Stats NZ
Tatauranga Aotearoa

Electoral boundaries sensitivity analysis of 2018 Census data

Prepared by Dot Loves Data for Stats NZ

New Zealand Government

Disclaimer

This paper represents the views of the authors, and do not imply commitment by Stats NZ to adopt any findings, methodologies, or recommendations. Any data analysis was carried out under the security and confidentiality provisions of the Statistics Act 1975.

Citation
Stats NZ (2019). *Electoral boundaries sensitivity analysis of 2018 Census data*. Retrieved from www.stats.govt.nz.

ISBN 978-1-98-858372-3 (online)

Published in December 2019 by
Stats NZ Tatauranga Aotearoa
Wellington, New Zealand

Contact
Stats NZ Information Centre: info@stats.govt.nz
Phone toll-free 0508 525 525
Phone international +64 4 931 4600

www.stats.govt.nz

Contents

List of tables and figures

List of tables

List of figures

Purpose and summary

Purpose

Electoral boundaries sensitivity analysis of 2018 Census data summarises the first of two sensitivity analyses conducted by Dot Loves Data under contract to Stats NZ. This paper analyses the decisions that were made in constructing the 2018 Census file and how different choices of model parameters might have affected New Zealand electorates.

This work fits within a much wider programme of engagement with technical census users to fully understand their requirements in terms of data quality and timeliness. It will provide impartial third-party input into Stats NZ decision-making processes and also provide key users with information about the impact of changes to methods on their specific use.

The work was initially carried out in March 2019 but was rerun in July 2019 after the 2018 Census unit record file was finalised.

Note:

Figures in this paper have been calculated independently from the census processing systems specifically for this analysis. Where figures are equivalent to numbers published elsewhere, they may not match.

Summary

- The 2018 Census is robust for the purpose of determining electoral boundaries and representation.
- We investigated how the choice of address match threshold for enumerating people from admin data into the census affects New Zealand electorates. Around 422,000 people could possibly be enumerated from admin data. Raising the threshold decreases the number of people who are added into the census count, but increases the likelihood that everyone was added to the right place.
- The number of Māori electorates remains at 7, regardless of what threshold is chosen.
- The number of North Island general electorates is 49, and this would drop to 48 only if a further 35,000 or more admin records were to be eliminated from the final census file.
- Electorate boundaries drawn using census counts are likely to be the same, regardless of reasonable choice of threshold. We tested removing over 35,000 people with the worst address match from the census output and inserting over 60,000 people with the best address match who were not already in the census output. A draft plan of the 2019 electorates was generated using census output, and we found that the boundaries of the plan did not need to change if people were inserted or removed.
- Auckland Central is the electorate most affected by the enumeration of people from admin data, and we would recommend further investigation into the cause of this.

Background

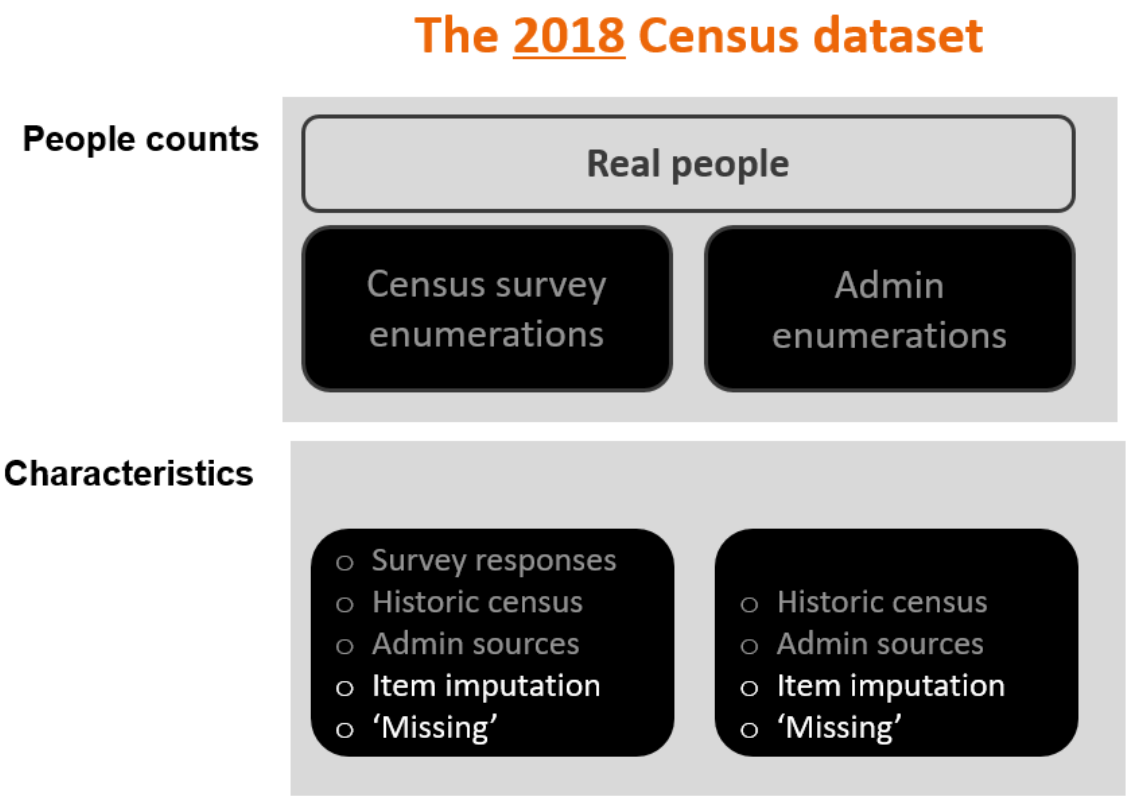
This document reports the results an assessment of the quality of census data outputs from the perspective of one of the most important uses of the data: determining electoral boundaries and representation.

This work fits within a much wider programme of engagement with technical census users to fully understand their requirements in terms of data quality and timeliness. It will provide impartial third party input into Stats NZ decision-making processes and also provide key users with information about the impact of changes to methods on their specific use.

While the census aims to collect information directly from all people in New Zealand on census night, it is usual for some people not to fill in census forms, and Stats NZ uses statistical processes to compensate for this missing data. These processes are designed to reduce the bias between the people who respond and those who do not. Because participation in the 2018 Census was lower than planned, Stats NZ is making use of data from alternative sources to fill in gaps in census responses. Overview of statistical methods for adding admin records to the 2018 Census dataset has more information.

The census count includes people who responded to the census, plus people added through administrative data enumeration. Alternative sources were also used to fill in missing characteristic information (via either administrative data sources or the 2013 Census) and imputation. The sources contributing to the 2018 Census file are shown in figure 1 below.

