Chapter 13:

Requests under s5K relating to the Nationally Determined Contribution and biogenic methane – supporting evidence

Contents

We have been asked two additional questions – about the compatibility of the Nationally Determined Contribution (NDC) with contributing to the global effort to limit the increase in global average temperature to 1.5°C above pre-industrial levels (the global 1.5°C effort), and about what long-term reductions of biogenic methane emissions the country might be required to make as part of that effort. In this chapter we show our work on how we have used the Intergovernmental Panel on Climate Change (IPCC) 1.5°C pathways in our assessment of the NDC. We also discuss the long-term global and local trends that will influence what contribution reductions of biogenic methane might need to make as part of the global 1.5°C effort in the future.

13.1 Introduction

Under section 5K of the Climate Change Response Act 2002 (CCRA) the Minister of Climate Change requested two reports as part of this first package of advice.

The **first** is related to biogenic methane. Specifically, the Minister has asked the Climate Change Commission (the Commission) to provide:

> *"advice on the potential reductions in biogenic methane emissions which might eventually be required by New Zealand as part of a global effort under the Paris Agreement to limit the global average temperature increase to 1.5° Celsius above preindustrial levels.*
>
> *In providing this advice the Commission must:*
>
> *a. leave aside considerations on the current target range for biogenic methane specified in section 5(Q)(1)(b) of the CCRA;*
> *b. consider the available scientific evidence on the global biogenic methane emissions reductions likely to be required to limit global average temperature increase to 1.5° Celsius above pre-industrial levels;*
> *c. consider New Zealand's potential contribution to global efforts to limit biogenic methane emissions, reflecting its national circumstances; and*
> *d. consider a range of potential scenarios for economic, social and demographic changes which might occur in New Zealand and globally until 2100."*

The **second** is related to the NDC of Aotearoa under the Paris Agreement. Specifically, the Minister has asked the Commission to provide:

> "*a report on New Zealand's first Nationally Determined Contribution (NDC), including:*
> *a. advice on whether the NDC is compatible with contributing to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5° Celsius above pre-industrial levels; and*
> *b. recommendations on any changes to the NDC required to ensure it is compatible with global efforts under the Paris Agreement to limit the global average temperature increase to 1.5° Celsius above pre-industrial levels."*

The methodology we have used to analyse the two questions and our findings are set out in *Chapters 21-23* of the Commission's advice, *Ināia Tonu Nei*. This chapter outlines additional evidence relevant to the two requests under s5K of the Act. It describes:

- The methodology for converting from emissions targets to NDC emissions budgets and how the results of the modelling that supported the *IPCC Special Report on Global Warming of 1.5°C* has been applied to Aotearoa

- Reference material on the future economic, social and demographic trends that might occur to 2100.

Further evidence relevant to these requests is included in *Chapter 1: The science of climate change* and *Chapter 2: What other countries are doing*.

13.2 Methodology to convert NDC targets to NDC emissions budgets

In this section we describe the conceptual approach to converting targets to NDC emissions budgets, how this was done under the Kyoto Protocol, the approach we have taken to doing so and how that differs slightly from the methodology used under the Kyoto Protocol.

In its first NDC, Aotearoa committed to reduce net greenhouse gas emissions to 30% below 2005 levels of gross emissions by 2030. The NDC uses an emissions budget approach which means we are taking responsibility for emissions over the whole period 2021-2030.

There is an approach to converting targets for a single year to allowed emissions over a whole period. This is described in a technical document developed for the Kyoto Protocol[1] and the initial report on the country's 2020 emissions target provides an example of its application in practice.[2] The IPCC has assessed emissions reduction pathways it considers would be consistent with a likely chance (50-66%) of limiting the increase on global average temperature to within 1.5°C above pre-industrial levels (the IPCC 1.5°C pathways). In assessing possible alternative NDCs associated with the IPCC 1.5°C pathways we have used a version of this approach. Some features of that methodology are particular to the Kyoto Protocol and are no longer necessary and so have not been applied. This section describes how the calculation is done and the parameters and assumptions the Commission has chosen in doing so.

13.2.1 General approach

The NDC emissions budget sets the total amount of emissions able to be emitted over the period covered by the NDC. To calculate this budget, we need to draw a trajectory between a start point and an end point. The end point is the point-year target of the NDC (in our case, 30% below 2005 levels). Starting from the previous target, there are choices to be made about the start point of the trajectory. The NDC emissions budget will be equal to the amount of emissions occurring under the trajectory over the period of the NDC (see Figure 13.1).

The actual emissions pathway does not have to follow this exact trajectory as long as the country's total emissions over the period is less than the allowed level.

[1] (UNFCCC Secretariat, 2010)
[2] (Ministry for the Environment, 2016)

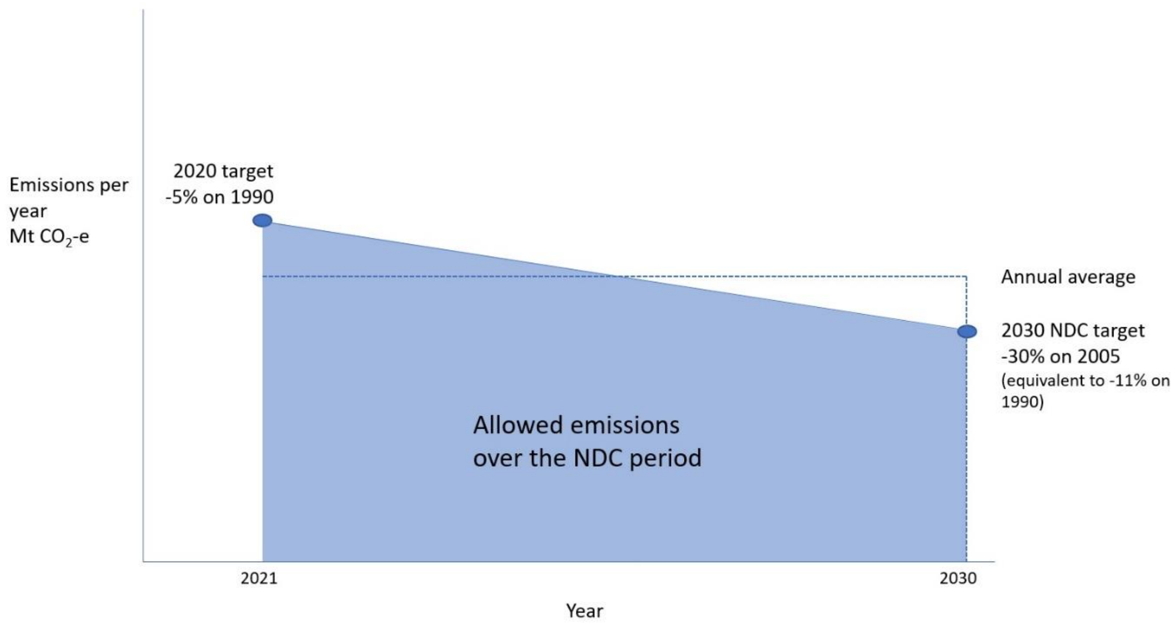

Figure 13.1: Illustration of conversion of the existing 2030 target to an NDC amount[3]

13.2.2 Starting point of the emissions trajectory under the Kyoto Protocol approach

The Kyoto Protocol methodologies that were used to determine the allowed emissions under the first NDC use a slightly more complex calculation. Under the Kyoto Protocol approach, the starting point for the emissions trajectory is the midpoint of the previous period, not the final year of the previous target. This was chosen because under the Kyoto Protocol, allowed emissions levels were averaged over the period and it was this average that was the stated target. Using that average target level in the final year as the start point for the next target would overstate the allowed emissions as the emissions in the final year of the previous period should be below the average by the final year as illustrated in Figure 13.2 below.

