ASSET
KIDNEY RESEARCH
HE RAWA RARAUNGA HAUORA MŌ NGĀ TĀNGATA O AOTEAROA

AcceSS and Equity in Transplantation

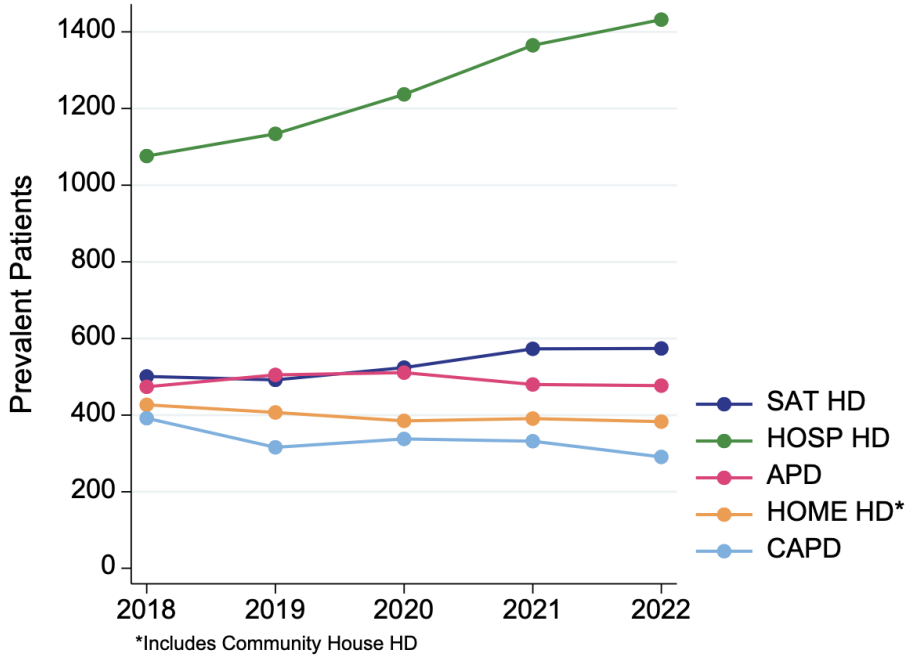
Project 2: Trends in dialysis modality and patient travel time in Aotearoa New Zealand

Johanna Birrell, Nick Cross, Angela Webster, Andrew Kindon, Matthew Hobbs, James Hedley, Tim Driscoll, Nicole De La Mata

Background (1/3)

- An increasing number of people are receiving dialysis across Aotearoa New Zealand (NZ)
- There is a trend towards use of in-centre haemodialysis (ICHD) rather than home-based dialysis (PD / home HD) (Figure 1)
  - 2006: 46% ICHD
  - 2022: 64% ICHD
- International comparison:
  - Australia: similar but more gradual rise in ICHD rates (from 68% in 2006 to 76% in 2022)
  - UK: stable ICHD rates
  - US: decreasing ICHD rates (home-based dialysis increasingly popular)

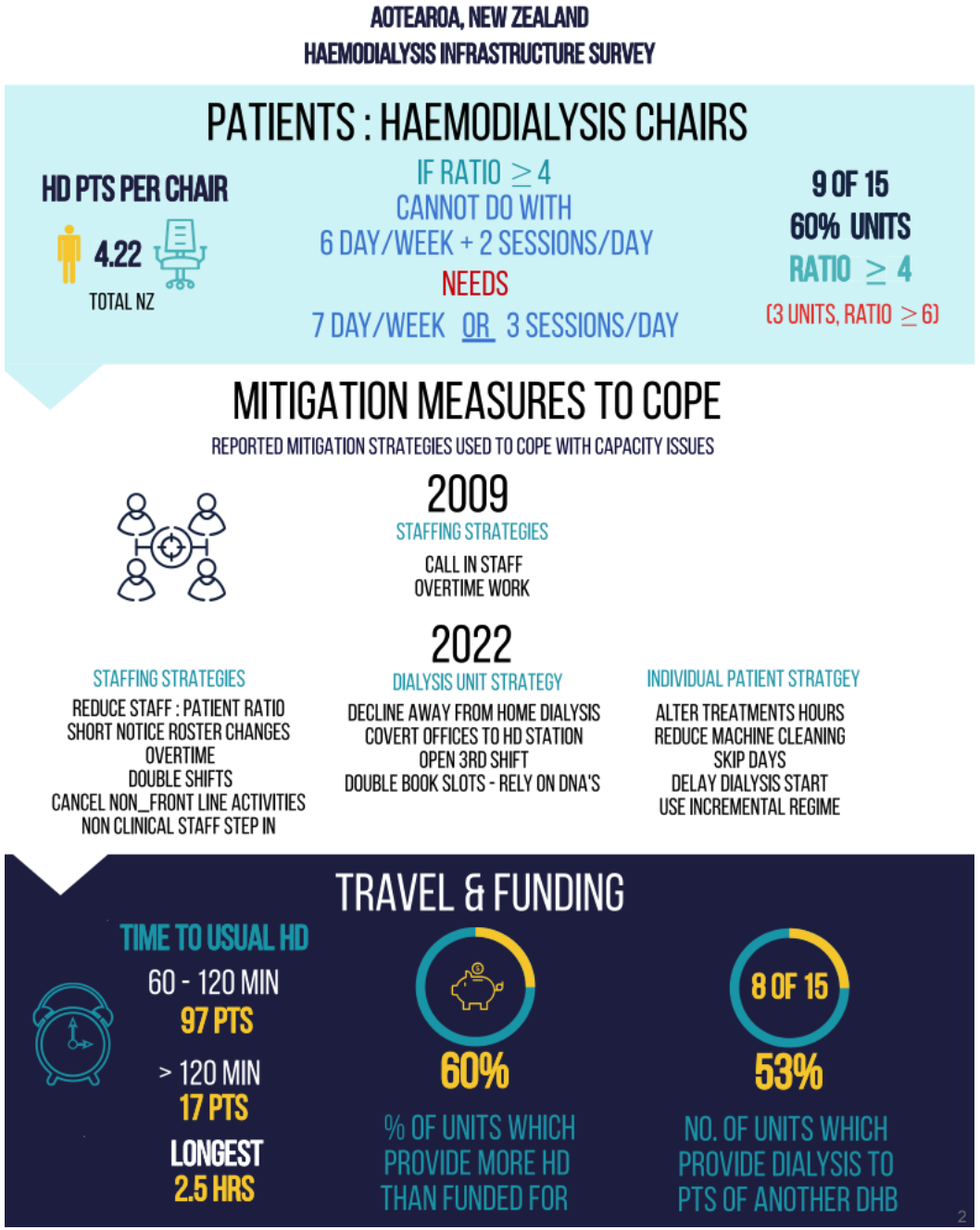
Figure 1. Method and location of dialysis – NZ 2018-2022



Background (2/3)

- Despite rapid expansion of ICHD units across NZ, current services are severely under-resourced to meet demands

- This is impacting patients:
  - Undue travel burdens
  - After-hours ICHD shifts and impromptu cancellations
  - Inability to achieve planned starts onto HD



Background (3/3)

- A greater understanding of the factors driving the surge in ICHD in NZ will support accurate modelling of future dialysis capacity requirements

- There is a need for national geo-spatial tools that:
  - Highlight locations where patients are bearing the greatest travel time burden
  - Track regional trends in dialysis capacity pressure

- Such resources would support innovative solutions and resource allocation to locations of highest need

Aims:

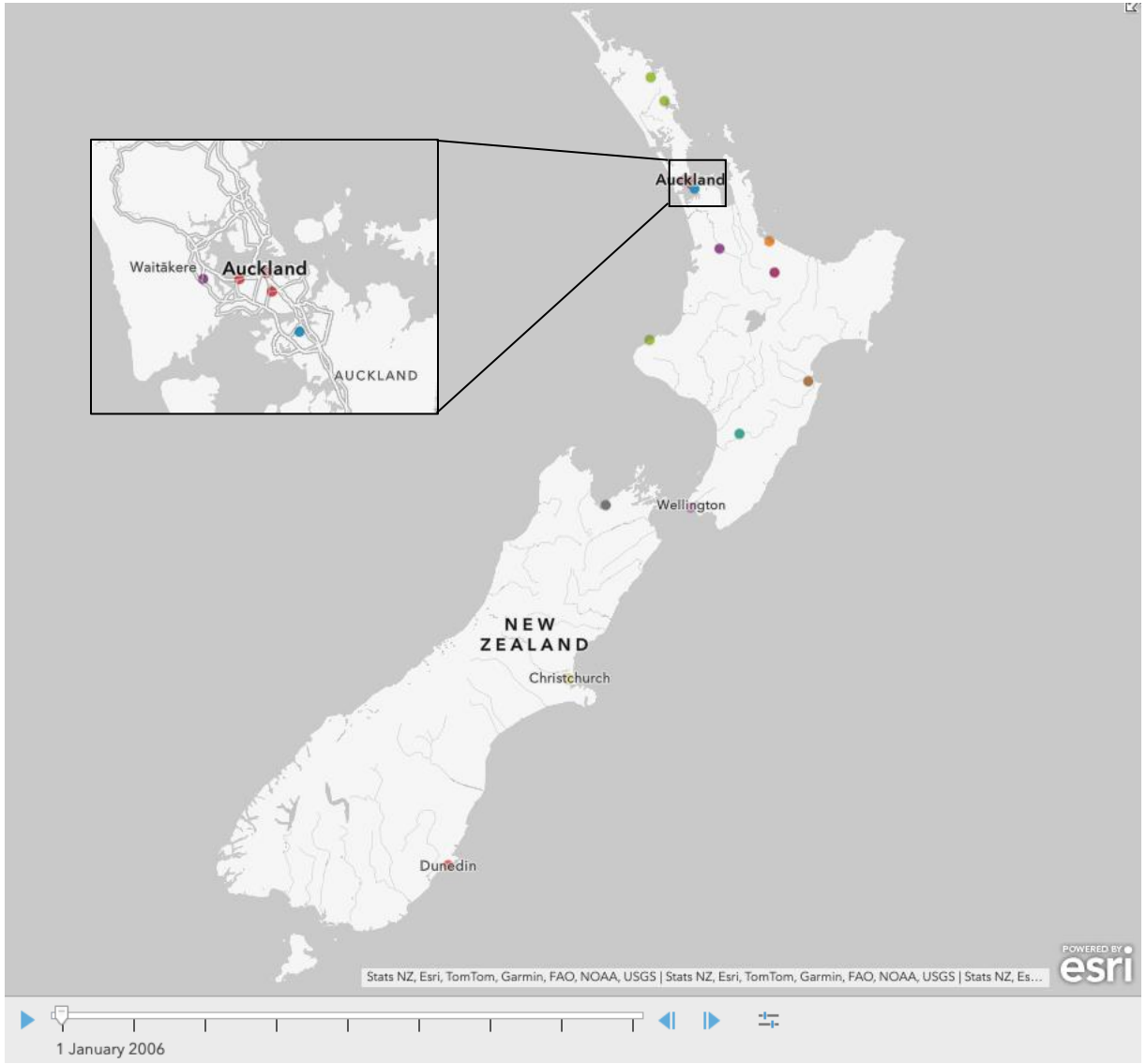
1. To analyse the burden and trends in **travel time** for patients receiving dialysis in NZ
2. To assess the factors contributing to **dialysis modality** decisions (in-centre haemodialysis (HD) vs home therapies (PD / home HD))
3. To create interactive regional maps to support national dialysis service planning

Methods:

1. Create a timeline of establishment of new haemodialysis units across NZ from 2006-19

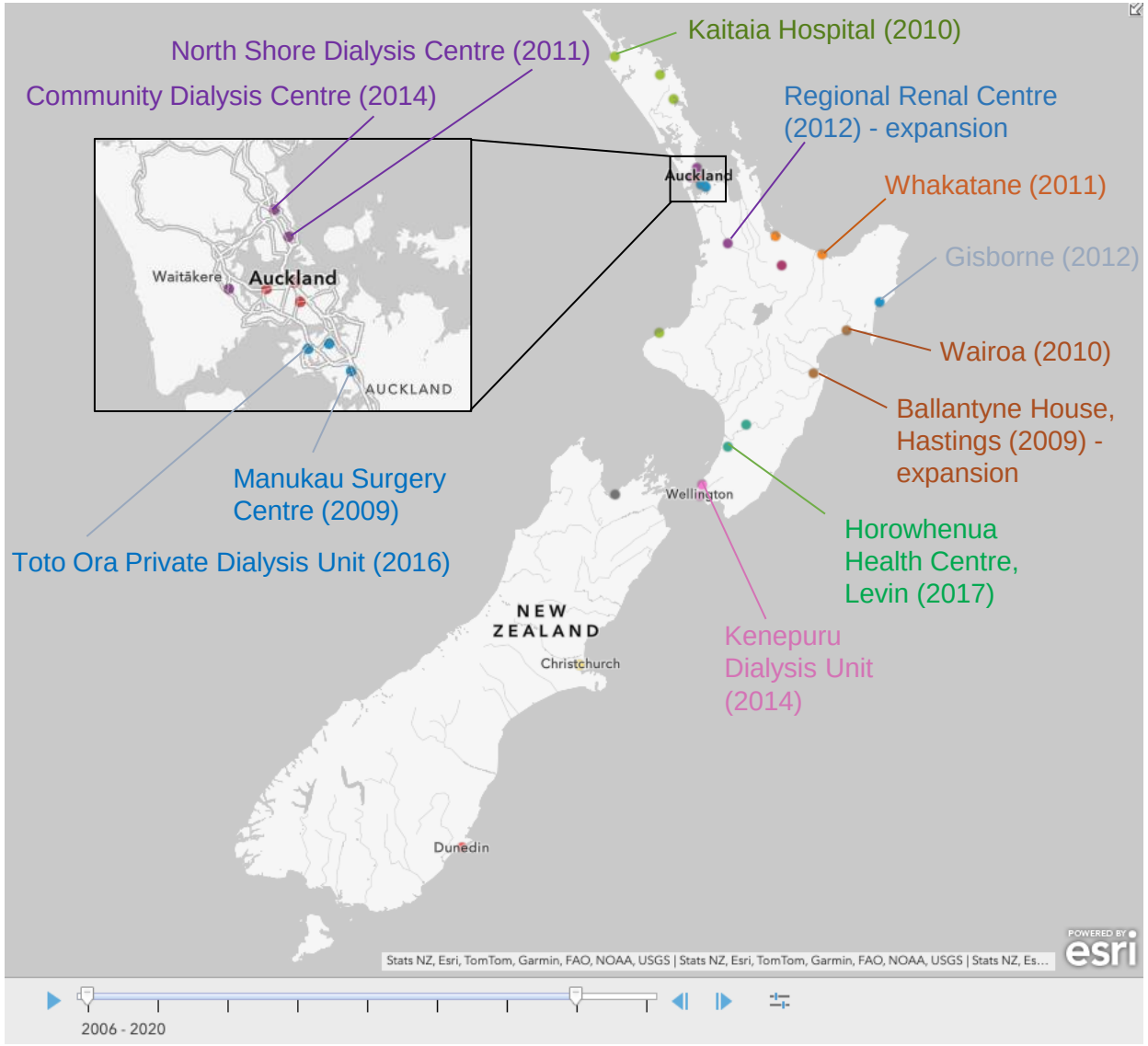
Haemodialysis unit locations in New Zealand

2006:



2019:

New units / major expansions 2006-2019



Methods:

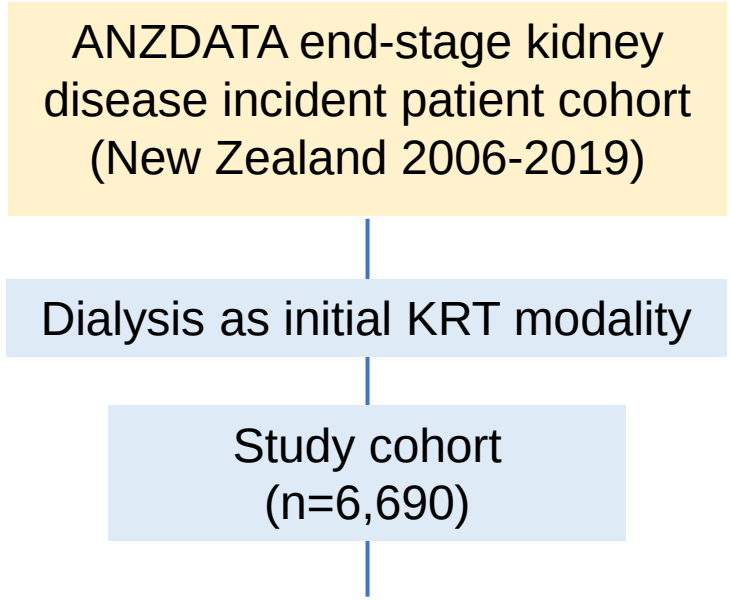
1. Create a timeline of establishment of new haemodialysis units across NZ from 2006-19

