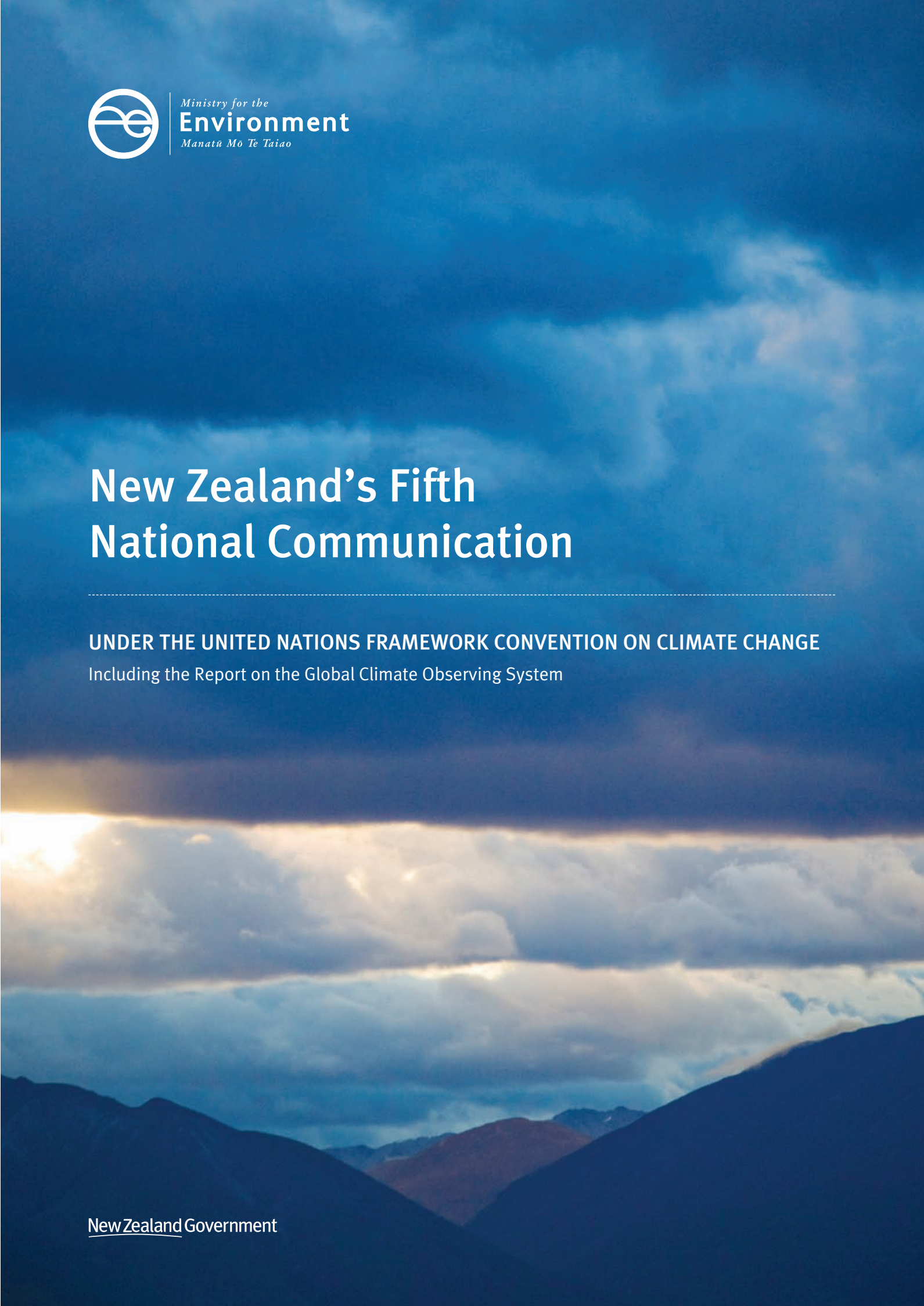

Ministry for the Environment
Manatū Mō Te Taiao

# New Zealand's Fifth National Communication

## UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Including the Report on the Global Climate Observing System

New Zealand Government

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# Foreword

The New Zealand Government is committed to doing its fair share in combating climate change and reducing New Zealand's greenhouse gas emissions. Tackling climate change is the Government's number one environmental priority.

New Zealand's emissions profile is unique for a developed country with half our greenhouse gas emissions coming from agriculture, one of the highest proportions of renewable energy in the world, and a dispersed population with limited viability of public transport. Added to this, we have extensive plantation forestry with 600,000 hectares planted in the 1990s that is due to be harvested in the 2020s. It will be a difficult challenge to reduce our emissions.

Taking into account these factors, and that to date New Zealand's track record has seen a 22 per cent growth of gross emissions above 1990 levels, the Government has announced an ambitious target to cut New Zealand's emissions by 10 to 20 per cent below 1990 levels by 2020. In setting our 2020 target the Government has balanced New Zealand's economic opportunities with its environmental responsibilities and made a commitment to securing a global agreement to limit temperature increases to two degrees.

New Zealand remains committed to exploring innovative, technological solutions to reduce greenhouse gas emissions. Our biggest challenge is agriculture and that is why we are ramping up our investment in research to find practical technologies that would reduce methane and nitrous oxide emissions on farms. New Zealand's biggest contribution to reducing dangerous climate change will be its continued development of the global alliance on agricultural greenhouse gas mitigation research and we welcome international partners in this initiative.

New Zealand is also taking an important first step in doing our fair share on climate change in introducing a modified emissions trading scheme (ETS) in July next year. The New Zealand ETS is the first of any country outside of Europe and will be the most comprehensive by including transport, industrial and energy emissions.

New Zealand is also the first country in the world to include forestry and will be the first country in the world to include agriculture. The gradual phase-in is about providing support and limiting the costs for households and business as New Zealand pulls out of recession. We do not want to reduce emissions in New Zealand only to have increased emissions elsewhere. The incentives from the ETS must be to invest in new technology and not to just move production offshore. The ETS is balanced and responsible and the right path to a low carbon future.

New Zealand's climate change policy is not just an ETS. It is complemented by many Government programmes to insulate homes, convert to clean heating, subsidise solar water heating, invest in public transport, facilitate the building of renewable power stations and encourage use of electric cars.

We also remain committed to ensuring New Zealand is prepared to adapt to changes in the climate that are already happening. Adaptation is crucial to the health and well-being of people around the world. New Zealand's Pacific Island neighbours are particularly vulnerable to the effects of climate change and we are committed to working with them to help mitigate the effects of a changing climate.

This *Fifth National Communication* reflects the fact that New Zealand's climate change policy is well placed for New Zealand to play a constructive role in securing an international agreement.

The Honourable Dr Nick Smith
Minister for Climate Change Issues

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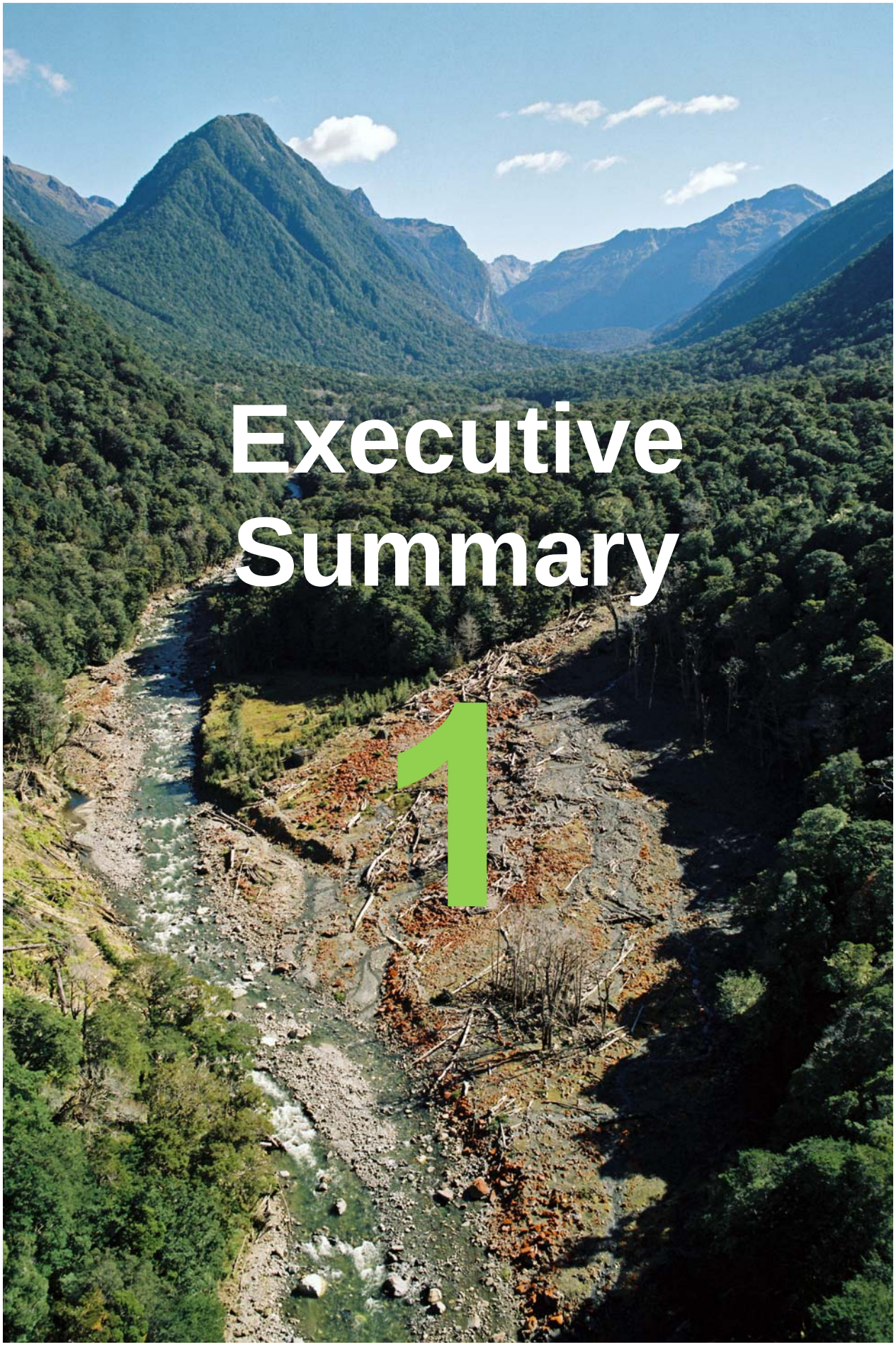


# Executive Summary

# 1

# 1 Executive summary

## 1.1 Introduction

The New Zealand Government is committed to playing its part in the global response to climate change. This *Fifth National Communication* provides a snapshot of New Zealand's progress with implementing the United Nations Framework Convention on Climate Change (UNFCCC or the Convention). It covers the period from the submission of the *Fourth National Communication* in 2006 through to the end of December 2009. This document also contains New Zealand's *Report on the Global Climate Observing System*.

## 1.2 National circumstances

New Zealand consists of two large islands and a number of smaller islands located in the southwest Pacific Ocean between 33° and 55° south latitude. The land area is approximately 27 million hectares, making it similar in size to Japan or the United Kingdom. The land cover is dominated by forest and pastoral land with indigenous forests occupying 6.3 million hectares, planted forest 1.8 million hectares and pastoral land 9 million hectares. Five million hectares of land are protected in parks and reserves.

New Zealand's population in the 2006 census was 4.2 million people. The estimated resident population in December 2009 was 4.3 million people.[1] Population growth between 1990 and 2007 was 25 per cent, the second highest of Annex 1 countries.

New Zealand's government is a parliamentary democracy with an elected House of Representatives. Representation is through a single-house, mixed-member proportional system (MMP). The principal functions of Parliament are to enact laws, scrutinise the Government's administration, and approve the Government's allocation of tax income. New Zealand has 85 local authorities that provide government for local and regional interests.

The New Zealand economy has sizeable manufacturing and services sectors complementing a highly efficient export-oriented agricultural sector. The primary sector contributes 7 per cent of New Zealand's gross domestic product. Energy-based industries (including dairy processing, and cement and steel manufacturing), forestry, mining, horticulture and tourism have expanded rapidly over the past two decades.

New Zealand's greenhouse gas emissions profile is different from that of many other countries in that nearly 50 per cent of its greenhouse gas emissions are from agriculture. Reducing greenhouse gas emissions in agriculture is a challenge, because many agricultural activities have a direct relationship between output and greenhouse gas emissions. New Zealand scientists are undertaking world-leading research to develop technologies and management practices that reduce methane emissions from ruminant livestock; however, identifying solutions that achieve reductions in a safe manner, meet all regulatory requirements and are adopted by industry remains a significant challenge.

[1] http://www.statistics.govt.nz/methods_and_services/information-releases/national-population-estimates.aspx

New Zealand has notably low emissions from thermal electricity production compared to other countries. In the year to June 2009 renewable energy from hydro-electric, geothermal and biomass sources, and combined heat and power generation comprised 71 per cent of New Zealand's electricity supply. Around 79 per cent of renewable generation is hydro-electric with limited storage potential which makes it susceptible to dry periods. Recent increases in geothermal and wind generation capacity have resulted in geothermal generation increasing to nearly 11 per cent of total generation for the year to June 2009 and wind generation contributing nearly 3 per cent.[2]

# 1.3 Greenhouse gas inventory

The Climate Change Response Act 2002 (updated 26 September 2008) was enacted to enable New Zealand to meet its international obligations under the Convention and the Kyoto Protocol. A prime ministerial directive for the administration of the Climate Change Response Act names the Ministry for the Environment as New Zealand's "inventory agency".

The Ministry for the Environment is responsible for the overall development, compilation and submission of the inventory to the Convention secretariat. The inventory is compiled using data and expertise from the Ministry of Economic Development, the Ministry of Agriculture and Forestry, the Ministry for the Environment, and Statistics New Zealand. Methods and emission factors relating to agriculture are underpinned by the research and modelling of researchers at New Zealand's Crown research institutes and universities.

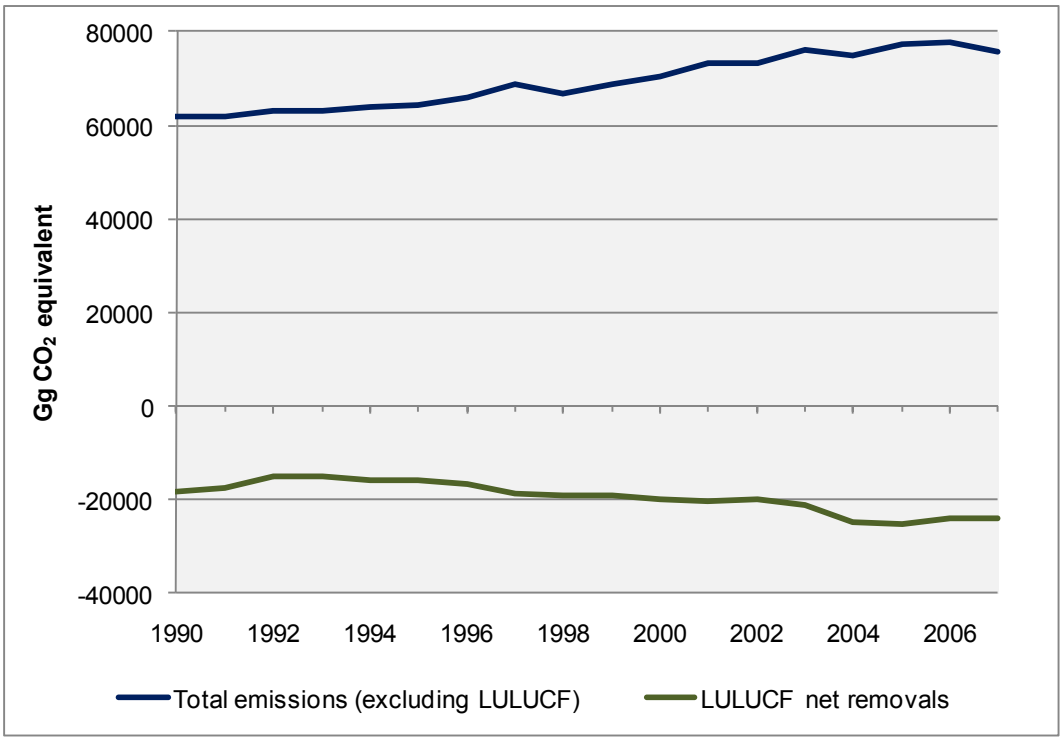
## National overview

In April 2009, New Zealand submitted its national greenhouse gas inventory for 1990 through 2007. In 1990, New Zealand's total greenhouse gas emissions were 61,852.8 gigagrams of carbon dioxide equivalent (Gg $CO_2$-e). By 2007, total greenhouse gas emissions had increased by 13,697.4 Gg $CO_2$-e (22 per cent) to 75,550.2 Gg $CO_2$-e. Between 1990 and 2007 the average annual growth in total emissions was 1.3 per cent per year (see figure 1.1).

Net removals from the Land use, Land-use Change and Forestry (LULUCF) sector increased from 18,138.5 Gg $CO_2$-e in 1990 to 23,836.0 Gg $CO_2$-e in 2007. The 2009 inventory submission included a provisional estimate of 10,000 hectares of deforestation in 2007. Updated information indicates the area of deforestation in 2007 was in the range of 15,000 to 20,000 hectares. A provisional calculation using the updated information indicates that LULUCF net removals are therefore in the vicinity of 19,000 to 21,000 Gg $CO_2$-e. The recalculation for the updated area will be included in New Zealand's inventory submission in 2010.

[2] *New Zealand Energy Quarterly:* June Quarter 2009. http://www.med.govt.nz/templates/ContentTopicSummary____32570.aspx

**Figure 1.1: New Zealand's total greenhouse gas emissions and net removals, 1990–2007**




## Emissions by sector

The agricultural sector is the largest source of emissions, contributing 36,430.0 Gg $CO_2$-e (48 per cent) of total emissions in 2007. New Zealand's agricultural emissions have increased by 3918.9 Gg $CO_2$-e (12 per cent) from the 1990 level of 32,511.1 Gg $CO_2$-e. The agricultural sector contributed 96 per cent of New Zealand's total nitrous oxide emissions and 91 per cent of total methane emissions in 2007.

The energy sector contributed 32,653.1 Gg $CO_2$-e (43 per cent) of total emissions in 2007, an increase of 9200.3 Gg $CO_2$-e (39 per cent) from the 1990 level of 23,452.8 Gg $CO_2$-e. This growth in emissions was primarily from electricity generation and heat production (91 per cent increase), and road transport (76 per cent increase).

The industrial processes sector accounted for 4601.9 Gg $CO_2$-e (6 per cent) of total emissions in 2007, an increase of 1192.7 Gg (35 per cent) from the 1990 level of 3409.2 Gg $CO_2$-e. This increase was mainly due to growth in emissions from metal production and to the consumption of hydrofluorocarbons. In 2007, the solvent and other product use sector contributed 43.4 Gg $CO_2$-e (less than 1 per cent) of New Zealand's total emissions.

The waste sector accounted for 1821.8 Gg $CO_2$-e (2 per cent) of total emissions in 2007, a decrease of 616.4 Gg (25 per cent) from the 1990 level of 2438.2 Gg $CO_2$-e. This decrease was the result of initiatives to improve solid waste management practices in New Zealand.

In the LULUCF sector, net removals were estimated at 23,836.0 Gg $CO_2$-e in 2007, an increase of 5697.5 Gg $CO_2$-e (31 per cent) from the 1990 level of 18,138.5 Gg $CO_2$-e. LULUCF removals fluctuate with the routine planting and harvesting of New Zealand's planted forest.

## 1.4 Policies and measures

New Zealand initiated its response to climate change in 1988 with the establishment of the New Zealand Climate Change Programme, coordinated by the Ministry for the Environment. The programme has steadily evolved and now spans several government departments and agencies. A group comprised of government chief executives (the Natural Resources Sector Group) provides governance for the coordination of policy on environmental issues, including climate change. The history of New Zealand's climate change response until 2006 is documented in *New Zealand's Fourth National Communication*.[3]

The Government has recently undertaken a comprehensive review of climate change policies, in particular the New Zealand Emissions Trading Scheme (NZ ETS). The aim of the review was to ensure New Zealand's response to climate change is appropriate given New Zealand's national circumstances. The Government also announced emissions reduction targets for 2020 and 2050.

### Key targets

The Government has set two national targets for reducing New Zealand's greenhouse gas emissions.

- A medium-term responsibility target of a 10 to 20 per cent reduction in emissions below 1990 levels by 2020.
- A long-term target of a 50 per cent reduction in net greenhouse gases from 1990 levels by 2050.

The medium-term target range reflects a fair contribution by New Zealand to the international effort to reduce greenhouse gas emissions. This is because New Zealand's national circumstances (including already high levels of renewable electricity generation and a large proportion of emissions from agriculture) make the cost of mitigation higher than for most other developed countries. The decision on the target range was made after considering efforts pledged by other Annex 1 countries, environmental, social and economic factors, international relations aspects, and the results of public consultation.

A 'responsibility target' means it is expected New Zealand will meet its target through a mixture of domestic emission reductions, the storage of carbon in forests, and the purchase of emission reduction units in other countries. The 2020 target is conditional on the level of global ambition agreed to at international negotiations and on international rules relating to land use, land-use change and forestry, and recourse to carbon markets for compliance.

### The New Zealand Emissions Trading Scheme

The Government's principal policy response to climate change is the NZ ETS. Legislation implementing the NZ ETS was passed in September 2008, and the first sector (forestry) entered the scheme retrospectively on 1 January 2008. In November 2009, the Government passed legislation modifying the NZ ETS. The purpose of the modifications was to ease the effect of the scheme on the economy, particularly in the transition period as the scheme takes effect. Under the scheme, participants (aside from forestry) will have to surrender one emission unit to the Government for every two tonnes of greenhouse gas they emit until 2013. This obligation will rise to one emission unit for each one tonne of emissions from 2013. By 2015, the NZ ETS

[3] *New Zealand's Fourth National Communication under the United Nations Framework Convention on Climate Change* is available at http://www.mfe.govt.nz/publications/climate/national-communication-2006/index.html.

will cover all sectors and all gases. Trade-exposed industries will receive an allocation of free emission units that will phase down over time. The NZ ETS will be reviewed every five years, with the first review to be carried out in 2011.

## Energy policies and measures

The Government's policy direction and priorities on energy will be described in the New Zealand Energy Strategy. The Strategy is being updated in 2009 and 2010. The Government has a target that 90 per cent of electricity will be generated from renewable sources by 2025. Energy efficiency is also a priority, and the New Zealand Energy Efficiency and Conservation Strategy sits under the New Zealand Energy Strategy. The Energy Efficiency and Conservation Strategy provides more detail on measures to increase the uptake of energy efficiency, energy conservation and renewable energy programmes across the economy. The Energy Efficiency and Conservation Strategy is also being updated during 2009 and 2010.

## Transport policies and measures

The New Zealand Transport Strategy outlines the Government's vision for the transport system to 2040, along with the strategic approach taken to achieve this vision. This strategy also provides a framework for the transport activities of Crown entities and guidance for local authorities.

The Government's primary policy to mitigate greenhouse gas emissions from the transport sector is to include liquid fossil fuels in the NZ ETS. Liquid fossil fuels will enter the NZ ETS on 1 July 2010. Other transitional incentives and research are underway to complement the scheme in the areas of new fuels and technology, improved efficiency of commercial fleets and encouraging forms of transport that are less carbon intensive. The Ministry of Transport is responsible for the development of transport policy in New Zealand.

## Industry policies and measures

Industrial processes will enter the NZ ETS in July 2010 and will be required to surrender one emission unit for every two tonnes of $CO_2$ equivalent emissions until 2013. From 2013, the sector will be required to surrender one unit for each tonne of emissions. The synthetic gases perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride will be included in the scheme from 2013.

## Agriculture policies and measures

At present there are limited methods for reducing nitrous oxide emissions from agricultural pastures, and no practical methods for mitigating methane from enteric fermentation in ruminants grazed on pastures. To help address New Zealand's emissions from these sources, the Government is establishing a domestic Centre for Agricultural Greenhouse Gas Research. This builds on existing efforts through the Pastoral Greenhouse Gas Research Consortium and the Sustainable Land Management and Climate Change Plan of Action. Funding will be provided through the Primary Growth Partnership.

In September 2009, the New Zealand Prime Minister announced a proposal to establish a Global Alliance on agricultural greenhouse gas mitigation research. The initiative would bring interested countries together to drive greater international cooperation, collaboration and investment in this area of research. In this way, the Global Alliance aims to help reduce emissions from agricultural production and improve its potential for soil carbon sequestration, while safeguarding food security.

### Forestry policies and measures

The NZ ETS is the main policy instrument to encourage afforestation and reduce deforestation. In addition to the NZ ETS, New Zealand has three major schemes that promote afforestation and provide incentives to maintain forests: the East Coast Forestry Project, the Afforestation Grant Scheme, and the Permanent Forest Sinks Initiative.

In 2007, New Zealand had 1.8 million hectares of plantation forest and 8.2 million hectares of native forest. Commercial timber harvested from private native forest was restricted to that sourced under sustainable forest management plans and permits by a 1993 amendment to the Forests Act 1949. Only a few areas were exempt from the Act. Amendments in March 2002 resulted in the cessation of any logging of native forest on public land. Less than 0.1 per cent of New Zealand's total forest production is now harvested from native forests. The Ministry of Agriculture and Forestry (MAF) is responsible for developing forestry-related policy.

### Waste policies and measures

The New Zealand Waste Strategy (2002) set in place a framework for minimising and managing waste, and included targets for reducing waste. The major piece of legislation that governs waste management in New Zealand is the Waste Minimisation Act 2008. The Ministry for the Environment is responsible for developing waste policy in New Zealand alongside local and regional councils.

## 1.5 Projections and the total effect of policies and measures

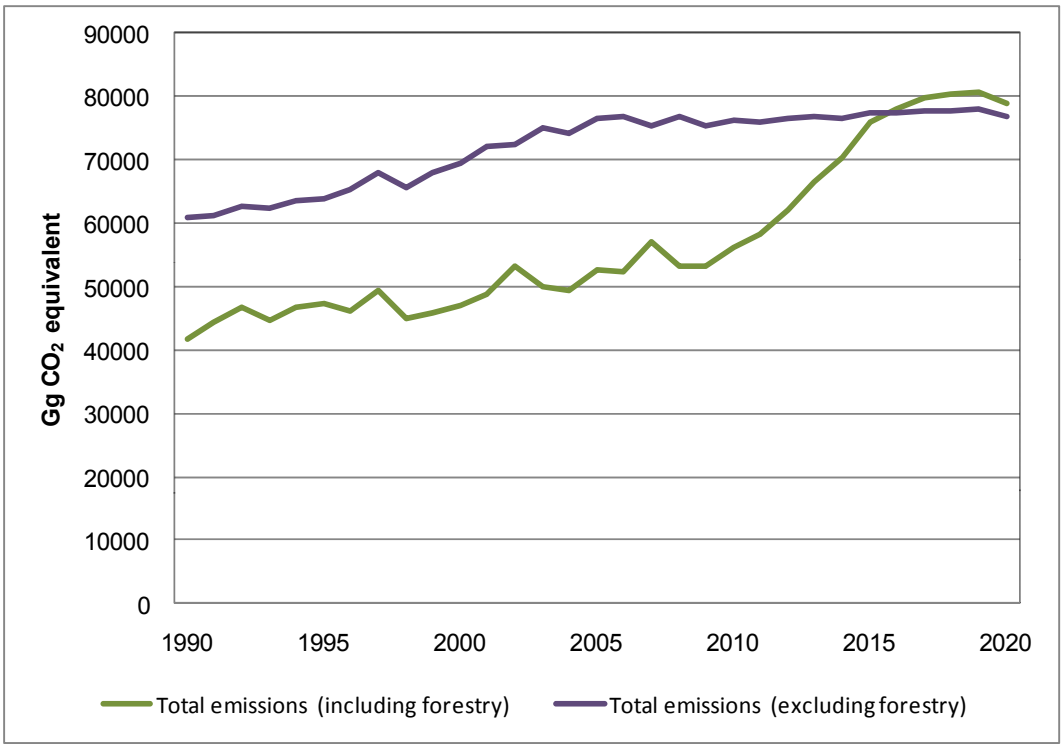
Under a "with measures" scenario, New Zealand's total emissions (excluding net removals from the forestry sector) are projected to rise to 76,085.3 Gg $CO_2$-e equivalent by 2010 and 76,895.7 Gg $CO_2$-e by 2020. These projections equate to an increase in emissions from 1990 of 15,178.5 Gg $CO_2$-e (25 per cent) in 2010 and 15,988.9 Gg $CO_2$-e (26 per cent) in 2020.

New Zealand's net emissions (including removals from the forestry sector) are projected to rise to 78,822.6 Gg $CO_2$-e by 2020 (90 per cent above net emissions in 1990). In 2010, net removals from forestry are projected to be approximately 20,084.0 Gg of $CO_2$-e. However, by 2020 forestry is expected to become a net source of emissions as relatively large areas of production forests planted in the 1990s are harvested (see figure 1.2). Net emissions from forestry in 2020 are projected to be 1,926.9 Gg of $CO_2$-e.

Projections of emissions and removals are inherently uncertain. Economic variables such as commodity and oil prices, the assumed carbon price, the assumed rate of afforestation and deforestation, and the harvest age of forests have significant effects on projected emissions and removals. For example, the "with measures" projection assumes a carbon price of NZ$25/tonne $CO_2$-e, rising to $50/tonne from 2013, and afforestation increasing from 3500 hectares in 2009, to 30,000 hectares of planting by 2020. If the carbon price rose to NZ$100/tonne $CO_2$-e, and afforestation increased to 50,000 hectares of planting per year, New Zealand's total net emissions are projected to be 68,471.0 Gg $CO_2$-e in 2020 (64 per cent above net emissions in 1990).

New Zealand produces an annual projection of progress towards meeting its commitment under Article 3.1 of the Kyoto Protocol. This projection report is available at http://www.mfe.govt.nz/publications/climate/net-position-report-2009/index.html. The latest report produced in April 2009, projected that New Zealand will have a surplus of 9.6 million units over the first commitment period of the Kyoto Protocol.

**Figure 1.2: New Zealand's actual and projected total greenhouse gas emissions, "with measures", 1990–2007**




Projections of emissions "without measures" show the effect of New Zealand's policies and measures. Total emissions (excluding forestry) "without measures" are projected to be 85,828.9 Gg $CO_2$-e in 2020, 11.6 per cent higher (8,933.3 Gg) than projected emissions "with measures" (figure 1.3) Total emissions including forestry "without measures" are projected to be 91,137.5 Gg $CO_2$-e in 2020, 15.6 per cent higher (12,314.9 Gg) than projected emissions "with measures" (figure 1.4).

**Figure 1.3: Actual and projected total emissions, with measures versus without measures, 1990–2020**

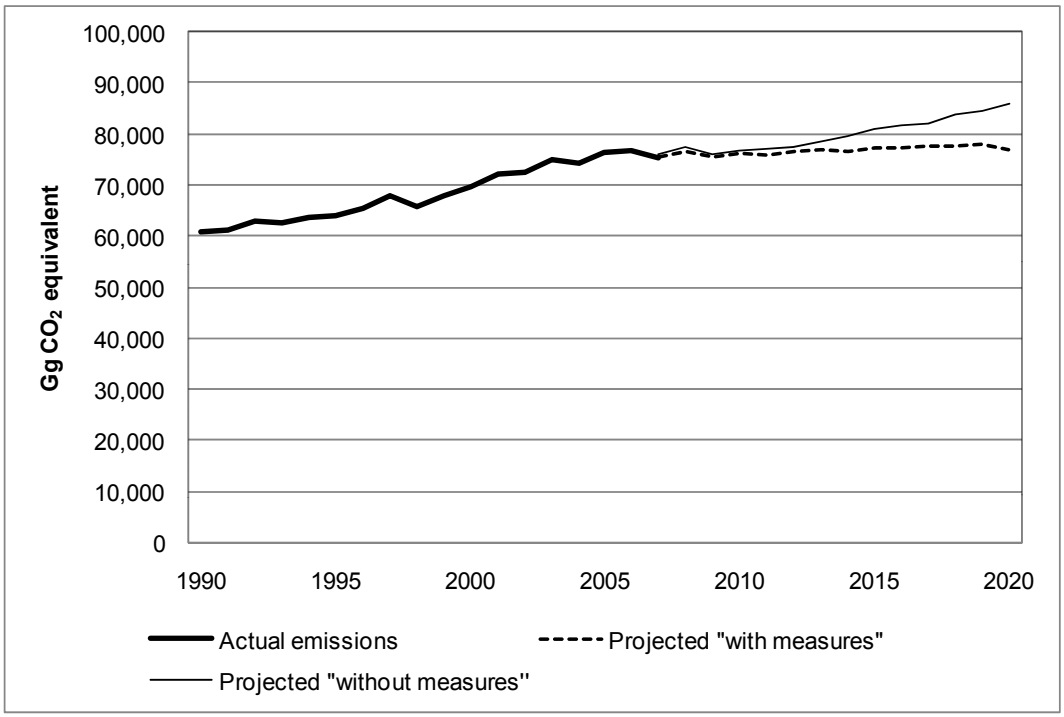
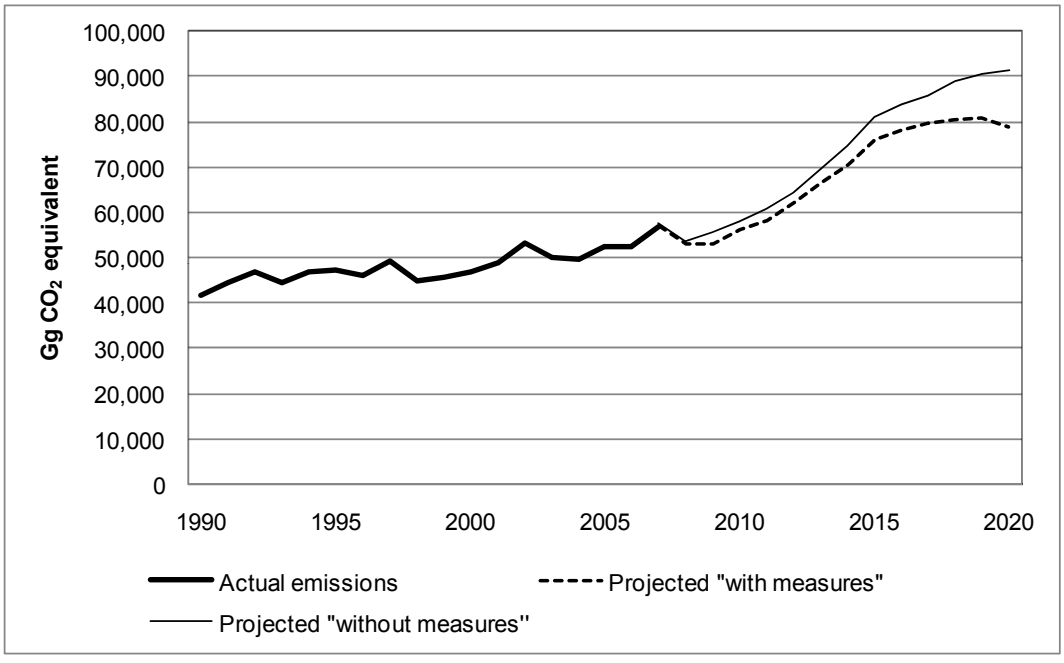



**Figure 1.4: Actual and projected net emissions, with measures versus without measures, 1990–2020**




Emissions from the energy sector (excluding transport) are projected to rise to 15,946.2 Gg $CO_2$-e by 2020, 6.4 per cent higher than 1990 levels. Emissions from thermal electricity generation are expected to remain relatively constant until 2015, as all new generation is expected to be from geothermal and wind. These renewable forms of generation are considered

to be the most economical, with a carbon price expected in the range of NZ$25 to NZ$50 per tonne of $CO_2$-e over the medium term.

Emissions from the transport sector are projected to rise to 15,583.6 Gg $CO_2$-e (78 per cent above 1990 levels) by 2020. Road transport accounts for 91 per cent of New Zealand's transport emissions, and over 95 per cent of the growth in transport emissions between 1990 and 2007. Transport emissions grew rapidly until 2005 but have slowed since 2006 due to higher crude oil prices and an economic recession in world economies. From 2010, emissions from transport are projected to resume growing, reflecting a recovery in the New Zealand economy.

Emissions from the industrial processes and solvents sectors are projected to rise to 4,572.2 Gg $CO_2$-e by 2020, 32 per cent above 1990 levels. Industrial process $CO_2$ emissions in New Zealand are derived from the manufacture of iron and steel, aluminium, urea, cement, lime and hydrogen. The level of output from these industries is expected to remain steady between 2007 and 2020.

Emissions from the agricultural sector are projected to rise to 39,072.4 Gg $CO_2$-e in 2020, 25 per cent higher than 1990 levels. Agricultural emissions decreased in 2007 due to a New Zealand-wide drought over 2007/08 and falling global dairy prices. However, emissions are expected to increase as the New Zealand and world economies recover.

Emissions from the waste sector are projected to fall to 1,721.3 Gg CO2-e, 29 per cent below 1990 levels by 2020. This reduction is mainly due to the increasing capture and destruction of landfill gas (methane).

## 1.6 Vulnerability assessment, climate change impacts and adaptation measures

### Observed and projected changes in climate

A low population density, a long coastline, varied geomorphology and an economy reliant on the primary production sector make New Zealand particularly vulnerable to climate related risks. Climate change is expected to exacerbate these risks. Information on climate variability and observed changes in the New Zealand climate is contained in the document *Climate Change Effects and Impacts Assessment: A Guide for Local Government in New Zealand.* The key findings are:

- in recent decades, the climate has become warmer, even though cooler southerly airflows have dominated. Average temperatures have increased by 0.9$^{o}$C since 1908
- the number of frost days has decreased at many sites, although some sites have seen increases or no change
- extreme 24-hour duration rainfall events increased in the west of the country and decreased in the north and east between 1930 and 2004
- an increase in heavy rainfall has been observed in western parts of the North and South Islands, while decreases have been observed in eastern regions. This is most likely to be the result of natural decadal variability, although a contribution from climate change cannot be excluded
- several recent studies have found increases in the number of Southern Hemisphere extra-tropical cyclones of about 50 per cent over the period 1979 to 1999
- sea level rose at an average of 1.6 millimetres per year during the 20th century.

New Zealand temperatures are expected to be on average 1°C warmer by the period 2030–2049 (referred to as 2040) and 2°C warmer by the period 2080–2099 (referred to as 2090), relative to 1980–1999 (referred to as 1990). The projected average annual rainfall shows a pattern of increases in the west of up to 5 per cent by 2040 and 10 per cent by 2090, and decreases in the east and north exceeding 5 per cent in places by 2090. Updated projections of changes in seasonal mean rainfall show a different and more marked seasonality than in previous projections.

## Adaptation

New Zealand's approach to adaptation policy consists of legislation, guidance material on impacts assessment, case studies, and underpinning information material. Planning to reduce the adverse effects of natural hazards is particularly important at the local government level. Legislation including the Resource Management Act 1991, Civil Defence Emergency Management Act 2002 and the Local Government Act 2002 establish and support the responsibilities of local authorities for avoiding, minimising, and mitigating the costs and effects of natural hazards and managing natural resources.

The Ministry for the Environment has produced technical manuals and summary reports to help people plan for the effects of climate change:

- *Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand* (2nd edition, May 2008) was produced for New Zealand's local government and updates the 2004 edition to include the findings of the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report. *Preparing for Climate Change* (July 2008) is the accompanying summary publication
- *Coastal Hazards and Climate Change* (July 2008) is a technical guidance manual that provides information on planning for climate change in the coastal margins. This report also includes information from the IPCC's Fourth Assessment Report. *Preparing for Coastal Change* (March 2009) is the accompanying summary publication.

The Ministry of Agriculture and Forestry is working with land-based sectors, local government, and Māori to ensure land-based sectors are resilient to climate change. Increasing awareness of climate change among land managers is a priority. Other key priorities are understanding the impacts of climate change on production systems and developing tools for land managers to use to respond to climate risks.

Current research includes the impacts of climate change on pasture, extreme wind, fire, drought and groundwater systems. Work is also underway on sub-tropical boundaries and pest impacts on forests. A series of fact sheets and case studies has been produced. The Ministry of Agriculture and Forestry's adaptation work is supported by research and technology transfer work, as well as actions taken by sectors and land managers.

Other key government workstreams include work in the health, fisheries, biodiversity and transport sectors. Much of the focus in these areas is understanding the potential impacts of climate change. Local government is also an active participant with impacts assessments completed in some areas.

## 1.7 Financial resources and technology transfer

New Zealand is committed to supporting developing country parties to meet the dual challenges of reducing emissions and adapting to the impacts of climate change. New Zealand is addressing these challenges by delivering new and additional financial resources through a range of channels, primarily to its partner countries in the Pacific, but also to countries in Asia, Africa and Latin America.

In 2001, New Zealand joined the European Union, Canada, Norway, Switzerland and Iceland in a voluntary commitment to increase financial assistance to developing countries to support climate change action. Between 2005 and 2008, New Zealand's share of this voluntary commitment has been NZ$5 million per year. This comprises four main components:

- the proportion of funds from New Zealand's total annual contribution to the Global Environment Facility that is likely to be spent on climate change projects, which is estimated at 32 per cent of total expenditure between 1991 and 2008.
- contributions to a range of multilateral organisations and programmes, including special funds under the United Nations Framework Convention on Climate Change
- support for climate change-related assistance administered by the New Zealand Agency for International Development
- funding for specific projects administered through the New Zealand Ministry for the Environment.

New Zealand continues to support a number of UN development agencies and other international financial institutions and programmes, including those with specific programmes related to the implementation of the Convention. In recognition of the importance of developing countries participating at Convention meetings, New Zealand has made an annual contribution to the UNFCCC Trust Fund for Participation.

New Zealand, through the New Zealand Agency for International Development (NZAID), is a major funder of a number of Pacific regional organisations with mandates to provide Pacific Island countries with technical and policy assistance in a number of sectors, including those affected by climate change.

New Zealand supports climate change adaptation work that is primarily designed to reduce the vulnerability of communities – particularly those in the Pacific – to longer term environmental change and weather-related impacts, and to improve the resilience of key climate-sensitive sectors. National and community-level actions are delivered within the context of national and regional plans, strategies and frameworks, which New Zealand helps to shape and deliver in cooperation with its development partners.

New Zealand considers the creation of "enabling environments" as important for research and development activities, and for the commercial deployment of current, new and innovative technologies. Cooperation with host parties is important in terms of increasing the size of investments and increasing the speed of development and deployment of new technologies.

Two examples of New Zealand's support for technology transfer initiatives include:

- a new microfinance project in the Solomon Islands and Kiribati that has successfully implemented a solar lighting finance scheme. The project (funded jointly by New Zealand and the United Kingdom), enables rural communities to trade crops for access to electricity

- New Zealand established the Livestock Emissions Abatement Research Network (LEARN) in 2007. LEARN is an international research network focused on improving the understanding of greenhouse gas emissions from livestock.

## 1.8 Research and systematic observations

New Zealand has continued to promote and collaborate in research and systematic observations on climate change, as required by Articles 4 and 5 of the Convention. Central government expenditure on climate change-related research for the 2007/08 financial year is estimated at approximately NZ$55 million, an increase of around NZ$23 million over the amount reported in the Fourth National Communication. This expenditure was complemented by expenditure by regional governments and the private sector.

New Zealand continues to contribute actively to the work of the IPCC. New Zealand supports a representative on the IPCC Bureau and the Bureau of the Task Force on National Greenhouse Gas Inventories as well as participating in task groups, workshops, expert meetings and contributing to the IPCC's Assessment reports.

New Zealand research groups have participated in international research and observation programmes of the World Meteorological Organization; the World Climate Research Programme; the Global Climate Observing System (GCOS) and its Pacific component (PI-GCOS); the International Geosphere-Biosphere Programme; and the Asia-Pacific Network for Global Change Research. The Meteorological Service of New Zealand has provided some assistance to a number of Pacific Island nations with their weather and climate observing systems.

Overall responsibility for climate change research strategy rests with the Ministry for the Environment. The Ministry works with other government departments involved in climate change policies and strategic policy development, and liaises closely with New Zealand scientists and science organisations to monitor and review the adequacy of the climate change research portfolio to meet national needs. Additional input to strategic research directions comes from the Royal Society of New Zealand's Climate Committee.

The Government's Foundation for Research, Science and Technology is the dominant channel for central government funding of strategic research and has the main responsibility for funding climate change research from public investment. Domestically, the Ministry for the Environment disseminates most research findings on climate change, mitigation options and adaptation processes and methodologies. There is also direct funding of research in some climate change areas by core government departments to meet operational and policy development needs and some research by local government to help develop community or regional policies.

In the agricultural sector, the Government has joined with the private sector to form the Pastoral Greenhouse Gas Research Consortium to jointly fund research into reducing agricultural methane and nitrous oxide emissions. The Ministry of Agriculture and Forestry funds research and technology transfer on adaptation and mitigation for the primary land-based sectors.

Internationally, New Zealand exchanges data and information with other countries in line with the policies of the World Meteorological Organization to expand an archive of systematic atmospheric, oceanic and terrestrial observations which are based on the monitoring activities described in the First, Second, Third and Fourth National Communications.

New Zealand has initiated the establishment of a multilateral partnership, the Livestock Emissions and Abatement Research Network (LEARN), which brings together scientists to share information and expertise on greenhouse gas emissions from livestock. Building on this network, New Zealand is also seeking to establish a global alliance on agricultural greenhouse gas mitigation research.

