Estimating Human Mobility

Computing Commute Graph Across Aotearoa

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Overview

- Means of travel to work data
- Estimating commute routes
- Traffic-relates use cases
- Generating commute mobility graph
- Properties
- Conclusions

Commute routes and graphs

- Commutes take significant fraction of human life
- Estimate which areas are affected
- Understand traffic (volumes, risk areas, etc.)
- Human mobility - flows at larger scale as graphs

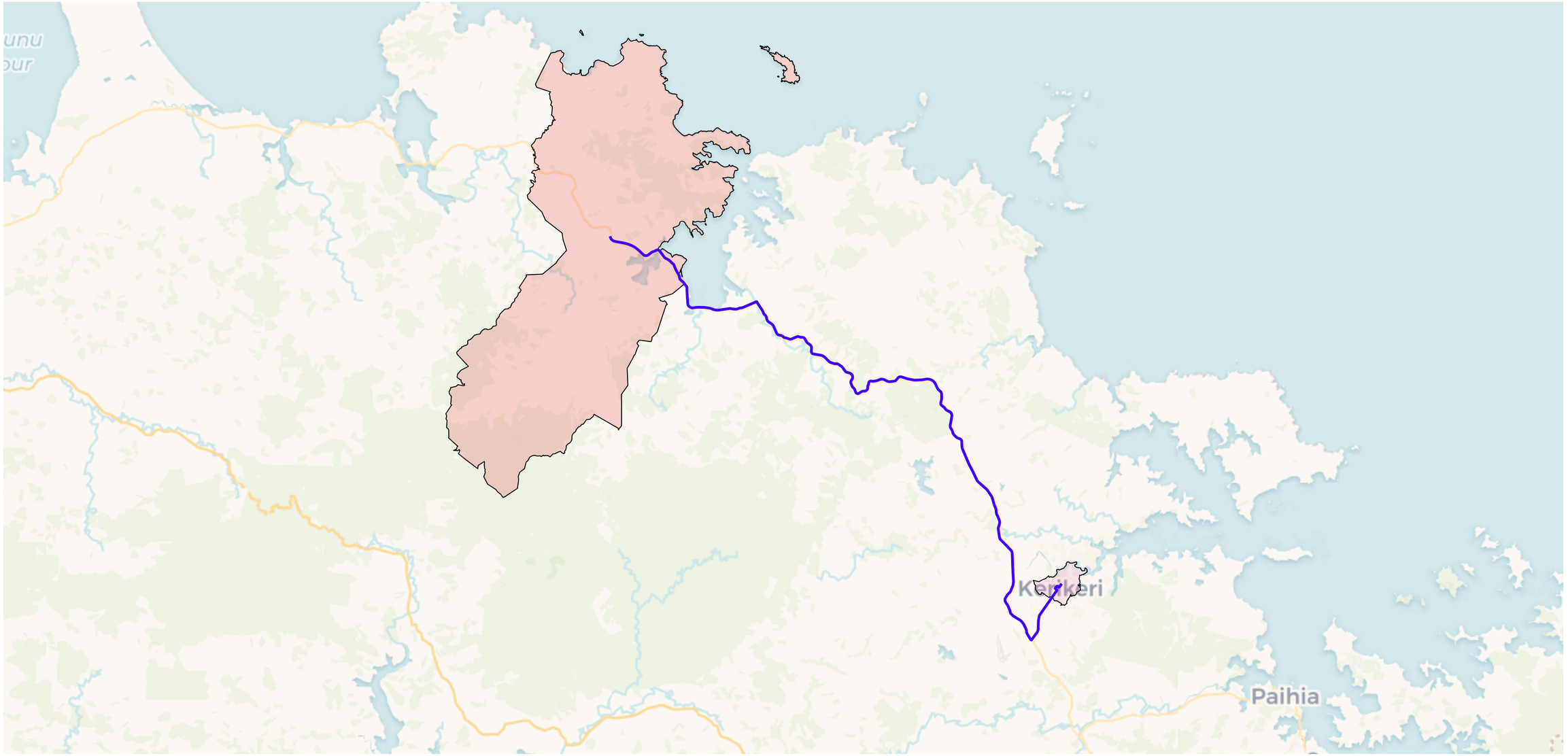
- Idea:
  - Estimate commuting routes
  - Create mobility graph with areas as nodes

Data Source

- 2018 Census Main means of travel to work by Statistical Area 2 (SA2) from StatsNZ
  - Usual residence SA2
  - Workplace SA2
  - Means of transport
    - driver/passenger, bus/train/ferry, cycle/walk
- Aggregated at SA2 level
- Counts for home/work pairs