Methods:

1. Create a timeline of establishment of new haemodialysis units across NZ from 2006-19

2. Establish a cohort of patients commencing dialysis in NZ from 2006-19

Data sources



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Data sources

ANZDATA end-stage kidney disease incident patient cohort (New Zealand 2006-2019)

Dialysis as initial KRT modality

Study cohort (n=6,690)

National Minimum Dataset (admitted patient records, 2001-2019)

Domicile, coded hospital ICD-10-AM diagnoses

Calculation of Charlson Comorbidity Index & M3 Multimorbidity Index

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KRT modality and treatment centre at 1 year after starting dialysis

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1. District Health Board (DHB) jurisdictions

2. New Zealand Index of Deprivation

3. Rural-urban Geographic Classification for Health (GCH)

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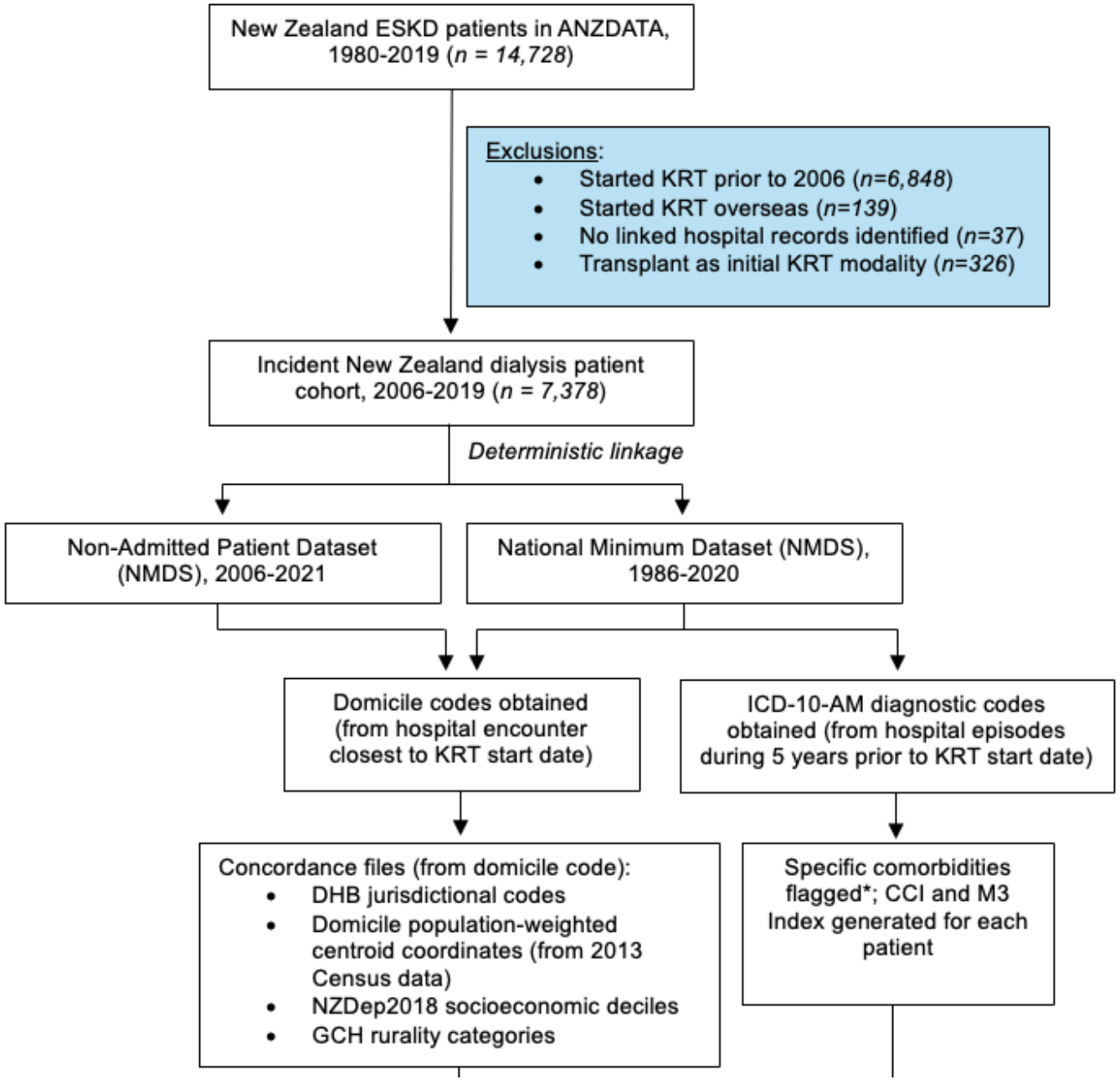
Domicile population-weighted centroid coordinates

Patient residential location at dialysis commencement

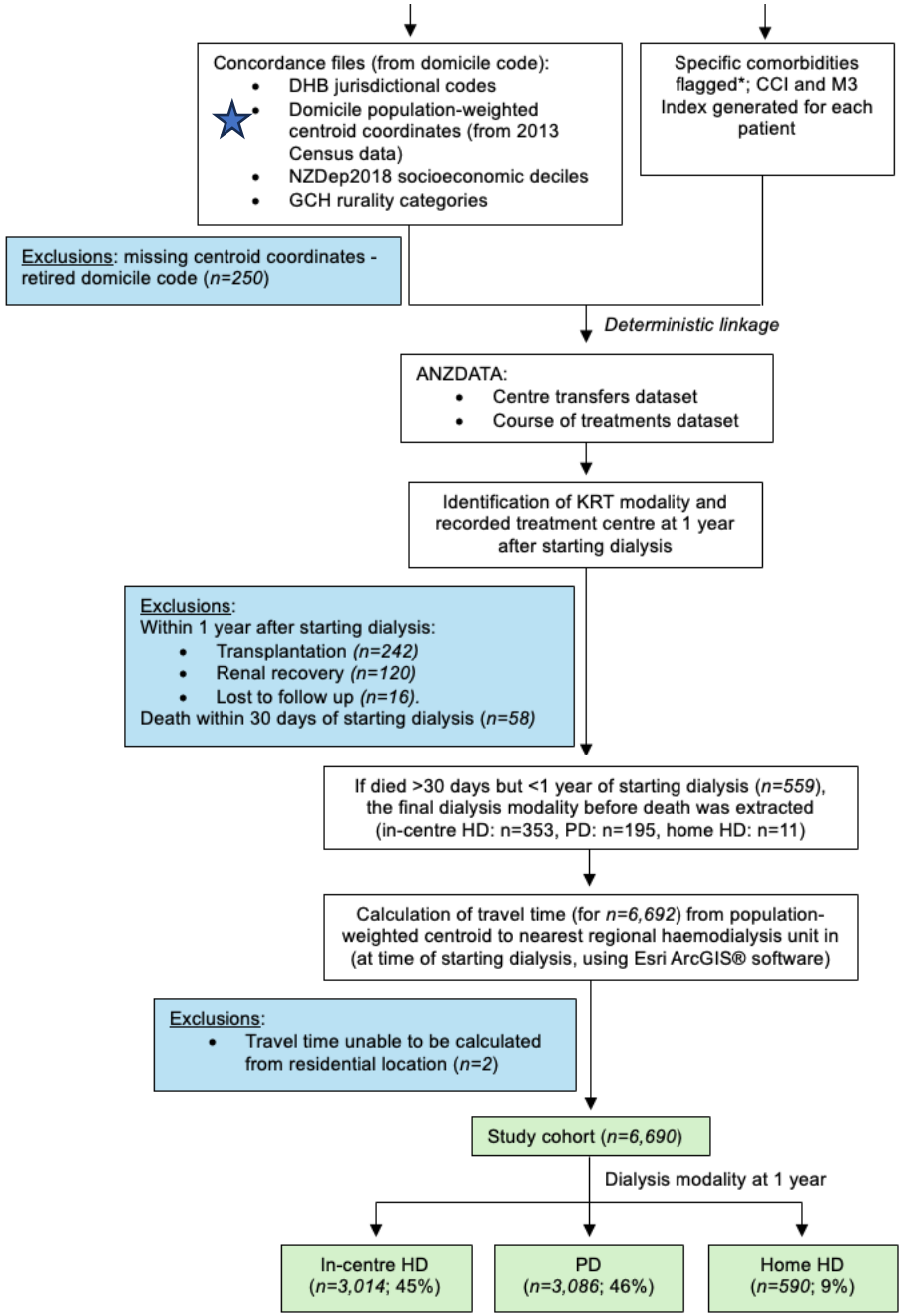
NZ haemodialysis units

Coordinates, opening and expansion dates, chair capacity

Flowchart of data linkage and analysis (1/2)

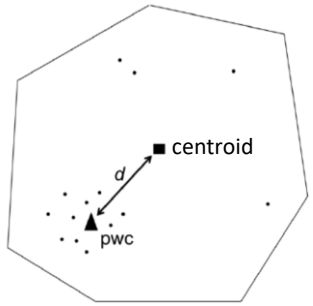


Flowchart of data linkage and analysis (2/2)



Methods – driving time calculations

- Esri® ArcGIS software – ‘find nearest’ tool
- Starting point: population-weighted centroid (pwc) of residential domicile



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- Traffic conditions set for 8am Monday

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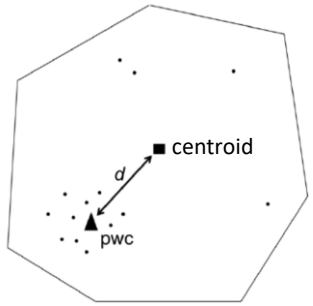

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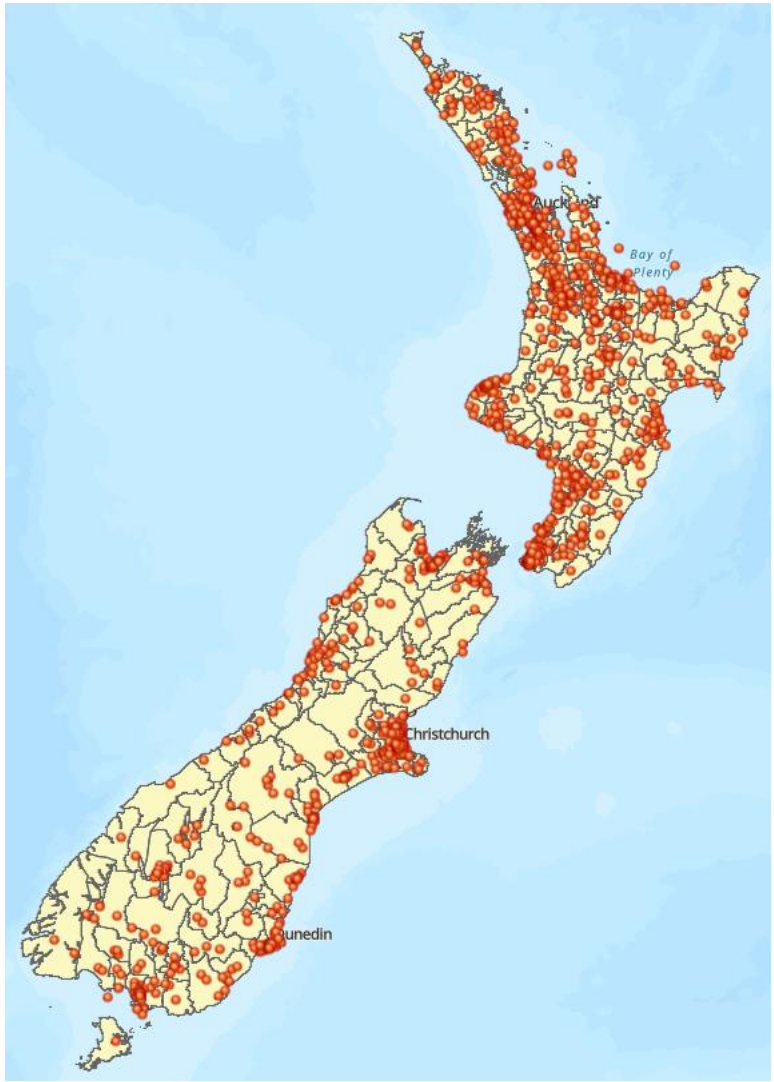

