2019

# Potential Social Impacts of Land-use Changes, 2020-2050

REPORT TO THE INTERIM CLIMATE CHANGE COMMITTEE

# Potential Social Impacts of Land-use Changes 2020-2050

## Introduction

This report summarises the results of an analysis of the socio-economic characteristics of areas across New Zealand that are most likely to be subject to land-use change between 2020 and 2050 as a result of climate change policy. This analysis has been commissioned from Motu by the Interim Climate Change Committee, to better understand the potential implications of climate policy targeting agricultural greenhouse gases on land-use change and rural communities. As such, the analysis has three components: 1) to forecast land-use changes under different scenarios using the Land Use in Rural New Zealand (LURNZ) model, 2) to report the current socioeconomic characteristics of the areas where land-use changes are predicted in order to better understand those areas most likely to be affected, and 3) to estimate the potential changes in employment given the forecast land-use changes in these areas.

For the first component, we use the LURNZ model to estimate land use in 2020 and 2050 (see below for a more detailed description of the model and its key inputs and assumptions for this report). The base assumptions used for this report are largely the same as those used in the *Low-emissions economy: Final report* released by the Productivity Commission in August 2018[1]. This report builds on the base model from the Productivity Commission report to investigate how land-use might vary under different scenarios. The base scenario assumes the same climate policy as used in the Productivity Commission report where both agricultural emissions and carbon sequestration are exposed to a carbon price (with a gradual phase-out of free allocation – for details see the Productivity Commission report, 2018). A second scenario deviates from the base scenario by assuming a climate policy where agriculture is assumed to face no costs for its greenhouse gas emissions, but forest owners (who may also be farmers) receive a reward for carbon sequestration (the Reward Only scenario). A third scenario deviates from the base scenario by assuming that there are no changes to horticultural land use.

Using the results from the LURNZ model, we then describe the socioeconomic characteristics (e.g., employment, income, Māori land ownership, deprivation level, and ethnicity) of those areas that are expected to undergo land-use change between 2020 and 2050. This provides a picture of the communities that are most likely to face the effects of land-use change in the future. As part of this analysis, we also examine the likely employment changes in those sectors and regions where land-use is expected.

## LURNZ model, assumptions and data

Motu's LURNZ model is a dynamic, spatially explicit, partial-equilibrium model of rural land use[2]. It forecasts changes in land use for dairy, sheep/beef, forestry, and scrub in response to changes in economic incentives.[3] Horticulture change is exogenous, but it is included in the spatial modelling. In

[1] New Zealand Productivity Commission. (2018). *Low-emissions economy: Final report*. Available from www.productivity.govt.nz/low-emissions.

[2] It is beyond the scope of this project to fully document every aspect of the LURNZ model. However, detailed information about the LURNZ model can be found on Motu's website: https://motu.nz/our-work/environment-and-resources/lurnz/lurnz-overview/lurnz-documentation/.

[3] The LURNZ model effectively assumes that emissions costs affect farm decision-making in exactly the same way as commodity prices do through their effect on profits. Hence, the effect of a policy such as the emissions trading

LURNZ, land use is defined in 25-hectare (500m x 500m) sections according to land suitability, land-use intensity, and emissions (or sequestration) associated with these land uses.

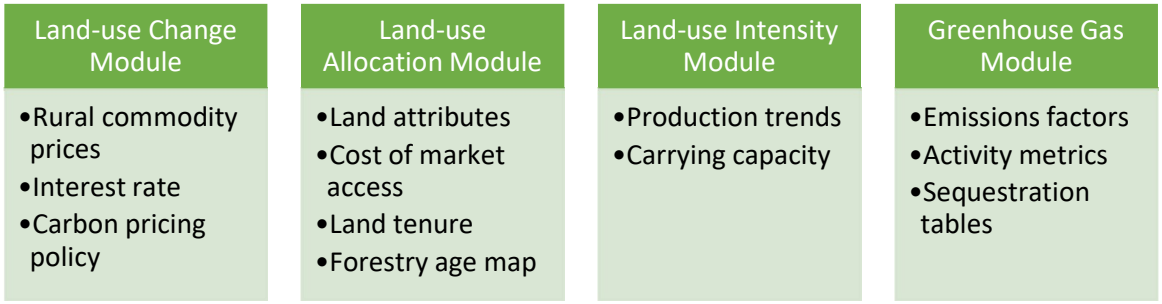
At the core of LURNZ are two econometrically estimated models that establish the relationship between observed drivers of land use and land-use outcomes:

- A system of regression equations that estimate dynamic land-use responses to changes in economic drivers, such as commodity prices, at the national level; and

- A spatial model that relates land-use choices to various geographical characteristics of the land, and to proxies for the cost of market access, land tenure and yields. The spatial model disaggregates land into 25 hectare blocks.

LURNZ has a strong empirical basis. It requires relatively few assumptions about farmers' objectives and decision processes – results are largely driven by how land use has responded to its main drivers in the past. The model's underlying datasets and processes have been validated, and its results are consistent with data and trends at the national scale, including New Zealand's Greenhouse Gas Inventory. The data used by the modelling system are detailed in Figure 1.

*Figure 1. Main inputs into the LURNZ modelling system*




Source: BERG Report 2018[4]

There are a foundational set of assumptions used for the construction of the land-use maps in this report, which reflect the assumptions under the Policy Driven Decarbonisation scenario of the Productivity Commission's 2018 final report[5] with a net emissions target in 2050 of 25 Mt CO2e.[6] Given a

environment (including emissions pricing and any free allocation) is modelled through adjustments to commodity prices received in each rural sector. While this can be interpreted as the effect of emissions trading, it could equally be interpreted as any type of policy that has the equivalent effect on the profit a land user earns - such as a subsidy, a tax, farm education and support, or efficiency gains resulting from R&D.

[4] Dorner, Z., et al. 2018. *Land-use change as a mitigation option for climate change*. Report to the Biological Emissions Reference Group (Project No. 18398). Motu Economic and Public Policy Research.

[5] New Zealand Productivity Commission. (2018). *Low-emissions economy: Final report*. Available from www.productivity.govt.nz/low-emissions.

[6] These assumptions include standard commodity prices (as per SOPI projections), a medium rate of horticulture expansion (reaching around 1 million hectares by 2050), no methane vaccine or other major technological breakthroughs for on-farm mitigation options for agriculture, one-third of all new forestry area being dedicated to native species, a halt in dairy expansion in 2025 due to water quality regulations, and free allocation is phased out

25Mt net emission target and the assumptions under this scenario, the carbon price was projected to reach around NZD$150 by 2050.[7]

In the model for the Productivity Commission, the assumption about native forest expansion was fundamentally non-spatial in nature – the change in plantation forestry area in LURNZ was modelled with an ex-post assumption that one third of the overall increase in forestry area will go to native species. However, the location of the native species is unknown. Therefore, the land-use maps and regional summary tables cannot reflect the increase in native forests, only the overall increase in plantation forestry area. [8]

As previously mentioned, this report will discuss the results for three different scenarios. The base scenario assesses the land-use changes that occur between 2020 and 2050 assuming a climate policy where all sectors are exposed to emissions prices, including agriculture. For the remainder of the document, we will refer to this as the *Full Cost* scenario. An alternative scenario deviates from the Full Cost scenario by assuming a climate policy where agriculture does not incur emissions charges but instead the economic incentive for land-use change comes about through reward for sequestration rather than through payments for emissions by farmers. We will henceforth refer to this as the *Reward Only* scenario. The third scenario – which we will refer to as the *No Horticulture* scenario – assumes that no additional land will change to horticulture and instead is limited to changes between scrub, forestry, sheep/beef and dairy. This assumption defines a conservative lower bound on total employment changes since horticulture is relatively labour intensive compared to the other sectors being analysed.

## Land-use Change 2020-2050

- Four main types of land-use changes are identified between 2020 and 2050 – a shift from dairy to horticulture, scrub to forestry, sheep/beef to forestry, and sheep/beef to scrub. There are also land-use changes from sheep/beef to dairy, sheep/beef to horticulture, scrub to dairy, and scrub to horticulture, but these changes are much more minor in extent.
- The full maps showing land uses in 2020 and 2050 as well as the changes between 2020 and 2050 are provided in Figure 11 to Figure 14 for the Full Cost scenario and in Figure 15 to Figure 18 for the Reward Only scenario. These maps can be found at the end of this document, but higher resolution maps have also been provided as separate documents.
- Regardless of the scenario used, land-use change is expected to be spread widely across New Zealand in diverse areas and regions as can be seen from the full maps.

gradually. It is assumed that there are continuous improvements in emissions efficiency per unit of dairy or sheep/beef production in line with historical improvements.

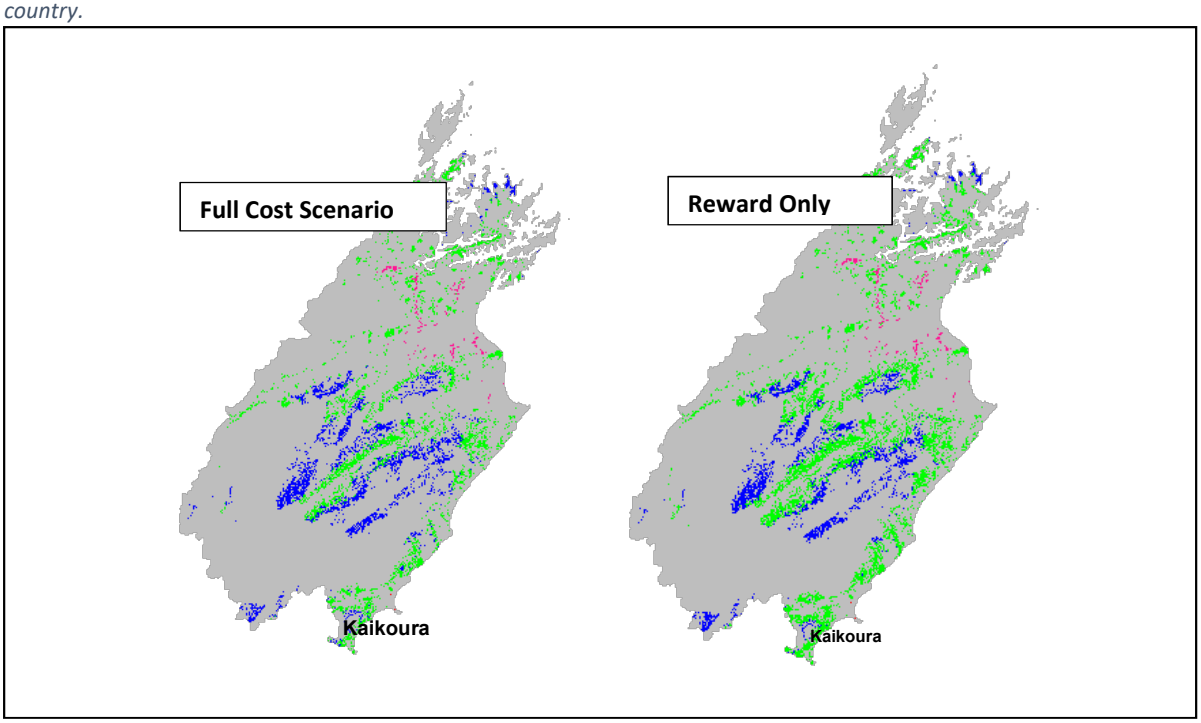
[7] The original method used for the Productivity Commission used a weighted average of LURNZ runs with different carbon prices to interpolate land-use, production and emissions outcomes at the national level, but this was unsuitable for mapping land-use change as spatial outcomes are discrete. Therefore, to create the maps for this report, the LURNZ model was re-run using the interpolated (weighted) carbon price path that emerged from original project. This interpolation across LURNZ runs was found to work well: interpolating outcomes across different runs produces nearly identical results to actually performing the LURNZ run with the weighted carbon price path.

[8] This introduces some inconsistency across the national, regional, and spatial summaries.

## Comparison of Full Cost and Reward Only Scenarios

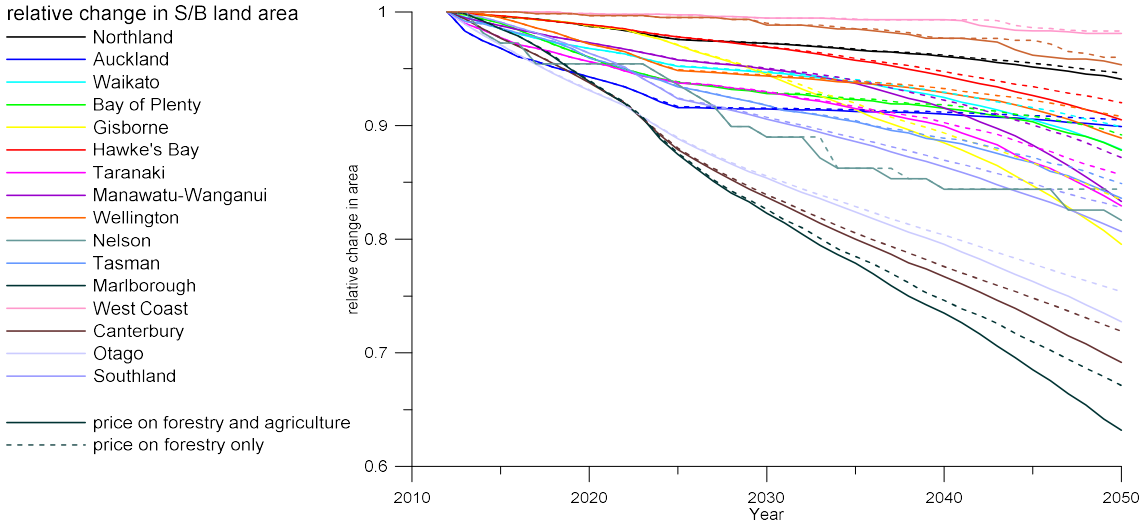
- At the national scale, there are minor differences between the Full Cost and Reward Only scenarios, but the main trends in conversion type and area are consistent.
- Within this summary report, we focus primarily on the Reward Only maps. The main difference in land-use change between these scenarios is that, under the Full Cost scenario, there is additional conversion from scrub and sheep/beef land to forestry. However, comparison of the ***Reward Only*** and ***Full Cost*** scenarios suggests that the main driver for land-use change from sheep/beef to forestry is the reward for carbon sequestration in forests, not the cost imposed on agricultural greenhouse gas emissions from sheep/beef operation.
- In the Full Cost scenario, sheep/beef and dairy would face a cost for their greenhouse gas emissions and thus would, in turn, drive up their operational costs. This increased cost relative to the costs (and benefits) of forestry cause a greater land conversion toward forestry, even with a carbon price reaching $150 by 2050 as the model assumes. Land in the areas described above is hard to convert and not ideal for plantation forestry (green), so there needs to be enough of an incentive to convert (*i.e.*, increased relative value of forestry due to increased costs of sheep/beef and dairy operations).
- There is marginally more land-use change in the Central South Island in the *Full Cost* scenario and land is more likely to convert to forest. While in the *Reward Only* scenario, the conversion is more likely to be to scrub.
- Figure 2 shows a close-up view of the Marlborough District and the Kaikoura District to show the slight differences in areas that are more likely to be converted to scrub in the *Reward Only* scenario compared to the areas that are more likely to be converted to forestry under the *Full* Cost scenario.

*Figure 2. This figure focuses on a small area – the Marlborough District and the Kaikoura District – of the full land-use change maps in order to show the slight difference in the expected areas changing to scrub and forestry under the Full Cost scenario (left) and a Reward Only scenario (right). The full land-use maps show the widespread changes over the entire country.*




- A key overall conclusion from this comparison of scenarios is that most of the land-use change that is expected to occur, especially for the conversion away from sheep/beef land (into forestry or scrub), occurs even if there is no price on agricultural emissions. In other words, the main driver of this land-use change, based on the LURNZ model, is the reward for carbon sequestration in scrub and forestry, rather than the cost on agricultural emissions.

*Figure 3. The relative change in sheep/beef land area by region using a carbon price based on forestry and agriculture (solid line) and using a carbon price based on forestry only (dashed line).*



## Land-use change – No Horticulture Conversion

- One LURNZ scenario used for this report assumes that horticulture conversion is not possible.[9] This provides an important point of comparison for the other scenarios because horticulture is a main source of employment for land-use conversion compared with forestry and scrub. Moreover, we recognize that there may be substantial barriers to entry for new entrants in the market and that the full conversion of land to horticulture assumed under the baseline and reward only scenarios may be overly optimistic. Hence, this scenario provides a lower bound for the potential changes in employment between 2020 and 2050 based on the changes in land use over the same time period.
- In this scenario, there is a net gain in land converting to dairy by 2050 (approximately 87,000 hectares), whereas in the both the Full Cost and Reward Only Scenarios there is a net loss in dairy land (approximately 195,000 hectares) for all of New Zealand.
- For forestry, there is absolutely no difference between the Full Cost and the No Horticulture scenarios and a very small difference in scrub land.
- Under all three scenarios, there is a net loss in sheep/beef land between 2020 and 2050, but this loss is greater under the Full Cost scenario than under the No Horticulture scenario. In the No Horticulture scenario, some of the sheep/beef land that converted to horticulture in the Full Cost Scenario converts to dairy. In the LURNZ model, horticulture requires the best land, and if that land is currently used for sheep/beef, it will convert to horticulture. However, under the No Horticulture scenario, the sheep/beef land that would have converted to horticulture in the Full Cost scenario will convert to dairy as long as dairy is expanding.
- Table 1 shows estimates of national-scale employment levels for dairy, sheep/beef, forestry, and horticulture projected into 2020 and 2050 based on the expectation of land use under the three scenarios. We multiply the total number of hectares used by each sector in the three scenarios by a national estimate of the number of FTEs per hectare used for each land-use type. A full description of the methodology used and additional employment changes is discussed in the socioeconomic impacts section. With no conversion to horticulture, employment in horticulture is estimated to stay the same from 2020 to 2050. Without the gain in jobs from horticulture, we can see an estimated loss in employment of 741 FTE positions across the country.

*Table 1. Employment (as number of FTEs) under each LURNZ scenario: Reward Only, Full Cost, No Horticulture*

| | | Dairy | Sheep/Beef | Forestry | Horticulture | Total |
|---|---|---|---|---|---|---|
| 2020 | Reward Only | 45,932 | 41,824 | 6,633 | 26,170 | |
| | Full Cost | 45,927 | 41,812 | 6,636 | 26,170 | |
| | No Horticulture | 47,093 | 42,078 | 6,636 | 21,404 | |
| 2050 | Reward Only | 41,757 | 35,639 | 9,799 | 44,042 | |
| | Full Cost | 41,784 | 34,538 | 10,704 | 44,042 | |
| | No Horticulture | 48,949 | 35,414 | 10,704 | 21,404 | |
| net 2020-2050 | Reward Only | -4,175 | -6,185 | 3,167 | 17,872 | 10,679 |
| | Full Cost | -4,144 | -7,274 | 4,068 | 17,872 | 10,522 |
| | No Horticulture | 1,856 | -6,664 | 4,068 | 0 | -741 |

[9] These maps have been provided in high resolution as separate documents.

## Land-use change in the Reward Only Scenario

- In the Reward Only scenario, the South Island primarily changes from sheep/beef to forestry and scrub. However, there is also some dairy converting to horticulture along the east and south coasts.
- The North Island primarily changes from scrub to forestry and from concentrated areas of dairy to dense areas of horticulture in the Bay of Plenty and Taranaki. There are small areas of change to dairy from sheep/beef.
- While this report primarily focuses on land-use changes, it is important to note that, most land being used for dairy, sheep/beef, forestry, or scrub does not change. In the Reward Only scenario, approximately 21% of land will change to another type between 2020 and 2050. For dairy land, the net change will be limited to approximately 9% of land used for dairy in 2020, and for sheep/beef land, the net change will be approximately 15%. Scrub and forestry have a larger percentage of land changing, 33% and 48% respectively.
- Overall, the model indicates that land-use change is spread broadly across the country and is not concentrated into a single area or region. Given the results from the model, land-use change is expected to occur in many diverse pockets and regions across New Zealand. Changes to horticulture are more concentrated in certain areas than other types of land-use change, but that is primarily due to the suitability of land for horticulture. Nonetheless, at smaller scales, such changes could still imply a locally significant shift.
- To show some of these smaller scale changes, examples of land-use changes are shown in Figure 4 to Figure 7 using close-up maps (extracted from the full maps) for different areas and regions. These figures highlight the smaller scale changes in different areas of the country.
- For example, Figure 4 highlights the changes in the Gisbourne Region, which is an area of change that coinicides with large proporitons of Māori land ownership. Land in this area is largely predicted to be scrub (blue) or sheep/beef farming (yellow) in 2020. In 2050, this land is likely to convert to forestry with small changes to horticulture in the south. The conversion of scrub (blue) to forestry (green) has the potential to improve social outcomes such as employment as scrub is untended land. However, the additional conversion from sheep/beef to forestry along the east of this map could potentially reduce overall employment in this area as the average workers per hectare ratio for forestry is 43% lower than that of sheep/beef farming based on 2013 national employment figures[10].
- Figure 5 shows the land-use changes predicted under the Reward Only scenario between 2020 and 2050 in the Taranaki Region. The dominance of horticulture conversion highlighted in Figure 5 is encouraging if such a full conversion to horticulture is possible. Given that horticulture requires a much higher ratio of workers per hectare, employment in Taranaki is expected to increase.