[3] The 2030 target is to reduce emissions to 30% below 2005 levels. Here it is presented as a reduction against 1990 levels for easier comparison to the 2020 target that preceded it.

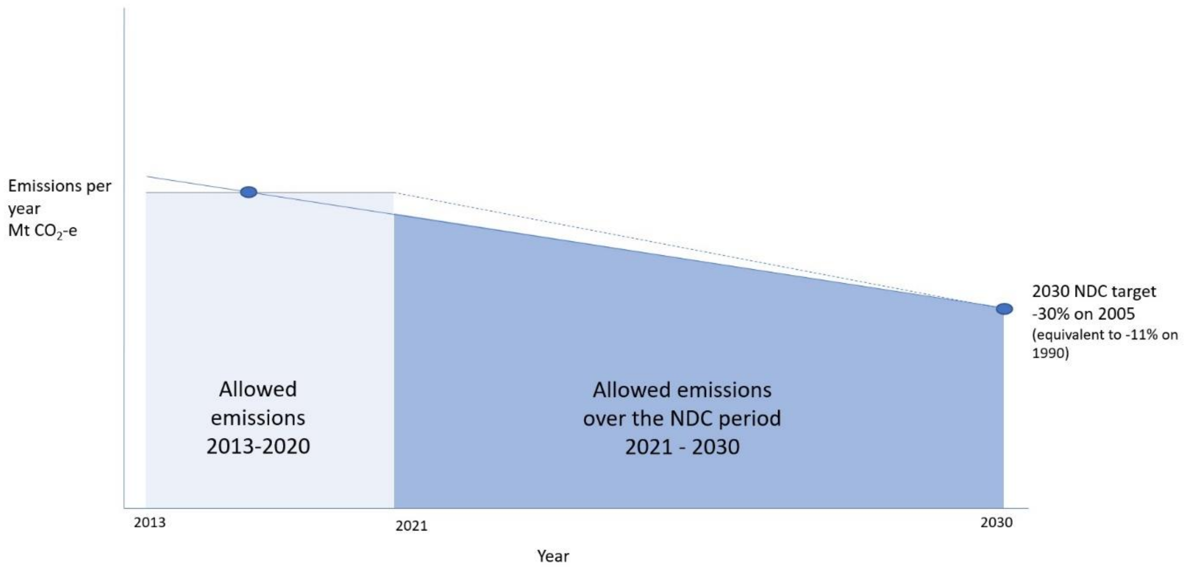

Figure 13.2: Illustration of Kyoto approach to converting targets to NDC amounts

Using this approach, the Ministry for the Environment previously calculated the allowed emissions budget for the NDC period 2021-2030 was 601 $MtCO_2e$.[4] This was based on estimates of past emissions from the greenhouse gas inventory published in 2017. The 601 $MtCO_2e$ figure will be adjusted and finalised by government officials in 2023/24 after the greenhouse gas inventory covering the 2020 year has been finalised and reviewed. We have applied this approach using the latest inventory figures and calculated that the current NDC allows net emissions of 596 $MtCO_2e$ over 2021-2030. This is our current estimate of the NDC emissions budget.

We have developed comparator NDCs to help us assess the compatibility of our existing NDC with the global 1.5°C effort. To do so we have selected the end point of the previous target (5% below 1990 levels) as the starting point for the emissions trajectory used to calculate the NDC emissions budget. This is because the country's 2013-2020 commitment was expressed as a target level in 2020 and calculated as an emissions budget from that stated target. As the target expresses a trajectory to a level in 2020 and not only an average over the period, it is unnecessary to start from the middle of the previous period. The approach we have taken is consistent with how other countries taking an emissions budget approach to their NDCs, such as Australia, are calculating their budgets.

13.2.3 Applying the IPCC modelled reductions to Aotearoa

In our advice on the compatibility of the NDC, we compare the current NDC to the comparator NDC budgets developed using the modelled global greenhouse gas reductions in the IPCC 1.5°C pathways. Here we explain how that was done, and the judgements that have been made in applying the methodology above.

Gases

We have applied separate trajectories for each of the main greenhouse gases, carbon dioxide, methane, nitrous oxide, and sulphur hexafluoride to distinguish between the different levels of emissions reductions modelled for different gases in the IPCC 1.5°C pathways. Separate trajectories were also developed for hydrofluorocarbons and perfluorocarbons – one trajectory for each of

[4] (Ministry for the Environment, 2019b)

category of gas. These were then reaggregated together using the GWP_{100} metric from the IPCC *Fourth Assessment Report (AR4)* to create a total NDC emissions budget. The cuts to agricultural methane and nitrous oxide assessed by the IPCC were applied to total emissions of methane and nitrous oxide respectively, as the vast majority of the country's emissions of those gases are from the agriculture sector and the reductions of fossil methane and agricultural methane differ significantly in IPCC pathways.

Starting point for calculating NDC emissions budget

The assessment of the NDC is very sensitive to the level of emissions and the year chosen as the starting point of the trajectory to calculate the comparator emissions budgets. We have chosen a 2020 start year, starting at the level of the 2020 emissions target (5% below 1990 levels).

Starting year of the trajectory

We have chosen a 2020 start year. Alternatively, 2010 could have been selected as the trajectory starting point, for consistency with the base year used in the IPCC 1.5°C pathways.

Using 2010 emissions (or any date significantly before 2020) as the trajectory starting point would not be appropriate in the context of assessing the compatibility of our current NDC (which covers the period 2021-2030) with the global 1.5°C effort. To do so would be to broaden the scope of our assessment to include previous targets, which we have not been asked to do.

Starting level of the trajectory

We chose the level of the 2020 target (5% below 1990 emissions) as the stating level of the trajectory.

Some submitters argued that the start level of the trajectory for the NDC assessment should be the country's current level of net emissions. We believe that using this start point would lack environmental integrity. Much of the emissions reductions used to meet the country's 2020 emissions target were temporary – either forest offsets or offshore mitigation. They genuinely reduced net emissions at that time, but as offsets did not permanently lower the country's rate of emissions.

