NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Growing up in Auckland?

Mapping drivers of residential land growth

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NZIER was established in 1958.

Authorship

Each year NZIER devotes resources to undertake and make freely available economic research and thinking aimed at promoting a better understanding of New Zealand's important economic challenges. This paper was funded as part of this public good research programme.

This paper was prepared at NZIER by Dr Kirdan Lees.

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L13 Grant Thornton House, 215 Lambton Quay | PO Box 3479, Wellington 6140
Tel +64 4 472 1880 | econ@nzier.org.nz

Key points

The new National Policy Statement requires councils to plan for growth

- This is the latest in a series of moves by central and local government to make land supply more responsive to slow growth in urban house prices.
- Our work shows councils with rapid population growth could test plans for the capacity of urban land for development by learning from the past.

We decomposed growth in residential land into population growth, household size, and land use per capita

- We find that, based on past experience Auckland will struggle to intensify. Historically, demand for housing has pushed Auckland out and not up.

Surging city land prices mean rethinking plans to accommodate growth

- House prices across many of our cities, but mainly Auckland, are skyrocketing, reducing housing affordability and limiting economic growth.
- Current approaches to planning to accommodate future growth are fraught since they require precision on just how many people will find Auckland the place to live and work and how many households people will form over coming decades.

Soaring house prices signal we haven't got it right

- With demand running up against a lack of homes, house prices are squeezed ever higher – a clear signal of a market that needs repair.
- Migration matters but Auckland's geography constrains growth, exacerbating the impact of intransigence by local communities to intensify.
- Auckland will need to grow out by providing a lot more additional land for development at the edge of the city.
- Auckland will also need to grow up, by lifting some combination of existing constraints on height restrictions and lot sizes. The price of preserving heritage, protecting volcanic viewshafts and providing land intensive public sports to a fraction of the population has gone up. Something has to give.

We can learn from our past

- Planning – releasing land and putting in place the infrastructure to enable firms to build homes – has not got the scale of what is required right.
- We can learn much from the history of the development of residential land in Auckland and across the rest of New Zealand.
- We don't need to develop detailed and complex models. We first establish a measure of residential land based on population density at the suburb level and show that residential land grew 28 percent between the 1996 Census and the 2013 Census.
- Between 1996 and 2013, density remained little changed since population growth was identical to the rate of land growth at 28 percent – on average New Zealand has been growing out not up and house prices have gone up.

Only a few areas accommodated people by growing up more than out

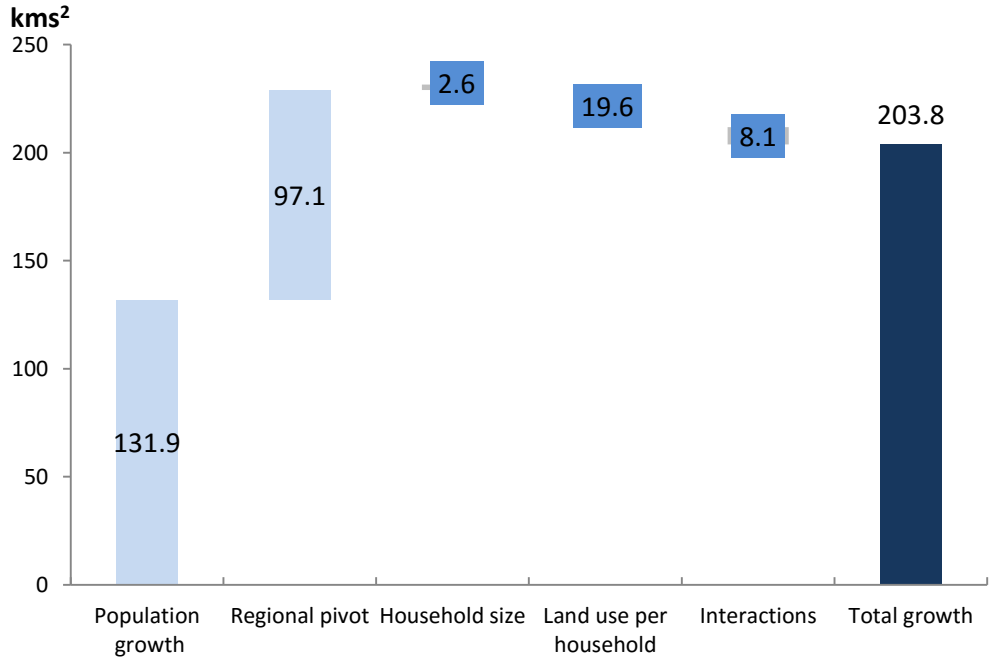
- To quantify what might be required to accommodate future population growth, we assume half of population growth might be accommodated by growing out and half might be accommodated by growing up.
- But between 1996 and 2013 only a small fraction of suburbs attained the 23 percent growth consistent with the scenario of accommodating population growth equally between growing out and growing up. So policy will have to do much more than we have seen historically if growing up is to be part of the solution.

A closer look at Auckland shows levers will need to be pulled very hard

- Our land decomposition shows that a 203.8 square kilometres increase in residential land in Auckland between 1996 and 2013 was driven mainly by population growth: national growth and a shift in the population towards Auckland (a regional 'pivot'). See Figure 1.
- Auckland's household size remained relatively constant, at least compared to other regions of New Zealand where smaller households increased the amount of residential land required to meet demand.
- Effects of population growth were offset only slightly by a modest increase in land use per household (density).
- Much, much more needs to be done to accommodate moving up if we expect Auckland to accommodate more people over the coming decades.

Figure 1 Population growth pushed Auckland out rather than up

Drivers of the change in Auckland's residential land area between 1996 and 2013



Source: Statistics New Zealand

Contents

Figures

Tables

1. Introduction

Soaring house prices

House prices in Auckland and elsewhere continue to skyrocket, pricing out many younger productive workers that would otherwise boost income growth in our cities.

Many agencies across central and local government are looking for solutions. Those solutions lie in unlocking enough flexibility of land supply to keep pace with strong population growth and immigration that has been unevenly distributed and focussed on Auckland and other urban areas. Existing land use regulation is simply too restrictive.

Moving up or moving out?

Relaxing the suite of land use restrictions that apply within the city limits would allow developers to build up, so-called brownfield developments that intensifies and makes the most of land supply within the city limits.[1]

Progressively moving out Auckland's city limit, by providing additional development-ready greenfield land and resolving the funding of infrastructure needs would also help make land supply more responsive.[2]

Current forecasting approach is fraught

But understanding the likely limits to moving up and moving out are difficult. Typical approaches take forecasts for population growth and then reverse engineer land requirements based on assumptions about future household size and land use per household.[3]

These forecasting exercises are often fraught and generally struggle to robustly confront that development hinges on the types of dwellings and residential land that people want and the willingness of residents and developers to make those properties available.[4]

We can learn from our past

Much can be learned about future needs from a detailed assessment of what has driven growth in residential land in the past. Has population growth been driving increases in the use of land? Is the relationship one-for-one or is demand for land increasing on a per person basis as well?

If land use per person – or more precisely per household – is growing, then we might expect that residential land growth has to accommodate not just a growing population, but a population that is prepared to pay to more for additional land.

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1 See Lees (2014) on the benefits of moving out the city limit in simple model calibrating to Auckland city.