[10] Descriptions of this data and the method of calculation are described in the social impacts methodology.

*Figure 4. Land-use changes in the Gisborne Region, Reward Only. As an example of one area that is changing, this figure focuses on changes In the Gisborne region from 2020 (left) to 2050 (right), where sheep/beef farms (yellow) and scrub (blue) convert mostly to forestry (green). There are also some pockets of conversion to horticulture (pink). The grey areas do not change. Maps at the end of the document show the full change across New Zealand.*

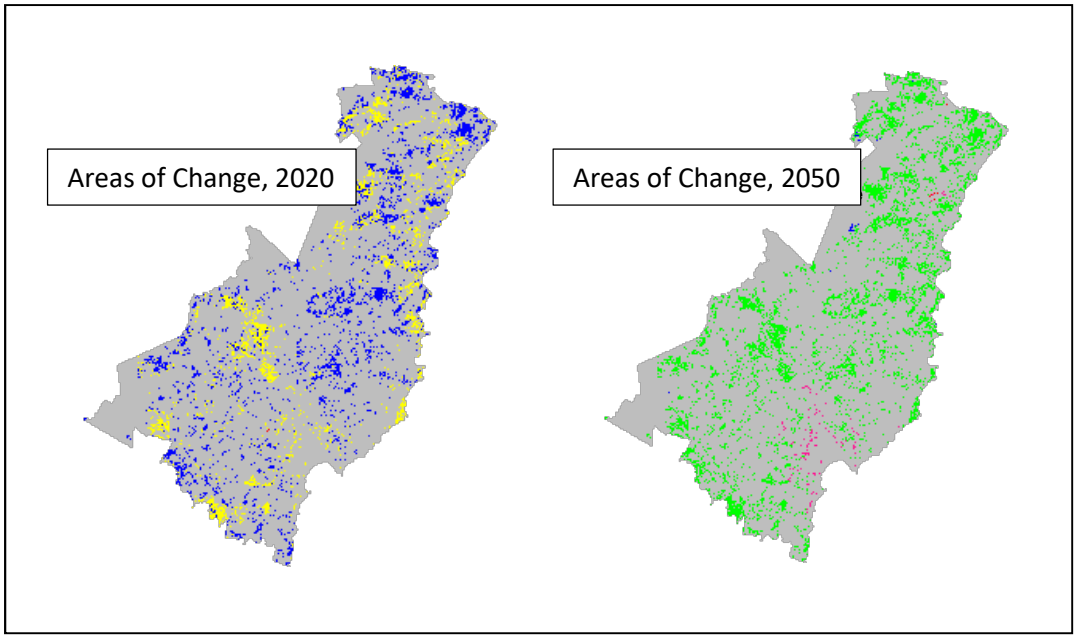
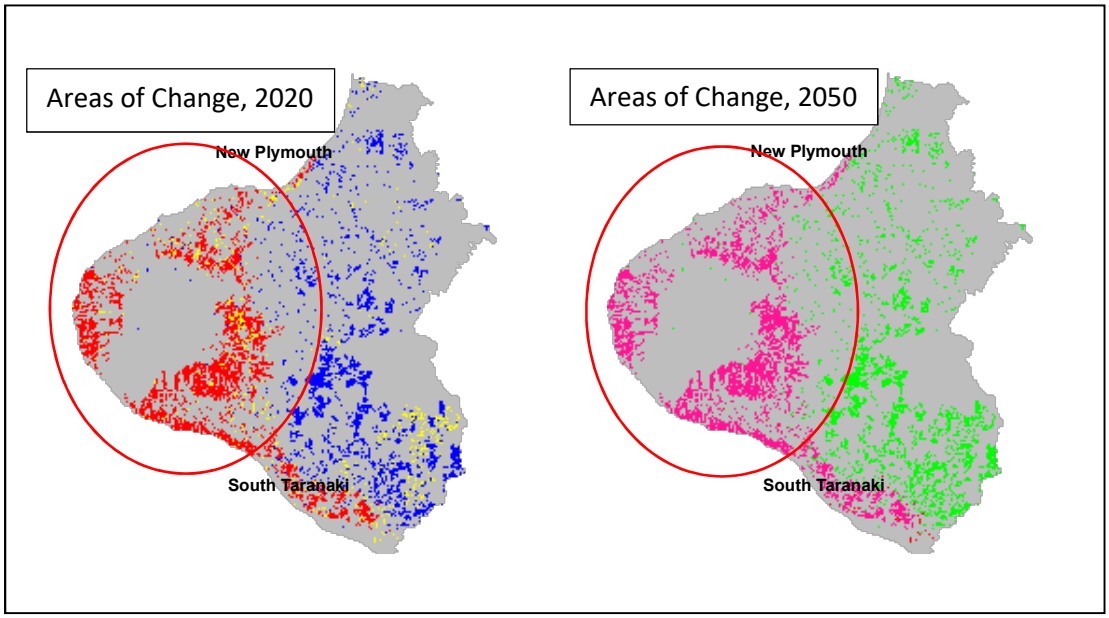
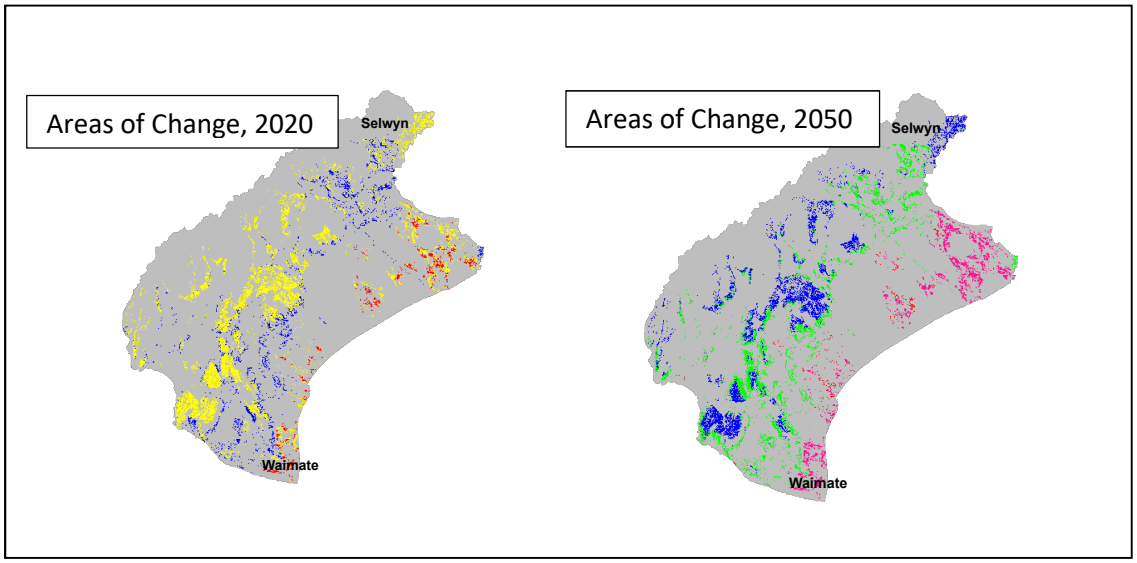


*Figure 5. Land-use changes in the Taranaki Region 2020-2050, Reward Only. In this figure, dairy farms (red) in 2020 convert to horticulture (pink) in 2050 in the areas surrounding Mt. Taranaki, including Stratford, Altham, Manaia, Auroa, Oanui, Rahotu, Pungarehu, Warea and Kaitake. The grey areas do not change. Maps at the end of the document show the full change across New Zealand.*



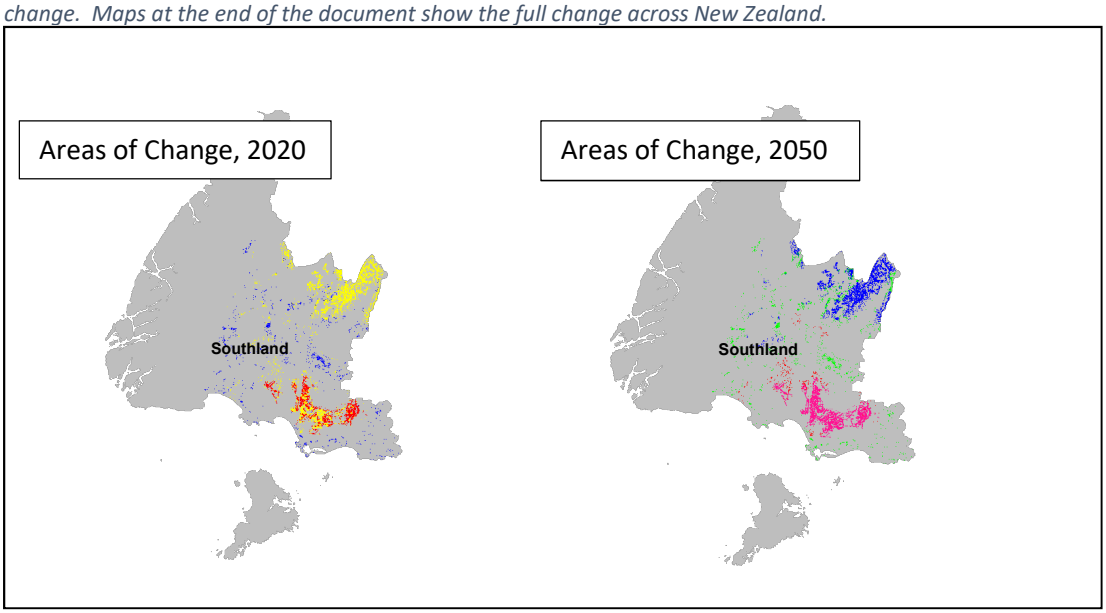

- An example of land use changes in areas on the South Island are shown in Figure 6. This figure illustrates areas of land use change in the districts southwest of Christchurch, from the Selwyn District to the Waimate District.

*Figure 6. Land-use changes between the Selwyn and Waimate Districts 2020-2050, Reward Only. In these districts, dairy farms (red) in 2020 mostly convert to horticulture (pink) by 2050 along the East Coast. Sheep/beef farms (yellow) in 2020 convert to a mixture of scrub (blue), forestry (green), and horticulture by 2050. The grey areas do not change. Maps at the end of the document show the full change across New Zealand.*



- As can be seen in Figure 7, there is primarily areas of concentrated change in land use in the Southland Region. An interesting change is modelled to occur around Invercargill where a cluster of sheep/beef and dairy farms are expected to change toward horticulture.

*Figure 7. Land-use changes in the Southland Region 2020-2050, Reward Only. In Southland, dairy (red) and some sheep/beef in 2020 convert to horticulture (pink) by 2050. Areas of sheep/beef (yellow) in 2020 also convert to scrub (blue) by 2050, and some scrub (blue) in 2020 converts to forestry (green) by 2050. The grey areas do not change. Maps at the end of the document show the full change across New Zealand.*




# Socioeconomic Characteristics of Areas with Land-Use Change

## Methodology

The social impacts of land-use change were modelled using an overlay methodology in QGIS using the Reward Only scenario. Mapping of land-use changes and the socioeconomic characteristics of the area were done at a pixel level. Pixels are defined as 25-hectare blocks (500m x 500m). We match the locations of pixels with a shape file of meshblock boundaries that code each pixel into a specific geographic meshblock area. The outcome of the LURNZ model indicates which pixels across New Zealand change and the type of land-use change.

These indicators of land-use change are then used to show the social characteristics underlying these areas. If a pixel within a meshblock indicates land-use change, then the value of the social variable for the meshblock in which the pixel is located is assigned to that pixel and mapped. Furthermore, we can isolate these social variables by the type of land-use change (e.g., from dairy or sheep/beef to forestry, scrub or horticulture). This allows us to identify the social characteristics of geographic areas in which change in land-use is expected to change.

New Zealand is defined geographically by different boundary groups that vary by size. The most detailed statistical areas are meshblocks (MB) with an average of 80 individuals per meshblock, which is why we use it for mapping pixels. Meshblocks can also be used to aggregate data to larger statistical areas

including area units, statistical areas 1 or 2 (SA1 or SA2), or urban-rural areas (UA)[11]. These intermediate boundary groups are useful in our analysis to identify areas within larger communities such as farming communities that may be heavily impacted by changes in land use. Meshblocks can also be aggregated to larger non-statistical areas such as Territorial Authorities (TA) or Regional Councils (RC). These two boundary groups are used in our analysis to identify large communities for in-depth analysis of social and land-use changes. The mapping of social characteristics was done using data either at the meshblock or statistical area 2 level.

Census 2013

We used publicly available data from the 2013 Census primarily at the meshblock level for the mapping of social characteristics, including employment, unemployment, median income, ethnicity, and government benefits received. A limitation of the detailed nature of this dataset is the small population in some areas and the confidentiality rules imposed by Statistics New Zealand. On average, a meshblock is designed to capture approximately 80 residents, but some have far fewer residents especially in rural areas. Moreover, for characteristics with many categories (e.g., ethnicity), dividing even 80 residents into different groups can lead to very small numbers very quickly. For confidentiality, Statistics NZ rounds all data to a random base of three, and data are suppressed when there are a small number of individuals. When a value has been suppressed, we use the publicly available data from the 2013 Census primarily at the area unit level.

Land Values

Our land values data come from Quotable Value New Zealand (QVNZ)[12]. QVNZ conduct property valuations and purchase external valuations to compile a database of all properties in New Zealand. These valuations are usually conducted on a 3-year cycle. QVNZ assigns each property a value in each year using its most recent valuation. Our data run from 1995-2012, meaning we have six full valuation cycles. This property valuations database is matched to 2006 Statistics New Zealand (SNZ) meshblock (MB) boundaries by QVNZ. We then match this data to the Territorial Authority valuation cycle and keep the observation that corresponds to a particular meshblock's valuation year. We then group these observations together into 3-yearly valuation cycles to create a national level dataset. In order to merge this data with other corresponding data using the 2013 meshblock definitions, we use a concordance of the 2006 and 2013 meshblocks.

For each MB, the QVNZ data record the total capital value of all assessments[13], and the total land area assessed by QVNZ land use category. We are limited in this dataset to only rural land values, and we focus our analysis on the capital value (land and buildings). There is missing capital value data for horticulture land use. The majority of capital value in rural land is assigned to land value. We use the SNZ classification of 2006 meshblocks and drop those classified as urban by SNZ. Once we have our sample of rural MBs, we turn our attention to identifying the rural land within each meshblock. For this, we use the QVNZ land use categories. We focus our analysis on the three main rural land uses: dairy,

[11] The urban areas within the UAs are limited to areas with substantial residential populations and do not cover all land in New Zealand.

[12] The data on residential, farming and commercial property prices was sourced by Motu Economic and Public Policy Research Trust from Quotable Value New Zealand as part of Motu's FRST-funded Adjustment and Inequality programme.

[13] Capital value is equal to land value plus improved value. Improved value refers to the value of buildings on the property, while land values reflects what the property would sell for without buildings and other improvements.

sheep/beef, and forestry.[14] Dairy, sheep/beef, and exotic forestry alone account for around 75% of private rural land in New Zealand (Kerr and Olssen 2012).

Maori Land Ownership Data

The Māori Land Spatial dataset provides spatial information of Māori-owned land recorded by the Māori Land Court[15]. The original dataset is managed by the Ministry of Justice and the Ministry for Primary Industries. This data records the status of Māori land and the management structures that administered the land according to Te Ture Whenua Maori Act 1993 (MJ, MLC, and MPI 2017). This dataset does not provide information on land return or land involved in any Treaty of Waitangi Settlement process, unless the settlement legislation requires the land become Māori Freehold land or Māori Reservation.
The following table summarises the description of the type of land and the number of pixels associated with each category. The category mapped for the purposes of this report is *Māori Freehold land*.

*Table 2. Number of Pixels by Land Ownership Categories*

| Description | Pixels |
|---|---|
| Māori Freehold land | 52,868 |
| General land owned by Māori | 614 |
| Crown Land | 2 |
| Crown Land reserved for Māori | 324 |
| Māori customary land | 30 |

Employment by Sector Data Sources

National estimates for total employment in terms of the number of Full-Time Equivalent (FTE) workers in the dairy, sheep/beef, forestry and horticulture sectors are from a special tabulation of the 2013 Census data provided by Statistics NZ[16]. We use these numbers to estimate national and broad regional employment changes based on the projected land use changes. Hence, we use summaries of the outputs of the LURNZ model (the total number of hectares for each land use type across New Zealand) with the national estimate of FTEs in each sector to calculate the ratio of Full Time Equivalent (FTE) workers per hectare by sector. Then, using this ratio and the regional estimates of land-use change in 2020 and 2050, we estimate the total number of workers by sector and region in each time period. Although this data is useful as it pertains directly to the industries of interest in our analysis, a key limitation is the scale at which it is available. This method of regional estimation is based on national estimates of land-use and workers rather than on actual employment numbers within the region[17].

For a more in-depth regional analysis, Census 1976-2013 data processed by Dave Mare (Motu research, 2018) is used. The census data on employment includes detailed NZSIOC codes denoting industry and is available for Urban Areas. There are 143 unique urban areas in this data set each containing the same 65 industry codes. The data is collected from the employee, not the employer, so the geographic

[14] There is no single 'sheep/beef' land use category in the QVNZ database. Stillman (2005) showed that two QV use categories, extensive pasture and intensive pasture, have a high correlation with sheep/beef land. We combine these two QV land uses into what we call sheep/beef.

[15] Source: Ministry of Justice and Ministry for Primary Industries © Crown Copyright - Licensed for re-use under the Creative Commons Attribution 4.0 International License (BY) 4.0

[16] These data were originally provided by Statistics NZ for the 2018 Motu Report to the Biological Emissions Reference Group (BERG), *Land-Use change as a mitigation option for climate change,* by Zack Dorner, Tarek Soliman, Adolf Stroombergen, Suzi Kerr, David Fleming, Sandra Cortés-Acosta , and Suzie Greenhalgh.

[17] Due to a lack of spatial modelling for future planting of native forest, the national and regional estimates may differ slightly.

location is the employee's residence rather than the location of the business. The limitation of this data set is that it does not count employees who live in rural areas. However, this data is the only publicly available data that provides the detailed sectoral and geographic categories required for our analysis. These data allow us to analyse employment patterns in focused areas in the sectors of interest that are likely to be impacted by land-use change. This report focuses specifically on the Taranaki and Bay of Plenty/Gisborne regions, but further analysis into additional areas such as Canterbury and Northland could also be done as areas of interesting land-use change.

New Zealand Deprivation Dataset

The New Zealand Deprivation Index 2013 reflects various dimensions of deprivation using Census 2013 data, including communication, income (welfare), income (below threshold), employment, qualifications, owned home, support, living space, transport. The index separates New Zealand's population into a distribution of tenths of the first principal component scores at the meshblock level. For example, a value of 10 indicates that the meshblock is in the most deprived 10 percent of areas in New Zealand, according the NZDep2013 scores.

# Results of the Analysis using the Reward Only Scenario

## Median Income

- Figure 19 maps median personal income at the meshblock level across New Zealand for those areas where land-use change occurs. This means that the ranges shown in the map are based on the median personal income for all individuals in a given meshblock. The median personal income for New Zealand as a whole is $28,500. Table 11 provides the median for each region.
- The points on the map reflect the meshblock value for each pixel (25-hectare area) which is expected to have a change in land use.
- When looking at the map in Figure 19, no clear pattern emerges for the distribution of income levels across the areas of land-use change. However, there are some pockets of clustering. For example, areas of land-use change in the Far North are on the lower end of the income distribution. As much of the change in this area would be from scrub to forestry, we would expect a gain in employment in this region. A similar pattern can be seen on the east coast of the South Wairarapa District, where a conversion from scrub to forestry could provide additional employment in this area.
- In general, median household income in areas of land-use change across New Zealand is significantly higher than areas without land-use change[18]. However, this is generally true across regions except in Tasman where the difference is not significant between areas with or without land-use change. The largest difference is in Southland, where the average median household income was more than $16,000 higher in areas with land-use change than in areas without land-use change. Table 11 provides the median household income by region.