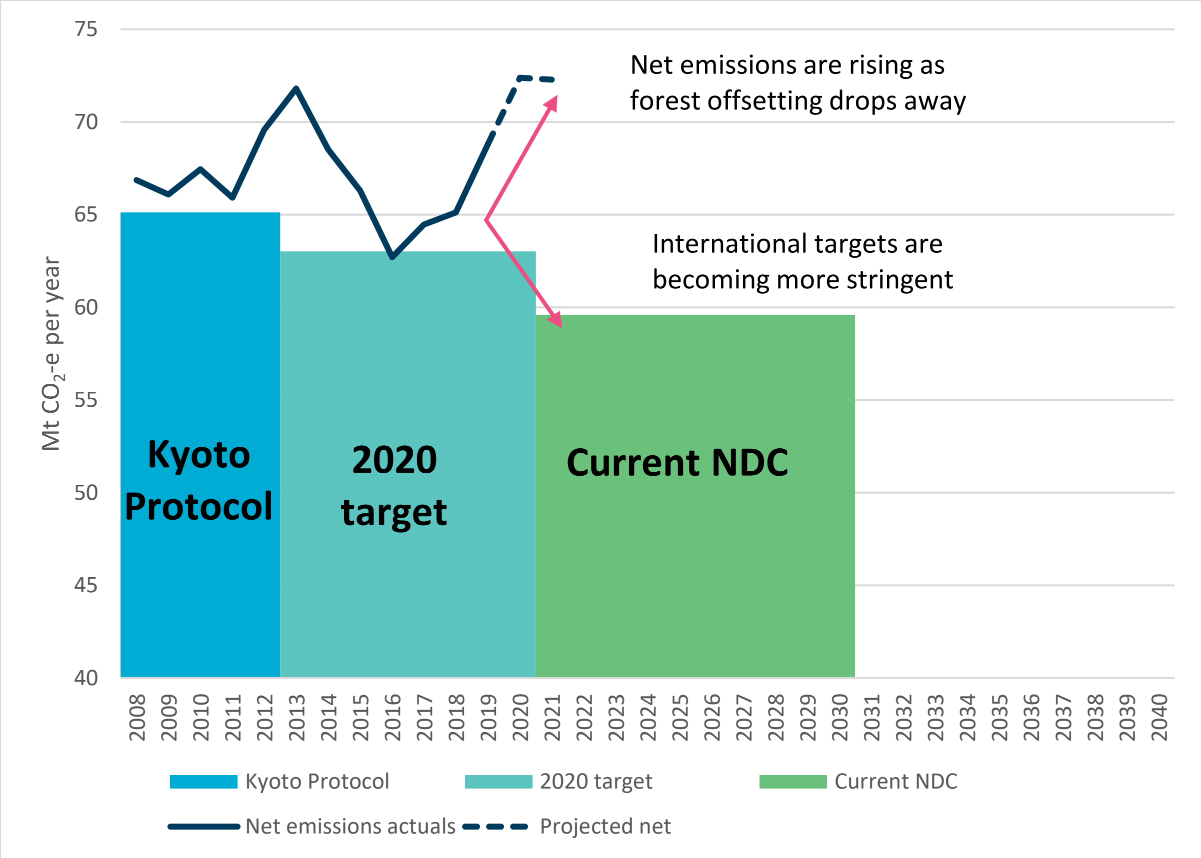

Figure 13.3: International targets and net emissions (target accounting) in Aotearoa 2008 - 2021

Consequently net emissions in Aotearoa are rising above the level of the 2020 target (see Figure 13.3 above). If we used today's net emissions as the starting point for the trajectory, we would be walking back from the level of net emissions that the country committed to being at in 2020. Under the Paris Agreement, each NDC must represent a progression in ambition beyond its previous NDC.[5] Using today's net emissions as the starting point for the trajectory used to calculate our emissions budget would be result in a less ambitious NDC overall.

Approach taken

In applying the IPCC modelled reductions by gas, we have applied the 2020 emissions reduction target of 5% on 1990 levels to each of the gases as the start point for each gas.

Endpoint of the trajectory used to calculate the comparator NDC emissions budgets

The current NDC is expressed as a 30% reduction in emissions from 2005 levels. The modelled emissions reductions assessed by the IPCC 1.5°C pathways are expressed as percentage cuts for individual gases from 2010 levels.

In describing the NDCs that would be compatible with the IPCC 1.5°C pathways we have therefore used a 2010 base year to be consistent with how modelling underlying the IPCC 1.5°C pathways, and

[5] Article 4(3).

converted these targets to absolute levels of emissions in 2030 for each of the greenhouse gases or groups of gases.

Gross-net accounting

Consistent with the Kyoto Protocol-based target accounting approach, we have chosen to exclude forestry from the base year in developing the comparator NDCs (i.e., we have selected a gross-net accounting approach). The IPCC 1.5°C pathways adopt a net-net approach. Some submissions have pointed to this apparent inconsistency.

Under the agreed accounting rules for the Kyoto protocol, emissions and removals of carbon from land-use change and by forestry are excluded from the base year in calculating targets if the sector was a net sink of emissions in the base year – which it was in Aotearoa.

This is because carbon removals from new plantation forestry deliver a one-off removal from the atmosphere over the first decades of the life of the forest. After that time, the forest is neither a sink nor a source of emissions as carbon removals from growth are balanced by emissions at harvest. Including these emissions removals in the base year would mean an ongoing level of new forest planting would be required to maintain net emissions at a constant level. This does not accurately represent the level of effort in the base year and would not be sustainable indefinitely.

At a global level however emissions from land-use change represent additional emissions every year through deforestation and need to be reduced in the same way gross emissions do.

The IPCC 1.5°C pathways use a net-net approach, because this is the most appropriate approach at the global level (because globally, the forestry sector is a net source of emissions). Aoteroa uses a gross-net approach, because our forestry sector has been a net sink of emissions. Both these approaches are consistent with the international accounting guidance and appropriate to the circumstances they are being applied to.

Chapter 3: How to measure progress, provides further detail on this issue.

13.2.4 Application to Aotearoa

Trajectories for each of the greenhouse gases (and groups of gases) are calculated from the 2020 starting point, to the 2030 target level, converted to carbon dioxide equivalent using GWP_{100} values from the *AR4* (25 for methane, 298 for nitrous oxide). The upper and lower quartiles of emissions reductions by gas in the IPCC 1.5°C pathways were used for the target level in 2030. The interquartile range was selected in order to exclude the least feasible of the modelled scenarios while still providing a range of possible pathways. The sum of emissions over the 2021-2030 period provides the indicative allowed emissions over the NDC period associated with the IPCC 1.5°C interquartile range.

The range of global emissions reductions modelled are given in Table 13.1 below.

Table 13.1: Percentage emissions reductions by gas by 2030 in IPCC pathways

	Percentage change relative to 2010 by 2030	
	Lower quartile	Upper quartile
Net carbon dioxide emissions	-40%	-58%
Agricultural methane emissions	-11%	-30%
Agricultural nitrous oxide emissions	+3%	-21%
Hydrofluorocarbon emissions	-65%	-77%
Perfluorocarbon emissions	-59%	-70%
Sulphur hexafluoride emissions	-49%	-67%

Table 13.2 steps through the figures for each of the greenhouse gases. It includes the emissions of each gas in 1990, and therefore what the 2020 target level is pro-rated to each gas (a 5% reduction on 1990 levels). It includes 2010 emissions of each gas. The upper quartile and lower quartile emissions reductions from Table 13.1 are applied to 2010 emissions to get two sets of 2030 end points for the NDC trajectory for each gas.