2 Lees (2015) scopes the likely magnitude of relaxing the suite of land use restrictions within Auckland.

3 See New Zealand Productivity Commission (2015) for example and NZIER (2014) on issues with long-term demographic forecasting.

4 See Cheshire, Overman and Nathan (2014).

Our approach

To analyse the drivers of land use growth, we define residential land using Census population density at the suburb level from 1996 to 2013. Then we decompose growth in residential land into demographic factors that include population growth, household size and land use per capita.

This approach isn't perfect, in the sense that what we see both affects and is affected by land use regulation. But, it is a straightforward step towards understanding changes in demand for land. With a solid understanding of what has driven residential land growth, our final section takes a closer look at how the past can be used to frame likely possibilities for Auckland to move out and move up across the next twenty-five years.

Our approach also has the benefit of providing a simple test of the feasibility of change – how far aspirations for urban form are from past experience.

2. What is driving urban growth?

2.1. Defining the city footprint

Before mapping and scrutinising the drivers of residential land use, we first need to define residential land and the extent of the urban area within which it is found.

Previous work uses a variety of measures to define the reaches of an urban area or a city. This includes many aspects of urban living including, labour markets (see for example, the approach in Demographia 2015), travel times (see Jacques and El-Geneidy 2014), identifying building structures using satellite imagery (for example, Overman, Puga and Turner 2008 and Pesaresi et al. 2009) and minimum population and population density.

Ideally a boundary would neatly separate urban residential land from other areas but cities tend to have fluid boundaries, not easily defined by a single feature or administrative boundaries. Other approaches to defining cities include weighting density measures by population so that density measures reflect the experience of the average resident (see Nunns 2014, for example).

To define residential urban land, we use population density at the meshblock level – the most granular administrative region available from Statistics New Zealand – to obtain population data and the number of households.[5]

Our measure is simple, transparent and easily replicable. We fix the boundary between urban and non-urban areas at 100 people per hectare, lower than international norms that sometimes define cities as areas with 400 people per hectare but across broader land areas rather than our granular measures.[6] Incrementally larger density thresholds result in a smaller urban footprint.

We focus on residential land. Since industrial and some commercial land contains no, or few, residents these land areas are not included. That can produce a quilt-like coverage of some cities with industrial or commercial land.[7] In Figure 2 we use the example of Dunedin to show how our meshblock measure defines the residential land footprint relative to other possible density choices.

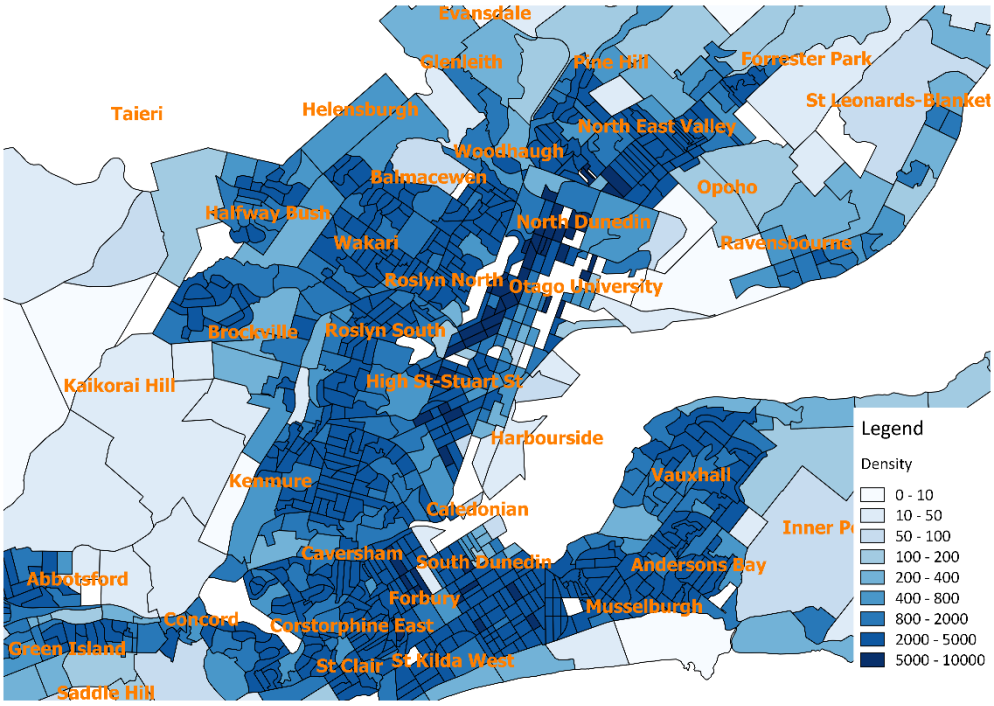
[5] In 2013, the average meshblock contained 90 people living in 33 households. There were 46,637 meshblocks in 2013.

[6] Since we use residential areas to define the urban footprint and don't use contiguity on urban areas (for example, by imposing an algorithm that groups together less dense meshblocks that are near dense meshblocks) our measure of urban growth excludes areas of commercial development.

[7] Overman, Puga and Turner (2008) note that the ratio of commercial to residential land in the US was close to constant between 1976 and 1992.

Figure 2 We use meshblock-level density to define residential land

Dunedin, 2013 Census

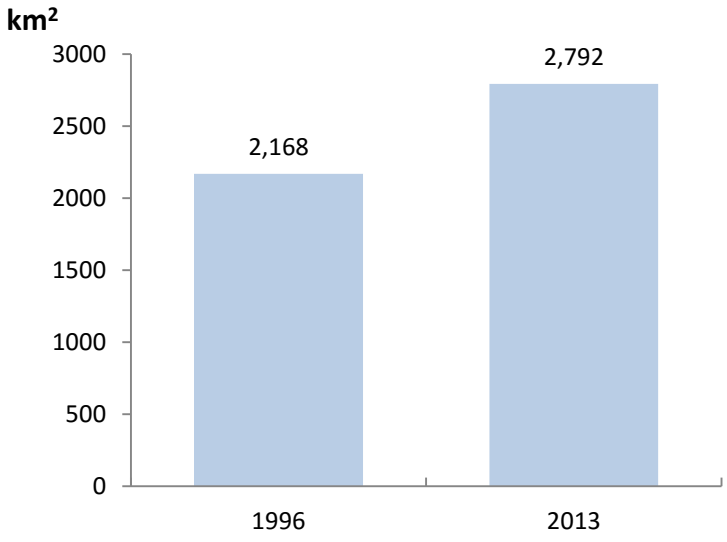


Source: Statistics New Zealand

Figure 3 compares the footprint of residential land between the 1996 and 2013 Census years. Residential land expanded 28 percent in this period or 1.5 percent per year.