## New Zealand Deprivation Index

- Figure 20 maps the meshblock-level New Zealand Deprivation Index for 2013. Areas of green on the map represent a low deprivation score which indicates higher socio-economic measures. People in these areas are doing well. Areas of red represent high deprivation scores indicating lower socioeconomic measures and poorer outcomes. Areas in dark grey are areas of land-use change for which we do not have data. Light grey areas are those in which land use does not change.

[18] The median household income in 2013 was $63,800.

- Most of the land-use change areas on the South Island are low deprivation areas with small pockets of higher deprivation. While the land-use change areas on the North Island range from low to high deprivation, most of the high-deprivation areas experiencing land-use change are found on the North Island. These high-deprivation areas are most concentrated in the Northland Region (especially the Far North District), in the Gisborne Region, and in the Opotiki District. These areas are also expected to primarily convert from scrub to forestry with smaller areas converting from sheep/beef to horticulture and dairy; hence, these changes are expected to improve employment in these areas.
- Across New Zealand, areas of land-use change, on average, have lower levels of deprivation than areas without land-use change. This is also generally true in the regions, except in Gisborne where the difference is not significant. Table 11 provides the mean deprivation index for all meshblocks by region.

## Unemployment Rate

- The unemployment rate is calculated using the Census 2013 data at the level of the statistical area 2 (SA2). The rate is calculated as the number of unemployed divided by the total labour force (the number of people employed full-time, part-time, or unemployed).
- Figure 21 maps the unemployment rate for the statistical area 2 (SA2). The pattern for unemployment is very similar to the pattern for the deprivation index – land-use change areas on the South Island primarily have low unemployment and those on the North Island have a more mixed pattern, with significant clusters of locations experiencing land-use change having higher unemployment.
- In New Zealand, the overall unemployment rate was 7.1% in 2013. Table 11 provides the unemployment rate for each region in 2013.
- Land-use change areas with higher levels of unemployment include Gisborne and Northland, which is consistent with patterns of high deprivation in these areas.

## Government Benefits

- We estimate the percentage of individuals receiving some form of government benefit. This includes the total number of individuals receiving an unemployment benefit, sickness benefit, domestic purposes benefit, invalids benefit, or other government benefit. This allows us to draw attention to areas that already demand higher levels of social assistance that overlap with areas that land use is likely to change.
- Figure 22 shows the percentage of the population within a given statistical area 2 unit that received government assistance in 2013 in the form of a sickness benefit, unemployment benefit, invalids benefit, domestic purposes benefit or other government benefit. The map illustrates areas of high welfare incidence as being 20% or higher (in red) and areas of low welfare incidence as being less than 10% (in cream). Dark grey areas indicate areas of land-use change for which we have no data. Light grey indicates areas where land use does not change.
- Higher percentages of individuals receiving government benefits in land-use change areas in Gisborne and Northland are consistent with patterns of high deprivation in these areas. These areas also overlap with areas that have high levels of Māori representation both in measures of ethnicity and land ownership.
- Areas of land-use change with higher proportions of individuals receiving government benefits tend to overlay areas that are changing from scrub to forestry. Given that forestry is generally less labour-intensive per hectare, employment in these areas may not increase as much as areas that are likely to change toward horticulture.

## Ethnicity

- For ethnicity, we use the publicly available 2013 Census data which provides counts of the population that identify as NZ European, Māori, Pacific, Asian, Latin American, or Other at the meshblock level. During the Census, an individual is able to identify as belonging to multiple ethnicities. Hence, a person who identifies their ethnicity as both Asian and Pacific will be counted in the number of people in the meshblock with Asian ethnicity and again in the number of people with Pacific ethnicity. Due to small populations at the meshblock level, small changes in the number of people in a category can cause large changes in the percentage of people in the category. In the case of missing or suppressed data at the meshblock level, the area unit numbers were used.
- Most areas where land use is predicted to change have higher concentrations of the population identifying as NZ Europeans. In fact, Figure 23 shows that most areas where land use is changing more than 80 percent of the population identifies as NZ Europeans.
- Most of the areas where land-use changes have relatively low concentrations of Māori as can be seen in Figure 24. However, there are areas of land-use change on the North Island where more than 80 percent of the population has identified as Māori. These meshblocks are primarily in Gisbourne, Northland, and Manawatu-Wanganui. This aligns closely with the areas of Māori freehold land as described in the following section.
- Table 11 provides the percentage of the population that identify their ethnicity as European as well as the percentage that identify as Māori for each region in 2013.

## Māori Land Ownership

- In order to identify Māori land ownership, we use the Māori Land Court Spatial Dataset from the Ministry of Justice and Ministry for Primary Industries.[19] Māori land ownership is most commonly classified as *Māori Freehold Land Ownership*. All other land use observed (*All other ownership types*) is split across DoC land, Crown land and other private land. There are data confidentiality and access issues that prevent us from being more specific about the other types of land use.
- The majority of Māori land ownership occurs on the North Island but there are a few sections around the coastal areas of the South Island that are owned by Māori and most of the land-use changes occur on the North Island. Moreover, only a fraction of Māori land is actually predicted to change in its land-use between 2020 and 2050 as can be seen in Figure 25.
- For the land that does change use on the North Island, the predominant change is from sheep/beef to forestry. Examples of areas where these changes include areas in Gisborne and clusters of Māori land in central Manawatu-Wanganui as can be seen in Figure 26.
- The small areas of Māori-owned land that do change from dairy to horticulture are concentrated in Taranaki along the west and south coasts.

## Land Values

- Average land values are shown in Figure 27 for those areas were land-use is expected to change. From the map, it appears that average land values are higher in areas that will convert from dairy or sheep/beef relative to horticulture. Areas that are expected to convert from sheep/beef to forestry and scrub tend to be on the lower end of the spectrum. Table 11 provides the regional averages for land values.

[19] This work is based on/includes Ministry of Justice and Ministry for Primary Industries data © Crown Copyright - Licensed for re-use under the Creative Commons Attribution 4.0 International Licence (BY) 4.0.

## Sectoral Employment Changes by Region, 2020-2050

- Employment in the tables in this section are calculated using the special tabulation data provided by Statistics NZ[20]. National employment per hectare values are calculated using the FTE Employment figures from the BERG report and the estimated land-use change summaries from the LURNZ model *Reward Only* scenario.
- Table 3 shows the estimated number of workers (FTEs) per hectare required for each sector. However, these are national averages, and it is noted that actual employment could differ significantly in the regions especially between extensive hill country and intensive sheep/beef finishing farms.

*Table 3. FTEs per Hectare*

| | 2013 |
|---|---|
| Dairy | 0.021 |
| Sheep/beef | 0.005 |
| Forestry | 0.003 |
| Horticulture | 0.045 |

- While the land-use change maps provide a general sense of the spatial distribution of the changes, Table 4 provides a numerical view of these changes by showing the change in land use in a region between 2020 and 2050 as the percentage of the regional total for that use type in 2020 for the Reward Only and Full Cost scenarios.
- From Table 4, the declines in dairy and sheep/beef will be modest in most regions under either scenario, but increases in most regions in forestry and horticulture will be relatively large.
  - In Waikato, the increase in horticulture land is expected to exceed 214%, with declines in dairy and sheep/beef land of less than 10 percent each for the region.
  - In Taranaki, horticulture land is expected to increase 252% while dairy land is expected to decline by 32% and sheep/beef land to decline by 10-13%. Forestry land is also expected to increase 163-175%.
  - In Manawatu-Wanganui, forestry land is expected to increase 133% and dairy is expected to increase by almost 4%.
  - Horticulture land in Southland is expected to increase by more than 600% with declines in dairy and sheep/beef land of approximately 12 and 14% respectively.
- The magnitude of decreases in land use for dairy, sheep/beef and scrub are smaller although the proportions of lands used for these activities is arguably larger.

[20] These data were originally provided by Statistics NZ for the 2018 Motu Report to the Biological Emissions Reference Group (BERG), *Land-Use change as a mitigation option for climate change,* by Zack Dorner, Tarek Soliman, Adolf Stroombergen, Suzi Kerr, David Fleming, Sandra Cortés-Acosta , and Suzie Greenhalgh.

*Table 4. Changes in Land Use (in hectares, expressed as percentage of retional land use in 2020 in the sector) between 2020 and 2050, by Region and Sector, under the Reward Only and Full Cost Scenarios*

| | Reward Only Scenario | | | | | Full Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Region** | **Dairy** | **SB** | **Forestry** | **Scrub** | **Hort.** | **Dairy** | **SB** | **Forestry** | **Scrub** | **Hort.** |
| Northland | -5.3% | -4.2% | 38.7% | -78.4% | 189.1% | -5.2% | -4.7% | 41.0% | -81.6% | 189.1% |
| Auckland | 7.2% | -4.0% | 56.6% | -55.9% | 0.7% | 7.5% | -4.6% | 58.8% | -56.8% | 0.7% |
| Waikato | -8.6% | -7.1% | 36.8% | -82.9% | 214.3% | -8.5% | -9.2% | 41.7% | -87.3% | 214.3% |
| Bay of Plenty | -17.5% | -7.1% | 12.0% | -73.3% | 59.2% | -17.5% | -8.5% | 13.1% | -77.8% | 59.2% |
| Gisborne | 11.1% | -15.5% | 53.4% | -88.7% | 15.6% | 11.1% | -19.4% | 60.3% | -92.7% | 15.6% |
| Hawkes Bay | -1.2% | -6.9% | 59.5% | -80.2% | 35.8% | -1.1% | -8.5% | 66.8% | -84.5% | 35.8% |
| Taranaki | -32.0% | -10.4% | 162.9% | -93.8% | 251.7% | -32.0% | -13.3% | 175.5% | -94.8% | 251.7% |
| Manawatu-Wanganui | 3.6% | -10.4% | 133.4% | -81.5% | 22.8% | 3.7% | -14.4% | 160.9% | -86.2% | 22.8% |
| Wellington | -14.6% | -6.6% | 117.5% | -83.1% | 134.0% | -14.1% | -8.5% | 132.7% | -90.4% | 134.0% |
| West Coast | 0.1% | -1.5% | 55.8% | -46.9% | 0.0% | 0.1% | -1.8% | 76.8% | -64.8% | 0.0% |
| Canterbury | -7.5% | -23.4% | 219.1% | 7.2% | 29.6% | -7.4% | -26.2% | 318.0% | -16.1% | 29.6% |
| Otago | -8.4% | -19.1% | 126.3% | 35.7% | 89.2% | -8.3% | -21.9% | 205.9% | 9.6% | 89.2% |
| Southland | -11.7% | -14.1% | 39.7% | 53.4% | 622.8% | -11.6% | -16.3% | 69.8% | 31.8% | 622.8% |
| Tasman | -1.4% | -11.5% | 33.5% | -79.3% | 48.1% | -1.4% | -12.9% | 34.8% | -81.0% | 48.1% |
| Nelson | -8.3% | -11.5% | 38.7% | -92.1% | 41.7% | -8.3% | -14.4% | 39.3% | -93.5% | 41.7% |
| Marlborough | -12.9% | -28.6% | 75.4% | -2.6% | 12.3% | -12.9% | -32.7% | 108.3% | -18.3% | 12.3% |

- We estimate regional employment by sector based on these regional land uses, again from the estimated LURNZ model *Reward Only* scenario. The change in employment values are calculated by multiplying the estimated difference of change in land use between 2020 and 2050 by the estimated number of workers per hectare values provided in Table 3.
- Table 5 and Table 6 show the estimated net change in employment in each sector in the region between 2020 and 2050. The net change in employment is provided as the percentage change for the sector in the region (in Table 5) as well as counts of FTEs in order to give an idea of the magnitude of the change (in Table 6).

*Table 5. Changes in Employment as Percentage of Sectoral Employment in the Region due to Land-use Change between 2020 and 2050 for the Reward Only Scenario, by Region and Sector*

| Region | Dairy | SB | Forestry | Horticulture |
|---|---|---|---|---|
| Northland | -5.3% | -4.2% | 38.7% | 189.1% |
| Auckland | 7.2% | -4.0% | 56.6% | 0.7% |
| Waikato | -8.6% | -7.1% | 36.8% | 214.3% |
| Bay of Plenty | -17.5% | -7.1% | 12.0% | 59.2% |
| Gisborne | 11.1% | -15.5% | 53.4% | 15.6% |
| Hawkes Bay | -1.2% | -6.9% | 59.5% | 35.8% |
| Taranaki | -32.0% | -10.4% | 162.9% | 251.7% |
| Manawatu-Wanganui | 3.6% | -10.4% | 133.4% | 22.8% |
| Wellington | -14.6% | -6.6% | 117.5% | 134.0% |
| West Coast | 0.1% | -1.5% | 55.8% | 0.0% |
| Canterbury | -7.5% | -23.4% | 219.1% | 29.6% |
| Otago | -8.4% | -19.1% | 126.3% | 89.2% |
| Southland | -11.7% | -14.1% | 39.7% | 622.8% |
| Tasman | -1.4% | -11.5% | 33.5% | 48.1% |
| Nelson | -8.3% | -11.5% | 38.7% | 41.7% |
| Marlborough | -12.9% | -28.6% | 75.4% | 12.3% |

*Table 6. Changes (FTE) in Employment due to Land-use Change between 2020 and 2050 in the Reward Only Scenario, by Region and Sector*

| | Dairy | SB | Forestry | Horticulture | Net Employment Change |
|---|---|---|---|---|---|
| Northland | -191 | -79 | 249 | 887 | 865 |
| Auckland | 83 | -30 | 93 | 3 | 149 |
| Waikato | -1115 | -219 | 381 | 2847 | 1893 |
| Bay of Plenty | -364 | -42 | 107 | 992 | 694 |
| Gisborne | 2 | -271 | 373 | 129 | 233 |
| Hawkes Bay | -8 | -230 | 343 | 648 | 752 |
| Taranaki | -1331 | -79 | 174 | 3219 | 1983 |
| Manawatu-Wanganui | 148 | -549 | 702 | 183 | 484 |
| Wellington | -128 | -104 | 329 | 678 | 776 |
| West Coast | 1 | -3 | 71 | 0 | 69 |
| Canterbury | -457 | -2021 | 903 | 3741 | 2166 |
| Otago | -217 | -1641 | 574 | 1552 | 268 |
| Southland | -561 | -533 | 116 | 2532 | 1555 |
| Tasman | -9 | -39 | 112 | 258 | 322 |
| Nelson | -1 | -2 | 16 | 6 | 20 |
| Marlborough | -27 | -340 | 198 | 191 | 23 |

- Overall employment losses from expected land-use changes are in dairy and sheep/beef.
    - The most impacted dairy areas include Bay of Plenty, Gisborne, Taranaki, Wellington, Southland and Marlborough.
    - The most impacted sheep/beef areas include Gisborne, Canterbury, Otago, Southland and Marlborough.
- Overall employment gains from expected land-use changes are in forestry and horticulture.
    - The most impacted forestry areas are in Taranaki, Manawatu-Wanganui, Wellington, Canterbury and Otago
    - The most impacted horticulture areas include Northland, Waikato, Taranaki, Wellington, Southland
- The Net Employment Change column in Table 6 suggests that all regions will gain in net employment between 2020 and 2050, contingent on the prescribed expansion of horticulture.
- Since it is difficult to tell from Table 5 or Table 6 from how much of an impact these employment changes might have on the overall region, we have estimated these changes as percentages of total regional employment from the 2013 Census data as shown in Table 7.
- From Table 7, the largest negative impact on total regional employment would be a decline of 2.53% from a decline in dairy employment in Taranaki; however, the largest positive impact (6.12%) would also be in Taranaki from an increase in horticulture employment. Southland is also expected to gain 5.27% in employment from horticulture. Overall, all the regions are expected to gain – not lose – employment, if the expansion of horticulture occurs as prescribed for this scenario.
- Net employment changes can, of course, hide impacts on specific parts of the work force. While a gradual transition from employment in livestock industries to horticulture may be feasible, this may not be realistic for a transition to employment in forestry. In addition, employment is assumed to occur in the area where the land-use takes place, whereas in practice especially for forestry, the location of the work force may not coincide with the location where the work takes place. Moreover, an analysis of incomes in these regions may look very different if there is a large discrepancy in pay across these sectors. More detailed analysis would be necessary to understand the potential impacts on, and re-training needs of, parts of the work force and their particular requirements.

*Table 7. Changes in Employment as Percentage of 2013 Regional Employment due to Land-use change between 2020 and 2050 under Reward Only Scenario, by Region and Sector*

| | Dairy | SB | Forestry | Horticulture | Net Change |
|---|---|---|---|---|---|
| Northland | -0.31% | -0.13% | 0.41% | 1.45% | 1.41% |
| Auckland | 0.01% | 0.00% | 0.01% | 0.00% | 0.02% |
| Waikato | -0.60% | -0.12% | 0.20% | 1.53% | 1.01% |
| Bay of Plenty | -0.31% | -0.04% | 0.09% | 0.85% | 0.60% |
| Gisborne | 0.01% | -1.49% | 2.05% | 0.71% | 1.29% |
| Hawkes Bay | -0.01% | -0.34% | 0.50% | 0.94% | 1.10% |
| Taranaki | -2.53% | -0.15% | 0.33% | 6.12% | 3.77% |
| Manawatu-Wanganui | 0.15% | -0.55% | 0.70% | 0.18% | 0.48% |
| Wellington | -0.05% | -0.04% | 0.14% | 0.29% | 0.33% |
| West Coast | 0.01% | -0.02% | 0.44% | 0.00% | 0.43% |
| Canterbury | -0.16% | -0.73% | 0.33% | 1.35% | 0.78% |
| Otago | -0.22% | -1.63% | 0.57% | 1.55% | 0.27% |
| Southland | -1.17% | -1.11% | 0.24% | 5.27% | 3.23% |
| Tasman | -0.04% | -0.17% | 0.47% | 1.10% | 1.37% |
| Nelson | 0.00% | -0.01% | 0.07% | 0.03% | 0.09% |
| Marlborough | -0.12% | -1.55% | 0.90% | 0.87% | 0.10% |

# In-depth Analysis

The employment data used for this analysis is the Census 1976-2013 data processed by Dave Mare (Motu research, 2018). The census data on employment includes detailed NZSIOC codes denoting sector of employment and is available for Urban Areas. It contains counts of usual residents in urban areas employed at the time of each census by sector. Sectors are classified using NZSIOC codes, and cities are classified using the 2013 Urban Area definitions. The Urban Area classification excludes employees who live in rural areas, but it is the only publicly available data with the requisite level of detail on the sector.

These more in-depth analyses are done for the Taranaki, Bay of Plenty, and Gisborne Regions.

## Employment in the Taranaki Region

A more in-depth analysis of the Taranaki region is carried out due to the concentration of land-use change in this area primarily from dairy to horticulture as well as other socioeconomic characteristics of the region. For example, there is some Māori land ownership to the south of Taranaki. There are also areas with high levels of unemployment, reported Māori ethnicity, and incidence of social welfare, yet the region has a relatively wide range of deprivation levels.

- As Figure 8 shows, volatility is common at a regional level, where percentage changes are large due to smaller sample sizes. This is illustrated in Table 8 with small changes at the urban area responsible for much of the large percentage change volatility reflected in employment trends.
- The largest changes in employment have been in the forestry and logging sector in Taranaki which has consistently decreased since 1996.
- Similar downward trends in horticulture in this area are observed from 1986 although the changes are less volatile.