Table 13.2: Aotearoa NDC emissions trajectory start and end point calculations by gas

	Start point		End point		
	1990 emissions (kt gas)	**2020 target 5% reduction on 1990 (kt gas)**	**2010 emissions (kt gas)**	**IPCC 2030 lower quartile reductions (kt gas)**	**IPCC 2030 upper quartile reductions (kt gas)**
Net carbon dioxide[6]	25,649	24,367	35,031	21,019	14,713
Methane	1,312	1,246	1,381	1,229	967
Nitrous oxide	19.3	18.3	25.6	26.4	20.3

Table 13.3 describes the start and end point for emissions of fluorinated gases used in the NDC calculations. As hydrofluorocarbons and perfluorocarbons represent categories with multiple gases, only figures for total emissions in $ktCO_2e$ are provided.

[6] Reductions of net carbon dioxide emissions have here been applied to gross carbon dioxide levels consistent with target accounting. This accounting recognises that land sector emissions need to be reduced, but land sector removals do not need to continue indefinitely. This is discussed in the forest accounting section above, and in further detail in *Chapter 3: How to measure progress.*

Table 13.3: Aotearoa start and end points used for fluorinated gas emissions

	Start point		End point		
	1990 emissions	2020 target 5% reduction on 1990	2010 emissions	IPCC 2030 lower quartile reductions	IPCC 2030 upper quartile reductions
	(kt CO_2-e)	(kt CO_2-e)	(kt CO_2-e)	(kt CO_2-e)	(kt CO_2-e)
Hydrofluorocarbons	0	0	1053	369	242
Perfluorocarbons	910	864	48	20	14
Sulphur hexafluoride	20	19	23	12	8

Table 13.4 and Table 13.5 then step through the emissions trajectories of each gas or group of gases by drawing a straight path from the given start point in 2020 to the target level in 2030 for the lower quartile and upper quartile of IPCC 1.5°C pathways respectively. Aggregating the volume of emissions allowed by these trajectories over 2021-2030 is how the NDC range of 527-608 $MtCO_2e$ were calculated.

Table 13.4: NDC emissions trajectories by gas for the IPCC 1.5°C upper quartile emissions pathway

Emissions trajectory associated with IPCC lower quartile cuts for 1.5°C pathways									
Year	Carbon dioxide	Methane	Methane	Nitrous oxide	Nitrous oxide	Hydro fluorocarbons	Per-fluorocarbons	Sulphur hexafluoride	Total
	(kt CO_2)	(kt CH_4)	(kt CO_2e)	(kt N_2O)	(kt CO_2e)	(kt CO_2e)	(kt CO_2e)	(kt CO_2e)	(kt CO_2e)
2020 start point	24,367	1,246	31,156	18.3	5,467	0	864	19	61,873
2021	24,032	1,244	31,112	19.2	5,707	37	780	18	61,687
2022	23,697	1,243	31,069	20.0	5,948	74	695	18	61,501
2023	23,362	1,241	31,025	20.8	6,189	111	611	17	61,315
2024	23,028	1,239	30,982	21.6	6,429	147	526	16	61,129
2025	22,693	1,238	30,939	22.4	6,670	184	442	15	60,943
2026	22,358	1,236	30,895	23.2	6,910	221	357	15	60,756
2027	22,023	1,234	30,852	24.0	7,151	258	273	14	60,570
2028	21,688	1,232	30,808	24.8	7,391	295	188	13	60,384
2029	21,354	1,231	30,765	25.6	7,632	331.7923	104	12.37983	60,198
2030	21,019	1,229	30,722	26.4	7,872	368.6581	20	11.64713	60,012
Total 2021-2030	225,254	12,367	309,168	227.8	67,898	2,028	3,997	149	608,495

Table 13.5: NDC emissions trajectories by gas for the IPCC 1.5°C lower quartile emissions pathway

Emissions trajectory associated with IPCC lower quartile cuts for 1.5°C pathways									
Year	Carbon dioxide	Methane	Methane	Nitrous oxide	Nitrous oxide	Hydro fluorocarbons	Per-fluorocarbons	Sulphur hexafluoride	Total
	(kt CO_2)	(kt CH_4)	(kt CO_2e)	(kt N_2O)	(kt CO_2e)	(kt CO_2e)	(kt CO_2e)	(kt CO_2e)	(kt CO_2e)
2020 start point	24,367	1,246	31,156	18.3	5,467	0	864	19	61,873
2021	23,401	1,218	30,456	18.5	5,524	24	779	18	60,203
2022	22,436	1,190	29,757	18.7	5,581	48	694	17	58,534
2023	21,471	1,162	29,058	18.9	5,638	73	609	16	56,864
2024	20,505	1,134	28,359	19.1	5,695	97	524	14	55,195
2025	19,540	1,106	27,659	19.3	5,752	121	439	13	53,525
2026	18,575	1,078	26,960	19.5	5,810	145	354	12	51,856
2027	17,609	1,050	26,261	19.7	5,867	170	269	11	50,186
2028	16,644	1,022	25,561	19.9	5,924	194	184	10	48,517
2029	15,679	994	24,862	20.1	5,981	218	99	9	46,848
2030	14,713	967	24,163	20.3	6,038	242	14	8	45,178
Total 2021-2030	190,57 3	10,924	273,096	194.0	57,810	1,332	3,969	127	526,907

13.3 NDC accounting issues

Some submitters have raised questions about how the NDC is accounted for. Two key issues raised through consultation are the metric used to compare greenhouse gases and the approach taken to account for forest removals.

13.3.1 Alternative metrics

Some submitters argued that the Global Warming Potential metric used in international reporting is incorrect, and that we should recommend a different metric for reporting and accounting against the NDC.

Different metrics are good at addressing different questions – there is no one 'correct' metric that is useful for all purposes. This is because each metric makes assumptions and judgements about what is important in order to simplify the physical differences between gases down to a quantitative relationship. Three of the most commonly discussed metrics are Global Warming Potential (GWP), Global Temperature Potential (GTP) and Global Warming Potential Star (GWP*).

GWP compares the relative total radiative forcing between gases over a set timeframe (e.g., 100 years). However, GWP excludes any considerations of the effects after that period. GWP values with shorter time horizons therefore put a greater emphasis on warming from short-lived gases, as they exclude the effects of long-lived greenhouse gases that continue to have a warming effect beyond its time horizon. GWP also only includes the aggregate forcing over the period and does not consider the resulting temperature trajectory. This makes it less useful in analysis of pathways to a specified temperature goal.

GTP looks at the temperature effect of a pulse of gases at a defined point in the future. It ignores any effects of warming before its stated time horizon. It puts a strong emphasis on long-lived gases for a long-time horizon, shifting over time to a strong emphasis on short-lived gases as the date of the temperature goal approaches. Consequently, it is not consistent through time.

GWP* compares the warming effect of a sustained rate of emitting short-lived greenhouse gas emissions such as methane against a cumulative total of carbon dioxide emissions. As a warming metric it is useful for tracking progress directly towards a long-term temperature target. However, its usefulness in national policy or in making trade-offs with short-term targets has yet to be demonstrated. It may be useful to explore how it could be applied in practice, without losing sight of the fact that the international community has agreed to use GWP_{100} to account for NDCs.

We discuss different metrics further in the *Chapter 1: The science of climate change.*

13.3.2 Inventory accounting

Some submitters have called for us to account for all emissions and removals in a given year (inventory accounting). However, using the inventory accounting approach would make our effort towards meeting our climate targets particularly easy in some decades and particularly hard in others, without making any real difference to the atmosphere over the longer-term.