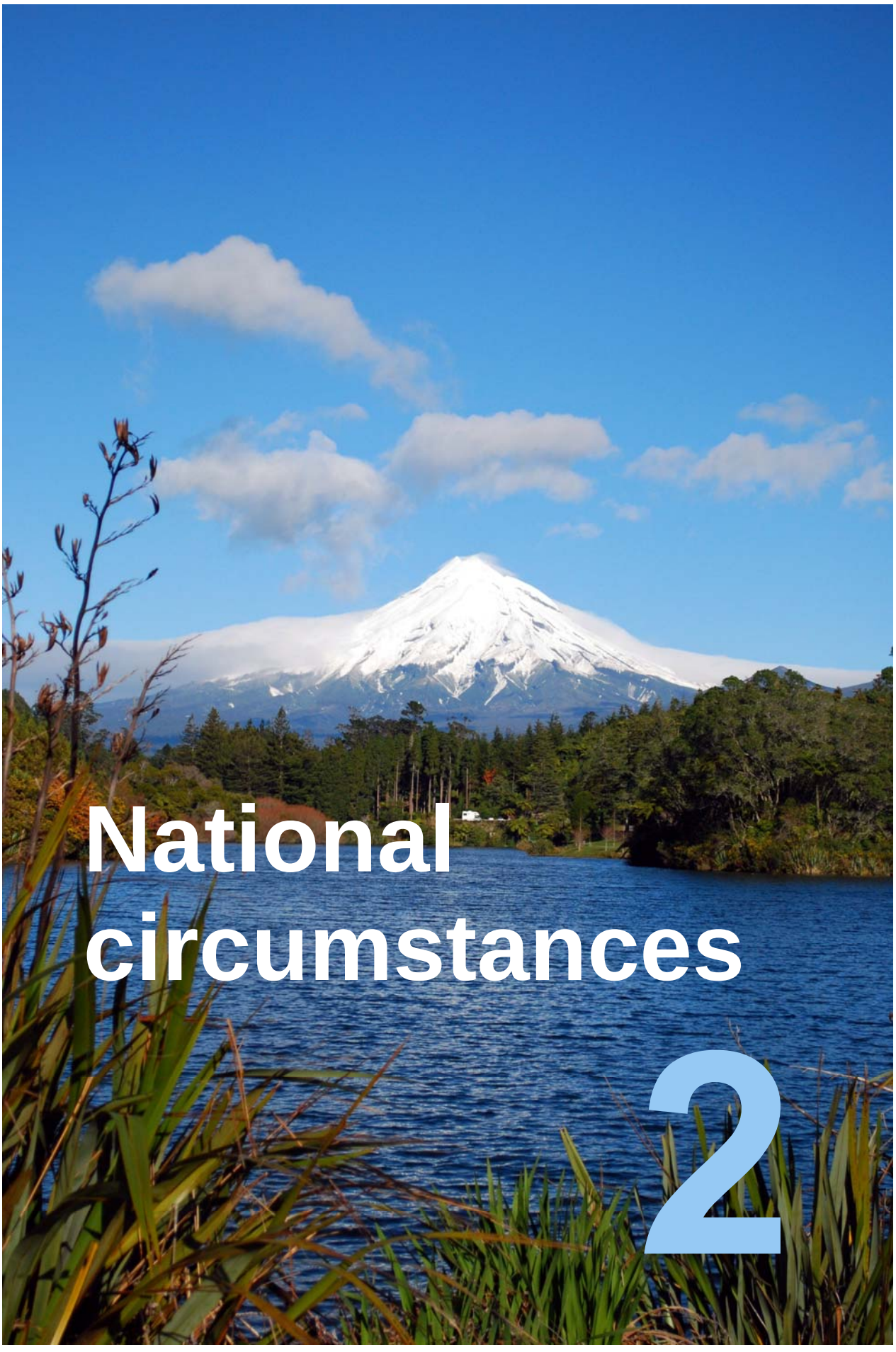
New Zealand established a climate change partnership with the United States to enhance dialogue and practical cooperation on climate change issues in 2002. A climate change partnership between New Zealand and Australia was announced in 2003. New Zealand is a member of the International Energy Agency and the International Partnership for the Hydrogen Economy and has observer status at the Carbon Sequestration Leadership Forum.

## 1.9 Education, training and public awareness

An increase in awareness of environmental issues has brought about a stronger demand for information on actions people can take to reduce emissions and prepare for the effects of climate change. The Government has provided information on the science and impacts of climate change and specific actions to reduce greenhouse gas emissions through a variety of websites and publications. Publications have also been produced explaining specific policy areas including the New Zealand Emissions Trading Scheme, the Sustainable Land Management and Climate Change Plan of Action, the New Zealand Energy Strategy, and the New Zealand Energy Efficiency and Conservation Strategy.

Between 2005 and 2008, a number of public awareness campaigns were introduced to improve New Zealanders' understanding of climate change and inspire people to take individual action. These campaigns were part of the Government's Towards a Sustainable New Zealand programme. Campaigns have included the Household Sustainability Campaign, the Business Partnerships for Sustainability programme, Govt$^3$ programme and the Enhanced Sustainable Government Procurement project. In June 2008, New Zealand hosted World Environment Day with a theme of "Kick the Carbon habit – working towards a low-carbon economy".

In July 2009, the Government announced that it wanted to consult with the public as part of setting a mid-term emissions reductions target for New Zealand. The Minister for Climate Change Issues held a series of public meetings around the country at which he discussed the key issues and invited public feedback. Over 1600 people attended these meetings and aired their views about the target. Members of the public also took part in an online forum with the Minister.



# National circumstances

# 2

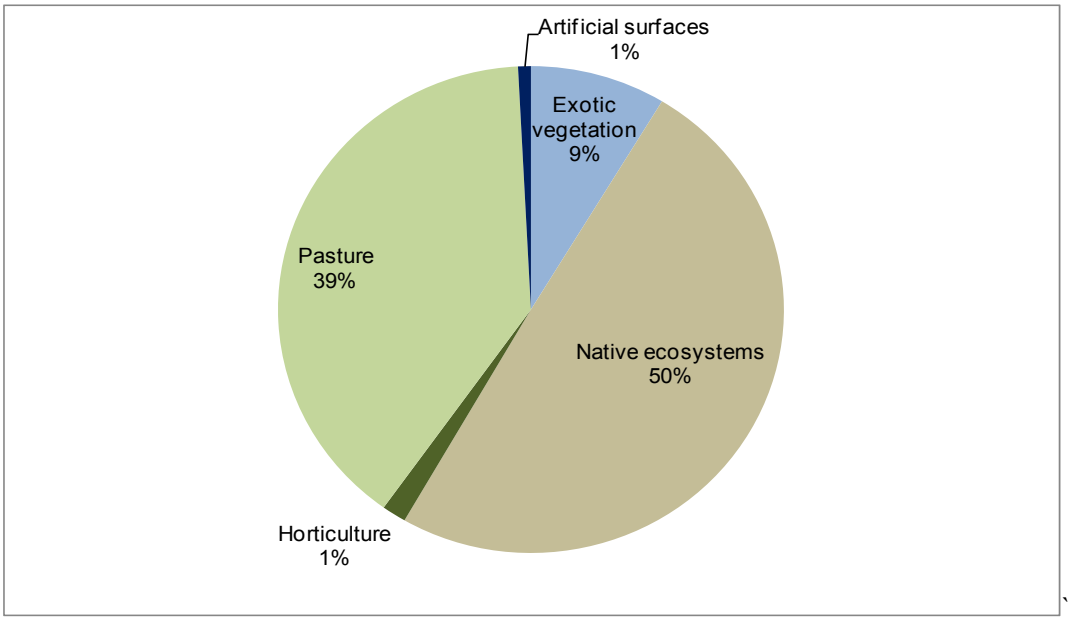
# 2 National circumstances

## 2.1 Geographic profile

New Zealand consists of two large islands, the North Island and the South Island, and a number of smaller islands. It is located in the southwest Pacific Ocean between 33° and 55° south latitude. With a combined land area of 27 million hectares it is similar in size to Japan or the United Kingdom. New Zealand has one of the longest (at 11,500 kilometres) and, in some places, most deeply indented coastlines in the world. Its Exclusive Economic Zone is vast, with the marine area covering 14 times the land area.

New Zealand straddles the boundary of the Pacific and Indo-Australian tectonic plates. The resulting earth movements have produced hilly and mountainous terrain over two-thirds of the land, with frequent earthquakes in most parts of the country and a zone of volcanic and geothermal activity in the central North Island.[4] Native ecosystems, agriculture and exotic forestry are New Zealand's main land uses (figures 2.1 and 2.2).

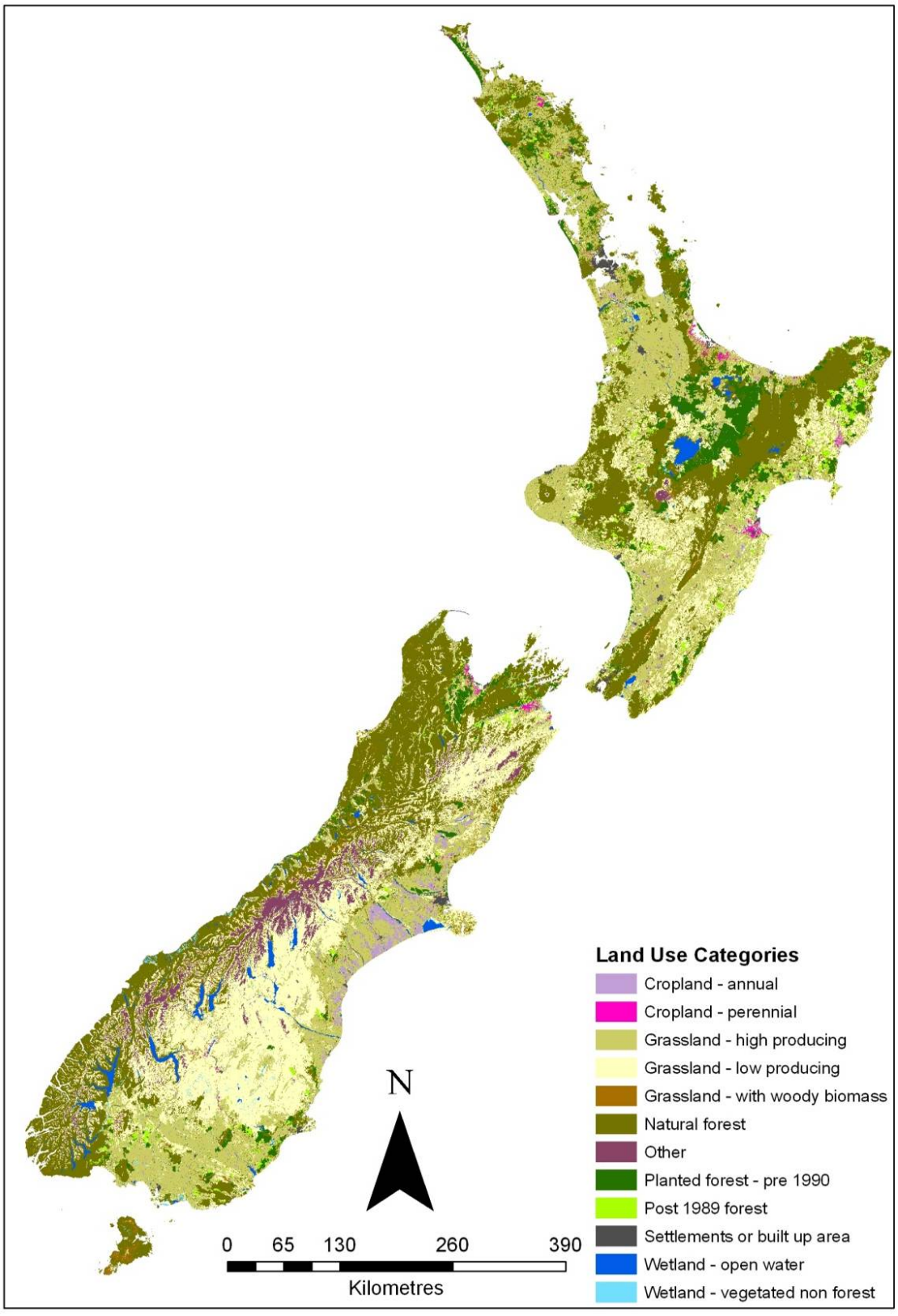
**Figure 2.1: Land cover in New Zealand, 2002**




**Source:** Ministry for the Environment, Land Cover Database 2.

[4] Ministry for the Environment. 1997. *State of the Environment Report.* Wellington: Ministry for the Environment.

**Figure 2.2: Land use in New Zealand, 2008**




**Data source:** Ministry for the Environment.

## 2.2 Population profile

In 2006, the year of the last census, the New Zealand population was 4.2 million, of which 76 per cent resided in the North Island. The estimated resident population in December 2009 was 4.3 million people. New Zealand has a highly urbanised population, with around 72 per cent living in urban centres of 30,000 or more people. The largest city is Auckland, and 33 per cent of New Zealand's total population live within the Auckland region alone.

Between 1951 and 2006 the population of New Zealand grew at an average rate of 1.4 per cent per annum. New Zealand's population growth between 1990 and 2007 (25 per cent) was the second highest of Annex 1 countries and the New Zealand population is expected to reach 5 million by the late 2020s (see table 2.1). Population growth has slowed recently, and by 2031 the growth rate is expected to be 0.6 per cent per annum.[5]

**Table 2.1: The population of New Zealand, actual and projected**

| Area | 2006 population | 2006 population density (persons per $km^2$) | Proportion of total NZ population (2006) | Projected 2031 population | Population change between 2006 and 2031 |
|---|---|---|---|---|---|
| North Island | 3,185,100 | 27.8 | 76% | 3,963,400 | 24% |
| South Island | 998,800 | 6.5 | 24% | 1,125,700 | 13% |
| New Zealand[6] | 4,184,600 | 15.7 | 100% | 5,089,700 | 22% |

**Sources:** Statistics New Zealand. Subnational Population Projections: 2006 (base) – 2031. http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/subnationalpopulationprojections_hotp06.aspx

**Note:** This table uses the mid-range scenario for population projections to 2031.

## 2.3 Climatic profile

### 2.3.1 Current

New Zealand is a long, narrow, mountainous country, with the nearest, large land mass (Australia) more than 2000 kilometres away. As a result, its climate is heavily influenced by its location in a latitude zone with prevailing westerly winds, by the surrounding ocean, and by the mountain chains that modify the weather systems as they sweep eastward. These factors make New Zealand's weather more variable than that of larger continental countries.

The average rainfall in most urban areas is between 600 millimetres and 1.5 metres a year. In the mountain ranges annual rainfall often exceeds 5 metres, and in the Southern Alps annual rainfall can be more than 10 metres a year. However, areas to the east of the main ranges have an average rainfall of less than 600 millimetres a year.[7]

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5 Statistics New Zealand. 2007. National Population Projections. http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/nationalpopulationprojections_hotp06-61.aspx

6 New Zealand comprises the North Island and South Island regions plus areas not included in a region (eg, Chatham Islands Territory). All derived figures have been calculated using data of greater precision than published. Owing to rounding, individual figures may not sum to give the stated totals.

7 Ministry for the Environment. 2007. *Environment New Zealand 2007*. Wellington: Ministry for the Environment.

The average temperature at sea level decreases steadily from the north to the south, from about 15°C in the far north of the North Island to about 10°C in the far south of the South Island.[8]

### 2.3.2 Projected changes in climate

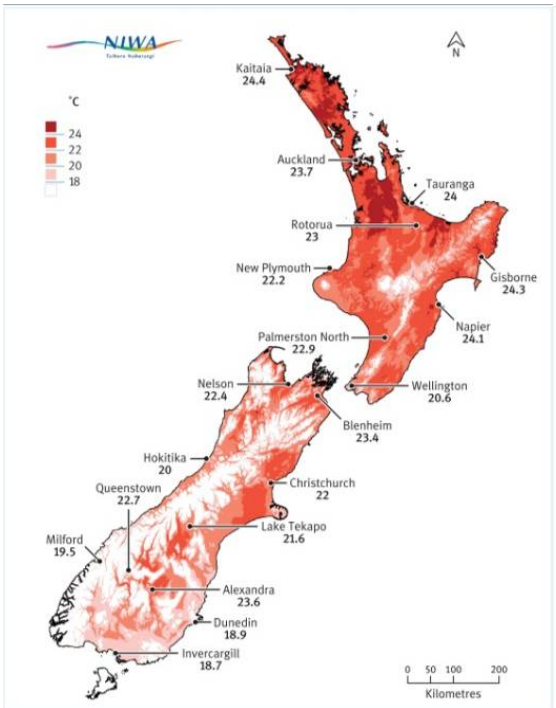
Climate change scenarios suggest that New Zealand's average annual temperature could rise by about 1°C by 2040 and 2°C by 2090, relative to 1990.[9] The projected mid-range change in the average annual rainfall has a pattern of increases in the west (up to 5 per cent by 2040 and 10 per cent by 2090) and decreases in the east and north (exceeding 5 per cent in places by 2090).

[8] Meteorological Service of New Zealand Limited. http://www.metservice.co.nz/public/learning/nz-climate.html

[9] Ministry for the Environment. 2008. *Climate Change Effects and Impacts Assessment*. Wellington: Ministry for the Environment.

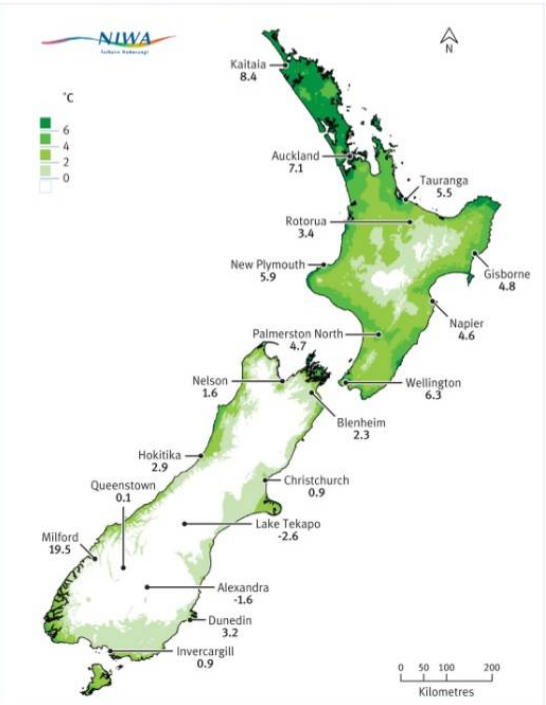
**Figure 2.3: New Zealand's weather**

Maximum daily temperature (mid-summer average)



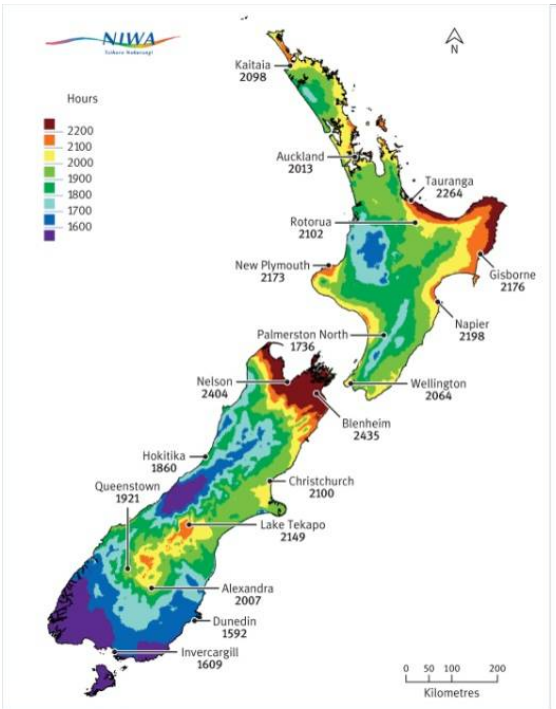

Source: NIWA (2005)

Minimum daily temperature (mid-winter average)



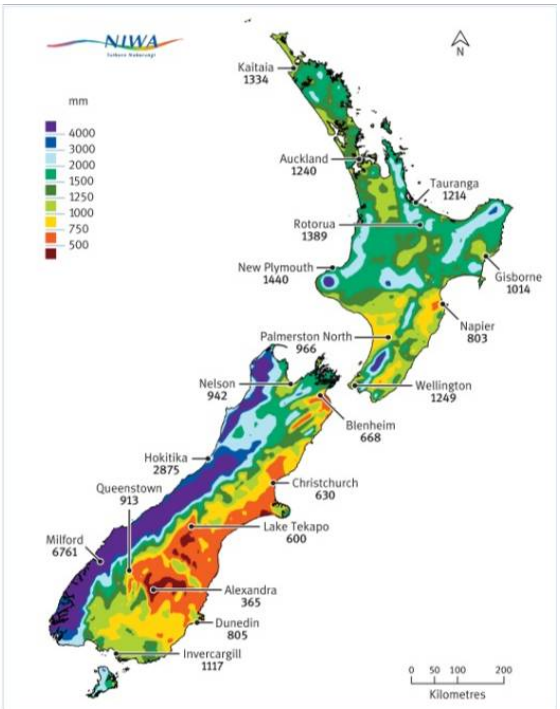

Source: NIWA (2005)

Sunshine hours (annual average)




Source: NIWA (2005)

Rainfall (annual average)




Source: NIWA (2005)

**Figure 2.4: Projected annual mean temperature change between 1980–1999 and 2080–2099**

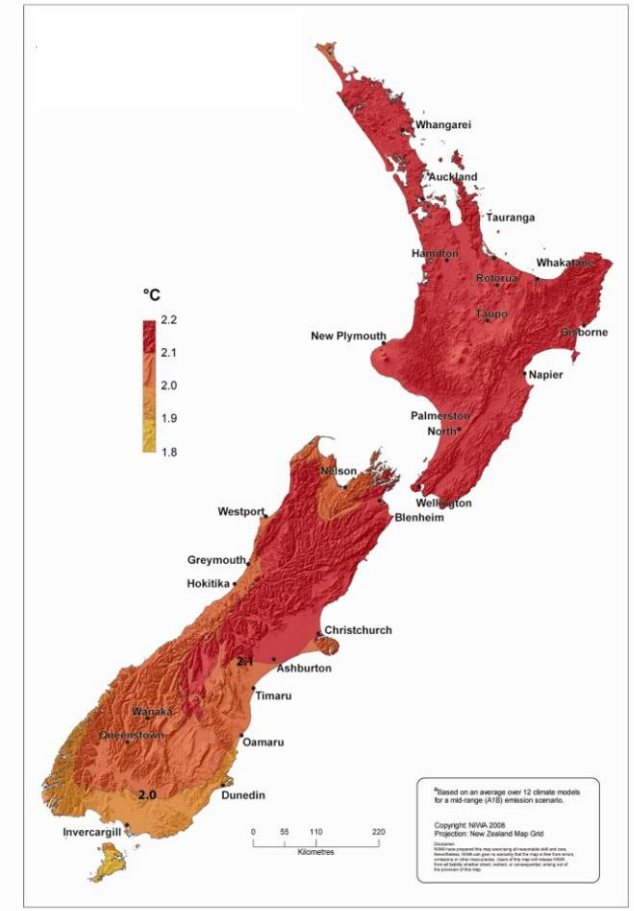
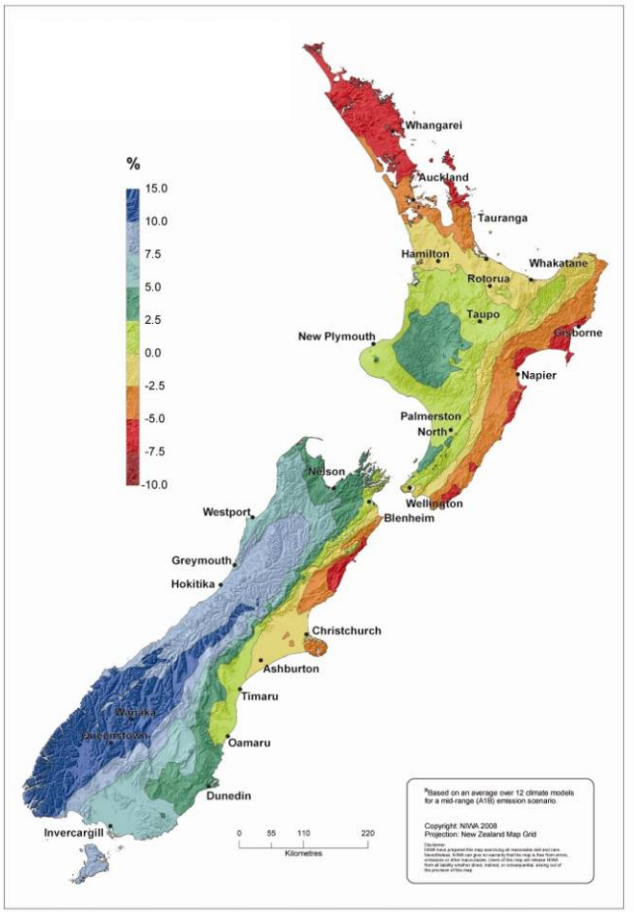



**Figure 2.5: Projected annual mean precipitation change between 1980–1999 and 2080–2099**




**Source**: Ministry for the Environment

## 2.4 Government structure

### 2.4.1 Central government

New Zealand's Government is formed from a democratically elected House of Representatives. The Government advises the head of state, who is Queen Elizabeth II (the Queen). By convention the Queen, the source of all executive legal authority in New Zealand, acts on the advice of the Government in all but the most exceptional circumstances. This system is known as a constitutional monarchy. The Queen is represented in New Zealand by a Governor-General, currently the Honourable Sir Anand Satyanand, GNZM, QSO.[10]

Parliament comprises the House of Representatives and the Sovereign. The principal functions of Parliament are to enact laws and to hold the Government to account over its policies, actions and spending. Since 1996 Members of Parliament have been elected using the mixed member proportional representation system. There are currently seven political parties with parliamentary representation.

### 2.4.2 Local government

New Zealand has a system of 85 local authorities that, due to devolved decision-making, are largely independent of the central executive government. Local authorities fall into two main categories, namely regional and territorial authorities. They have their own sources of income independent of central government, including taxes on land and property, and council-owned enterprises.

The purpose of the Local Government Act 2002 is for local government to promote the social, economic, environmental and cultural well-being of communities and to enable democratic decision-making. A sustainable development approach and community planning are cornerstones of the Local Government Act, with its requirement to consult communities on their desired outcomes and prepare Long-term Council Community Plans. Activities of local government include provision of utility services, recreation assets, transportation services and land and resource management.

Local authorities have primary responsibility for regulating resource use in New Zealand. The mandate for this is governed by a range of legislation, but in particular the Resource Management Act 1991. The Resource Management Act integrated the provisions of more than 75 earlier laws and is founded upon the principle of sustainable management of natural and physical resources.[11]

## 2.5 Building stock and urban structure

There were 1.5 million occupied dwellings recorded in the 2006 census, with approximately 26,000 new dwellings built during 2006. That year there was an average of 2.8 people per dwelling. Seventy-seven per cent of dwellings were separate houses and 17 per cent were two or more flats or apartments joined together.[12]

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10 http://www.gg.govt.nz/

11 More information on the role of local government bodies can be found at http://www.lgnz.co.nz/lg-sector/role/index.html

12 Department of Building and Housing. http://www.dbh.govt.nz

## 2.6 Economic and industry profile

New Zealand has an export-dependent economy, operating on free market principles. The agricultural, horticultural, forestry, mining and fishing industries play a fundamental role in New Zealand's economy, particularly in the export sector and in employment. Overall, the primary sector accounts for 7 per cent of gross domestic product (GDP) and contributes 64 per cent of New Zealand's total merchandise export revenue.[13]

A drought over the summer and autumn of 2007/08 affected many of New Zealand's regions, leading to a reduction in agricultural productivity. In 2008, domestic activity slowed sharply as a result of the global financial crisis. In March 2009, the unemployment rate had increased for the fifth consecutive quarter to reach a six-year high of 5.0 per cent.[14]

Overseas visitor arrivals numbered 2.4 million in the year ended June 2009. The most important sources of visitors to New Zealand over this period were Australia, the United Kingdom, the United States, China and Japan.[15]

### 2.6.1 Exports

New Zealand's merchandise exports were valued at NZ$42.8 billion for the year ended July 2009. Australia continued to be New Zealand's primary export market, worth NZ$9.6 billion, followed by the United States with NZ$4.7 billion, and China with NZ$3.5 billion.[16]

New Zealand is the world's largest single-country exporter of dairy products and sheep meat, has the world's most profitable kiwifruit industry and is a significant player in other areas such as pip fruit and wool. Dairy products were New Zealand's largest export earner in the year to July 2009, accounting for NZ$9.0 billion. In the same year meat products and wood products were New Zealand's next two largest exports, accounting for 13 per cent and 5 per cent of total exports, respectively. Rising demand from developing countries and supply constraints helped push dairy prices to their highest-ever level in both world and New Zealand dollar terms in late 2007. As commodity prices have weakened, world dairy prices have fallen by 50 per cent from the 2007 peak.

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13 The Treasury. *New Zealand Economic and Financial Overview 2009*. http://www.treasury.govt.nz/economy/overview/2009/

14 Statistics New Zealand. *Household Labour Force Survey: March 2009 Quarter – Hot Off the Press*. http://www.stats.govt.nz/browse_for_stats/work_income_and_spending/employment/householdlabourforcesurvey_hotpmar09qtr.aspx

15 Statistics New Zealand. *International Travel and Migration: June 2009.* http://www.stats.govt.nz/browse_for_stats/population/Migration/InternationalTravelAndMigration_HOTPJun09.aspx

16 Statistics New Zealand. *Overseas Merchandise Trade: July 2009*. http://www.stats.govt.nz/browse_for_stats/imports_and_exports/Goods/OverseasMerchandiseTrade_HOTPJul09.aspx. Note that the July 2009 figures are provisional.

### 2.6.2 Imports

New Zealand's merchandise imports were valued at NZ$45.3 billion in the year ended July 2009. Australia continued to be New Zealand's largest source of imports, accounting for 18 per cent of the total. China and the United States were New Zealand's next two largest import markets, accounting for 15 per cent and 10 per cent of total imports, respectively.[17]

Fuels and oils were New Zealand's most valuable imported products in the year to July 2008, accounting for 15 per cent of total imports. Other significant imports were mechanical and electrical machinery, with 13 per cent and 9 per cent, respectively.[18]

## 2.7 Energy

### 2.7.1 Electricity

The electricity industry has gone through a long process of reform, with competition in the generation sector first introduced in 1996. Electricity is sold by generators and bought by retailers and direct (large industrial) users under governance rules that came into force in March 2004. The national distribution grid is operated by Transpower, a state-owned enterprise, and there are a number of local distribution networks with a variety of ownership structures.

Electricity consumers can choose between competing suppliers of electricity. There are currently five main generation companies providing over 92 per cent of New Zealand's total electricity generation. Three of these are state-owned enterprises and the other two are private companies. The Electricity Commission regulates and monitors the electricity industry.

In a dry year, where low rainfall affects the majority of New Zealand's hydro-electric lake levels, the shortfall is made up by thermal electricity generation. Figure 2.6 shows the close inverse relationship between thermal and hydro generation. This relationship has historically influenced the yearly fluctuations seen in New Zealand's total and energy greenhouse gas emissions from 1990 to 2007. In 2007, electricity contributed 6.6 million tonnes carbon dioxide equivalent (9 per cent) to New Zealand's total greenhouse gas emissions, an increase of 91 per cent from 1990.[19] This rise was due to an increase in thermal generation, particularly in coal (figure 2.7).

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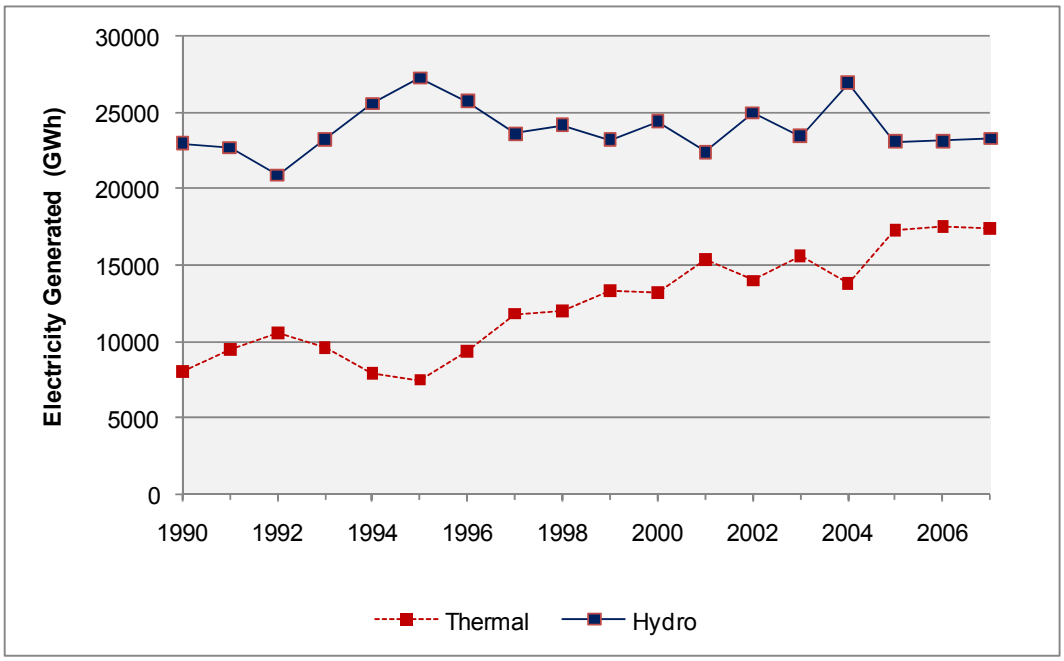
17 Statistics New Zealand. *Overseas Merchandise Trade: July 2009*. http://www.stats.govt.nz/browse_for_stats/imports_and_exports/Goods/OverseasMerchandiseTrade_HOTPJul09.aspx. Note that the July 2009 figures are provisional.

18 Statistics New Zealand. *Overseas Merchandise Trade: July 2009*. http://www.stats.govt.nz/browse_for_stats/imports_and_exports/Goods/OverseasMerchandiseTrade_HOTPJul09.aspx. Note that the July 2009 figures are provisional.

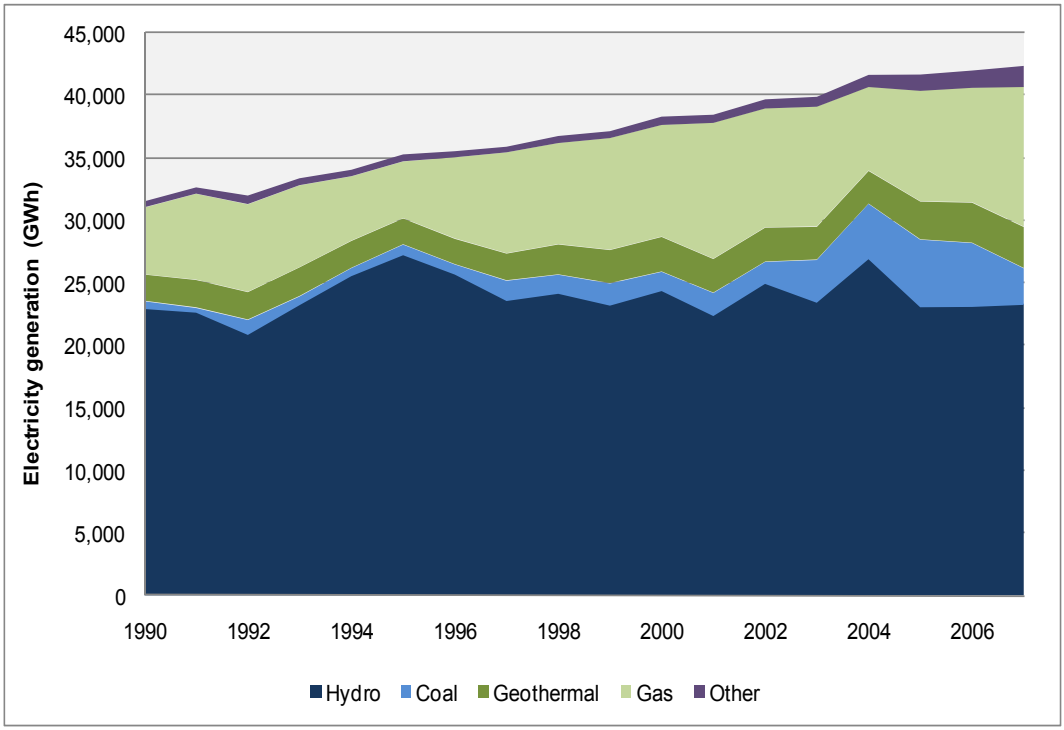
19 New Zealand's Greenhouse Gas Inventory 1990 – 2007: An Overview. http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-overview-2009/index.html. Ministry for the Environment (2009).

**Figure 2.6: New Zealand's hydro-electric and thermal generation, 1990–2007**




**Source:** Ministry of Economic Development. 2008. *Energy Data File.* Wellington: Ministry of Economic Development.

**Figure 2.7: Electricity generation, by fuel type, 1990–2007**




**Source:** Ministry of Economic Development. 2008. *Energy Data File.* Wellington: Ministry of Economic Development.

**Note:** "Other" includes electricity generation from biogas, waste heat and wood, including cogeneration. Coal generation includes the output of cogeneration plants for these fuel types.

### 2.7.2 Gas

The gas sector is currently made up of nine producing companies, seven wholesalers (including the Government), two high-pressure transmission companies, five low-pressure distributing companies and six main retailing companies providing gas to commercial or residential customers. In 2008, New Zealand produced 174 PJ of gas from 14 gas fields and wells, almost 154 PJ of which was consumed domestically. The largest proportion (54 per cent) was used for electricity generation.

In 2007, gas contributed 12 per cent of New Zealand's total greenhouse gas emissions. Between 1990 and 2007 emissions from gas consumption increased by 10 per cent. Gas consumption dropped between 2007 and 2008, and in 2008 emissions from gas consumption were only 3.6 per cent above 1990 levels.[20]

### 2.7.3 Oil

New Zealand is a net importer of oil and oil products. In 2007, it had a primary "self-sufficiency" in oil of 32 per cent, rising with increased production to 47 per cent in 2008. However, due to its high quality and consequent value, most of New Zealand's oil (96 per cent) was exported unrefined. Almost all of the oil consumed in New Zealand is imported and refined domestically.

In 2008, the oil sector was made up of nine companies producing oil, one refinery, five wholesalers, a range of independent distributors and five main oil retailers. In 2008, New Zealand produced oil from 16 fields: 71 per cent of the production was crude, 27 per cent condensate and 2 per cent naphtha.

In 2007, oil contributed 23 per cent of New Zealand's total greenhouse gas emissions. Between 1990 and 2007 emissions from oil increased by 58 per cent.

### 2.7.4 Coal

Currently a net exporter of coal, New Zealand produced 4.9 million tonnes of coal in 2008. Some 95 per cent of the coal produced was bituminous and sub-bituminous coal, and 5 per cent was lignite, and 42 per cent was exported. The majority of the coal exported was premium bituminous. New Zealand has an estimated 15 billion tonnes in coal deposits, with lignite making up 80 per cent.

In 2008, New Zealand consumed 3.9 million tonnes of coal. Most (51 per cent) of the coal consumed was used for electricity generation (up from 40 per cent in 2007). Consumption of coal increased 25 per cent between 2007 and 2008. This increase demonstrates the fluctuation between thermal and hydro-electricity generation as a dry 2008 reduced hydro-electric generation.

Coal consumption contributed 6 per cent of New Zealand's total greenhouse gas emissions in 2007. Between 1990 and 2007 emissions from coal increased by 41 per cent.

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[20] *New Zealand Energy Data File 2009*. Ministry of Economic Development. Available at http://www.med.govt.nz/templates/StandardSummary____15169.aspx

## 2.8 Transport

The nature of New Zealand's transport system has been influenced by the distribution of a small population over the two main islands and New Zealand's remoteness from many of its trading partners, which requires extensive use of shipping and, more recently, air transport. Transport accounts for approximately 5 per cent of GDP, with road transport accounting for 3.3 per cent.

As with other developed countries, transport in New Zealand is energy intensive and relies on fossil fuels. In 2007, transport contributed 14.9 million tonnes carbon dioxide equivalent (20 per cent) of New Zealand's total greenhouse gas emissions, an increase of 70 per cent from 1990. Road transport is the largest contributing source of these emissions.

### 2.8.1 Road transport

Road transport is the central element of New Zealand's transport system, reflecting New Zealand's widely distributed population. Road transport carries most of the domestic freight (70 per cent), and most New Zealanders (84 per cent) use road transport to get to work.[21] In recent years, New Zealand has become increasingly reliant on road transport.

New Zealand's vehicle fleet is dominated by ageing petrol-fuelled light passenger vehicles. In 2007, the highest proportion of kilometres travelled in New Zealand (33 per cent) was by vehicles between 8 and 12 years old. In 2002 the introduction of the New Zealand Frontal Impact Standard restricted the import of used vehicles by limiting them to vehicles manufactured after 1996.[22]

In 2005 there was an average of 70 vehicles per 100 people. Ownership per person of light vehicles has increased significantly over the last decade. This increase is due to high levels of employment and the high New Zealand exchange rate, making imported vehicles less expensive. Consumers are also spending an increasing amount of time travelling by road (figure 2.8), which partly reflects the growth in the total number of vehicles on New Zealand roads.

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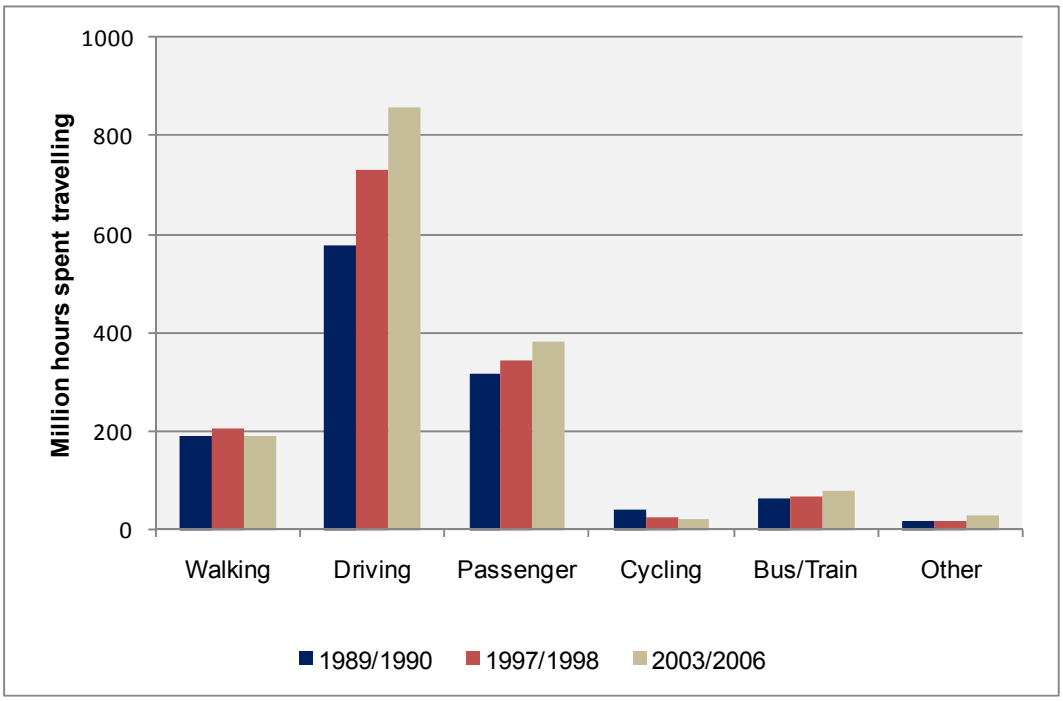
21 Ministry of Transport. http://www.transport.govt.nz/ourwork/land

22 Ministry for the Environment. 2009. *Environmental Report Card: Vehicle Kilometres Travelled by Road*. http://www.mfe.govt.nz/environmental-reporting/transport/vehicle-km-travelled/

**Figure 2.8: Annual travelling time, by mode, in New Zealand**




**Source:** Ministry of Transport. 2009. *Comparing Travel Modes.* Wellington: Ministry of Transport. http://www.transport.govt.nz/research/LatestResults (16 September 2009).

**Notes:** Ages five and over. "Other" includes travel by plane and boat as well as uncommon land modes (eg, horse-riding).

## 2.8.2 Rail

The national rail network totals approximately 4000 kilometres. The Government owns and controls the rail infrastructure and the majority of the rolling stock. There are urban rail networks in Wellington and Auckland, which provide approximately 19.5 million passenger trips annually: 11.9 million in Wellington[23] and 7.6 million in Auckland.[24] Fifteen per cent of freight moved within New Zealand is also carried by rail.

## 2.8.3 Aviation

New Zealand continues to be a very aviation-oriented nation. Virtually all passenger travel to and from New Zealand is by air, and aviation is essential for exports of time-sensitive goods, including horticultural and seafood products. There were 4,483,000 passenger arrivals into New Zealand in the year ended December 2007, an increase of 8 per cent since the year ended December 2004.[25] This growth has contributed to a tourism industry that is now supporting nearly one in ten New Zealand jobs. Of the total arrivals, 54 per cent were overseas visitors and 44 per cent were returning New Zealand residents.[26]

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23 2008/09 figures, provided by Greater Wellington Regional Council.

24 2008/09 figures, provided by the Auckland Regional Transport Authority.

25 Statistics New Zealand. *Tourism and Migration 2007*. Table 1.04. http://www.stats.govt.nz/methods_and_services/access-data/tables/tourism-migration-2007.aspx

26 Statistics New Zealand. *Tourism and Migration 2007*. Table 1.01. http://www.stats.govt.nz/methods_and_services/access-data/tables/tourism-migration-2007.aspx

### 2.8.4 Maritime

International shipping carries the vast majority of New Zealand's imported and exported goods (99.4 per cent of imports and 99.5 per cent of exports). Shipping is also relied on to transport freight domestically. Most domestic shipping cargo is carried across Cook Strait between the North and South Islands. Daily ferry services are operated by two competing companies using a total of five vessels (rail and road ferries) transporting passengers and freight, with a journey time of around three hours. There are a small number of passenger ferries operating in the coastal cities (predominantly Auckland), which provide commuter and recreational services.

## 2.9 Agriculture

The agricultural sector is New Zealand's largest export earner, accounting for 64 per cent of New Zealand's total merchandise export value in the year to June 2008. New Zealand is the largest single-country exporter of dairy products and sheep meat, has the world's most profitable kiwifruit industry, and is a significant player in other areas such as pip fruit and wool. In 2007, agriculture contributed 48 per cent of New Zealand's total greenhouse gas emissions.

From 1984, the Government's commitment to economic liberalisation, including the removal of most agricultural support, has had an impact by shifting production away from sheep and towards dairying, deer and horticulture (fruit, vegetables and vines). As a result, from the early 1990s to the present, dairy cow and deer numbers grew while sheep numbers declined (figure 2.9). Total annual nitrogen fertiliser use increased by a factor of approximately six between 1990 and 2007, with phosphate fertiliser use doubling over the same period.[27] [28]

There have been changes in animal numbers for each of the major ruminant species (figure 2.9) as well as productivity increases across all major animal species and classes. Agricultural productivity has improved substantially over the last 18 years as a result of technological change, improved animal husbandry and breeding, effective targeting of investment, cost cutting and efficiency gains, and economies of scale through the expansion of average-sized farms and orchards. Irrigated agriculture is one example of technological change.

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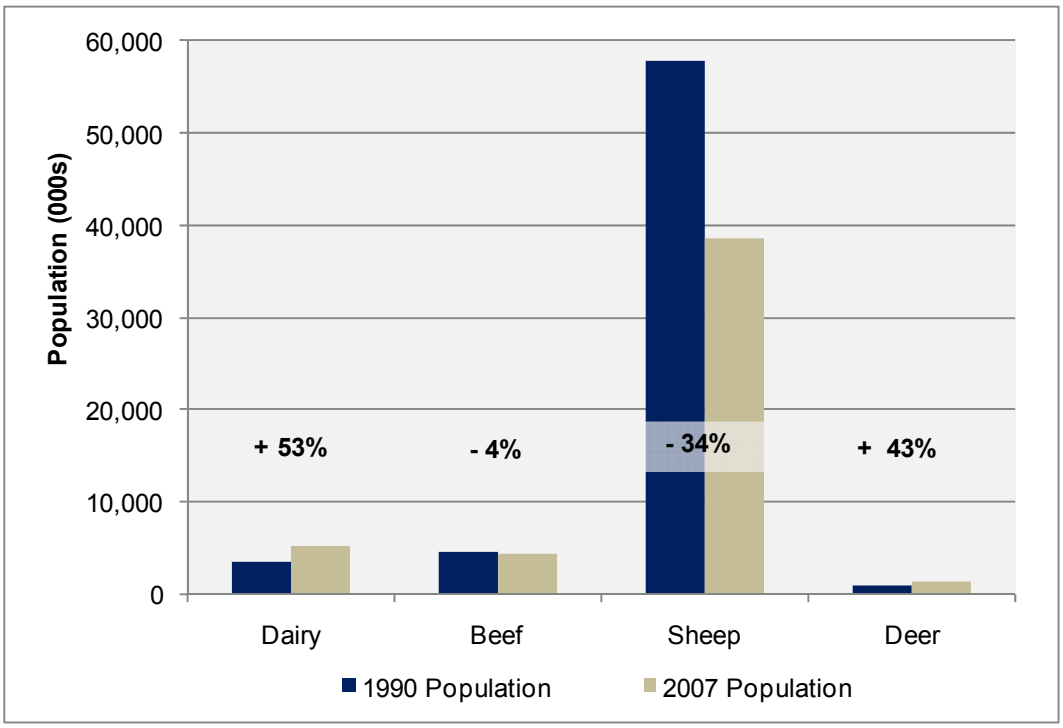
27 OECD. *OECD Environmental Data Compendium: Agriculture: September 2008*. http://www.oecd.org/document/49/0,3343,en_2649_34283_39011377_1_1_1_1,00.html (9 September 2009)

28 New Zealand's Greenhouse Gas Inventory 1990 – 2007. http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2009/

**Figure 2.9: Change in the population of New Zealand's livestock, 1990–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

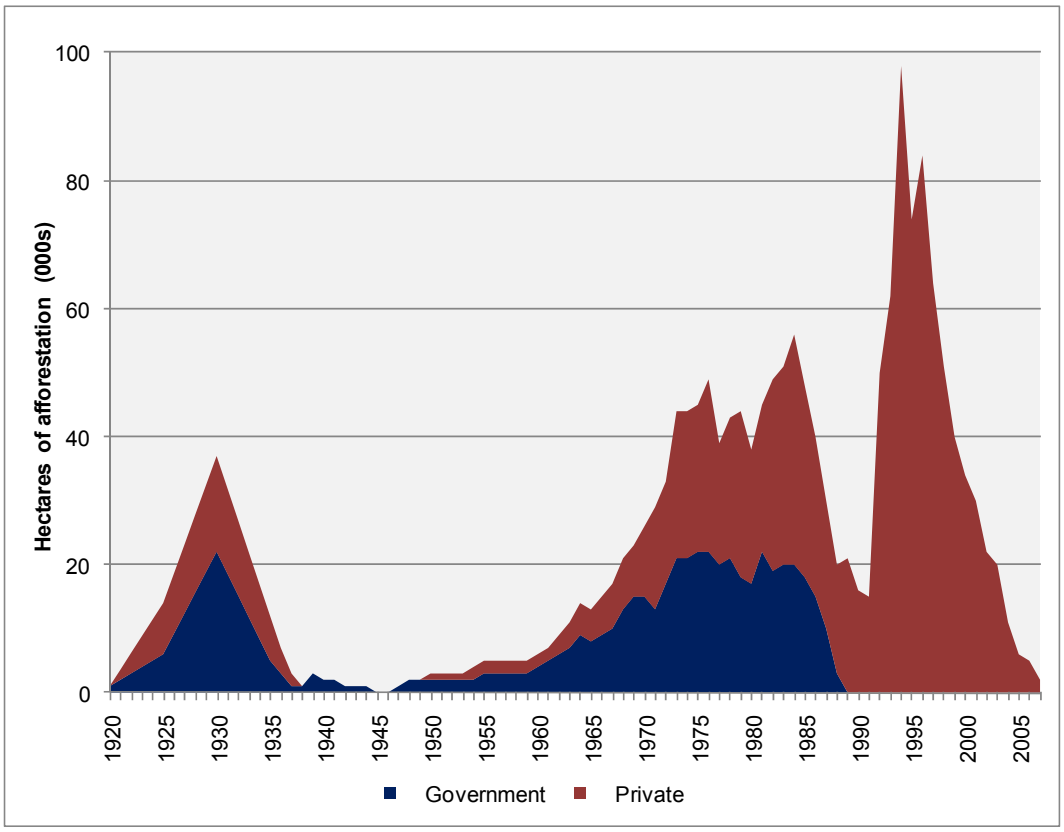
# 2.10 Forestry

In 2007, the total area of forestry in New Zealand was 10.0 million hectares (38 per cent of the national area). Native forest made up 82 per cent (8.2 million hectares) of the total forest area and forest planted specifically for timber purposes made up the remaining 18 per cent (1.8 million hectares). There are two principal types of native forest in New Zealand: beech (mainly *Nothofagus*) and podocarp/broadleaf. In addition, shrublands (mainly manuka and kanuka) and retired grasslands are defined as forests in some locations. The Department of Conservation is responsible for managing 5.6 million hectares of New Zealand's native forest.

Less than 0.1 per cent of New Zealand's total forest production is harvested from native forests, and the timber industry is now based almost entirely on planted forests. In the year to June 2008 forestry contributed 8 per cent of merchandise export income, a decrease of 10 per cent since 1990. *Pinus radiata* makes up 90 per cent of the planted forests, which are usually composed of stands of trees of a single age class, and all production forests are managed under a relatively standard silviculture regime.

The new planting rate was relatively high between 1992 and 1998 (an average of 69,000 hectares per year), but after 1998 the rate rapidly declined (figure 2.10). Some of the land not replanted was converted into grassland due to the relative profitability of pastoral farming (particularly dairy farming) compared to forestry.

**Figure 2.10: Annual forest planting in New Zealand, 1920–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

As is the case with agriculture, forestry producers do not receive price or production subsidies from the Government. As a result their incomes are directly influenced by changes in international prices, exchange rates, market conditions and other external and domestic factors. However, the Government has devolved international carbon units (removal units, or RMUs) to foresters, if they qualify under New Zealand's Emissions Trading Scheme. The foresters that participate are also liable for the debits that accrue once they harvest the forest. Limited support is available for stabilising land with forest plantings on confined areas of erosion-prone hill country and for forestry research, including research on biosecurity, pest and disease control.

In 2007, net removals from the land use, land-use change and forestry (LULUCF) sector were 23,836.0 Gg $CO_2$-e.[29] Net removals increased by 31 per cent between 1990 and 2007. (See section 3.5.6 for further information.)

# 2.11 Waste

In 2007, the waste sector contributed 2 per cent of New Zealand's total greenhouse gas emissions. Between 1990 and 2007 emissions from the waste sector decreased by 25 per cent (section 3.5.7). The decrease is partly due to improved solid waste management practices, described in chapter 4.

[29] Gigagrams of carbon dioxide equivalent.

### 2.11.1 Solid waste

In 2007, 3.2 million tonnes of solid waste were produced in New Zealand, equivalent to 749 kilograms per person. Figure 2.11 shows the approximate composition of solid waste in 2007. Solid waste in New Zealand is disposed of at managed landfills or is recycled. In 2006, 73 per cent of New Zealanders had access to kerbside recycling and 97 per cent had access to either kerbside recycling or drop-off centres.[30]

### 2.11.2 Wastewater

Wastewater from almost every town in New Zealand with a population over 1000 is collected and treated in community wastewater treatment plants. There are approximately 317 municipal wastewater treatment plants in New Zealand. In addition, there are approximately 50 government or privately owned treatment plants serving populations of between 100 and 1000 people.

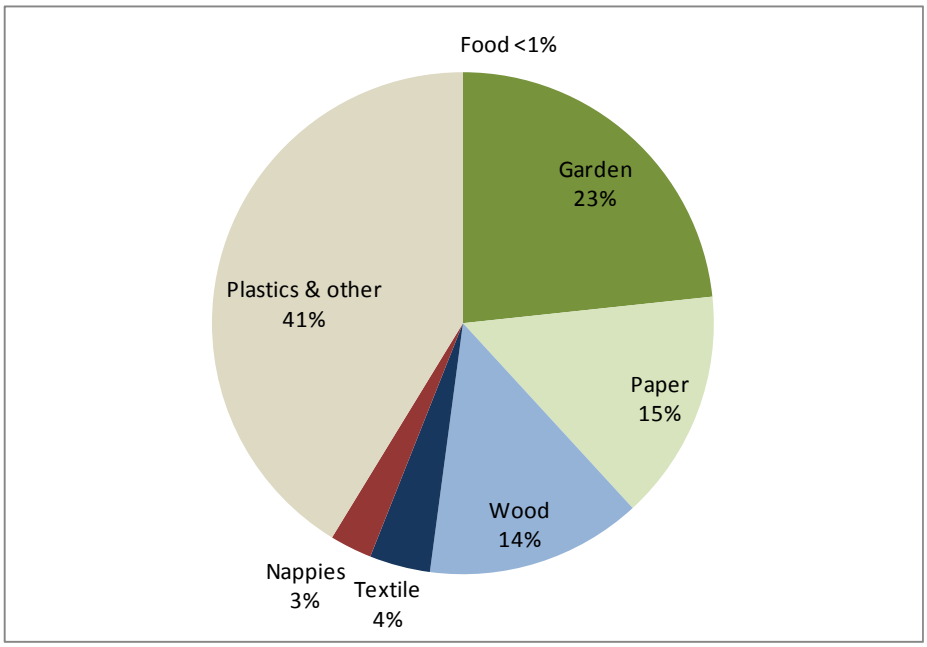
### 2.11.3 Incineration

There is no incineration of municipal waste in New Zealand. The only incineration is for small specific waste streams, including medical, quarantine and hazardous wastes. The practice of incinerating even these waste streams has declined since the early 1990s due to environmental regulations and alternative technologies, primarily improved sterilisation techniques. Consents under New Zealand's Resource Management Act control non-greenhouse gas emissions from these incinerators.

In 2004 New Zealand introduced a suite of national environmental standards for air quality. These standards effectively required all existing, low-temperature waste incinerators in schools and hospitals to obtain resource consent by 2006, irrespective of existing planning rules. Incinerators without consents are prohibited.

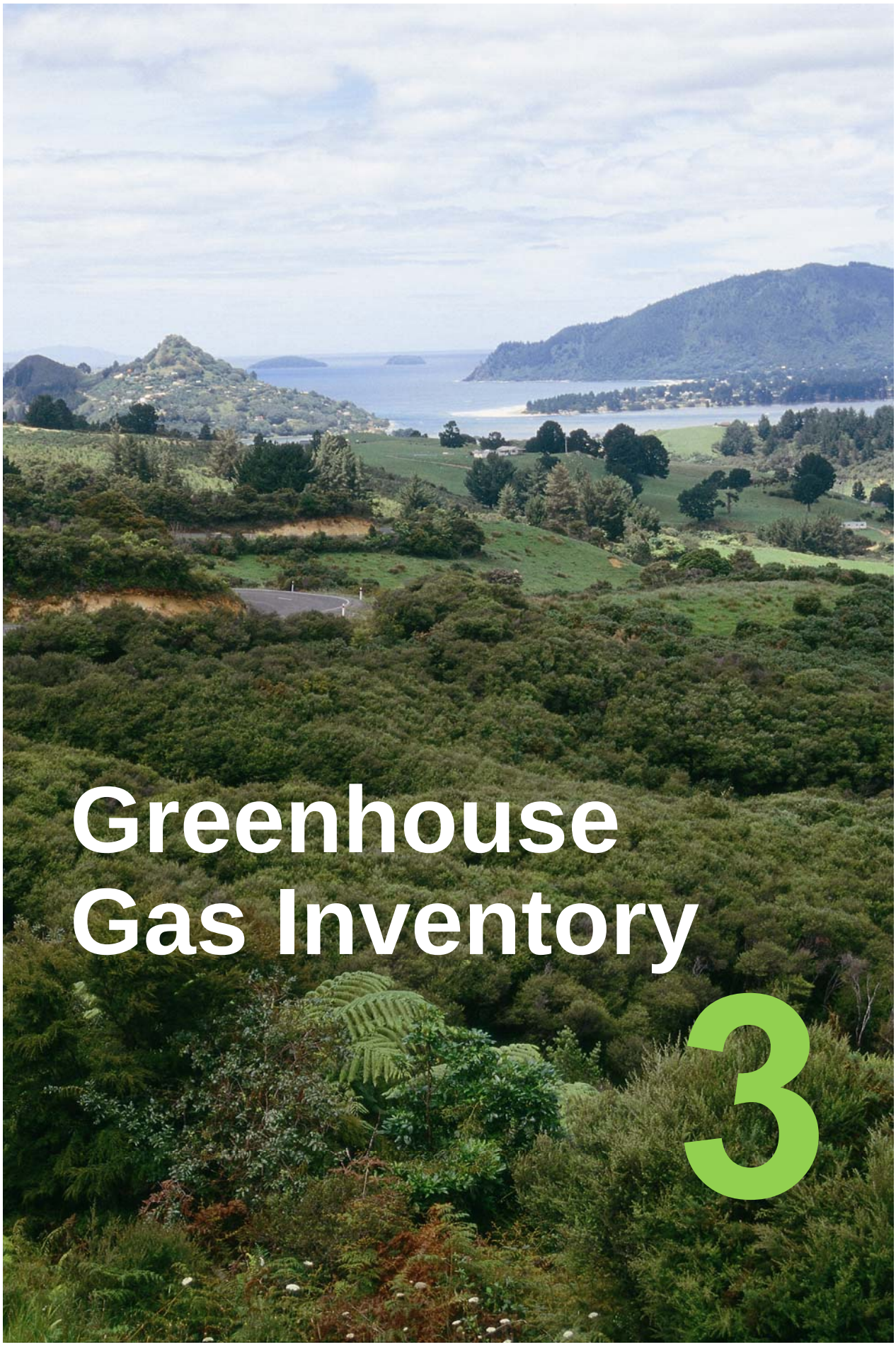
[30] *Environment New Zealand 2007*. Ministry for the Environment. 2008. http://www.mfe.govt.nz/publications/ser/enz07-dec07/

**Figure 2.11: Solid waste composition in New Zealand, 2007**




**Note:** "Plastics & other" includes solid waste not containing degradable organic carbon, glass metal etc.

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.



# Greenhouse Gas Inventory

3

# 3 Greenhouse gas inventory

## 3.1 Introduction

This chapter provides summary information on the latest trends in emissions and removals of greenhouse gases in New Zealand. The information provided here is consistent with *New Zealand's Greenhouse Gas Inventory 1990–2007* (the inventory) submitted to the United Nations Framework Convention on Climate Change (the Convention) on 15 April 2009.[31]

## 3.2 Roles and responsibilities

The Climate Change Response Act (2002, updated 26 September 2008) was enacted to enable New Zealand to meet its international obligations under the Convention and the Kyoto Protocol. A prime ministerial directive for the administration of the Climate Change Response Act names the Ministry for the Environment as New Zealand's "inventory agency".

The Ministry for the Environment is responsible for the overall development, compilation and submission of the inventory to the Convention secretariat. The Ministry also calculates estimates of emissions for the waste sector and emissions and removals from the land use, land-use change and forestry (LULUCF) sector.

The Ministry of Economic Development collects and compiles data on all emissions from the energy sector and carbon dioxide ($CO_2$) emissions from the industrial processes sector. Data on emissions of non-$CO_2$ gases from the industrial processes sector is obtained via industry surveys contracted to the Ministry for the Environment.

The Ministry of Agriculture and Forestry compiles data on the agricultural sector. Methods and emission factors relating to agriculture are underpinned by the research and modelling of researchers at New Zealand's Crown research institutes and universities.

Finally, New Zealand's national statistical agency, Statistics New Zealand, provides many of the official statistics for the inventory.

A full description of New Zealand's national system under Article 5.1 of the Kyoto Protocol is contained in Annex B.

## 3.3 National trends in New Zealand's emissions and removals

In April 2009, New Zealand submitted its national greenhouse gas inventory for 1990 through 2007.

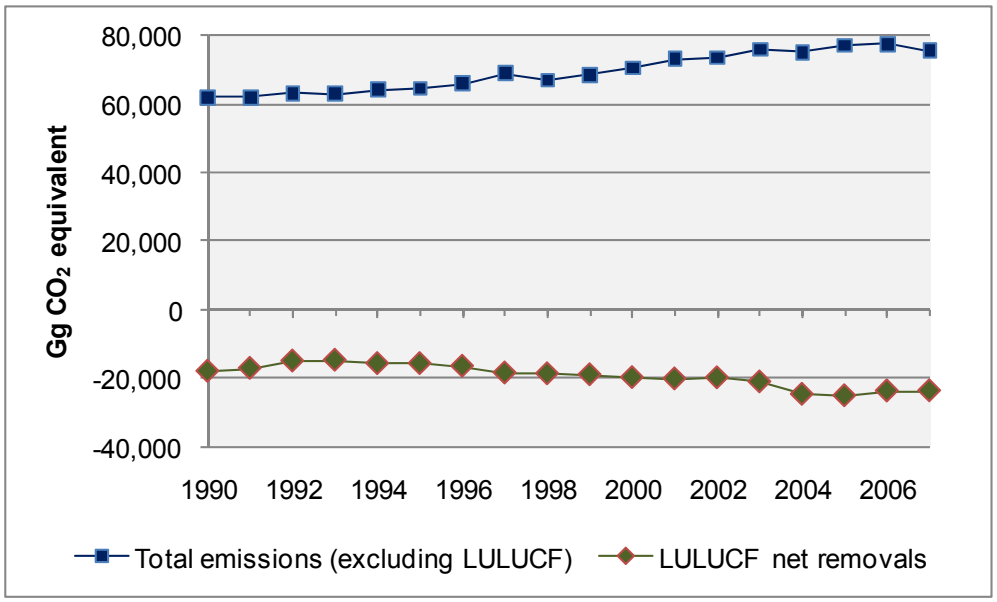
In 1990, New Zealand's total greenhouse gas emissions were 61,852.8 gigagrams of carbon dioxide equivalent (Gg $CO_2$-e). By 2007, total greenhouse gas emissions had increased by

[31] Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007*. http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2009

13,697.4 Gg $CO_2$-e (22 per cent) to 75,550.2 Gg $CO_2$-e (see figure 3.1). Between 1990 and 2007 the average annual growth in total emissions was 1.3 per cent per year.

Net removals from the LULUCF sector increased from 18,138.5 Gg $CO_2$ in 1990 to 23,836.0 Gg $CO_2$ in 2007. The 2009 inventory submission included a provisional estimate of 10,000 hectares of deforestation in 2007. Updated information indicates the area of deforestation in 2007 was in the range of 15,000 to 20,000 hectares. A provisional calculation using the updated information indicates that LULUCF net removals are therefore in the vicinity of 19,000 to 21,000 Gg $CO_2$-e. The recalculation for the updated area will be included in New Zealand's inventory submission in 2010.

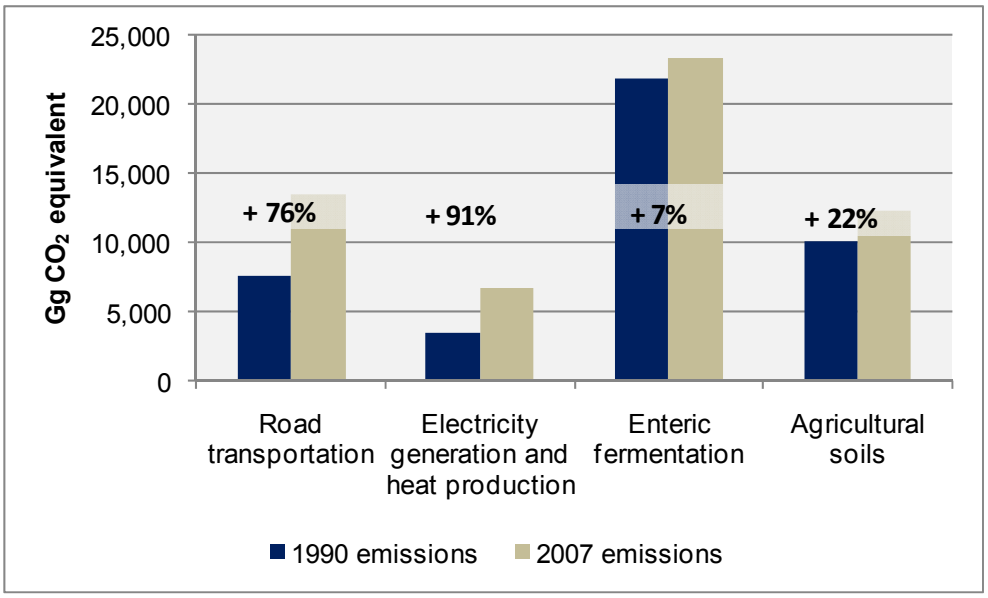
**Figure 3.1: New Zealand's total greenhouse gas emissions and net removals, 1990–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

The four sources that have contributed the most to the increase in New Zealand's total emissions are shown in figure 3.2.

**Figure 3.2: Changes in the sources that have contributed the most to New Zealand's greenhouse gas emissions between 1990–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

## 3.4 Emissions and removals by gas

Inventory reporting under the Convention covers six direct greenhouse gases: $CO_2$, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons and hydrofluorocarbons. Figure 3.3 shows New Zealand's 2007 profile by gas. Figure 3.4 and Table 3.1 show the change in each direct greenhouse gas between 1990 and 2007. Trends in $CO_2$, methane and nitrous oxide emissions over the period 1990–2007 are shown in figure 3.5.

In accordance with the Convention reporting guidelines, indirect greenhouse gases are included in inventory reporting but not in the national emissions total. These indirect gases include carbon monoxide, sulphur dioxide, oxides of nitrogen and non-methane volatile organic compounds. Removals of $CO_2$ from the atmosphere are reported in the LULUCF sector.

Carbon dioxide contributed the largest share of all 2007 emissions at 35,231.5 Gg $CO_2$-e (47 per cent). Carbon dioxide emissions increased 9893.9 Gg $CO_2$-e (39 per cent) from the 1990 level of 25,337.6 Gg $CO_2$-e. Between 2006 and 2007, $CO_2$ emissions decreased 1012.9 Gg $CO_2$-e (3 per cent). This was due to the commissioning of Genesis Energy's combined gas turbine at Huntly power station, which led to a corresponding reduction in coal-fired electricity generation.

Methane (excluding LULUCF) contributed 26,560.1 Gg $CO_2$-e (35 per cent) of total emissions in 2007. Between 1990 and 2007 methane emissions grew by 1131.6 Gg $CO_2$-e (4 per cent) from the 1990 level of 25,428.5 Gg $CO_2$-e. Between 2006 and 2007 total methane emissions decreased 1012.9 Gg $CO_2$-e (2.8 per cent). A drought throughout the summer and autumn of 2007/08 was the primary reason for this, affecting many regions, leading to reduced livestock numbers and productivity. The reduction in livestock population, especially in sheep and deer, contributed 679.8 Gg $CO_2$-e to the decrease in methane emissions.

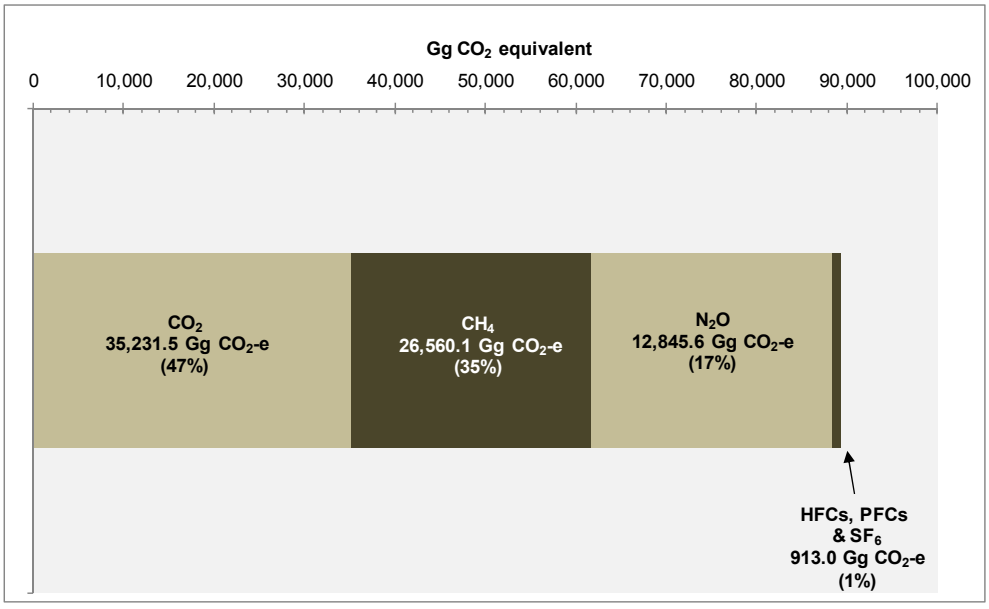
Nitrous oxide (excluding LULUCF) contributed 12,845.6 Gg $CO_2$-e (17 per cent) of emissions in 2007. Emissions had increased by 2416.3 Gg $CO_2$-e (23 per cent) from the 1990 level of 10,429.3 Gg $CO_2$-e. Between 2006 and 2007, total nitrous oxide emissions decreased 383.2 Gg $CO_2$-e (2.9 per cent). This is largely due to the drought affecting livestock productivity, which contributed 381.4 Gg $CO_2$-e to the decrease in nitrous oxide emissions.

Perfluorocarbons (PFCs), sulphur hexafluoride and hydrofluorocarbons (HFCs) contributed the remaining 913.0 Gg $CO_2$-e (1 per cent) of emissions in 2007. Emissions of PFCs decreased 600.5 Gg $CO_2$-e (94 per cent) from the 642.2 Gg $CO_2$-e in 1990 to 41.7 Gg $CO_2$-e in 2007. Emissions of sulphur hexafluoride decreased 0.5 Gg $CO_2$-e (3 per cent) from the 1990 level of 15.2 Gg $CO_2$-e to the 2007 level of 14.7 Gg $CO_2$-e. In 1990, no HFCs were used in New Zealand. In 2007, 856.6 Gg $CO_2$-e of HFC emissions were produced.

The growth in $CO_2$ emissions from 1990 to 2006 represents the increased emissions from the energy sector, particularly in road transport and energy generation. The growth in nitrous oxide is from the increase in emissions from animal excreta and the increase in the use of nitrogenous fertilisers in the agricultural sector: the amount of nitrogenous fertilisers used in New Zealand has increased six-fold since 1990.

Although the contribution of the other gases (sulphur hexafluoride, PFCs and HFCs) in the inventory is around 1 per cent of the total emissions, these gases have also undergone large relative changes between 1990 and 2007. Emissions of PFCs have decreased due to improvements in the aluminium smelting process, while HFC emissions have increased because of their use as a substitute for chlorofluorocarbons (CFCs), which were phased out under the Montreal Protocol. No emissions of HFCs occurred in 1990 and so no percentage has been shown in table 3.1 and figure 3.4.

**Figure 3.3: New Zealand's total greenhouse gas emissions, by gas, 2007**




**Notes:** $CH_4$ = methane; $N_2O$ = nitrous oxide; $SF_6$ = sulphur hexafluoride.

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

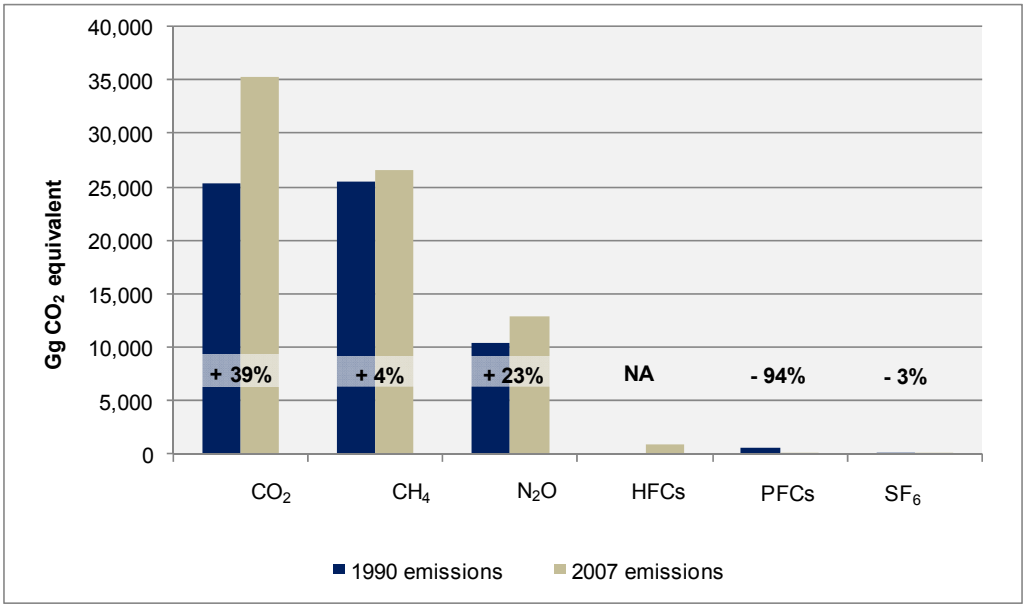
**Table 3.1: New Zealand's emissions of greenhouse gases, by gas, 1990 and 2007**

| Greenhouse gas | Gg $CO_2$-e | | Change from 1990 (Gg $CO_2$-e) | Change from 1990 (%) |
|---|---|---|---|---|
| | 1990 | 2007 | | |
| $CO_2$ (excluding LULUCF) | 25,337.6 | 35,231.5 | 9893.9 | 39 |
| $CH_4$ (excluding LULUCF) | 25,428.5 | 26,560.1 | 1131.6 | 4 |
| $N_2O$ (excluding LULUCF) | 10,429.3 | 12,845.6 | 2416.3 | 23 |
| HFCs | 0.0 | 856.6 | 856.6 | NA |
| PFCs | 642.2 | 41.7 | -600.5 | -94 |
| $SF_6$ | 15.2 | 14.7 | -0.5 | -3 |
| | **61,852.8** | **75,550.2** | **13,697.4** | **22** |

**Note:** The percentage change for HFCs is not applicable (NA) because there was no consumption of HFCs in New Zealand in 1990.

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

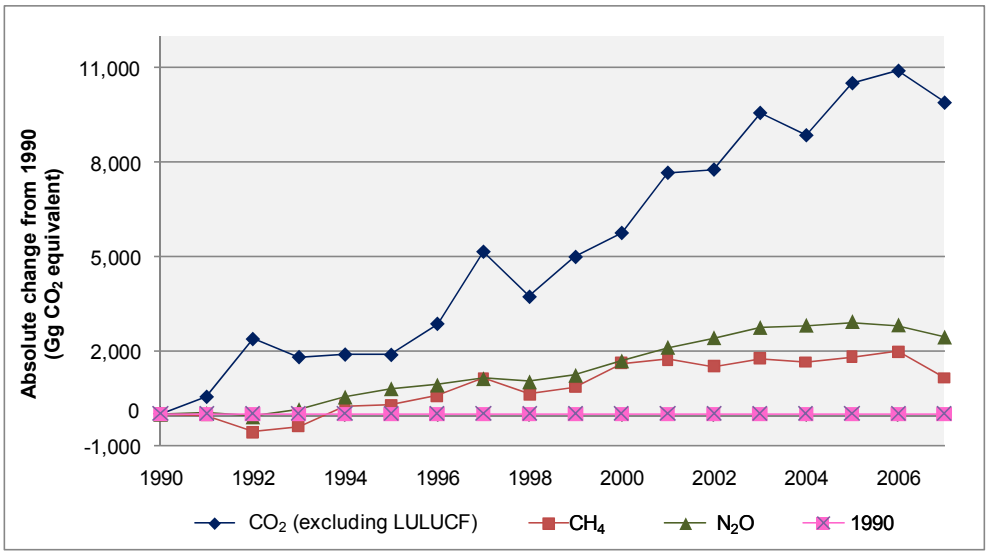
**Figure 3.4: Change in New Zealand's emissions, by gas, 1990–2007**




**Note:** The percentage change for HFCs is not applicable (NA) because there was no production of HFCs in 1990.

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

**Figure 3.5: Change in New Zealand's emissions of $CO_2$, $CH_4$ and $N_2O$, 1990–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

# 3.5 Emissions and removals by sector

## 3.5.1 Overview

The agricultural sector is the largest source of emissions, contributing 36,430.0 Gg $CO_2$-e (48 per cent) of total emissions in 2007 (table 3.2 and figure 3.6). In other developed countries agricultural emissions are typically around 11 per cent of national emissions, which means New Zealand has a unique emissions profile in this regard. In 2007, New Zealand's agricultural emissions had increased by 3918.9 Gg $CO_2$-e (12 per cent) from the 1990 level of 32,511.1 Gg $CO_2$-e (figure 3.7). The agricultural sector contributed 12,360.5 Gg $CO_2$-e (96 per cent) of New Zealand's total nitrous oxide emissions and 24,069.5 Gg $CO_2$-e (91 per cent) of its total methane emissions in 2007.

Between 2006 and 2007, emissions from the agricultural sector decreased 1061.2 Gg $CO_2$-e (2.8 per cent) (figure 3.8). As we have seen (above), this was due to a drought throughout the summer and autumn of 2007/08. The drought affected many regions, leading to reduced livestock numbers and productivity. The reduction in livestock population, especially in sheep and deer, led to a 679.8 Gg $CO_2$-e (2.7 per cent) decrease in methane emissions, while decreases in livestock productivity led to a 3.0 per cent (381.4 Gg $CO_2$-e) decrease in nitrous oxide emissions.

The energy sector was the source of 32,653.1 Gg $CO_2$-e (43 per cent) of total emissions in 2007, an increase of 9200.3 Gg (39 per cent) from the 1990 level of 23,452.8 Gg $CO_2$-e. This growth in emissions was primarily from electricity generation, heat production and transport. Between 2006 and 2007 emissions from the energy sector decreased 1357.5 Gg $CO_2$-e (4.0 per cent). This was due to the commissioning of Genesis Energy's combined-cycle gas turbine at Huntly power station and the corresponding reduction in coal-fired electricity generation.

The industrial processes sector accounted for 4601.9 Gg $CO_2$-e (6 per cent) of total emissions in 2007, an increase of 1192.7 Gg (35 per cent) from the 1990 level of 3409.2 Gg $CO_2$-e. This increase was mainly due to growth in emissions from metal production and to the consumption of HFCs. Between 2006 and 2007, emissions from the industrial processes sector increased by 368.1 Gg $CO_2$-e (9 per cent). This was caused by two factors: there was an increase in HFCs and PFCs used as replacement refrigerants for CFCs and HCFCs in refrigeration and air-conditioning equipment, and one cement company was increasing its production in 2007.

In 2007, the solvent and other product use sector was a minor contributor to New Zealand's total greenhouse gas emissions, being responsible for 43.4 Gg $CO_2$-e (less than 1 per cent) of total emissions. The waste sector accounted for 1821.8 Gg $CO_2$-e (2 per cent) of total emissions in 2007, a decrease of 616.4 Gg (25 per cent) from the 1990 level of 2438.2 Gg $CO_2$-e. This decrease was the result of initiatives to improve solid waste management practices in New Zealand.

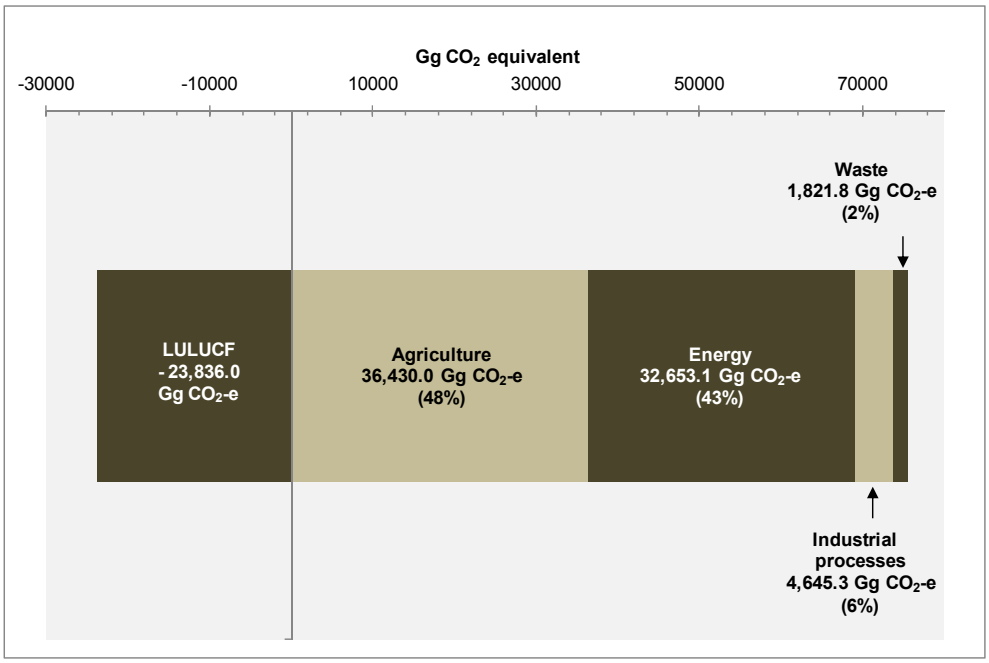
In the LULUCF sector, net removals were estimated at 23,836.0 Gg $CO_2$-e in 2007, an increase of 5697.5 Gg (31 per cent) from the 1990 level of 18,138.5 Gg $CO_2$-e. LULUCF removals fluctuate with the planting and harvesting of New Zealand's planted forest.

**Table 3.2: New Zealand's emissions of greenhouse gases, by sector, 1990 and 2007**

| Sector | Gg $CO_2$-e 1990 | 2007 | Change from 1990 (Gg $CO_2$-e) | Change from 1990 (%) |
|---|---|---|---|---|
| Energy | 23,452.8 | 32,653.1 | 9,200.3 | 39 |
| Industrial processes | 3,409.2 | 4,601.9 | 1,192.7 | 35 |
| Solvent and other product use | 41.5 | 43.4 | 1.9 | 5 |
| Agriculture | 32,511.1 | 36,430.0 | 3,918.9 | 12 |
| Waste | 2,438.2 | 1,821.8 | -616.4 | -25 |
| Total (excluding LULUCF) | 61,852.8 | 75,550.2 | 13,697.4 | 22 |
| LULUCF (including $CH_4$ & $N_2O$) | -18,138.5 | -23,836.0 | -5,697.5 | 31 |
| **Net total (including LULUCF)** | **43,714.3** | **51,714.2** | **7,999.9** | **18** |

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

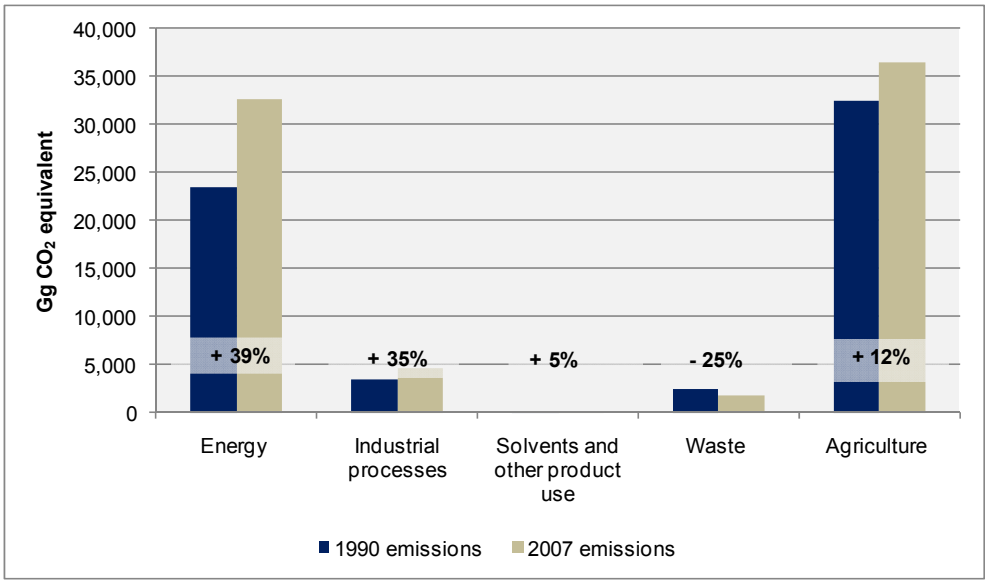
**Figure 3.6: New Zealand's total greenhouse gas emissions, by sector, 2007**




**Note:** The Industrial processes emissions shown here include emissions from the solvent and other product use sector.

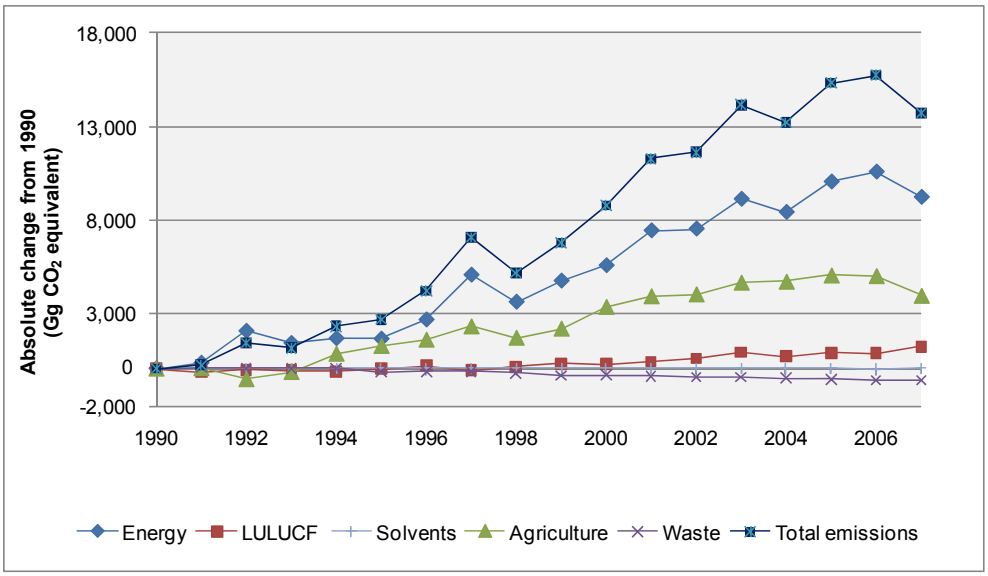
**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

**Figure 3.7: Change in New Zealand's greenhouse gas emissions, by sector, 1990–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

**Figure 3.8: Trends in New Zealand's greenhouse gas emissions, by sector, 1990–2007**



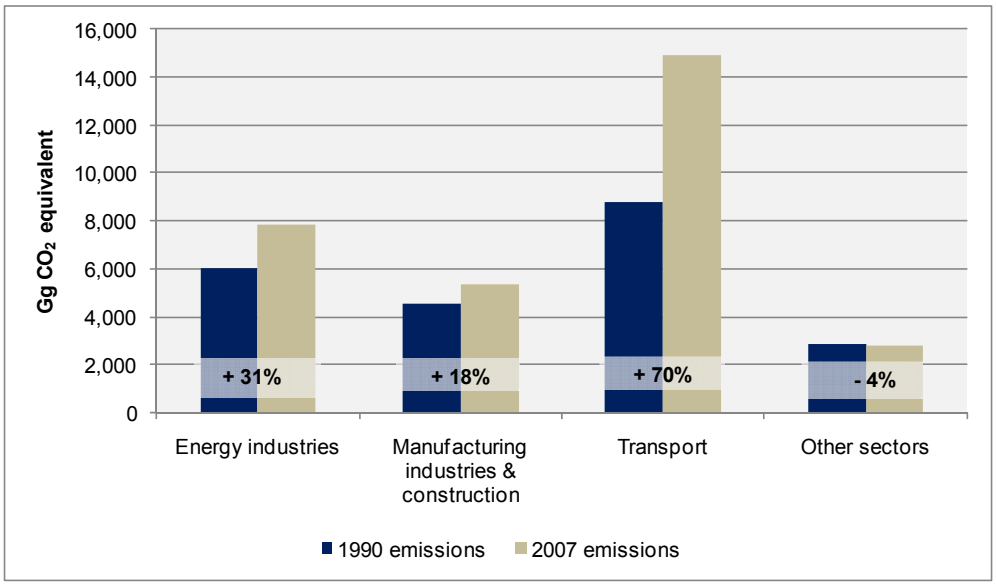

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

## 3.5.2 Energy sector

In 2007, the energy sector produced 32,653.1 Gg $CO_2$-e, representing 43 per cent of New Zealand's total greenhouse gas emissions. These emissions were 39 per cent (9200.3 Gg) above the 1990 level of 23,452.8 Gg $CO_2$-e. The sources contributing most to this increase were public electricity and heat production combined, with an increase of 3167.9 Gg $CO_2$-e (91 per cent), and road transportation, with an increase of 5832.9 Gg $CO_2$-e (76 per cent).