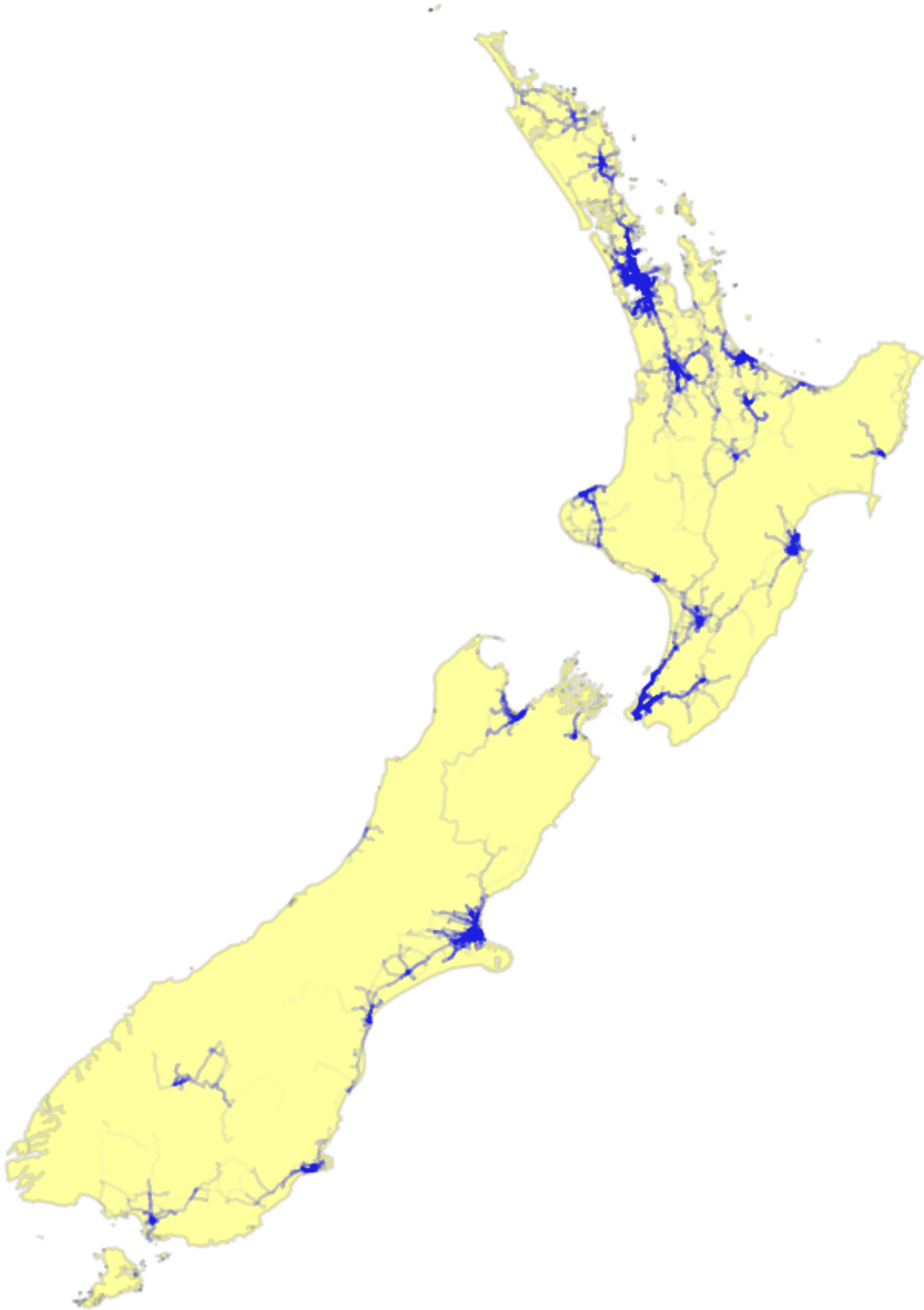
Home - Work pair

Computing commute route

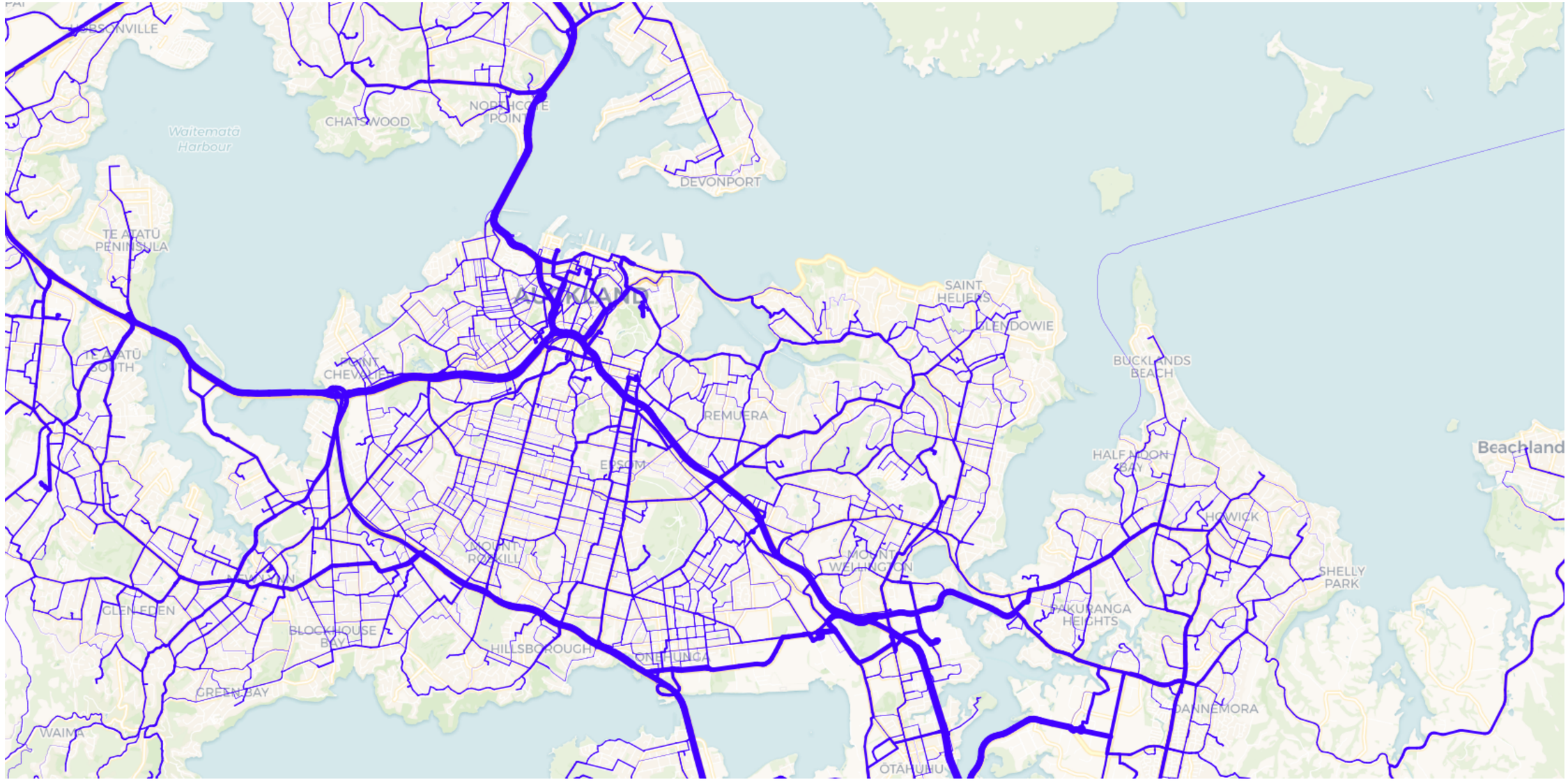


Commutes in Aotearoa

- 48,734 routes nationwide



Estimated Commute Traffic, Auckland Isthmus



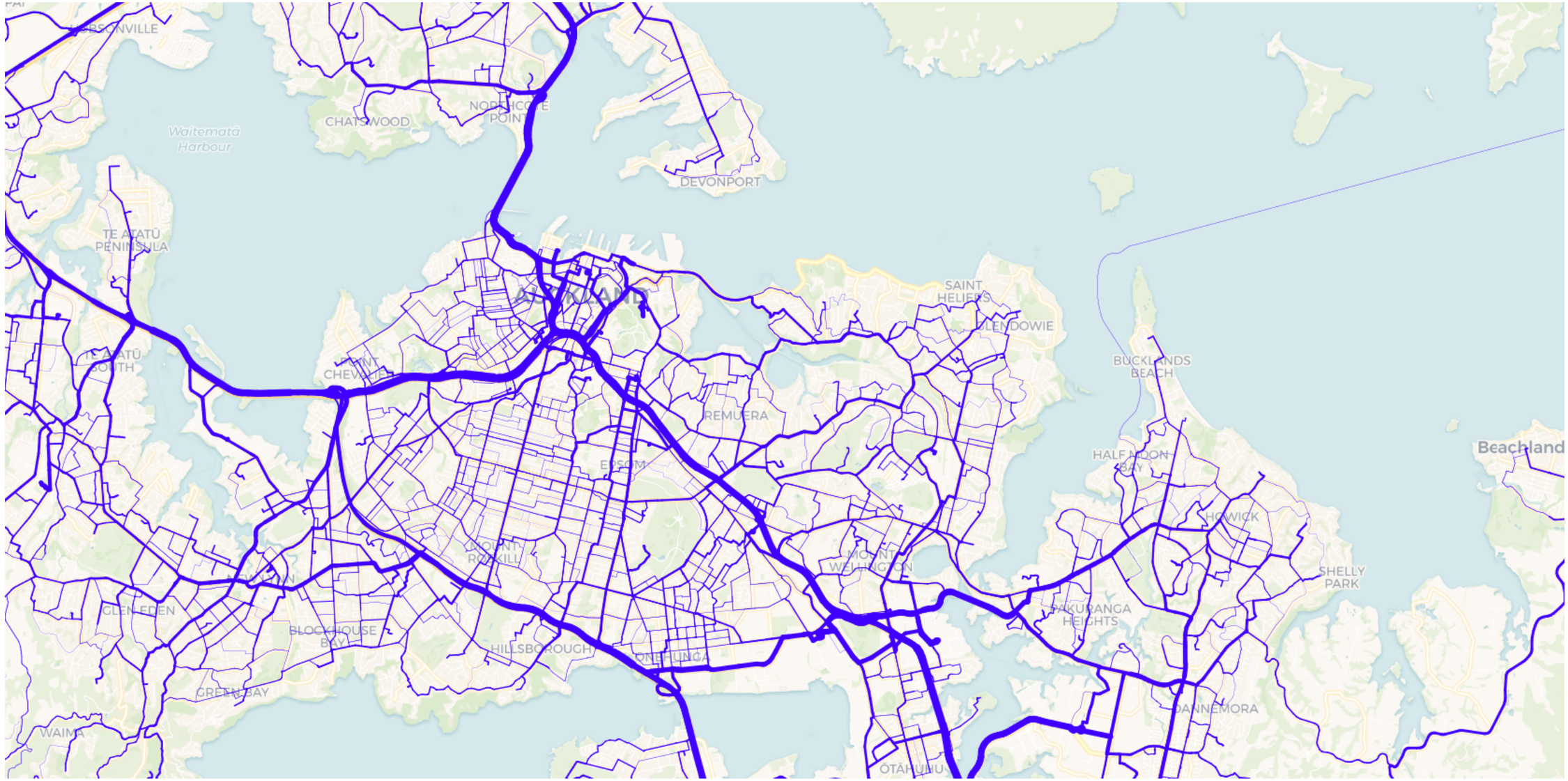
Use-cases

- Commute traffic estimation
- Distribution of commute distances by area

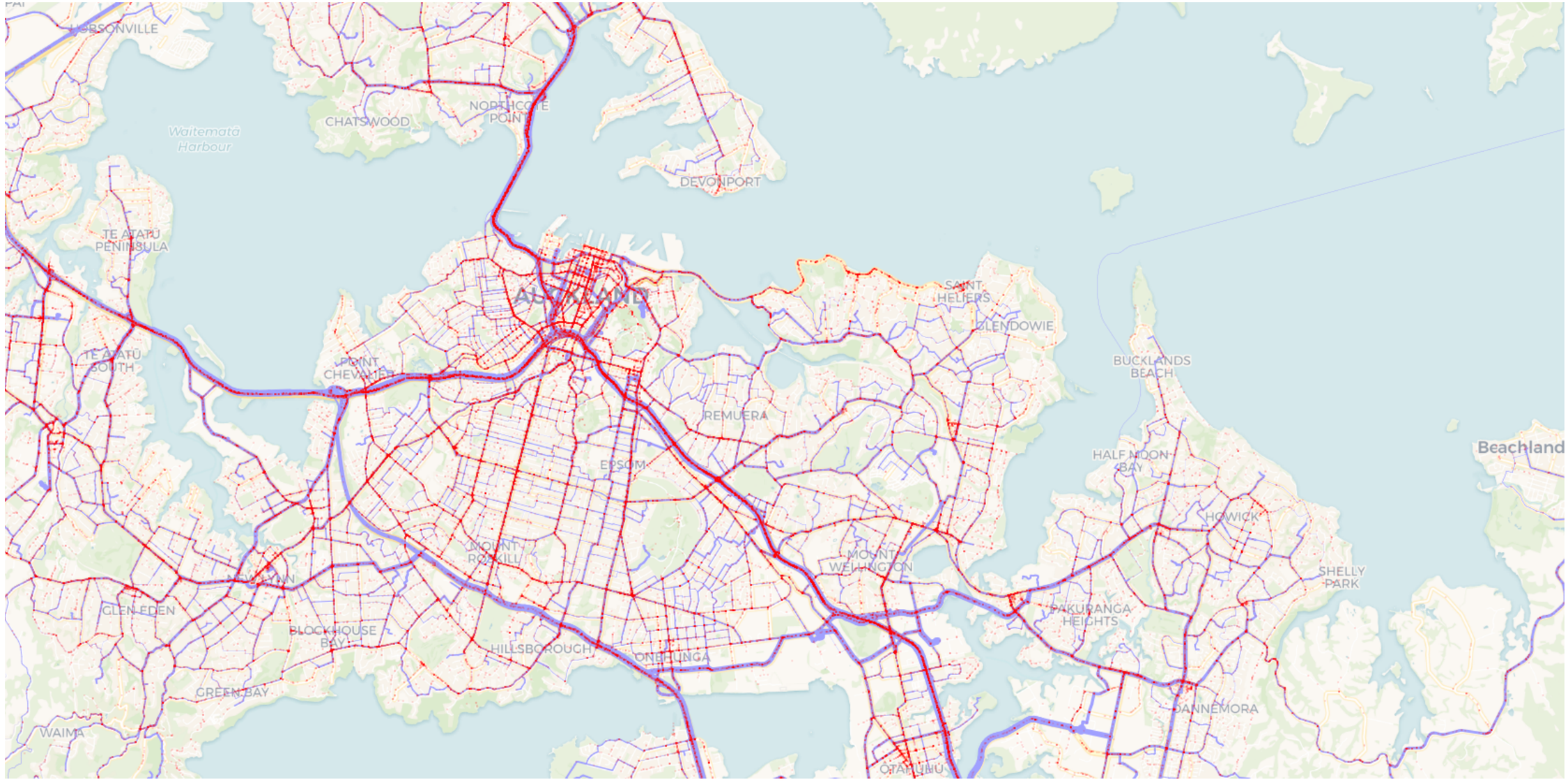
- Caveats
  - Not everyone commutes daily or at the same time
  - Data may be incomplete or outdated
  - Estimated routes may not be correct (traffic avoidance etc.)

- Combine with other location data

Estimated Commute Traffic, Auckland Isthmus



Example: Add Data from Crash Analysis System (CAS)