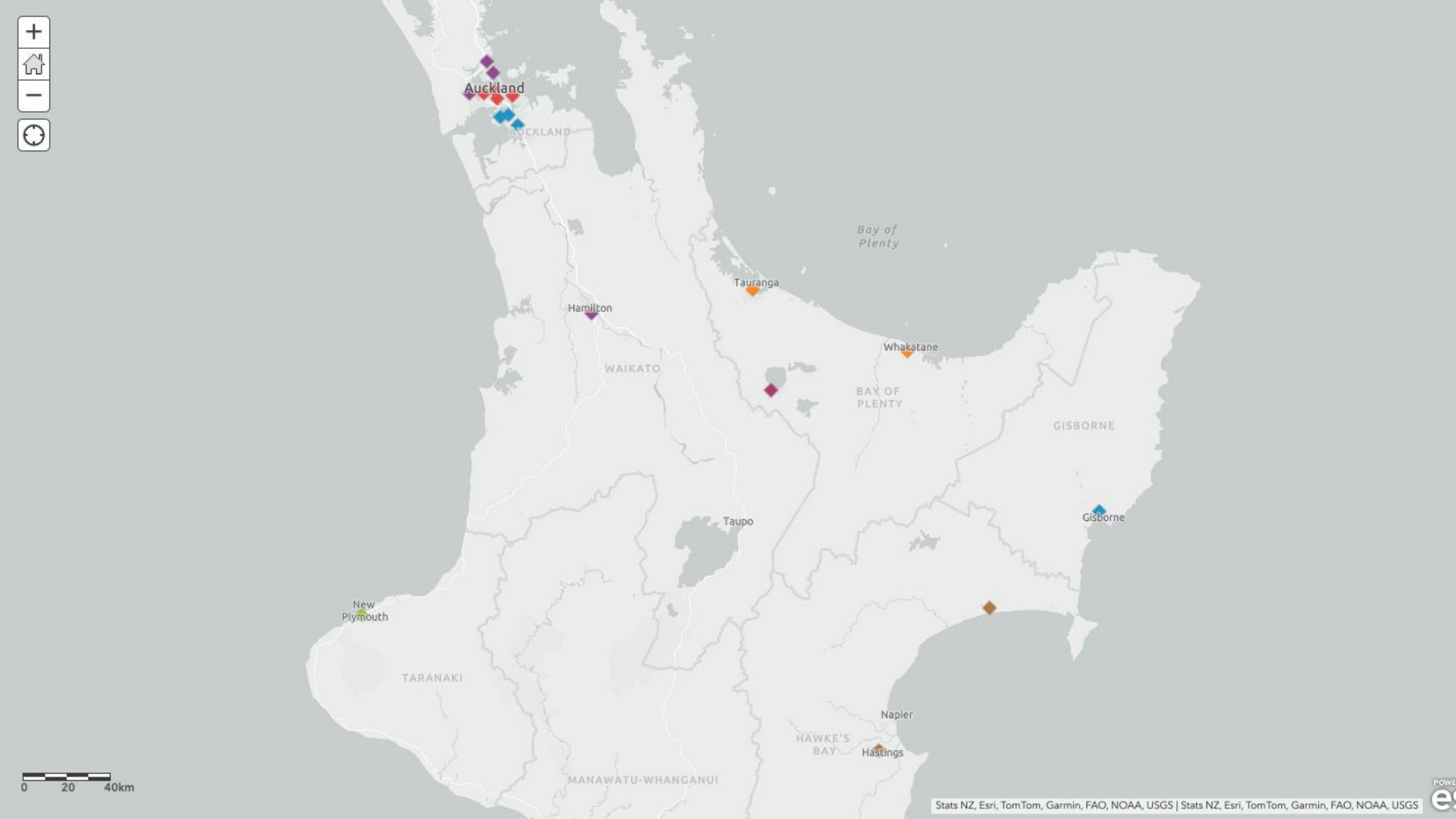
Auckland
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Hastings
MANAWATU-WHANGANUI
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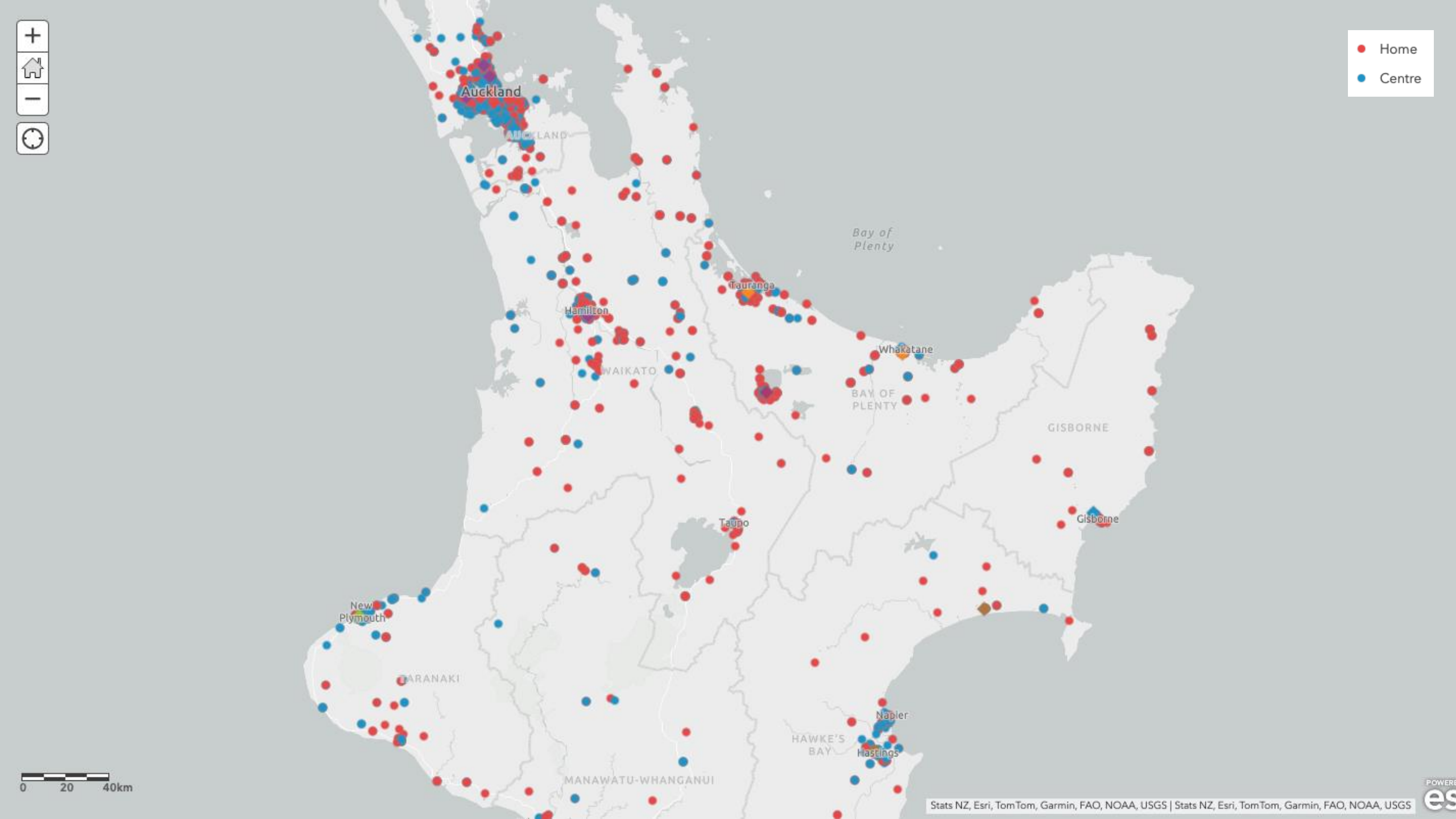
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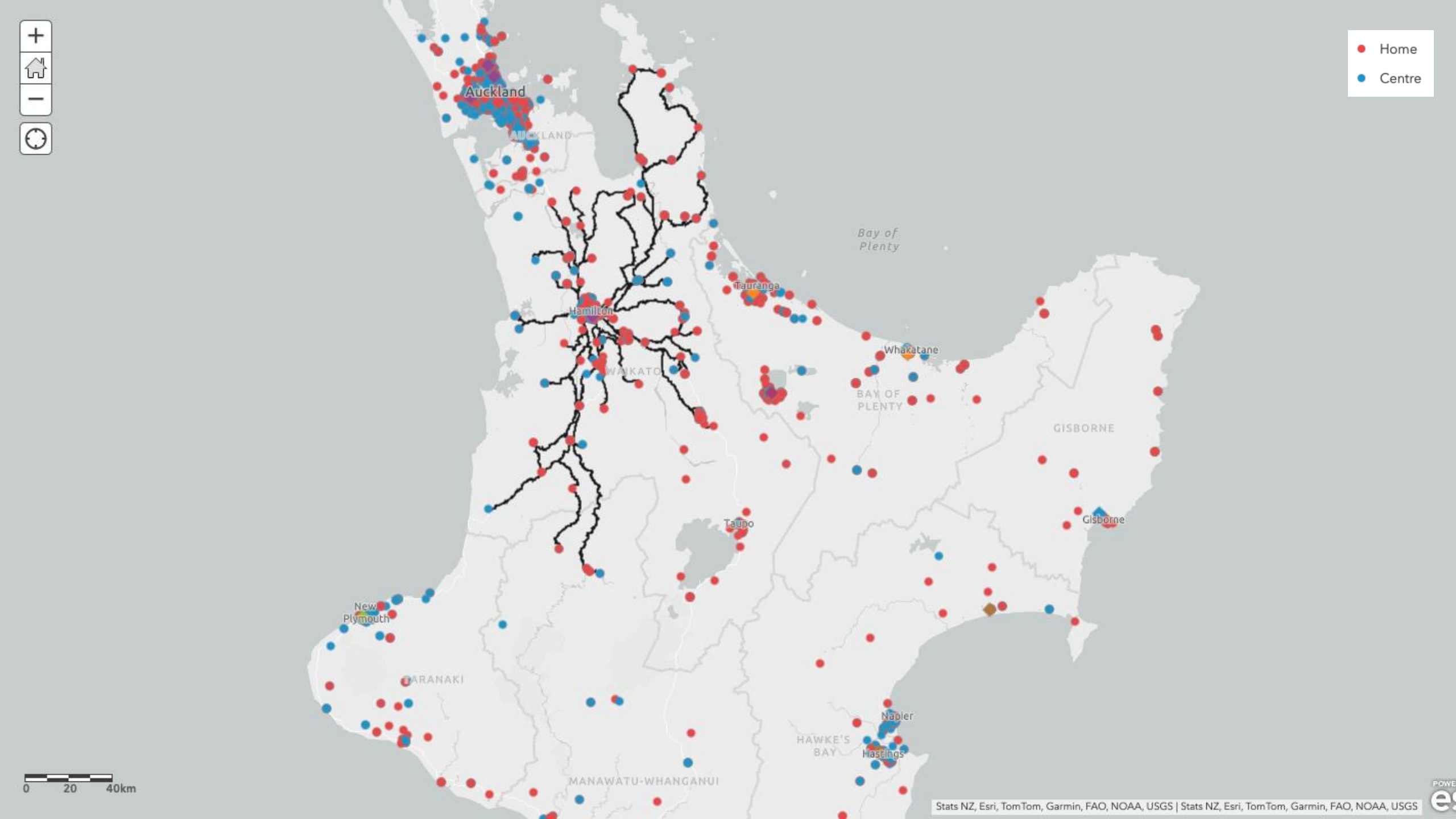
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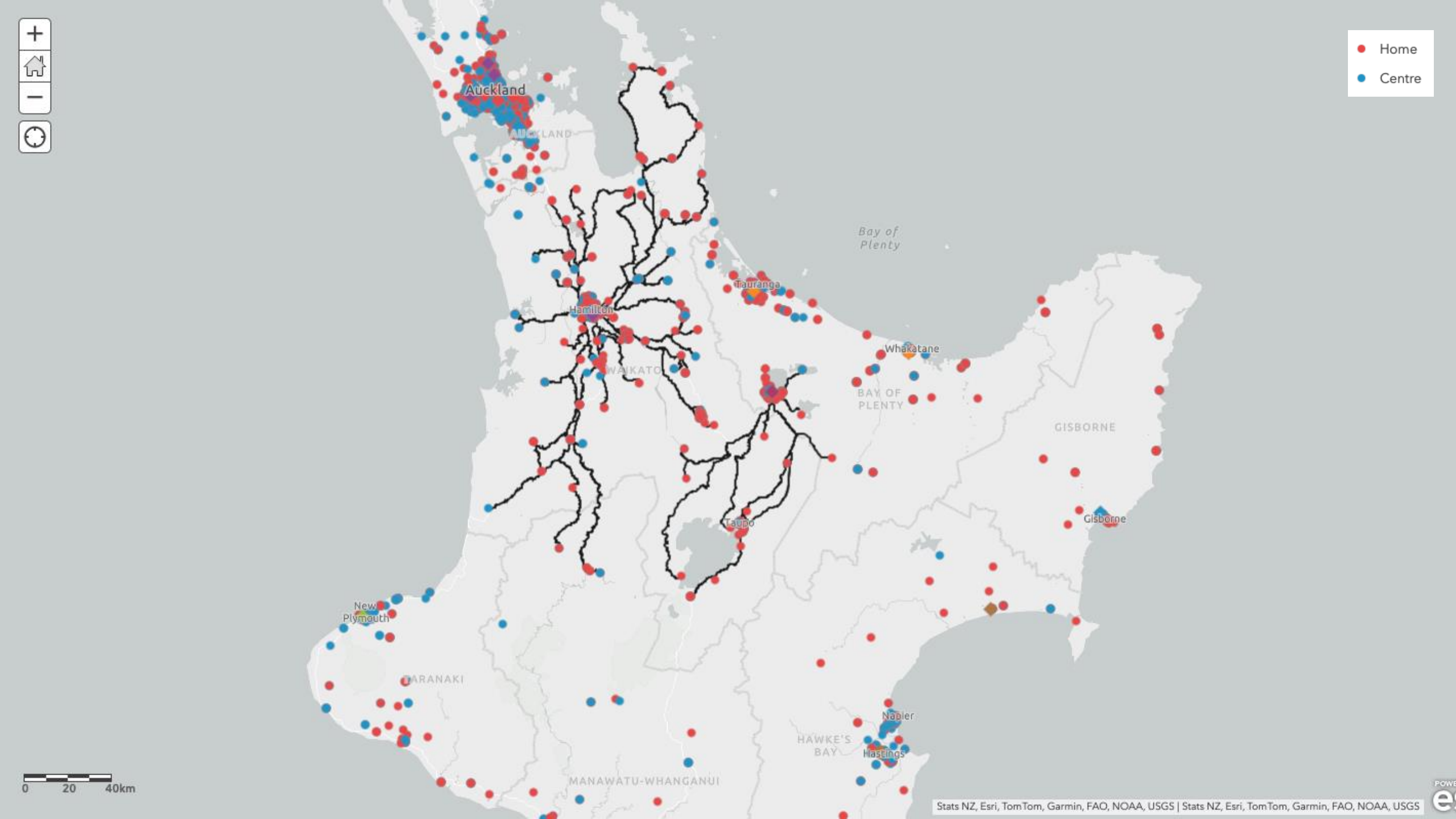
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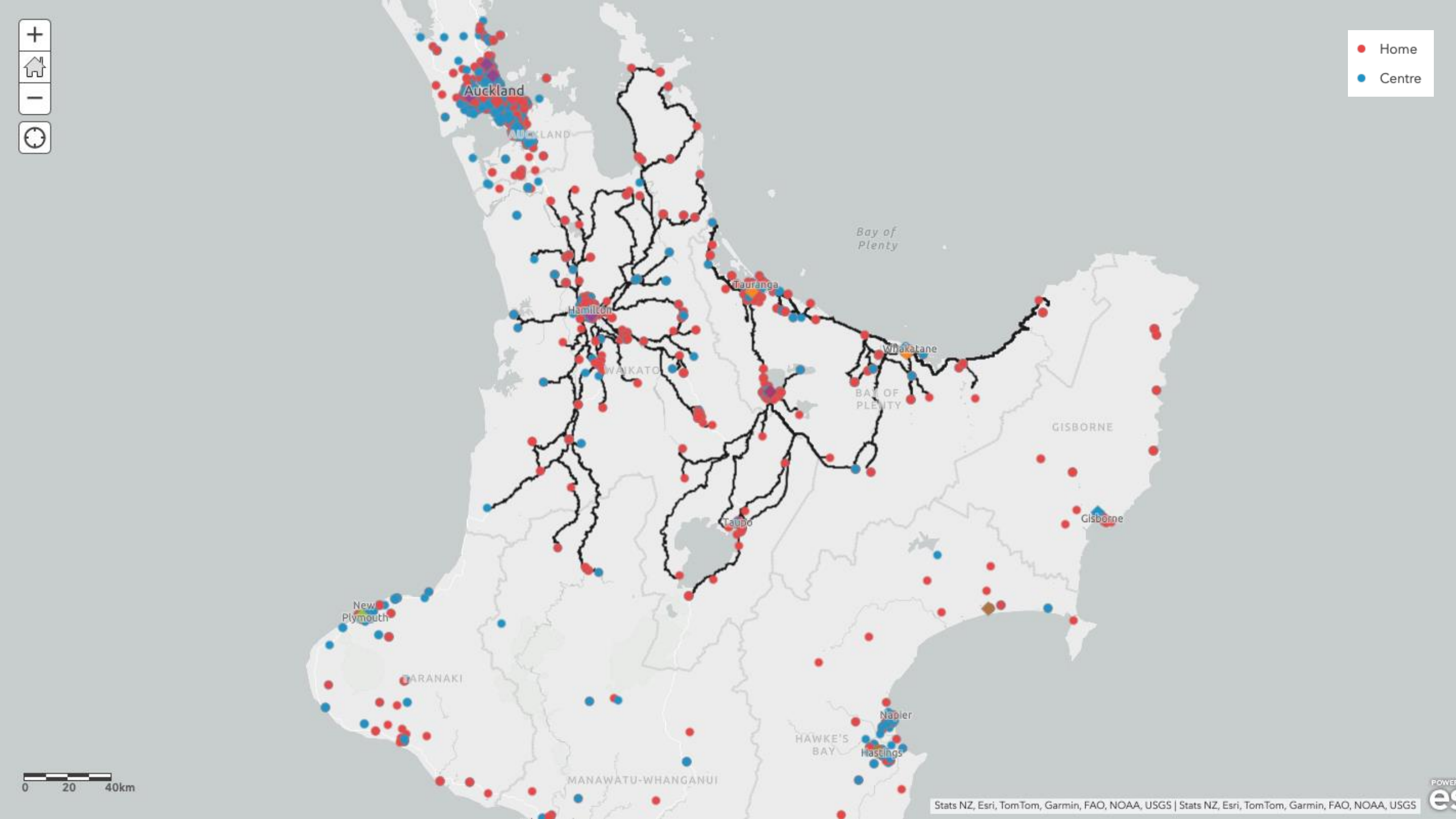
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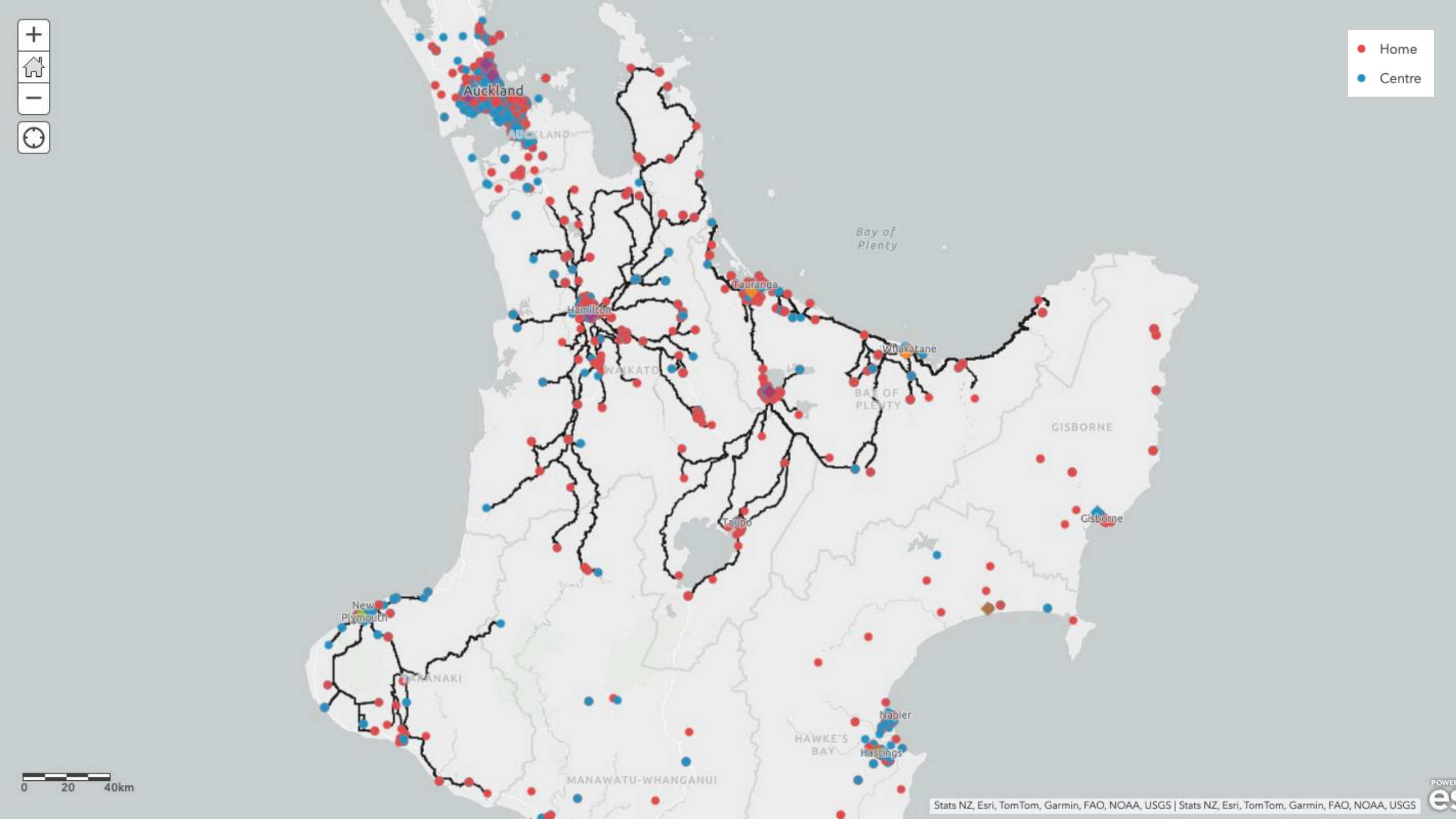
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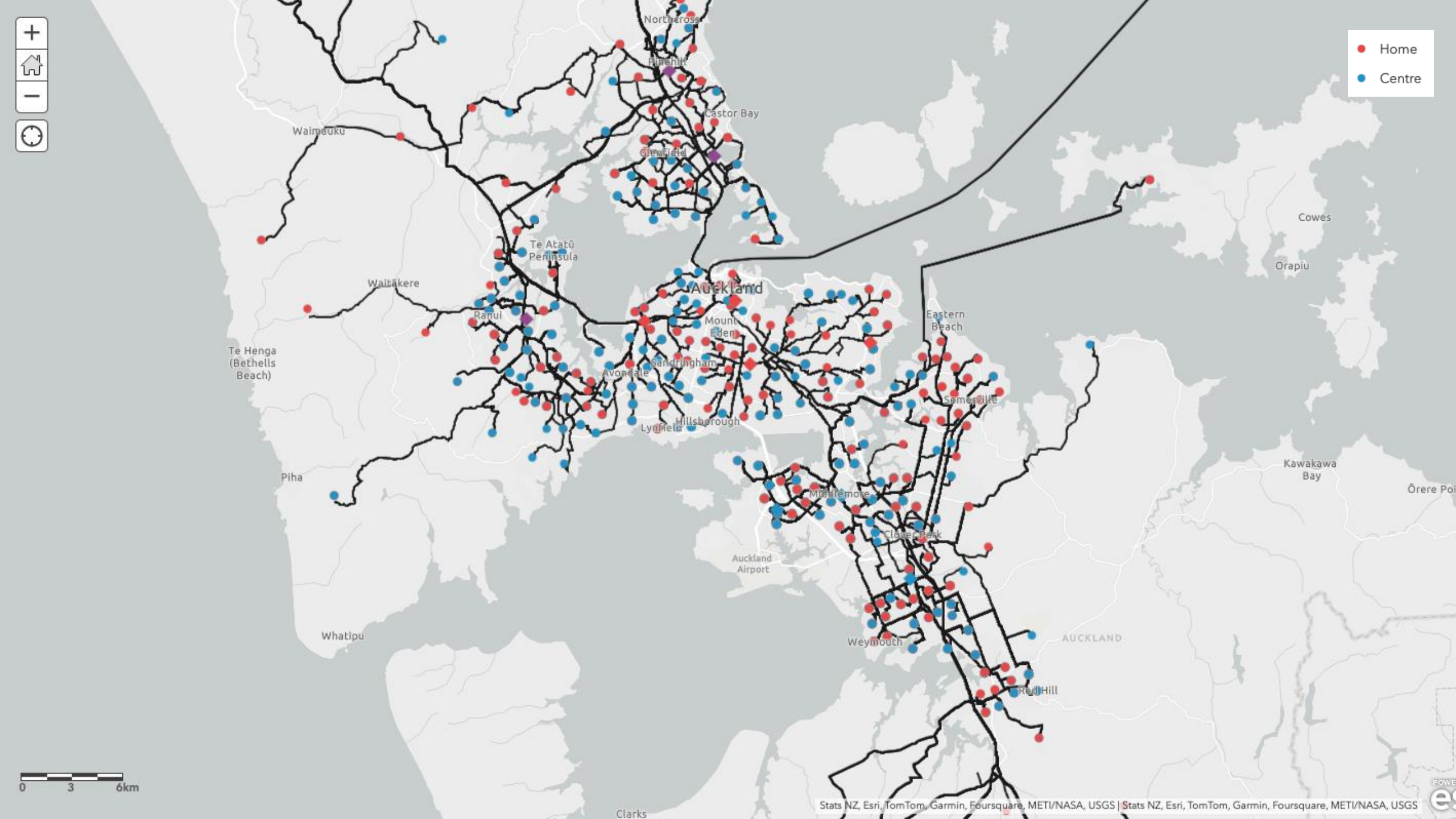
Home
Centre
Northcross
Pinehill
Castor Bay
Glenfield
Waimauku
Te Atatū Peninsula
Waitākere
Ranui
Auckland
Mount Eden
Eastern Beach
Cowes
Orapiu
Te Henga (Bethells Beach)
Sandringham
Avondale
Somerville
Hillsborough
Lynfield
Piha
Kawakawa Bay
Ōrere Po
Mangere
Clover Park
Auckland Airport
Whatipu
Weymouth
AUCKLAND
Red Hill
Clarks
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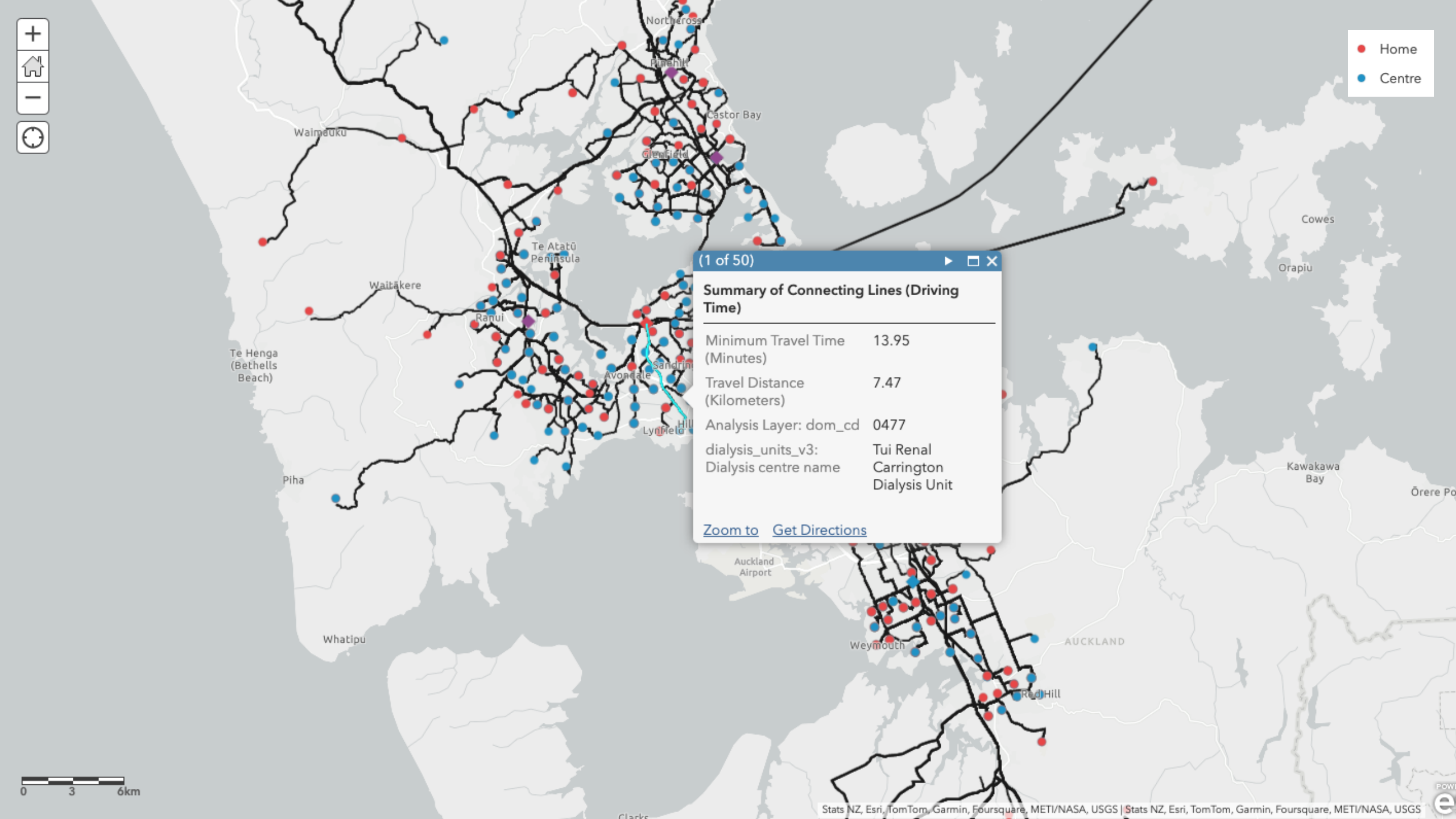
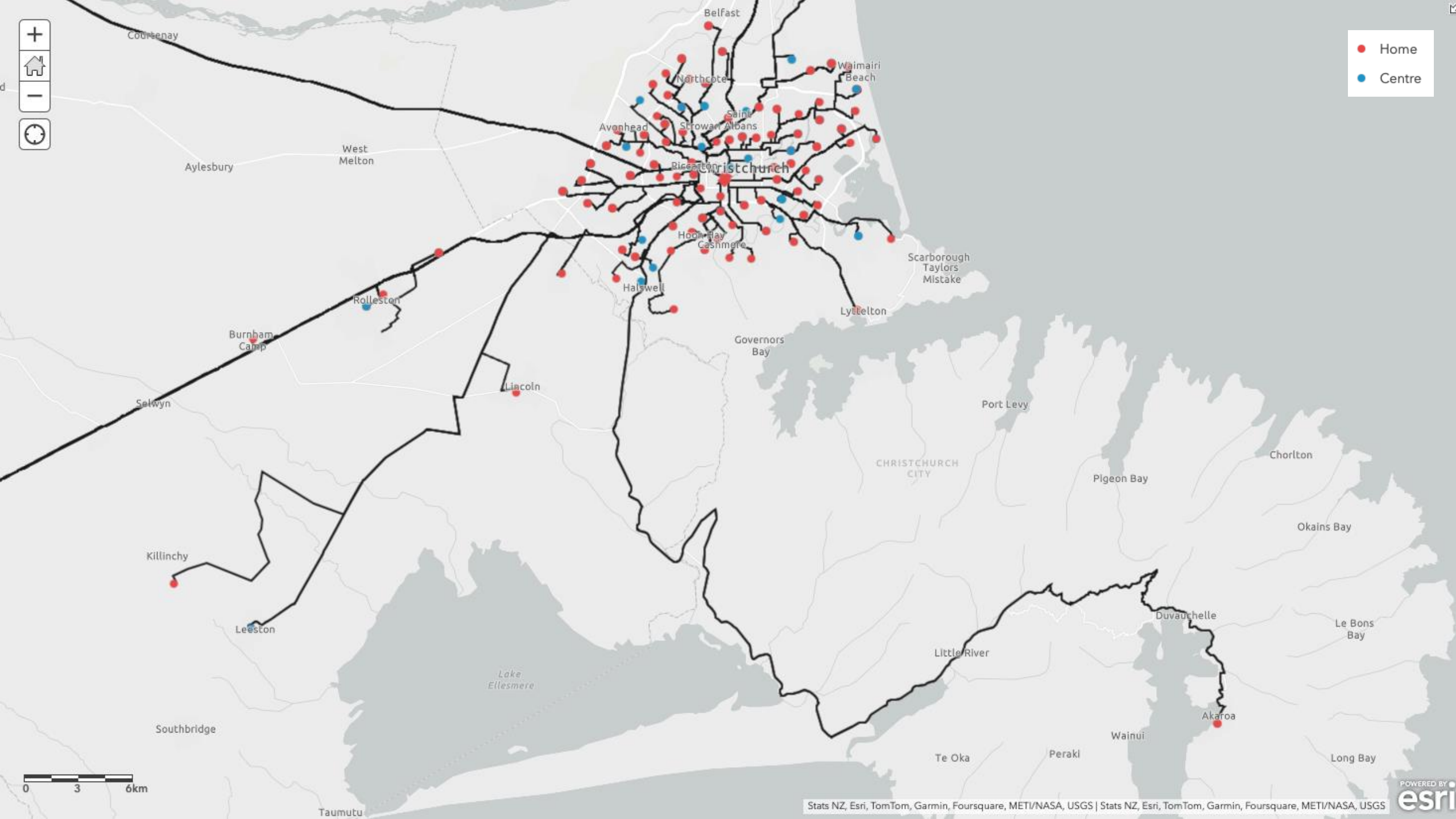
Stats NZ, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS | Stats NZ, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS


Home
Centre
Northcross
Pinehill
Castor Bay
Glenfield
Waimauku
Te Atatū Peninsula
Waitākere
Ranui
Te Henga (Bethells Beach)
Avondale
Sandrin
Lynfield
Piha
Whatipu
Auckland Airport
Weymouth
AUCKLAND
Red Hill
Cowes
Orapiu
Kawakawa Bay
Ōrere Po
(1 of 50)
Summary of Connecting Lines (Driving Time)
Minimum Travel Time (Minutes) 13.95
Travel Distance (Kilometers) 7.47
Analysis Layer: dom_cd 0477
dialysis_units_v3: Dialysis centre name Tui Renal Carrington Dialysis Unit
Zoom to
Get Directions
0 3 6km
Stats NZ, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS | Stats NZ, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS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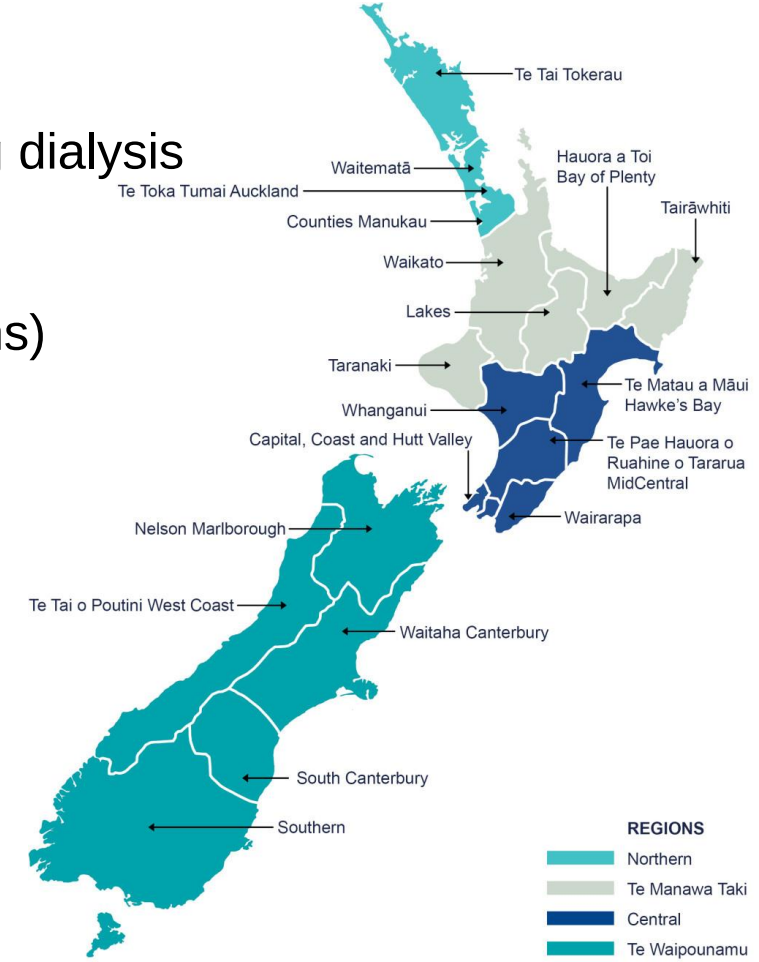
Belfast
Courtenay
Waimairi Beach
Northcote
Saint Albans
Avonhead
Strowan
Aylesbury
West Melton
Riccarton
Christchurch
Hoon Hay
Cashmere
Scarborough
Taylors Mistake
Halswell
Rolleston
Lyttelton
Burnham Camp
Governors Bay
Selwyn
Lincoln
Port Levy
CHRISTCHURCH CITY
Chorlton
Pigeon Bay
Okains Bay
Killinchy
Leeston
Duvauchelle
Le Bons Bay
Little River
Lake Ellesmere
Akaroa
Wainui
Southbridge
Te Oka
Peraki
Long Bay
Taumutu
0 3 6km
Stats NZ, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS | Stats NZ, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS
POWERED BY esri