*Figure 8. Change in Employment (%) in Taranaki 1981-2013, by Sector*

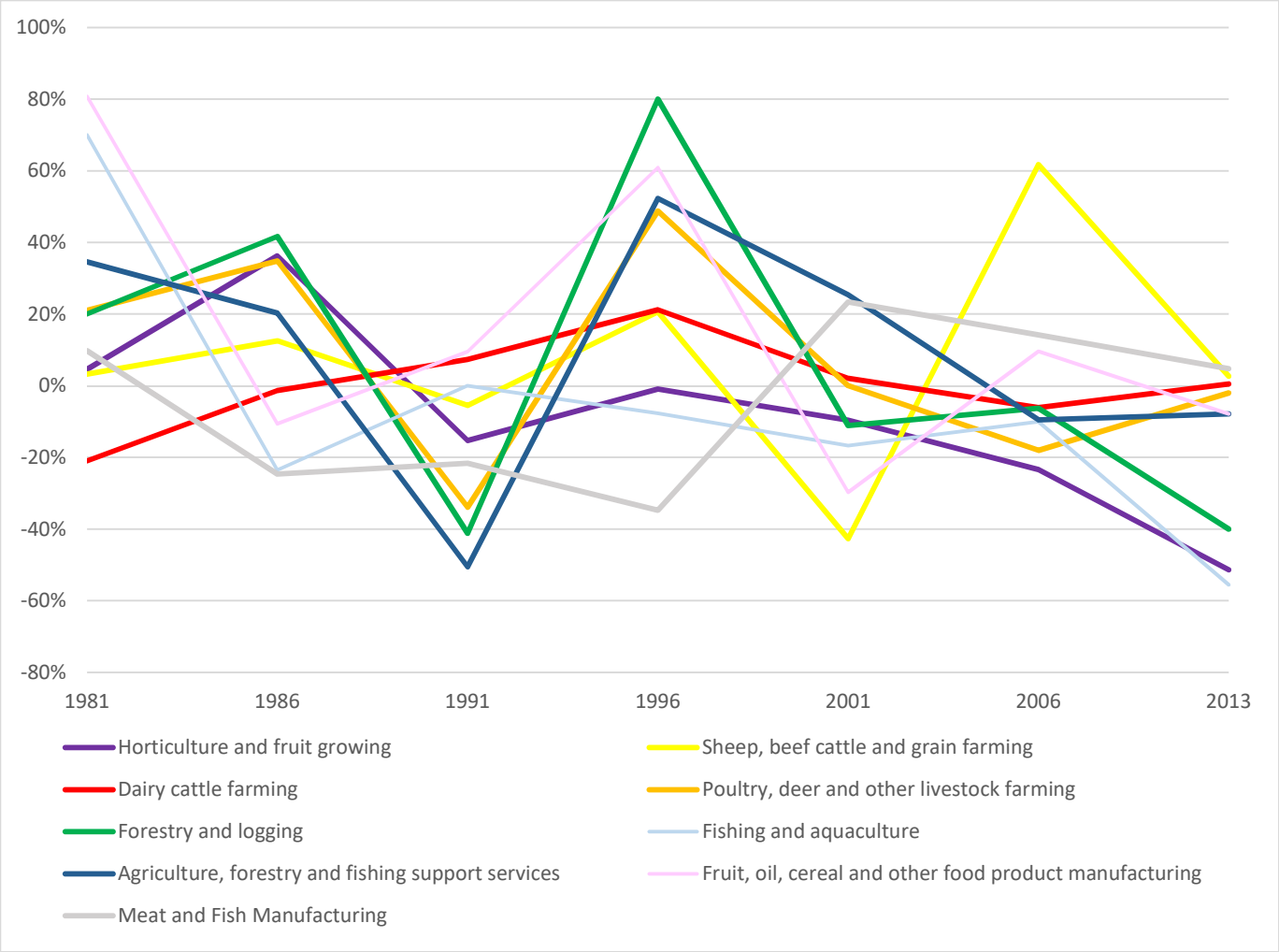



Table 8 provides employment counts for the distinct urban areas in the Taranaki Region by agricultural sector. These counts provide the following insights.

- In New Plymouth and Hawera, employment in horticulture has decreased over time as other agricultural employment has grown.
- Employment in the dairy and cattle farming sector and in the dairy product manufacturing sector form a major portion of employment for most urban areas in Taranaki with the exception of Waitara and Eltham. In New Plymouth, Waitara and Eltham employment in meat and fish manufacturing dominates.
- Stratford and Hawera also show strong increases in dairy product manufacturing employment over time.

*Table 8. Taranaki Regional employment breakdown by urban area broken down by sector, 1976-2013*

| Area | Sector | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Taranaki Region | Horticulture and fruit growing | 261 | 273 | 372 | 315 | 312 | 282 | 216 | 105 |
| | Sheep, beef cattle and grain farming | 186 | 192 | 216 | 204 | 246 | 141 | 228 | 234 |
| | Dairy cattle farming | 573 | 453 | 447 | 480 | 582 | 594 | 558 | 561 |
| | Poultry, deer and other livestock farming | 114 | 138 | 186 | 123 | 183 | 183 | 150 | 147 |
| | Forestry and logging | 30 | 36 | 51 | 30 | 54 | 48 | 45 | 27 |
| | Fishing and aquaculture | 30 | 51 | 39 | 39 | 36 | 30 | 27 | 12 |
| | Agriculture, forestry and fishing support services | 165 | 222 | 267 | 132 | 201 | 252 | 228 | 210 |
| | Dairy product manufacturing | 585 | 855 | 795 | 786 | 780 | 678 | 1062 | 1077 |
| | Fruit, oil, cereal and other food product manufacturing | 156 | 282 | 252 | 276 | 444 | 312 | 342 | 315 |
| | Meat and Fish Manufacturing | 1908 | 2094 | 1578 | 1236 | 807 | 996 | 1137 | 1191 |
| New Plymouth | Horticulture and fruit growing | 174 | 186 | 204 | 171 | 159 | 156 | 129 | 63 |
| | Sheep, beef cattle and grain farming | 60 | 81 | 78 | 72 | 120 | 63 | 99 | 114 |
| | Dairy cattle farming | 183 | 156 | 114 | 126 | 165 | 174 | 204 | 159 |
| | Poultry, deer and other livestock farming | 48 | 48 | 87 | 57 | 72 | 81 | 81 | 66 |
| | Forestry and logging | 18 | 18 | 24 | 15 | 21 | 21 | 21 | 9 |
| | Agriculture, forestry and fishing support services | 57 | 93 | 102 | 51 | 84 | 102 | 93 | 63 |
| | Dairy product manufacturing | 54 | 81 | 72 | 105 | 60 | 72 | 81 | 87 |
| | Meat and Fish Manufacturing | 279 | 312 | 288 | 261 | 156 | 255 | 240 | 327 |
| Hawera | Horticulture and fruit growing | 36 | 24 | 27 | 48 | 36 | 27 | 18 | 3 |
| | Sheep, beef cattle and grain farming | 69 | 63 | 57 | 63 | 45 | 27 | 57 | 45 |
| | Dairy cattle farming | 285 | 237 | 276 | 267 | 273 | 246 | 228 | 249 |
| | Poultry, deer and other livestock farming | 27 | 24 | 27 | 15 | 33 | 42 | 18 | 15 |
| | Forestry and logging | 0 | 0 | 3 | 3 | 9 | 9 | 3 | 3 |
| | Agriculture, forestry and fishing support services | 27 | 36 | 39 | 27 | 42 | 63 | 42 | 54 |
| | Dairy product manufacturing | 198 | 300 | 324 | 330 | 381 | 243 | 561 | 558 |
| | Meat and Fish Manufacturing | 309 | 387 | 279 | 342 | 360 | 324 | 366 | 315 |
| Waitara | Horticulture and fruit growing | 42 | 57 | 93 | 63 | 72 | 60 | 42 | 21 |
| | Sheep, beef cattle and grain farming | 21 | 9 | 27 | 9 | 18 | 12 | 18 | 27 |
| | Dairy cattle farming | 36 | 3 | 9 | 12 | 12 | 21 | 6 | 18 |
| | Poultry, deer and other livestock farming | 12 | 39 | 42 | 33 | 51 | 27 | 24 | 42 |
| | Forestry and logging | 0 | 0 | 0 | 0 | 9 | 3 | 3 | 9 |
| | Agriculture, forestry and fishing support services | 12 | 15 | 24 | 9 | 12 | 15 | 15 | 9 |
| | Dairy product manufacturing | 30 | 48 | 33 | 36 | 9 | 0 | 15 | 9 |
| | Meat and Fish Manufacturing | 759 | 786 | 777 | 417 | 144 | 132 | 165 | 195 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Inglewood | Horticulture and fruit growing | 6 | 3 | 15 | 21 | 27 | 15 | 15 | 6 |
| | Sheep, beef cattle and grain farming | 3 | 9 | 9 | 12 | 9 | 9 | 9 | 9 |
| | Dairy cattle farming | 6 | 6 | 6 | 15 | 18 | 15 | 24 | 18 |
| | Poultry, deer and other livestock farming | 15 | 15 | 15 | 12 | 12 | 15 | 15 | 15 |
| | Forestry and logging | 0 | 0 | 3 | 3 | 3 | 0 | 9 | 0 |
| | Agriculture, forestry and fishing support services | 21 | 27 | 24 | 15 | 24 | 21 | 15 | 12 |
| | Dairy product manufacturing | 93 | 123 | 117 | 105 | 21 | 18 | 24 | 27 |
| | Meat and Fish Manufacturing | 27 | 18 | 24 | 21 | 12 | 15 | 18 | 24 |
| Stratford | Horticulture and fruit growing | 3 | 0 | 15 | 6 | 9 | 9 | 3 | 3 |
| | Sheep, beef cattle and grain farming | 15 | 12 | 18 | 24 | 21 | 15 | 21 | 18 |
| | Dairy cattle farming | 21 | 15 | 9 | 21 | 36 | 54 | 33 | 51 |
| | Poultry, deer and other livestock farming | 3 | 3 | 3 | 0 | 6 | 9 | 3 | 3 |
| | Forestry and logging | 9 | 15 | 18 | 9 | 9 | 9 | 9 | 6 |
| | Agriculture, forestry and fishing support services | 24 | 21 | 33 | 21 | 21 | 27 | 33 | 39 |
| | Dairy product manufacturing | 84 | 123 | 36 | 54 | 132 | 144 | 165 | 195 |
| | Meat and Fish Manufacturing | 24 | 36 | 33 | 36 | 36 | 78 | 114 | 111 |
| Opunake | Horticulture and fruit growing | 0 | 3 | 3 | 3 | 3 | 0 | 3 | 3 |
| | Sheep, beef cattle and grain farming | 3 | 6 | 3 | 6 | 9 | 3 | 9 | 9 |
| | Dairy cattle farming | 24 | 18 | 18 | 18 | 42 | 39 | 42 | 36 |
| | Poultry, deer and other livestock farming | 0 | 0 | 0 | 0 | 6 | 3 | 0 | 3 |
| | Forestry and logging | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Agriculture, forestry and fishing support services | 6 | 9 | 12 | 3 | 9 | 6 | 12 | 12 |
| | Dairy product manufacturing | 60 | 66 | 84 | 27 | 18 | 21 | 36 | 45 |
| | Meat and Fish Manufacturing | 0 | 0 | 0 | 0 | 3 | 6 | 15 | 15 |
| Eltham | Horticulture and fruit growing | 0 | 0 | 3 | 0 | 0 | 6 | 0 | 3 |
| | Sheep, beef cattle and grain farming | 6 | 9 | 9 | 12 | 12 | 9 | 9 | 9 |
| | Dairy cattle farming | 15 | 15 | 15 | 15 | 21 | 33 | 15 | 18 |
| | Poultry, deer and other livestock farming | 9 | 9 | 12 | 6 | 3 | 3 | 9 | 3 |
| | Forestry and logging | 3 | 3 | 3 | 0 | 3 | 3 | 0 | 0 |
| | Agriculture, forestry and fishing support services | 15 | 18 | 21 | 3 | 6 | 15 | 12 | 9 |
| | Dairy product manufacturing | 63 | 108 | 111 | 114 | 138 | 168 | 156 | 138 |
| | Meat and Fish Manufacturing | 174 | 171 | 141 | 129 | 66 | 153 | 159 | 138 |
| Patea | Horticulture and fruit growing | 0 | 0 | 12 | 3 | 6 | 9 | 6 | 3 |
| | Sheep, beef cattle and grain farming | 9 | 3 | 15 | 6 | 12 | 3 | 6 | 3 |
| | Dairy cattle farming | 3 | 3 | 0 | 6 | 15 | 12 | 6 | 12 |
| | Poultry, deer and other livestock farming | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| | Forestry and logging | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |

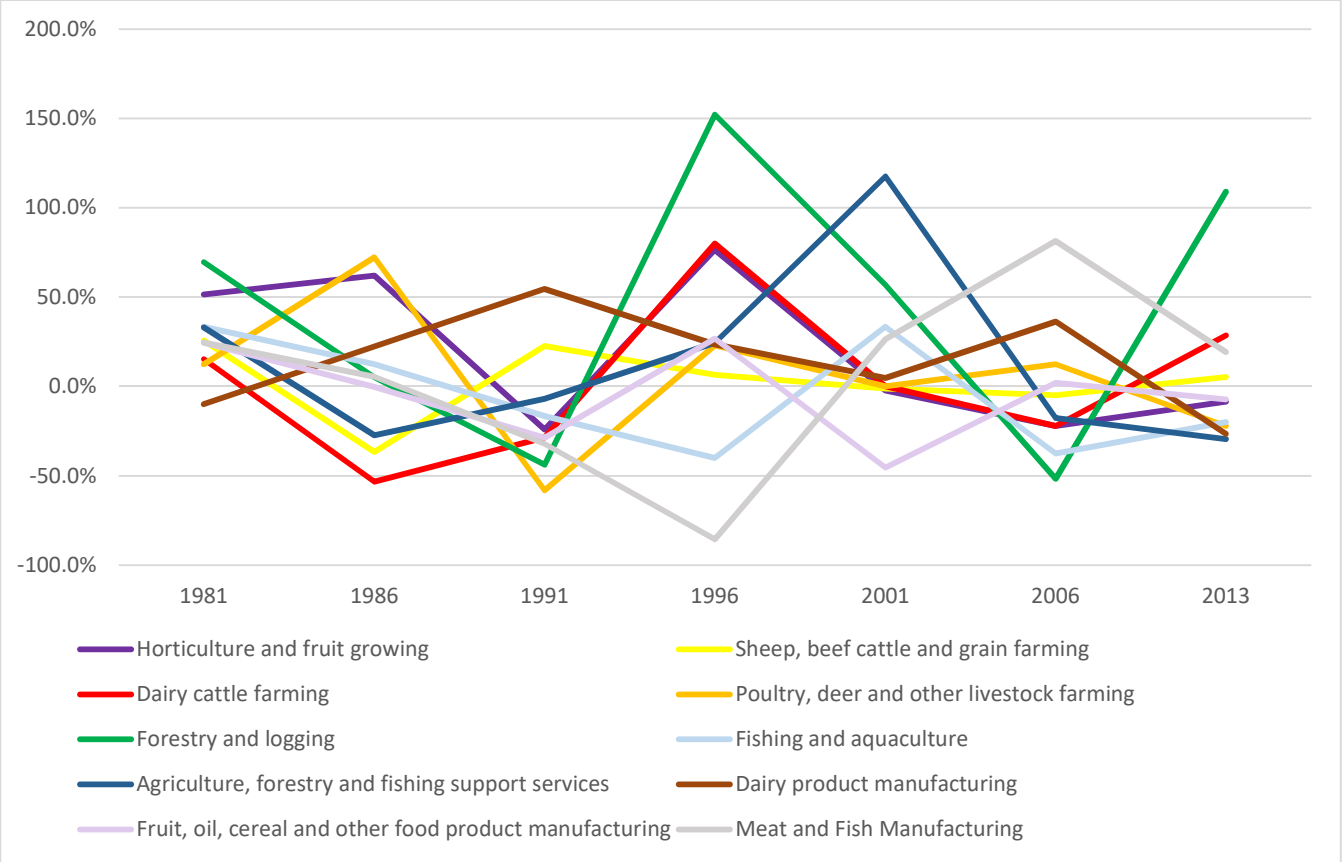
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing support services | 3 | 3 | 12 | 3 | 3 | 3 | 6 | 12 |
| Dairy product manufacturing | 3 | 6 | 18 | 15 | 21 | 12 | 24 | 18 |
| Meat and Fish Manufacturing | 336 | 384 | 36 | 30 | 30 | 33 | 60 | 66 |

## Employment in the Bay of Plenty and Gisborne Regions

The land-use changes in the Bay of Plenty/Gisborne area are of interest because the changes are not uniform across the regions. There are two distinct changes. One change around the Whakatane and Opotiki areas is a conversion from dairy to horticulture concentrated around urban areas. Another is a shift away from sheep/beef and scrub to predominantly forestry. These areas are of socio-economic interest due to the high proportion of Maori land and Maori populations located in this area.

First, we start with the Gisborne Region. As can be seen in Figure 9, the forestry and logging sector displays the most volatile patterns in this region with a strong increase between 2006 and 2013. Additionally, the agriculture, forestry and fishing support services sector and the meat and fish manufacturing sector are also volatile in this area. These additional sectors suggest that ancillary services are particularly sensitive in this area.

*Figure 9. Change in Employment (%) in the Gisborne Region 1981-2013, by Sector*



We separately examine employment changes in the Bay of Plenty Region. Figure 10 shows employment changes in agriculture for this region by sector, and from this, we see the following trends:

- Employment in the Bay of Plenty area is much less volatile when compared to the Gisborne and Taranaki regions.
- Similar to Gisborne, we also see more sectors in this region than in Taranaki (e.g., fishing and aquaculture).
- Employment in the horticulture and fruit growing sector has decreased historically suggesting that horticulture has been a sector of employment demand in the past. The main future conversion type in this area is toward horticulture which is expected to increase employment in this sector in the future.

*Figure 10. Change in Employment (%) in the Bay of Plenty Region 1981-2013, by Sector*

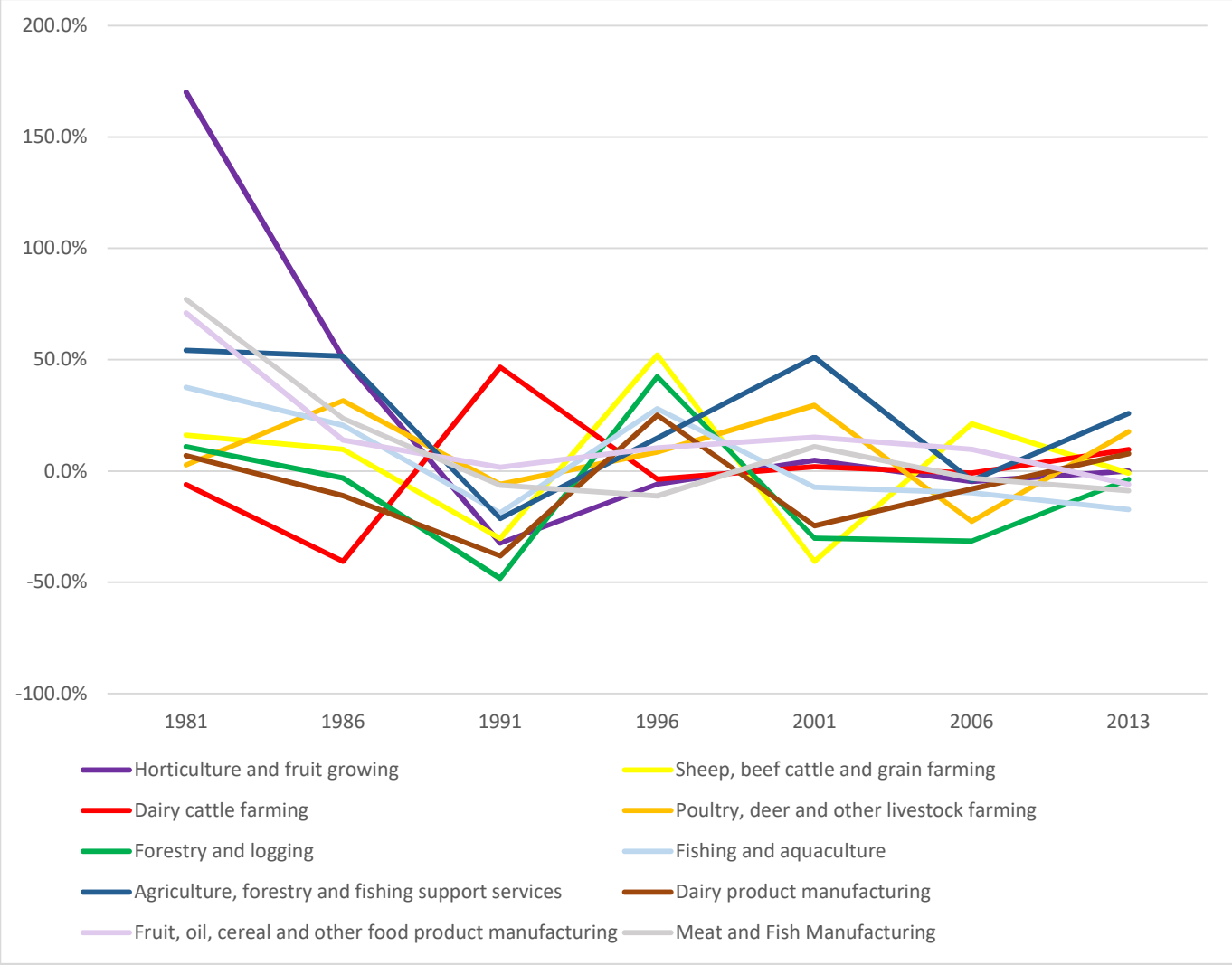


Table 9 and

- Table 10 provide employment counts for the distinct urban areas in the Bay of Plenty and the Gisborne Regions, respectively, by agricultural sector. Large absolute changes in employment in each sector by urban area are highlighted in green. These counts provide the following insights:
- Wood product manufacturing, support services and forestry are the most volatile in these areas. The employment numbers are not consistent across areas with some support services increasing and others decreasing over the same period. This might suggest local migration for work or larger trends in profitability of a given sector.
- These urban areas have low counts for these sectors as well as low counts relative to overall employment in these regions. Moreover, these sector changes are not large.