Figure 3 Residential land expanded 28 percent from 1996 to 2013

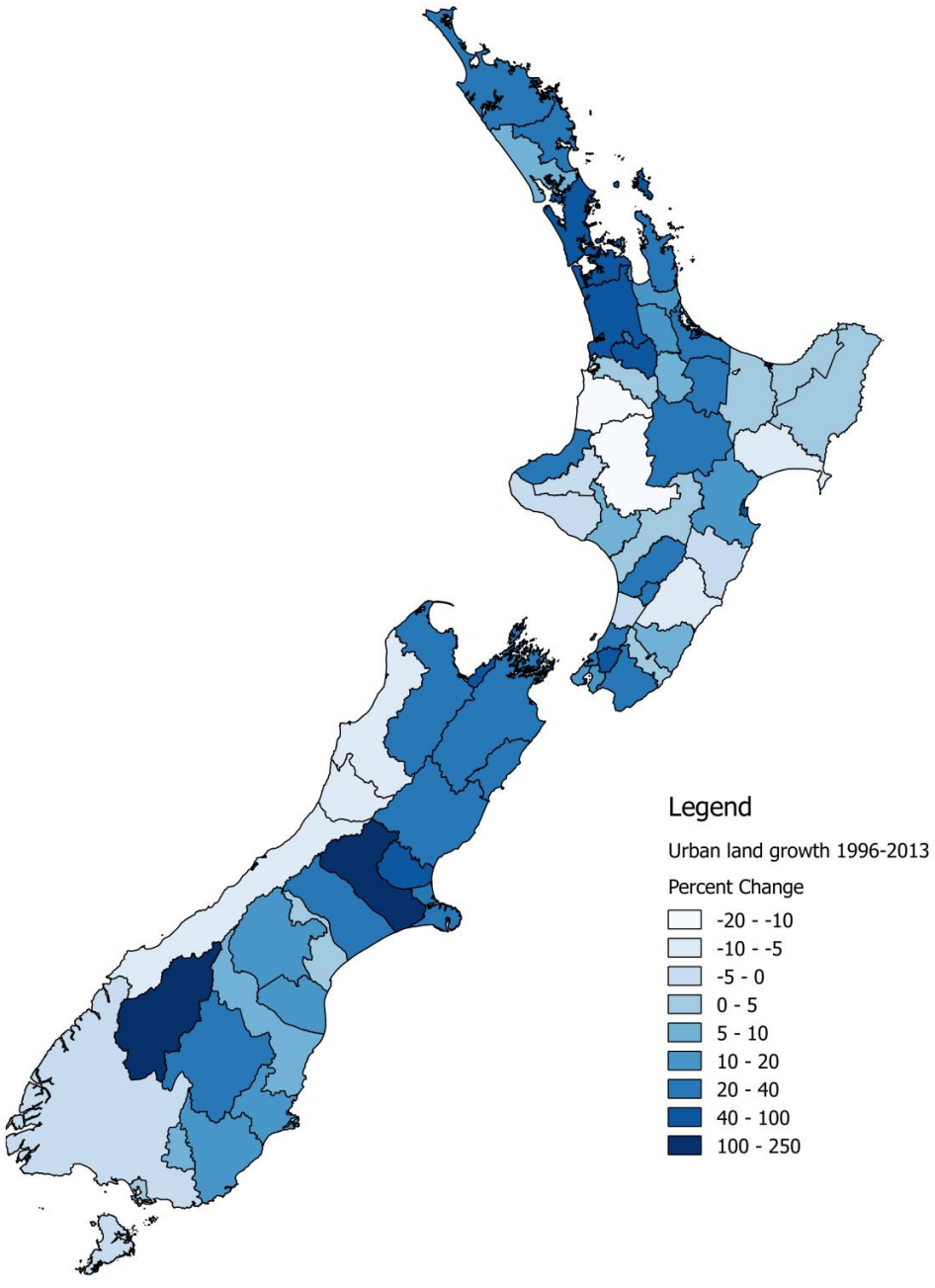
Residential land, square kilometres, 1996 and 2013



Source: Statistics New Zealand

The amount of residential land in some regions grew much faster than others. Tauranga, Selwyn, and the Queenstown-Lakes District exhibited the most rapid residential land growth. Residential land in Auckland grew 41.3 percent over the period at a compound average growth rate of 2.05 percent per year. Figure 4 maps residential land growth across New Zealand.

Figure 4 Residential land growth has been uneven



Source: NZIER

2.2. Drivers of New Zealand urban growth

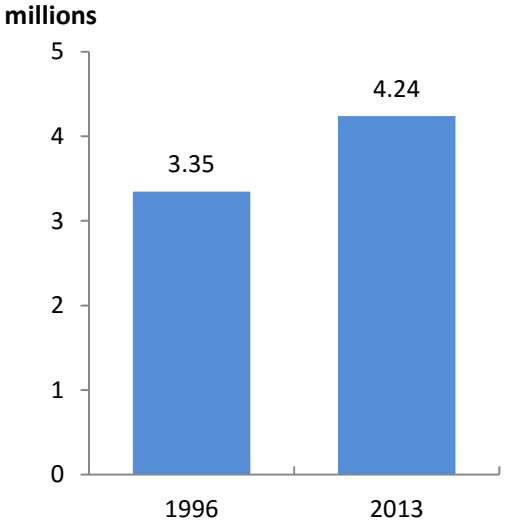
To explain the 28 percent growth in residential land and the distribution of growth in Figure 4, we focus on decomposing growth in urban land into several key factors:

- national population growth
- a population "pivot" where people shift to other regions and their demand for residential land changes to reflect typical land use in their new region
- changes in household size at the regional level
- changing intensity of land use
- interactions – a term which captures interactions between these various effects.

This decomposition allows us to examine some of the key factors that determine urban land use. This is the same decomposition Overman et al. (2008) used to examine growth in residential land that we discuss in more detail in Box A.

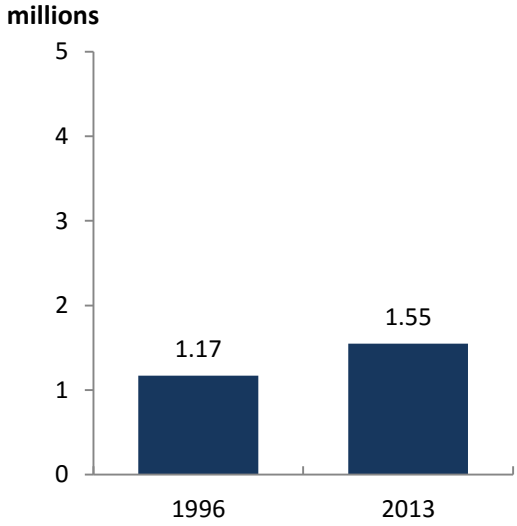
As a precursor to a closer examination of the decomposition, Figure 5 shows that the New Zealand population grew 26.7 percent – a little less strongly than the rate of residential land growth. An accompanying decline in household size implied the number of households grew 32.3 percent, outpacing the rate of growth in residential land (see Figure 6).

Figure 5 Population expanded 28 percent between 1996 and 2013



Source: Statistics New Zealand

Figure 6 Number of households grew 32.3 percent from 1996 to 2013



Source: Statistics New Zealand

There are many alternative decompositions of urban land growth available to explain the 28 percent growth in residential land. For example, we could decompose growth according to growth in coastal regions vs interior regions, warm regions vs cooler climates or provide detailed decompositions based on a variety of demographic characteristics such as age cohorts.