Methods:

4. Multiple logistic regression analysis

- Outcome measure:
  - Receiving **in-centre HD** (vs home therapy) at 1 year after starting dialysis

- Co-variates:
  - Driving time to nearest HD centre (0-10, >10-20, >20-30, >30 mins)
  - Age group (<45, 45-54, 55-64, 65-74, 75+ years)
  - Sex
  - Socioeconomic quintile
  - Ethnicity (European, Māori, Pacific, Asian, other ethnicity)
  - BMI category
  - M3 Multimorbidity Index (continuous)
  - Late referral (yes/no)*
  - Year category (2006-10, 2011-15, 2016-19)
  - Region (Northern, Te Manawa Taki, Central, Te Waipounamu)
  - ICHD Capacity Pressure Index (continuous)



*First nephrology assessment within 3 months of starting dialysis

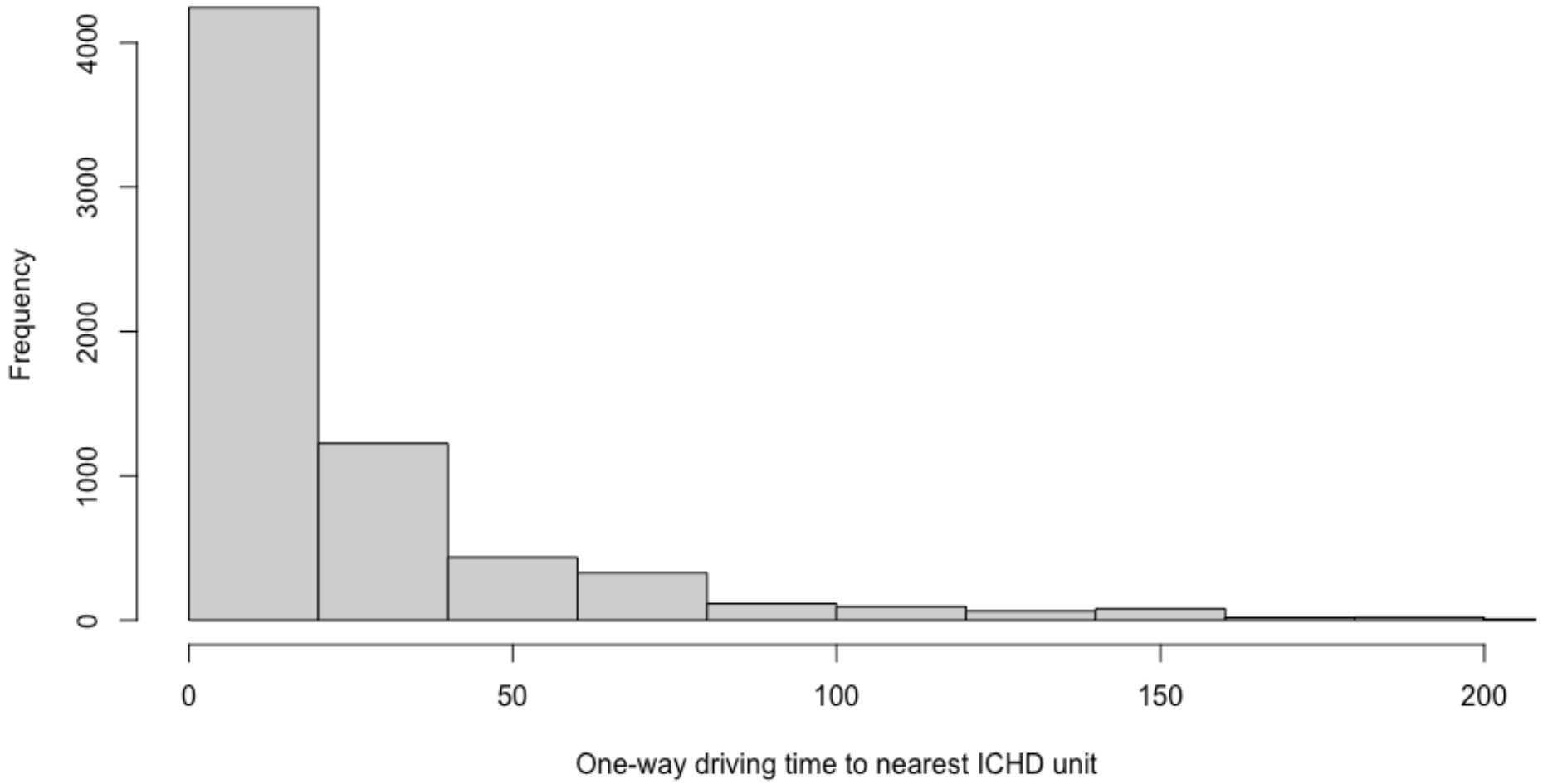
Methods:

5. Create interactive maps (2006-10, 2011-15, 2016-19) displaying:

   - Dialysis unit sites – with capacity bubbles
   - Patient distribution – by dialysis modality
   - DHB dialysis regions – colour gradients for:
     - Haemodialysis Capacity Pressure Index
     - Proportion of patients receiving in-centre HD
   - Domicile regions – patient counts and driving time

Results: travel time

Histogram of one-way patient travel times



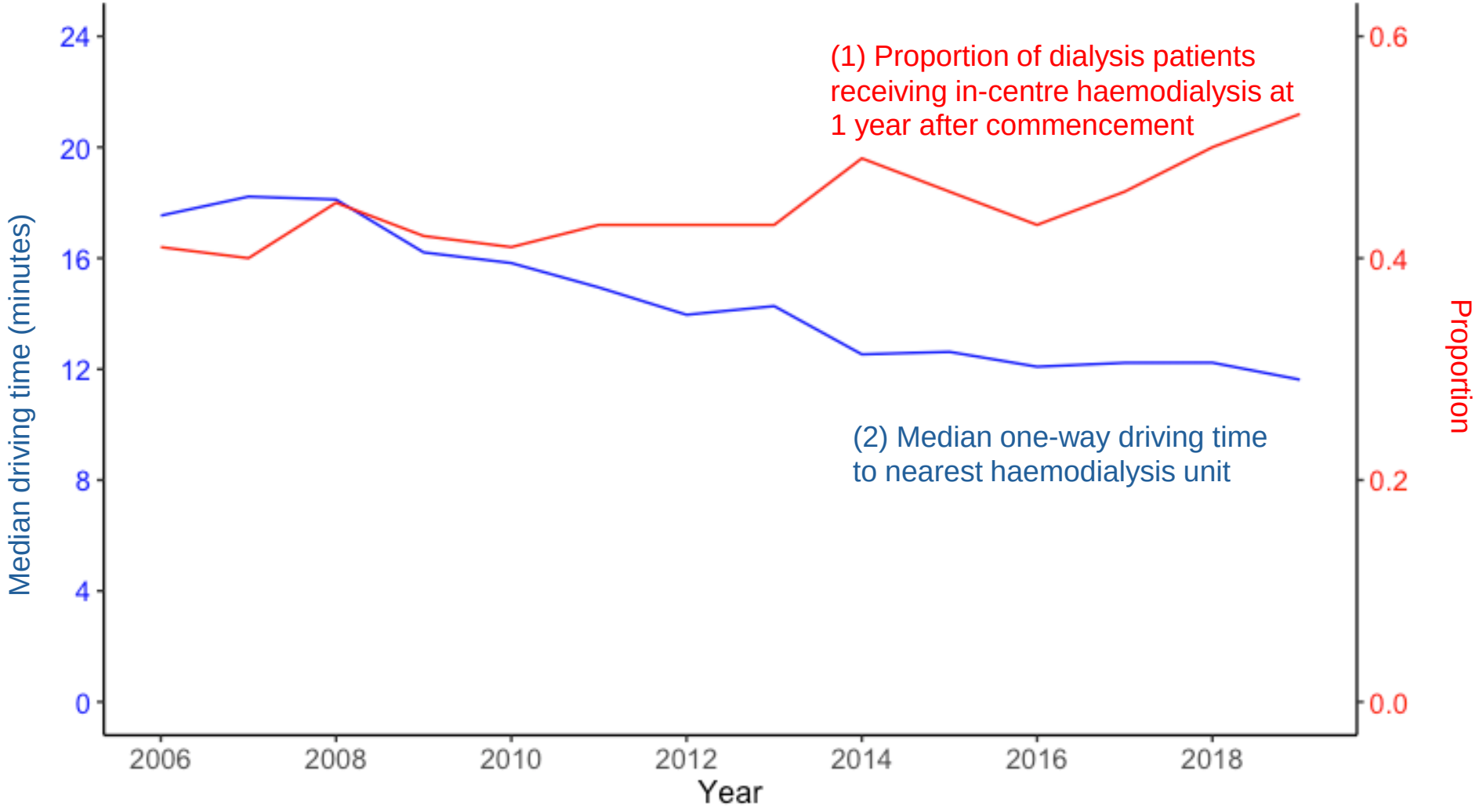
Cumulative weekly driving time and distance to nearest unit for patients receiving **ICHD**, by rurality, 2006-19 :

Rural/urban	n	Median weekly driving time (mins)	IQI	Median weekly driving distance (km)	IQI
Overall	**3,104**	**73**	**47-143**	**41**	**24-124**
Urban	2,585	65	45-110	36	23-67
Rural	429	272*	166-371	331	209-459