Emissions from the manufacture of solid fuels and the other energy industries have decreased by 1442.2 Gg $CO_2$-e (81 per cent) from 1990. This decrease is mainly due to stopping synthetic petrol production in New Zealand in 1997.

**Figure 3.9: Change in New Zealand's emissions from fuel combustion, by sector, 1990–2007**

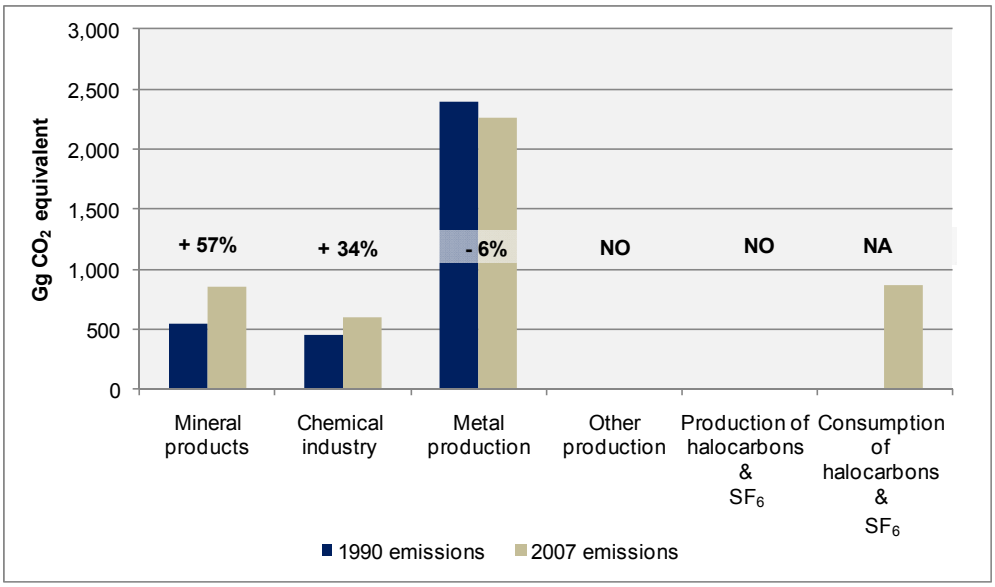



**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

### 3.5.3 Industrial processes sector

Greenhouse gas emissions from New Zealand's industrial processes sector were 4601.9 Gg $CO_2$-e in 2007, contributing 6 per cent of total emissions. This represents an increase of 1192.7 Gg (35 per cent) above the 1990 level of 3409.2 Gg $CO_2$-e. The sources contributing the most to this increase were mineral products (an increase of 312.8 Gg $CO_2$-e, or 57 per cent), emissions from the chemical industry (an increase of 153.1 Gg $CO_2$-e, or 34 per cent), and emissions from synthetic gases (236.5 Gg $CO_2$-e).

**Figure 3.10: Change in New Zealand's emissions from industrial processes, by sector, 1990–2007**




**Notes:** The activities in the "other production" category and the production of halocarbons and sulphur hexafluoride ($SF_6$) are not occurring (NO) within New Zealand.

The percentage change for the consumption of halocarbons and sulphur hexafluoride is not applicable (NA) because there was no consumption of HFCs within New Zealand in 1990.

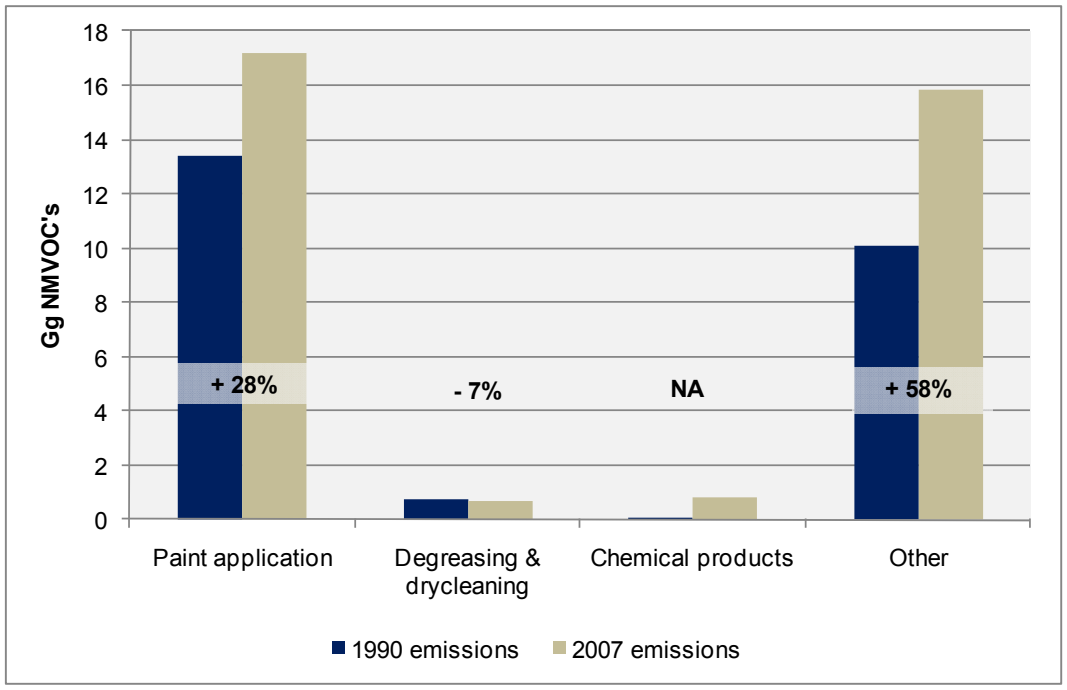
**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

## 3.5.4 Solvents and other product use sector

In 2007, emissions from the solvent and other product use sector comprised 34.5 Gg of non-methane volatile organic compounds (NMVOCs).[32] This was an increase of 10.2 Gg (42 per cent) from the 1990 level of 24.3 Gg. The sources dominating the sector were NMVOC emissions from paint application, and other domestic and commercial use (figure 3.11).

[32] NMVOCs are not measured in carbon dioxide equivalent because the metric used to calculate quantities in carbon dioxide equivalent does not currently include these gases.

**Figure 3.11: Change in New Zealand's emissions of NMVOCs from the solvent and other product use sector, 1990–2007**




**Note:** The percentage change for chemical products is not applicable (NA) because there is no activity data available for 1990.

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

## 3.5.5 Agricultural sector

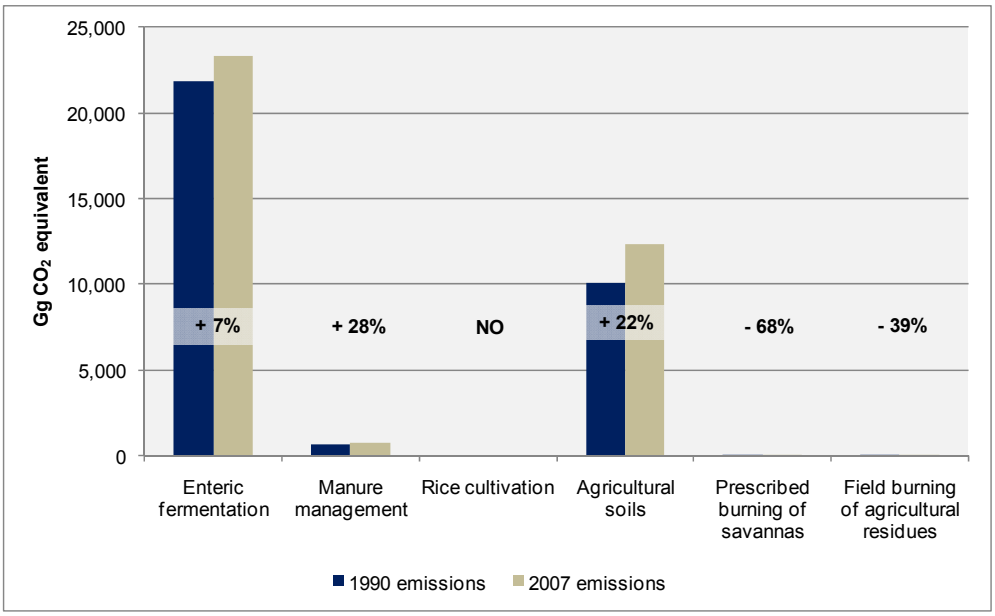
In 2007, the agricultural sector contributed 36,430.0 Gg $CO_2$-e (48 per cent) of New Zealand's total emissions, an increase of 3918.9 Gg (12 per cent) from the 1990 level of 32,511.1 Gg $CO_2$-e. This increase was primarily due to a 1507.4 Gg $CO_2$-e (7 per cent) increase in methane emissions from the enteric fermentation category, and a 2254.7 Gg $CO_2$-e (22 per cent) increase in nitrous oxide emissions from the agricultural soils category (figure 3.12).

Since 1990, there have been changes in the proportions of the main livestock species farmed in New Zealand: an increase in dairy and deer production because of high world demand and favourable prices, counterbalanced by land coming out of sheep production and decreasing sheep numbers. Beef numbers have remained relatively static. Productivity has increased across all major animal species and classes.

The land area used for horticulture increased by 50 per cent from 1990 to 2007, and the types of produce grown have changed, with less cultivated land area used for barley, wheat and fruit but more for grapes (for wine production) and vegetables than in 1990. There has also been a net increase in land planted in forestry, thereby taking land out of agricultural production.

There was a gradual increase in the implied emission factors for dairy cattle and beef cattle from 1990 to 2007. This is expected because the New Zealand inventory methodology uses annual animal performance data that reflects the increased levels of productivity achieved by New Zealand farmers since 1990.

**Figure 3.12: Change in New Zealand's emissions from the agricultural sector, 1990–2007**




**Note:** Rice cultivation does not occur (NO) in New Zealand.

Emissions from "Prescribed burning of savannahs" and "Field burning of agricultural residues" are 0.1 per cent of total agricultural emissions.

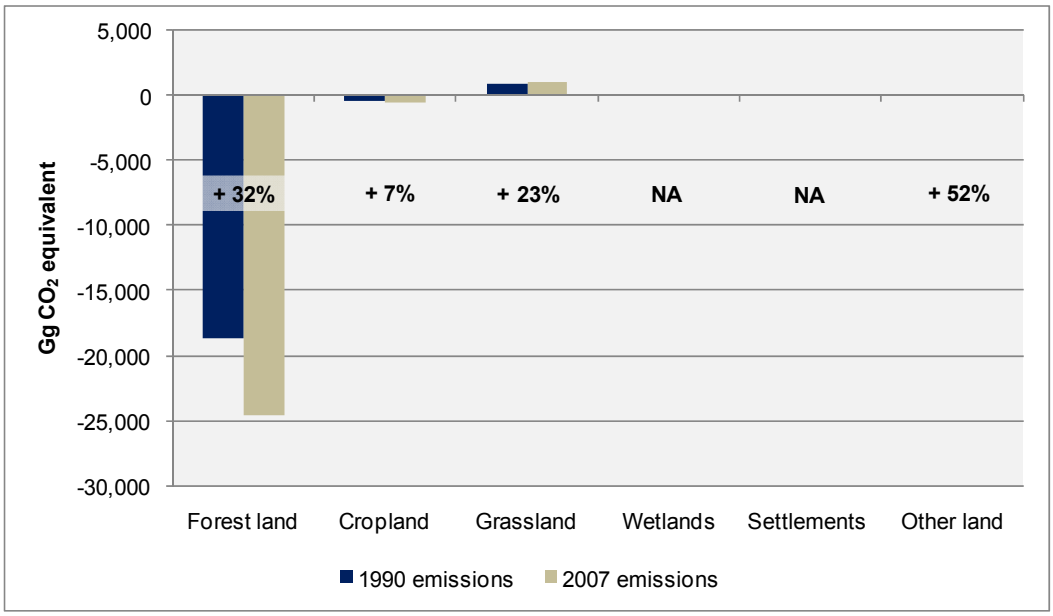
**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

## 3.5.6 Land use, land-use change and forestry (LULUCF) sector

In New Zealand the LULUCF sector is a net carbon sink. In 2007, net removals from the LULUCF sector were 23,836.0 Gg $CO_2$-e, an increase of 5697.5 Gg (31 per cent) over the 1990 removals of 18,138.5 Gg $CO_2$-e. Figure 3.13 shows changes in emissions and removals, by land-use category, from 1990 to 2007.

The 2009 inventory submission includes a provisional estimate of 10,000 hectares of deforestation in 2007. Updated information indicates the area of deforestation in 2007 was in the range of 15,000 to 20,000 hectares. A provisional calculation using the updated information indicates that LULUCF net removals are in the vicinity of 19,000 to 21,000 Gg $CO_2$-e. The recalculation for the updated area will be included in the 2010 submission.

**Figure 3.13: Change in New Zealand's emissions/removals from the LULUCF sector (net emissions and removals), by land-use category, 1990–2007**




**Note:** The percentage change for wetlands and settlements is not applicable (NA) because emissions are assumed to be constant. These two categories are not key categories.

**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007.* Wellington: Ministry for the Environment.

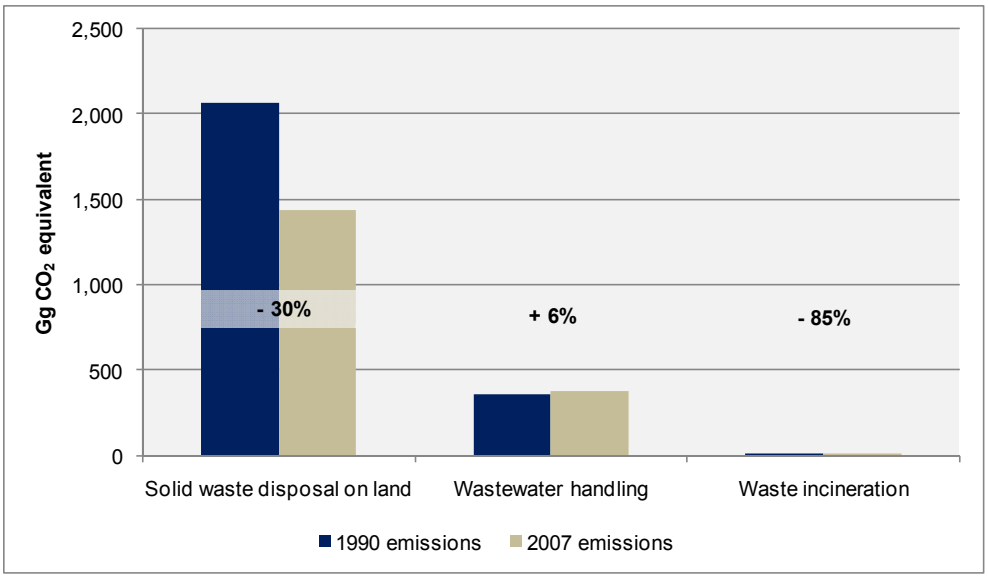
To improve the transparency and accuracy of reporting in the LULUCF sector, and to meet the supplementary reporting requirements for Article 3.3 of the Kyoto Protocol, New Zealand has developed the Land Use and Carbon Analysis System (LUCAS).[33] The land categories mapped and monitored through LUCAS are designed specifically for reporting under the Convention and the Kyoto Protocol. Initial results from LUCAS were produced in June 2009 and will be reported in New Zealand's 2010 inventory submission onwards.

## 3.5.7 Waste sector

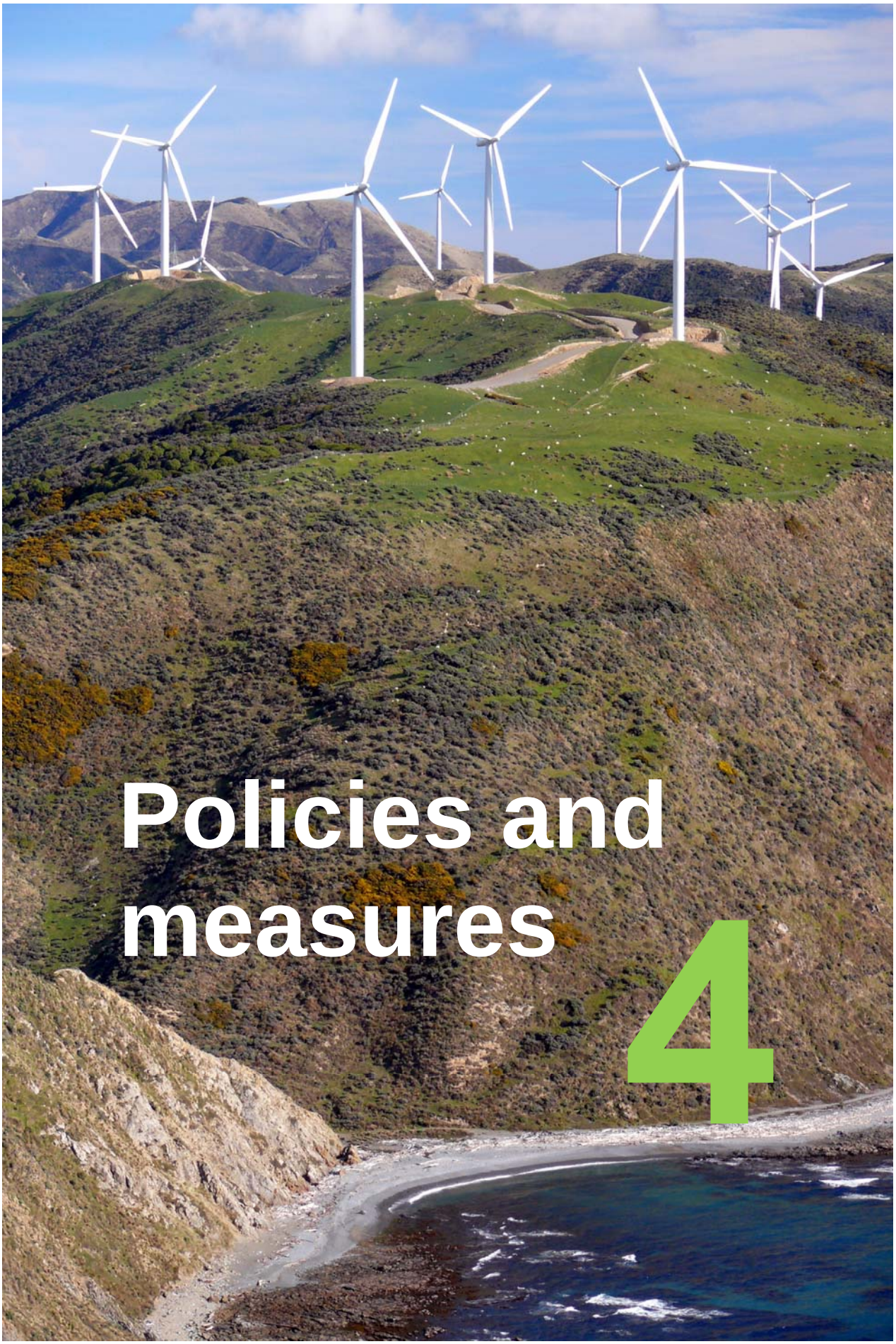
In 2007, the waste sector accounted for 1821.8 Gg $CO_2$-e (2 per cent) of total emissions, which was 616.4 Gg (25 per cent) below the 1990 baseline value of 2438.2 Gg $CO_2$-e. This reduction occurred in the "solid waste disposal on land" subcategory (figure 3.14) as a result of initiatives to improve solid waste management practices and increase the rate of landfill gas capture in New Zealand.

[33] Ministry for the Environment. 2009. *Looking at LUCAS.* http://www.mfe.govt.nz/publications/climate/looking-at-lucas/index.html (16 September 2009).

**Figure 3.14: Change in New Zealand's emissions from the waste sector, 1990–2007**




**Source:** Ministry for the Environment. 2009. *New Zealand's Greenhouse Gas Inventory 1990–2007*. Wellington: Ministry for the Environment.



# Policies and measures

# 4

# 4 Policies and measures

## 4.1 Introduction

New Zealand initiated its response to climate change in 1988 with the establishment of the New Zealand Climate Change Programme, coordinated by the Ministry for the Environment. The programme has steadily evolved and now spans several government departments and agencies. A group comprised of the relevant government agencies' chief executives (the Natural Resources Sector Group) provides governance for the coordination of environmental policy, including climate change. The history of New Zealand's climate change response and governmental decisions until 2006 are set out in *New Zealand's Fourth National Communication*.[34]

During 2008–2009, the Government undertook a comprehensive review of climate change policies, in particular, the New Zealand Emissions Trading Scheme. The aim of the review was to ensure the Government's policy response to climate change is appropriate, given New Zealand's national circumstances. During this time, the Government also announced emissions reduction targets for 2020 and 2050.

### 4.1.1 Key targets

The Government has set two national targets for reducing New Zealand's greenhouse gas emissions.

- A medium-term responsibility target of a 10 to 20 per cent reduction in emissions below 1990 levels by 2020.
- A long-term target of a 50 per cent reduction in net greenhouse gases from 1990 levels by 2050.

The medium-term target range reflects a fair contribution by New Zealand to the international effort to reduce greenhouse gas emissions. This is because New Zealand's national circumstances (including already high levels of renewable electricity generation and a large proportion of emissions from agriculture) make the cost of mitigation higher than for most other developed countries. The decision on the target range was made after considering efforts pledged by other Annex 1 countries, environmental, social and economic factors, international relations aspects, and the results of public consultation.

A 'responsibility target' means that it is expected that New Zealand will meet its target through a mixture of domestic emission reductions, the storage of carbon in forests, and the purchase of emission reduction units in other countries. The 2020 target is conditional on the level of global ambition agreed to at international negotiations and on international rules relating to land use, land-use change and forestry, and recourse to carbon markets for compliance.

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[34] *New Zealand's Fourth National Communication under the United Nations Framework Convention on Climate Change* is available at http://www.mfe.govt.nz/publications/climate/national-communication-2006/index.html

## 4.2 Policy context for climate change

### 4.2.1 Key strategies

The Government's principal policy response to climate change is the New Zealand Emissions Trading Scheme (NZ ETS). In various policy areas (such as energy), the Government is also undertaking a range of measures that are contributing to reducing greenhouse gas emissions while achieving other policy goals. New Zealand policy also includes measures to promote adaptation to changes in the climate (see chapter 6).

The Government's policy direction and priorities on energy will be described in the New Zealand Energy Strategy, which is being updated during 2009 and 2010. Energy efficiency is also a priority, and the New Zealand Energy Efficiency and Conservation Strategy sits under the New Zealand Energy Strategy. The Energy Efficiency and Conservation Strategy provides more detail on measures to increase the uptake of energy efficiency, energy conservation and renewable energy programmes across the economy. The Energy Efficiency and Conservation Strategy is also being updated during 2009 and 2010.[35]

The New Zealand Waste Strategy is an action plan that sets out the Government's targets and policies for managing waste in New Zealand. The plan covers solid, liquid and gaseous wastes.[36]

The New Zealand Transport Strategy outlines the Government's vision for the transport system to 2040, along with the strategic approach taken to achieve this vision. This strategy also provides a framework for the transport activities of Crown entities and guidance for local authorities.[37]

### 4.2.2 Roles and responsibilities

The Ministry for the Environment is responsible for coordinating climate change policy across government. However, the implementation of specific climate change policies, once agreed to by the Government, is led by other relevant departments. The following agencies execute functions relevant to climate change policy.

- The Ministry for the Environment is responsible for leading the development of the emissions trading legislation and for the development of allocation plans and regulations under the scheme. The Ministry is also responsible for reporting under the United Nations Framework Convention on Climate Change (the Convention) and the Kyoto Protocol.
- The Ministry of Transport contributes to the NZ ETS, and leads work on biofuels, electric vehicles, other alternative fuels and technologies and the energy efficiency of commercial fleets.
- The Ministry of Agriculture and Forestry contributes to government policy on climate change in a number of areas, including policy development and implementation of the NZ ETS, the Climate Change Plan of Action, and a range of other funding and research activities relating to agriculture and forestry policy.

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35 The New Zealand Energy Strategy and the Energy Efficiency and Conservation Strategy are available at http://www.med.govt.nz/templates/ContentTopicSummary____19431.aspx

36 The New Zealand Waste Strategy is available at http://www.mfe.govt.nz/publications/waste/waste-strategy-mar02/

37 The New Zealand Transport Strategy is available at http://www.transport.govt.nz/ourwork/KeyStrategies/Pages/new-zealand-transport-strategy.aspx

- The Ministry of Economic Development is responsible for energy policy and the management of the New Zealand Emission Unit Register. The Ministry of Economic Development is also involved in research into carbon capture and storage, energy information and modelling, and exploring the use of oil, natural gas, geothermal and alternative fuels.
- The Electricity Commission is responsible for regulating the operation of the electricity industry and markets. It also promotes and facilitates the efficient use of electricity.
- The Ministry of Foreign Affairs and Trade is responsible for leading New Zealand's international climate change negotiations. A number of other agencies contribute to and support this work.
- The Energy Efficiency and Conservation Authority is responsible for promoting the efficient use of energy and the use of renewable energy, for encouraging the conservation of New Zealand's energy reserves, and for developing research into new renewable energy and energy efficient technologies.
- The Treasury provides information, research and economic perspectives on climate change policy.
- The Ministry of Research, Science and Technology has a role in promoting New Zealand's innovation system by providing science and technology policy advice to the Government, some of which relates to climate change.
- The Foundation for Research, Science and Technology is responsible for investing money in science and research on behalf of the New Zealand Government, including research on climate change.
- The Department of Conservation is responsible for conserving the natural and historical heritage of New Zealand. It also manages large tracts of native forest and provides policy advice on climate change issues, where they relate to and intersect with conservation issues.
- Local authorities (regional, district and unitary authorities) have the primary responsibility for regulating resource use in New Zealand and for promoting the environmental, social, cultural and economic well-being of communities. Many local authorities are active in promoting emissions reductions policies and measures in their respective regions.

## 4.3 Policies and measures, and their effects

In preparing this chapter, New Zealand has followed the revised reporting guidelines for the preparation of national communications. Relevant UNFCCC decisions and conclusions have also been taken into account. Consistent with the *Reporting Guidelines on National Communications*, this chapter does not include all of New Zealand's policies and measures that mitigate greenhouse gas emissions.[38] Instead, it focuses on those that have the most significant effect on emissions, or are innovative or easily replicable by other parties. A summary of the policies and measures reported in this chapter is presented in table C.1, in Annex C.

[38] http://unfccc.int/resource/docs/cop5/07.pdf

### 4.3.1 Cross-cutting measures

#### The New Zealand Emissions Trading Scheme (NZ ETS)

In December 2006, the Government released a discussion document outlining a domestic emissions trading scheme as its preferred policy response to climate change. Over nine months the Government consulted with the public, non-government organisations, businesses and Māori and iwi leaders on the proposal.[39] Under the scheme, participants would have to surrender one emission reduction unit to the Government for every tonne of greenhouse gas they emitted.[40] Trade-exposed industries would receive an allocation of free emission units that would be phased out gradually over time.[41] The proposed scheme, when fully implemented, would cover all sectors and all gases and allow linking to other emissions trading schemes.[42]

Legislation implementing the NZ ETS was passed in September 2008,[43] and the first sector (forestry) entered the scheme retrospectively on 1 January 2008. In November 2008, following a change of government, the Minister for Climate Change Issues announced that the Government would undertake a comprehensive review of climate change policies, and of the NZ ETS in particular. A parliamentary select committee considered the relative merits of alternative climate change policies and reviewed the NZ ETS.

In November 2009, the Government passed legislation modifying the NZ ETS. The purpose of the modifications was to ease the effect of the scheme on the economy, particularly in the transition period as the scheme takes effect. The key changes to the scheme are that:

- agriculture will enter the scheme in 2015 rather than 2013
- stationary energy and industry will enter the scheme in July 2010 rather than January 2010, allowing extra time to develop the necessary regulations for the sectors' entry
- liquid fossil fuels will enter the scheme in July 2010, six months ahead of the former entry date of January 2011
- the Government will provide emission units for immediate surrender at a capped price of NZ$25 until 2013
- until 2013 participating sectors (aside from forestry) will need to surrender one unit for every two tonnes of emissions
- free allocation will be given to the most emission-intensive, trade-exposed industry (including agriculture) on an intensity basis, and will be phased out at a slower rate (industry that is not emission intensive and trade exposed will not receive free allocation).

The NZ ETS will be reviewed every five years, with the first review to be carried out in 2011.

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39 Māori are the indigenous people of New Zealand. An iwi is one of the larger collective Māori groupings and is sometimes described as a tribe.

40 Measured in carbon dioxide equivalent, using global warming potentials.

41 'Trade-exposed' industries are those that face competition from countries that do not impose a carbon price on that industry.

42 Including carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride from the following sectors: forestry, agriculture, waste, stationary energy, liquid fossil fuels and industrial processes and synthetic gases. See http://www.climatechange.govt.nz/emissions-trading-scheme/index.html for more information.

43 Climate Change Response (Emissions Trading) Amendment Act 2008.

The allocation plans, and regulations are being developed by the Ministry for the Environment, with the assistance of other government departments, notably the Treasury, the Ministry of Economic Development and the Ministry of Agriculture and Forestry.

The Emission Unit Register records all transactions of international units. The register is maintained by the Ministry of Economic Development, in conjunction with the Kyoto Protocol unit register.

**Other information**

*Greenhouse gases affected:* all greenhouse gases covered by the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride.

*Quantitative effect of the policy/measure:* the NZ ETS is projected to reduce New Zealand's net emissions by approximately 10,000.0 Gg $CO_2$-e per year in 2020. This is comprised of a reduction in total emissions (excluding forestry) of approximately 7000 Gg $CO_2$-e, and a reduction in forestry emissions of approximately 3000 Gg $CO_2$-e. See chapter 5 for further details[44]

*Type of policy or measure:* economic, regulatory

*Implementing entity:* the Ministry of Economic Development administers the register and enforces the scheme. The Ministry for the Environment develops regulations for the NZ ETS. The Ministry of Agriculture and Forestry administers the forestry allocation plan and compliance with forestry regulations

*Status of implementation:* implemented

*More information*: on the details of the NZ ETS can be found at http://www.climatechange.govt.nz/emissions-trading-scheme/index.html, and the register can be viewed at http://www.eur.govt.nz/eats/nz/

## 4.3.2 Energy

The Ministry of Economic Development is responsible for developing energy policy in New Zealand. During 2009 and 2010, the Ministry is preparing an update to the Government's high-level statement of energy policy, the New Zealand Energy Strategy. The New Zealand Energy Efficiency and Conservation Strategy is a statutory document produced under the Energy Efficiency and Conservation Act 2000. The Energy Efficiency and Conservation Strategy aims to improve energy efficiency and conservation, and increase the use of renewable energy across the economy. It is also being updated in 2009 and 2010.

### Energy supply and renewable energy

New Zealand has abundant and diverse renewable energy resources, and on average around two-thirds of electricity generated in New Zealand is derived from renewable sources. Most of this comes from hydro-electric power. There is considerable potential to further develop

[44] This estimate has been prepared by government departments (as set out in chapter 5).

renewable resources for electricity generation, replacement fuels for oil and gas and the production of direct heat.

The Government has a target for the energy sector that 90 per cent of New Zealand's electricity will be generated from renewable sources by 2025.[45] There is no government subsidy for new electricity generation in New Zealand. The Government's role is to oversee the electricity market and to remove any unnecessary regulatory barriers to the development of renewable generation. Most projects being planned and built use geothermal and wind energy as these sources are the most cost-effective options.

To increase awareness of the issues and opportunities relating to energy supply and renewable energy, the Government is providing consumers and industries with information on the available technologies and advantages of biofuels, distributed generation and marine energy. It is also providing funds for the development of renewable technologies.

### *Marine Energy Deployment Fund*

In October 2007 the Government established a four-year, $8 million Marine Energy Deployment Fund, aimed at supporting the deployment of generating devices that convert wave or tidal energy into electricity. The fund provides grants to deploy pre-commercial devices in the New Zealand marine environment.

The first recipient of funding received NZ$1.85 million to partially fund the first stage of an underwater power station comprising up to three tidal turbines at the entrance to Kaipara Harbour, north of Auckland. The second funding round was completed in May 2009, and NZ$760,000 was awarded to support a trial of a pre-commercial device with a peak capacity of 20 kilowatts (kW).

### *Distributed Generation Fund*

Distributed generation refers to small-scale power generation technologies (typically in the range of 3 kW to 10,000 kW) used to generate electricity from many small sources. Distributed generation projects include the use of wind turbines, photovoltaics (solar electricity), hydro turbines, geothermal heat, bio-energy, cogeneration and diesel or gas turbines.

Set up in 2008, the Distributed Generation Fund provides financial assistance for the completion of feasibility studies to investigate distributed generation projects which use renewable energy sources. Under the fund, the Energy Efficiency and Conservation Authority (the EECA) provides part-funding (up to 75 per cent or $20,000) for eligible feasibility studies. Feasibility studies funded under the Distributed Generation Fund have included small wind farms and wind turbines, micro hydro-electricity schemes, and the use of biogas derived from industrial waste products.

[45] In an average hydrological year.

**Other information**

*Greenhouse gases affected:* carbon dioxide, nitrous oxide

*Quantitative effect of the policy/measure:* in 2020, the measures implemented in the next three years are expected to provide 0.6PJ of renewable electricity and avoid 70.0 Gg of greenhouse gas emissions annually

*Type of policy or measure*: fiscal and information

*Implementing entity*: Energy Efficiency and Conservation Authority

*Status of implementation*: implemented

*More information is available on*:

- the marine energy fund at: http://www.eeca.govt.nz/node/1300
- the distributed generation fund at: http://www.eeca.govt.nz/distributed-generation-fund

## Improving energy efficiency

The EECA is the primary government agency responsible for encouraging more efficient use of energy. The agency runs programmes in various sectors to improve energy efficiency as well as promoting the use and development of renewable sources of energy. The Electricity Commission also runs programmes specifically to promote efficient use of electricity.

## Efficient products programmes

New Zealand works with Australia on a joint programme called the Equipment Energy Efficiency (E3) Programme.[46] Since 2006, this programme has been developing energy efficiency labels and mandatory performance standards for a range of commonly used electrical residential, commercial and industrial products, allowing both countries to set consistent standards and measures for energy efficiency.

As described below, the programme reduces emissions from electricity generation by enabling consumers to assess and compare the energy efficiency of a product when purchasing appliances. New Zealand also operates a voluntary product endorsement scheme (ENERGY STAR) to encourage consumers to purchase more efficient products.

### *Minimum energy performance standards (MEPS)*

Minimum energy performance standards ensure the most inefficient products are not available for sale. Under the standards, products must be tested and shown to meet a minimum standard for energy efficiency before they can be sold. MEPS are currently in place for eight product classes in New Zealand: air conditioners / heat pumps, distribution transformers, domestic fridges and freezers, electric hot water cylinders, fluorescent lamps, ballasts for fluorescent lamps, refrigerated display cabinets, and three-phase electric motors.

[46] http://www.energyrating.gov.au/naeeep.html

### *Compulsory product labelling*

Product labelling regulations require retailers of all whiteware appliances and heat pumps to provide energy efficiency information to consumers at the point of sale. The labels assess how much electricity the appliance is likely to use in a year (on average) and provide a star rating that compares the appliance's efficiency to other appliances of its type (see figure 4.2 for an example).

As with MEPS, mandatory labels in New Zealand align with those set by the Australian Government. Products covered by MEPS and/or labelling, and the relevant standards, are listed in schedules 1 and 2 of the Energy Efficiency (Energy Using Products) Regulations 2002.[47] Regulations in both Australia and New Zealand specify the general requirements for MEPS and labelling, including offences and the penalties if a party does not comply with the requirements.

**Figure 4.1: Example of an energy efficiency rating label**


### *Voluntary product labelling – ENERGY STAR®*

ENERGY STAR® is an independent, international programme that awards labels to only the most energy efficient products on the market.[48] The EECA is responsible for implementing the programme in New Zealand.

Established by the United States Department of Energy, the ENERGY STAR® programme takes into account a range of environmental standards when assessing the appliances. These labels make it easier for consumers to identify and purchase the most energy efficient products and reduce their electricity use.

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47 http://www.legislation.govt.nz/regulation/public/2002/0009/latest/DLM108730.html?search=ts_regulation_Energy+Efficiency+(Energy+Using+Products)+Regulations+2002_resel&sr=1

48 ENERGY STAR® is typically available to only the top 25 per cent of products in a class, based on energy efficiency.

ENERGY STAR® was launched in New Zealand in 2005, and by November 2008 coverage had been extended to 13 product classes. It is expected that an additional 12 product classes will be included in the programme by the end of 2012. The products currently included in the programme in New Zealand are: dishwashers, fridges, freezers, washing machines, audio equipment, DVD players, televisions, set-top boxes, imaging equipment, computers, monitors/displays, heat pumps and compact fluorescent lamps.

**Figure 4.2: The ENERGY STAR® mark**


### Other information

*Greenhouse gases affected:* carbon dioxide

*Quantitative effect of the policy/measure:* in 2020, the measures implemented in the efficient products programme are projected to save 10PJ of energy and avoid 1,400.0 Gg of carbon dioxide emissions[49]

*Type of policy or measure:* regulatory, voluntary, information

*Implementing entity:* Energy Efficiency and Conservation Authority

*Status of implementation:* implemented

*More information is available:*

- on minimum performance energy standards and labelling at: http://www.eeca.govt.nz/standards-and-ratings/minimum-energy-performance-standards-and-labelling
- on product models registered under MEPS in New Zealand and Australia at: http://www.energyrating.gov.au/man1.html
- on the ENERGY STAR® programme at: http://www.eeca.govt.nz/eeca-programmes-and-funding/programmes/efficient-products

[49] This is a maximum potential savings projection and includes projected savings from autonomous energy efficiency intensity improvements.

## Business programmes

The EECA runs several programmes to support businesses to become more energy efficient. It provides information on new technologies and energy management, grants for energy audits and demonstrations of new technology, and one-on-one support for energy-intensive businesses.[50]

Grant funding is available for energy and design audits. Energy audits analyse a business's current energy use and pinpoint where savings can be made. Design audits analyse the energy efficiency of premises or facilities yet to be constructed and propose design changes to make them more efficient. Grant funding is also available for new or under-utilised technology improvements. Up to 40 per cent of the total project cost is available (up to $100,000), or up to 75 per cent of the cost of a feasibility study (up to $10,000) for new technologies. Examples of technologies recently funded include fans and boiler controls, bio-digesters and heat recovery systems.

The EECA works directly with energy-intensive businesses on their energy management and works with industry associations in energy-intensive industries to promote best practice in energy management.

**Other information**

*Greenhouse gases affected:* carbon dioxide, nitrous oxide

*Quantitative effect of the policy/measure:* implementation of these measures is projected to reduce energy demand by 0.4 PJ and emissions by 32 Gg $CO_2$-e in 2020[51]

*Type of policy or measure:* voluntary, information, fiscal

*Implementing entity*: Energy Efficiency and Conservation Authority

*Status of implementation:* implemented

*More information is available at:* http://www.eeca.govt.nz/eeca-programmes-and-funding/programmes/business and http://www.eecabusiness.govt.nz

## ENERGYWISE homes

The EECA's ENERGYWISE programme aims to increase energy efficiency in New Zealand homes by providing information, grants and interest subsidies for energy efficiency initiatives. The programme also provides information on the funding available to reduce energy consumption, including clean heating options, solar water heating and installing heat-pump water heating.

### *Warm up New Zealand: Heat Smart*

Warm up New Zealand: Heat Smart is the principal energy efficiency programme for the residential sector. The aim of the programme is to deliver information and grants for the

[50] Energy intensive businesses are those that spend more than $500,000 per year on energy.

[51] This is a maximum potential savings projection and includes projected savings from autonomous energy efficiency intensity improvements.

installation of energy efficiency measures and clean heating devices in homes built prior to 2000.[52] The scheme offers to pay – without income restriction – one-third of the cost of installing ceiling and under-floor insulation (up to NZ$1300). Homes with sufficient ceiling and under-floor insulation may also get access to funding for clean heating devices of up to NZ$500.

People on lower incomes are eligible for higher levels of funding: up to 60 per cent of the total cost of the insulation package and $1200 towards a clean heating appliance, provided the home is first insulated. Landlords whose tenants hold a Community Services Card (ie, they are low income earners) can also receive the 60 per cent subsidy and up to NZ$500 for the clean heating device, provided the home is first insulated.

This programme aims to retrofit more than 180,000 New Zealand homes over the next four years.

**Other information**

*Greenhouse gases affected:* carbon dioxide, nitrous oxide

*Quantitative effect of the policy/measure:* 20Gg carbon dioxide equivalent annually by 2020.

*Type of policy or measure:* information, fiscal

*Implementing entity:* Energy Efficiency and Conservation Authority

*Status of implementation:* implemented

*More information is available on:*

- the ENERGYWISE homes programme at: http://www.energywise.govt.nz/how-to-be-energy-efficient and http://www.eeca.govt.nz/eeca-programmes-and-funding/programmes/homes
- the Warm up New Zealand: Heat Smart programme at: http://www.eeca.govt.nz/node/3107

## Electricity efficiency programmes

The Electricity Commission runs programmes that focus on improving the efficiency of electricity use. The Commission has developed electricity efficiency programmes which focus on the areas of greatest potential savings.[53]

### *Efficient Lighting Programme*

The KEMA Potentials Study estimated lighting was the single biggest area of potential energy efficiency savings. Lighting constitutes 8 per cent of electricity consumed in New Zealand homes, and constitutes 14 per cent of electricity used in commercial and public buildings. It is

[52] Clean heating devices approved by the EECA include specified wood burners, pellet burners, heat pumps and flued gas heaters.

[53] The Electricity Commission bases its programmes on the KEMA Potentials Study, published in 2007. The study is available at http://www.electricitycommission.govt.nz/opdev/elec-efficiency/approach/potentials/index.html. KEMA is an international consulting firm specialising in energy issues.

estimated that 2.65 million tonnes of greenhouse gas emissions are generated annually to meet New Zealand's lighting needs.

In 2008, the Efficient Lighting Strategy was published. The goals of the strategy are to eliminate the main types of inefficient lighting, and to increase the use of efficient lighting design and controls, across all sectors.

To increase the use of efficient lighting, the Electricity Commission subsidises energy-efficient bulbs. During 2007/08 the Electricity Commission subsidised the sale of 2.2 million energy-efficient bulbs, significantly increasing both market share and consumer awareness of efficient bulbs.

### *Commercial sector programmes*

The Electricity Commission offers financial assistance to businesses in the commercial sector to improve their electricity efficiency. The programmes allow businesses to apply for part-funding from the Electricity Commission for electricity efficiency projects where there is a current barrier preventing such projects from proceeding. These programmes include efficiency projects for commercial buildings, of which 75 projects were established by June 2009. Projects funded so far include electricity efficiency enhancements in several hospitals, office buildings, a tertiary educational institute, and retail outlets. These projects target efficiency measures such as upgrades of building management systems, lighting replacements, replacement of inefficient chiller systems, and installation of monitoring and targeting systems.

### *Industrial sector programme*

The Electricity Commission's industrial sector electricity efficiency programme focuses on motorised systems efficiency.

The Electric Motors Bounty Scheme provides a direct incentive to motor users to upgrade their electric motors. Under the Bounty Scheme, motor users are paid for the removal (and permanent disabling) of lower-efficiency, three-phase motors that are replaced with MEPS 2006-compliant motors. The scheme is for three-phase motors with capacities of 22kW to 185kW.

The Electricity Commission is also running a pilot Compressed Air Systems programme. Under this programme, subsidies are available for audits of compressed air systems for their energy efficiency. The Electricity Commission is also working to train and accredit auditors to enhance industry capacity to undertake energy audits of compressed air systems.

**Other information**

*Greenhouse gases affected:* carbon dioxide, nitrous oxide

*Quantitative effect of the policy/measure:* the efficient lighting programme is estimated to reduce emissions by 81 Gg carbon dioxide equivalent per year as of September 2009. The industrial and commercial programmes reduce carbon dioxide equivalent emissions by a further 8 Gg annually

*Type of policy or measure:* information, fiscal

*Implementing entity:* Electricity Commission

*Status of implementation:* implemented

*More information is available on:*

- the Efficient Lighting Programme at: http://www.electricitycommission.govt.nz/opdev/elec-efficiency/programmes/lighting/index.html
- the commercial sector programmes at: http://www.electricitycommission.govt.nz/opdev/elec-efficiency/programmes/commercial
- the industrial sector programmes at: http://www.electricitycommission.govt.nz/opdev/elec-efficiency/programmes/industrial/index.html

### Energy efficiency in government

The EECA provides support for central and local government entities to implement energy efficiency initiatives within their own operations. Under the Crown Energy Efficiency Loans Scheme, government entities can access funding for energy efficiency and renewable energy projects. Priority is given to projects that are cost effective and can be easily replicated.

One example of a project under the scheme is the development of a new West Auckland hospital by the Waitemata District Health Board. The EECA provided grant funding for an energy audit of the design, and a loan of $293,000 to support additional energy efficiency measures. These included more insulation, high-efficiency lighting and a low-loss ducting system for ventilation, heating and air conditioning. The measures were calculated to save $76,000 of electricity, gas and electricity charges a year, which would repay the loan in four years. The energy savings would avoid 476 tonnes of $CO_2$ emissions a year.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme have not been quantified

*Type of policy or measure*: fiscal, information

*Implementing entity:* Energy Efficiency and Conservation Authority

*Status of implementation*: implemented

*More information is available* at: http://www.eeca.govt.nz/node/1296

## 4.3.3 Transport

The *New Zealand Transport Strategy 2008* was developed to give a long-term perspective and direction to the transport sector. It sets out a series of aspirational targets for the year 2040. The New Zealand Transport Strategy is a non-statutory document.

A Government Policy Statement on land transport is produced every three years by the Ministry of Transport. This publication identifies short-term targets as well as the funding levels allocated to different areas of the transport system. Many of the specific actions that will deliver on land transport targets in the strategy will be set out in regional land transport strategies and regional land transport programmes, implemented by regional councils. The Government has made a commitment to develop a forward plan for transport that will complement the Government Policy Statement on land transport funding by providing further guidance on overall longer-term transport policy.

The Government's primary policy to mitigate greenhouse gas emissions from the transport sector is to include transport fuels in the NZ ETS. Other transitional incentives and research are underway to complement the scheme in the areas of new fuels and technology, improved efficiency of commercial fleets and encouraging forms of transport that are less carbon intensive. These policies and measures are discussed in the following section. The Ministry of Transport is responsible for the development of transport policy in New Zealand.