Box A: Breaking down residential land growth into drivers

We can use simple analytical relationships – that do not require estimation – to show the drivers of increasing residential land use. Many decompositions are possible but the Overman et al. (2008) breakdown spans key factors:

$$L_{NZ}^{2013} - L_{NZ}^{1996} = \sum_{R=NZ} \frac{P_{NZ}^{2013} - P_{NZ}^{1996}}{P_{NZ}^{1996}} P_R^{1996} l_R^{1996} \Bigg\} \; Contrib.\,of\; NZ\; pop.\,change \;(1)$$

$$+ \sum_{R=NZ} \left(\frac{P_R^{2013} - P_R^{1996}}{P_R^{1996}} - \frac{P_{NZ}^{2013} - P_{NZ}^{1996}}{P_{NZ}^{1996}} \right) P_R^{1996} l_R^{1996} \Bigg\} Contrib.\,of\; pop.\,pivot \;(2)$$

$$+ \sum_{R=NZ} P_R^{1996} h_R^{1996} (r_R^{2013} - r_R^{1996}) \Bigg\} \; Contrib.\,of\; changes\; in\; h'hold\; size \;(3)$$

$$+ \sum_{R=NZ} P_R^{2013} (h_R^{2013} - h_R^{1996}) r_R^{1996} \Bigg\} Contrib.\,of\; changing\; h'hold\; land\; use \;(4)$$

$$+ \sum_{R=NZ} P_R^{2001} (h_R^{2013} - h_R^{1996})(r_R^{2013} - r_R^{1996}) \Bigg\} Interactions$$

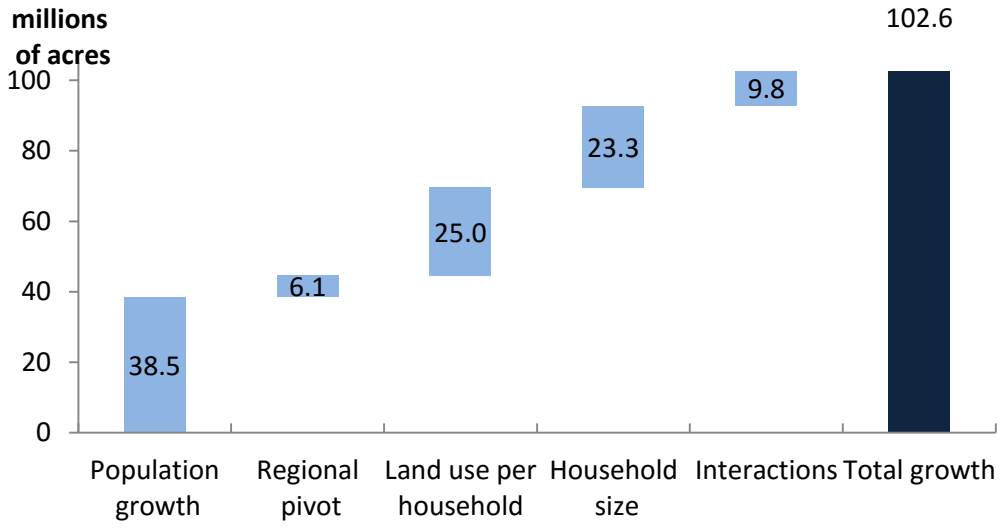
$$+ \sum_{R=NZ} P_R^{1996} (P_R^{2013} - P_R^{1996})(l_R^{2013} - l_R^{2001}) \Bigg\} \; Interactions \;(5)$$

where $L_{NZ}^{2013} - L_{NZ}^{1996}$is the change in urban land, P_{NZ}^{2013} is 2013 total population, h_R^{1996} is average urban land per household in 1996, l_R^{1996} is 1996 residential land per capita by region and r_R^{2013} is the 2013 households-to-population ratio by region.

Overman et al. (2008) use this decomposition to show the 102.6 million acre increase in residential land in the United States between 1976 and 1992 was only partly due to increased land use per household despite population growth driving only a fraction of the increase. Decreasing household size and a regional pivot where people move to less dense areas also increased residential land use.

Figure 7 Many factors drove increased residential land use in the US

Growth in residential land, United States, 1976-1992



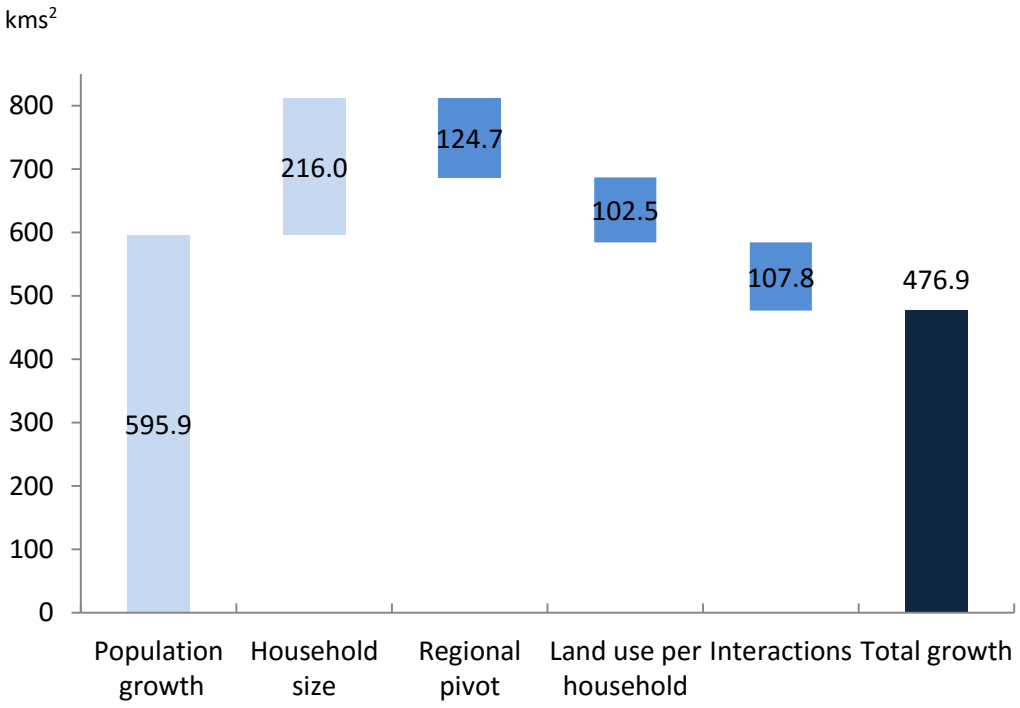
Source: Overman et al. (2008)

Figure 8 shows that the lion's share of residential growth can be attributed to population growth alone. National population growth drove 596 square kilometres of residential land growth (roughly twice the size of Wellington city).

Over the period household size decreased a little, falling from 2.86 to 2.74 people per household. This increases the number of households, beyond the population growth effect, lifting residential land by 216 square kilometres or 21.4 percent.

Unlike the example of the United States, inter-regional migration flows favoured movements from territorial authorities that have relatively large amounts of residential land used per household to territorial authorities (and in Auckland in particular) where land use per household is lower than the national average. That reduces the residential land required but is not sufficient to offset national population growth and the decrease in household size.[8]

Figure 8 Population growth and smaller households grew residential land



Source: Statistics New Zealand

These increases in residential land are offset a little by a fall in land use per household that reduces residential land required by over 100 square kilometres. The interaction of the factors also reduces the residential land required by just over 100 square kilometres.

[8] We use Census usually resident measures and drop the Chatham Islands and other off-shore islands from our metric. We also define the 1996 boundaries to be consistent with the 2013 definitions by replacing the territory authorities within Auckland with a regional definition, including Banks Peninsula within the Christchurch TA.

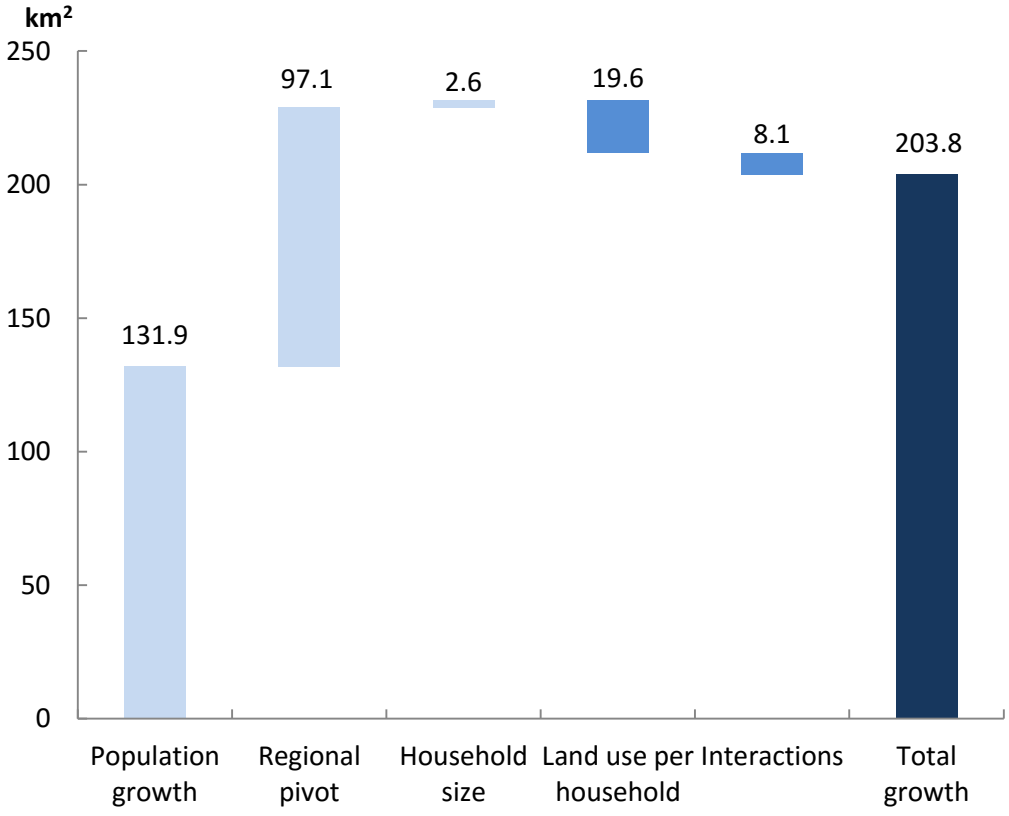
2.3. A look at the regions

We also apply the decomposition in Box A across New Zealand's territorial authorities and find a diversity of experiences. Some territorial authorities experience rapid increase in residential land. Our measure suggests residential land in Selwyn tripled between 1996 and 2013 and more than doubled in the Queenstown-Lakes District.

Regional population flows were a key factor for high growth regions driving 59 percent of growth in the Queenstown-Lakes region and half the growth in Tauranga. Only 13 of 66 territory authorities experienced positive regional migration flows (see Figure 10).

The regional population pivot is particularly important for Auckland. Figure 9 shows the shift in population from other regions and towards Auckland accounted for almost half the growth in residential land in Auckland between 1996 and 2013. Land use per household failed to move much – Auckland moved out rather up.

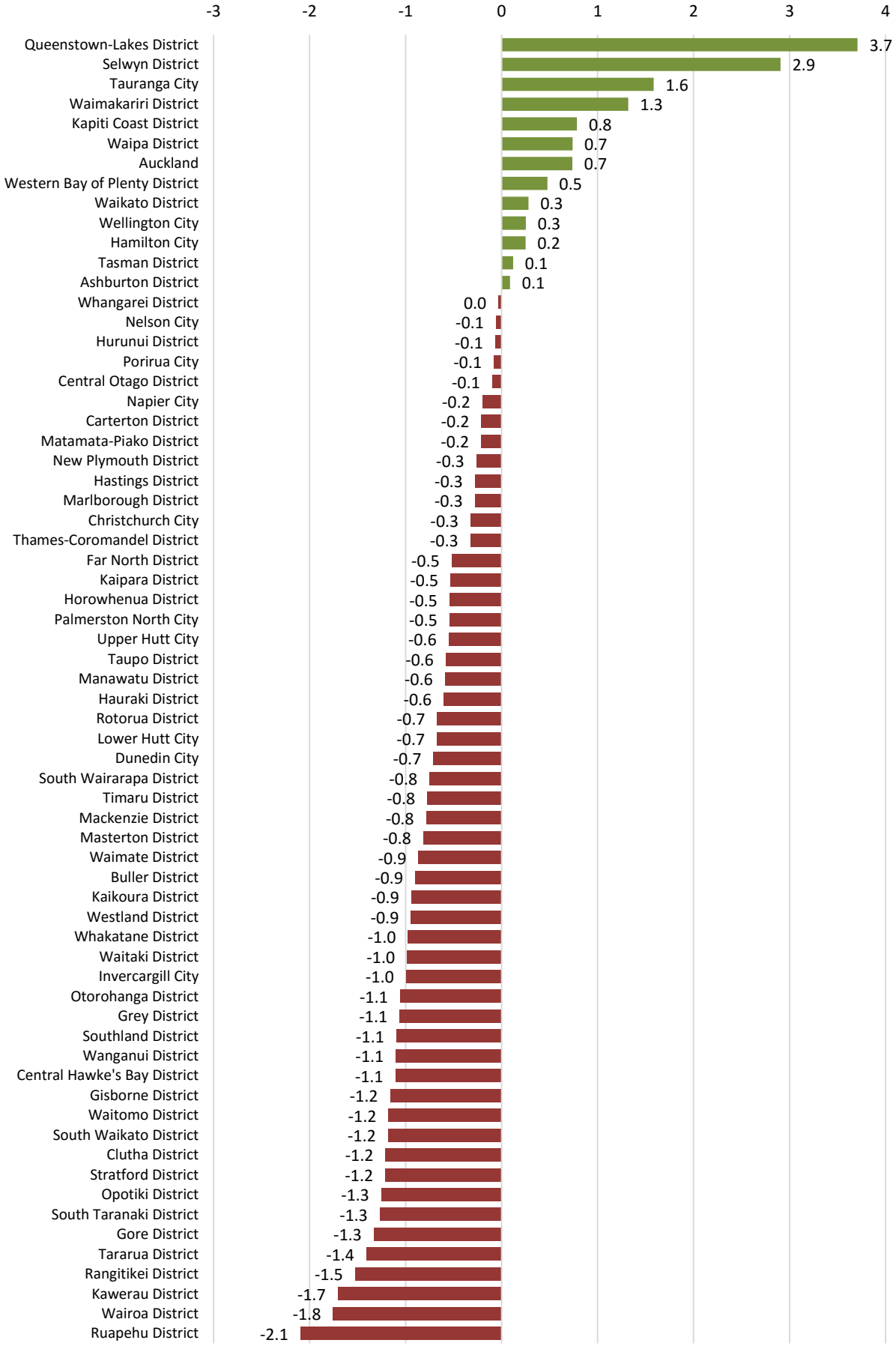
Figure 9 Population growth pushed Auckland out rather than up



Source: Statistics New Zealand

Figure 10 Regional migration flows have been uneven

Ratio of residential land growth from regional flows over national population growth



Source: Statistics New Zealand

Table 1 Decomposition of urban residential land growth by territorial authority

Territorial authority	Land growth	New Zealand population	Regional Population	Household size	Land per household	Interaction
Far North	14.49	35.68	2.55	46.84	6.84	8.09
Whangarei	13.75	47.16	54.82	35.74	-34.21	-3.51
Kaipara	1.55	160.64	7.05	201.90	-227.81	-41.78
Auckland	203.83	28.97	83.36	1.27	-9.64	-3.96
Thames-Coromandel	8.35	46.70	23.61	41.79	-15.03	2.92
Hauraki	3.25	61.40	-6.82	93.94	-44.70	-3.82
Waikato	21.59	20.15	37.45	11.17	19.15	12.08
Matamata-Piako	2.29	90.64	68.70	89.29	-123.73	-24.90
Hamilton	16.32	38.01	68.04	11.59	-15.56	-2.08
Waipa	17.08	14.55	41.93	11.07	17.09	15.36
Otorohanga	0.08	909.98	-1028.15	1380.37	-980.73	-181.46
South Waikato	1.02	155.02	-218.36	173.23	-1.32	-8.57
Waitomo	-1.05	-88.75	124.11	-61.79	119.69	6.74
Taupo	6.69	46.06	-2.97	53.59	-2.12	5.43
Western BOP	10.29	38.16	87.68	25.17	-40.50	-10.51
Tauranga	41.03	14.01	66.87	4.94	6.11	8.07
Rotorua	8.98	54.90	-14.52	48.59	5.61	5.42
Whakatane	0.47	483.56	-457.40	417.41	-311.84	-31.73
Kawerau	-1.22	-78.37	202.14	-144.57	94.42	26.38
Opotiki	0.13	539.61	-844.02	678.77	-213.01	-61.34
Gisborne	0.97	404.56	-551.14	392.40	-120.64	-25.18
Wairoa	-0.67	-136.62	367.38	-167.78	3.39	33.62
Hastings	7.17	73.13	44.91	28.75	-41.90	-4.89
Napier	10.74	29.19	22.94	17.28	20.69	9.89
Central Hawke's Bay	-0.28	-592.52	733.32	-763.09	624.81	97.48
New Plymouth	8.56	58.32	37.82	39.66	-33.69	-2.11
Stratford	-0.32	-322.35	474.47	-287.77	210.10	25.56
South Taranaki	-0.54	-537.37	859.11	-447.79	189.99	36.06
Ruapehu	-2.09	-103.17	355.93	-160.57	-46.83	54.64
Wanganui	2.37	149.29	-183.33	131.04	6.12	-3.12
Rangitikei	0.28	649.12	-1412.66	700.45	269.72	-106.63
Manawatu	3.04	49.20	-4.23	37.03	11.54	6.46
Palmerston North	13.22	37.83	0.78	22.90	29.66	8.83
Tararua	-0.94	-204.38	390.64	-252.00	135.23	30.51
Horowhenua	-1.04	-258.99	-5.51	-298.18	547.56	115.13
Kapiti Coast	9.97	37.23	111.24	21.43	-50.74	-19.15

Territorial authority	Land growth	New Zealand population	Regional Population	Household size	Land per household	Interaction
Porirua	5.47	51.92	54.65	38.57	-40.26	-4.88
Upper Hutt	9.82	28.26	0.00	17.81	43.02	10.91
Lower Hutt	6.28	114.17	-31.09	32.84	-16.70	0.78
Wellington	12.60	59.97	107.78	0.71	-51.40	-17.06
Masterton	1.22	138.75	-81.89	127.99	-78.23	-6.62
Carterton	0.01	4569.08	3481.01	3121.36	-8955.14	-2116.31
South Wairarapa	1.94	53.36	-23.77	42.32	21.66	6.44
Tasman	12.93	36.45	54.69	17.52	-10.12	1.46
Nelson	18.63	16.02	17.63	6.97	43.77	15.61
Marlborough	5.47	55.00	33.70	50.65	-37.09	-2.26
Kaikoura	0.66	47.33	-41.25	56.66	31.34	5.91
Buller	-0.97	-136.47	106.30	-126.77	228.22	28.72
Grey	-1.02	-177.55	203.03	-133.44	191.99	15.96
Westland	-0.63	-175.80	154.32	-225.01	298.95	47.54
Hurunui	2.81	41.80	45.28	28.86	-17.11	1.16
Waimakariri	17.55	17.06	71.27	4.61	2.52	4.55
Christchurch	30.72	58.47	30.05	4.87	4.81	1.81
Selwyn	28.24	5.74	44.33	2.32	21.10	26.51
Ashburton	5.68	30.52	43.69	8.45	11.16	6.18
Timaru	1.19	260.77	-129.38	155.92	-173.13	-14.17
Mackenzie	0.42	116.15	-60.83	60.78	-17.41	1.32
Waimate	0.47	89.18	-62.64	85.69	-13.23	1.00
Waitaki	1.36	165.64	-160.43	119.63	-23.18	-1.65
Central Otago	5.65	31.64	31.97	26.36	2.70	7.33
Queenstown-Lakes	22.31	7.17	68.23	0.67	10.11	13.82
Dunedin	11.99	79.30	-28.12	36.04	8.81	3.98
Clutha	1.98	100.86	-148.14	64.74	84.78	-2.24
Southland	-0.28	-976.53	1188.27	-921.09	724.59	84.76
Gore	0.72	192.51	-334.86	193.59	64.51	-15.76
Invercargill	1.24	366.03	-363.01	279.72	-167.52	-15.22

Source: NZIER

3. Accommodating Auckland's future population growth

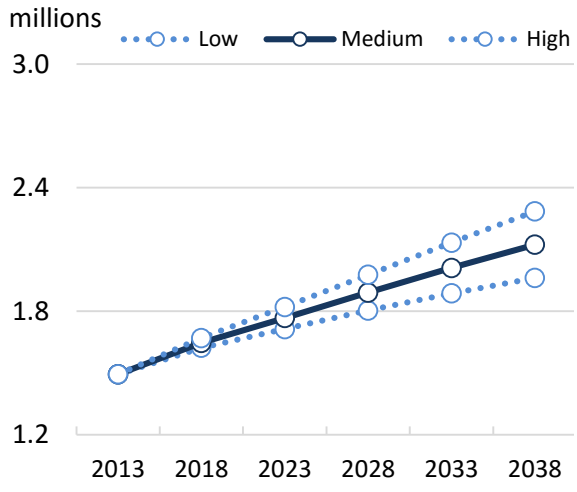
Unlike the mid-2000s, house prices have pushed higher in Auckland than most other regions. House prices have reached ten times average income in parts of Auckland and with house price inflation showing few signs of abating, the differences between the experience in Auckland and many other regions in New Zealand is striking.

But there are many more people that will need to be accommodated in Auckland in the future. Figure 11 shows Statistics New Zealand's low, medium and high population estimates for Auckland's regional population. The forecasts use the 2013 population as a base but national population growth has been double the rate of growth embedded in the subnational population projections so the numbers are likely to undercook the task of accommodating future population growth.[9]

Just how many is in part be determined by the extent the market adjusts and local and central government policies promote cheaper housing than they do currently. The number of households also influences the need for more residential land. Figure 12 shows that the number of households is also set to increase although household size will be partly determined by demographics and the price of land and housing.

Figure 11 Expect many more people

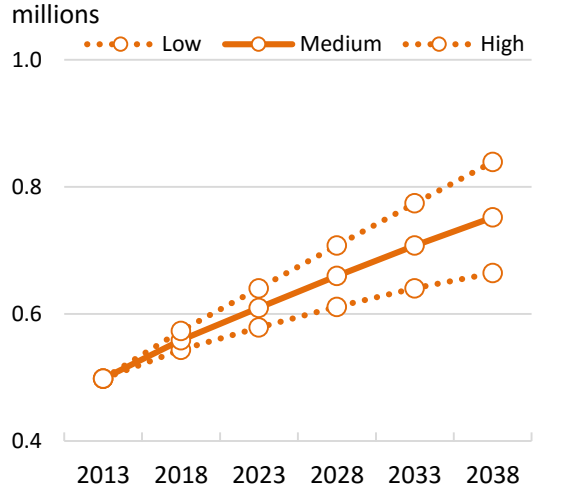
Low, medium, high population forecasts, 2013-2038



Source: Statistics New Zealand

Figure 12 Expect more households

Low, medium, high household forecasts, 2013-2038



Source: Statistics New Zealand

[9] Tasking Statistics New Zealand to provide forecasts (rather than statistics) probably made sense before computers reduced the intensity of calculating forecasts. Today, procuring forecasts from the private sector is likely to provide more innovation and reduce cost. NZIER (2014) provides some insights on how to improve population forecasting. The 013 Expert Working Group (2015) shows just how fraught planning for growth can be.

3.2. Moving out?

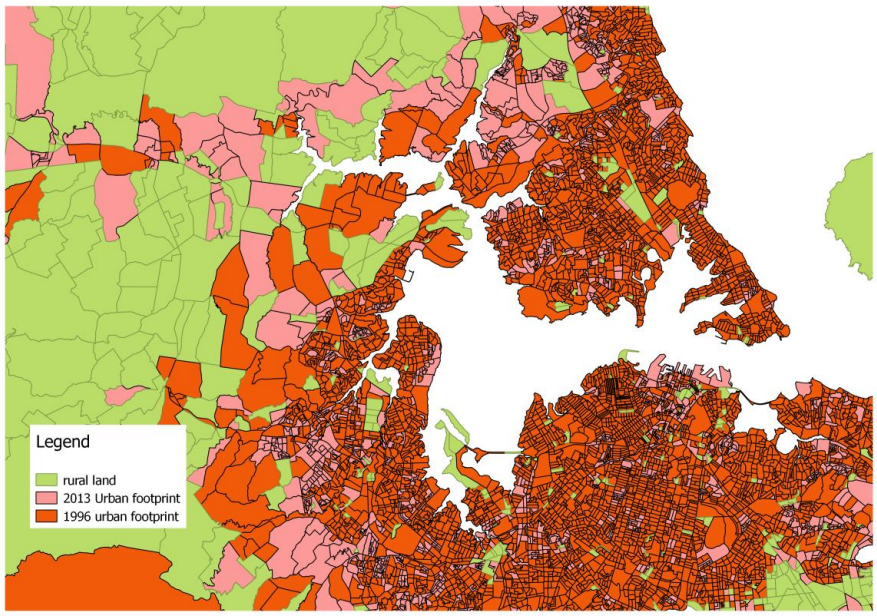
Without change much more land will be required for residential purposes

With no change in household size (Statistics New Zealand expects a small decline) or reduction in land use per household (land use per household reduced the amount of residential land required by 19 square kilometres between 1993 and 2013) the only margin for growth is increasing the use of residential land one-for-one – an additional 293 square kilometres is required.

Out not up is the theme of the past. In Auckland, population growth has tended to expand the footprint of Auckland city with much growth focussed to the west and south of the city (see Figure 13). With the exception of the downtown, the population in Auckland's outer suburbs has grown faster than in the inner suburbs (see Figure 14) on the isthmus.

Figure 13 Our metric shows city growth in the west of Auckland

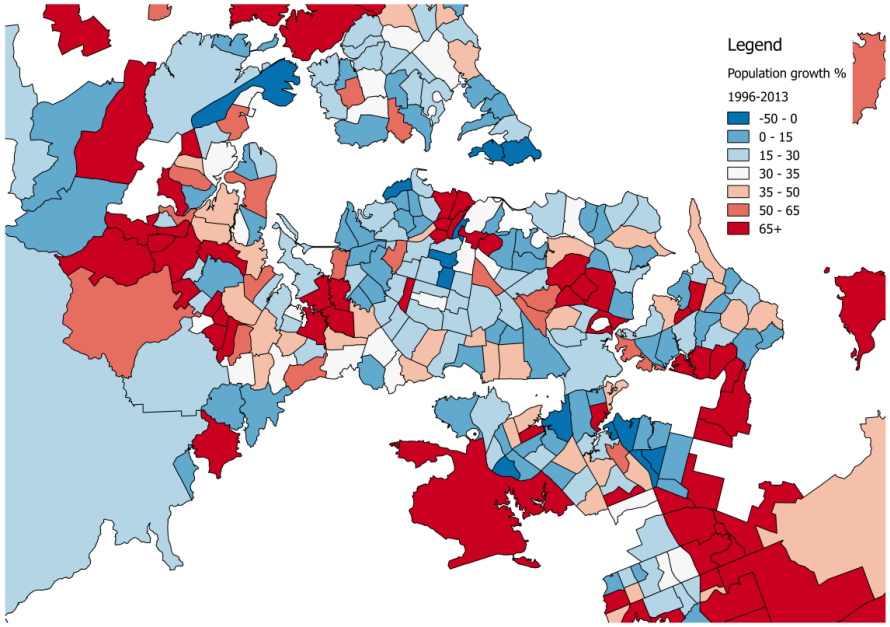
Residential land foot print, Auckland 1996 and 2013



Source: NZIER

Figure 14 Outskirts and downtown housed past population growth

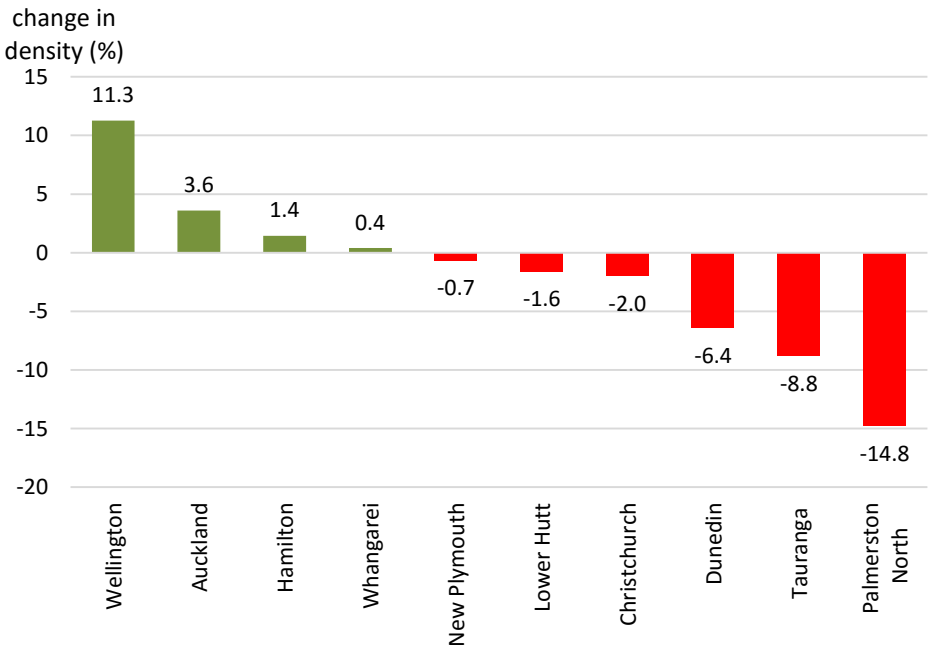
Population growth by area unit, (%)



Source: Statistics New Zealand

Indeed, as shown in Figure 15, Wellington has had much greater increases in population density than has Auckland.

Figure 15 Wellington increased density between 1996 and 2013



Source: NZIER

3.3. Moving up?

Moving out instead of up is not likely to be ideal. It would be better if Auckland's growth involved a combination of growing up and growing out. This would best contain house price growth and allow families to take advantage of local amenities or productivity opportunities by either moving to Auckland or remaining within the city limit.

To illustrate what intensification might entail, if land supply does not expand population growth would demand an average 50 percent increase in population in each suburb.

Based on the experience of the past 16 years a move up of this magnitude looks unlikely. While there are some spots in Auckland that lend empirical support to intensification, including downtown apartments,[10] the majority of Auckland's suburbs failed to accommodate even a quarter of the population growth required for a 'moving up' scenario.

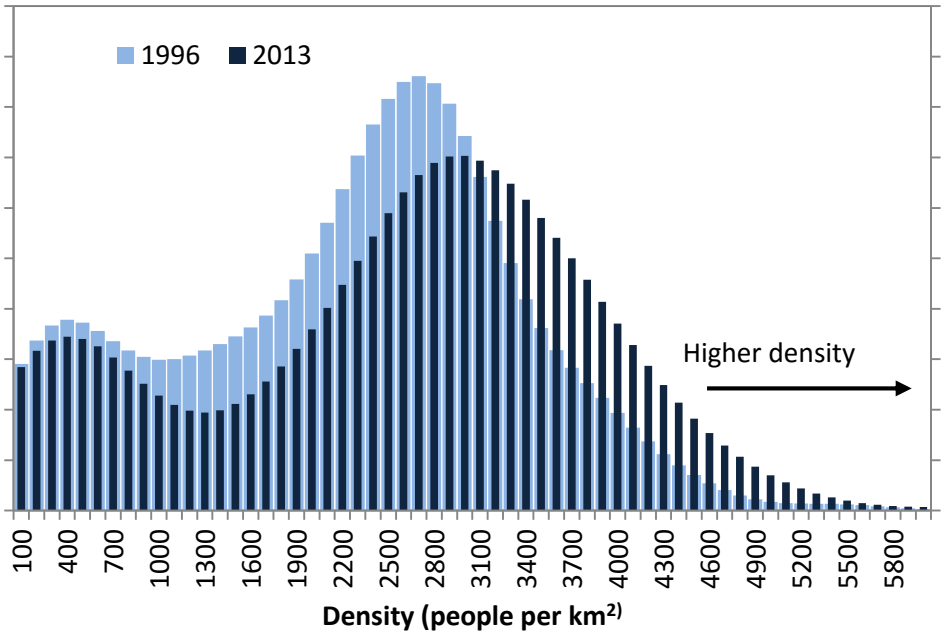
There are some 'solutions' in view, however. For example, the limited changes we have seen in density plus house price increases are consistent with material constraints of land use regulation. That constraints on residential development at either the city boundary (see for example, Turner et al. 2014 and Grimes 2009 that shows the impacts for Auckland) or within the city boundary (see for example, Glaeser and Gyourko 2009) can have large impacts on land values and the cost of housing is well known. So, relaxing regulation could help increase intensification.

The importance of relaxing regulation is perhaps more important in Auckland than elsewhere. Auckland's tight geography – with twin harbours on both sides of the city – fundamentally limits land supply and raises the costs of land use regulation that limits use of existing well-located land close to the city centre. That is, relative to other cities with similar populations, tight geography means high costs of setting aside land for heritage, the amenity benefit of volcanic viewshafts, or providing space for land intensive activities, like golf, that are only taken up by a fraction of residents.

[10] Many point to a growing number of residents from Asia and suggest these residents are used to living in apartments and will favour downtown living over a family home with a backyard in the suburbs. This misses the point that many of these residents live in cities that are extremely dense and backyard space is incredibly expensive. These residents may well prefer homes in the suburbs given the price of land is (at least for now) relatively cheap compared to many Asian cities.

Figure 16 Auckland's suburbs intensified but not enough to accommodate much growth

Distribution of density by suburb, Auckland 1996 and 2013



Source: NZIER

There are many ways to achieve growth within suburbs.

4. Conclusion

In four short years, the average value of a house in Auckland has increased 70 percent from $555,573 in April 2012 to $942,760 in 2016. Supply has simply been too tight and regulation too inflexible to accommodate people that want to live in Auckland.

Much of the current debate centres on the extent to which Auckland will need to grow up or grow out. Auckland will need to use many levers if house prices are to stabilise rather than move higher. That means growing out and growing up.

But using the past as a guide to the future suggests Auckland will grow out much more than it will grow up. Our measure of residential land shows Auckland grew up only a little between 1996 and 2013 – reduced land use per household decreased the size of the city by 19.6 square kilometres. But over the same period, national population growth and internal migration towards Auckland grew the city out by 229 square kilometres.

The past does not determine the future. But the past does act as a guide to what will transpire without material changes. Growing up will require far more growth accommodative policies. And Auckland's tight geographical constraints make the cost of setting aside well-located land for heritage, the amenity from volcanic viewshafts and land-intensive recreation activities close to the city centre high. Growing out requires resolving how to fund the infrastructure to make urban land development ready.

Moreover, the number of New Zealand cities and suburbs that have grown up rather than out is small. While Auckland's density has increased a little there are precious few examples of suburbs that have accommodated growth sufficient to limit the need of the city to expand. While apartments in the downtown area have intensified, only a handful of suburbs in the isthmus have accommodated much population growth.

Our analysis using residential land growth suggests it will be very difficult for Auckland to intensify. But regardless of the relative preferences of growing up versus growing out, our simply method could be used as a guide for councils that want to move out and move up. Combining our simple method for determining the change in residential land with our simple decompositions can easily be used by councils to track progress on both moving out and moving up. Our decompositions would also show any confounding factors – such as unexpected regional migration – that impact on the amount of residential land that needs to be made available.

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