If we were to account for all forest emissions and carbon dioxide removals in the current year without distinguishing new forest from pre-existing forest, reaching targets in the 2030s and 2040s would be extremely hard, because pre-existing forests would be in a harvest cycle. In contrast, reaching net-zero emissions in 2050 would require very little effort at all, because pre-existing forests will be in in a growth cycle. As long as the land remains used for forestry these cycles balance out over longer time scales of several decades. Any land use change away from forestry is fully accounted for.

By taking a longer-term view and factoring out historic forest cycles, we can make sure we are only accounting for real additional changes that actually contribute to climate change one way or the other.

Some submitters maintained that using the current forest accounting system would negatively affect the country's international reputation.

Aotearoa is following internationally agreed rules for carbon accounting. This system of accounting is part of the text of the Kyoto Protocol itself and was extensively negotiated to address complexities in accounting for the mechanics of a biological system over the long-term.[7] Aotearoa is applying the Kyoto Protocol approaches to accounting for its NDC target, just like many other developed countries such as the European Union and its members states and as allowed for under the Paris Agreement.

Using this accounting system provides continuity with our previous international commitments. Our emissions reporting and accounting is reviewed annually by international experts for compliance with these rules, and no issues of compliance with accounting approaches have been raised.

We discuss these issues and methodologies further in *Chapter 3: How to measure progress.*

[7] Kyoto Protocol, Article 3(7)

13.4 What social, economic and demographic changes may occur that could affect methane emissions from Aotearoa?

This section summarises information on key social, economic and demographic factors and changes that may occur until 2100 that could affect the level of methane reductions Aotearoa makes. The material considers both global 'megatrends' and factors within Aotearoa.

The section draws on a number of domestic and international sources. Key amongst these is a summary report of national and international factors that can affect the primary sector and land use, produced by the Our Land and Water National Science Challenge.[8]

13.4.1 Population growth and food demand

The world population is expected to continue to increase over the century, reaching more than 9 billion people by 2050. Figure 13.4 shows this with the medium, high and low projections from the *United Nations Population Prospectus 2019*. Global population growth rates are expected to slow over the century, although by how much is uncertain. Estimates used in the IPCC 1.5°C pathways put the likely global human population at between 9-11 billion by the end of the century.[9]

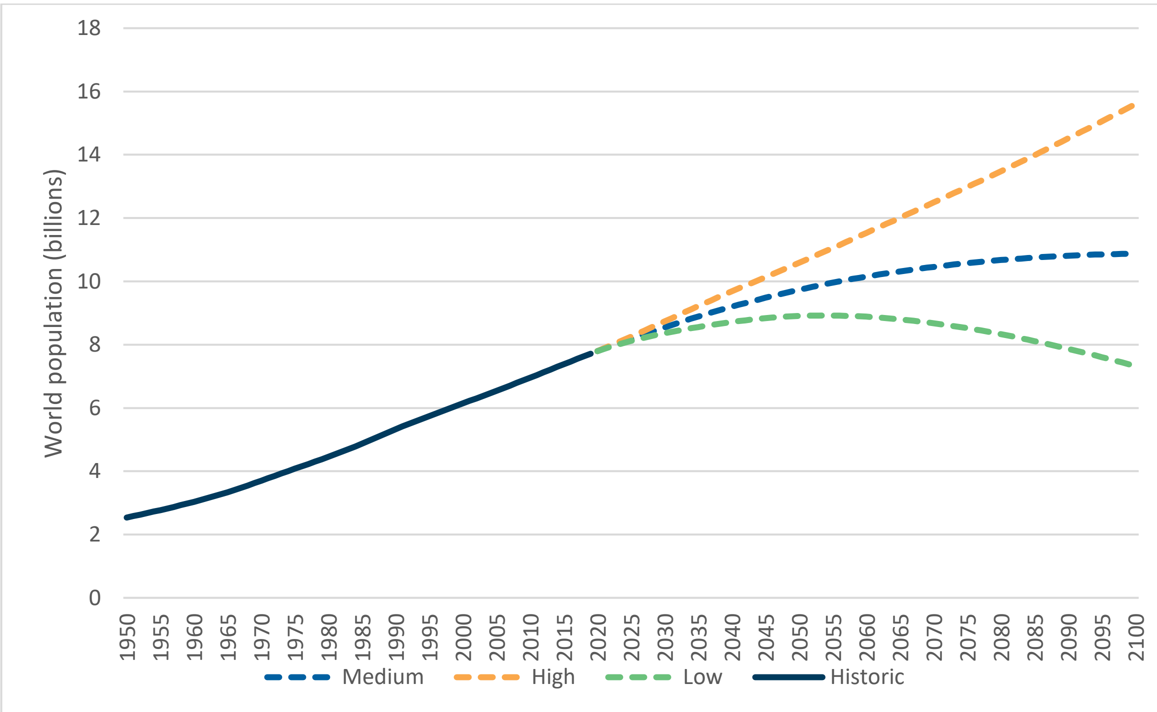

Figure 13.4: Historic and projected global population growth[10]

Population growth rates vary in different parts of the world. It is expected that Africa (predominantly sub-Saharan Africa) will account for most of this growth, with the population increasing from around

[8] (Driver et al., 2019)
[9] (IPCC, 2018)
[10] (United Nations, 2019)

1.3 billion to 4.3 billion people by 2100. In comparison, European and Latin American populations are expected to decline by 2100.[11]

This growing global population will require food and nutrition. A number of estimates exist for changes in food demand, which include both an increase in total amount and changes in the type food required.

The Food and Agriculture Organisation (FAO) has estimated the need to double global food production by 2050 to meet the expected demand of around 9.7 billion people, although this need is not evenly distributed around the world. Food demand in sub-Saharan African and South Asia is expected to double, and increase by around a third in the rest of the world. The FAO also predicts increasing demand for animal products, fruit and vegetables and more processed foods, due to a combination of increasing wealth and greater urbanisation.[12]

The IPCC 1.5°C pathways also model food demand, and largely expect individual demand for food (calories/person/day) to stay the same or to increase over the rest of the century. Combined with the expected increases in total population, this will lead to an overall increase in food demand.

Food exporting countries such as Aotearoa will have an important role to play in meeting this projected increased demand. As Figure 13.5 shows, many of the regions that will experience the greatest population growth are also already net food importers.