Figure 1: Data sources contributing to the 2018 Census

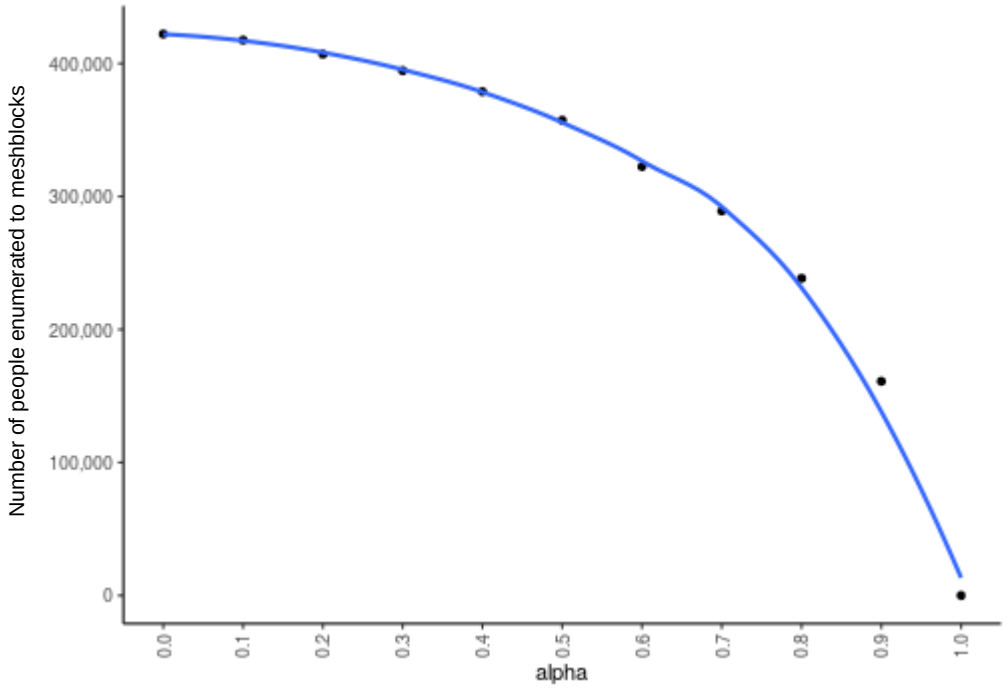


Around 422,000 people who didn't respondent to the 2018 Census could potentially be enumerated from admin data (the IDI-ERP) into a meshblock in the census output. People are only placed into a meshblock if there is good information about their address, so that we are confident that they are put in the correct area of New Zealand. There is some ambiguity about what the cut-off should be for a 'good' address match. If we tighten the criteria for a 'good' match, fewer people are enumerated into the census, but we are more confident that they are placed in the correct area. The choice of this criteria is the main source of uncertainty in the final census count.

The probability that a person in admin data will have their address matched to the correct meshblock is found using a predictive model. We call the cut off for the minimum value of this probability for the inclusion of a person in admin data in the final census count *alpha*.

- alpha=0, enumerates all 422,000 possible people from admin data into meshblocks.
- alpha=0.5 is the chosen value of alpha used in the current census output. This enumerates 357,000 people from admin data into meshblocks.

Figure 2: The number of people enumerated into a meshblock from admin data



Stats NZ uses census data to perform electoral population calculations (number of Māori and general electorates, quota in each electorate), and provides the information to the Electoral Commission. The 2013 calculations are described in The mathematics of electorate allocation in New Zealand based on the outcome of the 2013 Census and Māori Electoral Option 2013. The Electoral Commission then redraw the electoral boundaries as required to meet the constraints:

- each electorate must have an electoral population that is within +/- 5 percent of its electoral population quota; this is the only hard constraint
- existing electorate boundaries
- community of interest – including tribal affiliations for Māori electorates
- communications facilities – including links such as roads and telephone services

- topographical features – such as mountains and rivers
- projected variations in electoral populations – particularly large regional changes expected within five years.
- In respect of Māori electorates, the Representation Commission uses the above criteria and also takes into account tribal affiliations when deciding the electorate boundaries.

This process uses the census population counts of each meshblock, for the whole population, and for people of Māori descent as well as enrolment data from the Electoral Commission. Any uncertainty around these counts could result in uncertainty around the number of general or Māori electorates, and where the electorate boundaries would be drawn.

This report is a sensitivity analysis of how the electoral calculations and electorate boundaries could be affected by changing the value of alpha in the final census counts.

Method and materials

Materials

Census output

We used the latest 2018 Census data file available (as at July 2019) to find population counts and counts of people of Māori descent by meshblock. In the census output, alpha=0.5 (people from admin data were enumerated into a meshblock if they had address match probability over 0.5). This data had been processed so that all missing information about Māori descent was imputed, either from admin data, or by donor imputation.

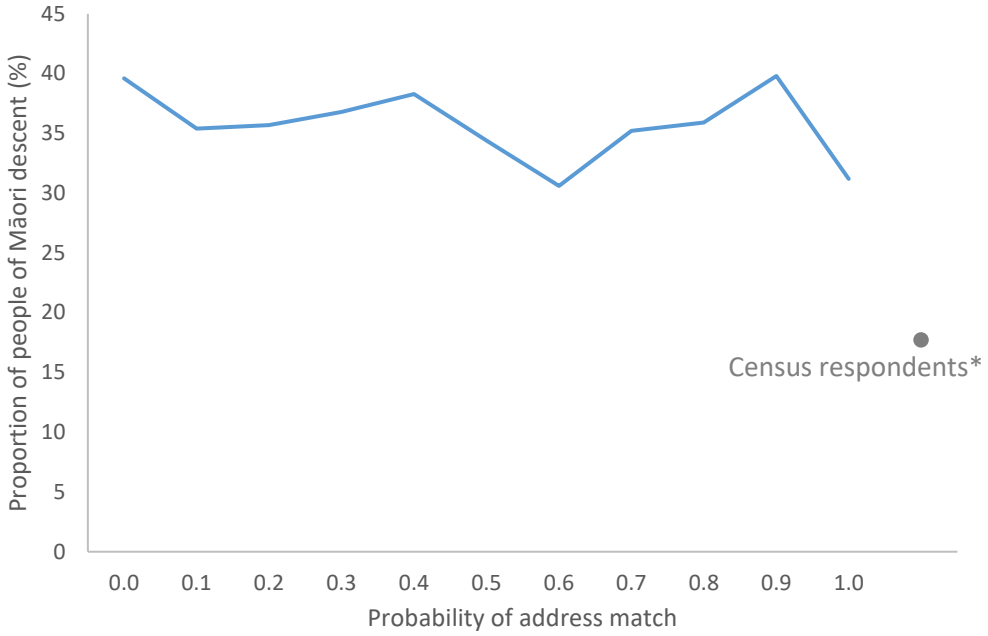
Admin data

We were supplied a file from the IDI Estimated Resident Population (ERP), which included all people counted in the census output, and also people who would be included if alpha were lowered. The probability of being enumerated into a meshblock was included in the data for each person.

