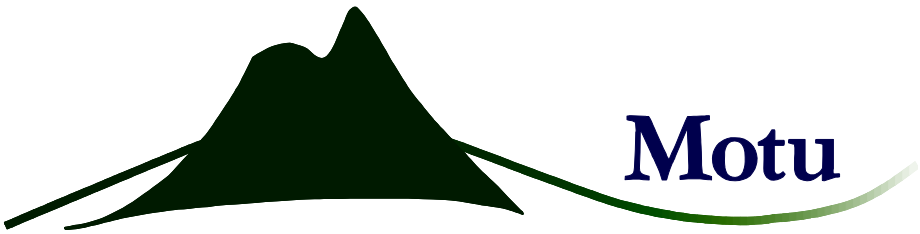

A regional summary of 2012 land use

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1. Introduction

Motu completed land-use simulations for the Parliamentary Commissioner for the Environment in November 2013 using the Land Use in Rural New Zealand (LURNZ) model. The original model results were based on an initial land-use map of 2008, constructed from the Land Cover Data Base (LCDB) version 3. Documentation for these results is contained in the report "Land Use and Farming Intensity: For 1996, 2008 and 2020" (Anastasiadis and Kerr, 2013). Please refer to this document for a full description of the model.

Since the completion of the report, version 4 of the LCDB with land-use information for 2012 has been released, providing an opportunity to assess how some of the simulation results compare to actual land-use change patterns (at the regional scale). The comparison requires that we process and amend the data in LCDB4 in a manner that is consistent with our previous approach. In this brief technical report, we document the main steps involved with a focus on new data processing; more detail about the model and methodology is provided by Anastasiadis and Kerr (2013).

2. Methodology

For consistency with the original work, we use the 1-hectare LURNZ grid and reclassify the LCDB4 land cover types exactly as before.

Land cover in 2012 is identified according to the LCDB4 (Landcare Research, dataset, 2015). This allows us to classify the entire country into pasture, plantation forestry, scrub, horticulture, non-productive, urban, or indigenous forest land. Public land is identified and classified separately according to an ownership map (Landcare Research, dataset, 2002). We differentiate between pasture on public land and all other public land. As in the original report, the Average Carrying Capacity (CCAV) map (Landcare Research New Zealand, dataset, 2002) is used to identify public land that is not suitable for animals: we reclassify public pasture with a carrying capacity of zero as non-productive land. With the exception of the LCDB4, the maps used to generate these classifications have not been updated since the original report.

The reclassified LCDB4 map[3] is a land-cover map, so it does not enable us to distinguish between different pastoral land uses. In particular, we are unable to identify land areas devoted to "dairy", "sheep and beef" and "other animal and lifestyle" uses in this dataset. Doing so requires additional information.

[3] Henceforth, "LCDB4" refers to the reclassified (LURNZ-compatible) map.

For dairy, we amend our data with information on dairy land area published in "New Zealand Dairy Statistics 2012-13" (Livestock Improvement Corporation and DairyNZ, 2013). Dairy areas are presented at the scale of districts, so this information in itself does not enable us to spatially pinpoint dairy areas.

The other animal and lifestyle land-use type is identified in the LURNZ base map (of 2008), partly based on information from the Agribase-enhanced LCDB of 2002. The land use is exogenous in LURNZ, so it is assumed constant in simulations. Accordingly, we assume that other animal and lifestyle areas do not change, unless we have evidence to the contrary: we assign this land use type to each grid cell classified as such in the LURNZ base map provided that the grid cell is still under pasture land cover in LCDB4.[4]

We apply two different geographic aggregations to summarise the data in LCDB4: "pseudo regional council" areas and "true regional council" areas. As explained below, the advantage of using pseudo regional council areas is that this level of aggregation is compatible with the dairy data, so it requires less modelling (and hence fewer assumptions). Conversely, the advantage of using true regional council areas is that results at this scale are directly comparable to those in the original report: tables 6-9 in Anastasiadis and Kerr (2013) present land-use areas for 1996, 2008 and 2020, respectively, by true regional council boundaries.