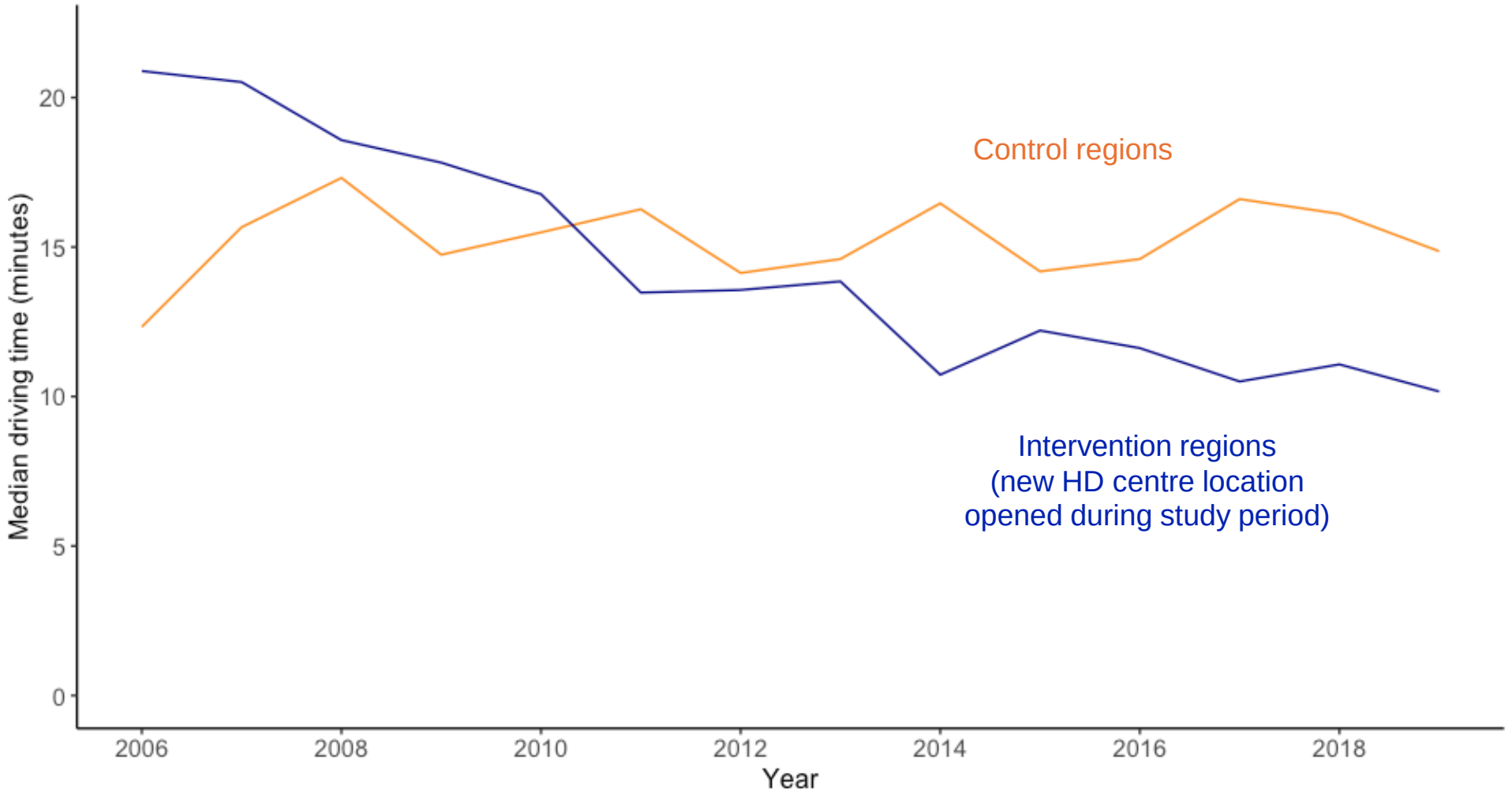
*=4.5 hrs

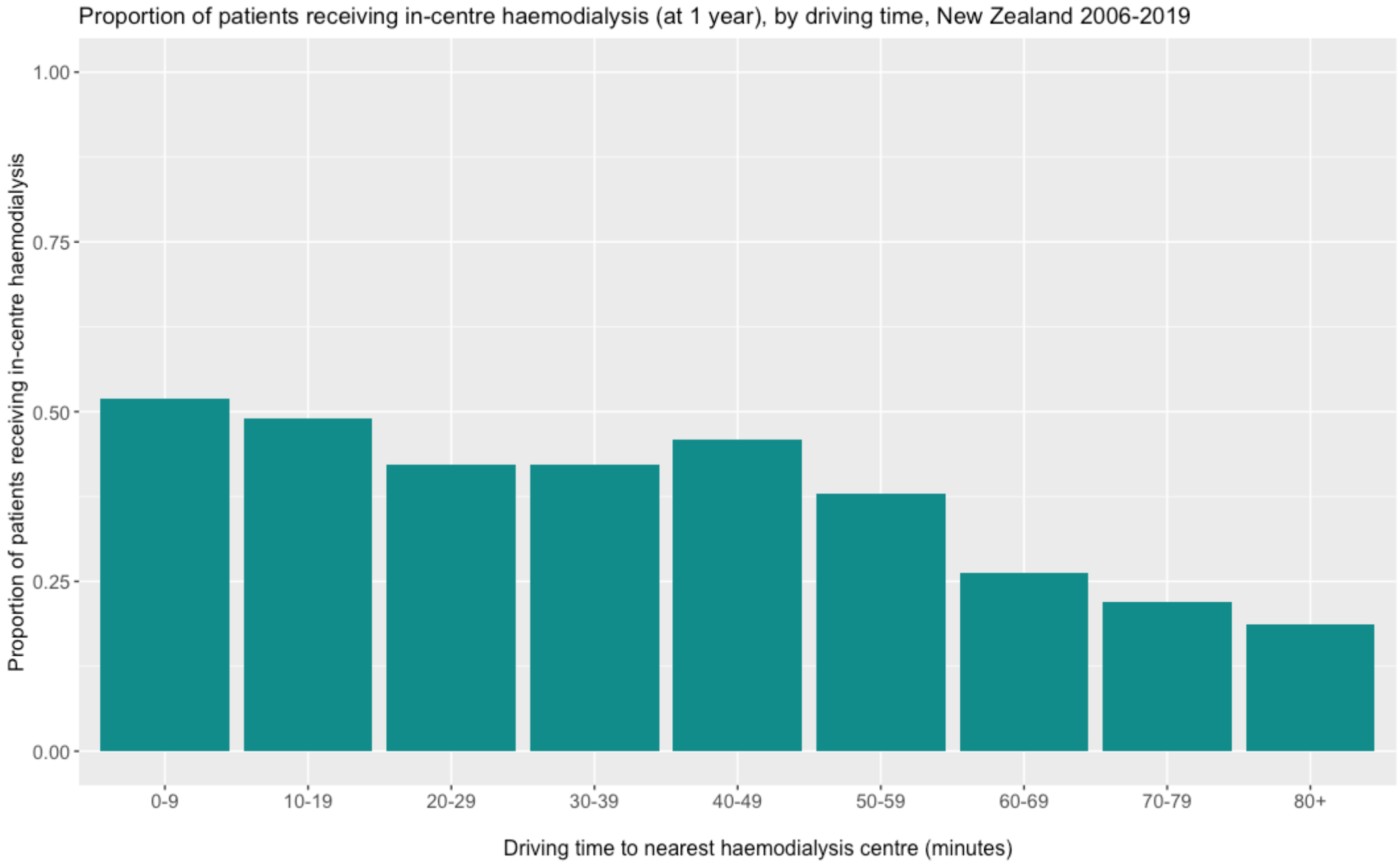
Note: assumes 3 HD sessions per week

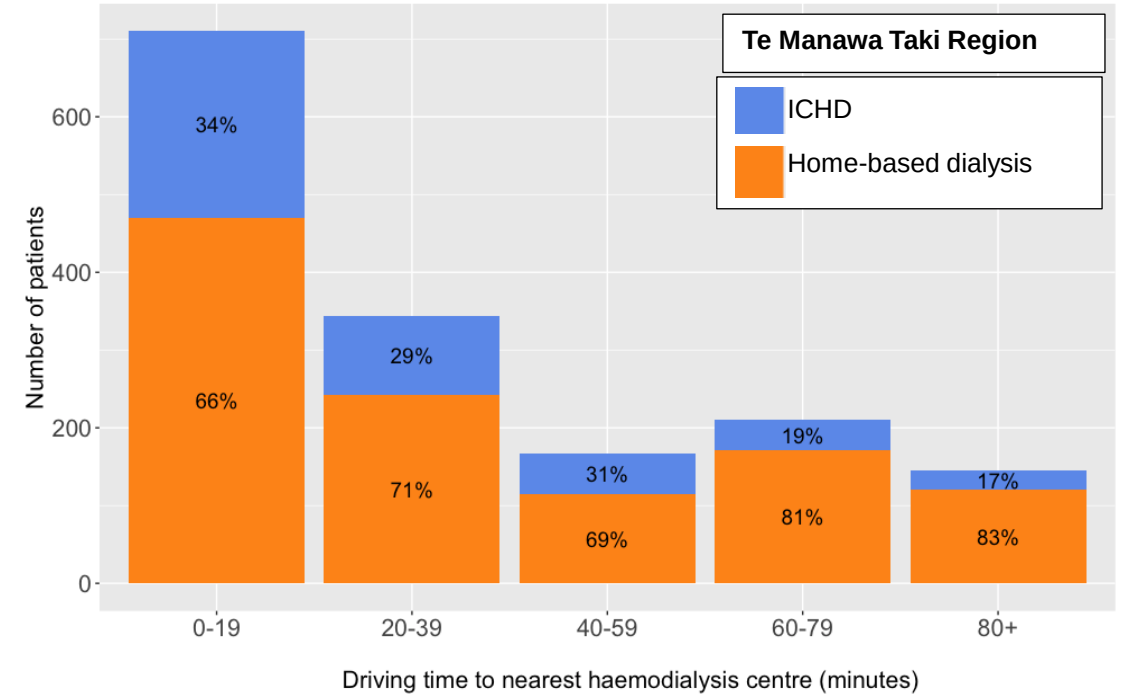
Results:

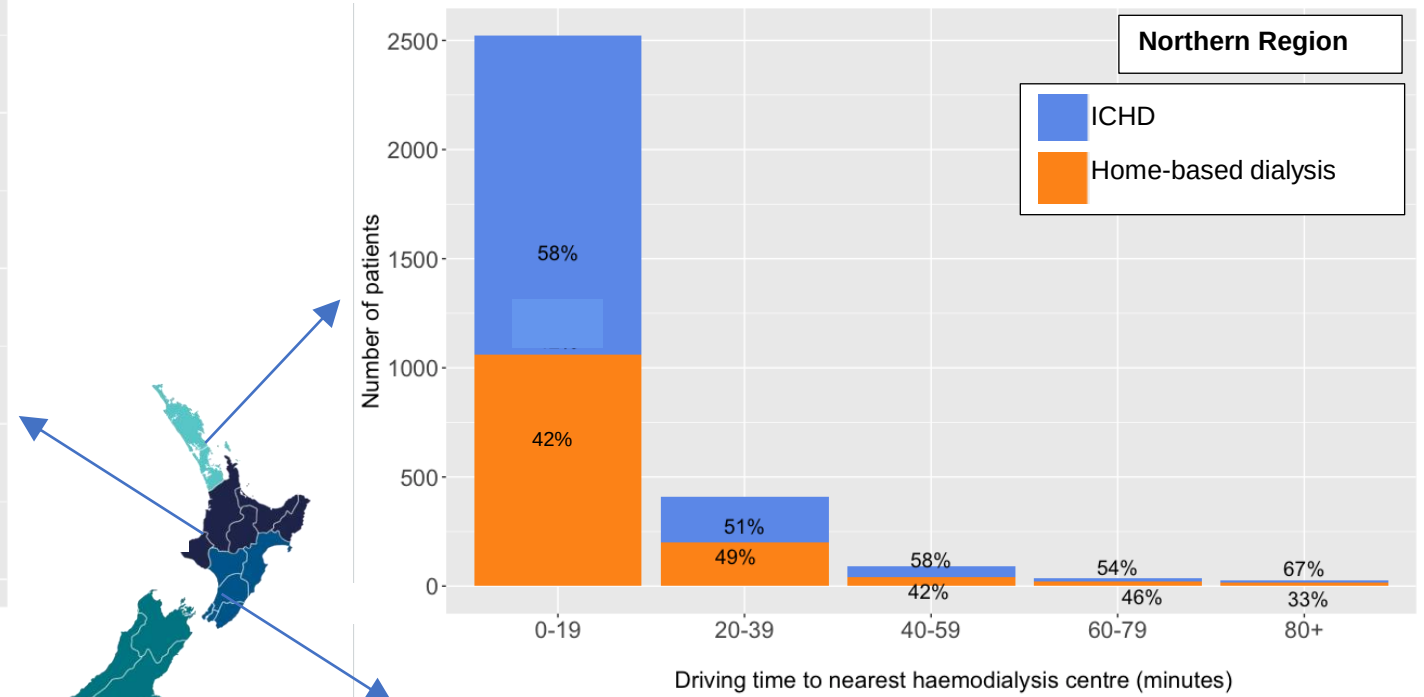

(1) Proportion of dialysis patients receiving in-centre haemodialysis at 1 year after commencement
(2) Median one-way driving time to nearest haemodialysis unit
Median driving time (minutes)
Proportion
Year
0
4
8
12
16
20
24
0.0
0.2
0.4
0.6
2006
2008
2010
2012
2014
2016
2018

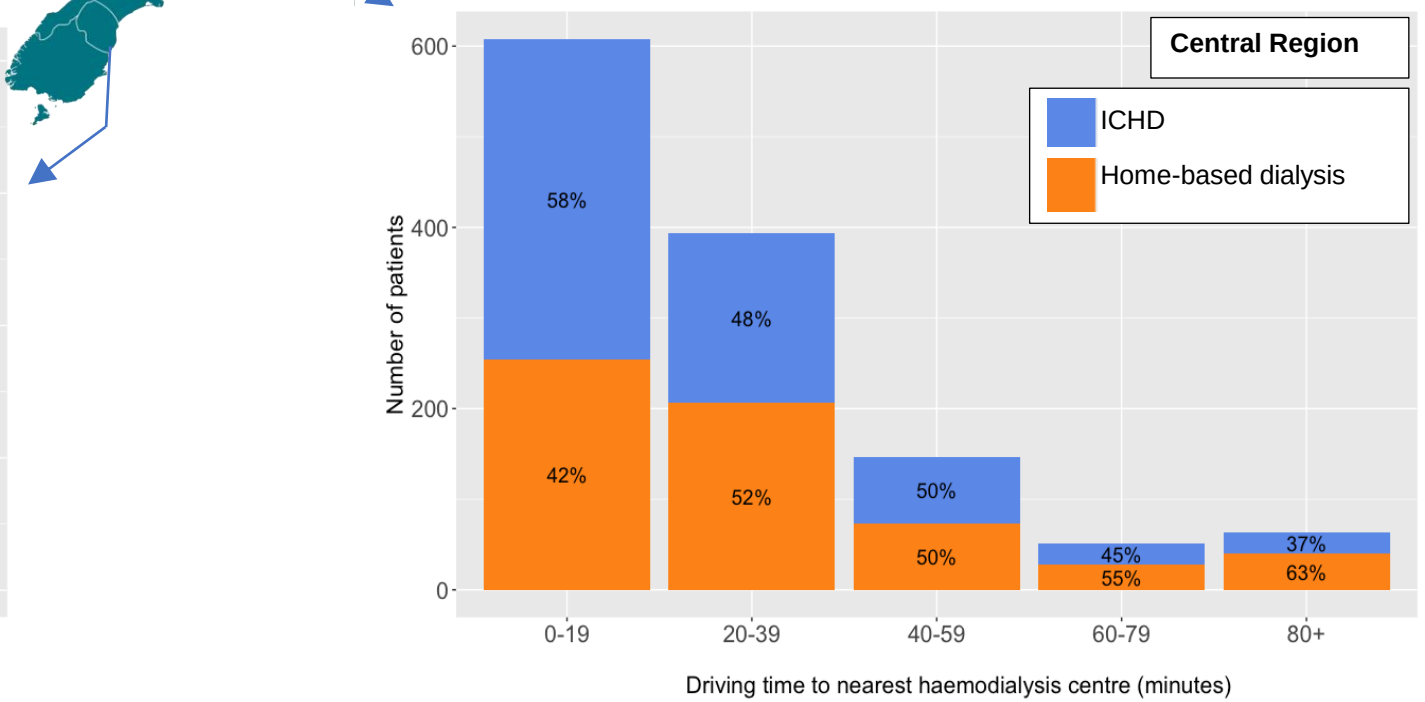
Results:

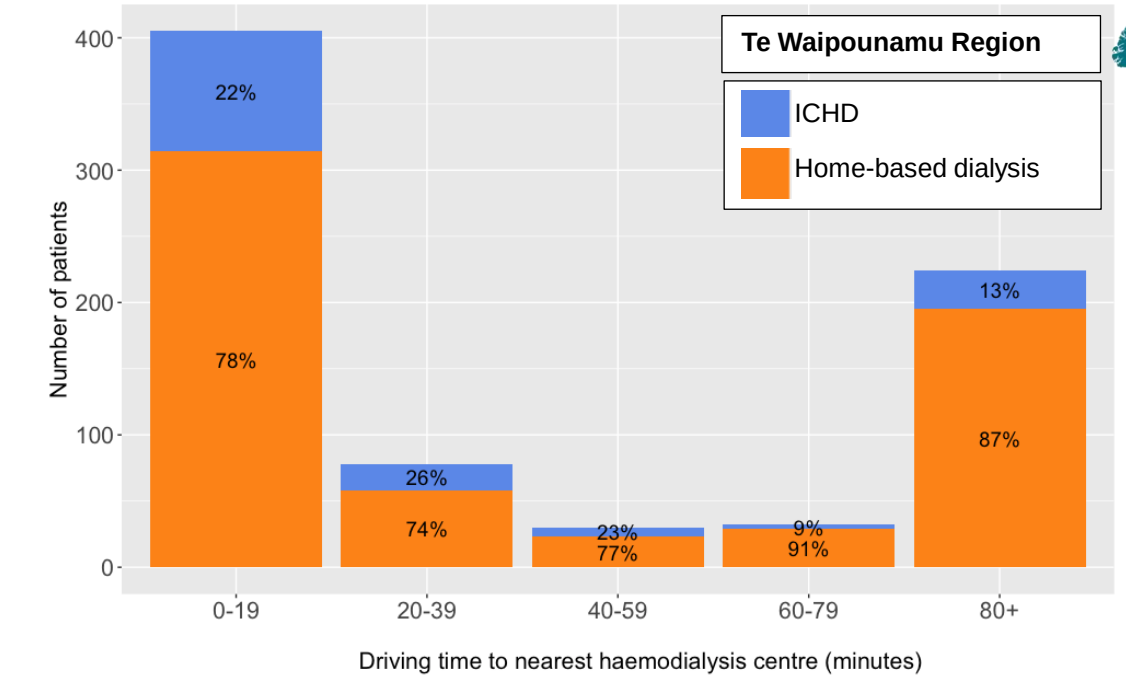

Median driving time (minutes)
20
15
10
5
0
2006
2008
2010
2012
2014
2016
2018
Year
Control regions
Intervention regions
(new HD centre location
opened during study period)

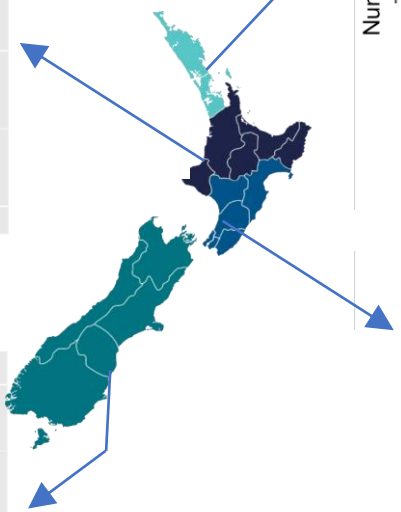

Proportion of patients receiving in-centre haemodialysis (at 1 year), by driving time, New Zealand 2006-2019
Proportion of patients receiving in-centre haemodialysis
1.00
0.75
0.50
0.25
0.00
0-9
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80+
Driving time to nearest haemodialysis centre (minutes)


Te Manawa Taki Region
ICHD
Home-based dialysis
Number of patients
0
200
400
600
34%
66%
29%
71%
31%
69%
19%
81%
17%
83%
0-19
20-39
40-59
60-79
80+
Driving time to nearest haemodialysis centre (minutes)


Northern Region
ICHD
Home-based dialysis
Number of patients
0
500
1000
1500
2000
2500
58%
42%
51%
49%
58%
42%
54%
46%
67%
33%
0-19
20-39
40-59
60-79
80+
Driving time to nearest haemodialysis centre (minutes)


Central Region
ICHD
Home-based dialysis
Number of patients
0
200
400
600
58%
42%
48%
52%
50%
50%
45%
55%
37%
63%
0-19
20-39
40-59
60-79
80+
Driving time to nearest haemodialysis centre (minutes)


Te Waipounamu Region
ICHD
Home-based dialysis
Number of patients
0
100
200
300
400
22%
78%
26%
74%
23%
77%
9%
91%
13%
87%
0-19
20-39
40-59
60-79
80+
Driving time to nearest haemodialysis centre (minutes)

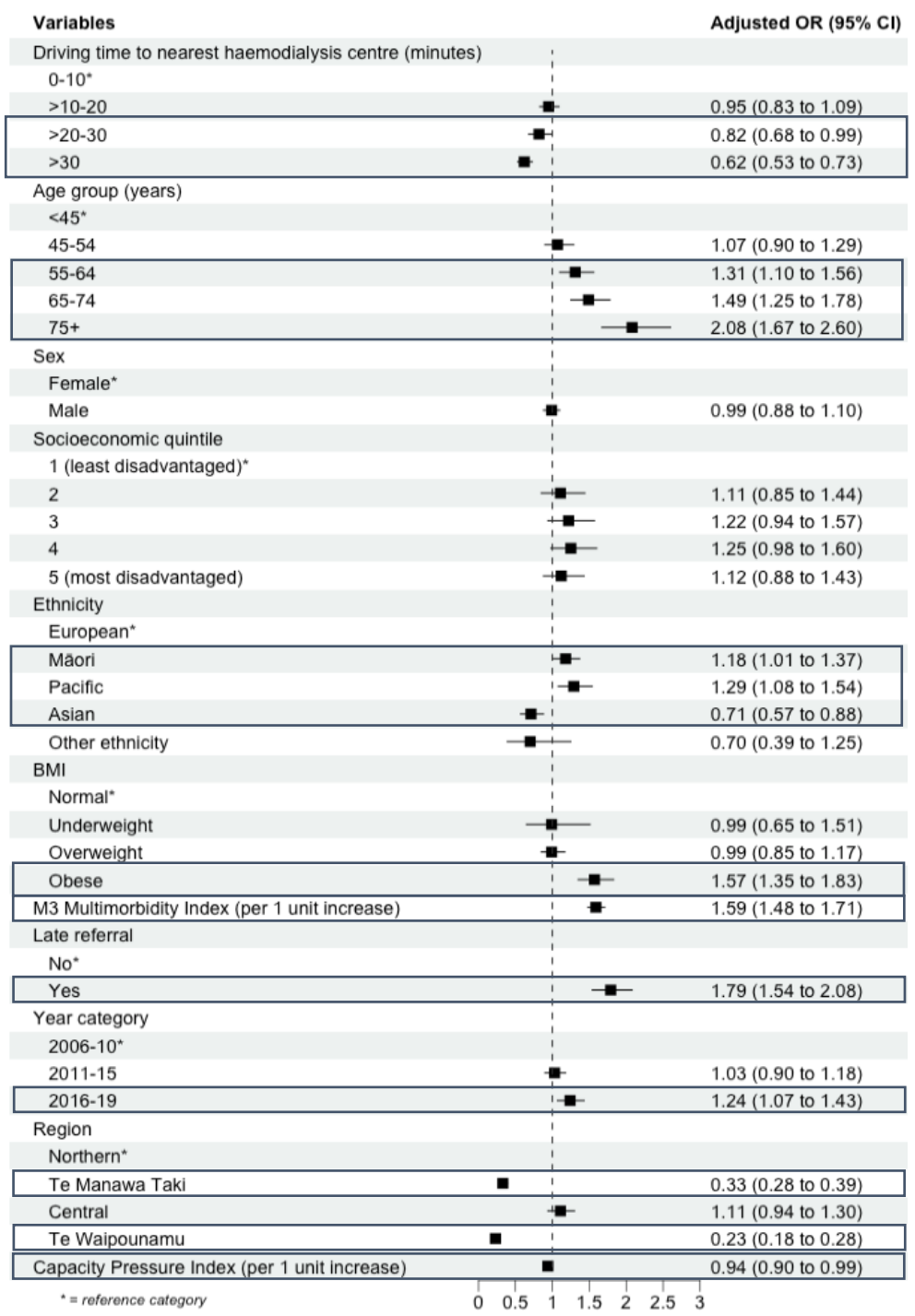


Results: multiple logistic regression analysis

Results:

- **Multiple** logistic regression analysis

- Outcome: **in-centre HD** (at 1 year after starting dialysis)

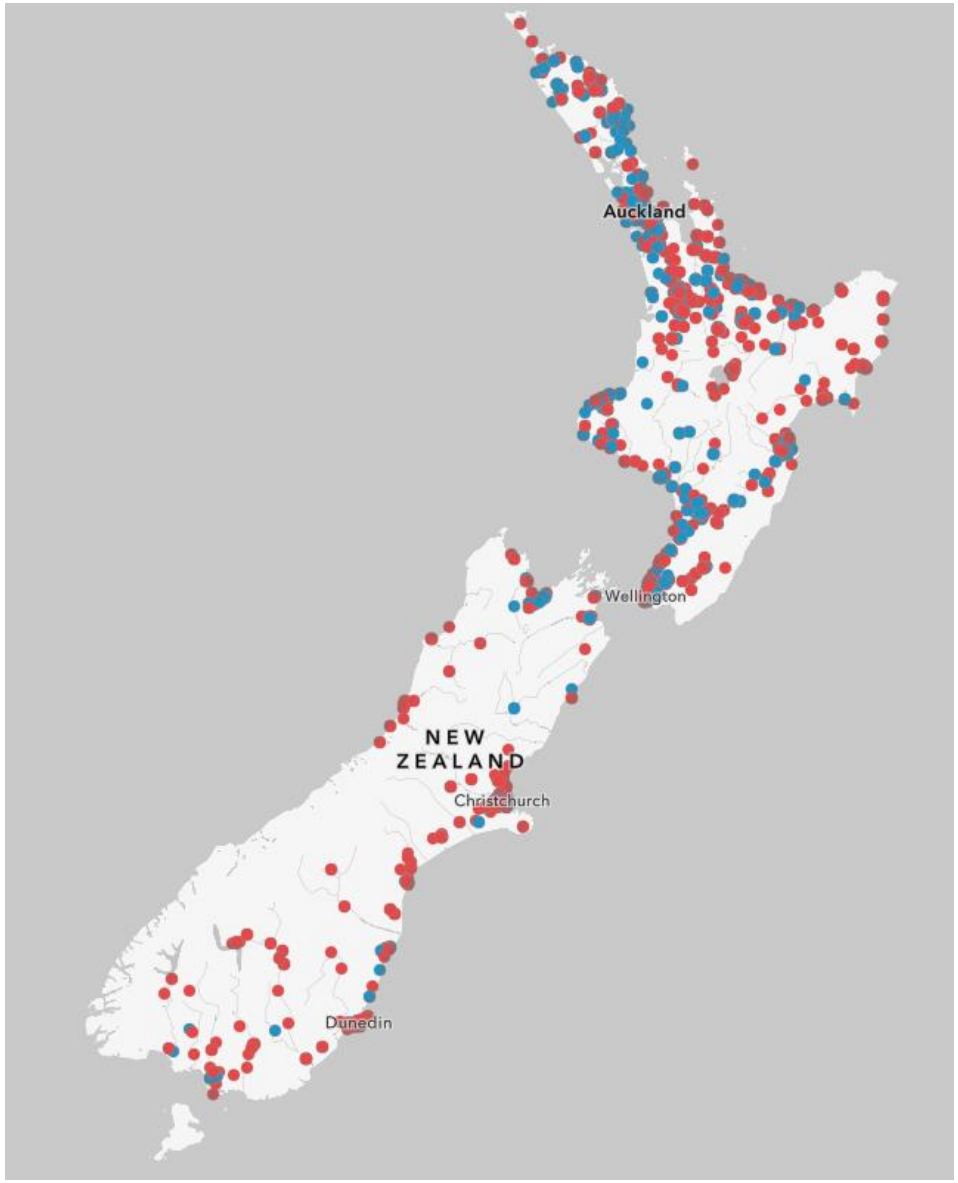


Results: interactive maps

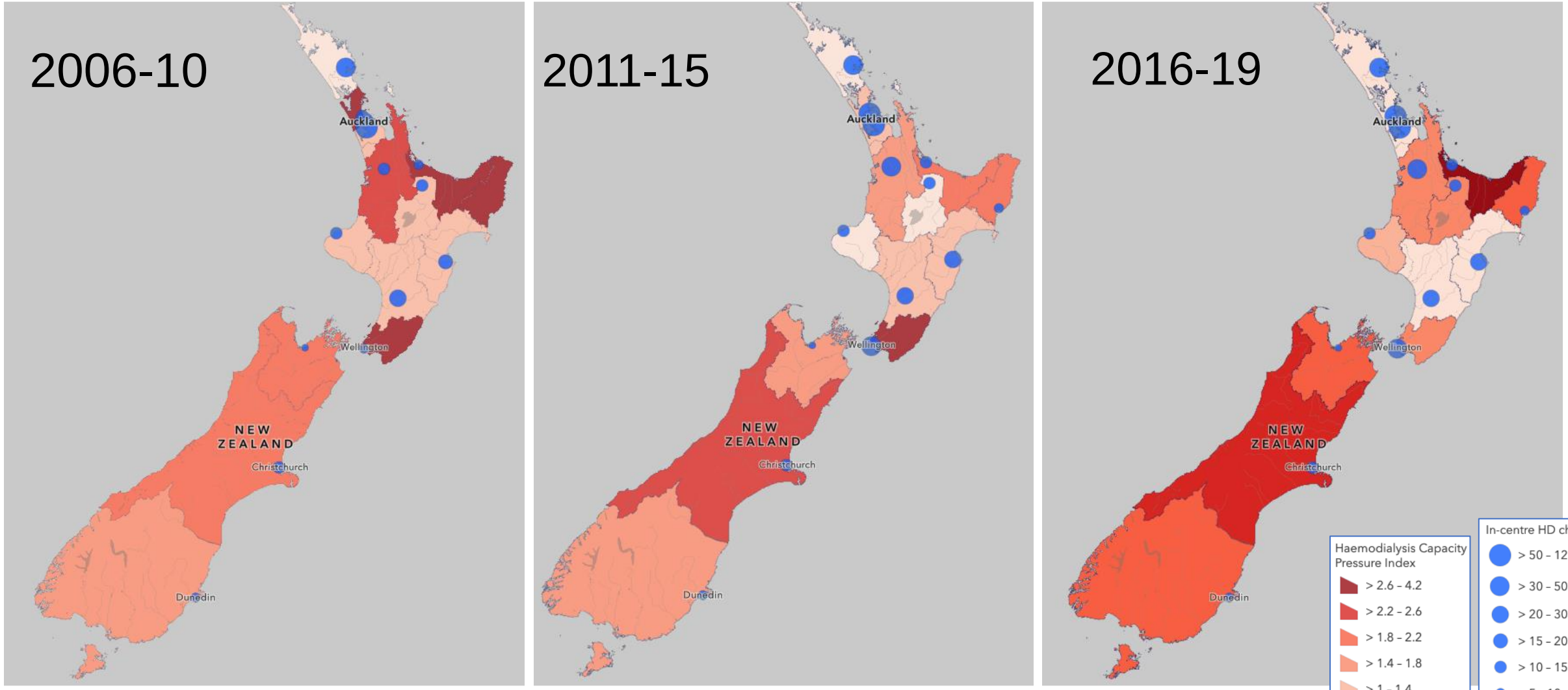
Residential location of new dialysis patients, 2006-19

Modality at 1 year:

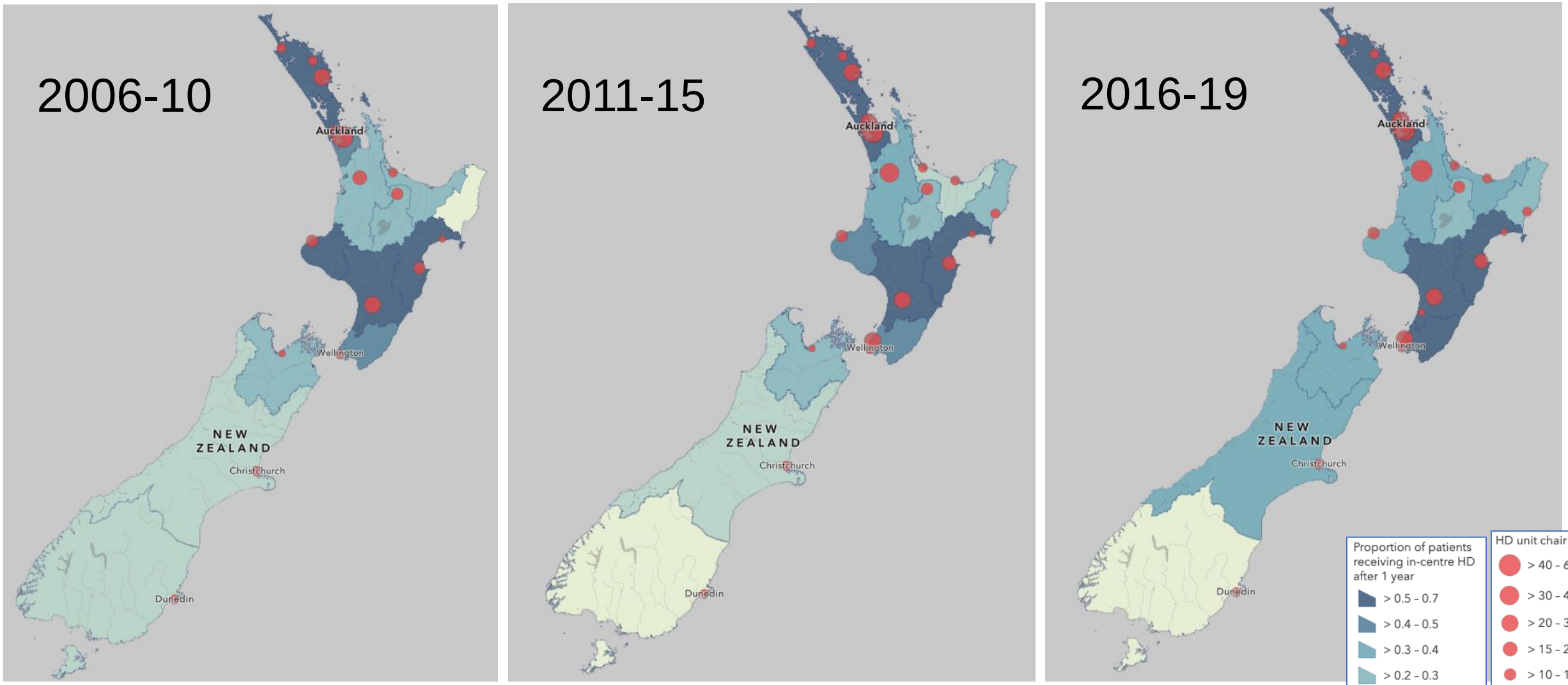
- Home dialysis (PD/HD)
- In-centre HD



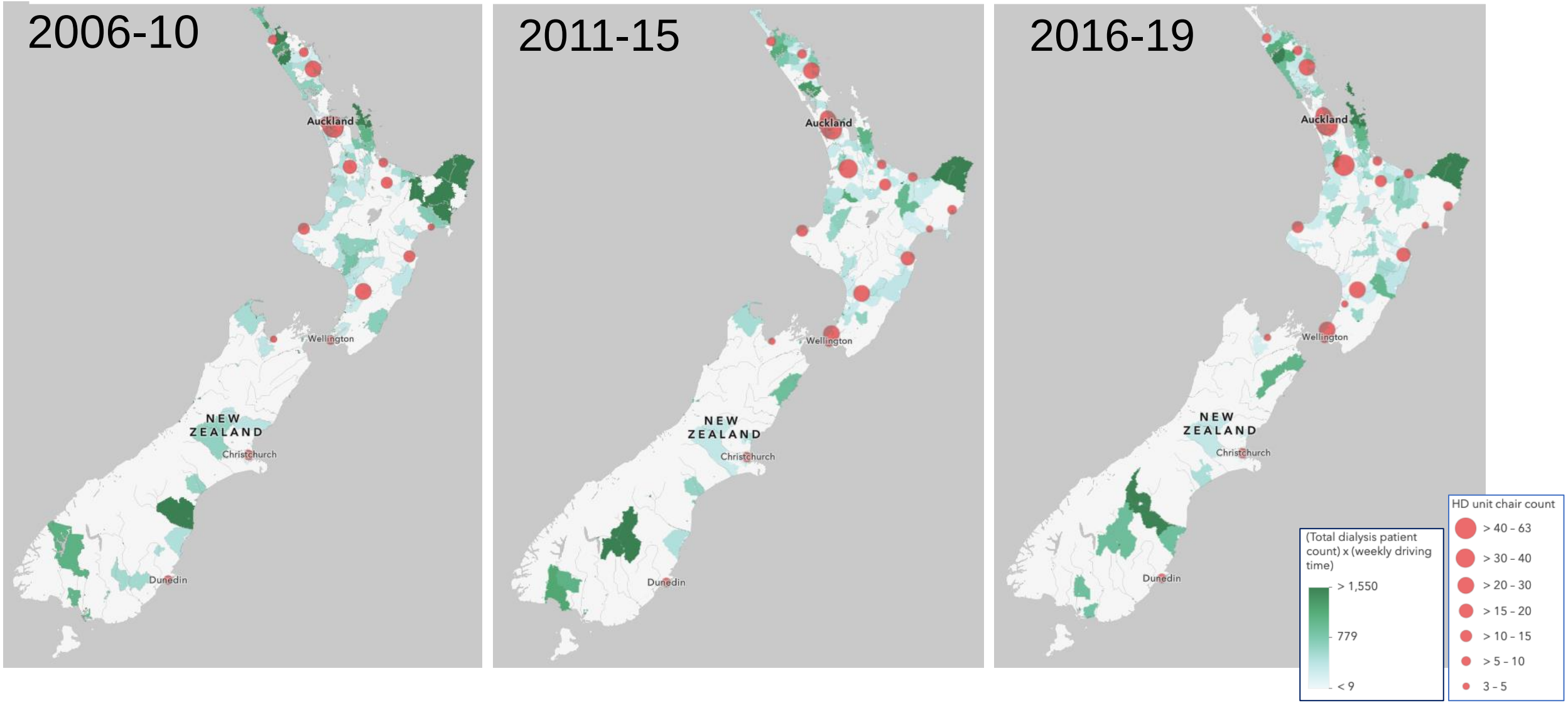
Haemodialysis ‘Capacity Pressure Index’