Example: Crash Risk Assessment

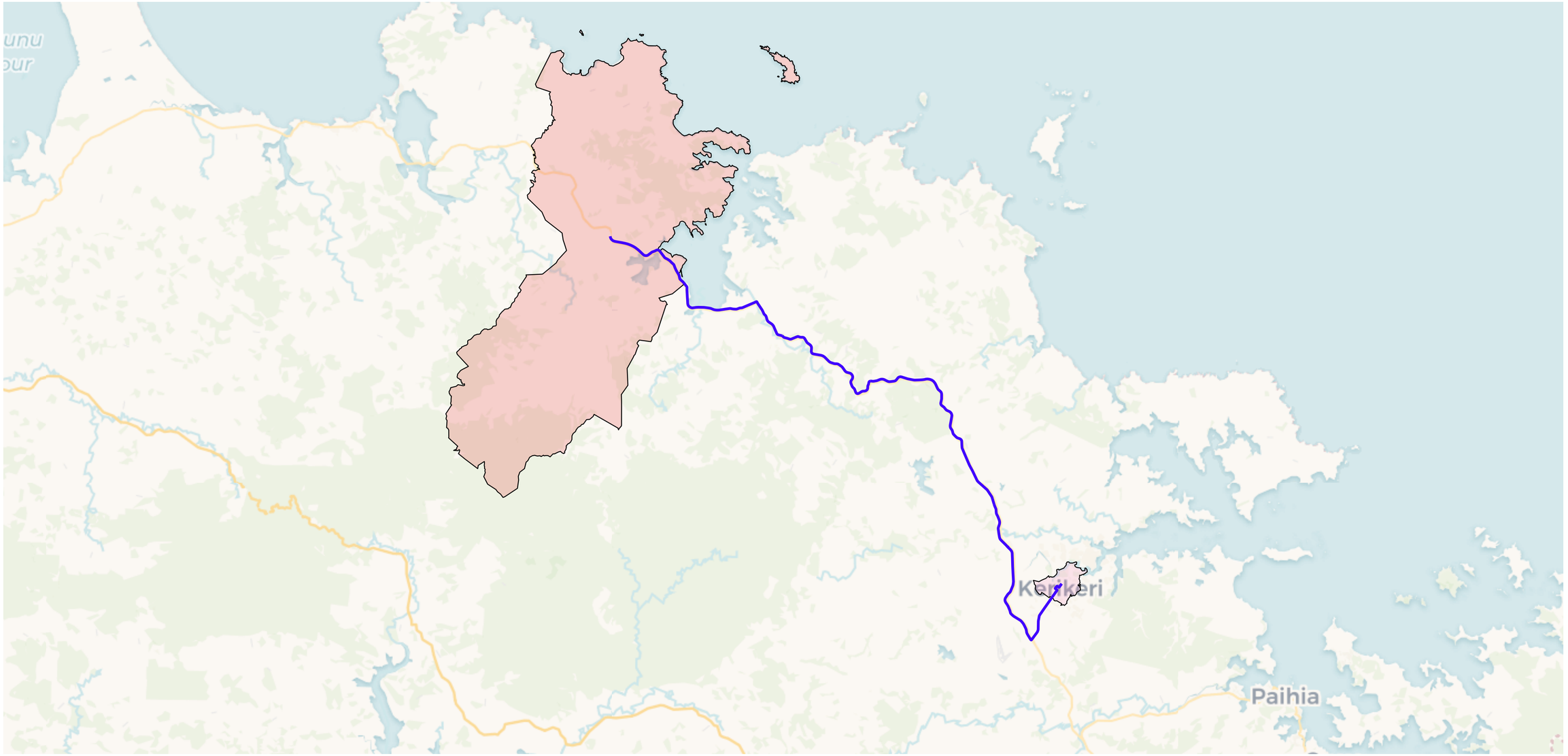
- Tie location of crash to commute routes
- Risk of routes (accidents by cars, distance)
- Aggregate risk by usual residence regions

For more see:
Kathlyn Ycong “*Road Safety Data Analysis*“
In collaboration with Shrividya Ravi (Ministry of Transportation)

Mobility Graph

- Movement of people between areas can be expressed as a **mobility graph**
- Areas are **nodes** and movement between adjacent ares are **flows** (edges)
- Graphs structure expresses transitions, but nodes have spatial meaning
- Aggregation ameliorates uncertainty about exact route taken
- Goal: create nationwide commute graph

From Routes to Graphs



From Routes to Graphs

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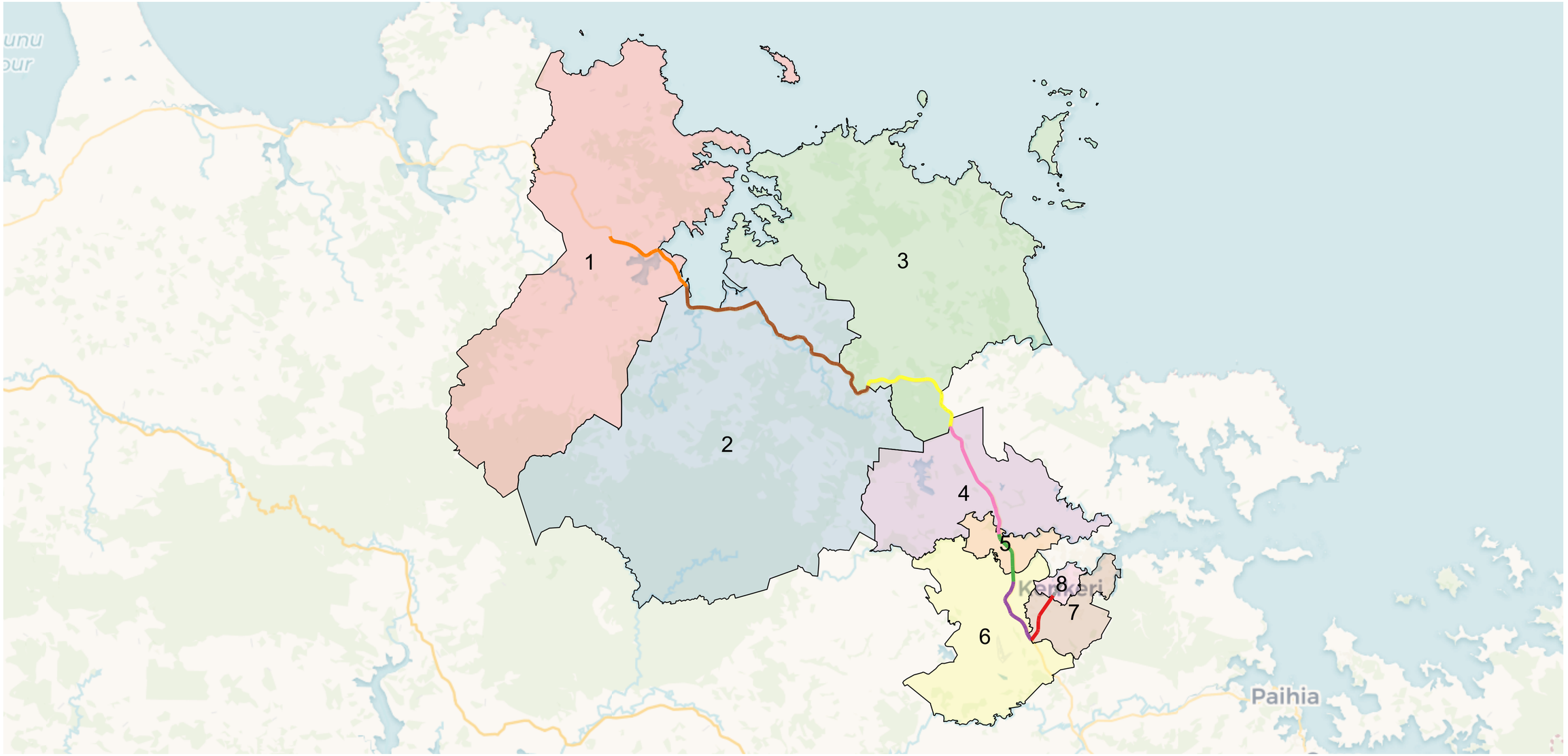
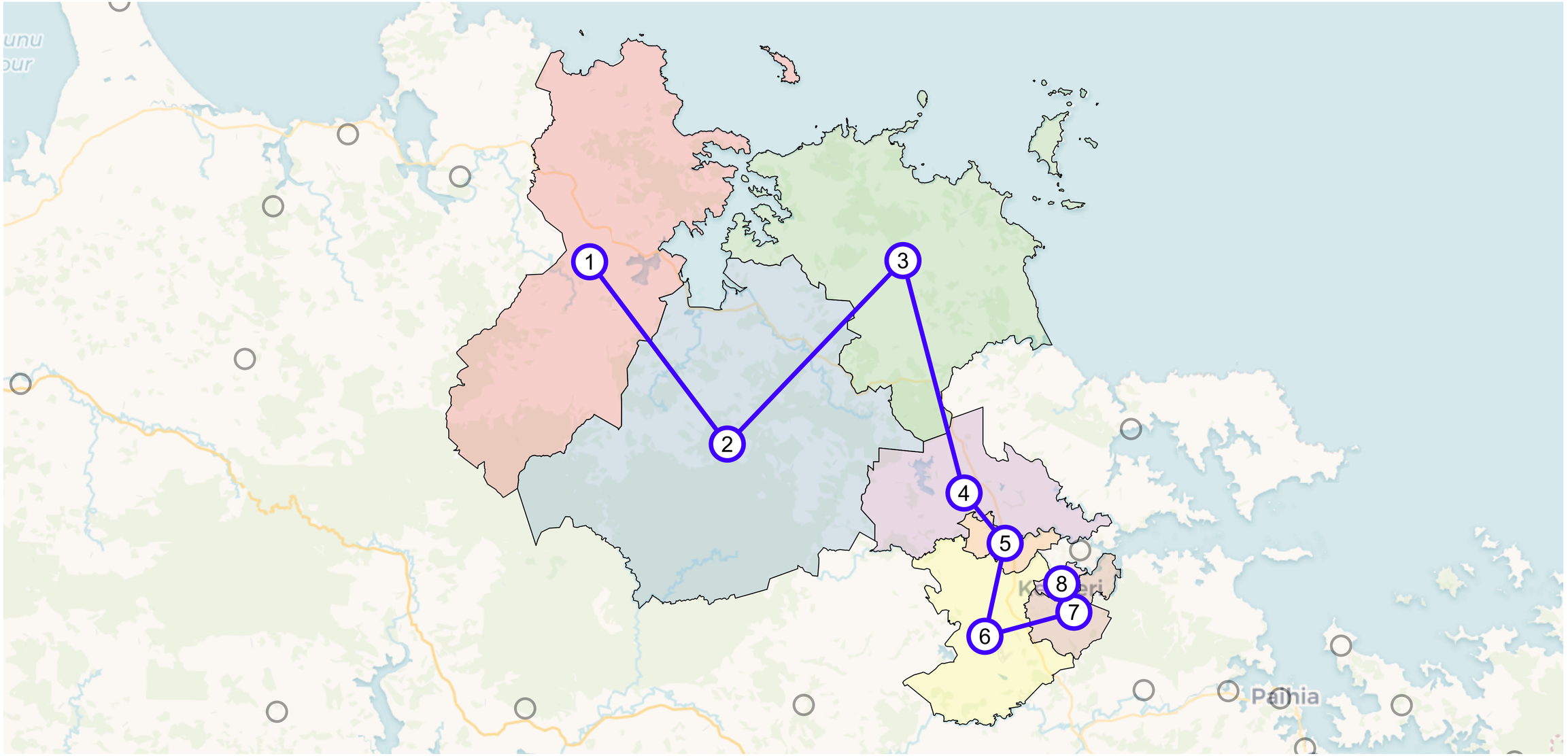
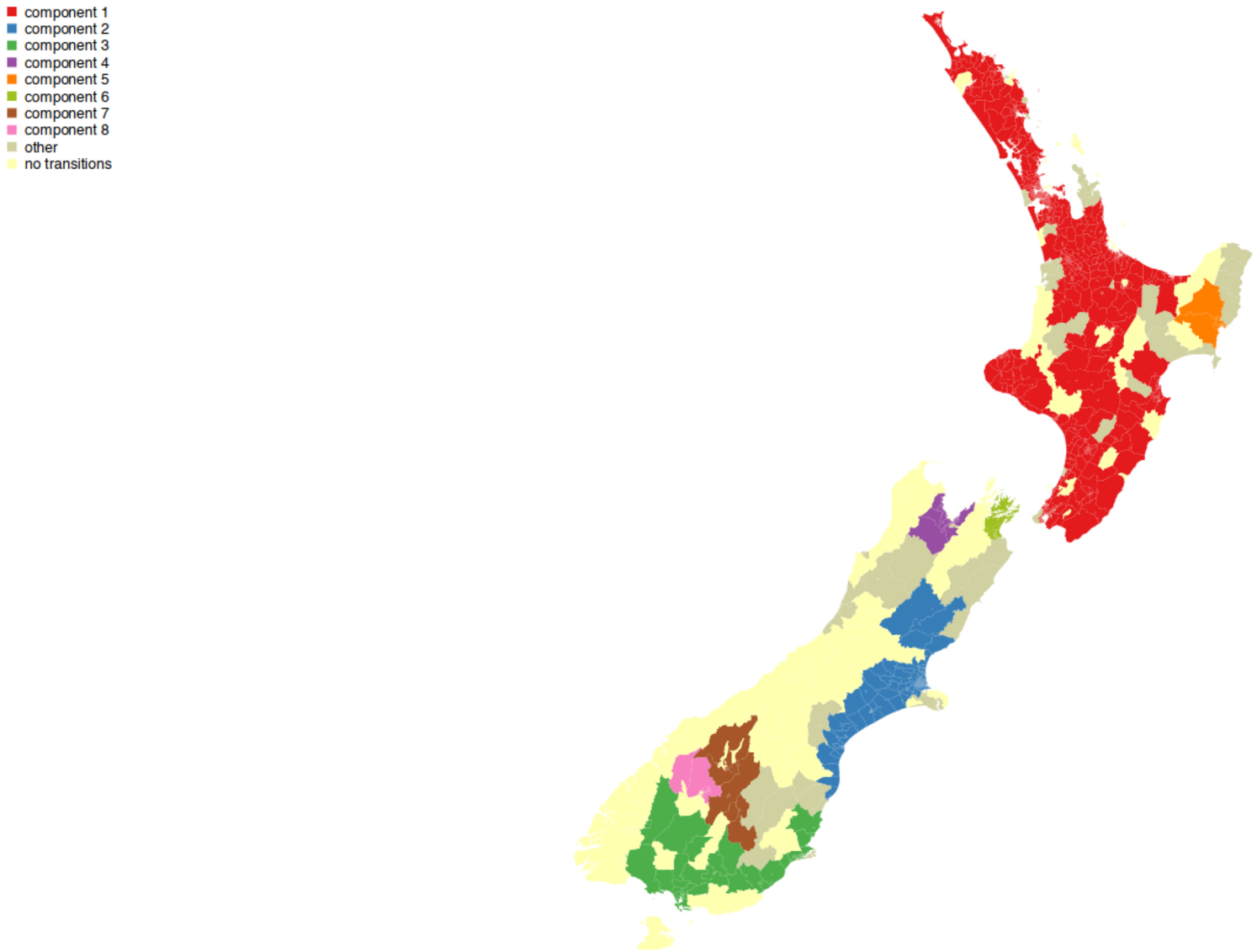


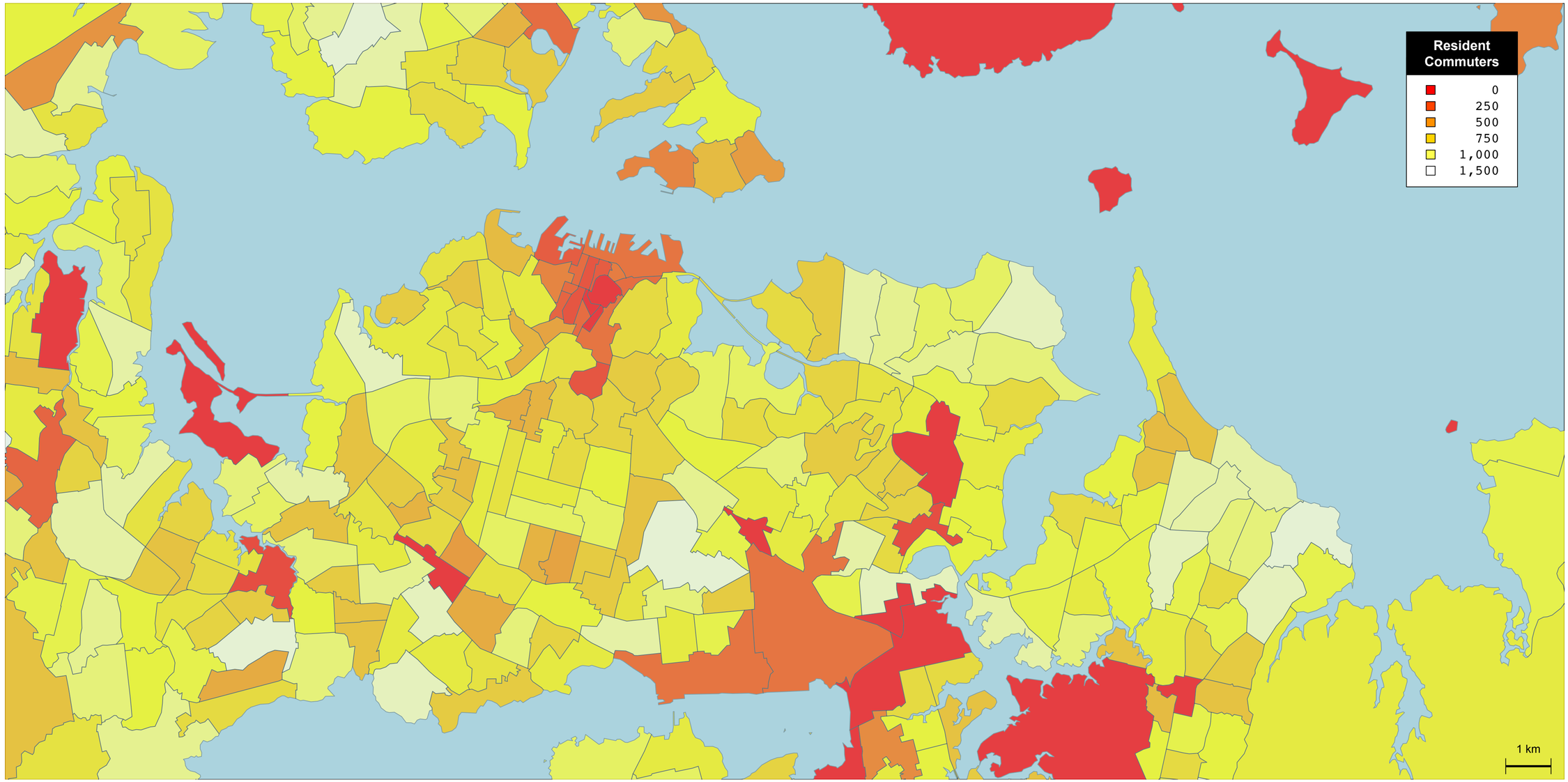
From Routes to Graphs



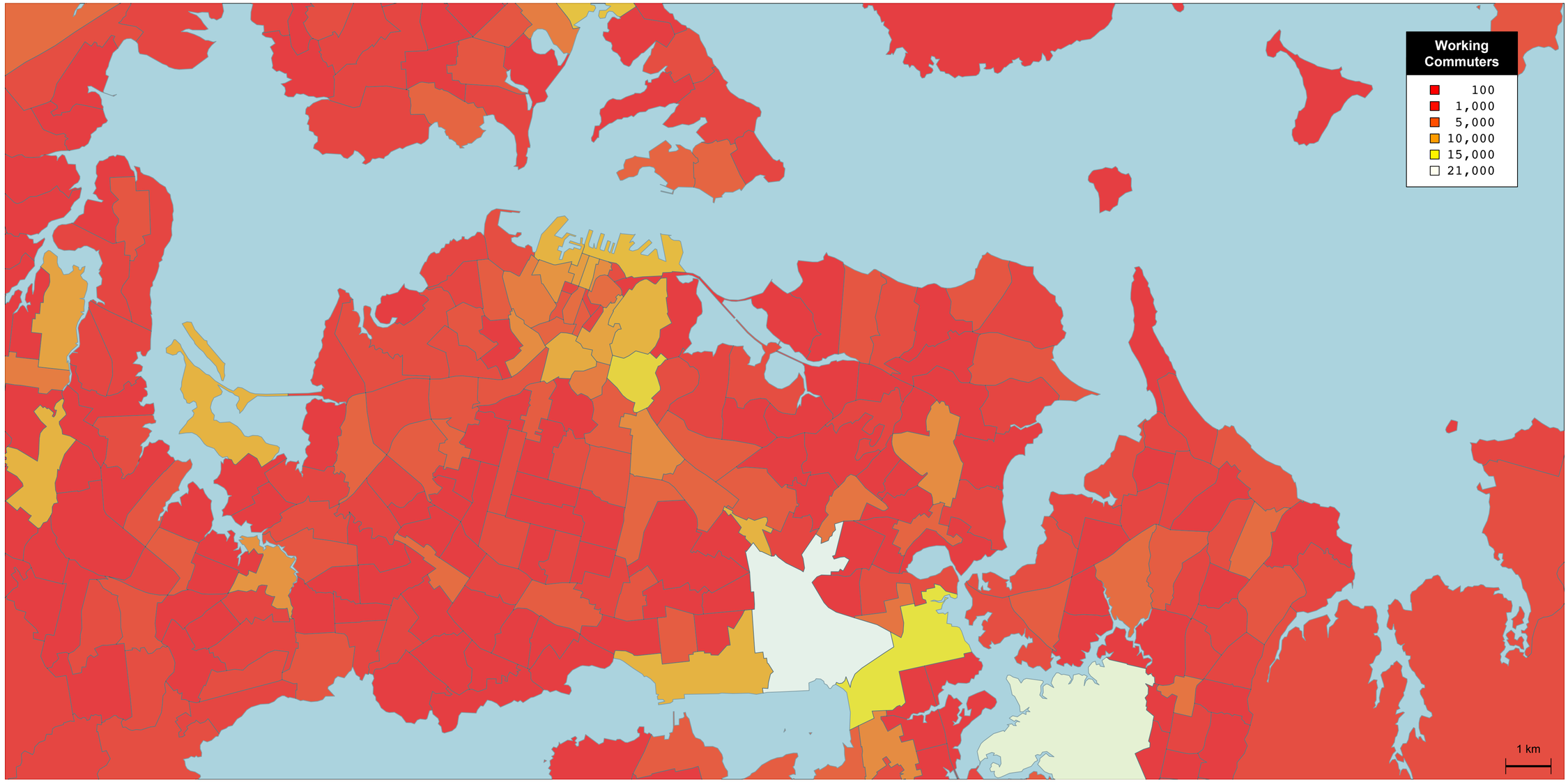
Commute Graph Components across Aotearoa