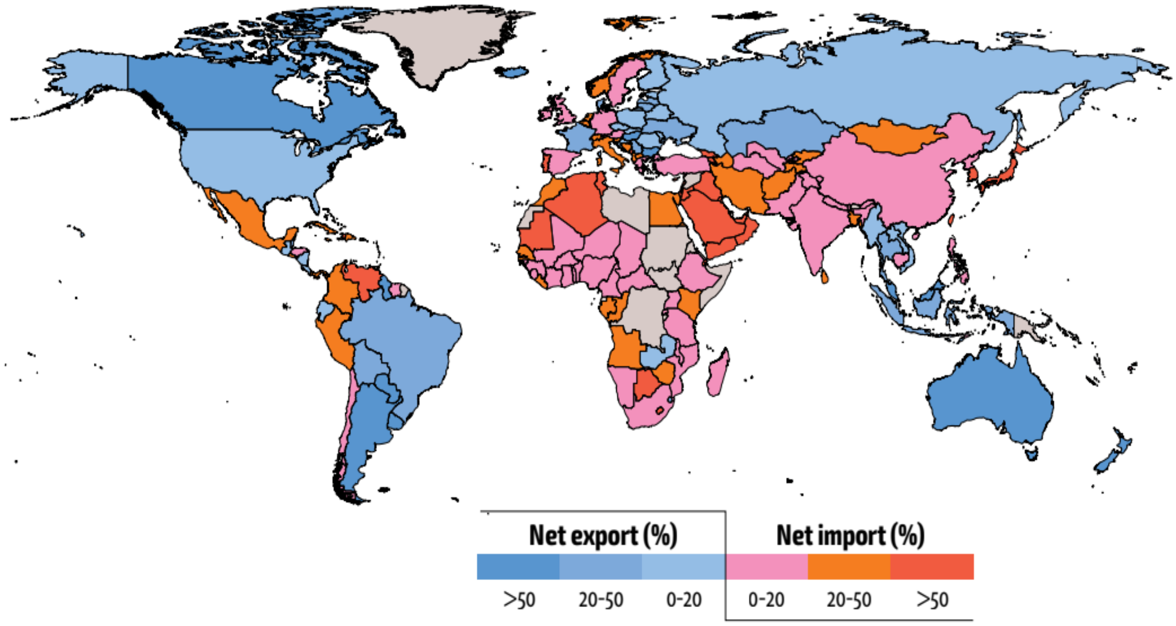

Figure 13.5: Percentage of net food imports in domestic food supply in total calories[13]

Aotearoa exports food and fibre to over 140 countries. The top ten countries by revenue are shown in Figure 13.6. China is the country's largest export destination, with dairy, meat and wool and forest products making up the majority of products sold.

[11] (United Nations, 2019)
[12] (FAO, 2017)
[13] (FAO, 2017, p. 29)

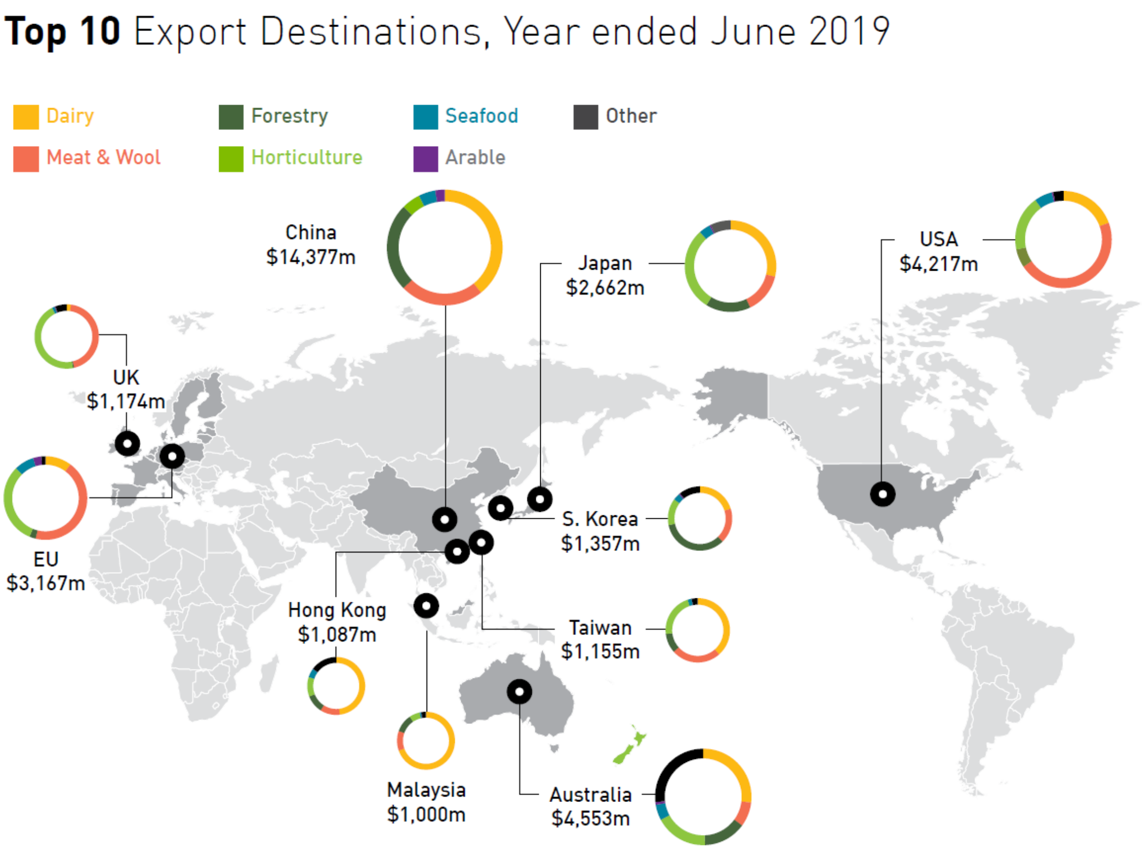

Figure 13.6: The top ten countries that Aotearoa exports primary produce to[14]

The bulk of global population growth is expected to occur in regions that are not currently major export destinations for Aotearoa, such as sub-Saharan Africa and South Asia. Most Aotearoa dairy and meat exports are targeted at middle-class and premium consumers in China, Europe and North America. However, in addition to global population growth, incomes in many developing countries are expected to rise and bring with it an expanded global middle class. Historic trends and population surveys show a clear relationship between increasing incomes and consumption of meat and dairy products, which may favour producers in Aotearoa.[15]

13.4.2 Demand for low-emissions agricultural production

Both globally and domestically, there are growing concerns about quality and environmental footprint of food. Food safety and quality is a fundamental expectation, and Aotearoa does well in this regard. We have well developed systems and processes to ensure the quality of the food that we consume domestically and export.

Rising consumer expectations regarding the climate impact of products could affect the context of the country's biogenic methane emissions reductions in several ways.

Firstly, it could lead to changes in demand for meat and dairy exports. On one hand, this could favour Aotearoa producers if consumers place a premium on lower-emissions varieties of the products they already consume. The country's meat and dairy products are already some of the least emissions intensive (emissions per unit of product) in the world,[16] and this efficiency has been

[14] (Ministry for Primary Industries, 2020, p. 5)
[15] (Godfray et al., 2018)
[16] (Parliamentary Commissioner for the Environment, 2019)

increasing over time. There has been an efficiency gain of approximately 33% for sheep meat, 30% for beef and 20% for dairy between 1990 and 2017 (see Figure 13.7).