*Table 9. Bay of Plenty Regional employment breakdown by urban area broken down by sector, 1976-2013*

| Area | Sector | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Bay of Plenty Region | Horticulture and fruit growing | 591 | 1596 | 2406 | 1626 | 1530 | 1602 | 1527 | 1527 |
| | Sheep, beef cattle and grain farming | 318 | 369 | 405 | 282 | 429 | 255 | 309 | 306 |
| | Dairy cattle farming | 393 | 369 | 219 | 321 | 309 | 315 | 312 | 342 |
| | Poultry, deer and other livestock farming | 111 | 114 | 150 | 141 | 153 | 198 | 153 | 180 |
| | Forestry and logging | 1470 | 1629 | 1578 | 816 | 1161 | 810 | 555 | 534 |
| | Fishing and aquaculture | 96 | 132 | 159 | 129 | 165 | 153 | 138 | 114 |
| | Agriculture, forestry and fishing support services | 366 | 564 | 855 | 672 | 771 | 1164 | 1113 | 1401 |
| | Dairy product manufacturing | 531 | 567 | 504 | 312 | 390 | 294 | 270 | 291 |
| | Fruit, oil, cereal and other food product manufacturing | 381 | 651 | 741 | 753 | 831 | 957 | 1050 | 987 |
| | Meat and Fish Manufacturing | 366 | 648 | 801 | 750 | 666 | 738 | 714 | 651 |
| Tauranga | Horticulture and fruit growing | 372 | 939 | 1443 | 1020 | 942 | 966 | 846 | 780 |
| | Sheep, beef cattle and grain farming | 120 | 162 | 144 | 114 | 186 | 114 | 147 | 123 |
| | Dairy cattle farming | 249 | 186 | 105 | 102 | 123 | 126 | 135 | 132 |
| | Poultry, deer and other livestock farming | 72 | 69 | 78 | 81 | 69 | 99 | 84 | 78 |
| | Forestry and logging | 51 | 66 | 51 | 42 | 96 | 69 | 78 | 69 |
| | Fishing and aquaculture | 69 | 78 | 111 | 84 | 126 | 126 | 108 | 87 |
| | Agriculture, forestry and fishing support services | 69 | 135 | 177 | 165 | 237 | 468 | 408 | 552 |
| | Dairy product manufacturing | 63 | 75 | 72 | 108 | 108 | 39 | 36 | 87 |
| | Fruit, oil, cereal and other food product manufacturing | 279 | 444 | 489 | 507 | 567 | 615 | 720 | 705 |
| | Meat and Fish Manufacturing | 171 | 348 | 444 | 462 | 441 | 474 | 417 | 435 |
| | Wood product manufacturing | 384 | 327 | 420 | 420 | 522 | 714 | 723 | 432 |
| Rotorua | Horticulture and fruit growing | 45 | 51 | 81 | 48 | 42 | 42 | 66 | 51 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sheep, beef cattle and grain farming | 114 | 120 | 120 | 69 | 96 | 48 | 81 | 81 |
| | Dairy cattle farming | 21 | 54 | 9 | 18 | 36 | 51 | 51 | 66 |
| | Poultry, deer and other livestock farming | 12 | 9 | 18 | 18 | 33 | 36 | 21 | 33 |
| | Forestry and logging | 798 | 792 | 759 | 477 | 702 | 414 | 273 | 270 |
| | Fishing and aquaculture | 3 | 3 | 9 | 3 | 15 | 9 | 9 | 12 |
| | Agriculture, forestry and fishing support services | 183 | 207 | 312 | 177 | 231 | 243 | 285 | 288 |
| | Dairy product manufacturing | 24 | 24 | 27 | 15 | 21 | 24 | 39 | 36 |
| | Fruit, oil, cereal and other food product manufacturing | 69 | 144 | 174 | 162 | 186 | 234 | 231 | 186 |
| | Meat and Fish Manufacturing | 36 | 60 | 102 | 114 | 84 | 108 | 144 | 96 |
| | Wood product manufacturing | 1335 | 1299 | 1428 | 795 | 873 | 1110 | 978 | 666 |
| Whaka-tane | Horticulture and fruit growing | 21 | 57 | 84 | 75 | 69 | 78 | 75 | 90 |
| | Sheep, beef cattle and grain farming | 27 | 42 | 51 | 36 | 57 | 36 | 30 | 42 |
| | Dairy cattle farming | 36 | 45 | 42 | 72 | 57 | 51 | 63 | 63 |
| | Poultry, deer and other livestock farming | 12 | 9 | 12 | 9 | 9 | 15 | 9 | 12 |
| | Forestry and logging | 21 | 78 | 129 | 57 | 105 | 129 | 78 | 63 |
| | Fishing and aquaculture | 18 | 42 | 36 | 33 | 15 | 9 | 15 | 12 |
| | Agriculture, forestry and fishing support services | 42 | 90 | 135 | 69 | 69 | 102 | 84 | 81 |
| | Dairy product manufacturing | 36 | 51 | 66 | 48 | 108 | 108 | 105 | 99 |
| | Fruit, oil, cereal and other food product manufacturing | 21 | 36 | 42 | 27 | 24 | 36 | 15 | 30 |
| | Meat and Fish Manufacturing | 15 | 30 | 21 | 9 | 3 | 12 | 12 | 9 |
| | Wood product manufacturing | 114 | 120 | 174 | 39 | 39 | 84 | 84 | 72 |
| Katikati Comm-unity | Horticulture and fruit growing | 33 | 120 | 183 | 138 | 126 | 138 | 159 | 153 |
| | Sheep, beef cattle and grain farming | 9 | 3 | 15 | 9 | 15 | 3 | 12 | 9 |
| | Dairy cattle farming | 21 | 21 | 12 | 9 | 12 | 9 | 6 | 15 |
| | Poultry, deer and other livestock farming | 6 | 12 | 12 | 9 | 6 | 15 | 3 | 9 |
| | Forestry and logging | 0 | 3 | 0 | 0 | 9 | 6 | 3 | 3 |
| | Fishing and aquaculture | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| | Agriculture, forestry and fishing support services | 9 | 12 | 18 | 27 | 39 | 57 | 57 | 105 |
| | Dairy product manufacturing | 42 | 36 | 3 | 0 | 0 | 0 | 0 | 0 |
| | Fruit, oil, cereal and other food product manufacturing | 3 | 3 | 3 | 12 | 9 | 9 | 12 | 9 |
| | Meat and Fish Manufacturing | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 6 |
| | Wood product manufacturing | 12 | 12 | 18 | 18 | 27 | 21 | 42 | 42 |
| Te Puke Comm-unity | Horticulture and fruit growing | 108 | 384 | 483 | 273 | 246 | 261 | 255 | 306 |
| | Sheep, beef cattle and grain farming | 15 | 18 | 36 | 18 | 33 | 18 | 15 | 15 |
| | Dairy cattle farming | 24 | 15 | 18 | 51 | 27 | 18 | 18 | 15 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Poultry, deer and other livestock farming | 3 | 3 | 12 | 6 | 12 | 9 | 9 | 21 |
| | Forestry and logging | 15 | 12 | 12 | 9 | 15 | 9 | 9 | 3 |
| | Fishing and aquaculture | 3 | 0 | 0 | 0 | 3 | 3 | 3 | 0 |
| | Agriculture, forestry and fishing support services | 27 | 48 | 63 | 72 | 75 | 153 | 138 | 270 |
| | Dairy product manufacturing | 117 | 126 | 126 | 36 | 27 | 18 | 6 | 6 |
| | Fruit, oil, cereal and other food product manufacturing | 9 | 12 | 15 | 24 | 27 | 36 | 42 | 42 |
| | Meat and Fish Manufacturing | 138 | 201 | 228 | 153 | 126 | 138 | 120 | 96 |
| | Wood product manufacturing | 42 | 69 | 87 | 72 | 126 | 87 | 81 | 45 |
| Edge-cumbe | Horticulture and fruit growing | 3 | 9 | 27 | 9 | 15 | 12 | 12 | 12 |
| | Sheep, beef cattle and grain farming | 3 | 3 | 3 | 9 | 3 | 3 | 3 | 12 |
| | Dairy cattle farming | 9 | 12 | 12 | 39 | 24 | 15 | 12 | 18 |
| | Poultry, deer and other livestock farming | 3 | 3 | 3 | 0 | 3 | 0 | 6 | 0 |
| | Forestry and logging | 0 | 12 | 12 | 15 | 12 | 12 | 3 | 12 |
| | Fishing and aquaculture | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| | Agriculture, forestry and fishing support services | 3 | 9 | 21 | 21 | 18 | 15 | 18 | 15 |
| | Dairy product manufacturing | 192 | 195 | 159 | 93 | 108 | 90 | 66 | 45 |
| | Fruit, oil, cereal and other food product manufacturing | 0 | 3 | 3 | 3 | 0 | 3 | 6 | 3 |
| | Meat and Fish Manufacturing | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| | Wood product manufacturing | 12 | 12 | 30 | 9 | 12 | 18 | 12 | 12 |
| Kawerau | Horticulture and fruit growing | 3 | 6 | 36 | 24 | 21 | 21 | 18 | 18 |
| | Sheep, beef cattle and grain farming | 15 | 3 | 15 | 9 | 15 | 9 | 3 | 9 |
| | Dairy cattle farming | 9 | 3 | 0 | 6 | 9 | 9 | 9 | 6 |
| | Poultry, deer and other livestock farming | 0 | 3 | 12 | 12 | 12 | 21 | 18 | 21 |
| | Forestry and logging | 9 | 27 | 66 | 45 | 78 | 63 | 36 | 36 |
| | Fishing and aquaculture | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| | Agriculture, forestry and fishing support services | 3 | 3 | 33 | 54 | 60 | 36 | 45 | 18 |
| | Dairy product manufacturing | 6 | 12 | 15 | 9 | 15 | 12 | 12 | 15 |
| | Fruit, oil, cereal and other food product manufacturing | 0 | 0 | 3 | 3 | 6 | 9 | 12 | 9 |
| | Meat and Fish Manufacturing | 0 | 0 | 0 | 0 | 3 | 3 | 12 | 6 |
| | Wood product manufacturing | 93 | 57 | 486 | 99 | 60 | 138 | 99 | 87 |
| Murupara | Horticulture and fruit growing | 0 | 3 | 3 | 6 | 9 | 3 | 9 | 18 |
| | Sheep, beef cattle and grain farming | 0 | 3 | 3 | 6 | 12 | 6 | 3 | 3 |
| | Dairy cattle farming | 0 | 9 | 0 | 6 | 3 | 9 | 0 | 6 |
| | Poultry, deer and other livestock farming | 0 | 3 | 0 | 0 | 3 | 0 | 3 | 0 |
| | Forestry and logging | 573 | 624 | 510 | 162 | 120 | 81 | 48 | 36 |
| | Fishing and aquaculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Agriculture, forestry and fishing support services | 9 | 15 | 36 | 45 | 15 | 27 | 21 | 12 |
| | Dairy product manufacturing | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fruit, oil, cereal and other food product manufacturing | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| | Meat and Fish Manufacturing | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 |
| | Wood product manufacturing | 9 | 27 | 15 | 6 | 9 | 33 | 33 | 18 |
| Opotiki | Horticulture and fruit growing | 6 | 27 | 66 | 33 | 60 | 81 | 87 | 99 |
| | Sheep, beef cattle and grain farming | 15 | 15 | 18 | 12 | 12 | 18 | 15 | 12 |
| | Dairy cattle farming | 24 | 24 | 21 | 18 | 18 | 27 | 18 | 21 |
| | Poultry, deer and other livestock farming | 3 | 3 | 3 | 6 | 6 | 3 | 0 | 6 |
| | Forestry and logging | 3 | 15 | 39 | 9 | 24 | 27 | 27 | 42 |
| | Fishing and aquaculture | 3 | 9 | 3 | 6 | 6 | 0 | 3 | 3 |
| | Agriculture, forestry and fishing support services | 21 | 45 | 60 | 42 | 27 | 63 | 57 | 60 |
| | Dairy product manufacturing | 51 | 48 | 36 | 3 | 3 | 3 | 3 | 3 |
| | Fruit, oil, cereal and other food product manufacturing | 0 | 9 | 6 | 15 | 12 | 15 | 12 | 3 |
| | Meat and Fish Manufacturing | 6 | 9 | 6 | 12 | 3 | 0 | 3 | 0 |
| | Wood product manufacturing | 18 | 12 | 12 | 9 | 3 | 6 | 6 | 3 |

Table 10. Gisborne Regional employment breakdown by urban area broken down by sector, 1976-2013

| Urban Area | Sector | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Gisborne | Horticulture and fruit growing | 159 | 246 | 384 | 276 | 525 | 540 | 438 | 417 |
| | Sheep, beef cattle and grain farming | 201 | 252 | 153 | 195 | 204 | 204 | 186 | 207 |
| | Dairy cattle farming | 18 | 27 | 12 | 9 | 12 | 12 | 6 | 12 |
| | Poultry, deer and other livestock farming | 42 | 33 | 66 | 18 | 21 | 33 | 33 | 24 |
| | Forestry and logging | 63 | 111 | 114 | 57 | 165 | 255 | 114 | 267 |
| | Fishing and aquaculture | 69 | 90 | 102 | 81 | 51 | 60 | 36 | 27 |
| | Agriculture, forestry and fishing support services | 246 | 330 | 246 | 225 | 279 | 645 | 516 | 360 |
| | Dairy product manufacturing | 18 | 21 | 18 | 24 | 12 | 3 | 24 | 24 |
| | Fruit, oil, cereal and other food product manufacturing | 702 | 867 | 855 | 582 | 732 | 354 | 357 | 342 |
| | Meat and Fish Manufacturing | 765 | 957 | 1002 | 669 | 69 | 102 | 213 | 252 |
| | Wood product manufacturing | 99 | 126 | 147 | 66 | 225 | 276 | 285 | 213 |
| Kapiti | Horticulture and fruit growing | 39 | 54 | 102 | 93 | 126 | 96 | 57 | 36 |
| | Sheep, beef cattle and grain farming | 33 | 42 | 33 | 33 | 39 | 36 | 42 | 33 |
| | Dairy cattle farming | 21 | 18 | 9 | 6 | 15 | 15 | 15 | 15 |
| | Poultry, deer and other livestock farming | 6 | 21 | 27 | 21 | 27 | 15 | 21 | 18 |
| | Forestry and logging | 6 | 6 | 9 | 12 | 9 | 18 | 18 | 9 |
| | Fishing and aquaculture | 3 | 6 | 6 | 9 | 3 | 12 | 9 | 9 |
| | Agriculture, forestry and fishing support services | 27 | 33 | 18 | 21 | 27 | 21 | 33 | 27 |
| | Dairy product manufacturing | 12 | 6 | 15 | 27 | 51 | 63 | 66 | 42 |
| | Fruit, oil, cereal and other food product manufacturing | 36 | 51 | 60 | 69 | 93 | 96 | 102 | 84 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Meat and Fish Manufacturing | 24 | 27 | 36 | 36 | 33 | 27 | 21 | 27 |
| Wood product manufacturing | 63 | 45 | 60 | 72 | 90 | 81 | 78 | 69 |

## Discussion

There are some key results from the analyses discussed in this report. For example, the LURNZ model indicates that land-use change is spread broadly across the country and is not concentrated into a single area or region. In fact, land-use change is expected to occur in many diverse pockets and regions across New Zealand based on the results of the model. Nonetheless, at smaller scales, such changes could still imply a locally significant shift.

In addition, net employment changes are likely to be small in magnitude and generally positive within regions; however, conversion to horticulture is a key factor for these employment gains. Moreover, net employment changes can hide impacts on specific parts of the work force. While a gradual transition from employment in livestock industries to horticulture may be feasible, this may not be realistic for a transition to employment in forestry. In addition, employment is assumed to occur in the area where the land-use takes place, whereas in practice especially for forestry, the location of the work force may not coincide with the location where the work takes place. Moreover, an analysis of incomes in these regions may look very different if there is a large discrepancy in pay across these sectors.

The work commissioned for this report was designed to provide a cursory overview of the expected changes in areas of land-use change resulting from climate policy, and this report provides a limited overview of the potential impacts of land-use change in the future. To fully understand the issues that communities are likely to face in the future, a more comprehensive analysis is required. One major limitation of the analysis was the need to use publicly available data due to time limitations. Using non-public data for individuals and businesses from Statistics NZ to study the localised effects and the relationships between various factors would be an important enhancement to these analysis. Further study is also be necessary to understand the potential impacts on, and re-training needs of, parts of the work force and their particular requirements.