2.1. Pseudo-regional council analysis

The pseudo-regional aggregation reflects the particular merging of the districts contained in the dairy statistics report. The districts cannot be rearranged to conform to true regional council boundaries, so we combine them into what we call pseudo-regional councils. We define these according to table 18 of Anastasiadis and Kerr (2013), with a couple of minor differences due to changes in the way dairy reports are now compiled compared to previous years:

- The Gisborne region now consists of Gisborne and Wairoa districts; previously, Wairoa was part of Hawkes Bay region
- The Nelson and Tasman districts have been combined into a single area

Some cells in the LURNZ grid, representing around 47,000 hectares of land nationally, have no territorial authority identifier (only a regional council identifier). These cells are therefore not assigned to a pseudo-regional council by our algorithm. In order to include these areas in the analysis, we assume that their regional council location accurately reflects their pseudo-regional council location.

[4] Due to this condition, the area of the other animal and lifestyle land-use type has decreased slightly compared to previous LURNZ results.

In summarising land use at this scale, total (non-public) pasture area is established from LCDB4. Dairy area is calculated directly from the dairy statistics and the land area used for other animals and lifestyle is established, as explained above, using information from both LCDB4 and the LURNZ base map. The remaining pastoral land area is assumed to be under sheep-beef farming. All other land-use areas are determined from the LCDB4 map.

That is, for the pseudo-regional analysis, dairy and sheep-beef areas are only known at the district scale, while the other land-use types are assigned to specific grid cells.

2.2. True regional council analysis

As already noted, pseudo-regional council boundaries do not always correspond to true regional council boundaries, so the results of the above analysis are not directly comparable to those presented in the original report. To produce comparable results, we need to assign dairy and sheep-beef areas to specific grid cells. This step requires additional modelling.

We perform the assignment by running the TA-level spatial allocation algorithm of LURNZ (with the appropriate land areas as the model input). Intuitively, if dairy area increases in a TA, the algorithm selects the most suitable pasture land that was not already in dairy use in 2008 for dairy conversion. Suitability is determined based on geophysical attributes, location and land tenure. Details on the conceptual model and the algorithm are provided in Anastasiadis and Kerr (2013) and Anastasiadis et al. (2014).

With all land uses spatially assigned to grid cells, it is now possible to provide land-use summaries for true regional council areas.

3. Results

Results for 2012 land use from LCDB4 are presented in table 1 for pseudo-regions and in table 2 for true regions.[5]

To facilitate the evaluation of the results in table 1, we also aggregate the results of the original report using pseudo-regions. Tables 3 and 4 show land use for 2008 and 2020 (under the $5 carbon price scenario) from Anastasiadis and Kerr (2013) aggregated to pseudo-regions.

For reference, tables 4 and 5 reproduce the original (true regional council) aggregations. These tables contain information that corresponds to that found in tables 7 and 8 of the original report.[6]

[5] There is a 76 hectare difference nationally in dairy area in tables 1 and 2 – this reflects quirks in the allocation algorithm. Other small differences in the "total" rows of the tables may result from cells with missing area identifiers in the LURNZ dataset.

We note that some of the observed land-use changes implied by the two versions of the LCDB involve land areas that are considered exogenous in LURNZ (and thus never change in simulations). For example, a small number of cells change from land to sea and vice versa, causing changes in total national land area. There are changes to other exogenous areas as well. In a similar manner, total endogenous land area in LURNZ (the combined area of dairy, sheep-beef, forestry and scrub) never changes in simulations, but it obviously is not constant in reality. These observations may affect the evaluation of our simulation results. Table 7 summarises the most important observed changes between endogenous and exogenous land-cover types from 2008 to 2012.