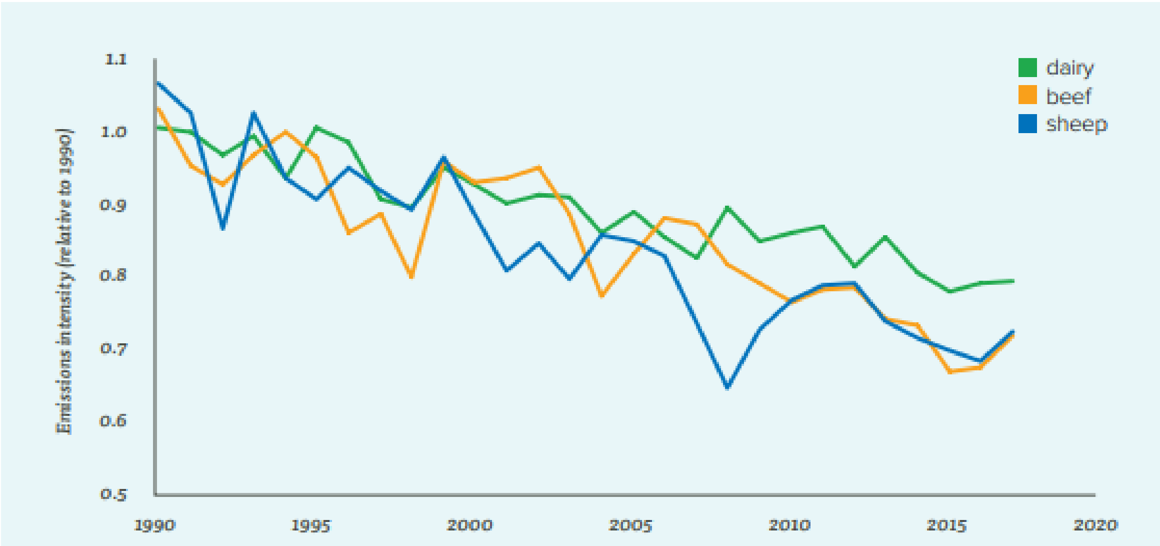

Figure 13.7: Emissions intensity (emissions per unit of product) 1990 to 2017[17]

Secondly, a shift in preferences towards low-emissions products could negatively impact Aotearoa exports if preferences move not to lower-emissions versions of meat and dairy products but away from these products entirely.

The production of some alternative protein products has been shown to have lower environmental impacts, including producing significantly less greenhouse gas emissions, than traditional ruminant-based dairy production.[18]

Alternative dairy products, based on plant ingredients such as soy, nuts and other plant products are a growing global market. The global market for dairy alternatives was valued at USD$15.5 billion in 2017 and expected to grow to USD$38.9 billion by 2025.[19] Global dairy company Danone has recently invested around USD$60 million in plant-based production to allow it to complete in the alternative dairy category.[20]

Similar, demand for other alternative protein sources is also growing. These sources include foods such as edible insects, plant and non-ruminant proteins, and cultured or synthetic proteins.

There has been significant growth in the availability of plant-based proteins over the last decade, including within Aotearoa – one domestic supermarket chain recorded a 36% increase in demand for plant-based protein between 2018 and 2019.[21] Globally, it has been estimated that plant-based meat replacements could make up 25% of global demand by 2040, compared to less than 10% in 2015.[22]

There is also growing interest in the production of cultured or synthetic proteins that are produced using biotechnical methods. They include culturing of animal tissue cells within laboratory conditions

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[17] (Interim Climate Change Committee, 2019, p. 27)
[18] For example, see (Poore & Nemecek, 2018)
[19] (Driver et al., 2019)
[20] (Driver et al., 2019)
[21] (Stuff, 2019)
[22] (A. T. Kearney, 2019)

to create alternatives to animal grown 'meat', and recombinant genetic technologies to produce milk or milk constituents, in place of milk from a cow or other ruminant. Fonterra has recently invested in a US-based food developer involved in alternative milk production to diversify its product portfolio.[23]

To date, no company has successfully brought a cultured meat or milk alternative to market, although there are more than 30 companies globally that are seeking to do so.[24] There are a range of reasons for this, including costs of production, uncertainties around acceptance by consumers, and a lack of regulatory systems to support commercialisation. Current estimates put the arrival of cultured meats on supermarket shelves at anywhere between 1-20 years.[25]

However, there is unlikely to be a global abandonment of animal-based proteins due to cultural and nutritional reasons. Animal-based food contain essential nutrients that are not always easily produced in certain environments. Vitamin B12, for example, is almost only found in animal products.

It is not possible to definitively say what the overall impact of these developments – both increasing demand for relatively low-emissions animal-based products that Aotearoa already produces, and for alternative sources of protein that do not come from ruminants – will be on production systems in Aotearoa. It is also not possible to say exactly what impact they may have on emissions of biogenic methane.

In light of this, both producers and government agencies have largely taken a 'watching brief' approach,[26] although as noted above, Fonterra has taken the more proactive step of investing in a US-based alternative milk company.

13.4.3 Other environmental challenges

Other environmental challenges are also related to the sources of biogenic methane emissions in Aoatearoa (waste and agriculture). These include freshwater quality, soil health, biodiversity loss and soil erosion. The growing pressure of these challenges combined with efforts to address them may have important consequences for efforts to reduce biogenic methane emissions.

Freshwater quality has been a particular focus of attention over the last few decades as large areas of sheep and beef farming and production forestry were converted to dairy. Although rates of nitrogen and phosphorus and pathogen loss into waterways varies with land management, rates of nutrient loss into waterways are generally higher from dairy operations than from sheep and beef farming and forestry.[27] In some parts of the country where there have been large-scale land conversions, such as Canterbury, Southland and the central North Island, indicators of water quality and ecological health have significantly declined.[28]

[23] (Fonterra, 2019)
[24] (Burton, 2019)
[25] (Driver et al., 2019)
[26] For example, The Treasury states *"While, artificial meats may not be in a position to significantly disrupt the market at present, they do pose a risk. This risk is not sufficiently certain in timing or magnitude to meaningfully incorporate into the Treasury's economic forecasts at this stage. However, it is a risk that the Treasury will continue to monitor."* (The Treasury, 2018)
[27] (Parliamentary Commissioner for the Environment, 2013)
[28] (Ministry for the Environment & Stats NZ, 2020)

Declining freshwater quality is a threat to many native species, this is also exacerbated by the clearance and conversion of native habitats – such as forests, wetlands and natural grasslands – often into pasture.[29]

Farmers and farmer groups have traditionally self-managed many of the environmental impacts of farming – either as a by-product of production-based activities, or through voluntary actions.

Over recent decades, farming industry bodies have also offered support to farmers in managing environmental impacts and have developed a range of voluntary schemes aimed at addressing environmental impacts. Most notably over the last few years, industry groups and agriculture companies have worked with the government to manage impacts on freshwater through the voluntary accord Sustainable Dairying: Water Accord.[30] The He Waka Eke Noa – Primary Sector Climate Action Partnership was established between the government and the primary sector in late 2019. The partnership aims *"to equip farmers and growers to reduce emissions, maintain or increase sequestration, and adapt to a changing climate."*[31]

Local and central government have also introduced a range of legislation and actions aimed at manging the environmental impacts of farming. Key among these has been the Resource Management Act 1991 (RMA), and more recently, the National Policy Statement for Freshwater Management and supporting National Environmental Standards.[32] The RMA has driven some key improvements in water quality – for example the removal or improvement of point-source discharges from dairy operations has resulted in significant reductions in phosphorus levels and improvements in water clarity in many areas.