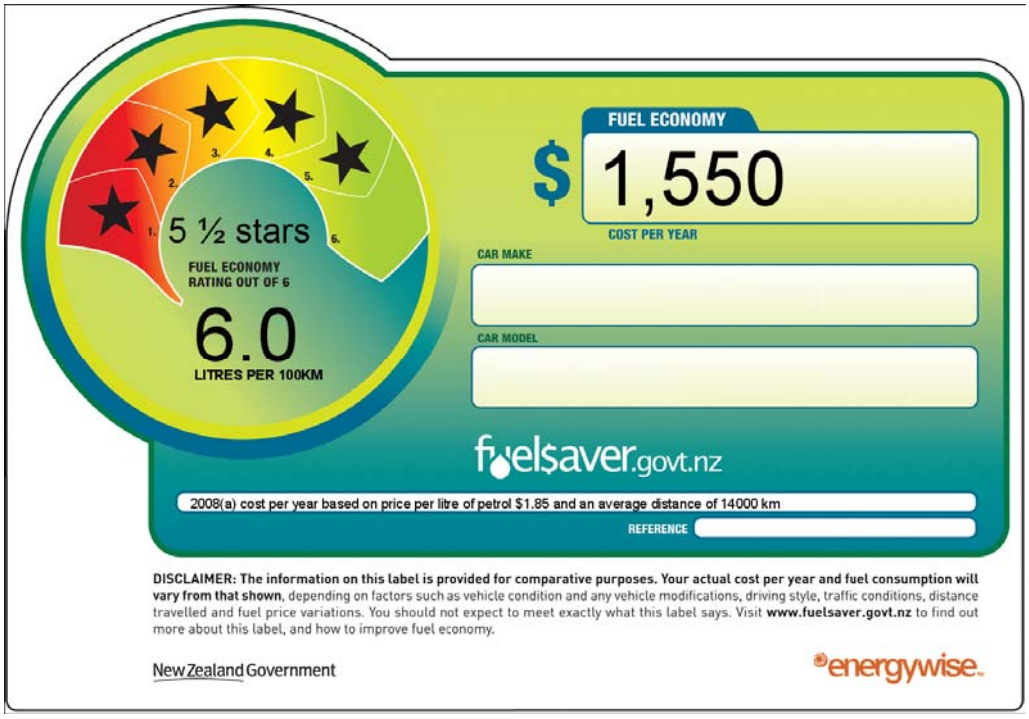
## Vehicle fuel economy labelling

In December 2007, the Government introduced the Vehicle Fuel Economy Labelling scheme making it compulsory for vehicle traders and online vendors to display information about the fuel economy of their vehicles. The scheme came into effect in April 2008.

The aim of the programme is to allow consumers to make a more informed choice when purchasing a vehicle and to place an appropriate value on fuel economy. This should encourage consumers to buy more fuel-efficient vehicles and thus reduce greenhouse gas emissions from New Zealand's transport sector.

The label provides information about the relative fuel economy of that make and model of vehicle. It displays the information as a star rating out of six stars, the number of litres of fuel per 100 kilometres travelled, as well as an estimate of the fuel costs per year. Figure 4.3 provides an example of a New Zealand fuel economy label.

**Figure 4.3: An example of a vehicle fuel economy label**




Fuel economy information must be displayed for all light vehicles (ie, cars, utilities and vans under 3.5 tonnes) whenever it is available. The information should be available for most vehicles manufactured after 2000. It is not required for motorcycles or vehicles over 3.5 tonnes.

**Other information**

*Greenhouse gases affected:* carbon dioxide

*Quantitative effect of the policy/measure:* The Energy Efficiency and Conservation Authority (EECA) estimates that the Vehicle Fuel Economy Labelling scheme will encourage carbon dioxide savings of 43.0 Gg $CO_2$-e per year, by 2020

*Type of policy or measure:* regulation

*Implementing entity:* New Zealand Transport Agency and the Energy Efficiency and Conservation Authority

*Status of implementation:* implemented

*More information is available at*: http://labelling.fuelsaver.govt.nz/

## Biofuels

To ensure equal incentives for different types of biofuels between now and 2012, the Government is providing a grant to biodiesel producers. This grant is designed to be equivalent to the petrol excise duty exemption currently in place for bioethanol. NZ$36 million has been allocated to the grant scheme over three years, starting in July 2009.

**Other information**

*Greenhouse gases affected:* carbon dioxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme have not been quantified

*Type of policy or measure:* fiscal

*Implementing entity:* the Energy Efficiency and Conservation Authority

*Status of implementation:* implemented

*More information is available at*: http://www.eeca.govt.nz/eeca-programmes-and-funding/programmes/renewable-transport-energy/biofuels

## Electric vehicles

In June 2009, the Government passed legislation to provide an exemption from road-user charges for electric vehicles from October 2009 until July 2013. This was done in recognition of the role electric vehicles will play in assisting with the reduction of greenhouse gas emissions from the transport sector. Combining highly efficient electric motors with New Zealand's competitive advantage in renewable electricity generation will reduce the greenhouse gases produced by the transport sector as well as harmful emissions that affect air quality.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme have not been quantified

*Type of policy or measure*: fiscal

*Implementing entity:* the Ministry of Transport

*Status of implementation:* implemented. Legislation to implement the exemption was passed by Parliament in August 2009.

*More information is available at:*
http://www.transport.govt.nz/research/Pages/electricvehicles.aspx

## Other transport measures

### *Fleet Best Practice Programme*

Commercial vehicle fleet fuel efficiency was a significant area of New Zealand-based research during 2008. The research culminated in two reports: *Fleet Commitment Initial Work Programme Trial*, by the Transport Engineering Research New Zealand Limited, and *Survey on Fleet Fuel Efficiency in the Heavy and Light Commercial Vehicle Fleet*, by Kissling

Consulting Limited (NZ) and Imise Limited (UK). These reports are available on the Ministry of Transport website.[54]

The research recommended that a New Zealand Fleet Best Practice Programme be developed. As the first stage, the Ministry of Transport, in conjunction with the New Zealand Transport Agency, is converting the UK Safe and Fuel Efficient Driver training programme to a New Zealand-based curriculum for heavy and light commercial vehicle fleets. Associated activities include the development of tip booklets and videos, additional New Zealand-based research to tailor driver training and fuel efficiency driving technique for the New Zealand fleet, training for driver trainers and driver training.

*Public transport*

Public transport will continue to play a growing role in the success of our cities and the wider economy by contributing to economic growth and productivity.

The Government is committed to continuing public transport funding. For example, the Government provided NZ$500 million for the electrification of the Auckland rail network. The purchase of electric trains to run on the new network will also be supported by the Government. Including this project, the Government will invest a total of NZ$1 billion in Auckland's rail network.

The Ministry of Transport is also examining ways to increase the productivity and efficiency of the public transport system. The main focus is looking at how to remove barriers to greater efficiency that have been identified by key stakeholders. Examples of these barriers include delays in the renewal of passenger class driver licences and buses losing time when re-entering heavy traffic from bus stops.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure*: education and fiscal

*Implementing entity:* the Energy Efficiency and Conservation Authority

*Status of implementation:* adopted. Legislation to implement the exemption is expected to be passed by Parliament in 2009

*More information is available* at: http://www.transport.govt.nz/ourwork/climatechange/Pages/VehicleFleetEfficiency.aspx

### 4.3.4 Industry

The main government policy aimed at reducing greenhouse gases from industrial sites is the New Zealand Emissions Trading Scheme (NZ ETS). Industrial processes will enter the scheme

[54] http://www.transport.govt.nz

from July 2010 and will be required to surrender one emission unit for every two tonnes of $CO_2$ equivalent emissions until 2013. From 2013, the sector will be required to surrender one unit for each tonne of emissions. The synthetic gases perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride will be included in the scheme from 2013.

The Ministry for the Environment is responsible for developing policy on industrial emissions in New Zealand. In addition to the NZ ETS, the Ministry continues to run the 'No Loss Campaign' with the refrigeration industry. This policy minimises the loss of refrigeration gases. Please refer to *New Zealand's Fourth National Communication* for details on this initiative.

## 4.3.5 Agriculture

At present there are limited methods for reducing nitrous oxide emissions from agricultural pastures, and no practical methods for mitigating methane for enteric fermentation in ruminants. New Zealand is a lead player internationally on researching effective mitigation technologies that will reduce ruminant greenhouse gas emissions. The Ministry of Agriculture and Forestry (MAF) is responsible for setting agricultural policy in New Zealand.

### Global Alliance on agricultural emissions

In September 2009, the New Zealand Prime Minister announced a proposal to establish a Global Alliance on agricultural greenhouse gas mitigation research. The initiative would bring interested countries together to drive greater international cooperation, collaboration and investment in this area of research. In this way, the Global Alliance aims to help reduce emissions from agricultural production and improve its potential for soil carbon sequestration, while safeguarding food security.

**Other information**

*Greenhouse gases affected:* methane, nitrous oxide, carbon dioxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure:* research, information, education

*Status of implementation:* planned

*More information is available at:* http://www.beehive.govt.nz/release/nz+pushes+global+alliance+agricultural+emissions

### Primary Growth Partnership (PGP)

The PGP is a government–industry initiative, which provides investment in significant programmes of research and innovation to boost the economic growth and sustainability of New Zealand's primary, forestry and food sectors. The PGP covers:

- pastoral (including wool) and arable production
- horticulture
- seafood (including aquaculture)

- forestry and wood products
- food processing (including nutriceuticals and bioactives).

The PGP will provide funding of no less than $500,000 over the lifetime of the programme, which must be matched by industry co-investors. In 2009, the Government increased the funding for the PGP from $30 million for 2009/10 to $70 million per annum from 2012/13.

### *Centre for Agricultural Greenhouse Gas Research*

A key programme under the PGP is the establishment of the Centre for Agricultural Greenhouse Gas Research, which has been allocated NZ$5 million of the PGP funding each year. It will be 100 per cent government-funded, with no requirement for industry co-funding and a commitment to 10 years' core funding.

Research will focus on ruminant methane, nitrous oxide and soil carbon in the pastoral and horticultural sectors. The aim of the research will be to promote technologies that both reduce emissions and improve on-farm efficiency and productivity.

**Other information**

*Greenhouse gases affected:* methane, nitrous oxide, carbon dioxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure:* research, information

*Implementing entity:* the Ministry of Agriculture and Forestry and the Foundation for Research, Science and Technology

*Status of implementation:* implemented

*More information is available on:*

- the Primary Growth Partnership at http://www.maf.govt.nz/pgp/
- the Centre for Agricultural Greenhouse Gas Research at: http://www.beehive.govt.nz/release/leap+forward+greenhouse+gas+research

### *Pastoral Greenhouse Gas Research Consortium (PGGRC)*

The PGGRC is a partnership between the Government and the dairy and fertiliser industries, formed in 2002. The role of the PGGRC is to coordinate the agricultural sector's programme of research into the abatement of agricultural non-carbon dioxide gases. The aim of the partnership is to provide livestock farmers with the information and means to mitigate their greenhouse gas emissions. The scope of the programme is broad, and includes research into the options to improve the production efficiency of ruminant animals. For more information on the PGGRC, see *New Zealand's Fourth National Communication*.

Industry funding is matched by the Government through the Foundation for Research, Science and Technology. Between 2001 and 2008 the PGGRC invested more than NZ$19 million in research on the production of methane and nitrous oxide from grazing livestock.

**Other information**

*Greenhouse gases affected*: methane, nitrous oxide

*Quantitative effect of the policy/measure*: the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure*: research, information, education

*Implementing entity*: Ministry of Agriculture and Forestry and the Foundation for Research Science and Technology

*Status of implementation*: implemented

*More information is available on*:

- the Pastoral Greenhouse Gas Research Consortium at: http://www.pggrc.co.nz/
- nitrification inhibitors at: http://www.maf.govt.nz/climatechange/slm/inhibitors/
- LEARN at: http://www.livestockemissions.net

## Sustainable Land Management and Climate Change Plan of Action

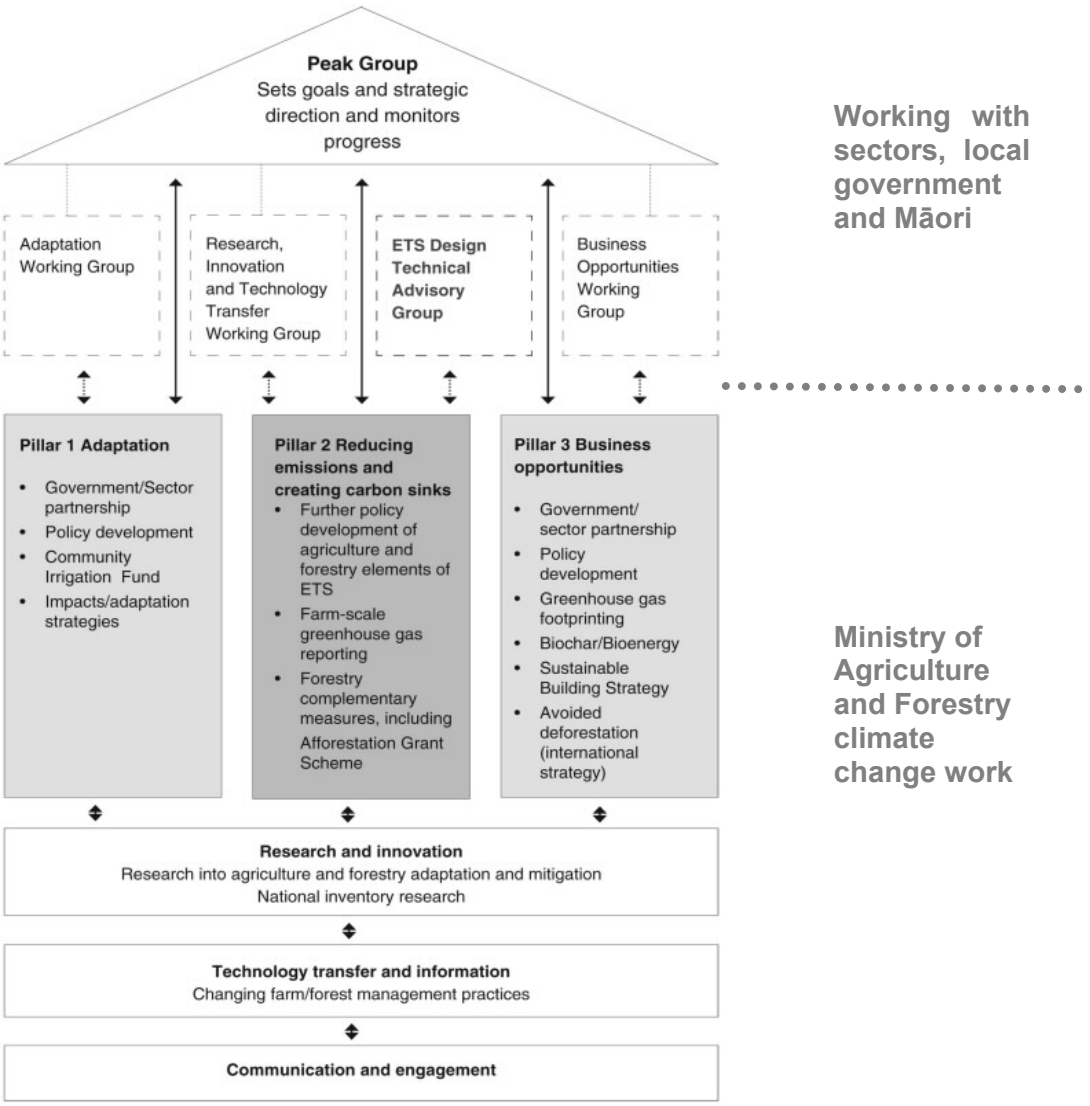
For New Zealand, the agriculture and forestry sectors are critical in responding to climate change because of their contribution to New Zealand's greenhouse gas emissions profile, and importance to the New Zealand economy. In September 2007, the Government outlined an integrated package for the land-based sectors called the Sustainable Land Management and Climate Change Plan of Action (the Plan of Action). The Plan of Action is a $175 million work programme work the Government is running in partnership with the land management sectors, local government and Māori.

The Plan of Action has three broad workstreams:

- adaptation
- reducing emissions and enhancing sinks
- business opportunities.

Initiatives and programmes under the three work areas are supported by research and a communications and technology transfer programme.

**Figure 4.4: Overview of the Sustainable Land Management and Climate Change Plan of Action**




### *Sustainable Land Management and Climate Change Plan of Action Research Programme*

The research programme will focus on the development of new technologies and practices for the measurement and mitigation of greenhouse gas emissions, adaptation and cross-cutting issues. The research programme has been allocated NZ$55 million of government funding. A working group has been set up with representatives from the land management sectors, local government and Māori, to refine the Strategic Research Framework and identify priorities for funding. The working group coordinates a process with other government agencies, research providers, the agriculture and forestry sectors, Māori, and local government to identify these priorities.

In addition to the contestable research programme above, research programmes have also been carried out in the following areas:

- farm-level greenhouse gas reporting using the Overseer nutrient budget model

- bioenergy and biochar research and development
- national nitrification inhibitor research
- national agriculture and forestry inventory development
- life-cycle analysis for a number of industry sectors and products.

Examples of programmes under the Plan of Action are described below.

### *Research programme to improve agricultural and forestry inventories*

The Government is providing national greenhouse gas inventory research grants. The aim of the grants is to improve the accuracy of New Zealand's agricultural greenhouse gas inventory to, reduce uncertainty in the greenhouse gas inventory, and to incorporate the effects of mitigation technologies. More than $2 million has been allocated to specific research proposals.

### *Greenhouse gas footprinting*

The New Zealand Greenhouse Gas Footprinting Strategy for the Land-based Primary Sectors is a plan for developing tools to accurately measure and represent the greenhouse gas footprint of New Zealand produce. The strategy also encourages New Zealand primary producers to participate in greenhouse gas measurement and enhance their greenhouse gas performance.

The development of sector-specific approaches ("sector methodologies") to greenhouse gas footprinting involves working with primary sector early adopters to develop comprehensive methods for measuring greenhouse gas emissions across the supply chain of a primary product. The method for a specific industry (eg, kiwifruit) can then be used to facilitate the development of methods for the wider sector (eg, horticulture). This approach aims to help sectors to measure, manage and mitigate greenhouse gas emissions across the supply chain.

### *Biochar professorships*

Biochar is created by a similar process to that used to make charcoal. The resulting charcoal-like material is a form of semi-permanent carbon storage. The Government is funding two professorships to promote the study and development of this technology. Each of these professorships will be funded for four years and are supported by one-off grants of $1.25 million in 2009/10 for research, laboratory equipment and facilities.

### *Nitrification inhibitors*

A significant area of investment for the PGGRC has been a three-year trial of nitrification inhibitors. The aim of the trial is to provide independent verification of the role these inhibitors play in reducing the environmental impacts of farming practices. The research aims to:

- determine the best management practice for the use of nitrification inhibitors in New Zealand grazing systems
- improve understanding of the potential for nitrification inhibitors to improve a broad range of environmental outcomes, including those related to water quality and greenhouse gas emissions
- assess the ability of nitrification inhibitors to reduce nitrous oxide emissions
- promote uptake by farmers by providing scientifically sound information on the productivity advantages, potential cost reductions and environmental benefits of using nitrification inhibitors.

In New Zealand's 2009 national greenhouse gas inventory submitted under the Convention and the Kyoto Protocol, the agricultural sector incorporated the use of nitrification inhibitors.

### *Livestock Emissions and Abatement Research Network (LEARN)*

In November 2007 New Zealand established LEARN, an international research and collaboration network with the aim of improving measurement of and reducing greenhouse gas emissions from livestock. The network now involves more than 300 researchers from 47 countries.

The objectives of LEARN are twofold: to improve understanding, measurement and monitoring of methane and nitrous greenhouse gas emissions from animal agriculture at all scales; and to facilitate the development of cost-effective and practical greenhouse gas mitigation solutions.

The Government will offer up to nine New Zealand LEARN fellowships a year for scientists or technicians from developing countries to work in New Zealand to gain experience in addressing livestock emissions. More information on the LEARN programme is contained in chapters 7, 8 and 9.

### *Other research*

In addition to the above research areas, the Ministry of Agriculture and Forestry also leads a research fund that contributes towards the Plan of Action goals. Priorities are set in consultation with researchers, land-based sectors, and Māori. To date research has included agricultural emissions, modelling, forestry rates and carbon sequestration.

### *Farm monitoring*

The farm monitoring programme models the production and financial status of farms, orchards and vineyards throughout New Zealand.

The aim of the programme is to analyse the relationship between financial results and the sustainability, productivity and adaptability of the different sectors. As part of this programme, AgResearch (a Crown research institute) won a NZ$4 million tender to develop a software package (called *Overseer*) that enables the modelling of pastoral greenhouse gas emissions at the farm level.

### *Technology transfer*

A technology transfer programme has been developed to encourage the land management sector to adopt greenhouse gas emissions mitigation technologies and land management practices.

The programme will include:

- coordination of government and industry activities
- communication of information on mitigation and adaptation to climate change
- demonstrations of new greenhouse gas emissions mitigation technologies and practices
- education and capacity-building, including industry training and tertiary education.

One example is the resource kit *Adapting to Climate Change in Eastern New Zealand: A Farmer Perspective*.[55] It contains case studies at both the farm level and the regional level, and looks at adaptations to, and solutions for coping with, climate change in the Hawke's Bay region of New Zealand.

[55] http://www.earthlimited.org/accenzpubs.html

**Other information**

*Greenhouse gases affected:* methane, nitrous oxide

*Quantitative effect of the policy/measure:* the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure:* research, information, education

*Implementing entity:* Ministry of Agriculture and Forestry

*Status of implementation:* implemented

*More information is available on:*

- the Plan of Action at: http://www.maf.govt.nz/climatechange/slm/poa/index.htm
- all of the research grants at: http://www.maf.govt.nz/climatechange/slm/grants/
- agricultural inventory research at: http://www.maf.govt.nz/climatechange/slm/gg-grants.htm
- greenhouse gas footprinting at: http://www.maf.govt.nz/climatechange/slm/ghg-strategy
- biochar research at: http://www.biochar.co.nz/, or http://www.maf.govt.nz/sff/about-projects/search/LC08-044/index.htm
- the technology transfer programme at: http://www.maf.govt.nz/climatechange/slm/investment-sheets/technology-transfer.htm
- the Overseer model at: http://www.maf.govt.nz/sff/about-projects/search/04-045/what-is-overseer.pdf and http://www.maf.govt.nz/mafnet/press/2009/140709-overseer.htm

### 4.3.6 Forestry

The New Zealand Emissions Trading Scheme (NZ ETS) is the main policy instrument to encourage afforestation and reduce deforestation. In addition to the NZ ETS, New Zealand has three major schemes that promote afforestation and provide incentives to maintain forests. These are detailed in the section below. The Ministry of Agriculture and Forestry (MAF) is responsible for developing forestry-related policy.

In New Zealand, commercial timber harvested from private native forest was restricted to that sourced under sustainable forest management plans and permits by a 1993 amendment to the Forests Act 1949. Only a few areas were exempt from the Act. Amendments in March 2002 resulted in the cessation of any logging of native forest on public land. Less than 0.1 per cent of New Zealand's total forest production is now harvested from native forests.

#### East Coast Forestry Project

The East Coast Forestry Project aims to encourage an additional 200,000 hectares of commercially productive forest to be planted (through to 2020) on eroding and erodible land in the East Coast region of the North Island. Land owners in specific areas tender for government

grants, which help to fund the cost of establishing and managing forest on eroding and erosion-prone land. The project allows a range of treatments to be applied to erosion-prone land, including commercial forestry, poplar and willow planting, and the ability to set aside areas for the regeneration of native forest.

Although the main purpose of this project is to reduce erosion, the project also enhances the sequestration of carbon in forest sinks. The project has been running since 1992, and 33,000 hectares of forest are now covered by the scheme.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure:* an estimated 3196 Gg of carbon dioxide have been sequestered as a result of this scheme. By 2040, an estimated total of 399.4 Gg tonnes of carbon dioxide per year will be sequestered from the forests already participating in this project (assuming no deforestation)

*Type of policy or measure*: voluntary agreement

*Implementing entity:* Ministry of Agriculture and Forestry

*Status of implementation*: implemented

*More information is available at:* http://www.maf.govt.nz/forestry/east-coast-forestry

## Afforestation Grant Scheme

The Afforestation Grant Scheme aims to increase the area of Kyoto-compliant forest in New Zealand. Kyoto-compliant forest refers to areas of forest planted after 1 January 1990 on to land which was non-forest land as at 31 December 1989. The scheme offers a simpler alternative to the NZ ETS for landowners with small tracts of forest. The Afforestation Grant Scheme is a part of the Sustainable Land Management and Climate Change Plan of Action (the Plan of Action).

Under the Afforestation Grant Scheme, landowners can receive a government grant for establishing new forests on Kyoto-compliant land (that is, land that was not forested as at 31 December 1989). Recipients of the grant own the new forests and earn income from the timber, while the Crown retains the Kyoto removal units (and liabilities) generated during the 10-year period of the grant agreement. A secondary objective of the scheme is to establish this new forest in areas where it will help reduce the likely impacts of climate change, and generate other environmental benefits such as reduced erosion, nutrient leaching and flood peaks; and improved indigenous biodiversity.

The Afforestation Grant Scheme is a contestable fund. Half of the funding is available to regional councils to help them meet their sustainable land management objectives; the other half is available to the general public via a public tender pool.

The majority of this public funding pool (70 per cent) is allocated to species that have high sequestration rates, eg, *Pinus radiata* and Douglas fir. The remaining 30 per cent of these public funds are reserved for species with low carbon sequestration rates, such as indigenous species.

Although these species grow more slowly, they promote greater biodiversity and provide habitats for threatened native birds and plants.

There are currently 96 participants in the scheme, with 29 participants in the public pool and 67 in the regional council pool.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure*: an estimated 6 Gg of carbon dioxide has been sequestered as a result of this scheme. By 2040, an average of 153.8 Gg tonnes of carbon dioxide per year will be sequestered from the forests already participating in the scheme (assuming no deforestation)

*Type of policy or measure*: fiscal, voluntary agreement

*Implementing entity*: Ministry of Agriculture and Forestry

*Status of implementation*: implemented

*More information is available at*: http://www.maf.govt.nz/climatechange/forestry/initiatives/ags/

## Permanent Forest Sinks Initiative

The Permanent Forest Sinks Initiative promotes the establishment of permanent forests on previously unforested land. It offers landowners the opportunity to earn assigned amount units for carbon sequestered in permanent forests established after 1 January 1990. The initiative is principally designed to allow greater economic benefit to be derived from land, especially marginal land that would have little other economic use. The Permanent Forest Sinks Initiative is a part of the Plan of Action, that also includes the Afforestation Grants Scheme.

Under the initiative, participants enter into an agreement with the Government to plant and manage forests on their land. Participants will have a covenant registered against their land titles for a minimum of 50 years. This covenant will ensure the forests are (semi-) permanent. Under the covenant, only limited harvesting is allowed, and this is only permitted on a continuous forest canopy cover basis. By putting the requirements in a covenant on the title to the land, the forest sink will still remain even if the land is sold.

In return, landowners who meet the requirements receive tradeable assigned amount units, which they are free to sell in either the domestic or international carbon market. The amount of units received is equal to the increased carbon dioxide stored in the forest for the period between 2008 and 2012.[56] Units will not be transferred to landowners until verification of the amount of increased carbon dioxide stored in the forest has occurred.

[56] Landowners will have rights to emission units beyond 2012 also, provided the rules of a future agreement allow for forestry to generate emission units.

The Government announced the Permanent Forest Sinks Initiative in August 2006, and the first covenants under the scheme were registered in August 2008. Twenty-two applications have been received, covering 5493 hectares of forest land.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure*: an estimated 6 Gg of carbon dioxide have been sequestered as a result of this scheme. By 2040, an estimated 84.0 Gg of carbon dioxide per year will be sequestered from the forests already participating in this scheme (assuming no deforestation)

*Type of policy or measure*: voluntary agreement

*Implementing entity*: Ministry of Agriculture and Forestry

*Status of implementation*: implemented

*More information is available at*: http://www.maf.govt.nz/forestry/pfsi

## Increasing the use of wood as a construction material

The Ministry of Agriculture and Forestry has developed the following initiatives to increase the use of wood as a construction material:

- commissioned full life-cycle analysis research that showed that wood-based building products have a lower greenhouse gas footprint than other construction materials
- provided seed funding in the form of two professorship positions to teach and research the use of timber in building design, and to reduce barriers to the increased use of wood as a construction material
- funded a design competition and provided support for the construction of a multi-storey timber-based building that will be available as a demonstration building for teaching purposes
- funded demonstration buildings that showcase the construction of wooden sustainable buildings. The initiative includes partial funding to construct in wood up to two government buildings that would ordinarily be built in concrete and steel. Funding will also be available for education and research on the demonstration buildings
- developed a website, funded under the Forest Industry Development Agenda (FIDA) / NZWood initiative, to provide ready access to technical information on building using wood.

**Other information**

*Greenhouse gases affected*: carbon dioxide

*Quantitative effect of the policy/measure*: the emissions reductions directly associated with this programme have not been quantified

*Type of policy or measure*: research, information, education

*Implementing entity*: Ministry of Agriculture and Forestry

*Status of implementation*: implemented

*More information is available on*:

- promoting wood design at: http://www.fida.org.nz/Wood_design
- the Forest Industry Development Agenda at: http://www.fida.org.nz/home
- life-cycle analysis at: http://www.scionresearch.com/life+cycle+analysis.aspx and http://www.maf.govt.nz/forestry/publications/lca-materials.pdf

### 4.3.7 Waste

The New Zealand Waste Strategy (launched in 2002) set in place a framework for minimising and managing waste, and included targets for reducing waste. The major piece of legislation that governs waste management in New Zealand is the Waste Minimisation Act 2008. The Ministry for the Environment is responsible for developing waste policy in New Zealand alongside local and regional councils.

#### New Zealand Waste Strategy

The New Zealand Waste Strategy aims to lower the social costs and risks from waste, reduce the damage to the environment from waste generation and disposal, and increase economic benefits by encouraging more efficient use of materials. Reducing the quantity of waste produced has the co-benefit of reducing emissions of landfill-gas (methane) at waste disposal sites. Progress against the targets was reviewed in 2003 and the strategy as a whole was reviewed in 2006. The strategy and targets are being revised in light of the 2006 review and a new strategy will be published in 2009.

#### Waste Minimisation Act 2008

The Waste Minimisation Act (2008):

- established a waste levy on all waste going to municipal landfills
- established a process for making the development of product stewardship schemes mandatory (for certain products)
- allows for mandatory waste reporting
- clarifies the roles and responsibilities of territorial authorities with respect to waste minimisation
- established the Waste Advisory Board to provide advice to the Minister for the Environment.

Operators of waste disposal facilities are required to pay a waste levy on all waste disposed of at their facility (currently set at NZ$10 a tonne in September 2009). Approximately half of the levy money is allocated to territorial authorities to spend on implementing their waste management and minimisation plans. The remaining levy money (minus administration costs) is allocated to waste minimisation projects through the Waste Minimisation Fund.

**Other information**

*Greenhouse gases affected*: methane

*Quantitative effect of the policy/measure*: the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure*: regulatory

*Implementing entity*: Ministry for the Environment

*Status of implementation*: implemented

*More information is available on*:

- the Waste Minimisation Act at: http://www.mfe.govt.nz/laws/waste-minimisation.html
- waste policies at: http://www.mfe.govt.nz/issues/waste

### National Environmental Standard for Landfill Methane

The National Environmental Standard (NES) for Landfill Methane requires landfill sites with a design capacity greater than one million tonnes of refuse to collect and destroy methane emissions. It is part of a suite of 14 standards on air quality. The NES was reported on comprehensively in the *Fourth National Communication*.

**Other information**

*Greenhouse gases affected*: methane, carbon dioxide

*Quantitative effect of the policy/measure*: the emissions reductions directly associated with this programme cannot be quantified

*Type of policy or measure*: regulation

*Implementing entity*: Ministry for the Environment

*Status of implementation*: implemented

*More information is available at*: http://www.mfe.govt.nz/laws/standards/air-quality-standards.html

## 4.4 Policies and measures no longer in place

The following policies and measures that were reported on in the *Fourth National Communication*, are no longer in place.

### *Mandatory biofuels sales obligation*

In December 2008, the Government repealed the biofuels sales obligation, opting instead for incentive-based measures. This was due to concerns that much of the biofuel necessary to meet the obligation would have been imported from environmentally unsustainable sources that encouraged deforestation and reduced biodiversity.

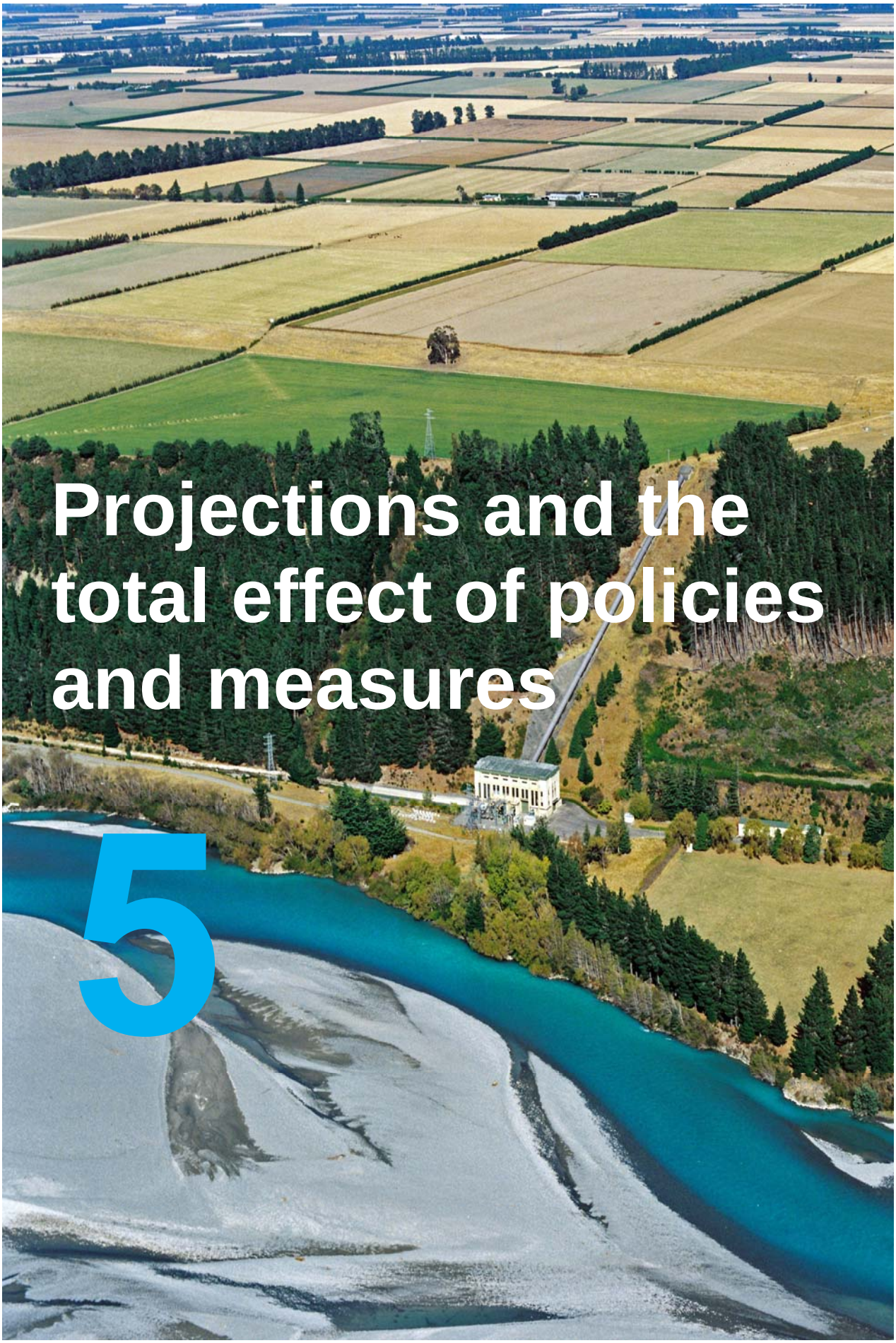
### *Projects to reduce emissions programme*

The Projects to Reduce Emissions programme has been discontinued. Existing agreements with project participants are being honoured and these abatement projects are progressing, but no new agreements are being made. The Projects to Reduce Emissions programme was developed to complement the proposed carbon tax that has since been replaced with an emissions trading scheme.

### *Communities for Climate Protection*

The Communities for Climate Protection programme (CCP) encouraged local government to reduce emissions in their own operations. Until June 2009, this programme was funded by the Ministry for the Environment. However, funding was not available for the 2009/10 financial year, and the programme is no longer running.

Local government bodies are still encouraged to reduce emissions, and many of the same agencies that assisted local government to reduce emissions under the CCP programme are still doing so (such as the EECA, and the Ministry for the Environment).



# Projections and the total effect of policies and measures

5

# 5 Projections and the total effect of policies and measures

## 5.1 Introduction

This chapter reports on projections of New Zealand's greenhouse gas emissions and removals from known anthropogenic sources and sinks. The projections of greenhouse emission sources and sinks cover energy, transport, industrial processes, agriculture, waste and forestry projections. All of the projections are "with measures" unless stated otherwise, which means that they include the effect of New Zealand's climate change policies. The chapter also provides "without measures" projections which project what New Zealand's emissions would be in the absence of climate change policies. All projections are measured in gigagrams of gas (Gg) unless specifically noted otherwise. Projected removals are net removals from forestry, as defined under the United Nations Framework Convention on Climate Change. Projected removals by forests under article 3.3 of the Kyoto Protocol (ie forest planted after 31 December 1989) have also been provided.

New Zealand produces an annual projection of progress towards meeting its commitment under Article 3.1 of the Kyoto Protocol. This projection report is available at http://www.mfe.govt.nz/publications/climate/net-position-report-2009/index.html. The latest report produced in April 2009, projected that New Zealand will have a surplus of 9.6 million units over the first commitment period of the Kyoto Protocol.

New Zealand's projections of emissions are produced by a cross-government technical group led by the Ministry for the Environment. Agricultural emissions and net removals from forests are projected by the Ministry of Agriculture and Forestry. Stationary energy, transport and industrial process emissions projections are provided by the Ministry of Economic Development. Projections of emissions from the waste sector are made by the Ministry for the Environment.

The projections methodology for New Zealand is linked to the methodology used to estimate the national inventory. The projections reported in this chapter will include inventory improvements that have been made ahead of the 2010 national inventory submission that were not implemented in the 2009 inventory submission.

## 5.2 Projected greenhouse gas emissions and removals, with measures

Tables 5.1 and 5.2 summarise actual and projected New Zealand greenhouse gas emissions and removals, by sector and gas respectively, for the "with measures" case. Values for the year 2007 and prior are based on actual data, while values for 2010 and later are based on projections. Key assumptions used in the "with measures" projection are detailed in section 5.3.

Under a "with measures" scenario, New Zealand's total emissions (excluding net removals from the forestry sector) are projected to rise to 76,085.3 Gg $CO_2$ equivalent ($CO_2$-e) by 2010 and 76,895.7 Gg $CO_2$-e by 2020. These projections equate to an increase in emissions from 1990 of 15,179.5 Gg $CO_2$-e (25 per cent) in 2010 and 15,988.9 Gg $CO_2$-e (26 per cent) in 2020.

New Zealand's net emissions (including removals from the forestry sector) are projected to rise to 78,822.6 Gg $CO_2$-e by 2020 (90 per cent above net emissions in 1990). In 2010, net removals from forestry are projected to be approximately 20,084.0 Gg of $CO_2$-e. However, by 2020 forestry is expected to become a net source of emissions as relatively large areas of production forests planted in the 1990s are harvested (see figure 1.2). Net emissions from forestry in 2020 are projected to be 1,926.9 Gg of $CO_2$-e.

The "with measures" projections include the effects of the NZ ETS, including the changes to the scheme passed into law in December 2009. The effects of the NZ ETS are included in projections for the energy, agricultural and forestry sectors. The "with measures" projections also include the effect of nitrification inhibitors in the agricultural sector. "With measures" projections for the waste sector take account of the National Environmental Standard to control methane emissions from landfills, introduced in October 2004. There are currently no adopted policies or measures that would have a significant impact on industrial process emissions.

Projections of emissions and removals are inherently uncertain. Economic variables such as commodity and oil prices, the assumed carbon price, the assumed rate of afforestation and deforestation, and the harvest age of forests have significant effects on projected emissions and removals. For example, the "with measures" projection assumes a carbon price of NZ$25/tonne $CO_2$-e, rising to $50/tonne from 2013, and afforestation increasing from 3500 hectares in 2009, to 30,000 hectares of planting by 2020. If the carbon price rose to NZ$100/tonne $CO_2$-e, and afforestation increased to 50,000 hectares of planting per year, New Zealand's total net emissions are projected to be 68,471.0 Gg $CO_2$-e in 2020 (64 per cent above net emissions in 1990). Projections of emissions and removals from forestry in 2020 are most sensitive to the harvest age of New Zealand's pre-1990 forests. Scenarios of emissions and removals under different forest harvest ages are presented in section 5.2.4.

Projections of emissions "without measures" have been made to show the effect of New Zealand's policies and measures. Total emissions (excluding forestry) "without measures" are projected to be 85,828.9 Gg $CO_2$-e in 2020, 11.6 per cent higher than projected emissions "with measures". Total emissions including forestry "without measures" are projected to be 91,137.5 Gg $CO_2$-e in 2020, 15.6 per cent higher than projected emissions "with measures".

**Table 5.1: Actual and projected emissions and removals, by sector, 1990–2020**

| Sector | Gg $CO_2$ equivalent | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2007 | 2010 | 2015 | 2020 |
| Energy | 14,987.5 | 14,444.4 | 16,731.3 | 19,364.3 | 18,153.4 | 18,723.8 | 17,765.9 | 15,946.2 |
| Transport | 8,748.9 | 11,051.3 | 12,484.7 | 14,557.8 | 14,903.1 | 13,954.5 | 14,823.9 | 15,583.6 |
| Industry | 3,450.8 | 3,435.2 | 3,695.1 | 4,311.2 | 4,645.3 | 4,708.7 | 4,805.4 | 4,572.2 |
| Agriculture | 31,281.4 | 32,716.2 | 34,483.2 | 36,385.7 | 35,839.8 | 36,934.2 | 38,168.4 | 39,072.4 |
| Forestry | (19,188.4) | (16,685.7) | (22,520.8) | (24,031.9) | (18,485.1) | (20,084.0) | (1,370.7) | 1,926.9 |
| Waste | 2,438.2 | 2,259.6 | 2,079.3 | 1,865.4 | 1,821.8 | 1,764.1 | 1,719.0 | 1,721.3 |
| Total emissions (excluding net emissions from forestry) | 60,906.8 | 63,906.6 | 69,473.7 | 76,484.4 | 75,363.3 | 76,085.3 | 77,282.6 | 76,895.7 |
| Total emissions (including net emissions/ removals from forestry)[57] | 41,718.4 | 47,220.9 | 46,952.8 | 52,452.5 | 56,878.3 | 56,001.3 | 75,912.0 | 78,822.6 |

[57] Note that 'Total emissions including forestry' is not a projection of New Zealand's net emissions under the Kyoto Protocol or any subsequent agreement, as it uses the UNFCCC definition of forests. Projections of emissions and removals from Kyoto-compliant forests are included in this chapter under forestry (section 5.2.5).

**Table 5.2: Actual and projected emissions, by gas, 1990–2020**

| Gas | 1990 | 1995 | 2000 | 2005 | 2007 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|---|---|---|
| **Gg gas except as noted** | | | | | | | | |
| Carbon dioxide | 25,573.3 | 27,619.6 | 31,311.7 | 36,289.2 | 35,631.2 | 35,345.3 | 35,236.1 | 33,968.6 |
| Methane | 1,172.6 | 1,191.0 | 1,246.5 | 1,260.4 | 1,267.3 | 1,288.0 | 1,334.2 | 1,361.0 |
| Nitrous oxide | 32.4 | 35.4 | 37.5 | 41.8 | 39.4 | 41.2 | 42.2 | 43.4 |
| HFC ($CO_2$ equivalent) | NA,NO | 148.3 | 304.3 | 675.5 | 856.6 | 868.3 | 886.1 | 842.5 |
| PFC ($CO_2$ equivalent) | 642.2 | 150.3 | 57.7 | 59.0 | 41.7 | 42.2 | 43.1 | 41.0 |
| $SF_6$ ($CO_2$ equivalent) | 15.2 | 17.9 | 10.5 | 19.0 | 14.7 | 14.9 | 15.2 | 14.5 |
| **Gg $CO_2$ equivalent** | | | | | | | | |
| Carbon dioxide | 25,573.3 | 27,619.6 | 31,311.7 | 36,289.2 | 35,631.2 | 35,345.3 | 35,236.1 | 33,968.6 |
| Methane | 24,623.8 | 25,011.0 | 26,176.7 | 26,468.5 | 26,614.3 | 27,047.1 | 28,018.4 | 28,581.9 |
| Nitrous oxide | 10,052.3 | 10,959.7 | 11,612.9 | 12,973.4 | 12,204.8 | 12,767.5 | 13,083.7 | 13,447.2 |
| HFC | NA,NO | 148.3 | 304.3 | 675.5 | 856.6 | 868.3 | 886.1 | 842.5 |
| PFC | 642.2 | 150.3 | 57.7 | 59.0 | 41.7 | 42.2 | 43.1 | 41.0 |
| $SF_6$ | 15.2 | 17.9 | 10.5 | 19.0 | 14.7 | 14.9 | 15.2 | 14.5 |
| **Total Gg $CO_2$ equivalent** | 60,906.8 | 63,906.6 | 69,473.7 | 76,484.4 | 75,363.3 | 76,085.3 | 77,282.6 | 76,895.7 |

**Note:** NA = Not Applicable; NO = Not Occurring.[58]

[58] Not occurring: when the activity or process does not occur in New Zealand. Not applicable: when the activity occurs in New Zealand but the nature of the process does not result in emissions or removals.

**Figure 5.1: Actual and projected carbon dioxide emissions, 1990–2020**

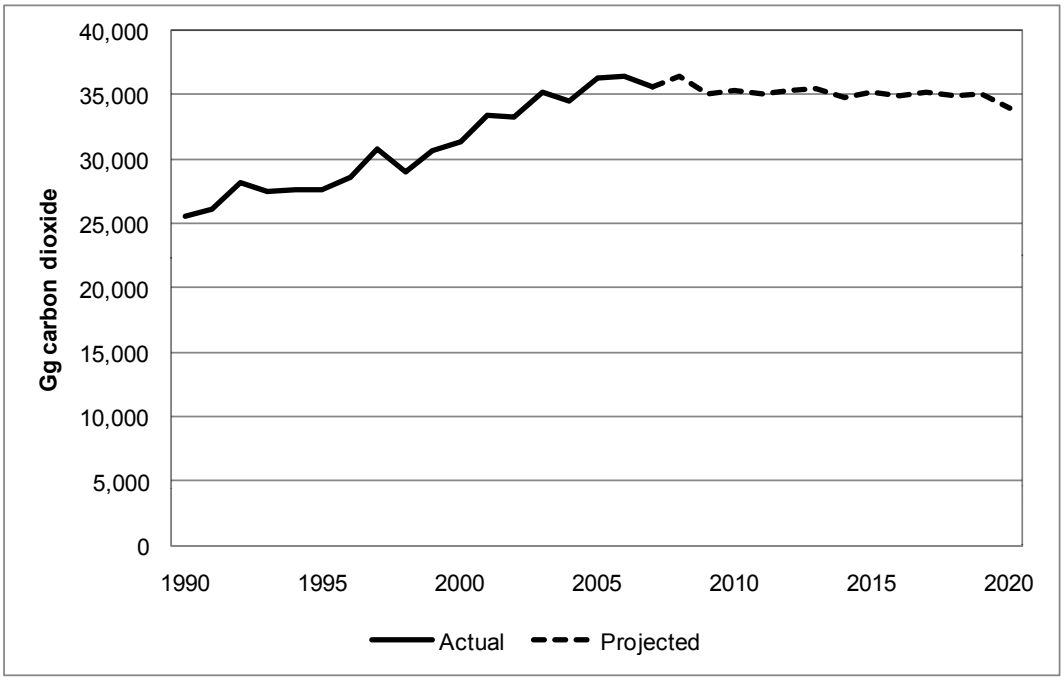



**Figure 5.2: Actual and projected methane emissions, 1990–2020**

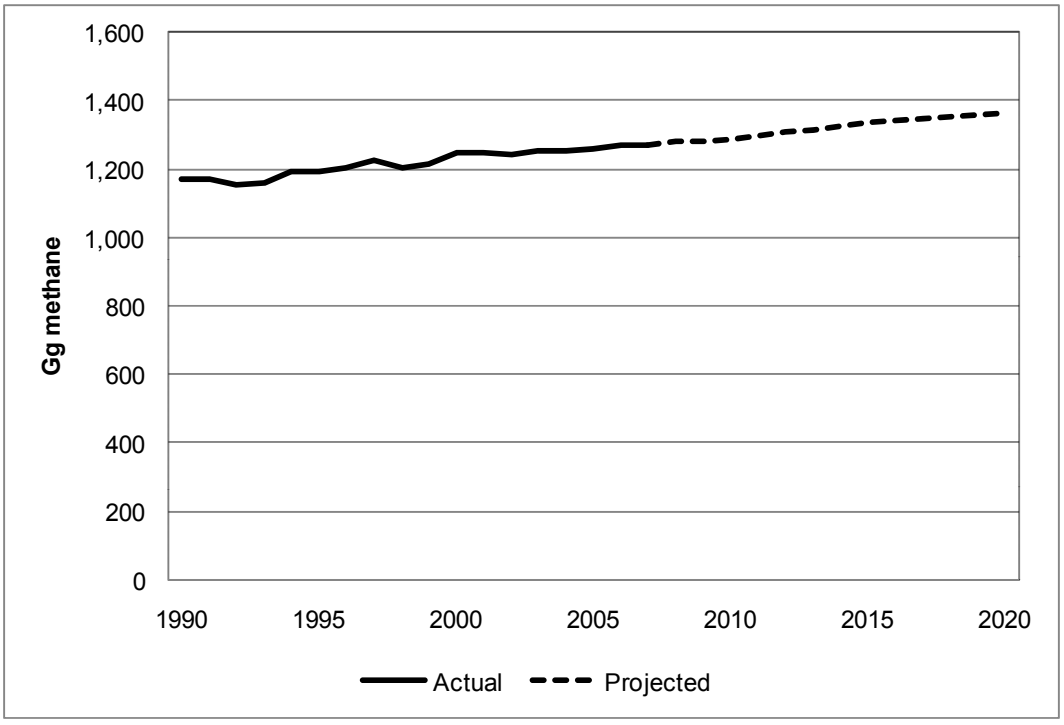


**Figure 5.3: Actual and projected nitrous oxide emissions, 1990–2020**

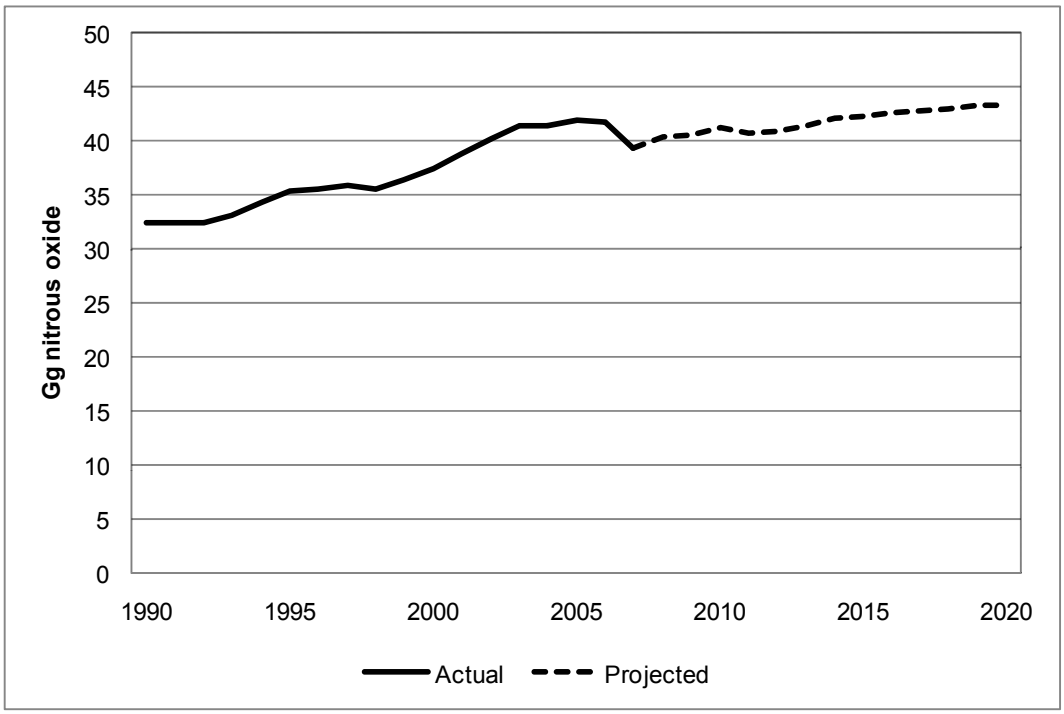
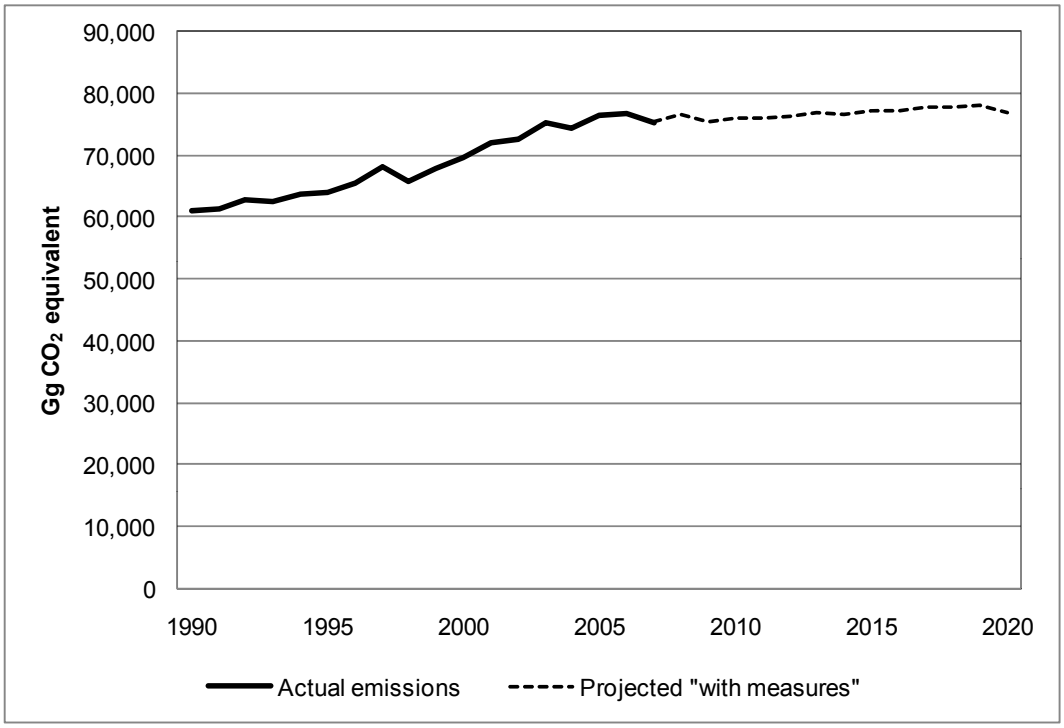



**Figure 5.4: Total actual and projected emissions, 1990–2020**



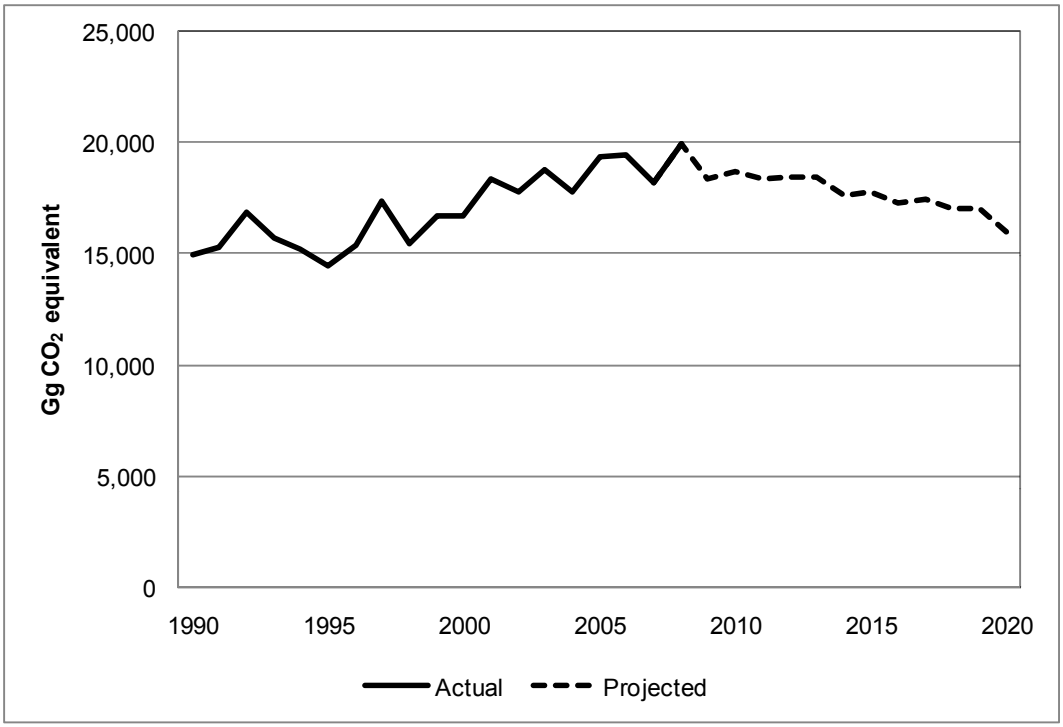
## 5.2.1 Energy sector

Emissions from the energy sector are expected to be 6 per cent higher than 1990 levels by 2020 (table 5.3). The energy sector includes electricity generation, other stationary energy, industrial and commercial use of energy, and fugitive emissions, but excludes emissions from transport. The projections for these sectors were produced by the Ministry of Economic Development and published in the New Zealand Energy Outlook in September 2009. Full details of the New Zealand Energy Outlook and the models sitting behind these projections can be found at www.med.govt.nz/energyoutlook.

**Table 5.3: Actual and projected energy sector emissions, by gas, 1990–2020**

| | Gg gas for energy sector (excluding transport) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gas** | **1990** | **1995** | **2000** | **2005** | **2007** | **2010** | **2015** | **2020** |
| Carbon dioxide | 14,224.5 | 13,706.4 | 15,822.4 | 18,436.7 | 17,272.5 | 17,869.9 | 16,828.9 | 15,001.3 |
| Methane | 32.4 | 31.1 | 38.9 | 38.7 | 37.2 | 36.2 | 40.3 | 41.1 |
| Nitrous oxide | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| Carbon dioxide equivalent | 14,987.5 | 14,444.4 | 16,731.3 | 19,364.3 | 18,153.4 | 18,723.8 | 17,765.9 | 15,946.2 |

**Figure 5.5: Actual and projected emissions from energy, "with measures", 1990–2020**



Levels of emissions from thermal electricity generation are expected to remain relatively constant until 2015, because all new generating plant is expected to be geothermal and wind. These renewable forms of generation are considered to be the most economical, with a carbon price expected in the range of NZ$25 to NZ$50 per tonne $CO_2$-e over the medium term.[59]

The industrial and commercial sector includes emissions from energy combustion in heavy industries, defined as metals (primarily aluminium and steel), refining, petrochemicals (primarily methanol and urea), forestry processing (primarily pulp and paper and milling), as well as "other industrial and commercial". The heavy industrial sector in New Zealand is dominated by a small number of firms. As a result, projections from this source are subject to an unusually high degree of variability because small changes in one firm (or a closure) will significantly affect the total projection.

Fugitive emissions are those that arise from the production, processing, transmission, storage and use of fuels, and from non-productive combustion (eg, the flaring of natural gas at oil and gas production facilities). Fugitive emissions in New Zealand also include methane emissions from geothermal electricity generation. Fugitive emissions have been included with energy emissions and make up approximately 10 per cent of projected energy emissions.

### 5.2.2 Transport sector

Emissions from the transport sector are projected to rise to 15,583.6 Gg $CO_2$-e (78 per cent above 1990 levels) by 2020 (see table 5.4). Road transport accounts for 91 per cent of New Zealand's transport emissions, and over 95 per cent of the growth in transport emissions between 1990 and 2007.

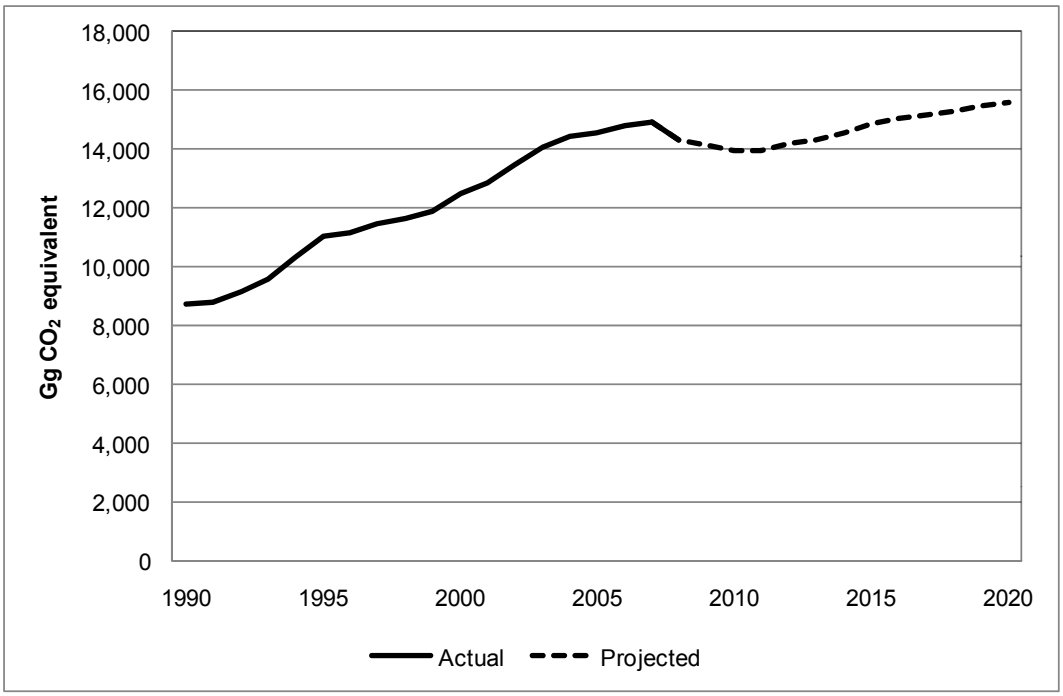
**Table 5.4: Actual and projected transport emissions, 1990–2020**

| | Gg gas for transport emissions | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gas** | **1990** | **1995** | **2000** | **2005** | **2007** | **2010** | **2015** | **2020** |
| Carbon dioxide | 8,604.2 | 10,884.5 | 12,309.1 | 14,349.8 | 14,687.2 | 13,753.8 | 14,609.2 | 15,356.2 |
| Methane | 3.3 | 2.9 | 2.2 | 2.5 | 2.6 | 2.4 | 2.4 | 2.4 |
| Nitrous oxide | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 |
| Carbon dioxide equivalent | 8,748.9 | 11,051.3 | 12,484.7 | 14,557.8 | 14,903.1 | 13,954.5 | 14,823.9 | 15,583.6 |

Figure 5.6 shows a chart of actual and projected $CO_2$-e emissions for the transport sector. These emissions grew rapidly until 2005 but have slowed since 2006 due to higher crude oil prices and the worldwide economic recession. From 2010 emissions from transport are projected to continue to resume growing, reflecting an expected recovery in the New Zealand economy. However, the rate of growth is expected to be at lower levels than seen from 1990 to 2005. During that period the New Zealand vehicle fleet grew rapidly to a per capita level that is now one of the highest in the world and near saturation levels.

[59] For more information on the Energy Outlook modelling, see http://www.med.govt.nz/templates/StandardSummary____10186.aspx. ing/generation/index.html

**Figure 5.6: Actual and projected emissions from transport, "with measures", 1990–2020**




Emissions from fuel used in international air and sea transport are reported separately and are not included in the historical or projected totals. Tables 5.5 and 5.6 show the imputed emissions from fuel sold in New Zealand for use in international air and sea transport, respectively. The sea transport numbers tend to be highly variable and difficult to project because international sea carriers have flexibility to choose the country where they buy their fuel. It is believed that most of the fuel used by international shipping travelling to and from New Zealand is purchased in other countries.

Emissions from international air transport showed continued growth between 1990 and 2005. From 2005, emissions have flattened in the face of higher fuel prices and with an ongoing focus from carriers on fuel efficiency and optimal loading of aircraft. Growth in international travel demand is expected to return from 2010 as the global economy recovers from recession.

**Table 5.5: Actual and projected New Zealand emissions from international air transport, 1990–2020**

| | Gg gas for international air transport | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gas** | **1990** | **1995** | **2000** | **2005** | **2007** | **2010** | **2015** | **2020** |
| Carbon dioxide | 1,338.2 | 1,571.0 | 1,733.1 | 2,630.0 | 2,611.9 | 2,564.1 | 3,228.5 | 3,768.4 |
| Methane | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Nitrous oxide | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Carbon dioxide equivalent emissions | 1,350.7 | 1,585.6 | 1,749.2 | 2,654.4 | 2,636.2 | 2,587.9 | 3,258.5 | 3,803.4 |

**Table 5.6: Actual and projected New Zealand emissions from international sea transport, 1990–2020**

| | Gg gas for international sea transport | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gas** | **1990** | **1995** | **2000** | **2005** | **2007** | **2010** | **2015** | **2020** |
| Carbon dioxide | 1,031.1 | 1,134.8 | 747.7 | 982.8 | 978.9 | 853.9 | 844.9 | 877.4 |
| Methane | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Nitrous oxide | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Carbon dioxide equivalent emissions | 1,044.6 | 1,149.3 | 756.3 | 993.7 | 989.4 | 863.4 | 854.0 | 886.8 |

## 5.2.3 Industry

Industrial process $CO_2$ emissions in New Zealand are derived from the production of iron and steel, aluminium, urea, cement, lime and hydrogen. The level of output from of these industries is expected to remain steady. Table 5.7 shows New Zealand's actual and projected emissions from the industrial sector.

**Table 5.7: Actual and projected emissions from industry, 1990–2020**

| **Gas** | **Gg gas for industry** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Industrial processes** | **1990** | **1995** | **2000** | **2005** | **2007** | **2010** | **2015** | **2020** |
| Carbon dioxide | 2,731.6 | 3,016.0 | 3,174.3 | 3,499.1 | 3,670.6 | 3,720.7 | 3,797.0 | 3,610.1 |
| Methane | 1.0 | 2.8 | 4.8 | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 |
| Nitrous oxide | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC ($CO_2$ equivalent) | NA,NO | 148.3 | 304.3 | 675.5 | 856.6 | 868.3 | 886.1 | 842.5 |
| PFC ($CO_2$ equivalent) | 642.2 | 150.3 | 57.7 | 59.0 | 41.7 | 42.2 | 43.1 | 41.0 |
| SF6 ($CO_2$ equivalent) | 15.2 | 17.9 | 10.5 | 19.0 | 14.7 | 14.9 | 15.2 | 14.5 |
| Carbon dioxide equivalent | 3,409.2 | 3,390.2 | 3,648.0 | 4,266.9 | 4,601.9 | 4,664.6 | 4,760.3 | 4,526.1 |
| **Solvent and other product use** | | | | | | | | |
| Carbon dioxide | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Methane | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nitrous oxide | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Carbon dioxide equivalent | 41.5 | 45.0 | 47.1 | 44.3 | 43.4 | 44.0 | 45.1 | 46.2 |
| **Total industrial processes and solvents (carbon dioxide equivalent)** | 3,450.8 | 3,435.2 | 3,695.1 | 4,311.2 | 4,645.3 | 4,708.7 | 4,805.4 | 4,572.2 |

Emissions of perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride are included in the projections of emissions from the industrial processes sector. Projected emissions of these fluorinated gases were not directly modelled, but were assumed to grow at the same rate as that projected for emissions of $CO_2$ from the industrial processes sector. Emissions from solvents and other product use make up a very small proportion of industrial emissions. Emissions from solvents and other product use have been extrapolated from historical trends.

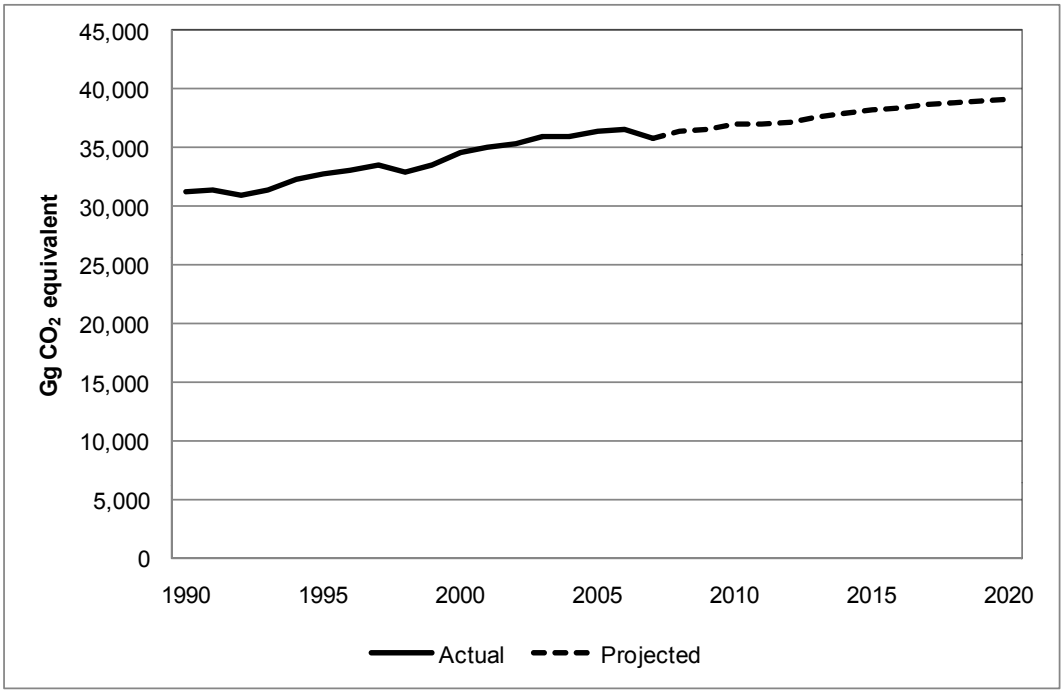
## 5.2.4 Agriculture

Emissions from agriculture are projected to rise to 25 per cent above 1990 levels by 2020. Agricultural emissions decreased in 2007 due to a drought across all of New Zealand over 2007/08 and falling global dairy prices, but emissions are expected to increase as the global economy recovers (see table 5.8).

**Table 5.8: Actual and projected emissions from agriculture, "with measures", 1990–2020**

| Gas | Gg gas for agriculture | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2007 | 2010 | 2015 | 2020 |
| Methane | 1,027.8 | 1,054.9 | 1,109.8 | 1,138.3 | 1,148.5 | 1,173.3 | 1,217.8 | 1,243.9 |
| Nitrous oxide | 31.3 | 34.1 | 36.1 | 40.3 | 37.8 | 39.7 | 40.6 | 41.8 |
| Carbon dioxide equivalent | 31,281.4 | 32,716.2 | 34,483.2 | 36,385.7 | 35,839.8 | 36,934.2 | 38,168.4 | 39,072.4 |

**Figure 5.7: Actual and projected emissions from agriculture, "with measures", 1990–2020**




Agricultural emissions in New Zealand are projected to rise as animal productivity (animal size and production) and nitrogen fertiliser use continue to increase. Animal performance in New Zealand is below biological limits and it is assumed that the rate of increase in productivity per animal to 2020 will be similar to the rate of increase since 1990.

The nitrogen application rate in New Zealand is lower than in most other OECD countries: the amount of fertiliser nitrogen applied per hectare in New Zealand in 2007 was 17.7 kilograms per hectare compared to the OECD country average of 59.3 kilograms per hectare. The rate of growth in emissions from the agricultural sector is expected to decline slightly from 2010 onwards due to the finite potential of agricultural land area and biophysical limitations on increasing underlying pasture production in New Zealand. Expansion of plantation forestry, encouraged by the NZ ETS, is also expected to gradually reduce pastoral agricultural areas.

The effects of nitrification inhibitors to reduce nitrous oxide emissions from agricultural soil has also been incorporated in these projections. The application of the nitrification inhibitor dicyandiamide to dairy pastures has been shown to reduce nitrous oxide emissions from fertiliser and animal-excreted nitrogen on pasture over a five-month period in winter. Nitrate leaching is also reduced. A report contracted by the Ministry of Agriculture and Forestry on the use of dicyandiamide developed a method for quantifying the reduced nitrous oxide emissions.[60]

However, the projections need to be assessed in light of the uncertainties of the continued expansion in the use of inhibitors, the biological processes involved and the economic circumstances of the agricultural industry, which are largely driven by overseas markets.

The major source of New Zealand's nitrous oxide emissions comes from nitrogen excreted in urine and dung by livestock. To estimate the indirect contribution to nitrous oxide from nitrogen excreted by livestock, the fraction of nitrogen in excreta on New Zealand pasture that converts to oxides of nitrogen is required. Until 2008 New Zealand used the international default value of 0.2 for this fraction (Fracgasm, Table 4.19 (IPCC 2000)). In a report for the Ministry of Agriculture and Forestry, Sherlock et al (2008) reviewed the relevant studies for this fraction of livestock-excreted nitrogen, and found that a more accurate New Zealand-specific fraction would be 0.1. The Sherlock et al (2008) report was internationally peer reviewed. This improvement has been included in the agriculture projections, and will be reported as a recalculation in the 2010 national greenhouse gas inventory submission.

### 5.2.4 Forestry

New Zealand's forestry sector is currently a net sink of carbon. In 2007, forest land contributed 18,485.1 Gg $CO_2$-e of net removals. This value includes removals from the growth of planted forests, emissions from the conversion of land to planted forest and emissions from harvesting and deforestation. This equates to 25 per cent of New Zealand's gross greenhouse gas emissions in 2007. In 2010, net removals from forestry are projected to be approximately 20,084.0 Gg of $CO_2$-e. However, by 2020 forestry is expected to become a net source of emissions as large areas of production forests planted in the 1990s start to be harvested (table 5.9).

**Table 5.9: Actual and projected net emissions and removals from forestry, UNFCCC basis, 1990–2020**

| | Net emissions and removals (Gg $CO_2$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2007 | 2010 | 2015 | 2020 |
| **All planted forests (UNFCCC basis)** | –19,188.4 | –16,685.7 | –22,520.8 | –24,031.9 | –18,485.1 | –20,084.0 | –1,370.7 | 1,926.9 |
| **Post–1989 forests only (Kyoto Protocol basis)** | 816.8 | –252.7 | –10,309.6 | –6,707.5 | –2,667.5 | –15,938.5 | –17,634.4 | –15,499.9 |

**Note:** Negative values denote net removals of $CO_2$. Positive values denote net emissions of $CO_2$. "Net removals" means gross removals by planted forests, less emissions from deforestation and harvesting.

These UNFCCC figures are projections of emissions and removals from all forests, including forests planted before and after 1990. The UNFCCC figures are distinct from the projections of

[60] The report is available on the Ministry of Agriculture and Forestry website: http://www.maf.govt.nz/climatechange/slm/inhibitors/

removals from Kyoto-protocol forests which only include removals from forests planted after 31 December 1989. Projections of net removals from forests meeting the definition of Article 3.3 of the Kyoto Protocol (ie, forests planted after 31 December 1989) are also reported in table 5.9 for comparison with the UNFCCC figures.

New Zealand has 8.2 million hectares of natural forest and 1.8 million hectares of planted production forest. A national carbon monitoring programme to produce accurate estimates of carbon stock and change for New Zealand's natural forests was developed between 1998 and 2001. In 2008, the carbon monitoring programme was integrated into the Land Use and Carbon Analysis System (LUCAS). As part of the carbon monitoring programme 1256 permanent plots were installed systematically over an 8-km grid across New Zealand's natural forests and were first measured between 2002 and 2007. The analysis of those plots found that natural forests in New Zealand were a slight carbon sink over the period 1990 to 2004 (Beets et al. 2009).[61] As the plot network is re-measured, the data collected will be suitable for determining if New Zealand's natural forests are carbon neutral, or whether they are a source or a sink of carbon. Until the entire plot network has been re-measured New Zealand continues to report natural forests as carbon neutral, and therefore these projections include emissions and removals only from plantation forests.

The projections include carbon stock change on forest land due to forest growth, with an allowance for carbon stock change associated with harvesting and the clearance of sparse woody vegetation (scrub) for afforestation. Non-$CO_2$ emissions from wildfires and prescribed burning are also included.

Projections of carbon stock changes in the non-forest land categories have not been developed. In New Zealand's 2007 greenhouse gas inventory reported to the United Nations Framework Convention on Climate Change, these categories accounted for only 1 per cent of net removals in the sector. Soil carbon stock changes have also not been included.

## Forestry scenarios

As with projections of emissions in any sector, the forestry sector is sensitive to the underlying assumptions. Projected net removals by forestry are determined by assumptions for the future values of deforestation, afforestation and rates of harvesting and reforestation.

The projections of forestry removals around 2020 are most sensitive to the assumed harvest levels. The forestry model uses an average rotation age to model harvest levels over time. If different assumptions are made about the average rotation length of planted forests, the projected emissions and removals from forestry can change significantly.

The forestry models assume forests are harvested to maximize the economic value of the timber. In recent years low returns to forest owners have resulted in the forests being harvested more slowly with a resulting increase in the average harvest age and delay in harvesting emissions.

During the early 1990s, rates of afforestation in New Zealand were high. The forests planted in the 1990s are expected to start to be harvested leading into the 2020s. The level of harvesting at any point in time is affected by log prices and harvesting costs.

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[61] Beets PN, Kimberley MO, Goulding CJ, Garrett LG, Oliver GR, and Paul TSH. 2009. *Natural forest plot data analysis: carbon stock analyses and re-measurement strategy*. Available on request from the Ministry for the Environment.

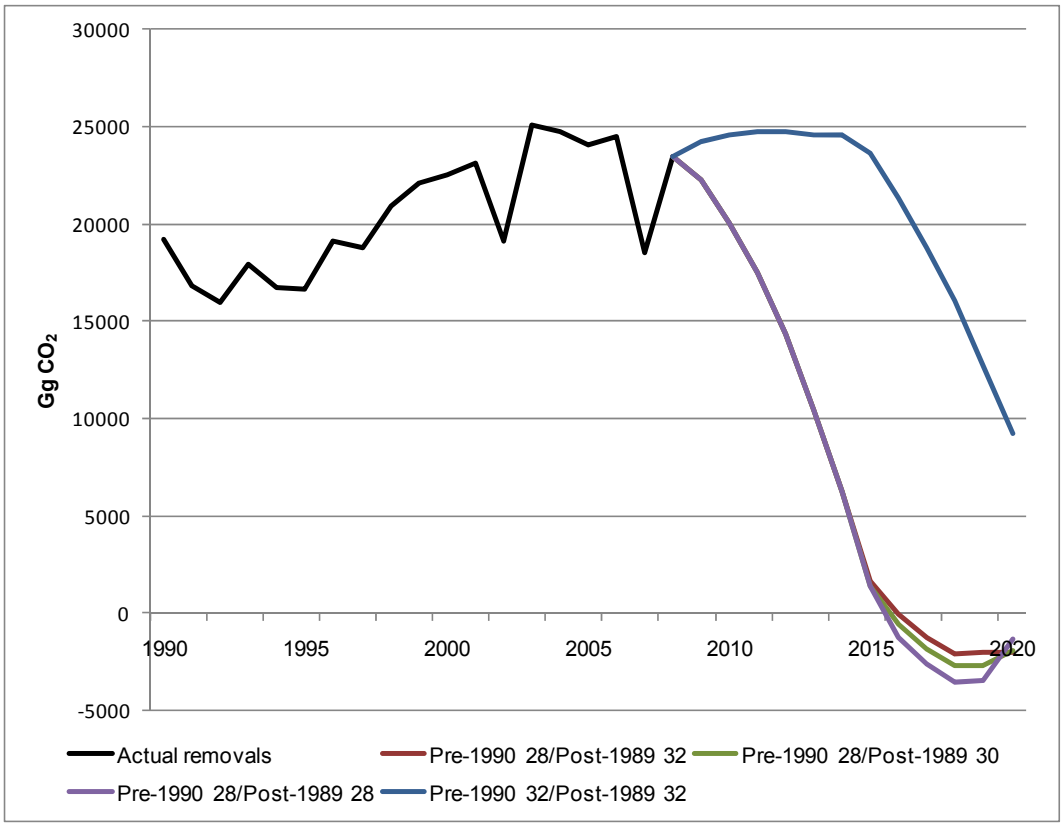
Figure 5.8 and table 5.10 compare the impacts of different harvest ages for pre-1990 forests and post-1989 forests. The scenario presented in the *Fifth National Communication* assumes pre-1990 forests are harvested after 28 years and post-1989 forests are harvested after 30 years. Table 5.10 and figure 5.8 show that projections of emissions and removals from forestry are not very sensitive to changes in the rotation length of post-1989 forests, but are sensitive to variations in the rotation length of pre-1990 forests. If pre-1990 forests and post-1989 forests are harvested on a 32-year rotation, then removals by forestry could be up to 11,134.5 Gg $CO_2$ more in 2020 compared with the estimate of removals presented in table 5.1 (included in table 5.10 in italics).

**Table 5.10: Removals by forests under different forestry harvest ages for pre-1990 and post-1989 forests**

| | | Net emissions and removals (Gg $CO_2$) | | |
|---|---|---|---|---|
| **Pre-1990 forest harvest age (years)** | **Post 1989 forest harvest age (years)** | **2010** | **2015** | **2020** |
| **28** | **28** | –20,085.9 | –1,364.9 | 1,279.7 |
| | **30** | *–20,084.0* | *–1,370.7* | *1,926.9* |
| | **32** | –20,084.1 | –1,676.3 | 1,971.3 |
| **32** | **32** | –24,591.5 | –23,596.2 | –9,207.5 |

**Note:** The projections used elsewhere in this chapter assume pre-1990 forests are harvested at an average age of 28 years, and post-1989 forests at an average age of 30 years.

**Figure 5.8: Removals by forestry under different assumptions for harvesting rates for pre-1990 forests and post 1989 forests.**



## 5.2.6 Waste sector

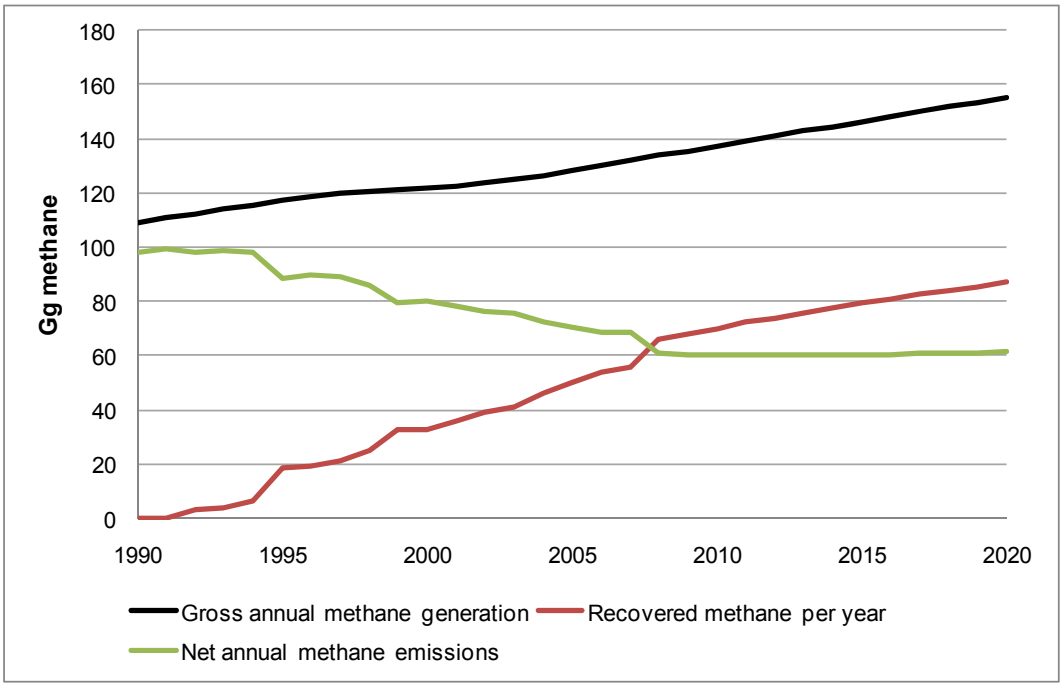
Emissions from the waste sector are projected to fall to 29 per cent below 1990 levels by 2020 (table 5.11). This reduction is mainly due to the increasing capture and destruction of landfill gas (methane).

**Table 5.11: Actual and projected emissions from the waste sector, 1990–2020**

| | Gg gas from the waste sector | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gas** | **1990** | **1995** | **2000** | **2005** | **2007** | **2010** | **2015** | **2020** |
| Carbon dioxide | 12.9 | 12.6 | 5.9 | 3.6 | 0.9 | 0.9 | 0.9 | 0.9 |
| Methane | 108.1 | 99.3 | 90.8 | 80.2 | 78.1 | 75.3 | 72.9 | 72.8 |
| Nitrous oxide | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Carbon dioxide equivalent | 2,438.2 | 2,259.6 | 2,079.3 | 1,865.4 | 1,821.8 | 1,764.1 | 1,719.0 | 1,721.3 |

Methane emissions from landfills are expected to be significantly below 1990 levels in the first commitment period of the Kyoto Protocol, and to continue to decline towards 2020. Figure 5.9 shows projections of methane emitted and recovered from landfills.[62]

**Figure 5.9: Gross methane generated from landfills, methane recovery and net methane emissions, 1990–2020**




[62] http://www.mfe.govt.nz/laws/standards/air-quality-standards.html

## 5.3 Key assumptions and methods used

The key assumptions used for projections of emissions for each sector are summarised in table 5.12.

**Table 5.12: Key assumptions for projections**

| Assumption | 2010 | 2015 | 2020 |
|---|---|---|---|
| GDP (2007 NZ$ billion) | 164.6 | 196.0 | 220.2 |
| Carbon price NZ$/tonne $CO_2$-e | 25 | 50 | 50 |
| Oil price (2004 US$/barrel) | 70.39 | 79.09 | 89.17 |
| Coal price (2004 NZ$/GJ) | 4.5 | 4.5 | 4.5 |
| Exchange rate (NZ$/US$) | 0.52 | 0.54 | 0.60 |
| Gas discoveries (PJ/year) | 0 | 0 | 100 |
| Population (thousand) | 4,352 | 4,550 | 4,735 |

**Sources:** New Zealand Treasury, Ministry of Economic Development, Statistics New Zealand.

The cross-government technical group ensures any assumptions for projections are common and consistent across all sectors.[63]

Economic assumptions for the short term are taken from the Budget Economic and Fiscal Update (BEFU) 2009. Longer-term projections are taken from the Treasury's Long Term Fiscal Model.

Population projections are based on the central estimate of population projections by Statistics New Zealand and assume medium fertility and mortality rates and net migration of 10,000 people per year.

Historical rates of energy efficiency improvements are assumed to continue in both the "with measures" and "without measures" emissions projections because the effects of policy induced energy efficiency improvements cannot be robustly separated from the effects of autonomous energy efficiency improvements.

Further details of the energy specific assumptions may be found in the New Zealand Energy Outlook at http://www.med.govt.nz/energyoutlook.

### 5.3.1 Methodology

#### Energy, transport and industrial processes

Energy, transport and industrial process emissions are projected using the Ministry of Economic Development's Supply and Demand Equilibrium Model (SADEM).[64] The Ministry of

[63] The Ministry of Economic Development maintains a web page that publicly documents energy-related modelling input assumptions. More detail can be found at: http://www.med.govt.nz/templates/MultipageDocumentPage____33244.aspx

[64] More information on SADEM can be found at: http://www.med.govt.nz/templates/MultipageDocumentPage____39787.aspx?&MSHiC=65001&L=0&W=SADEM+&Pre=%3cb%3e&Post=%3c%2fb%3e

Economic Development is assisted by modelling from the Ministry of Transport and the Electricity Commission.[65]

## Agriculture

Projections of methane and nitrous oxide emissions from the agricultural sector are produced by the Ministry of Agriculture and Forestry (MAF). Emissions projections from the agricultural sector are driven by future estimates of:

- animal numbers
- animal performance
- nitrogen fertiliser use.

Animal numbers and animal performance are projected using the Ministry of Agriculture and Forestry's Pasture Supply Response Model. Projections of nitrogen fertiliser use are made using the Ministry of Agriculture and Forestry's Nitrogen Demand Model. These estimates are combined using the tier 2 model used to calculate agricultural emissions in New Zealand's greenhouse gas inventory. More detail on the two models can be found in the appendices to the *Net Position Report 2009*.[66] The inventory model is described in *New Zealand's Greenhouse Gas Inventory 2007*.[67]

## Forestry

Emissions and removals from the forestry sector are calculated using the methodology used for the 2007 inventory submission (see section 7.2.2 of *New Zealand's Greenhouse Gas Inventory 1990–2007* for details).[68] The land area in planted forest that had been estimated using the Land Cover Database from 2002 was updated with new data from the Land Use Carbon Analysis System (LUCAS).[69] The projections here assume an afforestation rate that increases over time to 30,000 hectares per year at 2020, and little deforestation due to a price on carbon being in place.

## Waste

The method used for projecting emissions from the waste sector is set out in the appendices to the *Net Position Report 2009*. The projections in this chapter also account for greater population growth out to 2020, increased recovery of landfill gas and improved solid waste management practices.

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65 http://www.electricitycommission.govt.nz/opdev/modelling and http://www.med.govt.nz/templates/MultipageDocumentPage____39791.aspx

66 http://www.mfe.govt.nz/publications/climate/net-position-report-2009/index.html

67 http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2009/index.html

68 http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2009/index.html

69 http://www.mfe.govt.nz/publications/climate/stakeholder-progress-report/

## 5.4 Differences since the *Fourth National Communication*

The differences between the projections of emissions set out here, and those set out in the *Fourth National Communication* are shown in tables 5.12 and 5.13.

**Table 5.13: Differences in projections since the *Fourth National Communication*, by sector, 2010**

| Sector | Emissions (Gg $CO_2$ equivalent) | | | |
|---|---|---|---|---|
| | Fourth National Communication | Fifth National Communication | Difference (absolute) | Difference (percentage) |
| Energy | 20,292.5 | 18,723.8 | –1,568.7 | –7.7 |
| Transport | 15,937.7 | 13,954.5 | –1,983.2 | –12.4 |
| Industry | 4,378.0 | 4,708.7 | 330.7 | 7.6 |
| Agriculture | 40,476.0 | 36,934.2 | –3,541.9 | –8.8 |
| Forestry | –9,596.9 | –20,084.0 | –10,487.1 | 109.3 |
| Waste | 1,347.1 | 1,764.1 | 417.0 | 31.0 |
| Total emissions (excluding LULUCF) | 82,431.3 | 76,085.3 | –6,346.0 | –7.7 |
| Total emissions (including LULUCF) | 72,834.4 | 56,001.3 | –16,833.1 | –23.1 |

**Table 5.14: Differences in projections since the *Fourth National Communication*, by sector, 2020**

| Sector | Emissions (Mt $CO_2$ equivalent) | | | |
|---|---|---|---|---|
| | Fourth National Communication | Fifth National Communication | Difference (absolute) | Difference (percentage) |
| Energy | 21,715.0 | 15,946.2 | –5,768.8 | –26.6 |
| Transport | 19,796.1 | 15,583.6 | –4,212.5 | –21.3 |
| Industry | 4,618.4 | 4,572.2 | –46.2 | –1.0 |
| Agriculture | 43,794.6 | 39,072.4 | –4,722.2 | –10.8 |
| Forestry | –4,396.9 | 1,926.9 | 6,323.8 | –143.8 |
| Waste | 1,260.6 | 1,721.3 | 460.7 | 36.5 |
| Total emissions (excluding LULUCF) | 91,184.7 | 76,895.7 | –14,289.0 | –15.7 |
| Total emissions (including LULUCF) | 86,787.9 | 78,822.6 | –7,965.3 | –9.2 |

The differences between the projected removals in the *Fifth* and *Fourth National Communications* mainly result from changes in forecast future harvesting levels and the timing of harvesting. The forestry projections in the *Fourth National Communication* assumed around 30 million cubic metres would be harvested in 2010. The latest projections now assume about 19 million cubic metres will be harvested in 2010, resulting in lower harvesting emissions. The difference between the two sets of forestry projections in 2020 are due to differences in both harvest and afforestation levels.

Projections of annual planting rates of 10,000 and 40,000 hectares in the *Fourth National Communication* have not occurred, and new planting rates have fallen steadily since 2000. It is estimated that 2400 hectares of new forest were planted in 2007, and in 2008 it is provisionally estimated that 1000 hectares of new forest were planted. This highlights the uncertainties in projecting future afforestation, particularly in the longer term. These lower rates of afforestation have the effect of reducing carbon dioxide removals out to 2020.

Projections of emissions from the transport sector in 2020 are 21 per cent lower than in the *Fourth National Communication*. This is due to new projections of the price of oil in 2020 being much higher than in previous projections. Projections of emissions from the agricultural sector in 2020 are 12 per cent lower than in the *Fourth National Communication*. This reflects the reduced stock levels due to the effect of the drought in 2007/08. Stock levels and emissions are projected to grow from 2010, but from a lower base due to the drought.

## 5.5 Without measures projection

Table 5.14 shows the projected "without measures" by sector. Total "with measures" and "without measures" projections are compared in table 5.16 and Figures 5.10 and 5.11.

The "without measures" projection excludes the modelled effects of the NZ ETS from the energy, transport, agricultural and forestry sectors and the extended application of the nitrification inhibitor dicyandiamide in the agricultural sector. The effect of the landfill gas standard on waste emissions has not been modelled. Note also that modelled emissions projections from the industrial processes sector do not change significantly as a result of the NZ ETS.

**Table 5.15: Projected emissions, "without measures", 2010–2020**

| | Emissions (Gg $CO_2$-e) | | |
|---|---|---|---|
| **Sector** | **2010** | **2015** | **2020** |
| Energy | 18,782.0 | 20,294.6 | 23,157.3 |
| Transport | 13,955.0 | 14,959.4 | 15,717.4 |
| Industry | 4,708.7 | 4,805.4 | 4,572.2 |
| Agriculture | 37,588.8 | 39,132.9 | 40,660.7 |
| Forestry | –18,698.7 | 256.4 | 5,308.5 |
| Waste | 1,764.1 | 1,719.0 | 1,721.3 |
| Total emissions (excluding net emissions from forestry) | 76,798.6 | 80,911.2 | 85,828.9 |
| Total emissions (including net emissions from forestry) | 86,787.9 | 81,167.6 | 91,137.5 |

**Table 5.16: Comparison of projected emissions, "with measures" and "without measures" in 2020**

| | Without measures (Gg $CO_2$–e) | With measures (Gg $CO_2$-e) | Absolute difference (Gg $CO_2$–e) | Percentage difference |
|---|---|---|---|---|
| **Sector** | | | | |
| Energy | 23,157.3 | 15,946.2 | –7,211.1 | –31.1 |
| Transport | 15,717.4 | 15,583.6 | –133.8 | –0.9 |
| Industry | 4,572.2 | 4,572.2 | 0.0 | 0.0 |
| Agriculture | 40,660.7 | 39,072.4 | –1,588.3 | –3.9 |
| Forestry | 5,308.5 | 1,926.9 | –3,381.6 | –63.7 |
| Waste | 1,721.3 | 1,721.3 | 0.0 | 0.0 |
| Total emissions (excluding LULUCF) | 85,828.9 | 76,895.7 | –8,933.3 | –10.4 |
| Total emissions (including LULUCF) | 91,137.5 | 78,822.6 | –12,314.9 | –13.5 |

**Figure 5.10: Actual and projected total emissions, "with measures" versus "without measures", 1990–2020**

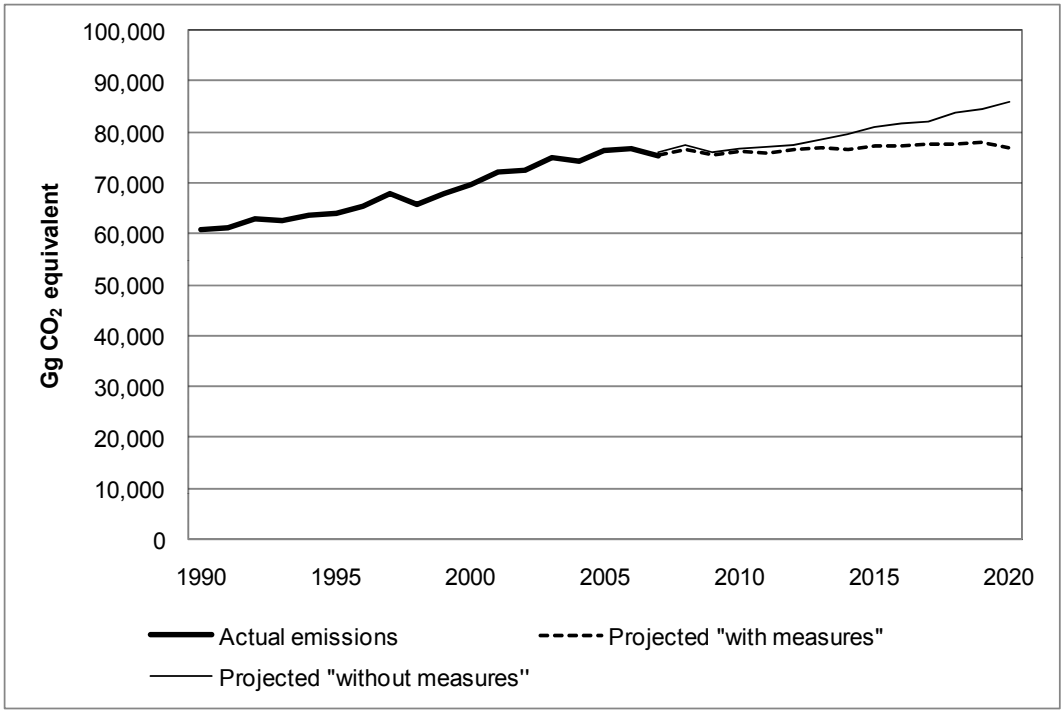
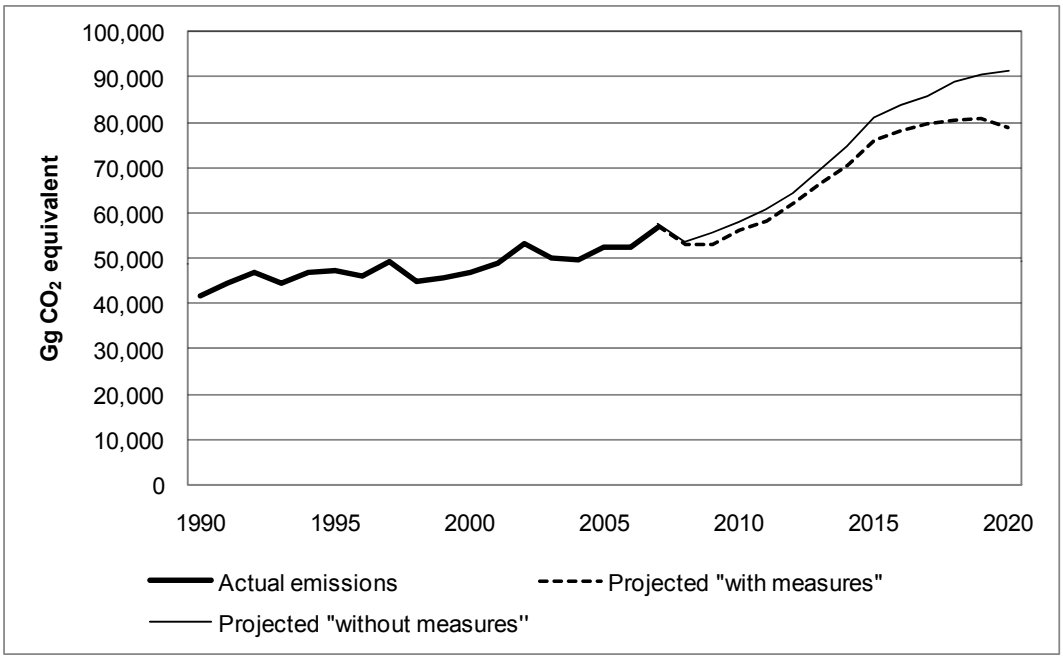


**Figure 5.11: Actual and projected net emissions, "with measures" versus "without measures", 1990–2020**





# Vulnerability assessment, climate change impacts and adaptation measures

# 6

# 6 Vulnerability assessment, climate change impacts and adaptation measures

**Key developments since the *Fourth National Communication***

- The *Climate Change Effects and Impacts Assessment* guidance manual, which includes the climate change scenario information for New Zealand, has been updated to include the findings of the IPCC's Fourth Assessment Report.
- The *Coastal Hazards and Climate Change* guidance manual has been updated to reflect information in the IPCC's Fourth Assessment Report.
- Additional guidance on climate change impacts and adaptation is being developed, targeted at local government and rural land managers.
- The New Zealand Government has continued to support research on climate change impacts and adaptation.
- A cross-government group has been established to coordinate the central government policy response.

## 6.1 Current climate variability and observed changes in New Zealand

A low population density (and related long-distance infrastructure), a long coastline, varied geomorphology and an economy reliant on the primary production sector make New Zealand particularly vulnerable to climate-related risks. Climate change is expected to exacerbate these risks. Information on climate variability and observed changes in the New Zealand climate is contained in the document *Climate Change Effects and Impacts Assessment: A Guide for Local Government in New Zealand.*[70] The key findings for New Zealand are presented below.

A number of natural oscillations operating over time scales ranging from seasons to decades influence New Zealand's weather patterns. The two most important to New Zealand are the El Niño–Southern Oscillation and the Interdecadal Pacific Oscillation. The dominance of these oscillations can make it difficult to identify long-term climate trends that may be attributable to climate change. However, the following trends have been observed:

- the climate has become warmer despite the dominance of cooler southerly airflows. Average temperatures have increased by 0.9°C between 1908 and 2006
- the number of frost days has decreased at many sites
- extreme 24-hour duration rainfall events increased in the west of the country and decreased in the north and east between 1930 and 2004.

[70] http://www.mfe.govt.nz/publications/climate/climate-change-effect-impacts-assessments-may08/

- an increase in heavy rainfall has been observed in western parts of the North and South Islands, while decreases have been observed in eastern regions. This is most likely to be the result of natural decadal variability, although a contribution from climate change cannot be ruled out
- several recent studies have found increases in the number of Southern Hemisphere extra-tropical cyclones of about 50 per cent over the period 1979 to 1999
- sea level rose at an average of 1.6 millimetres per year during the 20th century.

## 6.2 Future climate change scenarios for New Zealand

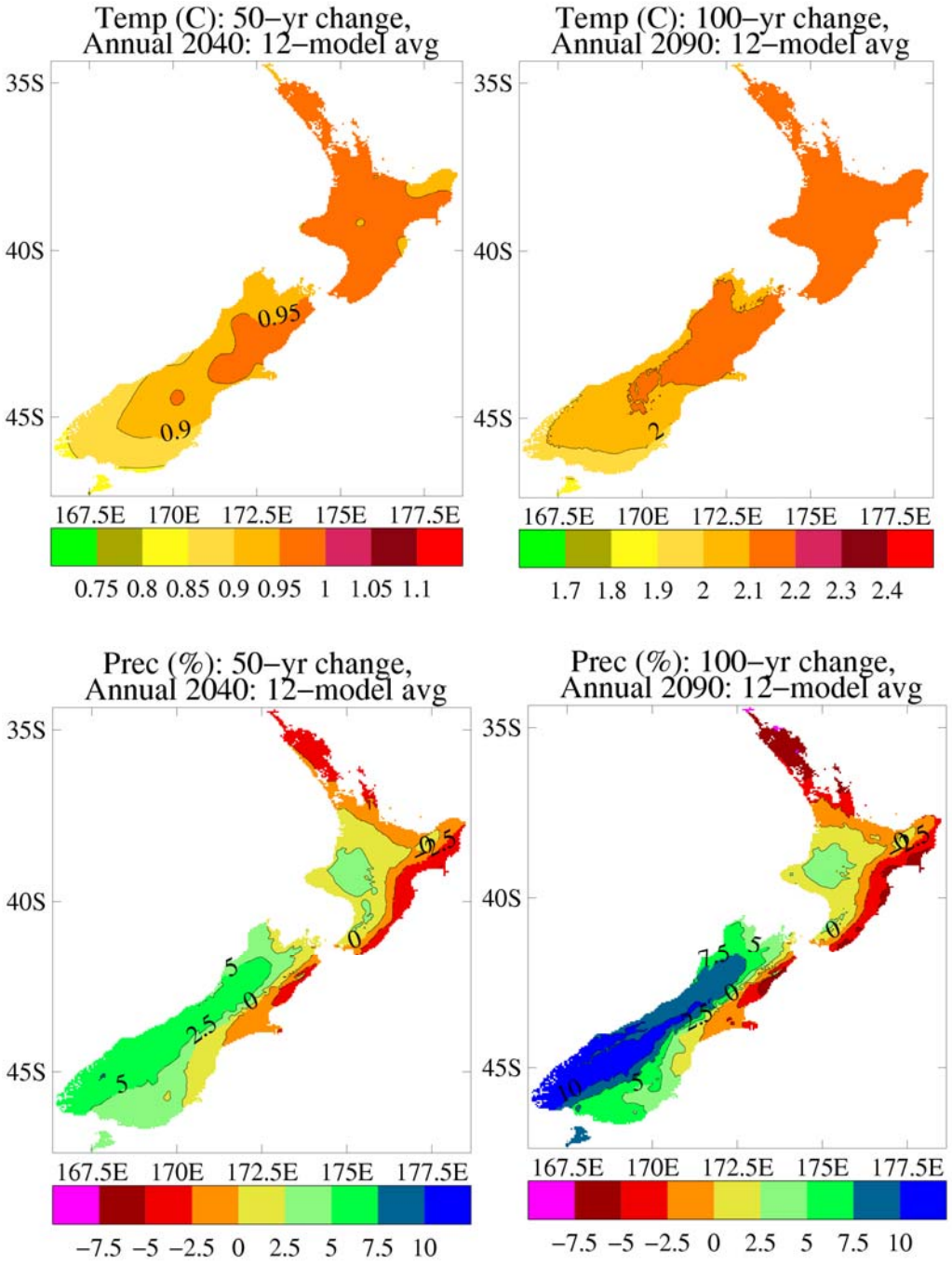
Information on future climate change scenarios for New Zealand is contained in *Climate Change Effects and Impacts Assess*ment.[71] Guidance on future sea-level rise is provided in *Coastal Hazards and Climate Change.*[72] These guidance manuals were updated in 2008 to reflect the findings of the IPCC's Fourth Assessment Report.

As illustrated in figure 6.1, New Zealand temperatures are expected to be on average 1°C warmer by the period 2030–2049 (referred to as 2040) and 2°C warmer by the period 2080–2099 (referred to as 2090), relative to 1980–1999 (referred to as 1990). The projected average annual rainfall shows a pattern of increases in the west of up to 5 per cent by 2040 and 10 per cent by 2090, and decreases in the east and north exceeding 5 per cent in places by 2090. The newly projected changes in seasonal mean rainfall show a different and more marked seasonality than was evident in the projections used in the previous guidance document.

[71] http://www.mfe.govt.nz/publications/climate/climate-change-effect-impacts-assessments-may08/

[72] http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/

**Figure 6.1: Projected changes in annual mean temperature (in °C) and annual mean rainfall (in %), relative to 1990: average over 12 climate models for Special Report on Emissions Scenarios (SRES) A1B emission scenario**




Other anticipated climate changes include:

- decreased frost risk
- increased frequency of high temperatures
- increased frequency of extreme daily rainfalls
- higher snow lines and changes in snow depth
- possible increase in strong winds.

The guidance provided for coastal hazards and sea-level rise uses a risk-based assessment and recommends planning for:

> ...a base value sea-level rise of 0.5 m by the 2090s (2090–2099) relative to the 1980–1999 average, along with an assessment of the potential consequences from a range of possible higher sea-level rises. At the very least, all assessments should consider the consequences of a mean sea-level rise of at least 0.8 m relative to the 1980–1999 average.
>
> For planning for the period beyond 2100, an allowance for sea-level rise of 10 millimetres per year beyond 2100 is recommended.[73]

The New Zealand Government is currently considering providing further national direction on planning for sea-level rise.

To assist decision-makers, climate change scenario information in the guidance manuals is also provided at the regional council scale. The information is presented as the average change, and the lower and upper limits, from the climate model runs for the location. Climate change scenario information is being further downscaled to provide better information at a local level.

## 6.3 Legislative context

New Zealand has a devolved system of resource management, and addressing and minimising the impacts of climate change is largely the responsibility of local government.[74] As a result, implementing climate change adaptation policy is an important focus for local authorities.

The Resource Management Act 1991 is the primary legislation that sets out how New Zealand manages its environment. To provide greater legal certainty for councils about their responsibility to consider the effects of climate change, the Act was amended in 2004 to require all persons exercising duties and functions under the Act to have particular regard to the effects of climate change. The Ministry for the Environment is in the process of developing further guidance and national direction on implementing the resource management legislation and planning for climate change. The principle focus of the policies is flood risk management and planning for future sea-level rise. Guidance has been developed to assist local government with carrying out its statutory functions.

Other key legislation related to managing the impacts of climate change includes the Local Government Act 2002, the Civil Defence and Emergency Management Act 2002 and the Building Act 2004. The Health Act 1956 includes a requirement that territorial authorities protect and promote public health, which can include emerging threats such as climate change.

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73 *Coastal hazards and climate change: A guidance manual for local government in New Zealand*. Ministry for the Environment 2008. http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/

74 See http://www.lgnz.co.nz/lg-sector/ for further information on the structure and role of local government in New Zealand.

## 6.4 The New Zealand Government's climate change response

Climate change adaptation is best achieved by integrating adaptation activities into existing processes, practices and policies at all levels of society. At the central government level this means departments incorporating climate change adaptation into their existing programmes and policies. The Ministry for the Environment leads the Interdepartmental Climate Change Adaptation group, which provides a forum for cross-government initiatives on climate change adaptation. The group allows government officials to share information between departments and helps ensure climate change adaptation policy is coordinated and consistent across government. There are currently 21 departments involved in the group, with varying levels of engagement.

New Zealand's policy response also includes a focus on engaging with priority stakeholders on the importance of preparing and planning for the impacts of a changing climate.[75] Another focus is on providing information and guidance on the effects considered most likely to have a significant impact at a regional, national or sectoral level, and the expected timing of such trends.

### 6.4.1 Methods, tools and guidance to assist with adaptation decision-making

The New Zealand Government provides a range of information to help people understand how they could be affected by climate change and what they can do to adapt. In particular, the Ministry for the Environment has developed resources specifically aimed at local government, and the Ministry of Agriculture and Forestry has developed materials for the rural sector. These climate change impact and adaptation publications are described briefly below and can be accessed in full from: http://www.climatechange.govt.nz/physical-impacts-and-adaptation/publications.html.

#### Technical manuals and summary publications

The Ministry for the Environment has produced guidance manuals to help people implement the legislation described above. The technical manuals contain a large amount of detailed information, so summary reports have also been developed that present the key information in an easy-to-understand format.

- *Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand* (2nd edition, May 2008)[76] was produced for New Zealand's local government and updates the 2004 edition to include the findings of the IPCC's Fourth Assessment Report. This manual contains information on trends in New Zealand's historic climate and scenarios of future climate change. *Preparing for Climate Change*[77] (July 2008) is the accompanying summary publication.
- *Coastal Hazards and Climate Change*[78] (July 2008) is a technical guidance manual that provides information on planning for climate change in the coastal margins. This report

[75] The priority partners for the Ministry for the Environment are local government, engineers, surveyors, planners and lifeline utility groups. The Ministry of Agriculture and Forestry partners with representatives from the land-based sectors and Māori.

[76] http://www.mfe.govt.nz/publications/climate/climate-change-effect-impacts-assessments-may08/

[77] http://www.mfe.govt.nz/publications/climate/preparing-for-climate-change-guide-for-local-govt/

[78] http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/

also includes information from the IPCC's Fourth Assessment Report. *Preparing for Coastal Change*[79] (March 2009) is the accompanying summary publication.

## Flood risk management

Guidance on planning for climate change and flood risk is being produced and will be available from 2010. This comprises two components: techniques for including climate change in flood planning, and tools for estimating the effect of climate change on flood flow. A summary document is being developed and is planned for release in early 2010.

## Local government guidance

In addition to the guidance manuals described above, the Ministry for the Environment has developed guidance aimed specifically at local government. These resources include a climate change guidance note for the Quality Planning website,[80] a number of planning guidance documents[81] and a series of two-page case studies.[82]

## Urban adaptation resources

The Ministry for the Environment has begun work on the development of resources to help urban communities to adapt to the impacts of a changing climate. These resources will be targeted at specific urban audiences, including households, businesses, development professionals and local government.

## Land-based primary production sector

The Ministry of Agriculture and Forestry has also developed a specific climate change programme for land-based sectors because of the importance of the agricultural, forestry and horticultural sectors to the economy. The Sustainable Land Management and Climate Change Plan of Action (the Plan of Action)[83] includes a specific adaptation work stream that is supported by research, technology transfer and communication programmes.

The Ministry of Agriculture and Forestry is working closely with land-based sectors, land manager interest groups, local government and Māori to develop resilient adaptation solutions. Guidance is being produced in the form of case studies, information sheets and land manager learning packages. A technology transfer programme is being developed with sectors to ensure research and other materials are available to land managers and can be easily applied on the ground.

The Plan of Action also funds research on the impacts of climate change on primary sectors, including the impacts of droughts, wind, and frost on areas such as pasture production, forestry and horticulture. This will form the basis for future guidance and developing tools that can assist land managers to adapt to climate change.

## Guidance for the general public

A series of three publications was produced by the Ministry for the Environment to provide information on the impacts of climate change to the general public. These publications are

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79 http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/

80 http://www.qualityplanning.org.nz/

81 http://www.climatechange.govt.nz/physical-impacts-and-adaptation/publications.html#find

82 http://www.climatechange.govt.nz/physical-impacts-and-adaptation/publications.html#case

83 http://www.maf.govt.nz/climatechange/slm/

currently out of date and the Ministry is considering updating them in early 2010. A stylised climate change impacts map was also produced for a general audience.[84] This map is intended to indicate the potential regional impacts of climate change in New Zealand.

### Web-based decision support tool

The Ministry of Agriculture and Forestry and the Ministry for the Environment are developing a web-based, decision-support tool (a "toolbox") to help users understand how climate change could affect them and what they can do to adapt. The toolbox will contain a generic component, as well as targeted modules for local government and land managers. The toolbox will be available from the New Zealand Climate Change website.[85]

## 6.4.2 Adaptation policy and measures: central government initiatives

### Supporting local government and the built environment

In addition to providing guidance on the climate change scenarios for New Zealand, the Ministry for the Environment has been working in various partnerships to facilitate and encourage adaptation activities. For the Ministry, priority partners include representatives from local government, along with planning, engineering, insurance, surveying and lifeline utility groups. The Ministry brings representatives from each sector together as a group to provide opportunities for the partners to work collectively to:

- identify barriers to adaptation
- identify gaps in information and tools that support decision-making
- contribute to identifying and developing solutions to overcome the barriers to adaptation. These solutions can then be incorporated into the Ministry's Adaptation Programme
- identify opportunities for joint adaptation initiatives between sectors.

### Flood risk management and planning for future sea-level rise

The Ministry for the Environment is considering how best to help local authorities in their flood risk management roles and responsibilities, and to provide further national direction on planning for future sea-level rise. In late 2008, work to scope a strategic framework on flood risk management and practical options for integration was commissioned, and it has now been completed. This work builds on the Flood Risk Management Review, which was completed by the Ministry in June 2007 following major flood events in New Zealand.

The Ministry is also investigating opportunities to reduce flood risk through integrated legislative, regulatory, policy and practical approaches. This work is being undertaken in collaboration with the Insurance Council, the Earthquake Commission and local government and central government policy departments.

### Primary production and land management

The Ministry of Agriculture and Forestry is working to ensure land-based sectors are resilient to climate change. Current priorities are to raise awareness of climate change adaptation among land managers and to improve understanding of the impacts of climate change on production

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84 http://www.mfe.govt.nz/issues/climate/resources/impact-map/

85 http://www.climatechange.govt.nz

systems, and to develop tools for land managers to use to respond to climate risks. Key actions include:

- developing a five-year adaptation programme, with land-based sectors and local government, to identify and work towards agreed priorities
- stocktaking the activities undertaken to adapt to climate change by land-based sectors, organisations, rural professionals and iwi organisations[86]
- commissioning research projects looking at the impacts of climate change on: pastoral production, forestry, forage crops, kiwifruit, soil conditions, river flow and floods, fire danger, subtropical boundaries, plantation forestry pests, pasture performance, extreme winds, drought risk, groundwater resources, land-use trends, major land-based primary sectors, catchments, land drainage, biosecurity and frosts
- producing a series of information sheets, case studies, and educational packages for land managers
- working with agricultural, horticultural and forestry education providers, including universities, to develop educational materials for climate change adaptation
- facilitating workshops around the country with land managers
- funding climate change adaptation projects under the Sustainable Farming Fund
- providing funding for community engagement on six irrigation schemes and four water strategies under the Community Irrigation Fund.

The Ministry of Agriculture and Forestry also administers the On Farm Adverse Events Recovery Plan, which covers climate-related events and outlines where government assistance may be available. In addition, there is a network of rural support trusts that provide assistance to the rural community during adverse events such as drought and floods.

## Biodiversity

New Zealand's biodiversity is unique, as it is an island nation with a large number of endemic native species. The Department of Conservation (DoC) is examining current and potential effects of climate changes on New Zealand's terrestrial natural heritage and is developing guidance for prioritising responses. The Department has produced a report, *Adapting to Climate Change: An Approach for Assessing and Managing Impacts on Native Terrestrial Biodiversity in New Zealand*. This is currently in draft form and will be published and available online towards the end of 2009. The work represented by this report reinforces the approach being adopted by the Department of Conservation to integrate adaptation to climate change into the monitoring, review and planning systems currently under development for biodiversity management.

The Department has commissioned a review of climate change impacts on New Zealand's biodiversity, which will update the report prepared for the Ministry for the Environment in 2001. It also commissioned a report from NIWA, called *Climate Change and the New Zealand Marine Environment*, which examines the possible effects of climate change on the marine environment and highlights some immediate actions which could be taken in response.[87]

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[86] Māori are the indigenous people of New Zealand. An iwi is one of the larger collective Māori groupings and is sometimes described as a tribe.

[87] http://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/climate_change

## Fisheries

New Zealand has a vast exclusive economic zone and a large fishing industry. The Ministry of Fisheries has undertaken several projects to better understand how climate change might affect fish stocks in New Zealand waters and the New Zealand fishing industry. The Ministry of Fisheries undertook projects looking at:

- the effects of climate on commercial fish abundance
- the long-term effects of climate variation and human impacts on the structure and functioning of New Zealand shelf ecosystems
- ecosystem indicators for New Zealand fisheries
- climate and oceanographic trends relevant to New Zealand fisheries
- ocean acidification and its effects on microbial diversity
- the distribution of plankton over the Southern Ocean.

## Community resilience to natural hazards

The Ministry of Civil Defence and Emergency Management (MCDEM) has integrated preparing for climate change into aspects of its work programmes, including the following:

- the revised National Civil Defence Emergency Management (CDEM) Strategy[88] has identified the implications for civil defence of the increased frequency and severity of existing climate hazards
- climate change and climate variability are included as modifying factors for hazards in the National Hazardscape Report[89]
- undertaking workshops to encourage local government to integrate natural hazard planning into plans produced under the Resource Management Act, Local Government Act and Civil Defence Emergency Management Act. This work includes climate change adaptation.

## Health

The Ministry of Health is leading projects to better understand the impacts of climate change on human health and health infrastructure. New Zealand is part of a research project, with the Centre for Health Assets Australasia at the University of New South Wales, Australia, to investigate the risks posed by the condition of existing health buildings and their ability to ensure high-quality health care continues to be delivered during increasing incidents of extreme weather events.

The Ministry of Health has started work on a vision and strategy on climate change adaptation for the health sector. The Ministry has also developed a resource (with the Institute of Environmental Science and Research) that provides a framework for linking New Zealand-specific climate change scenarios to their potential impacts on water supplies and health.

## Transport

The New Zealand Transport Agency has published a two-part research report entitled: "Climate Change Effects on the Land Transport Network". The research identified and assessed the

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88 http://www.civildefence.govt.nz/memwebsite.nsf/wpg_url/for-the-cdem-sector-national-cdem-strategy-index?opendocument

89 http://www.civildefence.govt.nz/memwebsite.NSF/wpg_URL/For-the-CDEM-Sector-Publications-National-Hazardscape-Report?OpenDocument

impacts of climate change on New Zealand's land transport networks including road, rail, ports and coastal shipping. It also made recommendations about policy options and adaptation measures that could be adopted in response to these risks. The research findings are intended to supply land transport infrastructure providers and policy makers with the information needed to adapt the design, operation and maintenance of critical assets to the impacts of climate change. The research was conducted by MWH New Zealand Limited and the National Institute of Water and Atmospheric Research. The reports are available on the New Zealand Transport Agency's website.[90]

### Labour market

A reference group has been established by the Department of Labour to explore possible future scenarios resulting from climate change in terms of employment, skills and economic performance. For this task, scenarios for 2020 have been developed that take account of natural resource pressures, which include climate change, and energy and water issues.

### Tourism

The Ministry of Tourism has developed a Tourism Climate Change Plan in collaboration with industry leaders and key agencies. Climate change impacts and adaptation research are components of this plan.

### Education

The Ministry for the Environment has worked with the Ministry of Education to scope the development of climate change adaptation resources to support the school curriculum.

### Māori

Climate change presents considerable challenges to Māori because they have a significant investment in primary sectors that are exposed to climate risk, including fisheries and forestry. Māori also place a high cultural value on land, including areas that could be affected by events such as flooding or sea-level rise due to climate change.

The Government held 14 hui in February/March 2007 on climate change.[91] The Māori Reference Group and the Iwi Leadership Group were mandated at the hui by iwi leaders to engage with the Government on developing climate change policies.

The Māori Reference Group has been a core part of developing the Sustainable Land Management and Climate Change Plan of Action (the Plan of Action), an integrated approach to climate change for land-based sectors. The Climate Change Iwi Leadership Group nominated two representatives to the "Climate Change Peak Group", which provides strategic advice and leadership on the Plan of Action. Māori representatives are also members of the technical working groups that support the Peak Group, including adaptation, research and technology transfer.

A range of Māori-specific projects have been commissioned by the Ministry of Agriculture and Forestry, as a result. A series of case studies has also been completed, outlining adaptation activities to date.

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90 http://www.landtransport.govt.nz/research/reports/index.html

91 A hui refers to a gathering or meeting. It can involve individuals, a hapū (a grouping of related families) or several hapū, an entire iwi (a larger Māori grouping sometimes called a tribe), or several iwi.

### 6.4.3 Adaptation policies and measures: local government initiatives

In 2004 the Resource Management Act was amended to require councils to have regard to climate change in making decisions under the Act. This amendment has resulted in councils including rules in their regional and district plans that include climate change. Climate change is usually mentioned in the natural hazards, subdivision and coastal sections of plans.

Many regional councils have undertaken climate change impact assessments for their regions, including Gisborne,[92] Taranaki,[93] Tasman,[94] Bay of Plenty[95] and Canterbury.[96] Taranaki Regional Council, through its proposed regional policy statement (2009),[97] includes a specific section responding to the effects of climate change. In addition, two regions, Auckland[98] and Wellington, are developing regional climate change energy and adaptation strategies. Nelson City Council has developed a Climate Change Local Action Plan,[99] which includes adaptation.

Local government has developed a leaders' position statement on climate change. The position statement provides a brief introductory context, a number of overarching statements in relation to local government's position on climate change, and statements on the areas of adaptation and mitigation. The position statement also includes the high-level expectations that local government have of central government, particularly around responsibilities for leading on mitigation.

92 http://www.gdc.govt.nz/climate-change-reports

93 http://www.trc.govt.nz/publications/publications/climate.htm

94 http://www.tdc.govt.nz/pdfs/Climate%20Change%20and%20Variability%20Tasman%20District%20June%202008.pdf

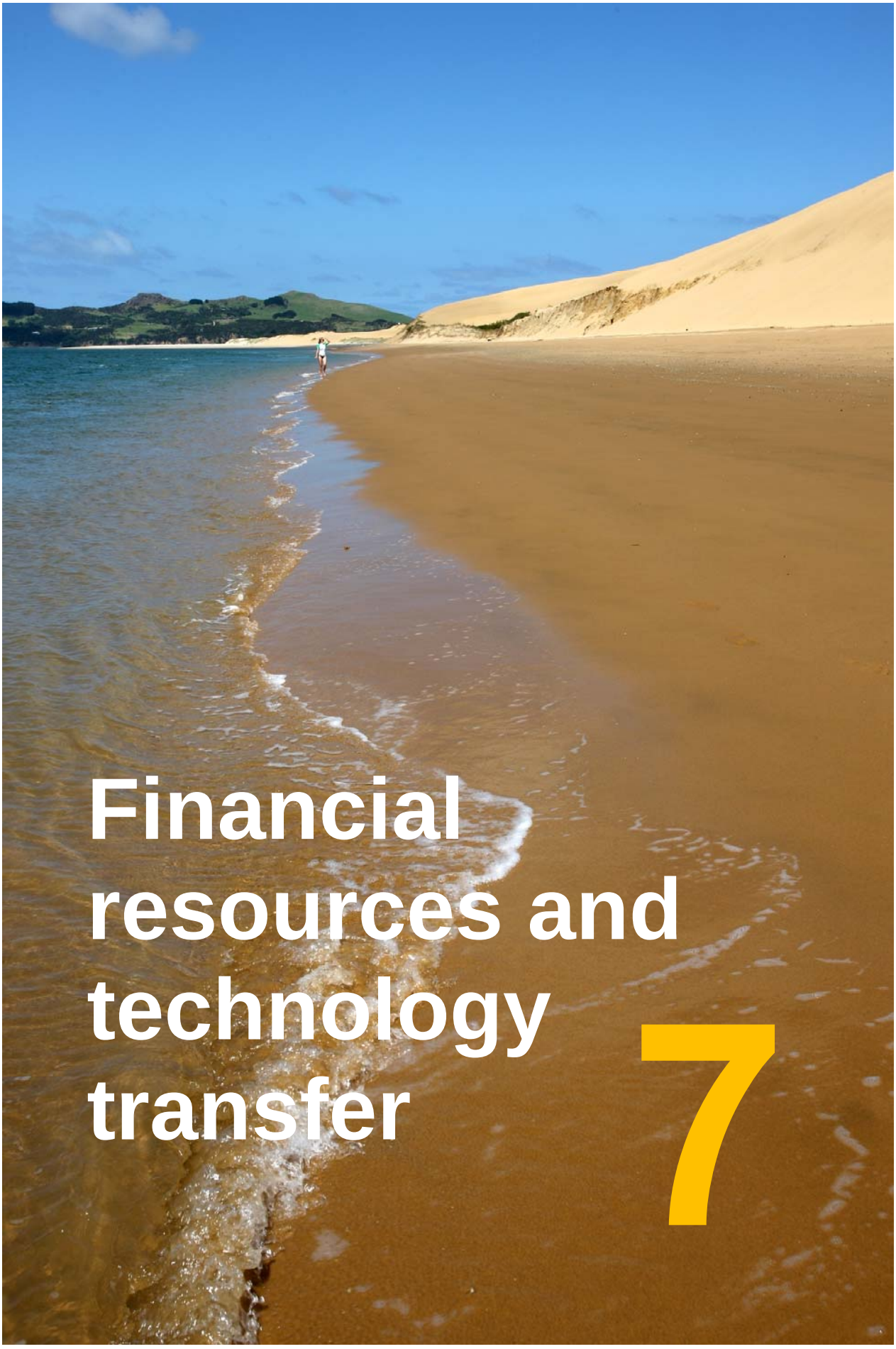
95 http://www.envbop.govt.nz/ClimateChange/What-we-are-doing.asp

96 http://www.ecan.govt.nz/Our+Environment/ClimateChange/ClimateChangeReport.htm

97 http://www.trc.govt.nz/publications/regional+policy.htm

98 http:/www.arc.govt.nz/plans/the-workroom/climate-change-and-energy.cfm

99 http://www.nelsoncitycouncil.co.nz/environment/climate-change/local-action-plan.htm



# Financial resources and technology transfer

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# 7 Financial resources and technology transfer

## 7.1 Introduction

New Zealand is committed to supporting developing country parties to meet the dual challenges of reducing emissions and adapting to the impacts of climate change. New Zealand is addressing these challenges by delivering new and additional financial resources through a range of channels, primarily to its partner countries in the Pacific, but also to countries in Asia, Africa and Latin America.[100]

This chapter reports on the financial and technological support New Zealand has provided to developing countries for climate change actions since the *Fourth National Communication*. It covers the support given through multilateral, bilateral and regional channels, as well as specific resources provided for mitigation, adaptation and technology transfer.

In 2001 New Zealand joined the European Union, Canada, Norway, Switzerland and Iceland in making a voluntary commitment to increase financial assistance to developing countries to support climate change action. Between 2005 and 2008 New Zealand's share of this voluntary commitment has been NZ$5 million per year. This comprises four main components:

- the proportion of funds from New Zealand's total annual contribution to the Global Environment Facility that is likely to be spent on climate change projects, which is estimated at 32 per cent of total expenditure between 1991 and 2008[101] (see table 7.1 at the end of this chapter)
- contributions to a range of multilateral organisations and programmes, including special funds under the United Nations Framework Convention on Climate Change (see table 7.2)
- support for climate change-related assistance administered by the New Zealand Agency for International Development (see tables 7.3 to 7.6)
- funding for specific projects administered through the New Zealand Ministry for the Environment (see example in table 7.7).

## 7.2 Multilateral support

### 7.2.1 Global Environment Facility

The Global Environment Facility (GEF) is the international entity entrusted with the operation of the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC, or the Convention). The GEF distributes financial assistance associated with the major multilateral environment agreements on climate change, biodiversity, persistent organic pollutants, ozone-depleting substances and desertification, and also supports activities relating

[100] "New and additional" resources are those provided since 1993 when New Zealand ratified the Convention.

[101] Global Environment Facility. 2009. GEF 2008 Annual Report. http://www.gefweb.org/uploadedFiles/Publications/annual-report-2008-lowres.pdf

to land degradation and international waters. New Zealand is fulfilling its Article 4.3 commitments through its contribution to the GEF.

For the fourth replenishment of the GEF Trust Fund (2007–2010), New Zealand committed a total of NZ$8.38 million. Table 7.1 provides details of New Zealand's total annual contributions to the GEF Trust Fund for the years 2005 to 2008. At the time of writing, negotiations are underway for the fifth replenishment of the GEF Trust Fund, covering the period 2010–2014. These negotiations are expected to be completed in early 2010.

### 7.2.2 Other multilateral support

New Zealand continues to support a number of UN development agencies and other international financial institutions and programmes, including those with specific programmes related to the implementation of the Convention (see table 7.2). In recognition of the importance of developing countries participating at Convention meetings, New Zealand has made an annual contribution to the UNFCCC Trust Fund for Participation.

The least developed countries and small island developing states are the countries most vulnerable to the effects of climate change and where support is needed most. New Zealand contributed NZ$1.4 million to the Least Developed Countries Fund in 2008. In its initial phase the fund has provided critical support for the completion of national adaptation programmes of action in a number of the least developed countries. These include some of New Zealand's partner countries in the Pacific, such as Samoa, Kiribati, Vanuatu, the Solomon Islands and Tuvalu. National adaptation programmes of action help developing countries to prioritise adaptation work and focus effort where it is needed most.

## 7.3 Regional support

New Zealand, through the New Zealand Agency for International Development (NZAID), is a major funder of a number of Pacific regional organisations that are mandated to provide Pacific Island countries with technical and policy assistance in a number of sectors, including those affected by climate change. These organisations include:

- the Secretariat of the Pacific Regional Environment Programme (http://www.sprep.org), which currently has the lead responsibility for climate issues and provides policy and technical support to its Pacific Island country members in meeting their commitments under the Convention and in supporting adaptation actions
- the Secretariat of the Pacific Islands Applied Geoscience Commission (http://www.sopac.org), which provides policy and technical assistance to its members in the key climate sectors of water, energy, disaster risk reduction and coastal processes
- the Secretariat of the Pacific Community (http://www.spc.int), which provides assistance to its members in a number of climate-affected sectors such as health, agriculture and marine resources management
- the University of the South Pacific (http://www.usp.org.fj), which is a centre of excellence for tertiary education and research in the Pacific region, providing instruction and research programmes in areas related to, and affected by, climate change.

All Pacific regional organisations are free to allocate NZAID funding among programmes in their overall strategic plan. Donor funding is not monitored at a level that traces individual funds to specific activities, such as for climate change. This is also the case for multilateral

allocations, which means the figures in table 7.2 are total allocations rather than estimates of specific expenditure on climate change actions.

New Zealand supports the development and implementation of regional frameworks, policies and action plans designed to address climate change and disaster risk. New Zealand addresses these frameworks through its membership of the Pacific Islands Forum, the region's political and economic policy organisation. At the 2008 Forum meeting in Niue, Pacific Island leaders prepared and endorsed the Niue Declaration on Climate Change. This declaration is the first that specifically addresses the shared concern among leaders of the effects of climate change in the Pacific region. The Niue Declaration builds on the existing Pacific Islands Framework for Action on Climate Change (2006–2015), which established an integrated, programmatic approach to addressing climate change-related impacts in the region.[102]

New Zealand also supports the Pacific Climate Change Roundtable,[103] which last met in October 2009 and is scheduled to meet every two years. The Roundtable meeting represents an opportunity for a wide range of stakeholders from government and non-government organisations to coordinate their climate actions in support of the regional frameworks.

## 7.4 Bilateral support

Small island developing states such as those in the Pacific are especially vulnerable to the effects of climate change and extreme weather events. New Zealand is focused on helping these countries adapt to the projected effects of climate change in order to increase their resilience to climate- and weather-related impacts.

Support for alternative and renewable energy sources through direct investment and technology transfer is also helping New Zealand's partner countries to reduce their carbon emissions and improve energy efficiency. New Zealand takes seriously its commitment to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other parties, particularly developing country parties, to enable them to implement the provisions of the Convention.

New Zealand contributes to technology and knowledge distribution through various Global Climate Observing System (GCOS) initiatives in the Pacific region. For example, New Zealand supports the production of the *Island Climate Update*, a monthly Pacific regional climate bulletin designed to build capacity among Pacific Island national meteorological services for generating their own national climate summaries and seasonal forecasts. New Zealand also provides support for the recovery and safe storage of historical climate data, and helps with a number of capacity building activities for Pacific Island hydrological and meteorological services. More details on GCOS activities are provided in *New Zealand's Report on the Global Climate Observing System (GCOS)* attached to this *Fifth National Communication*.

Further details of support for country-level adaptation, mitigation and technology transfer actions are provided in the relevant sections below, while tables 7.2 to 7.6 contain details of annual financial contributions made from 2005 to 2008 in support of these areas.

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[102] http://www.forumsec.org.fj/pages.cfm/newsroom/press-statements/2008/forum-leaders-endorse-niue-declaration-on-climate-change.html

[103] http://www.sprep.org/climate_change/pccr.htm

## 7.5 Mitigation

New Zealand's main areas of engagement in terms of mitigation have been in the energy and forestry sectors. The following are examples of such support.

- At the request of the Pacific Island leaders, in 2007 NZAID supported a meeting of the Pacific energy ministers to allow high-level discussion on the major energy problems facing the region, especially with regard to energy dependence and security, rising fuel prices, renewable energy, energy efficiency and conservation, and capacity issues.
- In 2007, New Zealand provided support for the participation by Pacific Island experts in a UNFCCC workshop on Reducing Emissions from Deforestation and Degradation in developing countries (REDD).
- NZAID has funded a number of training scholarships in forestry management as part of a wider programme of capacity support to the Solomon Islands forestry sector. Forestry is an important sector in the Solomon Islands' economy, but the pace of logging has far exceeded the estimated sustainable rate. At such high levels of extraction, commercially valuable forests will be depleted by 2010–2015, with consequent negative effects on the Solomon Islands' economy and emissions.
- The Vanuatu Carbon Credits Project was developed following a request from the UNFCCC for pilot projects to inform inter-governmental policy development on REDD. The project has been largely funded by the British Government through the Global Opportunities Fund. The funding provided by New Zealand supported a national capacity-building workshop under phase 2 of the project, which helped set priorities and consolidated Vanuatu government support and commitment. Since the completion of the workshop, funds have been provided from the World Bank, GEF and the European Union to enable a national climate change adaptation and mitigation programme. Funds have also been provided from the World Bank Forest Carbon Partnership Facility for REDD.

## 7.6 Adaptation

New Zealand's support for climate change adaptation work is primarily designed to reduce the vulnerability of communities – particularly those in the Pacific – to longer term environmental change and weather-related impacts, and to improve the resilience of key climate-sensitive sectors. National and community-level actions are delivered within the context of national and regional plans, strategies and frameworks, which New Zealand helps to shape and deliver in cooperation with its development partners.

The following are examples of adaptation projects and programmes that New Zealand has helped support between 2005 and 2008.