[6] There is a small inconsistency in Anastasiadis and Kerr (2013): the land areas of some of the exogenous uses differ slightly across tables representing observations and projections. For example, DoC and other public land area in Marlborough differs in tables 7 and 8. These land uses are assumed constant in LURNZ and should therefore not change in simulations. We suspect that a newer model version (with an updated base map) was used to produce the projections in the original report. Our table 5 represents a base map that is completely consistent with the results in our table 6. Therefore, table 5 in this report corresponds to, but is not identical to, table 7 in Anastasiadis and Kerr. Table 6 in this report is identical to table 8 in Anastasiadis and Kerr.

Table 1: 2012 land-use areas using pseudo-regional council boundaries

Pseudo-regional council	Dairy	Sheep & Beef	Forestry	Scrub	Horticulture	Non-productive	Urban	Other animal and lifestyle	Indigenous Forest	Pasture on public land	DoC and public land
Northland	124,747	442,910	145,947	105,930	9,012	21,670	7,985	8,455	131,854	26,452	220,147
Auckland	48,655	242,520	44,037	48,005	18,290	8,665	45,363	20,384	42,460	13,881	95,754
Waikato	442,782	648,342	235,384	119,682	12,299	81,170	22,791	36,392	160,880	51,012	602,811
Bay of Plenty	119,356	151,015	138,488	40,140	27,993	8,019	12,938	14,436	134,489	18,748	557,862
Gisborne	1,846	495,876	181,812	161,731	19,073	16,784	2,980	4,450	83,719	13,940	264,582
Hawkes Bay	16,870	488,323	67,272	42,514	30,485	8,683	6,793	11,256	44,367	9,211	140,301
Taranaki	172,571	211,455	25,904	53,834	1,680	3,820	6,001	6,973	98,047	17,326	197,939
Manawatu-Wanganui	116,524	1,106,164	120,272	149,434	17,116	16,643	12,106	24,730	129,727	43,024	460,657
Wellington	26,431	325,351	57,594	100,946	8,047	6,397	17,722	7,424	22,970	9,839	222,258
West Coast	68,399	59,665	34,450	38,277	45	25,372	2,687	5,913	69,897	30,818	1,999,017
Canterbury	241,190	1,112,039	106,720	182,330	247,111	64,803	27,842	71,548	22,378	661,740	1,352,792
Otago	76,886	1,392,979	126,980	98,469	20,998	90,361	11,894	28,399	15,741	905,877	848,928
Southland	194,322	625,265	78,579	41,808	6,992	21,902	6,121	57,376	47,854	220,606	1,881,978
Nelson-Tasman	20,553	95,950	82,765	47,846	9,263	6,326	4,845	7,017	45,601	6,566	679,492
Marlborough	6,263	204,515	61,110	81,782	31,679	17,745	2,409	3,569	20,052	138,682	483,571
Total	1,677,395	7,602,369	1,507,314	1,312,728	460,083	398,360	190,477	308,322	1,070,036	2,167,722	10,008,089

Table 2: 2012 land-use areas using true regional council boundaries

Regional council	Dairy	Sheep & Beef	Forestry	Scrub	Horticulture	Non-productive	Urban	Other animal and lifestyle	Indigenous Forest	Pasture on public land	DoC and public land
Northland	124,739	442,835	145,914	105,929	9,012	21,669	7,985	8,454	131,870	26,466	220,164
Auckland	35,499	167,984	37,376	40,468	11,635	7,418	44,536	17,257	35,423	12,177	89,536
Waikato	483,984	728,224	231,423	114,383	17,843	82,907	23,651	41,367	153,426	47,596	517,092
Bay of Plenty	89,267	138,163	138,741	39,483	29,091	7,378	12,879	12,320	131,970	19,481	603,979
Gisborne	825	344,112	138,814	120,418	16,016	13,231	2,435	3,881	58,288	8,361	129,052
Hawkes Bay	19,979	668,027	114,036	108,953	33,555	13,214	7,365	12,096	90,843	15,691	332,620
Taranaki	172,571	198,059	25,863	50,810	1,680	3,618	5,996	6,960	85,699	14,707	160,830
Manawatu-Wanganui	116,488	1,096,297	126,796	137,085	17,116	15,890	12,110	24,745	138,007	49,156	486,668
Wellington	26,479	328,217	57,747	104,688	8,047	6,526	17,722	7,420	22,987	9,800	222,373
West Coast	68,403	59,667	34,455	38,279	45	25,367	2,687	5,932	69,898	30,819	1,999,164
Canterbury	244,157	1,242,204	109,053	188,219	248,093	71,853	28,063	74,336	22,765	812,035	1,479,621
Otago	73,981	1,262,688	124,696	92,570	20,016	83,340	11,673	25,672	15,322	755,711	721,659
Southland	194,278	625,263	78,528	41,778	6,992	21,908	6,121	57,315	47,873	220,548	1,882,419
Tasman	20,285	92,284	75,420	43,499	9,247	6,064	2,681	6,856	44,447	5,859	657,851
Nelson	273	3,664	7,341	4,346	16	267	2,164	142	1,157	725	21,686
Marlborough	6,263	204,616	61,111	81,821	31,679	17,710	2,409	3,569	20,061	138,592	483,378
Total	1,677,471	7,602,304	1,507,314	1,312,729	460,083	398,360	190,477	308,322	1,070,036	2,167,724	10,008,092

Table 3: 2008 land-use areas using pseudo-regional council boundaries

Pseudo-regional council	Dairy	Sheep & Beef	Forestry	Scrub	Horticulture	Non-productive	Urban	Other animal and lifestyle	Indigenous Forest	Pasture on public land	DoC and public land
Northland	119,287	446,809	146,870	105,608	10,143	21,156	7,816	8,513	132,308	26,615	219,984
Auckland	47,506	245,058	44,115	46,346	18,243	8,635	44,993	20,666	42,817	14,088	95,547
Waikato	416,221	654,915	253,102	118,317	12,812	81,176	22,717	36,651	163,811	50,761	603,062
Bay of Plenty	115,394	150,052	144,206	40,238	26,207	7,429	12,763	14,723	135,862	18,044	558,566
Gisborne	1,631	511,815	174,787	153,219	18,540	16,755	2,896	4,560	84,068	14,563	263,959
Hawkes Bay	14,941	493,923	66,487	40,611	29,573	8,599	6,158	11,457	44,814	9,452	140,060
Taranaki	167,951	211,989	23,364	56,699	1,763	3,399	5,797	7,143	102,180	15,917	199,348
Manawatu-Wanganui	110,281	1,116,306	116,960	146,789	17,277	15,819	12,170	25,115	131,999	46,162	457,519
Wellington	26,220	329,521	54,219	101,358	7,532	6,017	17,405	7,548	23,062	10,469	221,628
West Coast	63,314	59,412	36,939	39,784	68	25,172	2,639	5,940	71,437	30,075	1,999,760
Canterbury	190,993	1,163,612	109,926	183,163	245,153	63,172	26,163	72,038	21,741	660,567	1,353,965
Otago	64,149	1,408,858	125,594	99,220	21,018	87,983	11,387	28,811	15,687	905,507	849,298
Southland	155,439	661,039	76,868	46,761	7,295	20,650	6,133	57,571	48,463	220,385	1,882,199
Nelson-Tasman	20,391	94,236	83,758	46,764	10,887	6,272	4,573	7,348	45,937	6,495	679,563
Marlborough	5,896	206,418	59,713	81,218	31,588	17,675	2,340	3,808	20,468	138,673	483,580
Total	1,519,614	7,753,963	1,516,908	1,306,095	458,099	389,909	185,950	311,892	1,084,654	2,167,773	10,008,038

Table 4: 2020 $5 carbon price land-use areas using pseudo-regional council boundaries

Pseudo-regional council	Dairy	Sheep & Beef	Forestry	Scrub	Horticulture	Non-productive	Urban	Other animal and lifestyle	Indigenous Forest	Pasture on public land	DoC and public land
Northland	136,200	420,658	171,725	89,991	10,143	21,156	7,816	8,513	132,308	26,615	219,984
Auckland	56,452	235,144	44,900	46,529	18,243	8,635	44,993	20,666	42,817	14,088	95,547
Waikato	440,973	601,944	268,841	130,797	12,812	81,176	22,717	36,651	163,811	50,761	603,062
Bay of Plenty	119,157	129,777	164,553	36,403	26,207	7,429	12,763	14,723	135,862	18,044	558,566
Gisborne	7,536	416,923	251,568	165,425	18,540	16,755	2,896	4,560	84,068	14,563	263,959
Hawkes Bay	35,200	453,878	89,785	37,099	29,573	8,599	6,158	11,457	44,814	9,452	140,060
Taranaki	185,605	178,425	38,867	57,106	1,763	3,399	5,797	7,143	102,180	15,917	199,348
Manawatu-Wanganui	142,479	970,040	128,991	248,826	17,277	15,819	12,170	25,115	131,999	46,162	457,519
Wellington	51,792	287,799	70,381	101,346	7,532	6,017	17,405	7,548	23,062	10,469	221,628
West Coast	61,012	65,119	36,984	36,334	68	25,172	2,639	5,940	71,437	30,075	1,999,760
Canterbury	289,851	998,415	115,236	244,192	245,153	63,172	26,163	72,038	21,741	660,567	1,353,965
Otago	114,240	1,255,284	132,725	195,572	21,018	87,983	11,387	28,811	15,687	905,507	849,298
Southland	208,250	606,717	79,751	45,389	7,295	20,650	6,133	57,571	48,463	220,385	1,882,199
Nelson-Tasman	30,403	80,731	94,884	39,131	10,887	6,272	4,573	7,348	45,937	6,495	679,563
Marlborough	10,795	167,759	72,915	101,776	31,588	17,675	2,340	3,808	20,468	138,673	483,580
Total	1,889,945	6,868,613	1,762,106	1,575,916	458,099	389,909	185,950	311,892	1,084,654	2,167,773	10,008,038

Table 5: 2008 land-use areas using true regional council boundaries (corresponds to Table 7 in Anastasiadis and Kerr (2013))

Regional council	Dairy	Sheep & Beef	Forestry	Scrub	Horticulture	Non-productive	Urban	Other animal and lifestyle	Indigenous Forest	Pasture on public land	DoC and public land
Northland	119,276	446,740	146,837	105,607	10,142	21,155	7,816	8,512	132,322	26,631	219,999
Auckland	35,089	169,966	37,521	38,651	11,517	7,450	44,221	17,517	35,664	12,441	89,272
Waikato	455,599	735,727	250,098	112,990	18,438	82,873	23,322	41,644	156,517	47,314	517,374
Bay of Plenty	86,463	137,058	143,016	39,906	27,308	6,770	12,863	12,604	133,304	18,758	604,702
Gisborne	613	358,081	132,803	113,381	15,218	13,163	2,379	3,988	58,394	8,853	128,560
Hawkes Bay	17,947	675,442	112,604	105,513	32,895	13,169	6,709	12,307	91,482	16,101	332,210
Taranaki	167,940	199,185	23,317	52,990	1,763	3,246	5,792	7,128	89,895	14,142	161,395
Manawatu-Wanganui	110,244	1,105,548	123,552	135,289	17,277	15,014	12,208	25,132	140,270	51,403	484,421
Wellington	26,261	332,652	54,362	104,859	7,532	6,145	17,405	7,544	23,073	10,430	221,743
West Coast	63,314	59,418	36,944	39,786	68	25,167	2,639	5,959	71,438	30,076	1,999,907
Canterbury	193,916	1,292,307	113,234	189,212	246,565	70,176	26,383	74,826	22,124	810,820	1,480,836
Otago	61,238	1,280,119	122,323	93,179	19,606	80,974	11,167	26,084	15,268	755,373	721,997
Southland	155,427	660,996	76,829	46,728	7,295	20,656	6,133	57,510	48,482	220,337	1,882,630
Tasman	20,118	90,585	76,362	42,436	10,869	6,010	2,433	7,187	44,783	5,797	657,913
Nelson	273	3,654	7,392	4,327	18	267	2,140	142	1,157	716	21,695
Marlborough	5,896	206,496	59,714	81,242	31,588	17,674	2,340	3,808	20,481	138,583	483,387
Total	1,519,614	7,753,974	1,516,908	1,306,096	458,099	389,909	185,950	311,892	1,084,654	2,167,775	10,008,041

Table 6: 2020 $5 carbon price land-use areas using true regional council boundaries (identical to Table 8 in Anastasiadis and Kerr (2013))

Regional council	Dairy	Sheep & Beef	Forestry	Scrub	Horticulture	Non-productive	Urban	Other animal and lifestyle	Indigenous Forest	Pasture on public land	DoC and public land
Northland	136,188	420,590	171,692	89,990	10,142	21,155	7,816	8,512	132,322	26,631	219,999
Auckland	43,266	161,285	37,866	38,810	11,517	7,450	44,221	17,517	35,664	12,441	89,272
Waikato	480,957	679,768	267,765	125,924	18,438	82,873	23,322	41,644	156,517	47,314	517,374
Bay of Plenty	91,337	118,827	161,225	35,054	27,308	6,770	12,863	12,604	133,304	18,758	604,702
Gisborne	4,853	284,547	195,169	120,309	15,218	13,163	2,379	3,988	58,394	8,853	128,560
Hawkes Bay	38,924	603,399	153,496	115,687	32,895	13,169	6,709	12,307	91,482	16,101	332,210
Taranaki	185,581	167,232	38,219	52,400	1,763	3,246	5,792	7,128	89,895	14,142	161,395
Manawatu-Wanganui	142,458	968,678	133,633	229,864	17,277	15,014	12,208	25,132	140,270	51,403	484,421
Wellington	51,830	290,268	70,549	105,487	7,532	6,145	17,405	7,544	23,073	10,430	221,743
West Coast	61,012	65,121	36,989	36,340	68	25,167	2,639	5,959	71,438	30,076	1,999,907
Canterbury	293,394	1,093,864	118,810	282,601	246,565	70,176	26,383	74,826	22,124	810,820	1,480,836
Otago	110,709	1,159,770	129,188	157,192	19,606	80,974	11,167	26,084	15,268	755,373	721,997
Southland	208,238	606,701	79,712	45,329	7,295	20,656	6,133	57,510	48,482	220,337	1,882,630
Tasman	29,845	77,392	84,936	37,328	10,869	6,010	2,433	7,187	44,783	5,797	657,913
Nelson	558	3,344	9,944	1,800	18	267	2,140	142	1,157	716	21,695
Marlborough	10,795	167,833	72,916	101,804	31,588	17,674	2,340	3,808	20,481	138,583	483,387
Total	1,889,945	6,868,619	1,762,109	1,575,919	458,099	389,909	185,950	311,892	1,084,654	2,167,775	10,008,041

Table 7: Changes between endogenous and exogenous land areas (ha) comparing LCDB3 and LCDB4

LCDB3 \ **LCDB 4**	**pasture**	**forest**	**scrub**	**other**
pasture	-	-	-	188,572
forest	-	-	-	92,717
scrub	-	-	-	126,097
other	333,205	8,007	14,587	-

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