The Government has also recently amended the National Policy Statement for Freshwater Management with the aim of strengthening environmental protection. The impact that the changes to the National Policy Statement for Freshwater Management are expected to have on greenhouse gas emissions are outlined in *Chapter 11: Where are we currently heading?*.

Waste management is also associated with other environmental challenges. While modern, engineered landfills mitigate some of the environmental impacts associated with their construction and management, they have wider ecological effects which may lead to landscape changes, loss of habitats and displacement of fauna. Waste leaching, particularly from older landfills, can also contaminate nearby soils and aquifers.[33] New landfills must be designed to prevent leaching and are subject to close compliance and environmental monitoring.

Overall, efforts to manage the environmental impacts of agriculture and waste can be expected to have largely positive impacts on biogenic methane emissions. Changes to agricultural management practices that help improve water quality impacts – such as modifying livestock feed or adjusting stocking rates – should also result in less methane emissions. Similarly, efforts to reduce the production of waste in the first place, or to divert waste away from landfills to composting or recycling, should also lead to reductions in biogenic methane emissions.

[29] (Ministry for the Environment & Stats NZ, 2020)
[30] (Dairy Environment Leadership Group (DELG), 2015)
[31] (He Waka Eke Noa, 2020)
[32] (New Zealand Government, 2020) and (Ministry for the Environment, 2020)
[33] A greater frequency of extreme weather events like storms and flooding as a result of climate change may also increase the risk that landfills are disturbed, resulting in the release of waste into the environment. Many old landfills are close to rivers or the coast (Parliamentary Commissioner for the Environment, 2008).

13.5 References

A. T. Kearney. (2019). *How Will Cultured Meat and Meat Alternatives Disrupt the Agricultural Food Industry?* https://www.kearney.com/documents/20152/2795757/How+Will+Cultured+Meat+and+Meat+Alternatives+Disrupt+the+Agricultural+and+Food+Industry.pdf/06ec385b-63a1-71d2-c081-51c07ab88ad1

Burton, R. J. F. (2019). The potential impact of synthetic animal protein on livestock production: The new "war against agriculture"? *Journal of Rural Studies*, *68*, 33–45. https://doi.org/10.1016/j.jrurstud.2019.03.002

Dairy Environment Leadership Group (DELG). (2015). *Sustainable Dairying: Water Accord*. https://www.dairynz.co.nz/media/3286407/sustainable-dairying-water-accord-2015.pdf

Driver, T., Saunders, C., Duff, S., & Saunders, J. (2019). *The Matrix of Drivers: 2019 Update* [Report for Our Land and Water National Science Challenge]. Agribusiness & Economics Research Unit (AERU), Lincoln University. https://ourlandandwater.nz/wp-content/uploads/2020/01/Matrix_OurLandandWaterScienceChallenge-TheMatrixofDrivers3-2019.pdf

FAO. (2017). *The future of food and agriculture: Trends and challenges* (p. 163). Food and Agriculture Organization of the United Nations (FAO).

Fonterra. (2019). *Fonterra to explore opportunities in complementary nutrition*. Fonterra. https://www.fonterra.com/nz/en/our-stories/media/fonterra-to-explore-opportunities-in-complementary-nutrition.html

Godfray, H. C. J., Aveyard, P., Garnett, T., Hall, J. W., Key, T. J., Lorimer, J., Pierrehumbert, R. T., Scarborough, P., Springmann, M., & Jebb, S. A. (2018). Meat consumption, health, and the environment. *Science*, *361*(6399). https://doi.org/10.1126/science.aam5324

He Waka Eke Noa. (2020). *He Waka Eke Noa Primary Sector Climate Action Partnership*. He Waka Eke Noa. https://hewakaekenoa.nz/

Interim Climate Change Committee. (2019). *Action on agricultural emissions: Evidence, analysis and recommendations*. https://www.iccc.mfe.govt.nz/what-we-do/agriculture/agriculture-inquiry-final-report/action-agricultural-emissions/

IPCC. (2018). *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. IPCC. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

Ministry for Primary Industries. (2020). *Situation and Outlook for Primary Industries, March 2020*. Ministry for Primary Industries. https://www.mpi.govt.nz/resources-and-forms/economic-intelligence/situation-and-outlook-for-primary-industries/sopi-reports/

Ministry for the Environment. (2016). *New Zealand's Report to facilitate the calculation of its emissions budget for the period 2013 to 2020* (p. 15). https://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/New%20Zealand%27s%20Initial%20Report%20July%202016.pdf

Ministry for the Environment. (2019a). *Kigali Amendment to the Montreal Protocol*. https://www.mfe.govt.nz/more/international-agreements-kigali-amendment

Ministry for the Environment. (2019b). *New Zealand's fourth biennial report under the United Nations Framework Convention on Climate Change*. Ministry for the Environment. https://www.mfe.govt.nz/publications/climate-change/new-zealands-fourth-biennial-report-under-united-nations-framework

Ministry for the Environment. (2020). *National Environmental Standards for Freshwater*. https://www.mfe.govt.nz/fresh-water/freshwater-acts-and-regulations/national-environmental-standards-freshwater

Ministry for the Environment, & Stats NZ. (2020). *New Zealand's Environmental Reporting Series: Our freshwater 2020* (p. 90). Ministry for the Environment & Stats NZ. https://www.mfe.govt.nz/publications/environmental-reporting/our-freshwater-2020

New Zealand Government. (2020). *National Policy Statement for Freshwater Management 2020*. https://www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2020

Parliamentary Commissioner for the Environment. (2008). *Levin landfill: Environmental management review* (p. 28). Parliamentary Commissioner for the Environment. https://www.pce.parliament.nz/publications/archive/2007-2010/levin-landfill-environmental-management-review

Parliamentary Commissioner for the Environment. (2013). *Water quality in New Zealand: Land use and nutrient polution* (p. 82). Parliamentary Commissioner for the Environment. https://www.pce.parliament.nz/media/1275/pce-water-quality-land-use-web-amended.pdf

Parliamentary Commissioner for the Environment. (2019). *Farms, forests and fossil fuels: The next great landscape transformation?* Parliamentary Commissioner for the Environment. https://www.pce.parliament.nz/media/196523/report-farms-forests-and-fossil-fuels.pdf

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, *360*(6392), 987–992. https://doi.org/10.1126/science.aaq0216

Stuff. (2019). *Supermarket shoppers hunt down plant-based proteins*. Stuff. https://www.stuff.co.nz/business/farming/116565410/supermarket-shoppers-hunt-down-plantbased-proteins

The Treasury. (2018). *Monthly Economic Indicators August 2018*. Special Topic: Alternative Proteins, Artificial Meats and the Implications for New Zealand's Agricultural Sector. https://www.treasury.govt.nz/publications/mei/monthly-economic-indicators-august-2018-html

UNFCCC Secretariat. (2010). *Issues relating to the transformation of pledges for emission reductions into quantified emission limitation and reduction objectives: Methodology and examples. Revised technical paper*. *FCCC/TP/2010/3/Rev.1*, 22. https://unfccc.int/documents/6283

United Nations. (2019). *World Population Prospects 2019: Highlights* (ST/ESA/SER.A/423; p. 46). Department of Economic and Social Affairs, Population Division. https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf