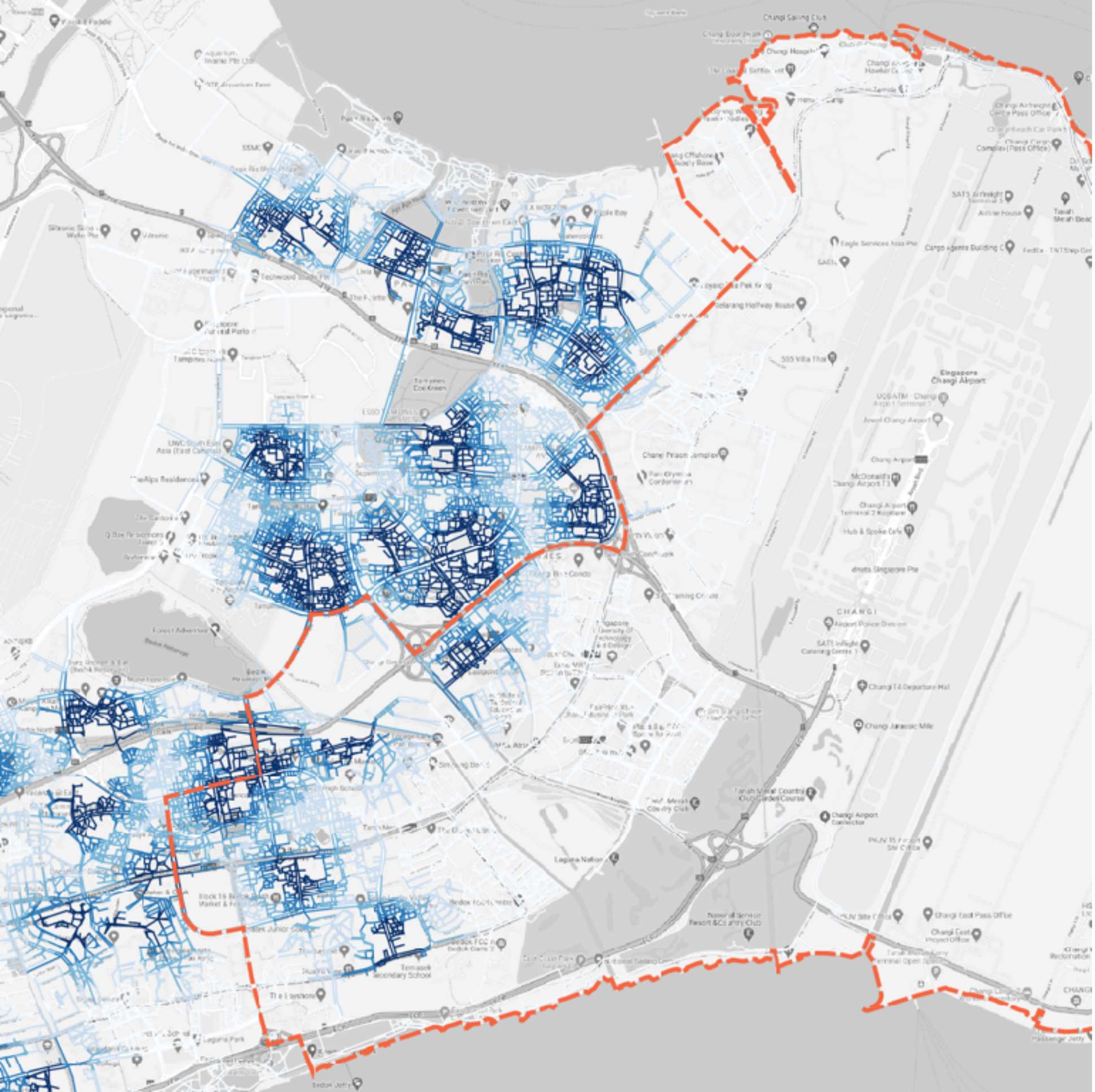
polyclinics - OSM & cleaned
hawker centres - data.gov.sg
parks - URA landuse masterplan
retail shops - OSM & cleaned



schools primary

0-1600m (20 min walk)

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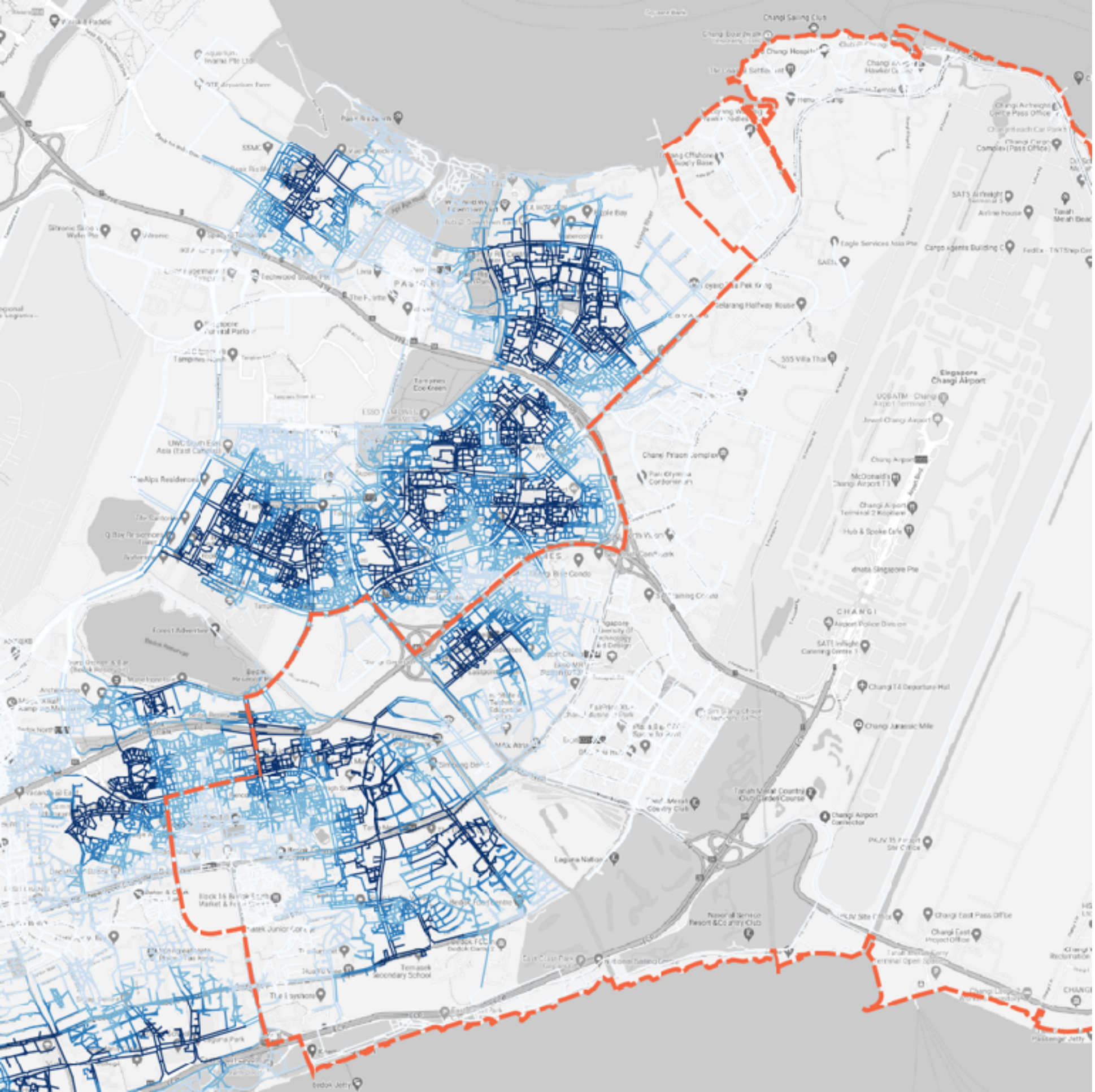
retail shops - OSM & cleaned



schools secondary

0-1600m (20 min walk)

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retail shops - OSM & cleaned

retail shops

0-1600m (20 min walk)

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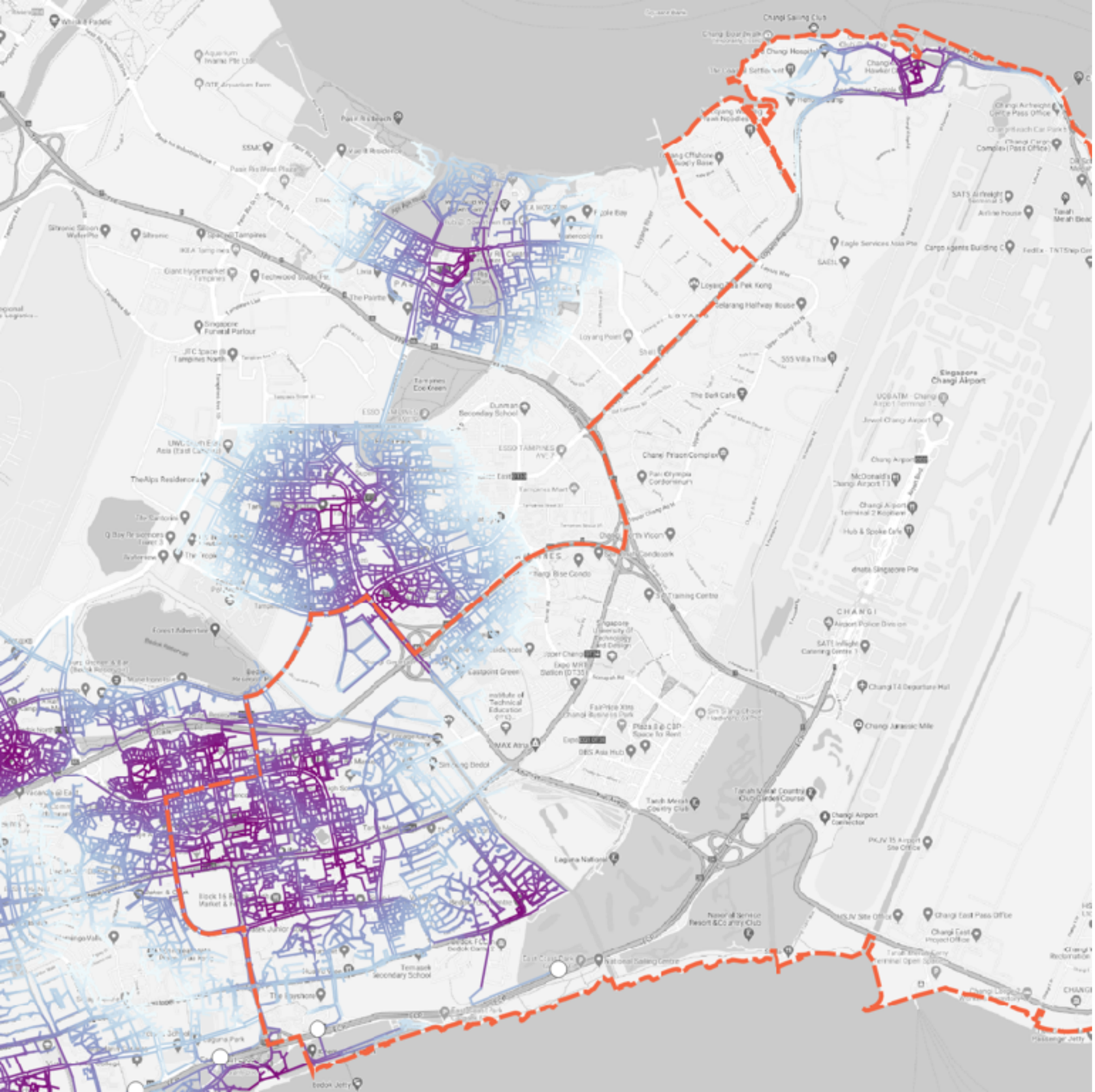

hawker centres

0-1600m (20 min walk)

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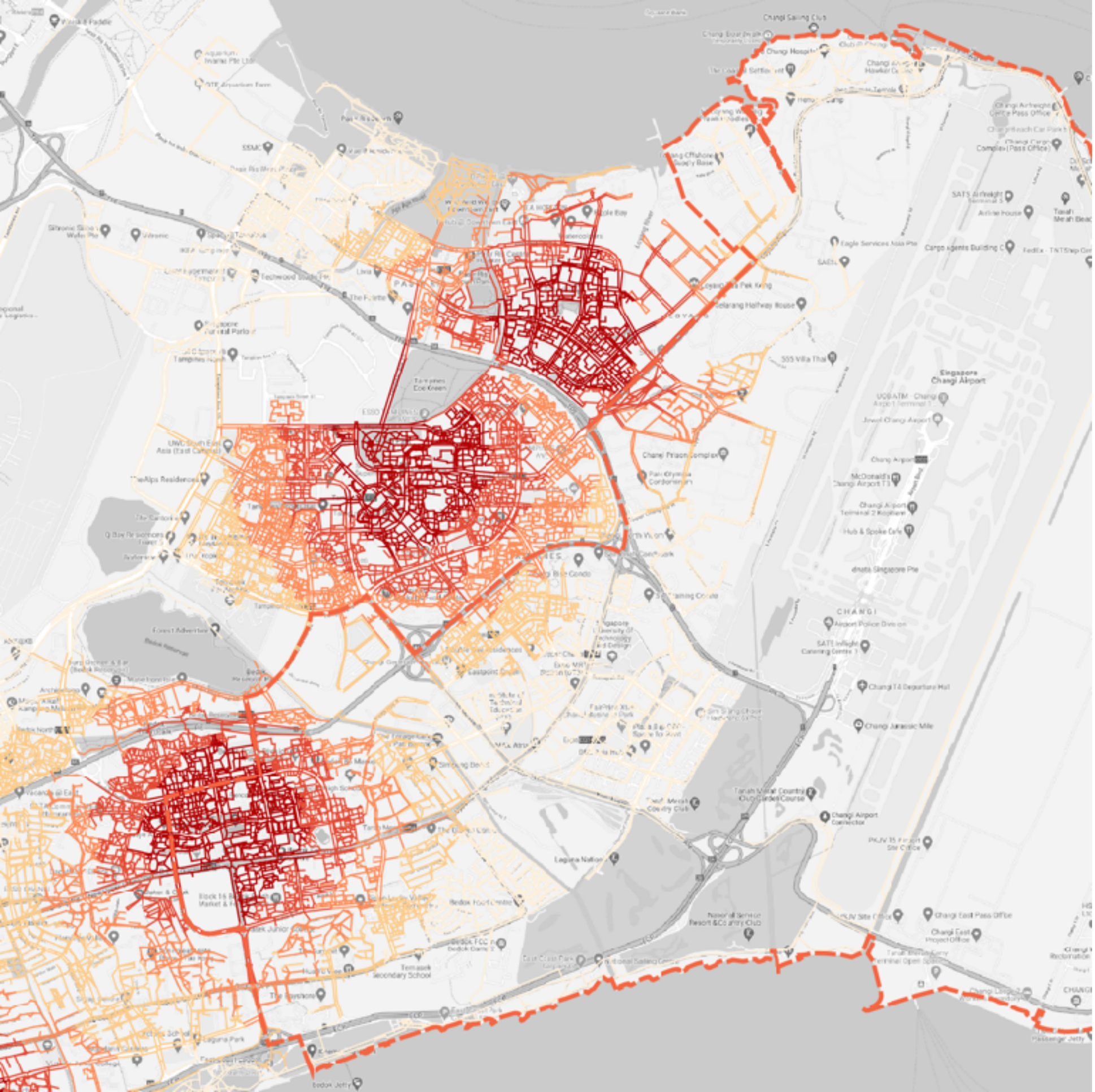

polyclinics

0-1600m (20 min walk)

baseline data sources for POI:

schools (primary, secondary, tertiary) - OSM & cleaned
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retail shops - OSM & cleaned

parks

0-1600m (20 min walk)

baseline data sources for POI:

schools (primary, secondary, tertiary) - OSM & cleaned
polyclinics - OSM & cleaned
hawker centres - data.gov.sg
parks - URA landuse masterplan
retail shops - OSM & cleaned

residential plots

east coast grc

Street network **catchment** from all residential plots to the ***nearest*** amenity (by type)

baseline data sources for POI:

schools (primary, secondary, tertiary) - OSM & cleaned
polyclinics - OSM & cleaned
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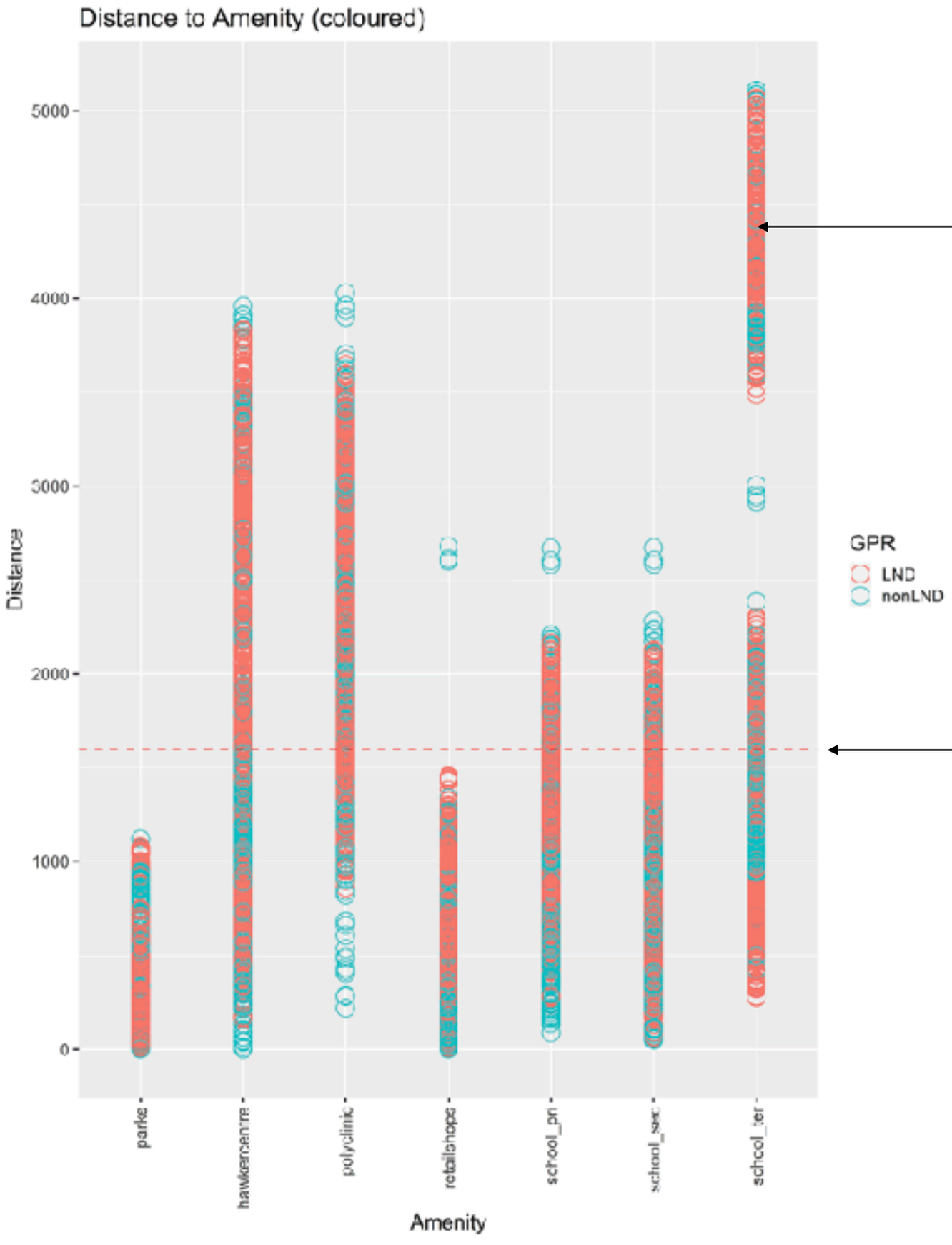
minimum distance from home to amenity

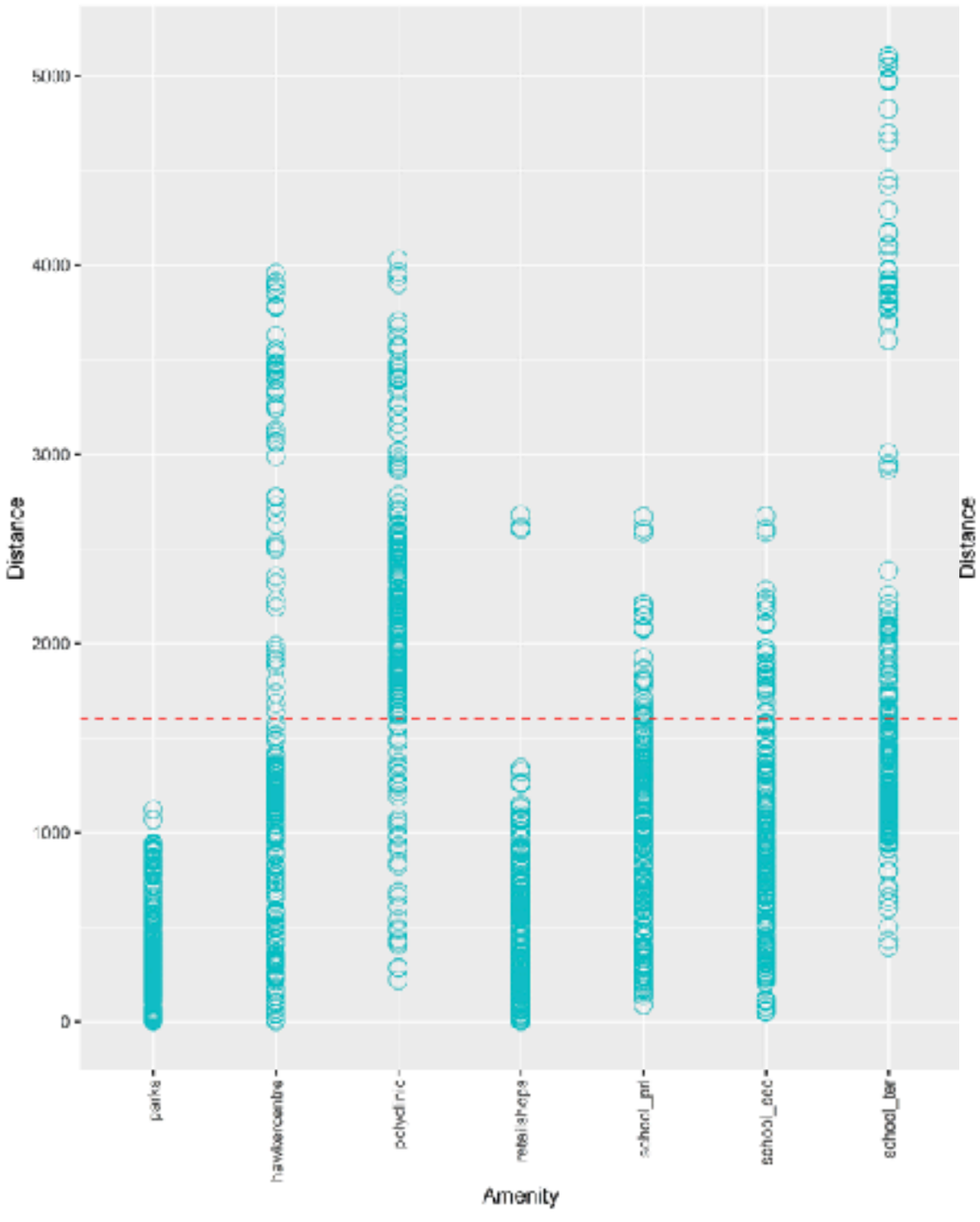


Each point represents a residential plot. Minimum distance away to the closest amenity.

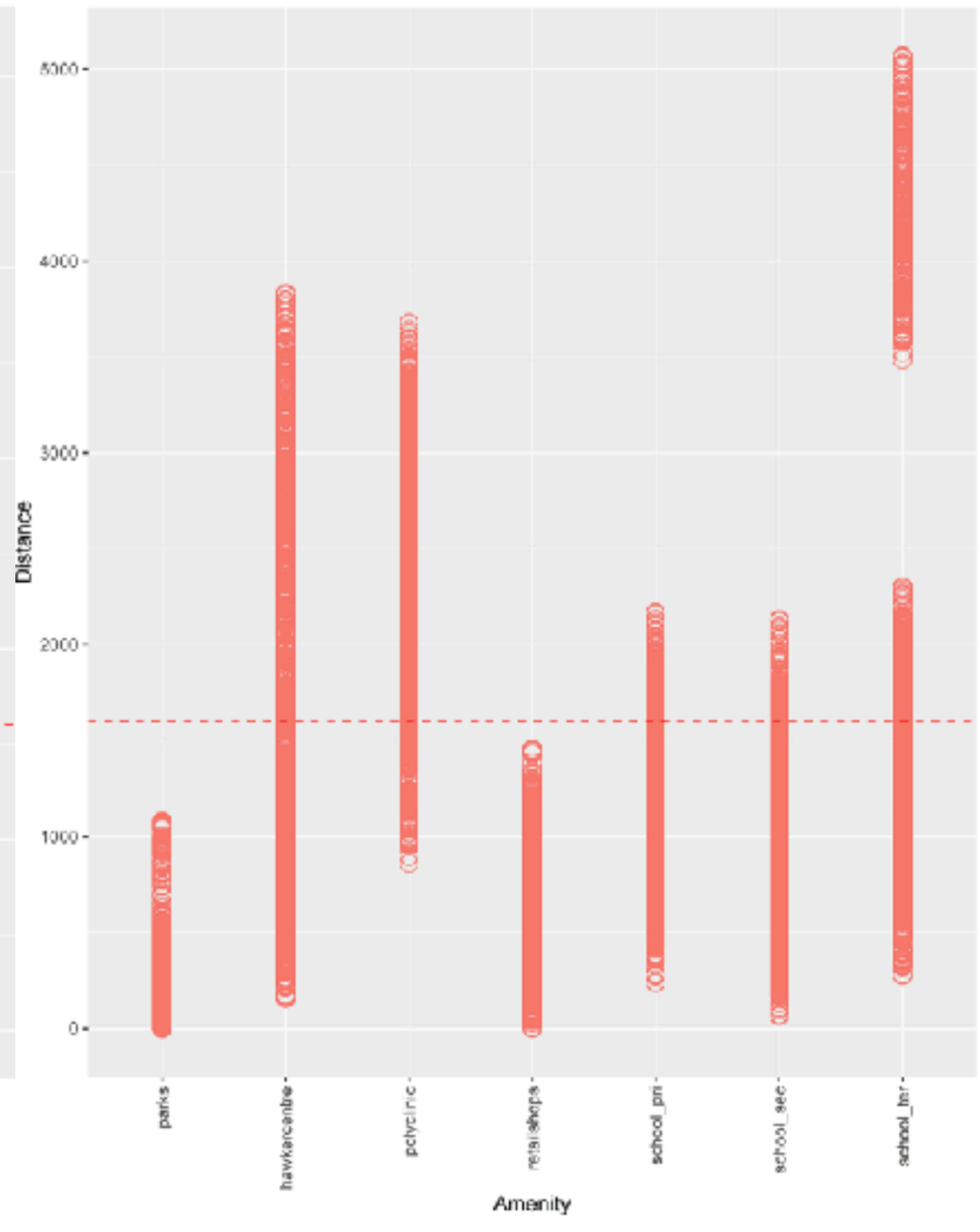
1600m (20 min walk)

minimum distance from home to amenity

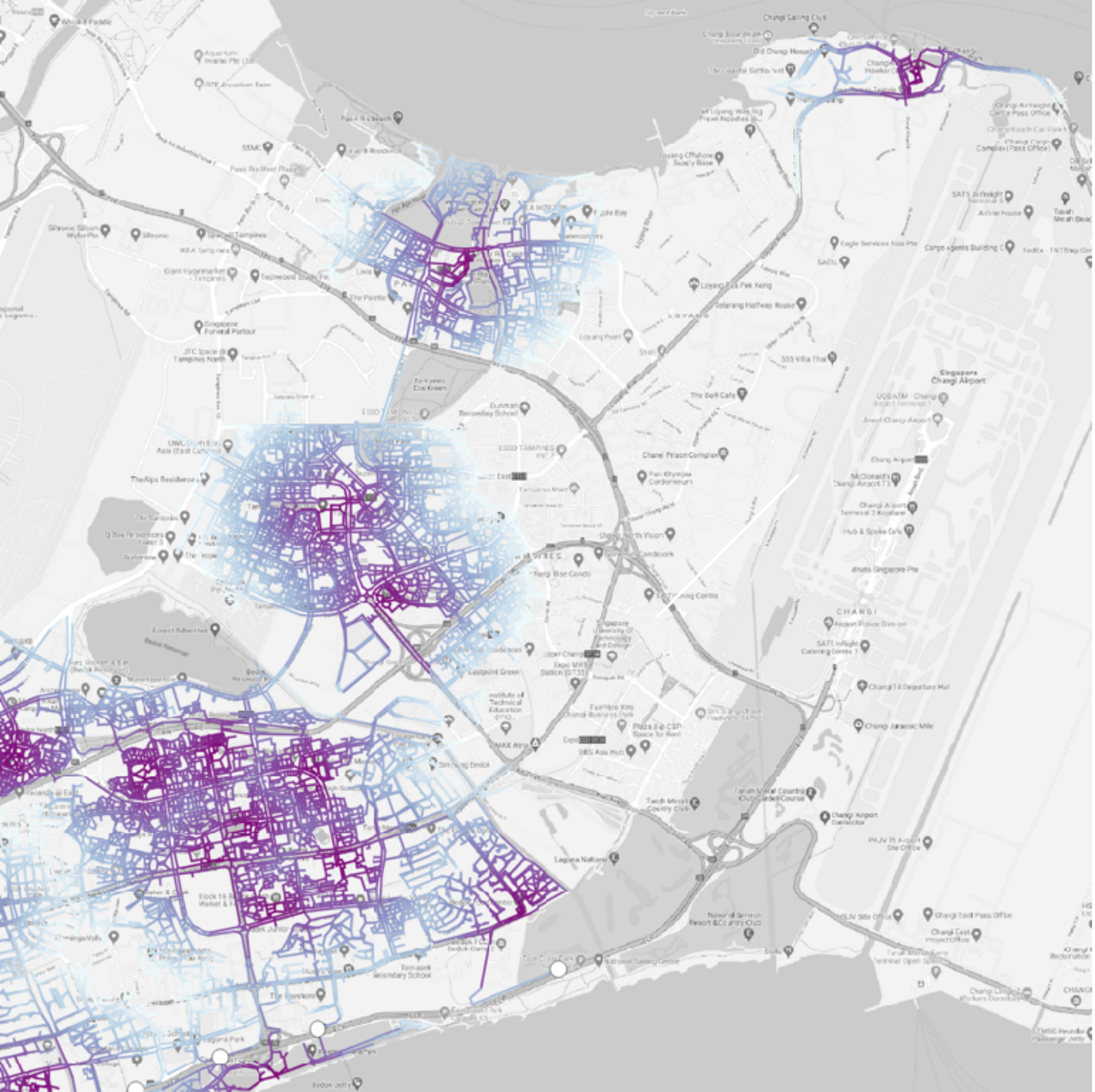
Non-landed



Landed



[note] landed v non-landed could be an indicator for socio-economic background, as well as reliances on car as a main form of commute



hawker centres

0-1600m (20 min walk)

hawker centre street catchment

baseline data sources for POI:

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hawker centres

0-1600m (20 min walk)

hawker centre street catchment

URA SDCP Cycling Path 2019

baseline data sources for POI:

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retail shops - OSM & cleaned

hawker centres

0-1600m (20 min walk)

hawker centre street catchment

URA SDCP Cycling Path 2019

space syntax recommended cycling routes

(High Choice Accessibility values for 1200, 2000, 3000m radius)

baseline data sources for POI:

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parks - URA landuse masterplan
retail shops - OSM & cleaned

hawker centres

0-1600m (20 min walk)

hawker centre street catchment

URA SDCP Cycling Path 2019

space syntax recommended cycling routes

residential plots within East Coast GRC

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polyclinics - OSM & cleaned
hawker centres - data.gov.sg
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retail shops - OSM & cleaned

providing analytical training to URA urban designers & architects

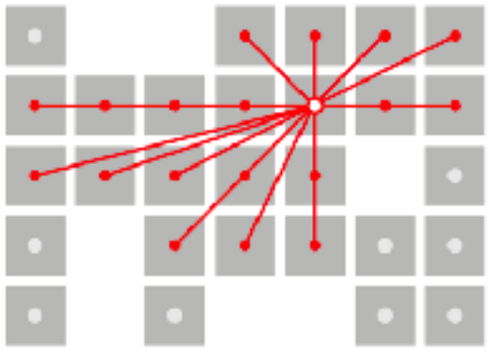
(Analytical Immersion Program)

analysing public spaces in Singapore

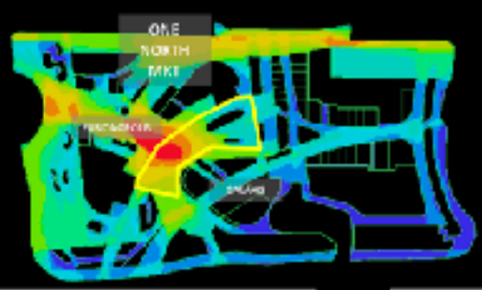
Connectivity & Visibility

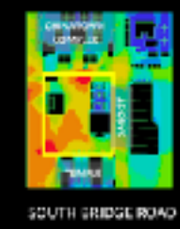
Visibility Graph Analysis investigates the properties of a visibility graph derived from a spatial environment.

1. **Knee level (connectivity)** – how people can move
2. **Eye level (visibility)** - where people can see



VGA: Connectivity





Paya Lebar Quarter (PLQ)	
Site area studied	19,700 sqm
Public space area (nominal)	3,500 sqm
Public space %	17.8%
High Connectivity	7%
Med Connectivity	55%
Low Connectivity	38%

Fusionopolis	
Site area studied	28,200 sqm
Public space area (nominal)	1,400 sqm
Public space %	5%
High Connectivity	18%
Med Connectivity	50%
Low Connectivity	32%

Kreta Ayer Square	
Site area studied	9,200 sqm
Public space area (nominal)	1,730 sqm
Public space %	18.8%
High Connectivity	29%
Med Connectivity	68%
Low Connectivity	14%

Observations:

1. Structure - PLQ and Fusionopolis public spaces have more focused points of entry, compared to the more porous Kreta Ayer Square.
2. Connectivity proportions – Kreta Ayer Square has the best proportion of connectivity, with few physical barriers in the way. Fusionopolis functions as a connecting space, while PLQ plaza is both a connector and destination in itself.

Research Question & Framework

OVERARCHING QUESTION

To what extent is a public space successful in engaging human activity?

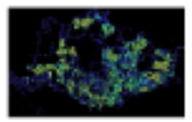
- What are the key qualities that enable the success of a public space?
- What are the factors that will strengthen or diminish these qualities?

MACRO

To what extent is a public space accessible within the neighbourhood?

QUANTITY
Catchment Analysis
ArcGIS Pro

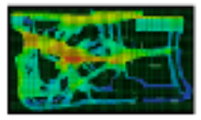
QUALITY
Network Analysis
SpaceSyntax



MICRO

To what extent are the amenities within a public space well/intuitively located?

VISIBILITY
Visibility Graph Analysis
SpaceSyntax



ACCESSIBILITY
Amenities & Furniture
Empirical Studies

THERMAL COMFORT
Shade Analysis
Shadow Study + Thermal Analysis

Conclusions & Insights

To what extent is a public space successful in engaging human activity?

Our studies help to pinpoint which particular criteria affects both the connectivity and comfort of a public space