65,000 people could be enumerated to a meshblock but were not already in the census output because they had probability <0.5. Of those people, 49 percent had missing values for Māori descent because this data had not been through the census processing pipeline. We imputed this information based on the data available. Māori descent was first imputed to be true for all people with Māori ethnicity and then a logistic regression model was used to impute descent for those who were not of Māori ethnicity. The model included age, sex, birthplace, prevalence of people of Māori descent in their meshblock and Area Unit, and imputation status into the census output. The gini of our logistic regression model was 0.67, indicating that the model was good at predicting Māori descent

We checked how the proportion of people of Māori descent is related to address data quality for those who could be enumerated from admin data. Figure 3 shows the proportion of Māori descent for groups of people in the admin data with the same probability of address match to a meshblock. Also shown is the proportion of people of Māori descent out of census respondents (17.7 percent). The proportion of people of Māori descent is much higher for the people imputed from admin data than census respondents. However, there is no strong trend of more people of Māori descent with lower quality address data.

Figure 3: Proportion of people of Māori descent by address match probability



*Census respondents includes people with imputed Māori descent data, but not admin enumerations to meshblocks.

Using the census output and the IDI-ERP, we essentially created 11 census meshblock datasets, for alpha = 0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0. This was the population count and count of people of Māori descent for each meshblock.

Other data

Electoral roll data was necessary for electoral calculations and was supplied by the Electoral Commission. We also used population projections based on an earlier version of the census output, but applied the proportional increases to the current census output.

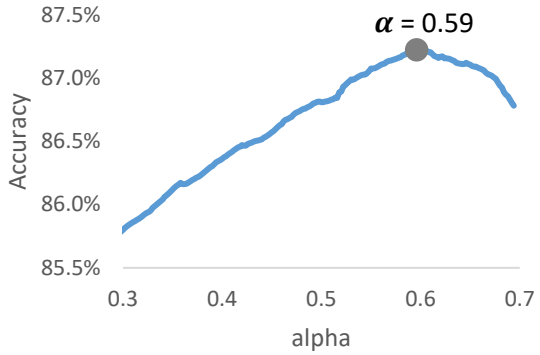
Method

Choose a parameter space

In this sensitivity analysis, we will see how different choices of alpha affect the electoral calculations, and it is necessary to choose reasonable bounds for alpha to conduct the analysis.

This is the choice of the trade-off between precision and recall of the model, but there is no right or wrong choice. Precision is the proportion of positive identifications that are actually correct whilst recall refers to the proportion of actual positives that were identified correctly. Accuracy is the proportion of correct identifications. It is possible to find the cut-offs for the models that maximise accuracy, shown in figure 4.

Figure 4: Model cut-offs that maximise accuracy



The accuracy of the person-place model is maximised at alpha=0.59. However, high recall is important to make sure as many people as possible get counted in the census. This why we chose to focus on a parameter space skewed to lower values of alpha, in particular, alpha between 0.1 and 0.7.

Calculate the number of electorates

The 2013 electoral calculations were replicated using 2018 Census data (The mathematics of electorate allocation in New Zealand based on the outcome of the 2013 Census and Māori Electoral Option 2013). The number of general and Māori electorates were calculated for different values of alpha.

Determine if electoral boundaries are sensitive to alpha

To evaluate how different values of alpha would affect electoral boundaries, we needed to create a potentially viable electoral plan for alpha=0.5 as our starting point. This initial plan was created using an interactive redistricting plugin to QGIS provided by LINZ.

We were unable to replicate the entire process of the Electoral Commission because of time constraints. However, for the purposes of sensitivity testing, the initial plan did not need to meet all the constraints, but only approximate what a plan that complies with the Electoral Act 1993 constraints (referred to as a legal plan) might look like. The purpose of the initial plan was to evaluate if small changes in meshblock counts would have large impacts on where boundaries would be drawn, and it was not intended to meet all the constraints of communities of interest beyond the legislative minimum.

The initial plan was designed to meet the constraint that each electorate must have an electoral population that is within +/- 5 percent of its electoral population quota. The projected populations were also considered, and geographic boundaries and communities of interest were considered to a limited extent. The boundaries were kept as close as possible to the 2014 boundaries.

Using the electorate boundaries of the initial plan, which satisfied the equal populations constraint, we tested if the constraint was still satisfied if different population data was used (for different values of alpha). In other words, the plan was created from the meshblock dataset with alpha=0.5, and we checked if it still met the legal constraint if we used a meshblock data with alpha=0.1 or

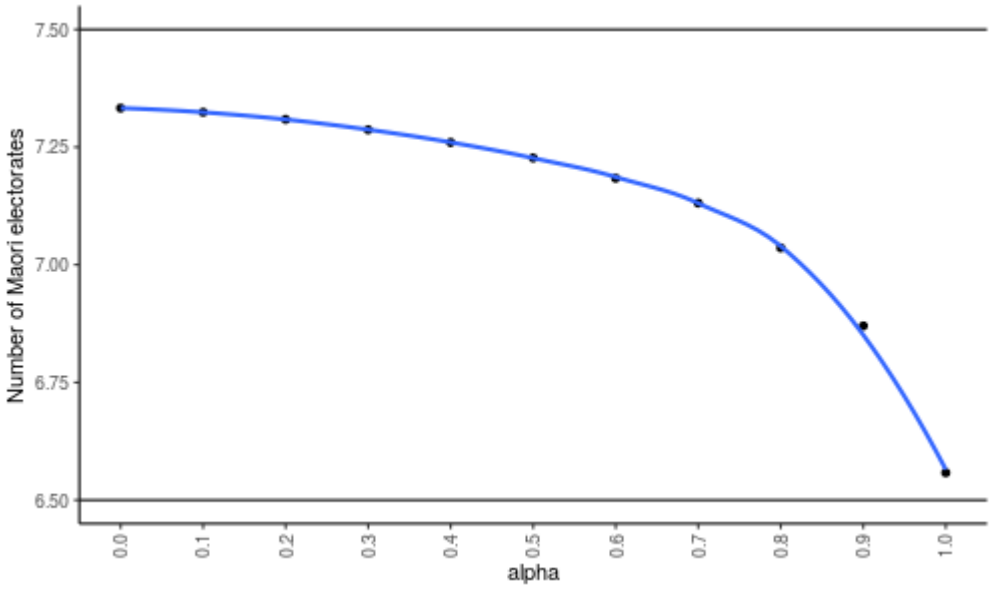
alpha=0.7 instead. If the plan did not meet the constraints when different population data was used, this would mean that the choice of electoral boundaries is sensitive to alpha.

Results

Calculation of the number of electorates

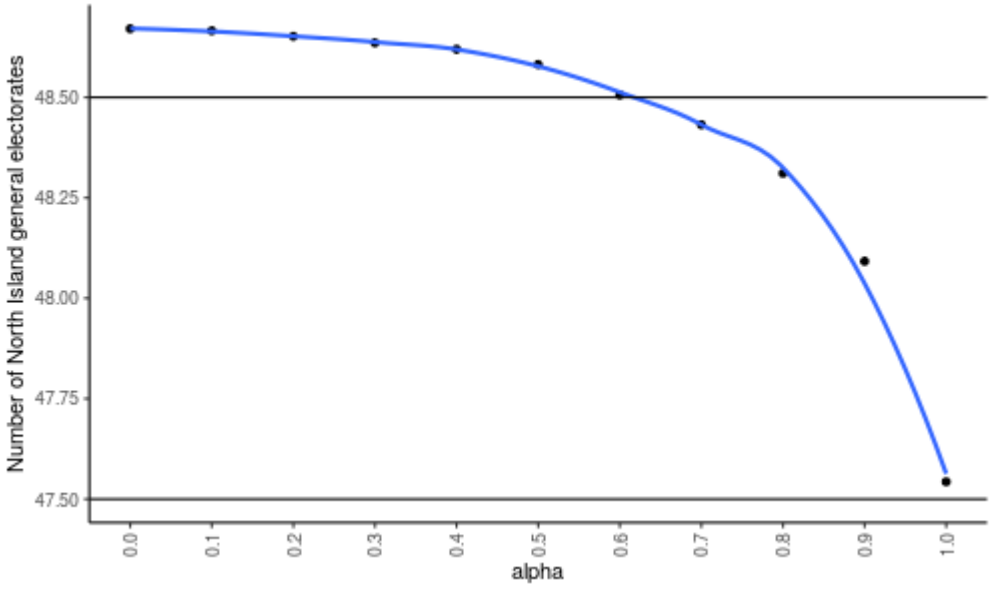
The choice of alpha does not affect the number of Māori electorates. Enumerating all 422,000 possible people into meshblocks results in seven electorates, and enumerating no people from admin data also results in seven electorates.

Figure 5: Number of Māori electorates by address linking threshold



The number of North Island electorates is sensitive to very high values of alpha. For alpha ≤0.6, there are 49 North Island electorates, and for alpha >0.6 there are 48.

Figure 6: Number of North Island general electorates by address linking threshold



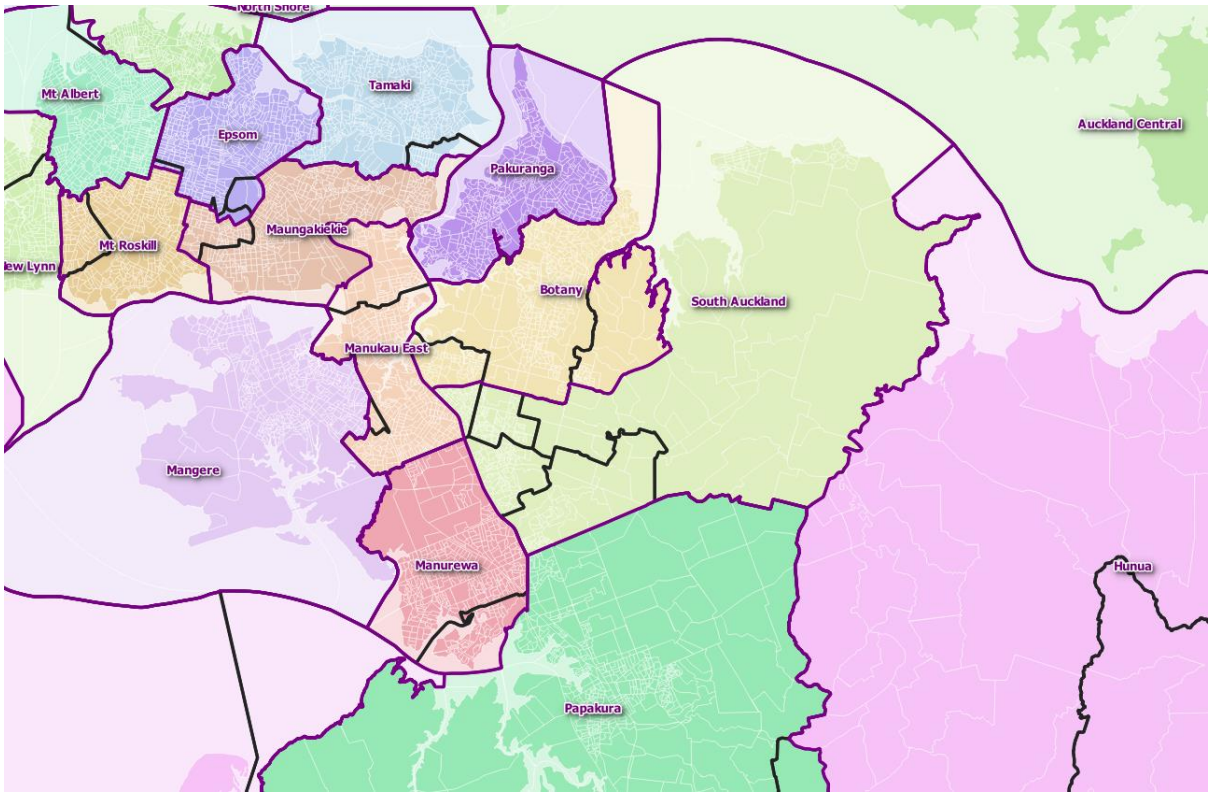
Examples of the electoral calculations and working is provided in appendix 1.

Determine if electoral boundaries are sensitive to alpha

We evaluated which 2014 electorates were furthest from meeting the legal population equality constraint and would need to be edited to form an initial electoral plan using the 2018 Census counts. The biggest modification was an additional general electorate to be inserted into the North Island, as the number of electorates increased from 48 in 2014 to 49 in 2019. In appendix 2, tables 3–5 show the variation from quota for the 2014 electorates using 2018 populations.

Because several electorates in the south of Auckland were over their quota, we put the additional electorate here, and gave it the name ‘South Auckland’. Some electoral boundaries had to be moved significantly from the 2014 positions, especially to accommodate the new electorate and the changing population in Auckland. Examples of how choices in electoral boundary positions are shown in figure 7, and the variations from quota of the initial plan is provided in tables 6–8 of appendix 2.

Figure 7: Indicative plan of south Auckland general electorates. Black lines are 2014 boundaries



Using the initial plan as a starting point, we swapped out the meshblock populations for populations made by setting alpha = 0.1 or 0.7. Setting alpha=0.1 essentially adds 60,000 people to the census, and alpha=0.7 removes 68,000 people from the census.

However, we already found that taking alpha to the extreme value of 0.7 would mean a different number of electorates in the North Island, which would result in very different electorate boundaries. For the North Island general electorates only, we used the upper limit of alpha=0.6, which effectively removes 35,000 people from the final census file, to see how electorate boundaries are sensitive to smaller changes in alpha.

For Māori electorates, changing alpha had minimal effect on the population parity of electorates. No alterations to the boundaries of the electorates would be necessary if a different value was chosen to produce the census output. Waiariki is the most affected by raising alpha, which would cause its population to change from +0.5 percent above the quota to -0.2 percent below quota, which is a shift of -0.7 percent.

In the South Island, when the populations are swapped all electorates still meet the population equality constraint. The electorates most affected were Christchurch Central and Clutha-Southland where removing people (alpha=0.7) produced a shift in the variation from quota. In Christchurch Central, the variation from quota was shifted by -0.8 percent (from +0.1 percent to -0.7 percent), and in Clutha-Southland it was shifted by -1 percent (+2.4 percent to +1.4 percent).

In the North Island, Auckland Central was strongly affected by changing alpha. For the alpha=0.5 census counts, Auckland Central was -0.1 percent from the quota. Setting alpha=0.6 (removing 35,000 people from the final census file) moved that to -3.3 percent (a shift of -3.2 percent), and alpha=0.1 (adding 60,000 people to the final census file) moved it to +3.1 percent (a shift of +3.2 percent). The boundaries of Auckland Central were drawn in the initial plan so that its population

was very close to the quota, so the changes in population did not shift the variation from quota to more than 5 percent. However, if Auckland Central's population were further from quota, the choice of a lower value of alpha would have a non-negligible impact on the choice of boundary.

Manukau East and Ohariu were also affected by changing alpha, but to a lesser extent than Auckland Central. Adding people to the census would shift these electorates 0.8 percent and 0.7 percent further from the quota, respectively.

Discussion and conclusions

The 2018 Census has proven to be robust for the purpose of redistricting. The largest source of uncertainty in the census meshblock counts is the choice of address matching threshold (alpha). We performed sensitivity analysis to explore the effect of this parameter on the application of drawing electoral boundaries. The choice of alpha has no effect on the number of Māori electorates (7).

However, the number of North Island general electorates would change from 49 to 48 if a value of alpha higher than 0.6 were chosen. This would essentially be removing 35,000 enumerated admin records with the lowest person-place probability from the final census file. Alpha over 0.6 could be a viable choice of parameter, but an unlikely choice. Although the precision of the person-place model keeps increasing with higher alpha, the accuracy peaks at alpha=0.59. Choosing a value of alpha above this would decrease recall and accuracy, and would exclude too many people with good quality address data from the census counts.

This report took a conservative approach in setting a very wide range of values of alpha to test the robustness of census meshblock counts for drawing electorates. The number of North Island general electorates did not pass this conservative test, but did pass a slightly less conservative test, which is closer to the range of parameters which would be sensible to consider.

It is likely that electorate boundaries would be drawn the same way, regardless of reasonable choice of alpha. The only instance when electoral boundaries may be affected by the choice of alpha is if they are drawn so that their population is further than 4 percent from their quota, and this would mainly affect Auckland Central, Manukau East, Ohariu, Clutha-Southland, Christchurch Central, and Waiariki.

Auckland Central is much more strongly affected by the choice of alpha than other electorates. This could be indicative of a data quality issue. People who have a low probability of address match to a meshblock are more likely to be placed into Auckland Central. This suggests that there could be an issue in the admin data like addresses defaulting to Auckland Central, or recent immigrants choosing Auckland Central as their address before settling elsewhere.

This sensitivity analysis looked only at one source of uncertainty in the census count: the address-match threshold, alpha. Any other sources of uncertainty in the distribution of the population, and in particular the distribution of people of Māori descent has not been investigated. Another limitation is that the people enumerated from admin data for alpha<0.5 had not been through the census processing pipeline, and we had to approximate the imputation process for missing Māori descent data.

To determine if electoral boundaries would need to change if a different value of alpha was used in the census counts, we had to create an initial electoral plan. This plan was drawn to meet the population equality constraint and considered the other constraints to a limited extent. This plan could have been drawn very differently, and it is expected that the final electoral boundaries would be different. In particular, the new North Island general electorate could be in a different place. The

conclusion that electoral boundaries are not sensitive to alpha is dependent on the initial plan that we drew but it is not expected that the results would change much if a different initial plan were used.

Appendix 1: Electoral population calculations

Sections 35(3b, 3c) and 45(3a) of the Electoral Act 1993 specify that the calculations of electoral populations be carried out separately for New Zealand and the North and South islands.

To determine the number of electorates, the Act divides the census usually resident population count of New Zealand into three groups:

- the North Island general electoral population (NI GEP)
- the South Island general electoral population (SI GEP)
- the Māori electoral population (MEP).

The methods for calculating the three electoral populations are provided below.

Māori electoral population

We define the Māori electoral population (MEP) as the proportion of enrolled Māori descent electors who choose the Māori electoral roll, multiplied by the electoral Māori descent census usually resident population count from the 2013 Census. This means that the MEP includes people who are not enrolled on the electoral roll (such as children). The actual calculation uses the following formula:

$$MEP = m/\ (m + g)\ d$$

where:

m is the total number of Māori descent electors registered on the Māori electoral roll,

g is the total number of Māori descent electors registered on the general electoral roll,

d is the total number of people with Māori descent in the census.

The proportion of enrolled Māori descent electors who choose the Māori electoral roll is of critical importance in all these calculations. We will refer to it as the Māori ratio (r):

$$r = m/\ (m + g)$$

The MEP is calculated at the national level using national totals, see table 1.

Table 1: Calculation of 2018 Māori electoral population of New Zealand				
Population	**Source**	**Number (α=0.3)**	**Number (α=0.5)**	**Number (α=0.7)**
Census usually resident population count (u)	2018 Census[1]	4,737,000	4,699,760	4,631,580
Electoral Māori descent census usually resident population count (d)	2018 Census[1]	909,730	896,570	874,750
Māori on Māori electoral roll (m)	Māori electoral roll	268,407	268,407	268,407
Māori on general electoral roll (g)	General electoral roll	240,273	240,273	240,273
% of Māori choosing Māori electoral roll (Māori ratio, r)	$r = m/(m + g)$	53%	53%	53%
Māori electoral population	$MEP = r \times d$	480,023	473,079	461,565
General electoral population	*GEP = u-MEP*	4,256,977	4,226,681	4,170,015

1. Figures have been independently calculated outside of the census processing system for the analysis and may not matched equivalent figures published elsewhere.

Note: Totals may not sum due to confidentiality and rounding.

General electoral population

The general electoral population (GEP) is the census usually resident population count (u) less the Māori electoral population.

$$GEP = u - MEP$$

To calculate the number of general electorates we need to calculate the GEP for each island, see table 2. The MEPs calculated here, at the island level, are only used for calculating the NI GEP and the SI GEP.

Table 2: Calculation of 2018 general electoral populations for each island

Population	Source	North Island (α=0.3)	North Island (α=0.5)	North Island (α=0.7)	South Island (α=0.3)	South Island (α=0.5)	South Island (α=0.7)	Chatham Island (α=0.5)
Census usually resident population count (u)	2018 Census[1]	3,624,470	3,594,560	3,539,080	1,111,870	1,104,530	1,091,840	660
Electoral Māori descent census usually resident population count (d)	2018 Census[1]	771,640	760,160	740,900	137,650	135,960	133,420	450
Māori on Māori electoral roll (m)	Māori electoral roll	236,913	236,913	236,913	31,352	31,352	31,352	142
Māori on general electoral roll (g)	General electoral roll	197,553	197,553	197,553	42,602	42,602	42,602	118
% of Māori choosing Māori electoral roll (Māori ratio, r)	$r = m/(m + g)$	55%	55%	55%	42%	42%	42%	55%
Māori electoral population	$MEP = r \times d$	420,773	414,513	404,011	58,355	57,639	56,562	246
General electoral population	*GEP = u - MEP*	3,203,697	3,180,047	3,135,069	1,053,515	1,046,891	1,035,278	414
Final MEP	*NI MEP = MEP +CI MEP*	421,019	414,759	404,257	58,355	57,639	56,562	
	SI MEP = MEP							
Final GEP	*NI GEP = GEP*	3,203,697	3,180,047	3,135,069	1,053,929	1,047,305	1,035,692	
	SI GEP = GEP+CI GEP							

1. Figures have been independently calculated outside of the census processing system for the analysis and may not matched equivalent figures published elsewhere.

Note: Totals may not sum due to confidentiality and rounding.

Electorate calculations

South Island electorates and quota

The number of general electorates in the South Island is fixed at 16. Therefore, dividing the SI GEP by 16 gives the South Island quota (qs), the average size of a South Island general electorate. For the 2018 calculations: **qs = SIGEP/16**

	α=0.3	α=0.5	α=0.7
qs	65,871	65,457	64,731

Māori electorates and quota

The populations for each electorate should be approximately equal. Therefore, the South Island quota is used to determine the number of Māori and general electorates. In the 2018 calculations, the number of Māori electorates (nm) is determined by: **nm = MEP / qs**

	α=0.3	α=0.5	α=0.7
nm (unrounded)	7.287	7.227	7.131
nm	7	7	7

The Māori quota (qm), or average population for Māori electorates, is: **qm = MEP / nm**

	α=0.3	α=0.5	α=0.7
qm	68,575	67,583	65,938

North Island electorates and quota

The South Island quota is used to determine the number of North Island electorates. In the 2013 calculations, the number of North Island electorates (nn) is determined by: **nn = NI GEP / qs**

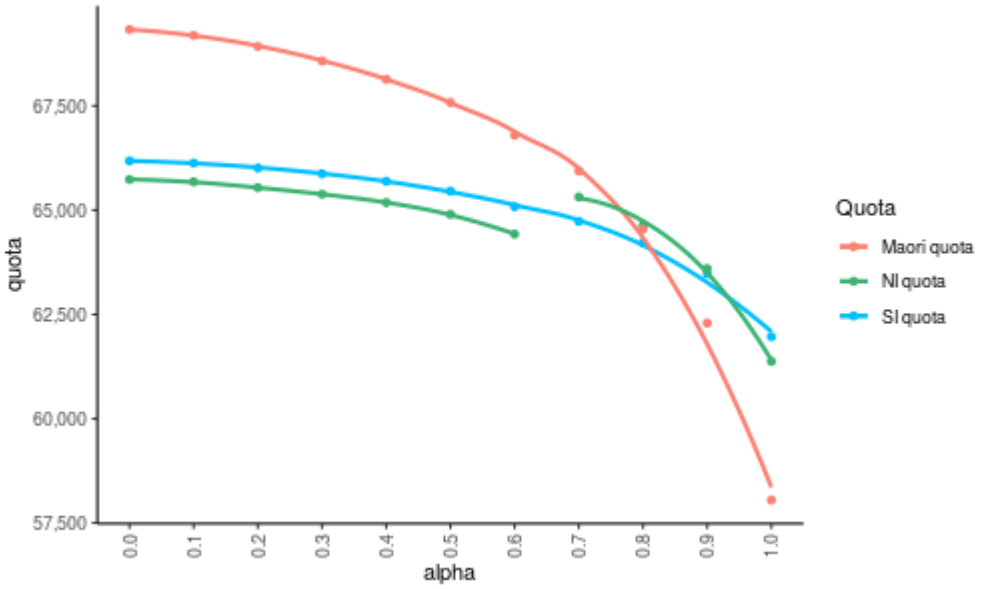
	α=0.3	α=0.5	α=0.7
nn (unrounded)	48.636	48.582	48.432
nn	49	49	48

The quota for North Island electorates (qn) is: **qn = NI GEP / nn**

	α=0.3	α=0.5	α=0.7
qn	65,382	64,899	65,314

The quotas for all values of alpha are shown in figure 8. The quota for the North Island general electorates jumps up for alpha=0.7, where the number of North Island electorates changes from 48 to 49 (see figure 6).

Figure 8: North and South island general electorate quota, and Māori electorate quota



Appendix 2

Variation from quota of 2014 electorates with 2018 Census data

Table 3: South Island 2014 electorates with 2018 Census populations (alpha=0.5)				
REGC2018 name	**GED2014 name**	**GEP[1]**	**Variation from quota (percent)**	**Variation from quota in 2023 (percent)**
Canterbury Region	Selwyn	76,260	16.50	23.80
Otago Region	Waitaki	72,760	11.10	13.70
Southland Region	Clutha-Southland	70,610	7.90	6.00
Otago Region	Dunedin South	61,130	-6.60	-7.20
Southland Region	Invercargill	61,350	-6.30	-10.80
Canterbury Region	Ilam	61,460	-6.10	-6.70
West Coast Region	West Coast-Tasman	61,560	-6.00	-9.50
Otago Region	Dunedin North	61,690	-5.80	-6.10
Canterbury Region	Christchurch East	62,270	-4.90	-5.10
Marlborough Region	Kaikoura	64,380	-1.60	-1.80
Canterbury Region	Port Hills	66,400	1.40	0.90
Canterbury Region	Rangitata	64,550	-1.40	0.70
Nelson Region	Nelson	66,140	1.00	0.60
Canterbury Region	Wigram	64,960	-0.80	-1.00
Canterbury Region	Waimakariri	65,940	0.70	2.30
Canterbury Region	Christchurch Central	65,570	0.20	-0.20
	quota	65,460	0.00	0.00

1. Figures have been independently calculated outside of the census processing system for the analysis and may not matched equivalent figures published elsewhere.

Note: Totals may not sum due to confidentiality and rounding.

Table 4: North Island 2014 electorates with 2018 Census populations (alpha=0.5)				
REGC2018 name	**GED2014 name**	**GEP[1]**	**Variation from quota (percent)**	**Variation from quota in 2023 (percent)**
Auckland Region	Papakura	74,510	14.80	17.40
Auckland Region	Hunua	74,140	14.20	16.80
Auckland Region	Rodney	74,000	14.00	19.20
Waikato Region	Waikato	71,190	9.70	10.60
Bay of Plenty Region	Bay of Plenty	71,060	9.50	12.80
Auckland Region	Manurewa	70,910	9.30	8.90
Auckland Region	Upper Harbour	70,350	8.40	8.00
Northland Region	Whangarei	70,140	8.10	10.50
Waikato Region	Taupo	70,120	8.00	6.10
Northland Region	Northland	69,740	7.50	4.90
Waikato Region	Hamilton West	69,370	6.90	10.60
Auckland Region	Tamaki	61,740	-4.90	0.20
Waikato Region	Hamilton East	67,680	4.30	7.90
Manawatu-Wanganui Region	Palmerston North	62,130	-4.30	-2.30
Auckland Region	Epsom	62,150	-4.20	-2.90
Auckland Region	Maungakiekie	67,640	4.20	1.10
Wellington Region	Ohariu	62,260	-4.10	-4.80
Auckland Region	Te Atatu	67,420	3.90	3.00
Auckland Region	Pakuranga	62,500	-3.70	-0.90
Auckland Region	Kelston	62,690	-3.40	-3.40
Wellington Region	Rimutaka	67,030	3.30	1.30
Auckland Region	Auckland Central	62,920	-3.10	-4.40
Wellington Region	Rongotai	62,900	-3.10	-3.90
Waikato Region	Coromandel	66,830	3.00	2.20
Taranaki Region	New Plymouth	66,810	2.90	5.50
Bay of Plenty Region	Tauranga	66,790	2.90	6.60
Wellington Region	Hutt South	66,560	2.60	1.10
Hawke's Bay Region	Tukituki	66,560	2.60	1.10
Hawke's Bay Region	Napier	63,260	-2.50	-1.70
Wellington Region	Otaki	63,260	-2.50	-1.60
Waikato Region	Taranaki-King Country	63,450	-2.20	-2.50
Bay of Plenty Region	East Coast	66,180	2.00	-2.90
Bay of Plenty Region	Rotorua	63,590	-2.00	-5.20
Manawatu-Wanganui Region	Rangitikei	63,670	-1.90	-2.90
Wellington Region	Mana	65,980	1.70	0.30
Auckland Region	Helensville	65,860	1.50	4.60
Auckland Region	Manukau East	65,860	1.50	-5.90
Auckland Region	Mt Albert	64,120	-1.20	-1.70
Auckland Region	New Lynn	64,120	-1.20	-2.30
Manawatu-Wanganui Region	Whanganui	64,180	-1.10	-2.90
Wellington Region	Wellington Central	64,270	-1.00	-1.80

Auckland Region	Mangere	65,510	0.90	-5.30
Auckland Region	Mt Roskill	64,320	-0.90	2.50
Wellington Region	Wairarapa	64,400	-0.80	-0.20
Auckland Region	North Shore	65,330	0.70	-2.90
Auckland Region	Northcote	65,250	0.50	-3.60
Auckland Region	East Coast Bays	64,640	-0.40	2.90
Auckland Region	Botany	65,120	0.30	1.90
	quota	64,900	0.00	0.00

1. Figures have been independently calculated outside of the census processing system for the analysis and may not matched equivalent figures published elsewhere.

Note: Totals may not sum due to confidentiality and rounding.

Table 5: Māori 2014 electorates with 2018 Census populations (alpha=0.5)

MED2014 name	MEP[1]	Variation from quota (percent)	Variation from quota in 2023 (percent)
Tamaki Makaurau	59,030	-12.70	-14
Hauraki-Waikato	72,040	6.60	9.10
Te Tai Tokerau	71,490	5.80	5.80
Te Tai Tonga	69,010	2.10	4.80
Ikaroa-Rawhiti	66,350	-1.80	-3.10
Te Tai Hauauru	68,030	0.70	0.30
Waiariki	67,110	-0.70	-2.40
quota	67,580		

1. Figures have been independently calculated outside of the census processing system for the analysis and may not matched equivalent figures published elsewhere.

Note: Totals may not sum due to confidentiality and rounding.

Variation from quota of 2019 electorates in the initial plan

Table 6: South Island 2019 initial plan electorates variation from quota						
	Variation from quota (percent)				Variation from quota shift (percent)	
South Island 2019 General electorate	**alpha=0.1**	**alpha=0.5**	**alpha=0.7**	**alpha=0.5, projected to 2023**	**alpha=0.1***	**alpha=0.7****
Christchurch Central	0.6	0.1	-0.7	-0.2	0.5	-0.8
Christchurch East	-1.2	-1.3	-1.4	-1.5	0.1	-0.1
Clutha-Southland	3.1	2.4	1.4	1.0	0.7	-1.0
Dunedin North	-2.9	-2.9	-2.8	-3.2	0.0	0.1
Dunedin South	-1.2	-0.9	-0.4	-1.5	-0.3	0.5
Ilam	-0.9	-0.8	-0.6	-1.4	-0.1	0.2
Invercargill	1.3	1.4	1.6	-3.6	-0.1	0.2
Kaikoura	-2.4	-2.5	-2.7	-2.3	0.1	-0.2
Nelson	1.0	1.0	1.1	0.6	0.0	0.1
Port Hills	-1.2	-0.9	-0.5	-1.4	-0.3	0.4
Rangitata	1.2	1.4	1.6	3.7	-0.2	0.2
Selwyn	-0.3	0.0	0.4	6.5	-0.3	0.4
Waimakariri	-0.3	0.0	0.5	2.2	-0.3	0.5
Waitaki	-2.7	-2.8	-2.8	-0.6	0.1	0.0
West Coast-Tasman	0.2	0.1	0.0	-3.3	0.1	-0.1
Wigram	3.5	3.4	3.4	3.2	0.1	0.0

* Variation from quota shift = variation from quota(alpha=0.1)-variation from quota(alpha=0.5)

** Variation from quota shift = variation from quota(alpha=0.7)-variation from quota(alpha=0.5)

Table 7: North Island 2019 initial plan electorates variation from quota						
	Variation from quota (percent)				Variation from quota shift (percent)	
North Island 2019 general electorate	**alpha=0.1**	**alpha=0.5**	**alpha=0.6**	**alpha=0.5, projected to 2023**	**alpha=0.1***	**alpha=0.6****
Auckland Central	3.1	-0.1	-3.3	-1.5	3.2	-3.2
Bay of Plenty	1.8	1.9	2.0	5.2	-0.1	0.1
Botany	-0.2	0.2	0.6	2.6	-0.4	0.4
Coromandel	3.1	3.1	3.2	2.3	0.0	0.1
East Coast	2.0	2.0	2.0	-2.9	0.0	0.0
East Coast Bays	1.2	1.5	1.6	4.9	-0.3	0.1
Epsom	-2.3	-2.3	-2.4	-0.7	0.0	-0.1
Hamilton East	-3.4	-3.4	-3.3	0.0	0.0	0.1
Hamilton West	2.5	2.4	2.5	6.0	0.1	0.1
Helensville	1.7	1.8	1.9	4.8	-0.1	0.1
Hunua	-4.0	-3.7	-3.5	-2.0	-0.3	0.2

Hutt South	2.0	2.3	2.6	0.9	-0.3	0.3
Kelston	-1.0	-1.1	-1.0	-0.1	0.1	0.1
Mana	-0.8	-0.4	-0.1	-1.7	-0.4	0.3
Mangere	1.3	1.0	0.8	-5.3	0.3	-0.2
Manukau East	3.6	2.8	2.3	-3.8	0.8	-0.5
Manurewa	-1.3	-1.9	-2.2	-1.9	0.6	-0.3
Maungakiekie	0.8	0.9	0.9	-0.3	-0.1	0.0
Mt Albert	-0.1	-0.3	-0.6	-0.8	0.2	-0.3
Mt Roskill	1.7	1.7	1.5	4.5	0.0	-0.2
Napier	-2.0	-2.0	-1.9	-1.0	0.0	0.1
New Lynn	-0.6	-0.7	-0.8	-2.2	0.1	-0.1
New Plymouth	2.7	2.9	3.2	5.4	-0.2	0.3
North Shore	0.3	0.6	0.8	-3.0	-0.3	0.2
Northcote	0.4	0.5	0.6	-3.6	-0.1	0.1
Northland	-0.2	-0.4	-0.4	-2.9	0.2	0.0
Ohariu	-2.7	-2.0	-1.6	-2.8	-0.7	0.4
Otaki	-2.8	-2.5	-2.2	-1.6	-0.3	0.3
Pakuranga	-4.2	-3.8	-3.6	-1.0	-0.4	0.2
Palmerston North	0.9	1.0	1.3	3.1	-0.1	0.3
Papakura	-2.2	-2.2	-2.3	0.4	0.0	-0.1
Rangitikei	-2.7	-2.4	-2.2	-3.7	-0.3	0.2
Remutaka	2.3	2.9	3.2	0.9	-0.6	0.3
Rodney	1.8	2.1	2.4	6.8	-0.3	0.3
Rongotai	-3.4	-3.1	-2.8	-3.9	-0.3	0.3
Rotorua	3.6	3.2	2.9	0.1	0.4	-0.3
South Auckland	-3.3	-3.3	-3.3	-5.3	0.0	0.0
Tamaki	-1.7	-1.3	-1.0	3.3	-0.4	0.3
Taranaki-King Country	-2.3	-2.0	-1.7	-2.2	-0.3	0.3
Taupo	3.3	3.3	3.5	1.5	0.0	0.2
Tauranga	2.6	2.5	2.4	6.2	0.1	-0.1
Te Atatu	-1.5	-1.4	-1.4	-2.2	-0.1	0.0
Tukituki	2.7	2.7	2.6	1.3	0.0	-0.1
Upper Harbour	1.0	1.1	1.2	0.8	-0.1	0.1
Waikato	-0.6	-0.3	0.0	0.9	-0.3	0.3
Wairarapa	-1.0	-0.7	-0.5	-0.1	-0.3	0.2
Wellington Central	-0.5	-1.0	-1.2	-1.8	0.5	-0.2
Whanganui	-0.9	-0.8	-0.7	-2.6	-0.1	0.1
Whangarei	0.6	0.8	0.9	3.0	-0.2	0.1

* Variation from quota shift = variation from quota(alpha=0.1)-variation from quota(alpha=0.5)

** Variation from quota shift = variation from quota(alpha=0.6)-variation from quota(alpha=0.5)

Table 8: Māori 2019 initial plan electorates variation from quota

	Variation from quota (percent)				Variation from quota shift (percent)	
Maori 2019 general electorate	**alpha=0.1**	**alpha=0.5**	**alpha=0.7**	**alpha=0.5, projected to 2023**	**alpha=0.1***	**alpha=0.7****
Hauraki-Waikato	-2.0	-2.3	-2.5	0.1	0.3	-0.2
Ikaroa-Rawhiti	0.6	0.6	0.4	-1.1	0.0	-0.2
Tamaki Makaurau	-0.1	-0.4	-0.9	-1.6	0.3	-0.5
Te Tai Hauauru	-0.9	-0.9	-0.8	-1.6	0.0	0.1
Te Tai Tokerau	2.4	2.2	1.8	1.8	0.2	-0.4
Te Tai Tonga	-1.2	-0.9	-0.5	1.7	-0.3	0.4
Waiariki	0.9	0.5	-0.2	-1.9	0.4	-0.7

* Variation from quota shift = variation from quota(alpha=0.1)-variation from quota(alpha=0.5)

** Variation from quota shift = variation from quota(alpha=0.7)-variation from quota(alpha=0.5)