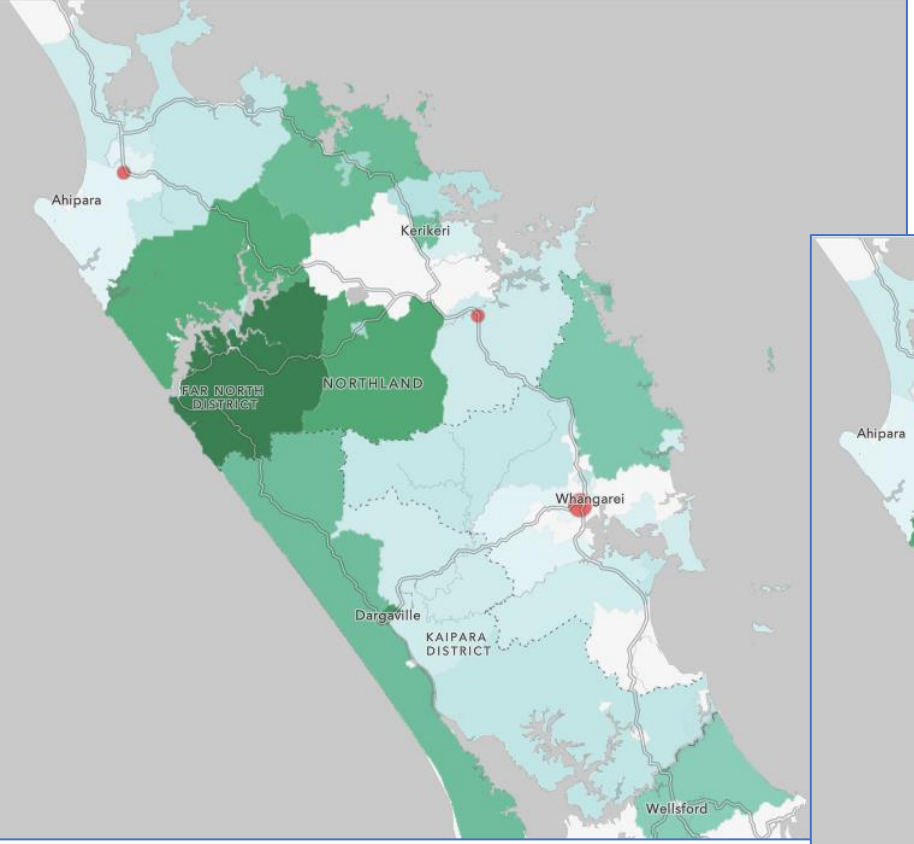


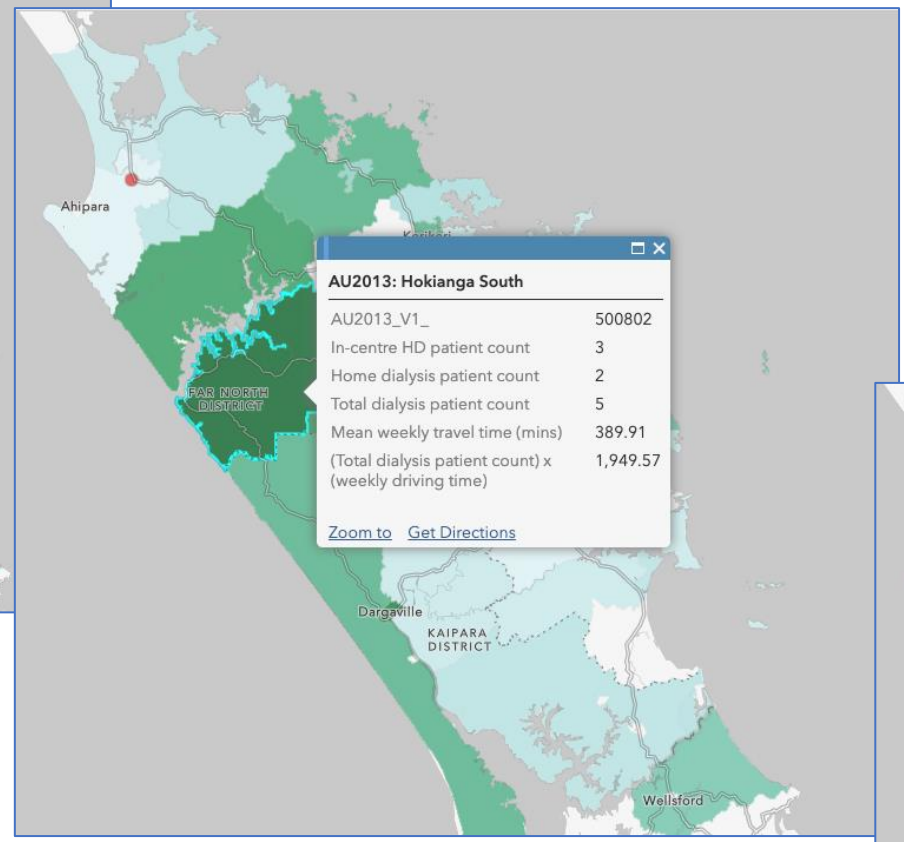
Proportion of dialysis patients receiving in-centre HD

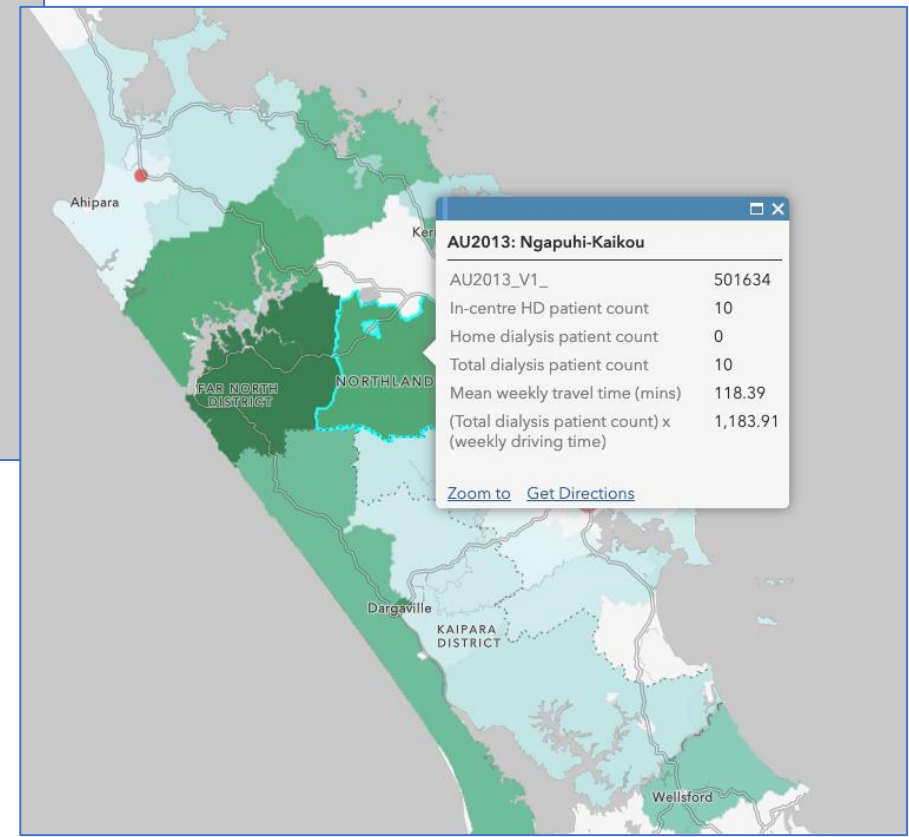


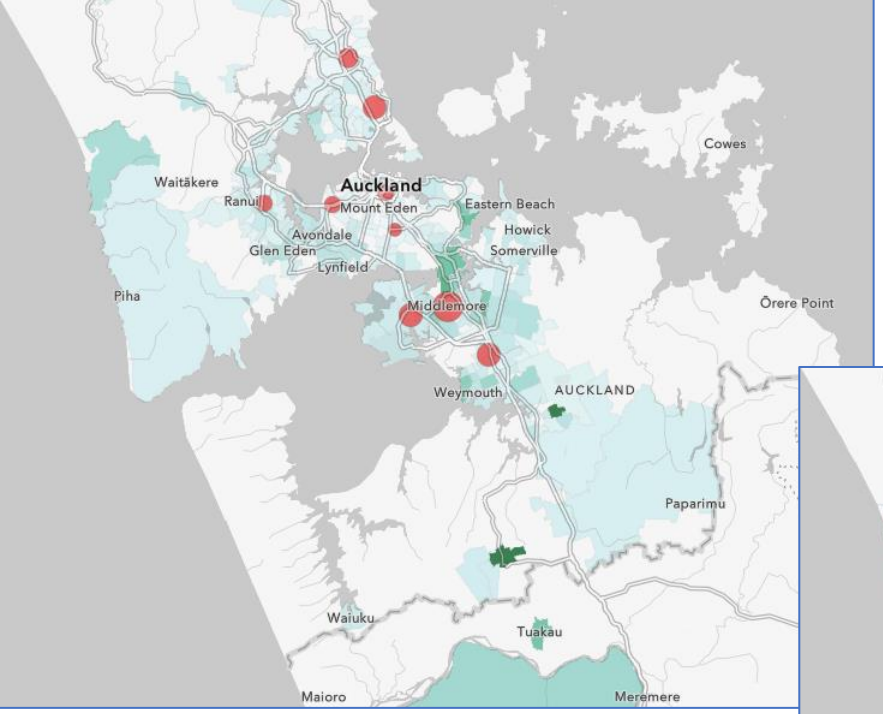
(Dialysis patient count) x (weekly driving time to HD)

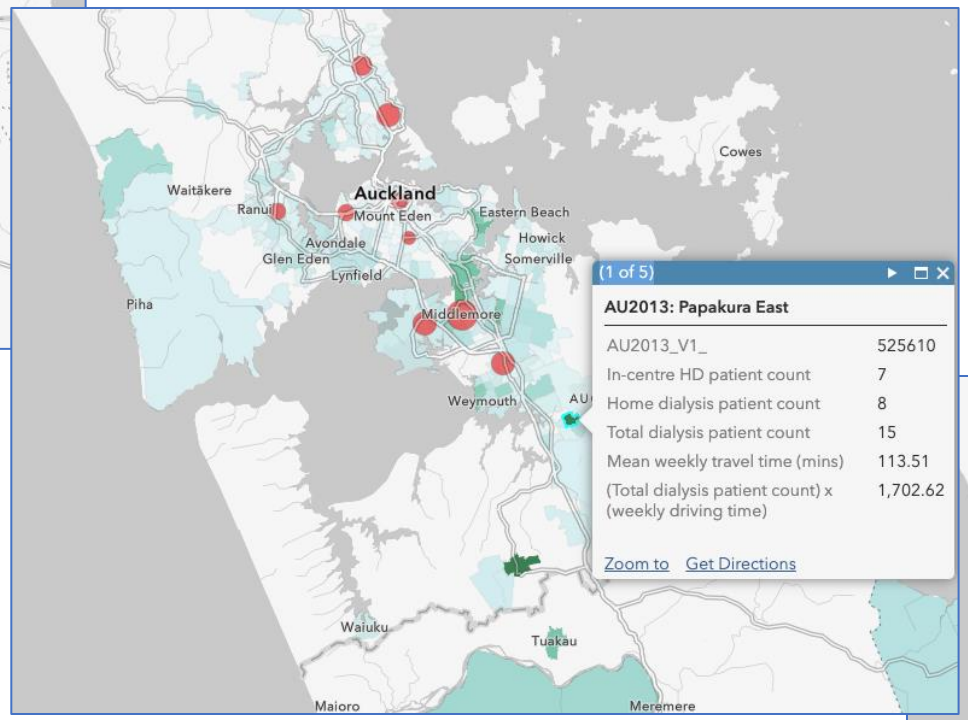


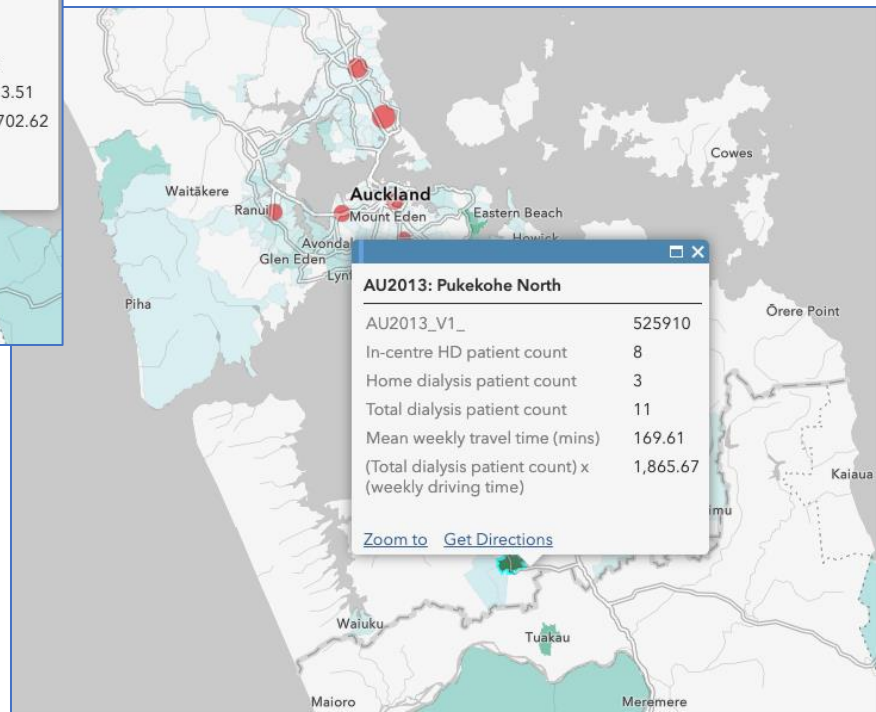

Ahipara
Kerikeri
FAR NORTH DISTRICT
NORTHLAND
Whangarei
Dargaville
KAIPARA DISTRICT
Wellsford


Ahipara
FAR NORTH DISTRICT
Dargaville
KAIPARA DISTRICT
Wellsford
AU2013: Hokianga South
AU2013_V1_ 500802
In-centre HD patient count 3
Home dialysis patient count 2
Total dialysis patient count 5
Mean weekly travel time (mins) 389.91
(Total dialysis patient count) x (weekly driving time) 1,949.57
Zoom to
Get Directions


Ahipara
FAR NORTH DISTRICT
NORTHLAND
Dargaville
KAIPARA DISTRICT
Wellsford
AU2013: Ngapuhi-Kaikou
AU2013_V1_ 501634
In-centre HD patient count 10
Home dialysis patient count 0
Total dialysis patient count 10
Mean weekly travel time (mins) 118.39
(Total dialysis patient count) x (weekly driving time) 1,183.91
Zoom to
Get Directions


Cowes
Waitākere
Auckland
Ranui
Mount Eden
Eastern Beach
Howick
Avondale
Glen Eden
Somerville
Lynfield
Piha
Middlemore
Ōrere Point
Weymouth
AUCKLAND
Paparimu
Waiuku
Tuakau
Maioro
Meremere


Cowes
Waitākere
Auckland
Ranui
Mount Eden
Eastern Beach
Howick
Avondale
Glen Eden
Somerville
Lynfield
Piha
Middlemore
Weymouth
Waiuku
Tuakau
Maioro
Meremere
(1 of 5)
AU2013: Papakura East
AU2013_V1_ 525610
In-centre HD patient count 7
Home dialysis patient count 8
Total dialysis patient count 15
Mean weekly travel time (mins) 113.51
(Total dialysis patient count) x (weekly driving time) 1,702.62
Zoom to
Get Directions


Cowes
Waitākere
Auckland
Ranui
Mount Eden
Eastern Beach
Glen Eden
Piha
Ōrere Point
Kaiaua
Waiuku
Tuakau
Maioro
Meremere
AU2013: Pukekohe North
AU2013_V1_ 525910
In-centre HD patient count 8
Home dialysis patient count 3
Total dialysis patient count 11
Mean weekly travel time (mins) 169.61
(Total dialysis patient count) x (weekly driving time) 1,865.67
Zoom to
Get Directions

Limitations:

Limitation	Potential implications
Assumption that nearest = actual dialysis unit in driving time calculations	- Travel times may be under-estimated

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Methods did not account for patients relocating for dialysis	- Travel times may be over-estimated in these cases - However, relocation carries other major financial and psychosocial burdens - Area for further research
Lack of data on regional differences in decision-making around supportive care vs dialysis	- May be a contributing factor in regional variation in modality choice - Area for future research

Key findings (1/2):

- There is an increasing trend towards in-centre HD rather than home dialysis therapies in NZ
- Independent predictors of receiving in-centre HD include:
  - Shorter driving time to a HD centre
  - Increasing age
  - Māori or Pacific ethnicity
  - Multimorbidity / obesity
  - Late referral
  - Lower local haemodialysis capacity pressure
  - Regional practices

Key findings (2/2):

- Rural patients receiving in-centre HD have a median driving time burden of at least **4.5 hours per week**, compared to 1 hour for urban patients
  - Satellite, mobile dialysis and assisted home dialysis solutions are needed
  - Further evidence of the need to improve transplant access for rural patients
- Geo-spatial mapping can provide an evidence base for National Renal Network planning, incorporating:
  - Regional epidemiology and dialysis modality trends
  - Capacity pressure
  - ‘Time toxicity’ for patients

Potential next steps:

- Hypothetical dialysis unit ‘location allocation’ modelling, including:
  - Projected regional demographic trends
  - Economic analysis
- Capturing the burden of chronic kidney disease (pre-dialysis)
  - Analyse performance of inpatient coding (ICD-10-AM codes) in the years preceding KRT
  - ? tool for regional assessment of CKD prevalence
- Rates and impact of relocation for dialysis
- Exploring renal supportive care practices in NZ, including:
  - Regional variation
  - Impact of rurality