*Figure 11. Land Use in 2020, Full Cost Scenario*

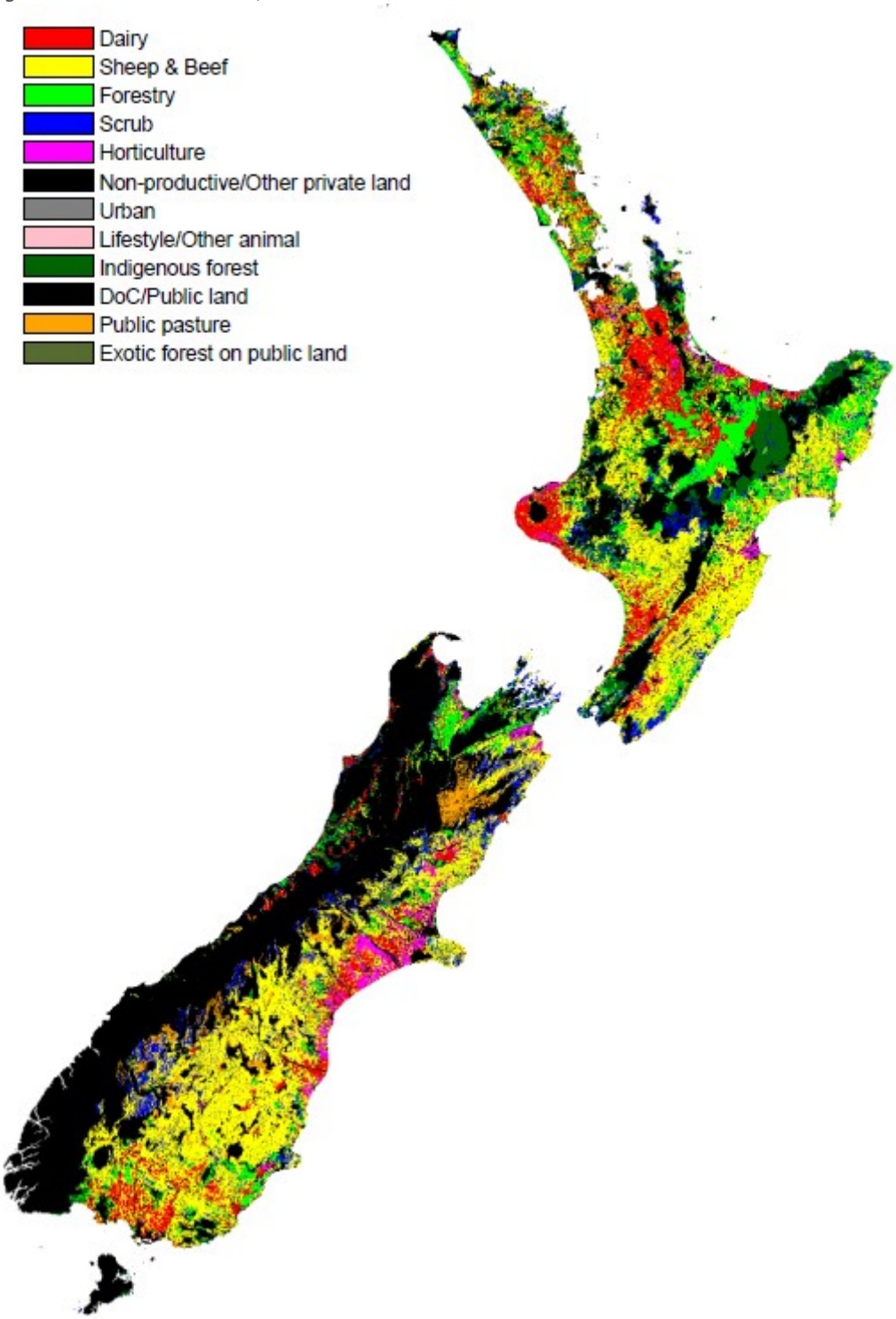


*Figure 12. Land Use in 2050, Full Cost Scenario*

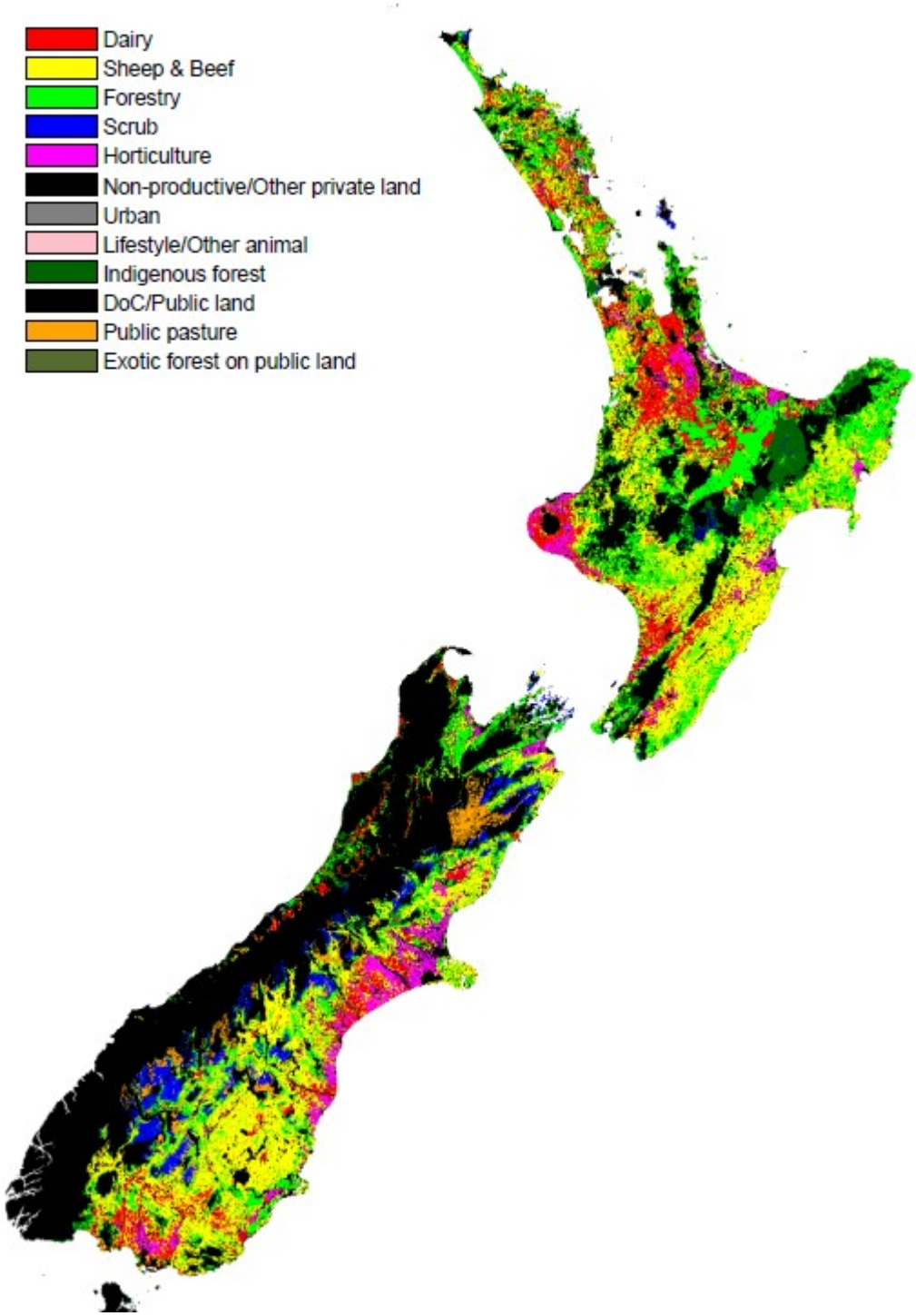


*Figure 13. Areas of Land Use Changes between 2020 and 2050 as they are in 2020, Full Cost Scenario. In this figure, areas shown in yellow will change from sheep/beef in 2020 to another land use in 2050 under the Full Cost scenario. Areas in red will change from dairy, and areas in blue will change from scrub. The areas shown in grey will not change.*

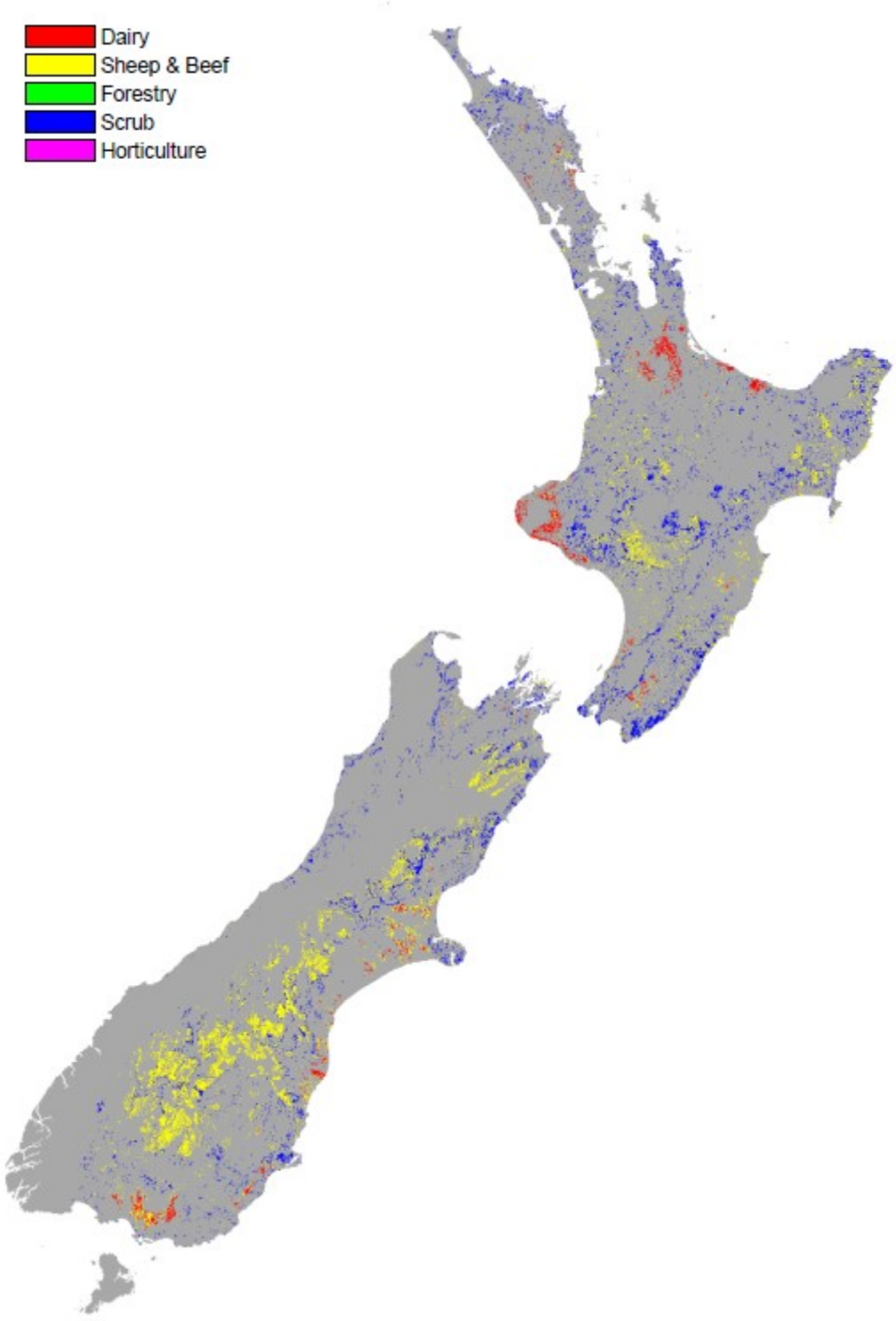


*Figure 14. Areas of Land Use Changes between 2020 and 2050 as predicted to be in 2050, Full Cost Scenario. In this figure, areas shown in green will change to forestry in 2050 under the Full Cost scenario. Similarly, areas in purple will change to horticulture, and areas in blue will change to scrub. The areas shown in grey will not change.*

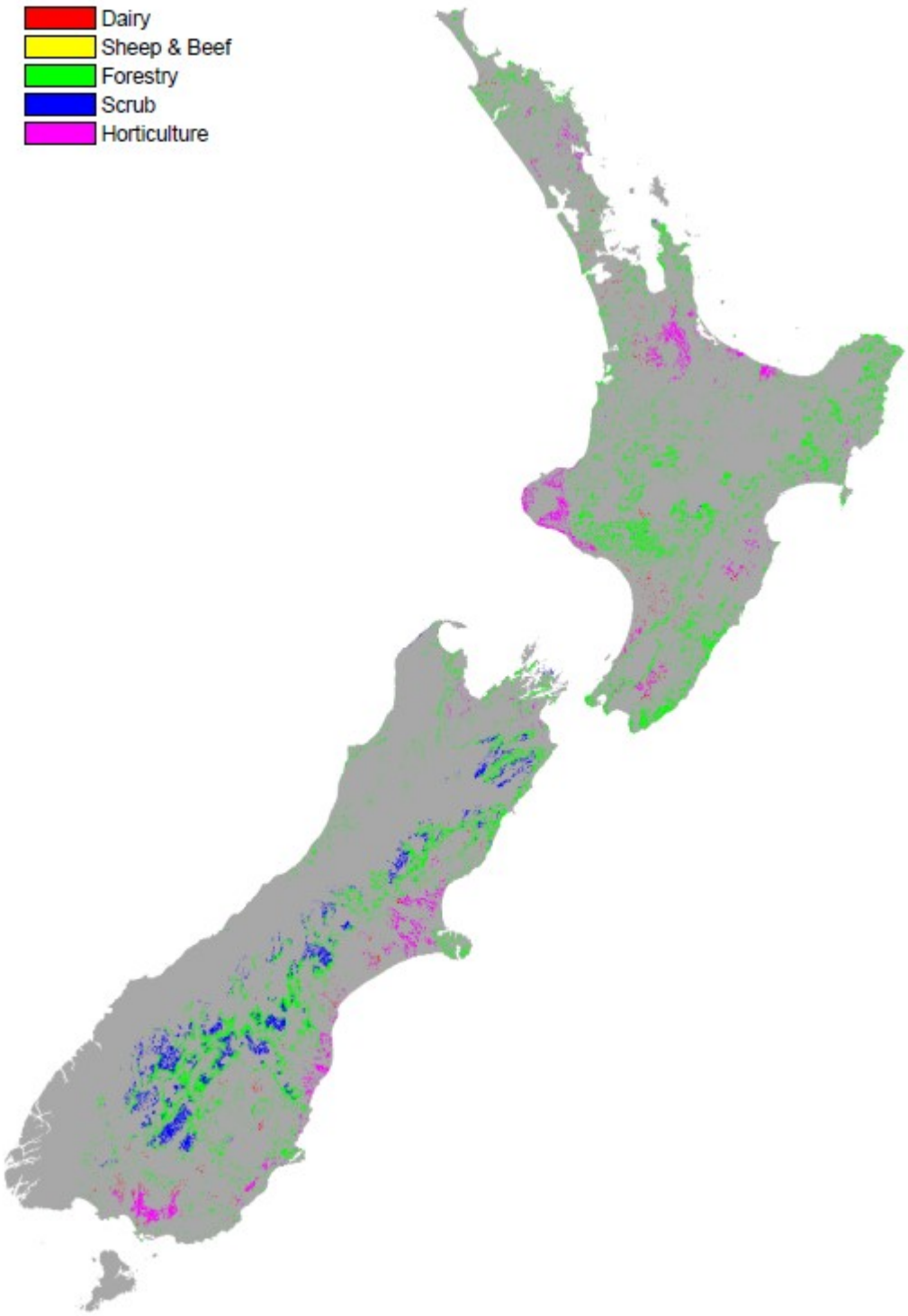


*Figure 15. Land Use in 2020, Reward Only Scenario*

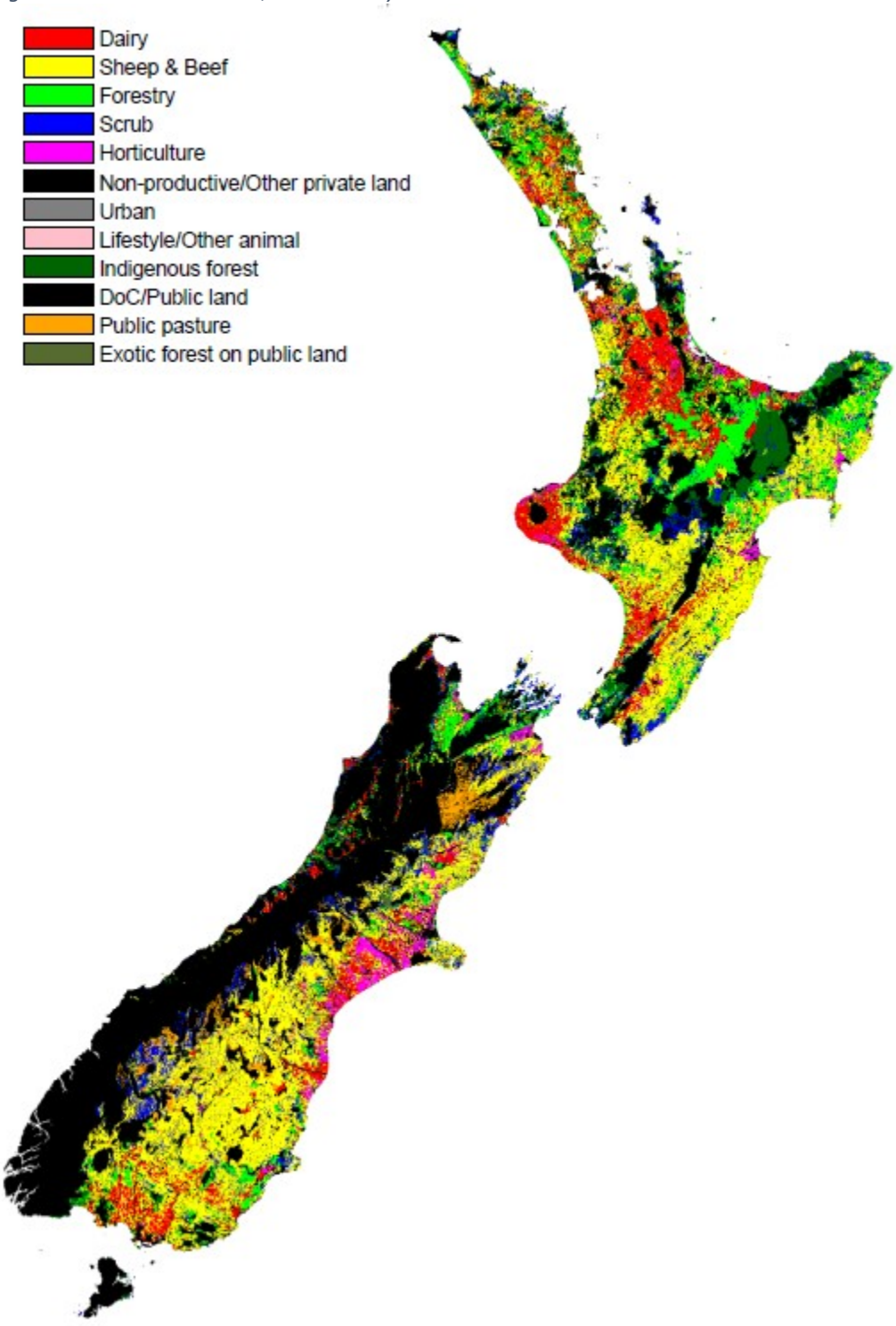


*Figure 16. Land Use in 2050, Reward Only Scenario*

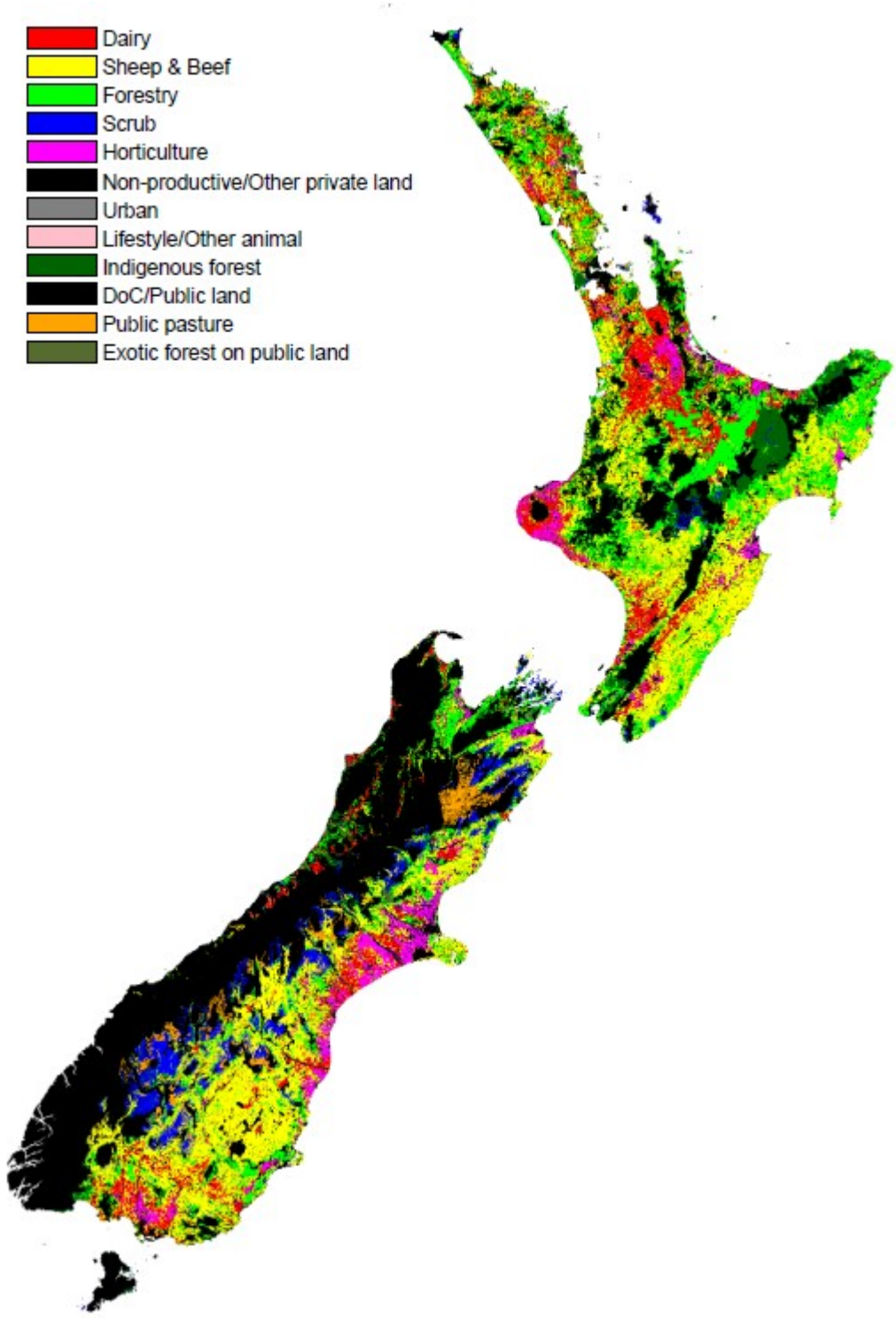


*Figure 17. Areas of Land Use Changes between 2020 and 2050 as they are in 2020, Reward Only Scenario. In this figure, areas shown in yellow will change from sheep/beef in 2020 to another land use in 2050 under the Reward Only scenario. Areas in red will change from dairy, and areas in blue will change from scrub. The areas shown in grey will not change.*

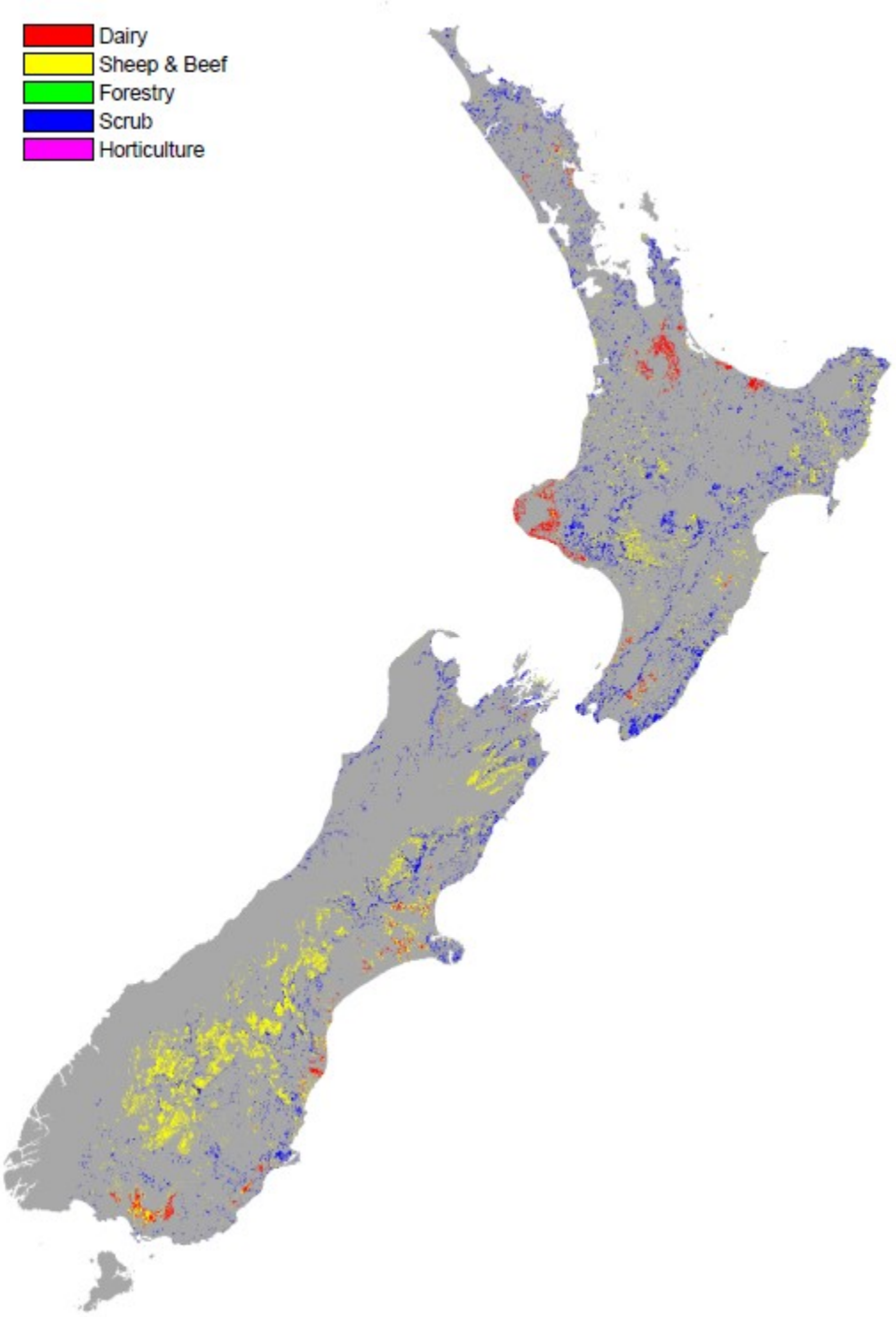


*Figure 18. Areas of Land Use Changes between 2020 and 2050 as predicted to be in 2050, Reward Only Scenario. In this figure, areas shown in green will change to forestry in 2050 under the Reward Only scenario. Similarly, areas in purple will change to horticulture, and areas in blue will change to scrub. The areas shown in grey will not change.*

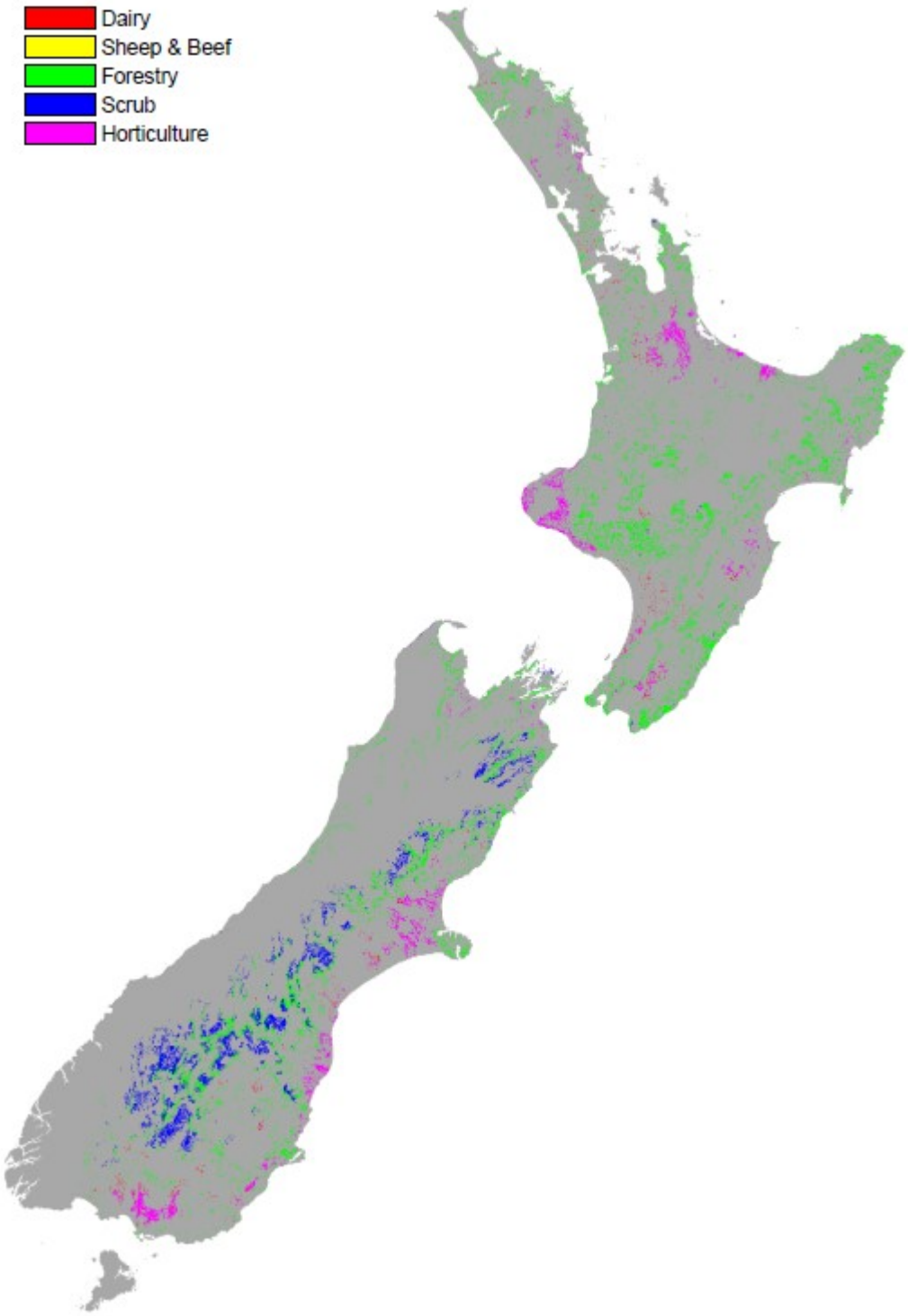


*Figure 19. Median Personal Income (MB), 2013*

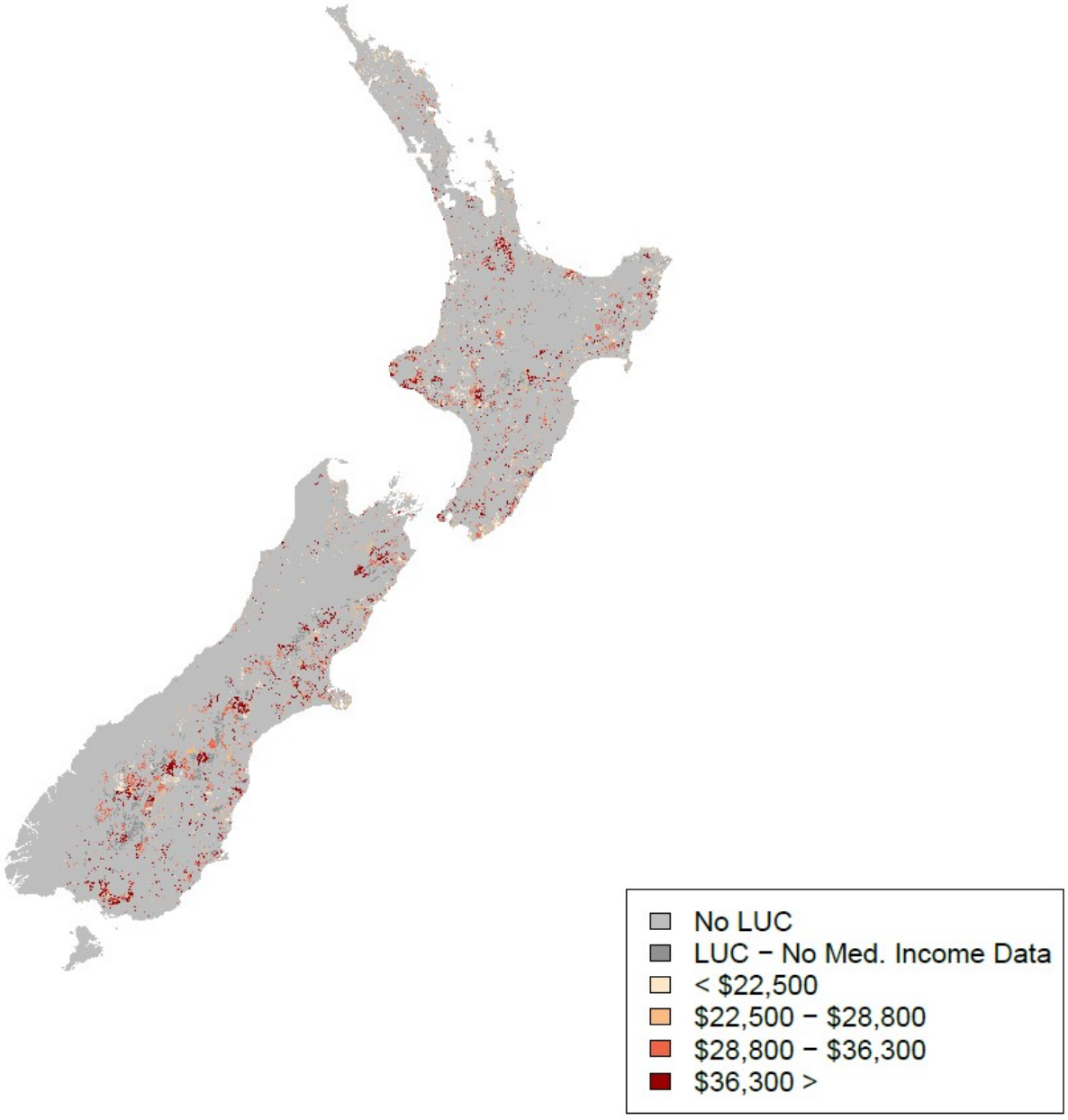


*Figure 20. NZ Deprivation Index, 2013*

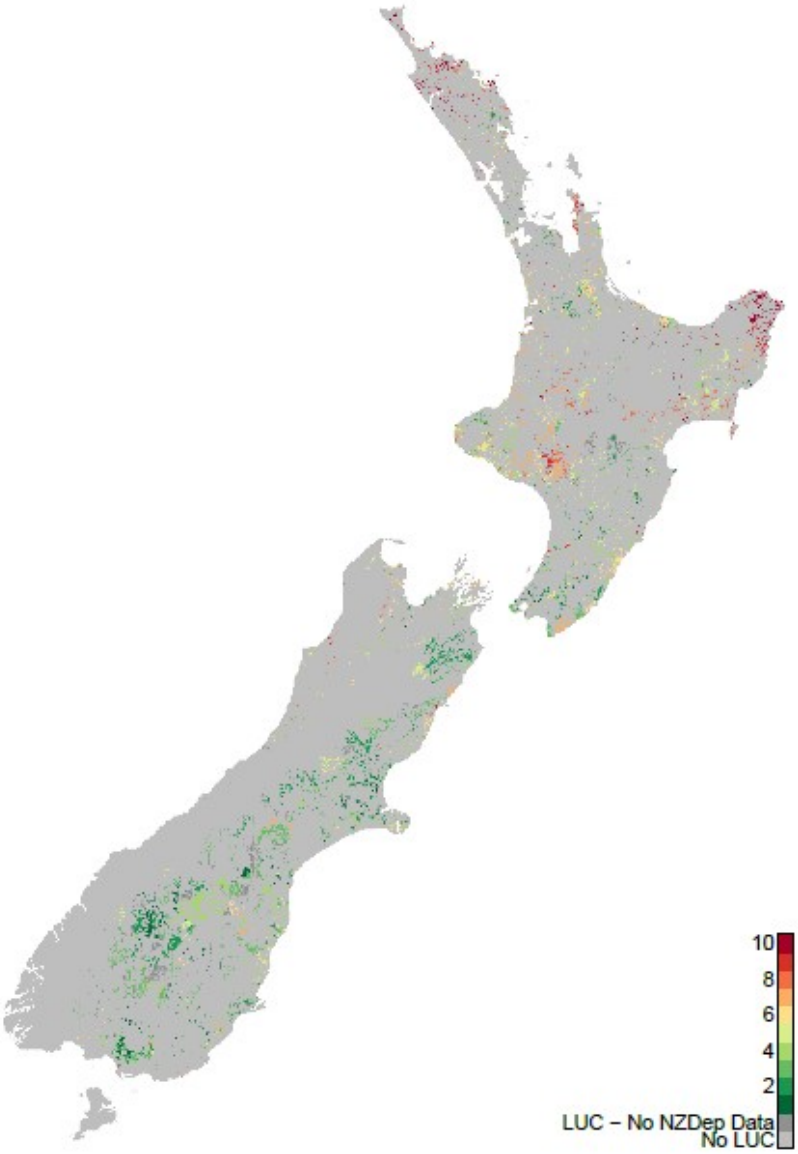


*Figure 21. Rate of Unemployment in the Population (SA2), 2013*

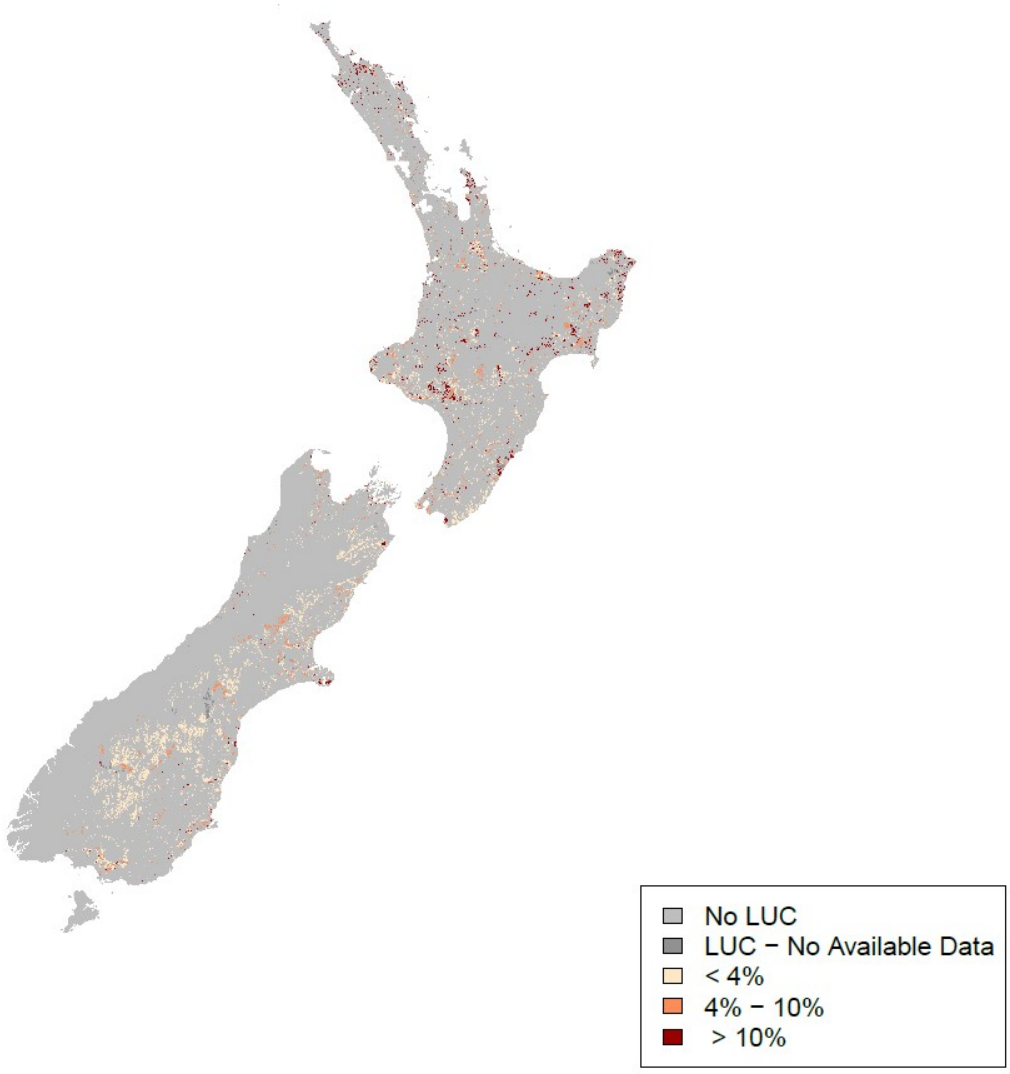


*Figure 22. Percentage of Population (SA2) Receiving Government Benefits, 2013*

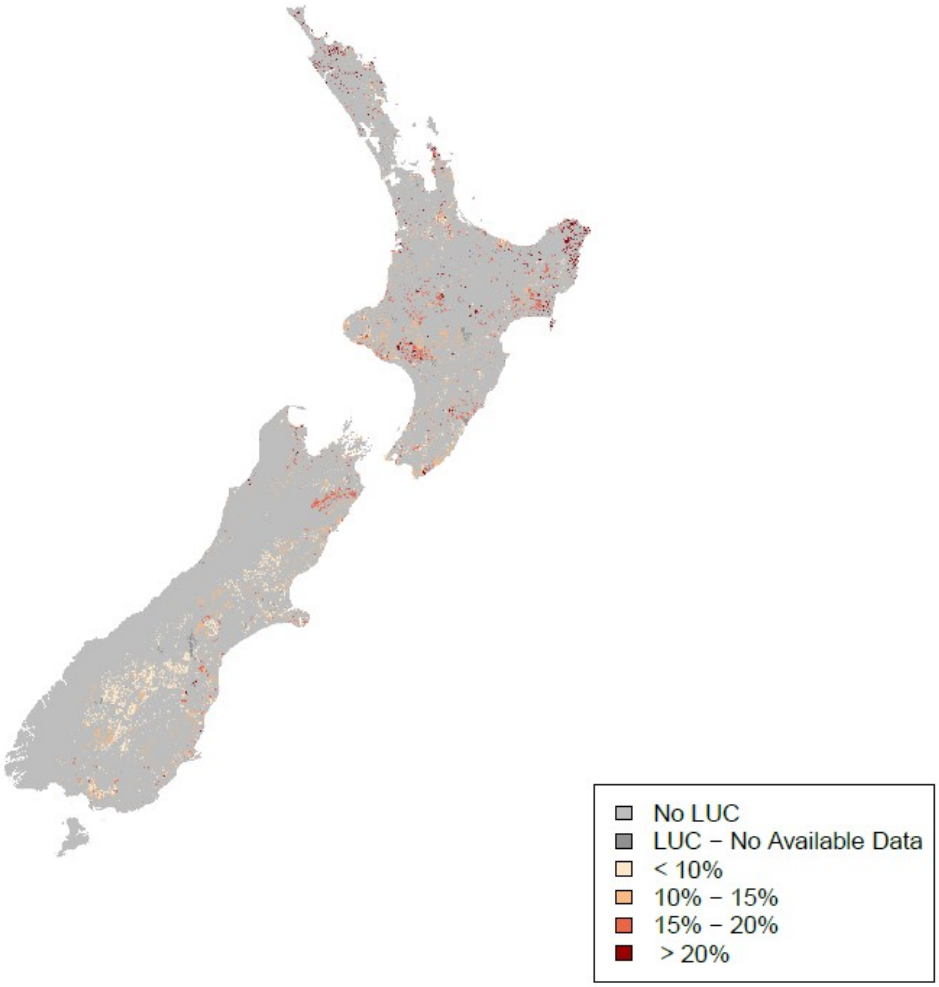


*Figure 23. Percentage of Population (SA2) Identifying as European, 2013*

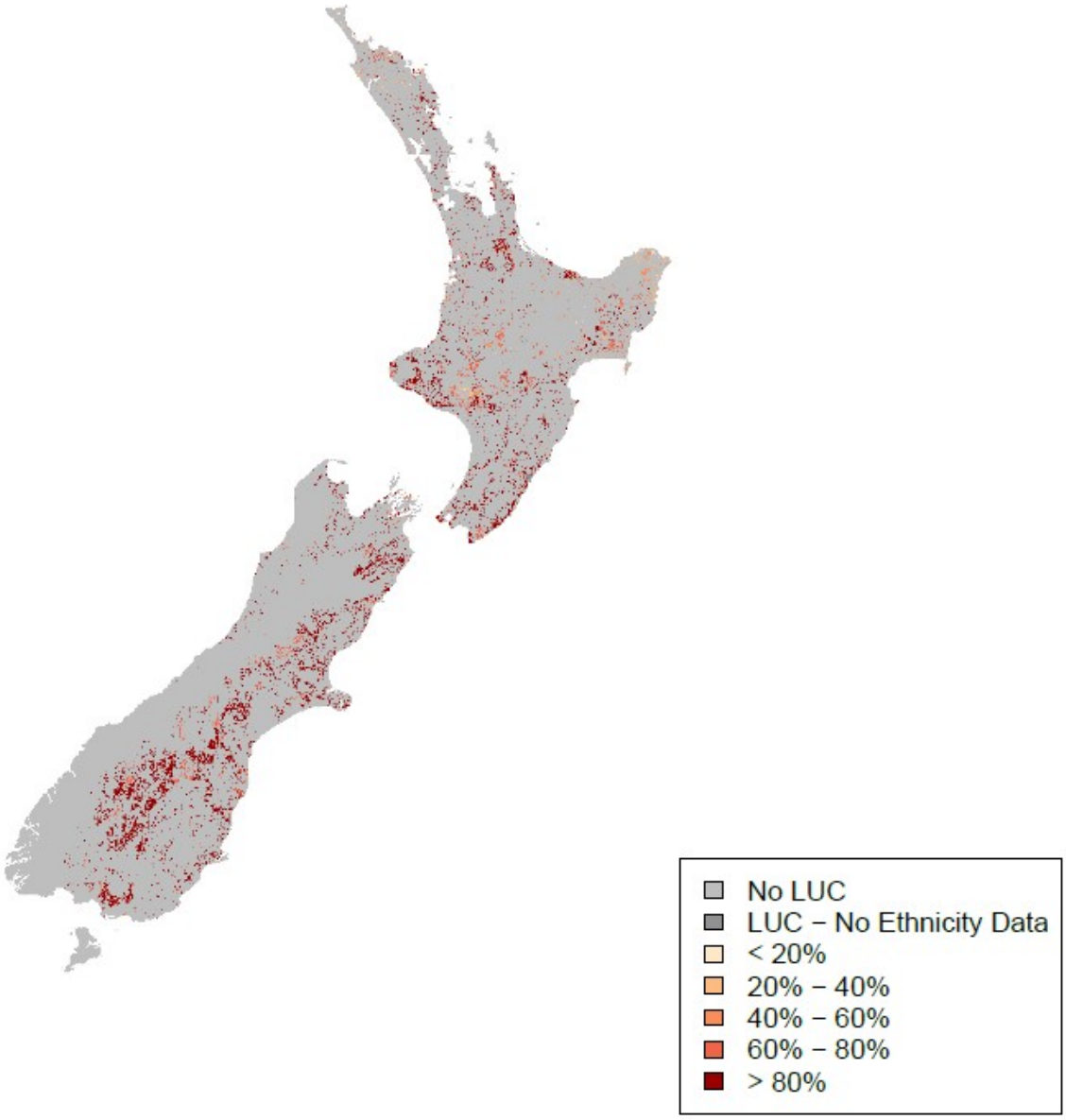


*Figure 24. Percentage of Population (SA2) Identifying as Māori, 2013*

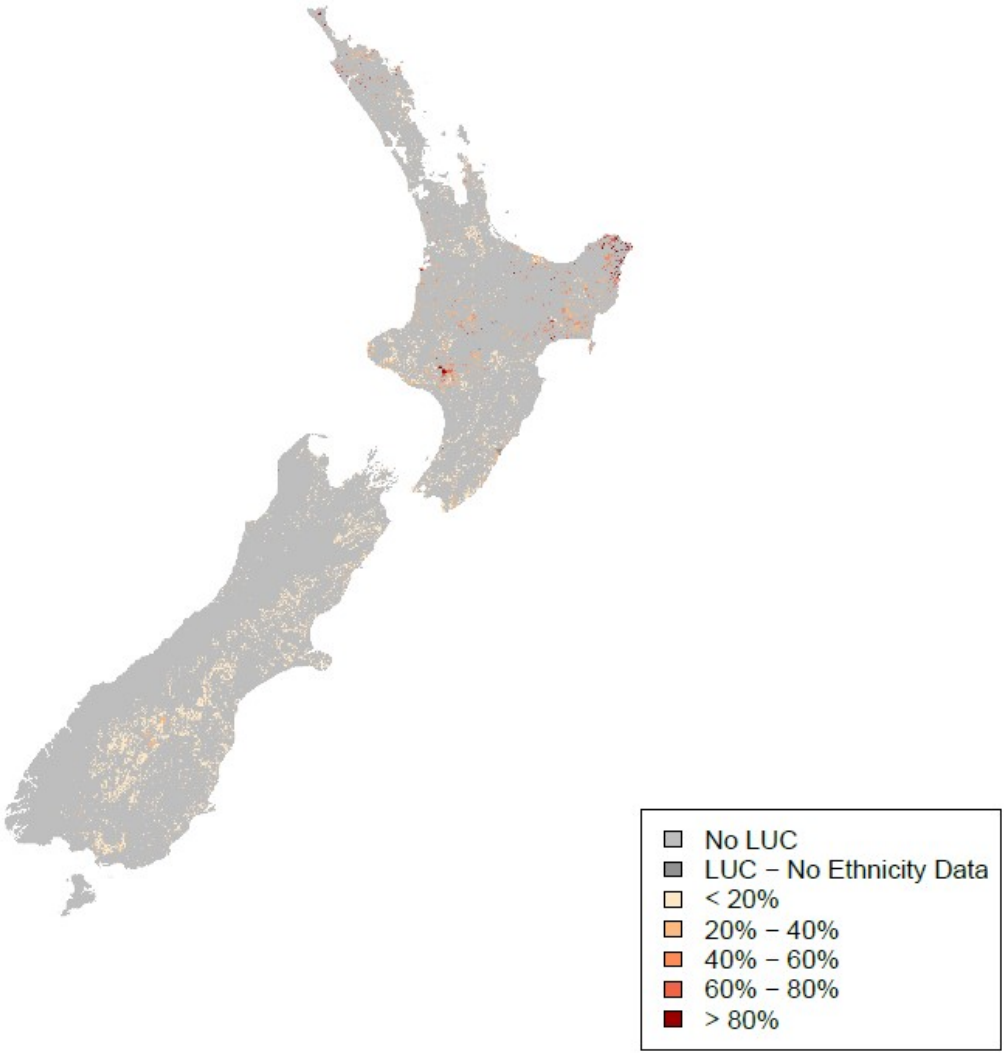


*Figure 25. Māori Freehold Land, 2017*

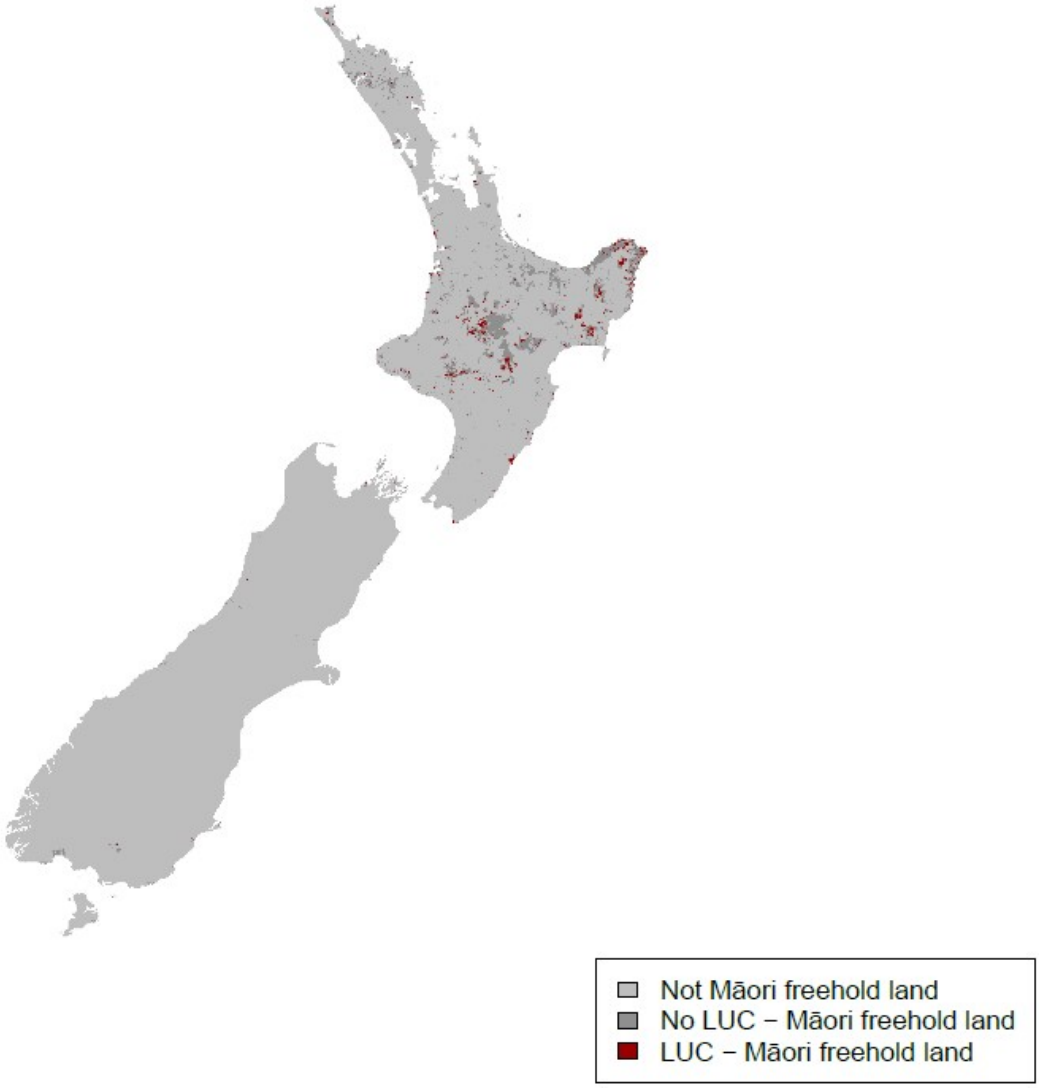


*Figure 26. Māori Freehold Land Converting From Sheep/Beef to Forestry or Scrub, Reward Only Scenario*

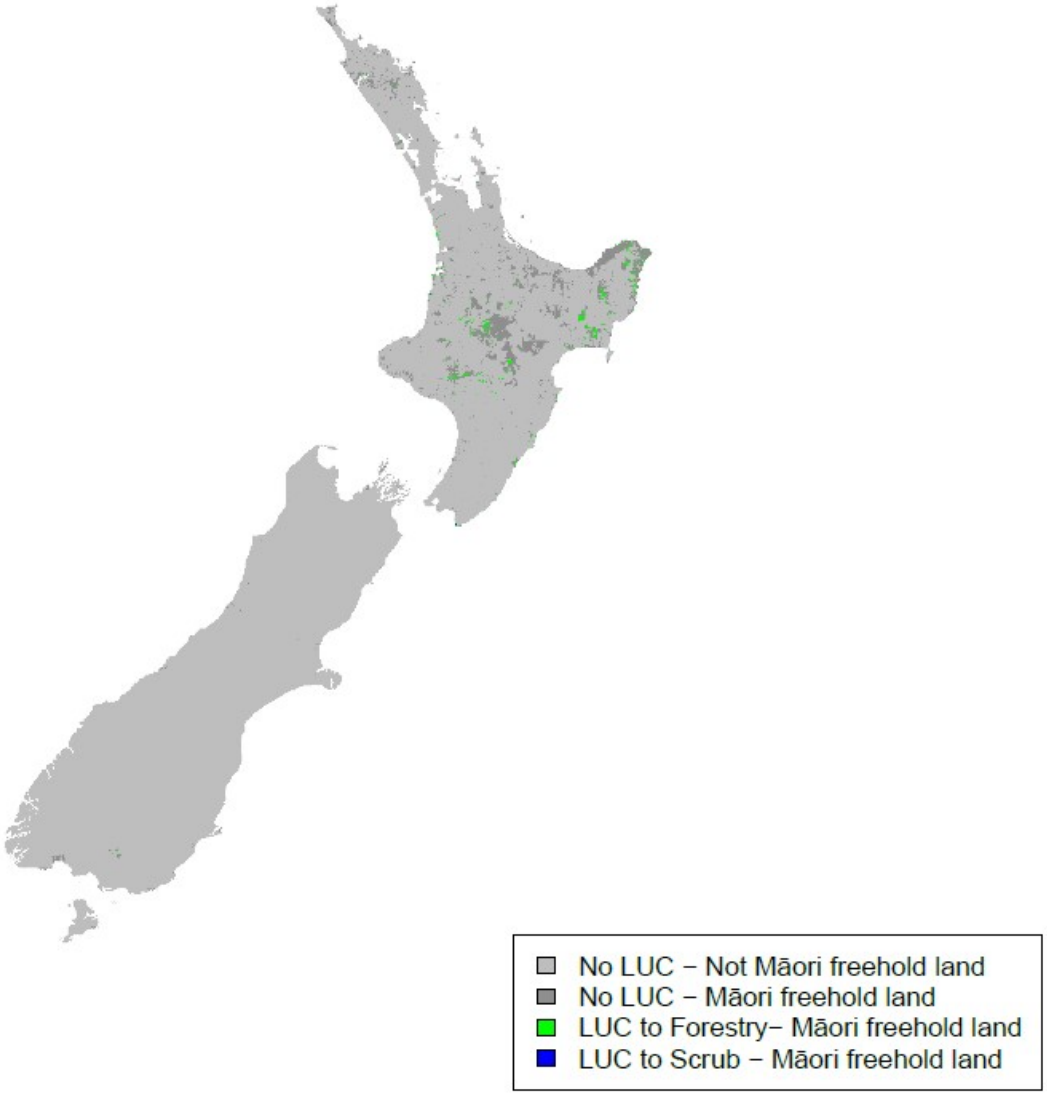


*Figure 27. Average Land Values in Areas with Land-Use Change 2020-2050, Reward Only Scenario*

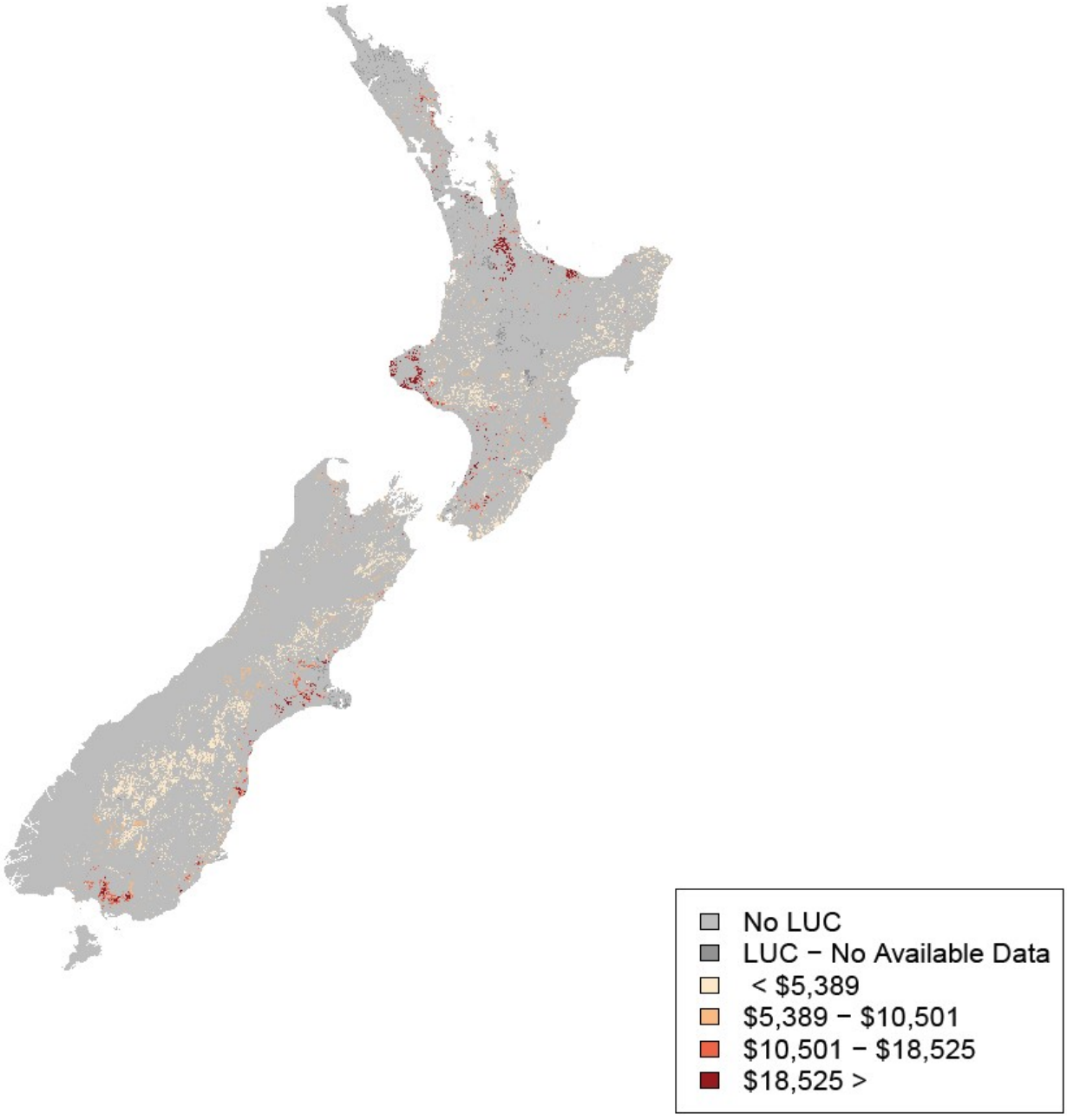


*Table 11. Summary Statistics for the Socio-economic Characteristics of Regions, 2013*

| Region | Median Personal Income ($) | Median Household Income ($) | NZ Deprivation Index | Unemployment Rate | Government Benefits* | European Ethnicity | Maori Ethnicity | Average Land Value ($) |
|---|---|---|---|---|---|---|---|---|
| Auckland | 29,600 | 76,500 | 5.21 | 8.12% | 12.9% | 55.8% | 10.1% | 20,197 |
| Bay of Plenty | 26,200 | 54,600 | 6.45 | 9.02% | 15.7% | 70.8% | 25.7% | 15,659 |
| Canterbury | 30,100 | 65,000 | 4.61 | 4.45% | 11.8% | 83.2% | 7.8% | 11,510 |
| Gisborne | 24,400 | 50,500 | 7.54 | 9.35% | 20.4% | 56.1% | 45.1% | 4,519 |
| Hawke's Bay | 26,100 | 53,200 | 6.26 | 6.98% | 16.3% | 73.4% | 22.9% | 6,925 |
| Manawatu-Wanganui | 25,000 | 50,000 | 6.49 | 7.81% | 16.8% | 77.3% | 19.6% | 13,184 |
| Marlborough | 27,900 | 55,200 | 5.00 | 4.44% | 11.3% | 85.3% | 11.0% | 5,730 |
| Nelson | 27,200 | 54,300 | 5.46 | 5.89% | 15.5% | 85.5% | 9.0% | 2,113 |
| Northland | 23,400 | 46,900 | 7.19 | 9.72% | 17.8% | 69.3% | 29.6% | 10,903 |
| Otago | 26,300 | 56,400 | 4.77 | 5.60% | 12.1% | 84.8% | 7.1% | 6,775 |
| Southland | 29,500 | 57,400 | 4.99 | 4.68% | 13.5% | 85.4% | 12.4% | 11,292 |
| Taranaki | 29,100 | 58,400 | 5.67 | 5.62% | 13.3% | 81.9% | 16.6% | 22,059 |
| Tasman | 25,700 | 53,500 | 4.76 | 4.03% | 12.5% | 89.5% | 7.3% | 8,697 |
| Waikato | 27,900 | 59,600 | 6.13 | 7.50% | 15.1% | 73.4% | 20.7% | 17,961 |
| Wellington | 32,700 | 74,300 | 5.02 | 7.21% | 12.8% | 73.2% | 12.4% | 10,324 |
| West Coast Region | 26,900 | 55,000 | 6.05 | 4.72% | 12.7% | 85.4% | 9.9% | 5,085 |

*Percentage of population receiving at least one of the following government benefits: unemployment benefit, sickness benefit, domestic purposes benefit, invalids benefit, or other government benefit