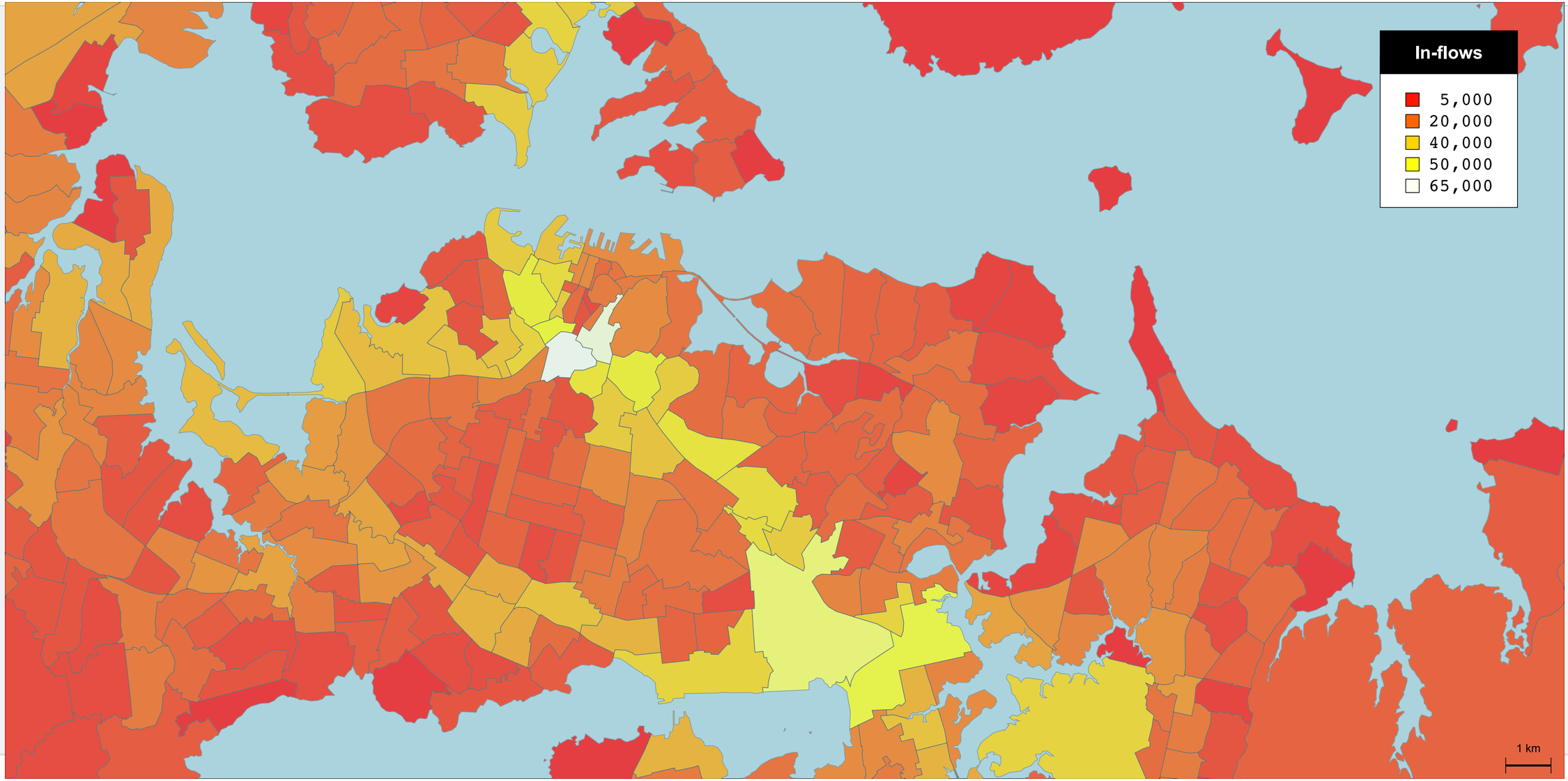
Usual Residents (Commuters)



Work Locations

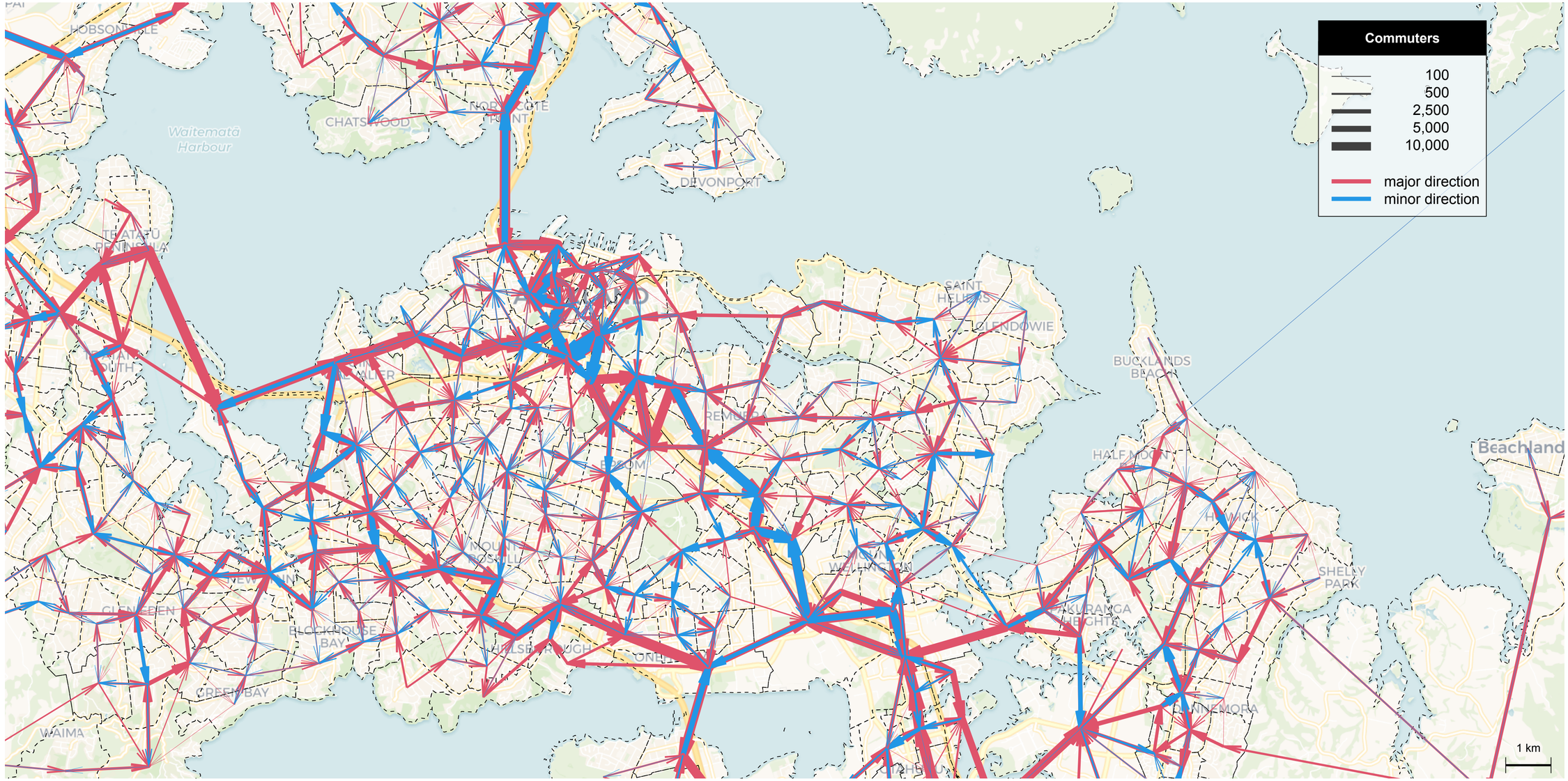


In-Flows (commute to work)



Back to Commute Route View

Mobility Graph Flows



Mobility Graph

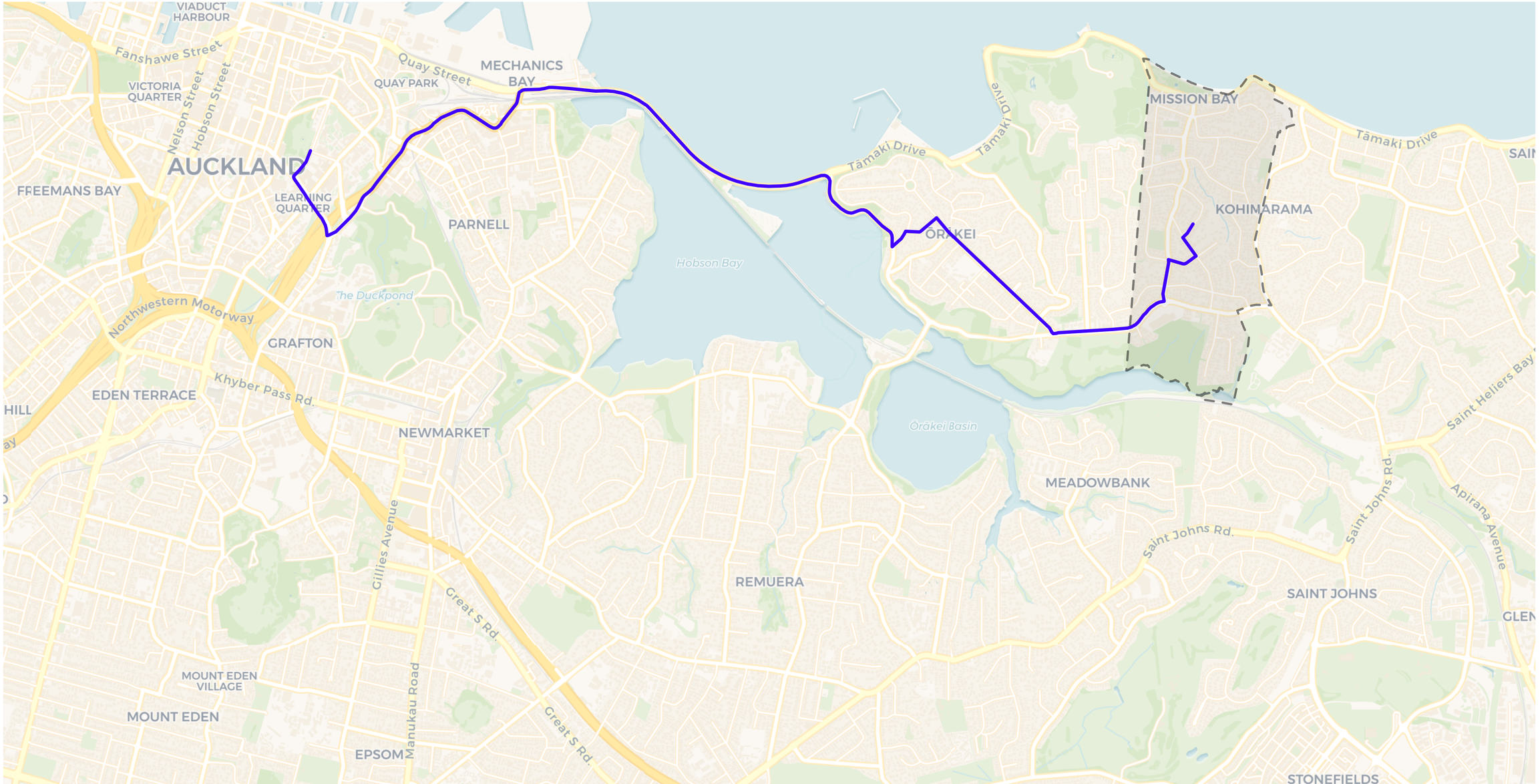
- Easy to work with
- Privacy-preserving (can be based on more fine resolution)
- Join with additional data
  - Pollution exposure
  - Spread of infectious diseases
  - …

For more see ”*Mobility Graph Attractors*” Kane (Yale), Owais (Bucknell) and Urbanek

Addressing Route Imprecision

- Problem: centroid-to-centriod routing may miss alternate routes
- Idea: sample random points from the SA2 polygon

Example: Mission Bay to UoA



Example: Mission Bay to UoA

- Sampled 1,000 points (can use weighted sampling by residences)
- `ghroute` R package for very fast routing (~100k/s)

Future Work

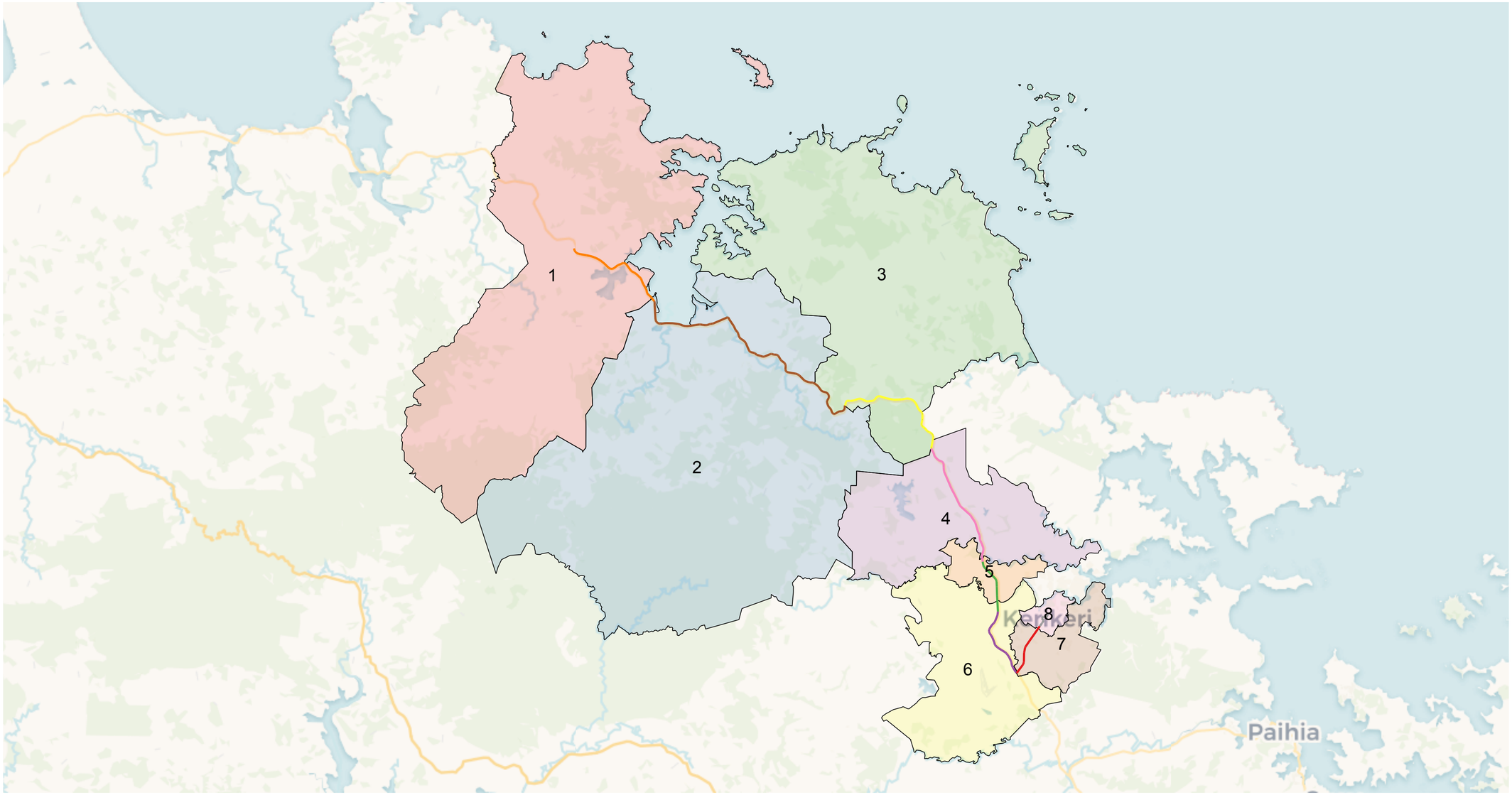
- Expand to other modes of transport
  - ghroute supports public transport, biking etc.
- Enhance sampling techniques
- Improved routing
- Additional use cases

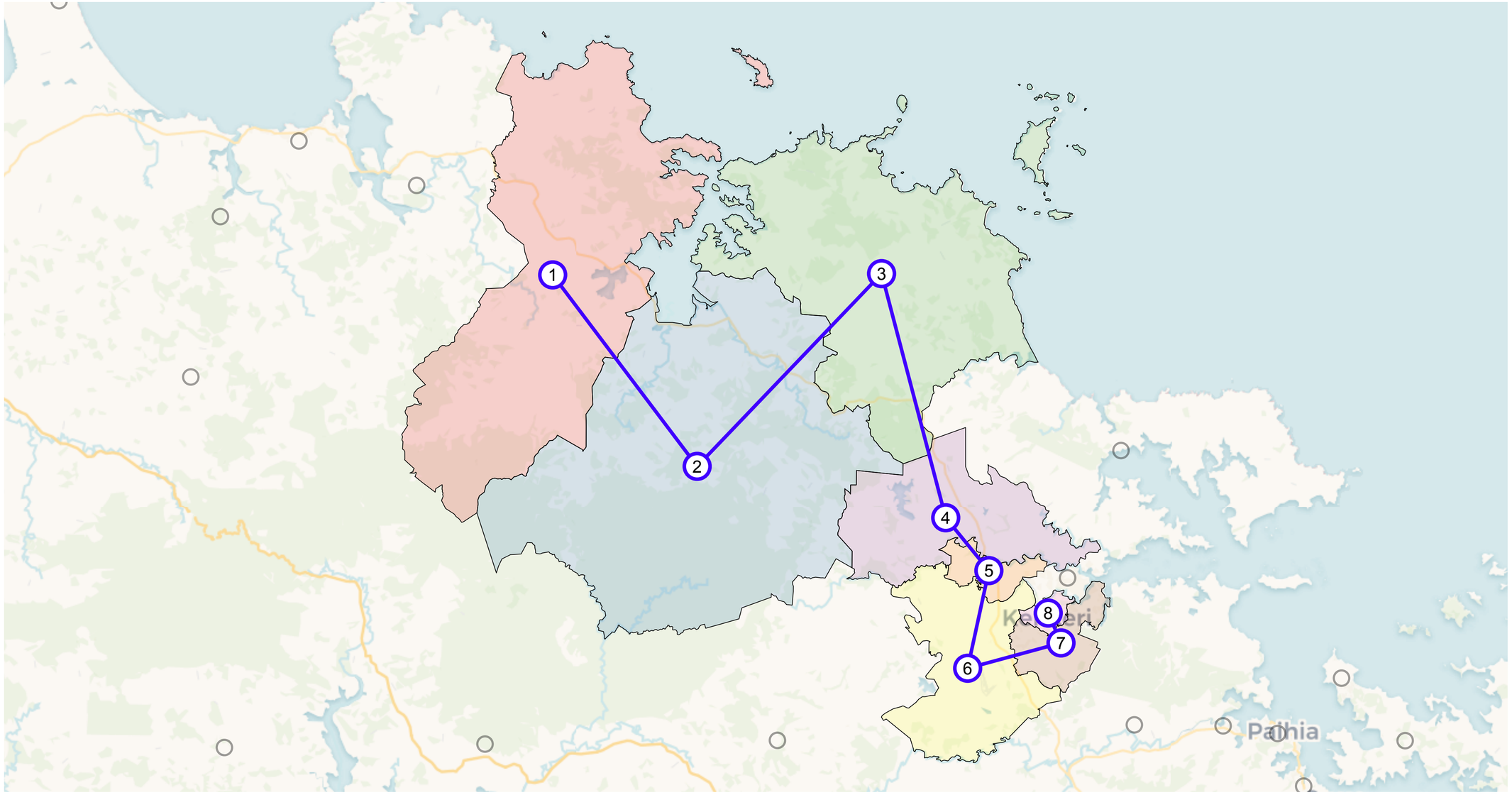
Contact and Acknowledgements

- Simon Urbanek
  simon.urbanek@R-project.org

  https://urbanek.nz rforge.net/ghroute
  GitHub.com/s-u

- Acknowledgements:
  Kathlyn Ycong - https://github.com/kathycong/motroadsafety
  Shrividya Ravi (Ministry of Transportation)


1
2
3
4
5
6
7
8
Kerikeri
Paihia


1
2
3
4
5
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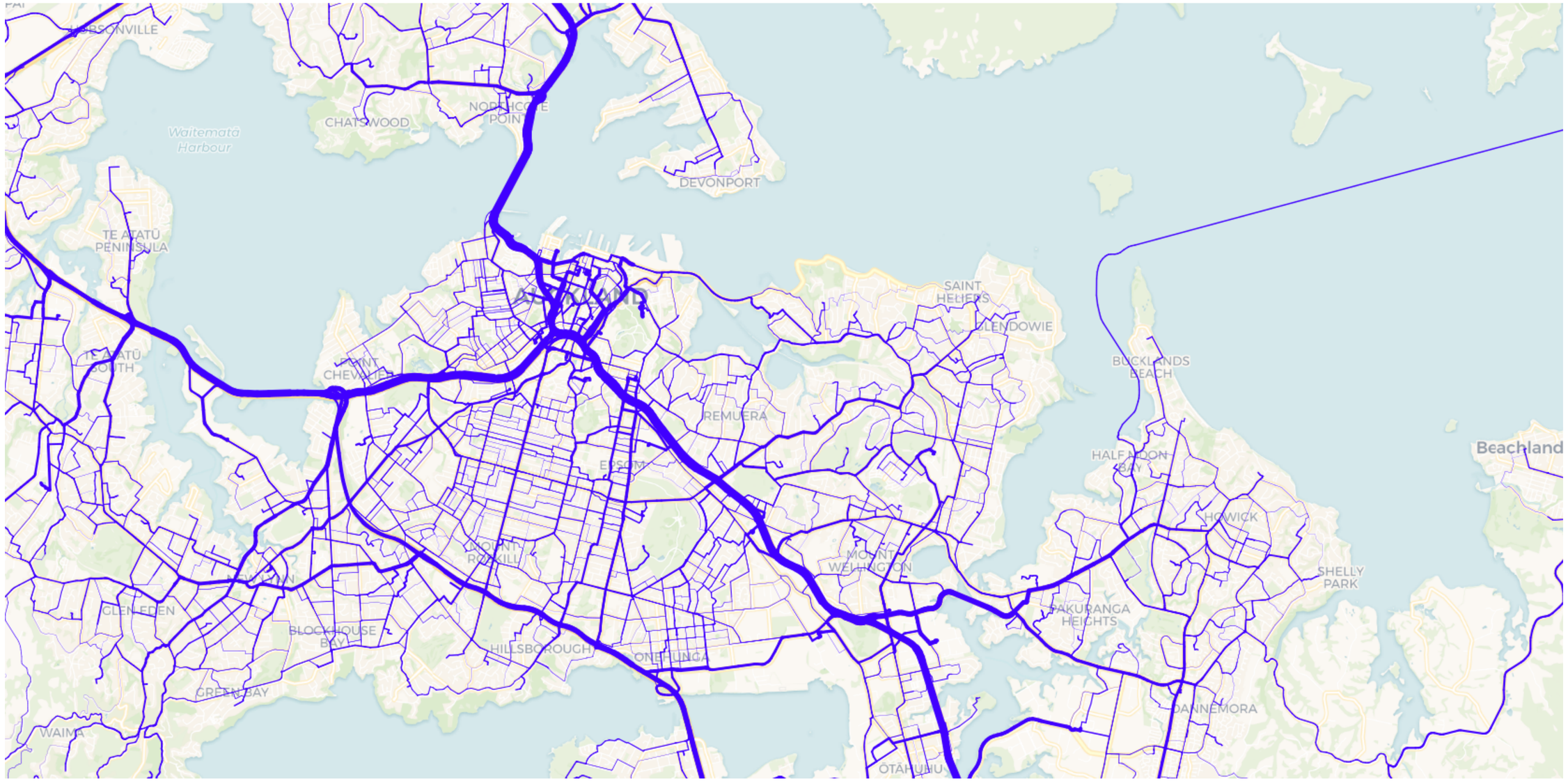
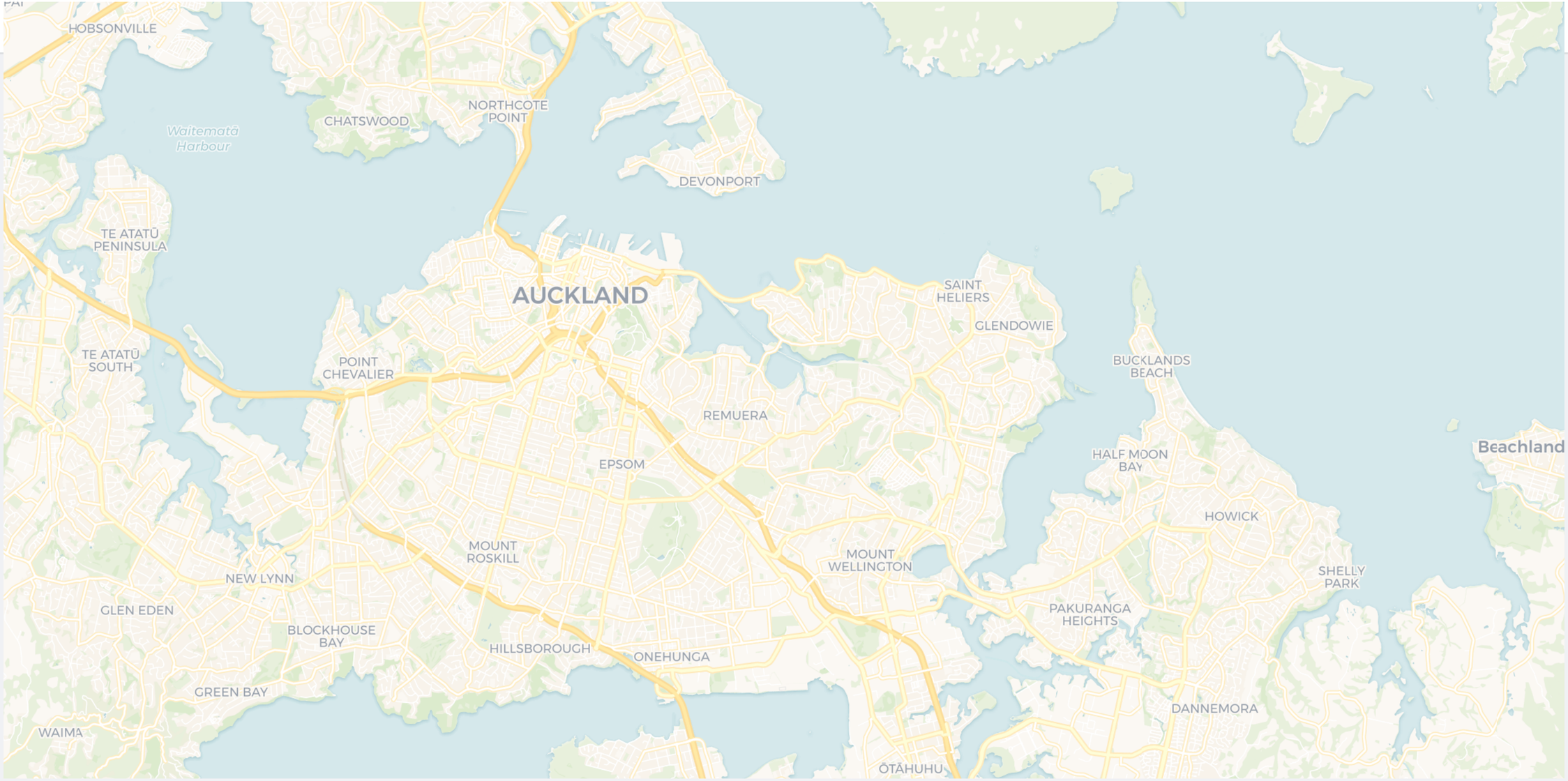
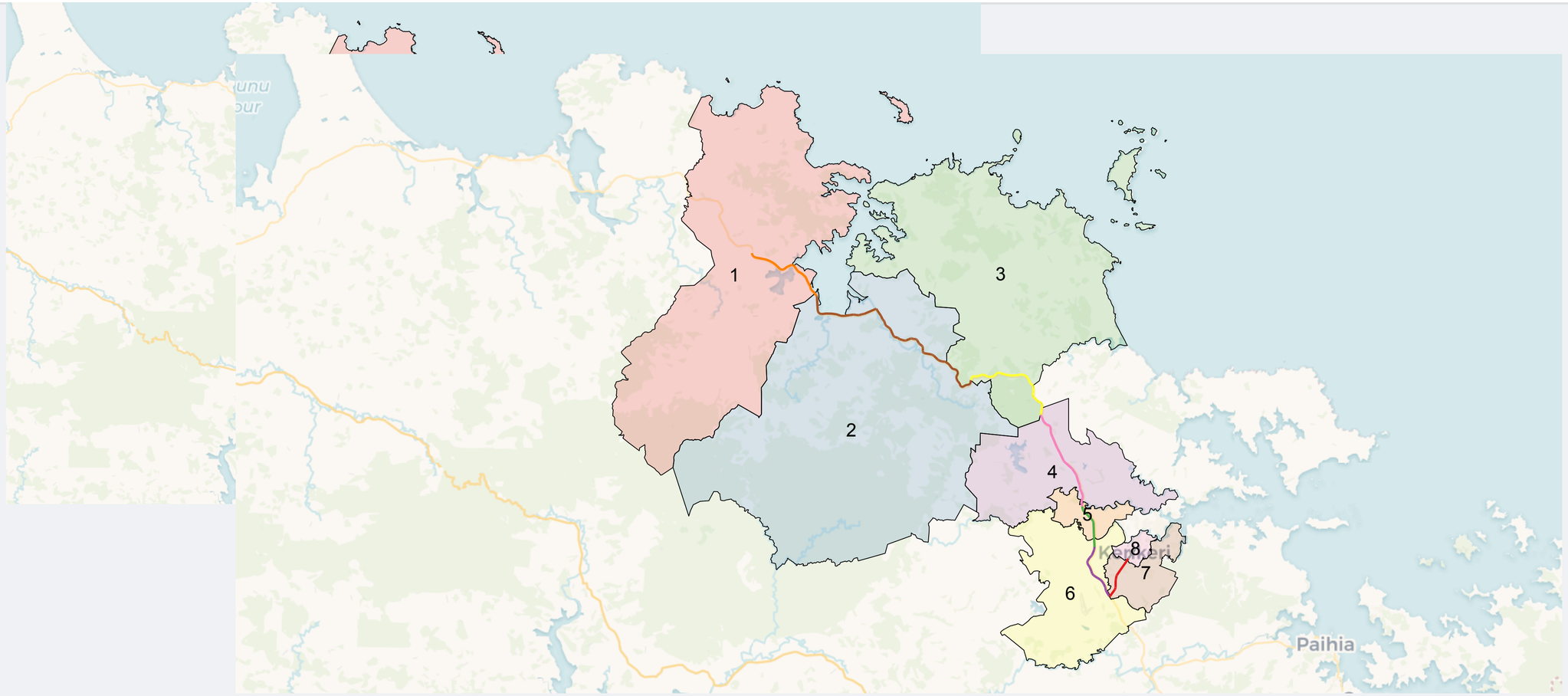
7
8
Pathia

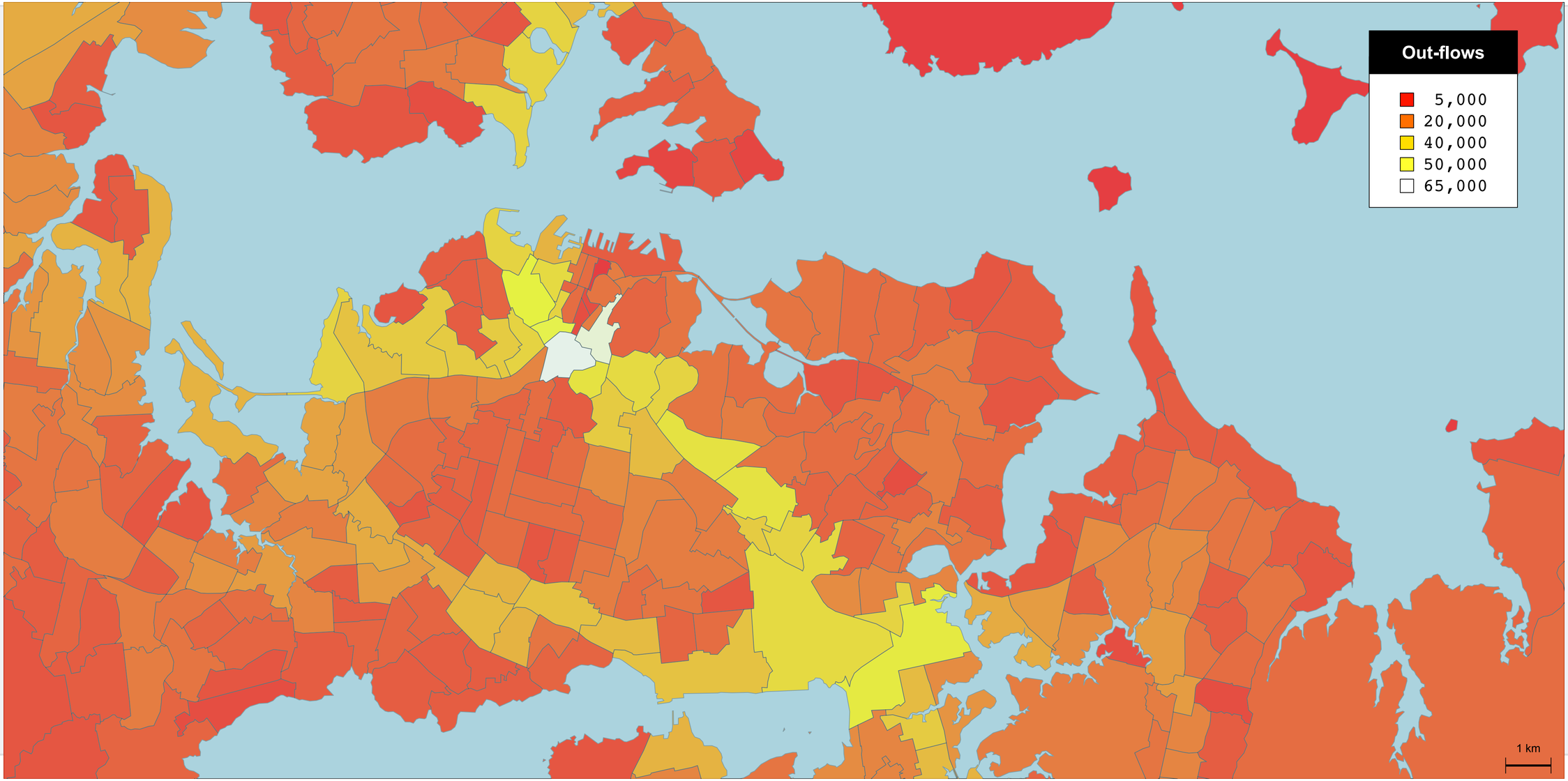
Auckland Isthmus example

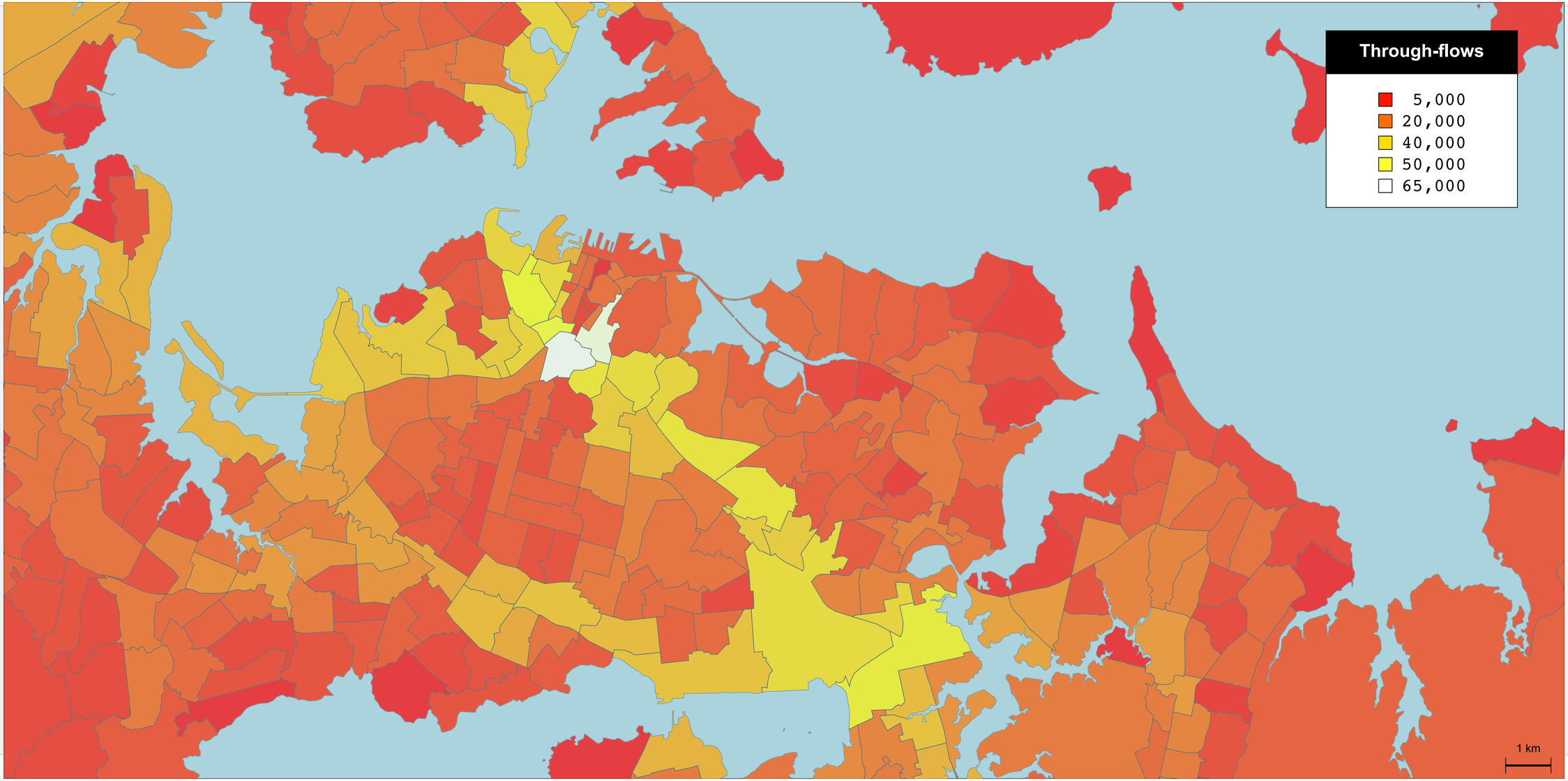


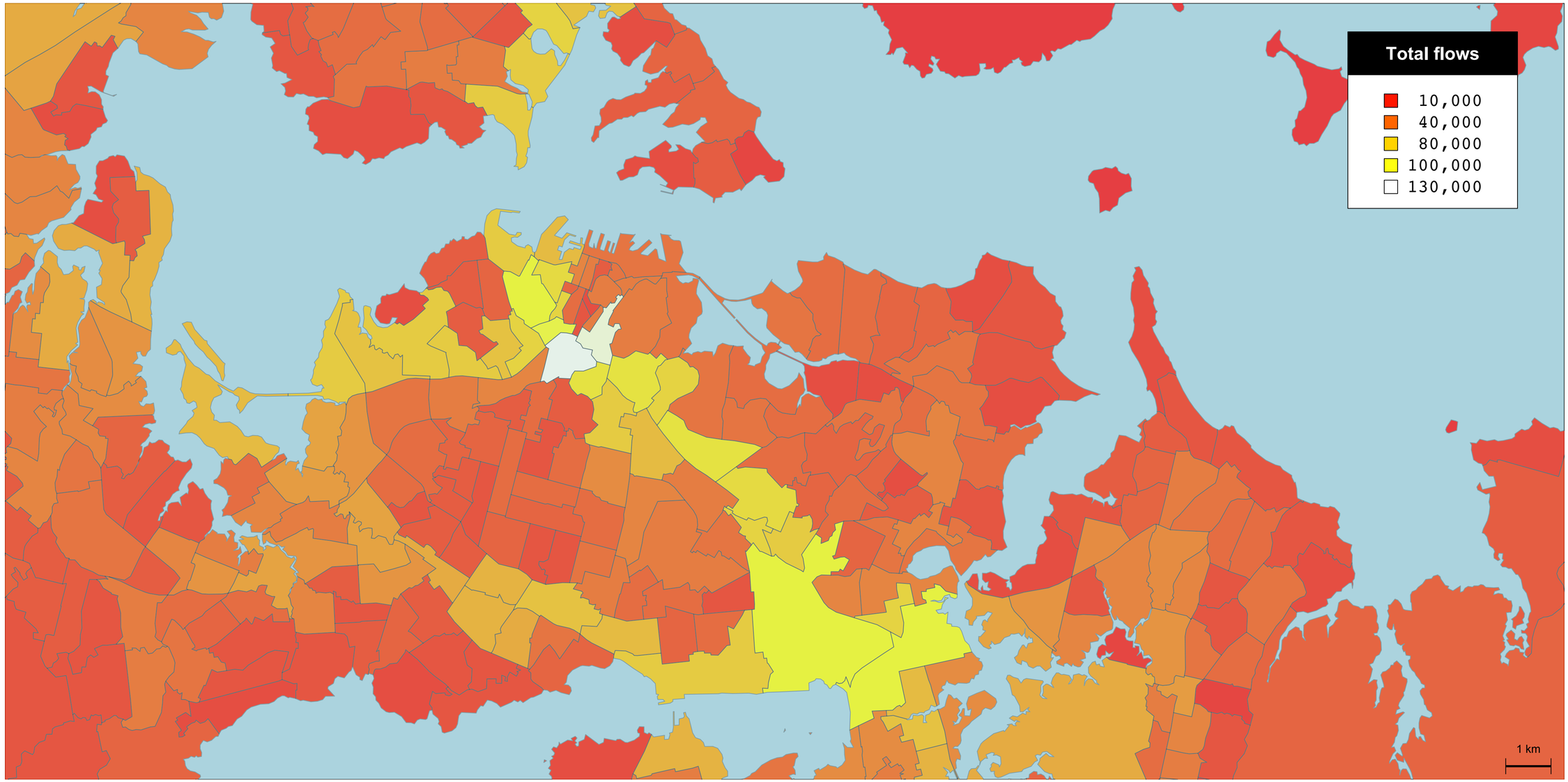

HOBSONVILLE
CHATSWOOD
NORTHCOTE POINT
Waitematā Harbour
DEVONPORT
TE ATATŪ PENINSULA
AUCKLAND
SAINT HELIERS
GLENDOWIE
TE ATATŪ SOUTH
POINT CHEVALIER
BUCKLANDS BEACH
REMUERA
HALF MOON BAY
Beachland
EPSOM
HOWICK
MOUNT ROSKILL
MOUNT WELLINGTON
SHELLY PARK
NEW LYNN
GLEN EDEN
PAKURANGA HEIGHTS
BLOCKHOUSE BAY
HILLSBOROUGH
ONEHUNGA
GREEN BAY
DANNEMORA
WAIMA
ŌTĀHUHU

From Trips to Graphs




Out-flows
5,000
20,000
40,000
50,000
65,000
1 km


Through-flows
5,000
20,000
40,000
50,000
65,000
1 km


Total flows
10,000
40,000
80,000
100,000
130,000
1 km