- In recognition of the importance of climate science and information to sound decision-making and adaptation planning, New Zealand provided support to a number of IPCC outreach sessions in the Pacific Islands during 2007 immediately following the publication of the IPCC's *Fourth Assessment Report*. The sessions were designed to increase awareness of the IPCC's findings, particularly as they relate to small island developing states in the Pacific.
- Beginning in 2006, New Zealand has funded a four-year Climate Data Rescue programme designed to capture, preserve and digitise historical climate observations from a number of Pacific Island countries. The information collected by the project has the potential to help

improve the quality of decision-making by the partner countries regarding adaptation strategies and actions.[104]

- The Pacific atoll nation of Kiribati is particularly vulnerable to climate impacts and has identified a number of sectors where adaptation support is needed. This is being provided through the multi-sector Kiribati Adaptation Programme, a partnership between the Government of Kiribati, NZAID, AusAID, GEF and the World Bank. Sectors where adaptation support is being provided include freshwater resources, land management and coastal zone management. Now into its second phase, the programme aims to improve the way in which climate risks are accounted for within these sectors.[105]
- In late 2006. NZAID formed a strategic partnership with the United Nations Development Programme to initiate and implement the GEF Small Grants Programme in the Pacific. The Programme was launched in 1992 with the aim of securing environmental benefits at the community level by working through non-government and community-based organisations. Primarily aimed at environmental improvement and poverty alleviation, the Small Grants Programme also helps build the capacity of communities and other national and local stakeholders to manage environmental issues. Although not targeted directly at climate change adaptation, the programme helps to improve the resilience of communities to climate impacts through improvements in environmental practice, conservation and management of natural resources.

## 7.7 Technology transfer

With regard to technology development and deployment, the creation of "enabling environments" is viewed as important for research and development activities, and for the commercial deployment of current, new and innovative technologies. For example, the investment community needs clear incentives when it comes to research, development and deployment of climate change mitigation technologies. A carbon price signal and the removal of environmentally harmful subsidies are critical for establishing environments that enable effective technology development and transfer.

Another important factor for encouraging research and development is cooperation. This is important in terms of increasing the size of investments (by reducing risk) and generally speeding up the development and deployment of new technologies. It is also useful for technology to be defined in the broadest context, where "technology" includes "soft technology", such as information and knowledge sharing.

The following are two examples of New Zealand's support for technology transfer initiatives.

- Funded jointly by New Zealand and the United Kingdom, a new microfinance project in the Solomon Islands and Kiribati has successfully implemented a solar lighting finance scheme, enabling rural communities to trade crops for much-needed access to electricity. The project developers focused on LED lights – an innovative, energy-saving lighting system – powered by a solar photovoltaic panel and installed in individual homes and municipal buildings. To pay for the investment, rural householders plant enough extra crops to make the planned monthly repayments. They take the crops to a cash-for-crops exchange, which arranges to repay the banks. Ideally, it is envisaged the system is paid off within 24 months. This project was facilitated through the Renewable Energy and Energy Efficiency Partnership.

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104 http://www.wmo.int/pages/prog/gcos/aocpXV/A_13.4_wcdmp_climate_data_rescue.pdf

105 http://www.nzaid.govt.nz/programmes/c-kiribati.html

- Recognising the lack of understanding of agricultural emissions and the importance of this sector to New Zealand and other countries, New Zealand established the Livestock Emissions Abatement Research Network (LEARN) in 2007 (see also section 4.3.3). LEARN is an international research network focused on improving the understanding of greenhouse gas emissions from livestock (see http://www.livestockemissions.net). Through LEARN, New Zealand supported a capacity-building workshop, GHG Measurement and Mitigation in Grazing Livestock Systems, held in Uruguay in July 2008; a workshop on Livestock and Global Warming on Andean Ecosystems, held in Peru in October 2008; and a workshop on nitrous oxide measurement and estimation, held in Chile in August 2009.

  New Zealand also established the LEARN Fellowship Programme to help facilitate the development of the wider LEARN network of researchers by allowing successful candidates to take up a short-term position in a New Zealand research institution. It is designed to facilitate in-country capacity building in developing countries with common research interests in livestock greenhouse gases. Fellowships have so far been awarded to researchers from Uruguay, Colombia, Iran, Peru, India and China.

**Table 7.1: New Zealand's financial contributions to the Global Environment Facility, 2005–2008**

| Contributions[1] (NZ$ million[2]) to the GEF Trust Fund | | | | |
|---|---|---|---|---|
| **2005** | **2006** | **2007** | **2008** | **Total** |
| 2.78 | 3.42 | 3.28 | 3.12 | 12.6 |

1 Annual contributions represent the combined total of New Zealand's payments to the GEF Trust Fund in the financial year (July to June). GEF projects address six global environmental issues, or "focal areas", of which climate change is one. Expenditure under the climate change focal area is estimated to be approximately one-third of total expenditure.

2 Over 2005 to 2008, the value of 1 NZD has fluctuated between = 0.49 and 0.81 USD.

**Table 7.2: Financial contributions to multilateral institutions and programmes, 2005–2008**

| Institution or programme | Contributions[1] (NZ$ million[2]) | | | | |
|---|---|---|---|---|---|
| | **2005** | **2006** | **2007** | **2008** | **Total** |
| **Multilateral institutions** | | | | | |
| 1. World Bank | 9.21 | 20.01 | 11.03 | 20.37 | 60.62 |
| 2. Asian Development Bank | 12.83 | 12.57 | 12.16 | 6.37 | 43.93 |
| 3. United Nations Development Programme | 8.00 | 8.00 | 8.00 | 8.00 | 32.00 |
| 4. United Nations Environment Programme | 0.25 | 0.21 | 0.21 | 0.35 | 1.02 |
| 5. UNFCCC Trust Fund for Participation* | 0.10 | 0.10 | 0.10 | 0.50 | 0.80 |
| 6. UNFCCC Least Developed Countries Fund* | 1.80 | 1.80 | 1.80 | 1.40 | 6.80 |
| 7. UNFCCC Trust Fund for Supplementary Activities* | 0.12 | 0.11 | 0.06 | – | 0.29 |
| 8. Montreal Protocol | 0.58 | 0.53 | 0.46 | 0.55 | 2.12 |
| **Total** | 32.89 | 43.33 | 33.82 | 37.54 | 147.58 |
| **Multilateral scientific, technological and training** | | | | | |
| 1. Secretariat of the Pacific Regional Environment Programme | 0.95 | 1.08 | 1.08 | 1.43 | 4.54 |
| 2. Secretariat of the Pacific Islands Applied Geoscience Commission | 1.40 | 1.64 | 1.80 | 2.05 | 6.89 |

| Institution or programme | Contributions[1] (NZ$ million[2]) | | | | |
|---|---|---|---|---|---|
| 3. Secretariat of the Pacific Community | 6.24 | 6.27 | 6.27 | 6.40 | 25.18 |
| 4. University of the South Pacific | 4.00 | 4.00 | 4.00 | 4.00 | 16.00 |
| 5. Consultative Group on International Agricultural Research (CGIAR) | 0.90 | 0.90 | 0.90 | 3.19 | 5.89 |
| **Total** | **13.49** | **13.89** | **14.05** | **17.07** | **58.50** |

1 Annual contributions cover calendar years, except for those institutions or programmes marked with an asterisk (*), which cover financial years (July–June). Contributions represent the full amounts provided to the organisation for the full range of activities covered by their programmes, which include climate change mitigation and adaptation.

2 Over 2005 to 2008, the value of 1 NZD has fluctuated between = 0.49 and 0.81 USD.

**Table 7.3: Bilateral and regional financial contributions[1] related to the implementation of the Convention, 2005 (millions of NZ dollars[2])**

| | Mitigation | | | | | Adaptation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Recipient country/region | Energy | Transport | Forestry | Agriculture | Waste management | Industry | Capacity building | Coastal zone management | Water resources | Other vulnerability assessment | Total |
| Pacific regional | 0.07 | | | 0.51 | | 0.01 | 1.19 | 0.25 | | 0.26 | 2.29 |
| Tonga | 0.04 | | | | | | | | | | 0.04 |
| Pakistan | 0.01 | | | | 0.01 | | | | | | 0.02 |
| Cook Islands | | | | | | | 0.01 | | | | 0.01 |
| Solomon Islands | | | 0.01 | | | | 0.01 | | | | 0.02 |
| Samoa | | | | | 0.01 | | | | | | 0.01 |

1 Sum of contributions provided by the New Zealand Agency for International Development and the New Zealand Ministry for Environment.

2 Over 2005 to 2008, the value of 1 NZD has fluctuated between 0.49 and 0.81 USD.

**Table 7.4: Bilateral and regional financial contributions[1] related to the implementation of the Convention, 2006 (millions of NZ dollars[2])**

| | Mitigation | | | | | | Adaptation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Recipient country/region | Energy | Transport | Forestry | Agriculture | Waste management | Industry | Capacity building | Coastal zone management | Water resources | Other vulnerability assessment | Total |
| Pacific regional | 0.30 | | | 0.16 | 0.04 | 0.01 | 1.81 | 0.40 | | 0.08 | 2.80 |
| Tonga | 0.57 | | | | | | | | | | 0.57 |
| Kiribati | | | | | | | 0.28 | 0.15 | | 0.10 | 0.53 |
| Philippines | | | | | | | 0.19 | 0.01 | | | 0.20 |
| Pakistan | 0.02 | | | | 0.02 | | | | | | 0.04 |
| Cook Islands | | | | | | | 0.01 | | | | 0.01 |

1 Sum of contributions provided by the New Zealand Agency for International Development and the New Zealand Ministry for Environment.

2 Over 2005 to 2008, the value of 1 NZD has fluctuated between 0.49 and 0.81 USD.

**Table 7.5: Bilateral and regional financial contributions[1] related to the implementation of the Convention, 2007 (millions of NZ dollars[2])**

| | Mitigation | | | | | | Adaptation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Recipient country/region** | **Energy** | **Transport** | **Forestry** | **Agriculture** | **Waste management** | **Industry** | **Capacity building** | **Coastal zone management** | **Water resources** | **Other vulnerability assessment** | **Total** |
| Pacific regional | 0.21 | | | 0.87 | 0.04 | | 1.30 | 0.70 | | 0.44 | 3.56 |
| Kiribati | | | | | | | 0.29 | 0.15 | | 0.10 | 0.54 |
| Solomon Islands | | | | | | | 0.05 | | | 0.05 | 0.10 |
| Pakistan | 0.04 | | | | 0.04 | | | | | | 0.08 |
| Tonga | 0.05 | | | | | | | | | | 0.05 |
| Philippines | | | | | | | | 0.01 | | | 0.01 |
| Samoa | | | | | | | | | | | 0 |
| Vanuatu | | | 0.04 | | | | | | | | 0.04 |

1 Sum of contributions provided by the New Zealand Agency for International Development and the New Zealand Ministry for Environment.

2 Over 2005 to 2008, the value of 1 NZD has fluctuated between 0.49 and 0.81 USD.

**Table 7.6: Bilateral and regional financial contributions[1] related to the implementation of the Convention, 2008 (millions of NZ dollars[2])**

| | Mitigation | | | | | | Adaptation | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Recipient country/region | Energy | Transport | Forestry | Agriculture | Waste management | Industry | Capacity building | Coastal zone management | Water resources | Other vulnerability assessment | |
| Pacific regional | 0.23 | 0.03 | | 0.16 | 0.10 | 0.01 | 2.71 | 0.26 | | 0.19 | 3.69 |
| Kiribati | | | | | | | 0.30 | 0.15 | | 0.10 | 0.55 |
| Viet Nam | | | | | | | 0.37 | | | | 0.37 |
| Indonesia | 0.11 | | 0.11 | | | 0.15 | | | | | 0.37 |
| Zambia | 0.16 | | | | | | | | | | 0.16 |
| Philippines | | | | | | | | 0.10 | | | 0.10 |
| Ecuador | | | | 0.05 | | | | | | | 0.05 |
| Pakistan | 0.02 | | | | 0.02 | | | | | | 0.04 |

1 Sum of contributions provided by the New Zealand Agency for International Development and the New Zealand Ministry for Environment.

2 Over 2005 to 2008, the value of 1 NZD has fluctuated between 0.49 and 0.81 USD.

**Table 7.7: Description of a selected project or programme that promises practicable steps to facilitate and/or finance the transfer of, or access to, environmentally sound technologies**

**Project/programme title**

Loss Reduction Project: Tuvalu

**Purpose:**

To help the Tuvalu Electricity Corporation (TEC) provide a higher quality of electricity services at lowest cost to consumers.

| Recipient country | Sector | Total funding | Years in operation |
|---|---|---|---|
| Tuvalu | Energy | NZ$138,500 | November 2007 – June 2009 |

**Description**

In 2007, energy ministers from the Pacific region met in Rarotonga, Cook Islands, to discuss energy issues facing the region. This resulted in a communiqué highlighting areas for action. To assist in achieving the desired outcomes, New Zealand offered to help the TEC (Tuvalu Energy Corporation) to provide higher quality electricity services at the lowest costs to consumers. The work was administered by the Ministry of Economic Development and was funded through the New Zealand Government Agencies Fund.

The first phase of the project was completed in late 2008 and included:

1. a review of distribution losses, both technical and non-technical
2. identification of opportunities for system design and operational performance improvements
3. a review and identification of demand-side management and renewable energy opportunities.

The second phase implemented the recommendations from phase 1. Phase 2 included:

1. training the TEC staff in the distribution system and in asset management
2. developing methods for the TEC to evaluate solar photovoltaic options
3. feasibility studies on the use of copra oil and wind for electricity generation
4. identification of opportunities for greater energy efficiency, and the setting up of a programme for improvement together with policy options for government
5. recommendations for improved corporate management.

**Indicate factors that led to the project's success**

The training/capacity building component means that the TEC can improve its service itself and be less dependent on external consultants. As well as identifying key renewable energy options for Tuvalu, the project developed methods through which the TEC could evaluate renewable energy options itself.

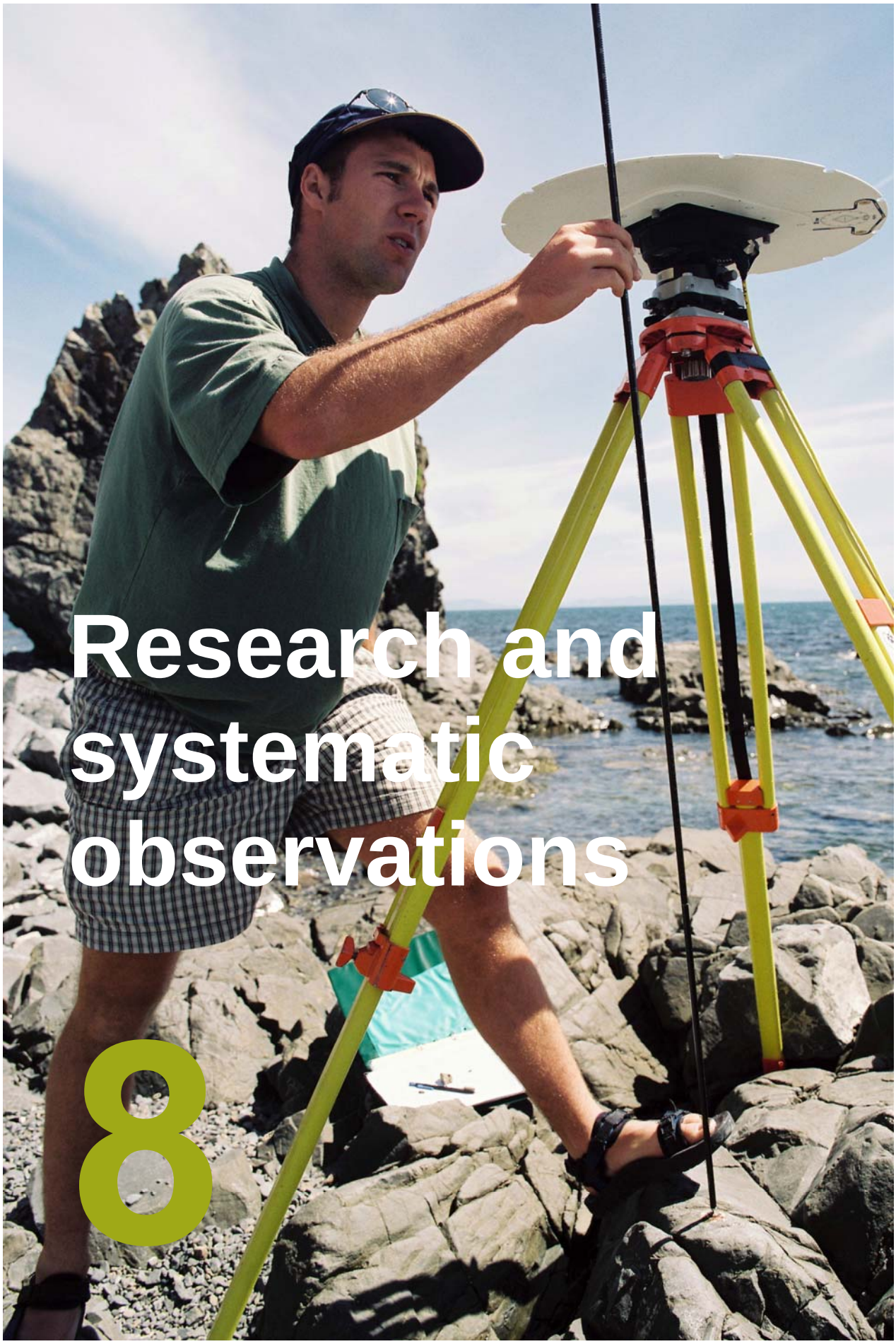
By considering the overall design of the electricity system, and making recommendations on corporate management, the project may also help to ensure the continued economic viability of Tuvalu's electricity company.

**Technology transferred**

The project recommended a number of ways that Tuvalu can reduce its reliance on diesel generation through a greater use of wind, copra oil, biogas and energy-efficiency technologies.

**Impact on greenhouse gas emissions/sinks**

Depending on the outcome of the project, a greater use of renewable energy and energy-efficiency measures will reduce Tuvalu's use of diesel for electricity generation and reduce greenhouse gas emissions.



# Research and systematic observations

8

# 8 Research and systematic observations

## 8.1 Introduction

New Zealand has continued to promote and collaborate in research and systematic observations on climate change, as required by Articles 4 and 5 of the Convention. Central government expenditure on climate change-related research for the 2007/08 financial year is estimated at approximately NZ$55 million, an increase of around NZ$23 million over the amount reported in the *Fourth National Communication*.[106] This expenditure was complemented by substantial expenditure by regional governments and the private sector.

Expenditure on systematic observations by central government included NZ$11.9 million through contracts to the Meteorological Service of New Zealand Limited (MetService) for its observing network, and NZ$1.4 million through contracts to the National Institute of Water and Atmospheric Research (NIWA) for maintaining the National Climate Database. Through this expenditure, climate observations have been maintained, new knowledge has been generated about climate change and its impacts in New Zealand and the southwest Pacific, and adaptation and mitigation options are being identified and developed.

New Zealand continues to contribute actively to the work of the IPCC. New Zealand supports a representative on the IPCC Bureau and the Bureau of the Task Force on National Greenhouse Gas Inventories as well as participating in task groups, workshops, expert meetings and contributing to the IPCC's Assessment reports.

New Zealand research groups have participated in international research and observation programmes of the World Meteorological Organization; the World Climate Research Programme; the Global Climate Observing System (GCOS) and its Pacific component (PI-GCOS); the International Geosphere-Biosphere Programme; and the Asia-Pacific Network for Global Change Research. New Zealand scientists are active participants in the Livestock Emissions Abatement Research Network (LEARN). Building on this network, New Zealand is also seeking to establish a global alliance on agricultural greenhouse gas mitigation research.

Under a New Zealand government contract, MetService provides some assistance to a number of Pacific Island nations with their weather and climate observing systems. With other New Zealand funding, NIWA has undertaken a Pacific Islands data rescue programme. Past New Zealand overseas development aid programmes have covered training in technical maintenance and observing practices in several of these states. New Zealand continues to lead the publication of the *Island Climate Update*, a monthly paper and web publication produced by NIWA with the support and collaboration of various organisations in the Pacific Islands, Australia, the United States and France. The *Island Climate Update* provides updates of current climate conditions and outlooks for the coming season to help Pacific Island nations adapt to climate variability and change.

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[106] Ministry for the Environment. 2006. *Fourth National Communication*. Wellington: Ministry for the Environment.

# 8.2 Research and systematic observations: policy and funding

## 8.2.1 Strategy for research and systematic observations

The New Zealand Government operates a balanced portfolio of research that aims to address core national needs and support areas of national research excellence. It also aims to maintain and develop international links that ensure collaboration with international research programmes and contribution to, and rapid uptake of, emerging new global technologies.

Research providers are mainly selected by competitive bidding, although some recent substantial long-term contracts have been made by negotiating outcomes with research providers. To be allocated funding, the areas of research must align with the strategic directions and goals set by the Government. Funding for climate change research is dominated by central government programmes, with additional contributions from local government and the private sector, including a number of joint ventures and partnerships. Government-funded research ranges from fundamental and underpinning research, to applied and operational research, including the development of specific tools and technologies. The range of different funding mechanisms is explained in more detail below.

The Ministry for the Environment and the Ministry of Research, Science and Technology coordinate climate change research and capability across government. Other government departments focus their attention on sectoral issues, for example, agriculture and energy. The Ministry also liaises with other government departments involved in climate change policies and strategic policy development, and liaises closely with New Zealand scientists and science organisations to monitor and review the adequacy of the climate change research portfolio to meet national needs. The Ministry of Agriculture and Forestry leads research relevant to the land-based primary sector under the Sustainable Land Management and Climate Change Plan of Action (the Plan of Action), an integrated approach to climate change for land-based sectors (see section 4.3.5).

Additional input to strategic research directions comes from the Royal Society of New Zealand's Climate Committee, which also facilitates interactions between scientists and stakeholders in New Zealand. This Committee maintains New Zealand's international links with the World Climate Research Programme. The Royal Society also supports the National Committee for the International Geosphere-Biosphere Programme (IGBP), which links New Zealand research with international IGBP projects.

New Zealand faces a number of significant challenges in meeting its climate change research needs. The diversity of the country, with climatic zones ranging from subtropical to subantarctic, means research has to address climate change projections and the likely effects of climate change on a diverse range of ecosystems. Mitigation and adaptation research has to cover equally diverse issues including: transport in a country with a low population base but large travel distances; substantial agricultural and forestry activities; energy demand and supply; and the sustainable development of growing urban settlements, often at or near coastal areas. The dependence of New Zealand's economy on export and international trade also means that mitigation options need to be compatible with the commercial requirements and technology standards of the international market.

New Zealand has a unique emissions profile among developed countries, with about 48 per cent of total greenhouse gas emissions coming from the agricultural sector. Given this unique profile

and the significant contribution agriculture makes to the New Zealand economy, New Zealand faces a particular need to undertake research to understand the climate change impacts and adaptation options for agriculture, as well as options to reduce greenhouse gas emissions from this sector. The Government has joined with the private sector to form the Pastoral Greenhouse Gas Research Consortium (see section 4.3.3), with the goal of developing tools that facilitate the mitigation of greenhouse gas emissions from the agricultural sector without loss of productivity.

As part of the Primary Growth Partnership, the Government established the domestic Centre for Agricultural Greenhouse Gas Research, which has been allocated NZ$5 million funding each year. It will be 100 per cent government-funded, with no requirement for industry co-funding and a commitment to 10 years' core funding. Research will focus on ruminant methane, nitrous oxide and soil carbon in the pastoral and horticultural sectors. The aim of the research will be to promote technologies that both reduce emissions and improve on-farm efficiency and productivity.

In addition to the domestic centre, the Government is actively promoting the establishment of a Global Alliance on agricultural greenhouse gas mitigation research. This initiative would bring interested countries together to drive greater international cooperation, collaboration and investment in this area of research. In this way, the Global Alliance aims to help reduce emissions from agricultural production and improve its potential for soil carbon sequestration, while safeguarding food security.

### 8.2.2 Funding policies

The Foundation for Research, Science and Technology (FRST) has the main responsibility for funding climate change research from public investment. FRST has 18 portfolio research strategies that provide the overall direction for its research investment. Each strategy is further arranged into target outcomes and themes that relate to a specific desired outcome.

Most of FRST's investment in climate change research is funded within the Understanding and Adapting to Global Environmental Change (GLO) portfolio, which invests in knowledge and data sets that underpin and enable management of the social, economic and environmental risks and opportunities associated with global environmental change and variability. The GLO portfolio has two target outcomes: GLO1 addresses the characteristics, causes and consequences of global change and variability, while GLO2 covers mitigation and adaptation responses to global change and variability.

Climate change research is also undertaken within other FRST portfolios where climate change and variability may have a significant impact on aspects of that sector (eg, the Sustainable Production Systems portfolio).

The Foundation for Research, Science and Technology purchases its portfolio of climate change research from various providers (Crown research institutes, universities and private organisations), guided by the funding policies outlined in the previous section. Its funding also covers the archiving and part of the collection costs for systematic climate observations. Some additional government support for research comes through:

- the Marsden Fund, which is administered by the Royal Society of New Zealand and is not subject to government research priorities
- funding for university research within Vote: Education
- the Health Research Council through Vote: Health
- the Pastoral Greenhouse Gas Research Consortium through Vote: Research, Science and Technology

- the Sustainable Land Management and Climate Change Plan of Action through Vote: Agriculture.

There is also direct funding of research in some climate change areas by core government departments to meet operational and policy development needs.

Systematic observations are part-funded through the Crown contract for public weather forecasts and warnings administered by the Ministry of Transport and awarded to MetService, which covers routine upper air and surface weather observations that are also used for climate research. Further observations for climate research are funded by FRST, and both weather and climate observations are incorporated in the National Climate Database, managed by NIWA under contract to FRST. Some support for observations in the Pacific is provided through the Ministry of Transport's contract with MetService, and additional support is provided through NZAID.

### 8.2.3 Funding levels

Table 8.1 summarises the estimated government-funded annual investment in climate change-related research. A further $11.9 million is spent on systematic climate observations.

**Table 8.1: Estimated annual investment in climate change research by central government for the 2007/08 year**

| | Investment (NZ$ million) | | | | | |
|---|---|---|---|---|---|---|
| **Area** | **FRST** | **MAF** | **Non-MAF departmental** | **Government PGGRC** | **Marsden** | **Total** |
| Underpinning science | 16.3 | 0.0 | 0 | 0 | 1.1 | **17.4** |
| Emissions reduction | 11.3 | 6.3 | 2.7 | 2.0 | 0 | **22.3** |
| Adaptation | 10.1 | 1.3 | 0.9 | 0 | 0.2 | **12.5** |
| Technology transfer | 2.0 | 0.3 | 0.6 | 0.5 | 0 | **3.4** |
| **Total** | **39.7** | **7.9** | **4.2** | **2.5** | **1.3** | **55.6** |

**Notes**: FRST = Foundation for Research, Science and Technology; MAF = Ministry of Agriculture and Forestry; PGGRC = Pastoral Greenhouse Gas Research Consortium.

## 8.3 Information exchange and dissemination of knowledge

Domestically, the Ministry for the Environment and the Ministry of Agriculture and Forestry work in conjunction with science providers to disseminate research findings on climate change, mitigation options, and adaptation processes and methodologies to ensure New Zealanders:

- are well informed on human modification of the climate
- better understand existing knowledge and uncertainties regarding the effects of climate variability and future climate change
- identify and implement technologies that underpin New Zealand's Kyoto Protocol commitments and long-term needs to substantially reduce greenhouse gas emissions
- participate effectively in managing and adapting to the impacts of climate change, including making use of any opportunities that may arise.

### 8.3.1 International exchange of data and information

New Zealand exchanges data and information with other countries in line with the policies of the World Meteorological Organization. Appropriate weather observations useful for climate modelling are disseminated in real time through standard World Meteorological Organization channels, and climate and greenhouse gas monitoring data is provided to appropriate world data centres.

New Zealand has identified particular opportunities for the dissemination of real-time climate data through the Pacific to provide up-to-date information on current climate conditions and seasonal outlooks to Pacific Island nations, and to help them deal with climate variability. This has led to the establishment of the *Island Climate Update*, discussed above in section 8.1, and NIWA also produces a similar monthly publication for New Zealand, *Climate Update*. Additional exchanges of information occur under the auspices of the Pacific Islands Global Climate Observing System (PI-GCOS) and the Asia-Pacific Network for Global Change Research.

### 8.3.2 Partnerships

#### Bilateral partnerships

New Zealand has established a climate change partnership with the United States to enhance dialogue and practical cooperation on climate change issues. The partnership was launched on 25 October 2002. As examples of the scope of this partnership, the most recent projects (as of May 2009) covered:

- a study of global methane emissions
- the rescue and digitalisation of historical climate data
- work on carbon dioxide sequestration in coal seams
- work to develop new materials for the hydrogen economy
- work on nitrous oxide emissions from grazed pastures
- the hosting of a joint event with Australia, to work with developing countries in the Pacific on climate observation.

A second bilateral climate change partnership, between Australia and New Zealand, covers a similar range of projects and exchanges.

#### Multilateral partnerships

New Zealand has initiated the establishment of a multilateral partnership, the Livestock Emissions and Abatement Research Network (LEARN), which brings together scientists to share information and expertise on greenhouse gas emissions from livestock (see also section 4.3.3). Currently (May 2009), 400 members in 48 nations have joined the LEARN partnership. In addition, New Zealand is a member of the International Energy Agency and the International Partnership for the Hydrogen Economy, and has observer status at the Carbon Sequestration Leadership Forum.

#### International organisations

New Zealand is an active member of the World Meteorological Organization and exchanges information and data through both the World Meteorological Organization and its subsidiary and associated bodies. Through membership of GCOS and its Pacific arm, PI-GCOS, and through the Asia-Pacific Network for Global Change Research, New Zealand works to lower barriers to, and further facilitate, such data exchanges.

# 8.4 Research

This section looks at the highlights, innovations and significant efforts made in relation to climate change research in New Zealand. More details about the research projects funded by the Foundation for Research, Science and Technology can be obtained from its searchable database of abstracts and project reports, using the search term "climate change".[107]

Climate change research in New Zealand seeks to develop information and knowledge on a wide variety of issues, including:

- past climate trends
- future impacts
- adaptation opportunities and risks
- reducing the emissions of greenhouse gases, particularly those resulting from pastoral production
- enhancing sinks, particularly forest sinks
- community resilience and human health
- oceanic and atmospheric chemistry
- climate systems
- greenhouse gas measurement and national greenhouse gas inventory development and support.

## 8.4.1 Climate processes and climate system studies

### Climatic variability and trends

Work continues on identifying and understanding the causes of variability and trends in atmospheric, oceanic, mountain glacier and sea-ice conditions in New Zealand, the southwest Pacific and Antarctica. This includes work on the influences of the El Niño–Southern Oscillation and the Interdecadal Pacific Oscillation on New Zealand patterns of rainfall, temperature, wind and river flow; and work on the predictability of seasonal climate variability and separating out these effects from the long-term trends that may be due to anthropogenic forcing.

Increased emphasis is being given to studies of changes in the frequency of extremes such as frost and intense rainfall and their statistical significance. Trends in ocean circulation in the South Pacific and their relationship to atmospheric changes have been analysed. Research is in progress on sea ice in the Ross Sea area of Antarctica, and on the relationship between the extent of the ice and atmospheric circulation. Research effort is also being focused on the trends and impacts of climate on ocean ecosystems, in particular the impacts on fisheries.

Research is ongoing to measure, understand and predict sea-level rise. This work has been used in the guidance developed by the Ministry for the Environment to help with planning for coastal hazard and climate change. Complementary work is underway to investigate current and future swell, wave and storm surge conditions near New Zealand coasts.

[107] http://myfrst.frst.govt.nz/Public/ResearchReports/

## Palaeoclimate

New Zealand collaborates with other countries on a significant amount of palaeoclimate research. This includes analysis of Antarctic ice, glacier and sediment cores to provide insight into the changes that have occurred to the climate in the past, over a variety of time scales.

Aspects of this research target periods of relatively high atmospheric carbon dioxide and times of rapid or abrupt global warming, and produce archives that extend the comparatively short Southern Hemisphere instrumental records of climate back in time. The data generated is being used to provide crucial constraints for collaborating climate modellers in New Zealand and overseas by testing the veracity of existing climate models. For example, the data is currently being used by modellers to look at heat transport mechanisms in the ancient South Pacific during a time of super-greenhouse climate.

One project, ANZICE (Antarctica – New Zealand Interglacial Climate Extremes), seeks to understand the likely response of the New Zealand / Antarctic region to a warmer world. To achieve this, the project focuses on environmental changes that occurred during peak warm periods in the past when the atmosphere and surface ocean were up to 3°C warmer than now. This research aims to:

- provide reconstructions of environmental responses to rises in temperature
- develop the reconstructions into models to help identify potential changes and consequences for a projected warmer world
- apply model results to guide policy for New Zealand's future.

Of particular interest is the analogue and computer modelling that will draw on the above research results to develop models that help clarify our view of the future. Information from the ice and sediment core studies will be compiled to form observational models to help answer basic research questions such as "How did the Antarctic environment appear during the last Interglacial Period, 125,000 years ago, and what was the impact on the Southern Ocean and New Zealand?" Answers to such questions will help guide and verify the computer models to give a measure of confidence in their results.

## New Zealand and the International Polar Year

For New Zealand scientists, the International Polar Year represents a unique opportunity to participate in a number of important Antarctic scientific collaborations. One of the projects in which New Zealand has taken a prominent leadership role is the ANDRILL project (ANtarctic geological DRILLing). The chief objective is to drill back in time to recover a history of palaeoenvironmental changes that will guide our understanding of how fast, how large and how frequent glacial and interglacial changes were in the Antarctic region. Future scenarios of global climate change require guidance from past history that will reveal the potential timing and frequency of future changes.[108]

## Foraminifera

Analysis of foraminifera (single-celled protists with shells) in shallow-water sediment cores from salt marshes has determined the 500-year local history of sea level at the first of four New Zealand localities. Results at Pounawea (South Otago) show there has been a rapid acceleration in sea-level rise (up to 2.8 millimetres per year) in the last 100 years, which is in agreement with the Port Chalmers tidal gauge records since 1924, and parallels the increase in

[108] http://www.andrill.org/

atmospheric greenhouse gas concentrations. This is the first Southern Hemisphere use of foraminifera for this purpose, and it shows a similar pattern of sea-level rise to three Northern Hemisphere records.

## Atmospheric chemistry

Measurements and computer modelling are continuing to improve knowledge about the sources, sinks and transport of greenhouse gases in the atmosphere. This work includes participation in the international Total Carbon Column Observing Network, the World Meteorological Organization's Global Atmospheric Watch, and the Network for the Detection of Atmospheric Composition Change.

Observations are also made from container ships travelling regularly between New Zealand and Japan. These observations include the isotope ratios of methane and carbon monoxide, as well as condensation nuclei and aerosol concentrations. The results highlight the differences in methane concentrations across the hemispheric boundary, reflecting differences in sources.

Finally, research is underway on the implications of climate change for the recovery of stratospheric ozone concentrations.

## Ocean–atmosphere gas exchange

The Carbon Workshop 2008: Global Cycle to Regional Budget was held in New Zealand in April 2008 as part of the International Geosphere-Biosphere Programme. One particular session was on ocean processes and involved looking at our understanding of the ocean carbon uptake and marine biosequestration. The research reported there included work carried out under the Surface Ocean – Lower Atmosphere Study, an international research initiative comprising over 1500 scientists in 23 countries.[109]

The broader aim of the workshop was to bring together the broad range of carbon researchers from within New Zealand, along with overseas experts, to review our current understanding of the global carbon cycle and to look ahead at the research challenges associated with the need to mitigate fossil carbon emissions and develop policies for carbon constraint.

Work is also continuing on improved techniques for assessing the effects of ocean-sourced biogenic sulphur emissions on aerosol and cloud properties, which may affect the radiation balance over the Southern Ocean.

## Land–atmosphere and land–ocean interactions

Research on the land–atmosphere exchange of carbon dioxide and the effects of land-use changes, land management and erosion continues to inform the national carbon monitoring systems for forest and scrub vegetation and for soil carbon. Research continues on carbon dioxide fluxes over scrubland, and on the validation by both flux-based and inventory methods of estimating the total exchange and net sequestration of carbon dioxide (and its spatial variability).

In the face of global environmental change and increasingly intensive land use, New Zealand needs to understand how landscapes respond to ever-changing global environmental drivers and human intervention. The MARGINS Source-to-Sink New Zealand programme is making significant progress towards developing a quantitative understanding of landscape response to environmental change. One of the key features of the research is the use of numerical landscape

[109] http://www.royalsociety.org.nz/Site/about/our_structure/advisory/igbp/default.aspx

modelling, which is a capability the programme is helping to develop in New Zealand. This development is aided by links with an international United States-led modelling programme, which aims to produce free-to-use models accessible through the web. Preliminary assessment of currently available models suggests they are well suited for use in New Zealand's tectonically dynamic landscapes.[110]

### 8.4.2 Modelling and prediction, including general circulation models

Regional climate scenarios for New Zealand through the 21st century, based on statistical downscaling from global climate models, have been extended to correspond to the full range of global temperature projections available from models used in the IPCC's Fourth Assessment Report. This downscaled data has been mapped onto a 5-kilometre grid to produce estimates of temperature and rainfall for any location across the country. Future scenarios for soil moisture changes (expressed in terms of potential evapotranspiration deficit) were also developed to investigate possible changes in drought frequency.

A regional climate modelling capability has now been implemented based on the United Kingdom Unified Model. It has so far been used to simulate current climate and palaeoclimate conditions, as well as several future climate runs to complement scenarios developed by statistical downscaling. The projections based on both the downscaling and the regional climate modelling provide data that is used extensively in other research, such as that for engineering design, health and other biological impacts, and socio-economic modelling.

### 8.4.3 Research on the impacts of climate change

#### Wind

Information on the patterns and extremes of our future wind environment is important for issues such as understanding New Zealand's wind energy resources, infrastructure design constraints, and the wind-throw impacts on New Zealand's planted forests. Research is currently underway to provide estimates of the future wind environment, including changes to extremes, based on both the downscaled data and the regional climate modelling projections. Included in this research are efforts to understand how changes to the atmosphere will affect the strength, frequency and location of convective storms.

#### Hydrology

Research drawing on a range of IPCC scenarios and climate models has suggested that soils in the east and far north of New Zealand will experience more long, dry periods (droughts) over the coming century. Initial results are now also available on the implications of these same scenarios for future river flows, and further analysis and research on this topic is underway looking at issues such as the availability of water for irrigation.

Research and modelling have also been undertaken on possible increases in the frequency of heavy rainfall events and the potential implications for flooding in some locations. Initial results suggest that some areas are likely to see increases in extreme events beyond that expected from the higher moisture-holding capacity of warmer air.

[110] http://www.nsf-margins.org/S2S/S2S.html

### Coastal impacts

Research is underway to provide estimates of the background wave and swell conditions expected over the 21st century. This work is using re-analysis data sets to provide boundary conditions for wave and swell models (WAM/Swan), and General Circulation Model data to provide estimates of these conditions into the future. This research will help to inform planning and engineering design on New Zealand coastal margins.

### Agriculture

Potential changes in drought frequency over the coming century have been identified for a range of climate scenarios that are likely to affect dry-land farming in eastern areas of New Zealand. This work is being reviewed to take account of the newly updated downscaled data. The long-term FACE (Free Air Carbon dioxide Enrichment) experiment is studying a grazed pasture ecosystem under the carbon dioxide concentration expected in 2030. The facility has been improved to provide an increase in temperature as well as in carbon dioxide concentration. The New Zealand FACE facility was established in 1997 and is one of the few long-term research programmes globally situated on improved pastoral grassland.[111]

### Plantation forestry

Research has looked into the likely changes in forest fire risk over New Zealand in coming decades as a consequence of climate change. This work is currently being updated to factor in the new climate projects. Research is also investigating the vulnerability of forests to future climate and biosecurity threats.

### Health

Ongoing research is looking at the impact of climate change on the occurrence and severity of vector-, water- and food-borne diseases. Research is also focusing on the changing needs of the health industry that may result from changes in disease prevalence, population changes and shifts, and socio-economic stressors.

### Infrastructure

The guidance documents on the projected impacts of climate change produced by the Ministry for the Environment are being used by planners and designers to inform the development of new infrastructure. Local authorities are also using the guidance documents to assess future and current climate risks to existing infrastructure. More information on adaptation work can be found in chapter 6.

## 8.4.4 Socio-economic analysis, including impacts and response options

Economic modelling work has identified impacts from climate variations on New Zealand's gross domestic product (GDP) through changes in pastoral production. This work uses the projected impacts – particularly the impacts on the occurrence of droughts – to estimate the changes in production, both in average years and in drought years.

[111] http://www.maf.govt.nz/climatechange/slm/grants/research/2007-08/pdf/2008-18-improved-field-facilities.pdf

Research is also beginning to look at community vulnerability/resilience to the impacts of climate change. One aspect of this work is aimed at developing indicators of vulnerability. Similar work is underway looking at coastal communities, with a particular case study on a Māori coastal hapū.[112]

Recently announced was New Zealand's first professorship in the life-cycle analysis and carbon footprint of New Zealand's primary industries. The Ministry of Agriculture and Forestry is funding the establishment of a centre for life-cycle analysis at Massey University. The centre aims to study the environmental footprint of products across their entire life cycle – from the farm, orchard or forest, through to processing, transportation, sale, consumption and disposal by the consumer. The centre will also be responsible for training experts who can work with the primary sector to enhance their overseas reputations, improve their production processes and help further promote New Zealand as a world leader in agriculture, horticulture and forestry.[113]

Work is in progress to identify impacts on the energy sector from climate-induced variations in water inflows to hydro-electricity generation systems, and on energy demand for space-heating.

Integrated socio-economic/natural-science models are now being developed for use in policy design and analysis for land-use and climate-change issues. Initial studies with these models are exploring the likely influence of various possible policies on changes of land use into and out of "Kyoto" forests, including different levels of carbon pricing. A further economics research project has examined greenhouse gas emission paths in connection with different New Zealand economic development scenarios.

### 8.4.5 Research and development on mitigation

Much research into the reduction of greenhouse gas emissions is focused on reducing emissions from agricultural production, reflecting the fact that it represents 48 per cent of New Zealand's emissions profile. Significant efforts are also being made on the role of forestry in sequestering carbon.

Much of the industry funding on agricultural emissions reduction is channelled through the Pastoral Greenhouse Gas Research Consortium (PGGRC), in which the Government matches the investment of the pastoral industry into research on the reduction of greenhouse gases from pastoral production. The PGGRC research programme aims to provide New Zealand livestock farmers with the knowledge and tools to mitigate greenhouse gas emissions from the agricultural sector. The PGGRC is a commitment by the pastoral sector to address pastoral emissions while ensuring that our nation's economic wealth is enhanced. (See also section 4.3.3.)

The announcement of the completion of the first rumen methanogen genomic sequence marks an important milestone for the PGGRC. Since its inception in 2002, the Consortium has had a programme developing a fundamental understanding of the organisms responsible for the production of methane from ruminant livestock. Although other methanogens have previously been sequenced, Methanobrevibacter ruminantium is the first from the rumen to have its genome or "parts list" identified. The Consortium will continue its programmes of work, which will use this knowledge for developing cost-effective mitigation solutions for livestock.

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[112] Māori are the indigenous people of New Zealand. A hapū is one of the collective Māori groupings and will usually consist of a number of related whānau (extended families).

[113] http://www.massey.ac.nz/massey/about-us/news/article.cfm?mnarticle=massey-awarded-major-maf-contract-16-04-2009

## Agricultural greenhouse gas emissions

This research has two strands: identifying and developing ways to reduce methane and nitrous oxide emissions and improving the inventory of New Zealand's agricultural emissions. Improved methods for measuring methane emissions at the animal, herd and farm scale are relevant to both strands since they provide validation for emission reductions technologies and assist with inventory improvement. In addition, greenhouse gas emissions functions have been integrated into an ecosystem model (EcoMod) in a joint New Zealand–Australian project. The model is being used to evaluate mitigation options for agricultural emissions.[114]

## Mitigation of agricultural emissions

A significant amount of research is undertaken through the PGGRC, but the Ministry of Agriculture and Forestry also funds research directly through the Sustainable Land Management and Climate Change Plan of Action. A particular focus is the investigation of rumen microbial strategies to lower methane emissions. New information has been obtained on rumen factors that affect methanogen survival and that have potential to be used in methane-abatement strategies. Investigation of forage plants to affect methane formation in the rumen continues, as does research on the variation between individual animals in the levels of methane emitted.

The PGGRC is also undertaking research on management practices to reduce nitrous oxide emissions. This includes linking with an industry trial to evaluate intensive dairy farm systems, which involves treatments with nitrogen fertiliser, maize silage and winter management strategies. The inclusion of low protein forage (eg, maize) to reduce dietary nitrogen concentration, and winter management practices to reduce excreta to soil, can potentially mitigate environmental nitrogen emissions and increase efficiency.

Full details of the PGGRC's work can be found at http://www.pggrc.co.nz/Research/AnnualReports/tabid/69/Default.aspx, and research funded through the Ministry of Agriculture and Forestry is set out at http://www.maf.govt.nz/ climatechange/slm/grants/research.

## Methane and nitrous oxide emission measurement and national inventories

In addition to abatement strategies, the Ministry of Agriculture and Forestry is funding research into improving the measurement and verification of agricultural emissions. This includes work to produce new models and methods to measure emissions (such as *Overseer*, discussed in section 4.3.3), as well as work to enhance and verify existing models.[115]

## Land use, land-use change and forestry (LULUCF): inventories and sequestration research

Research is being undertaken to improve inventory methods and models to estimate the carbon in each of the five land uses, land-use change and forestry carbon pools. The emphasis of this work is on planted forests and their soils. Research is also underway on improving methods of using historical remotely sensed information to develop land-use histories across New Zealand associated with regenerating native forest, the planting of forest species, patchy shrub cover in pastoral hill country, and other land-use information. Research is continuing on radar remote sensing from aircraft (and eventually satellite) for estimating woody biomass, and on scanning LIDAR (light interception detection and ranging) to estimate tree heights and forest health.

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114 http://www.maf.govt.nz/climatechange/slm/vggr/page-02.htm#P743_78272

115 http://www.maf.govt.nz/climatechange/slm/gg-grants.htm

Research into barriers and opportunities for enhancing the area of forest sinks includes investigating indigenous reforestation as a land-use option to gain income from forest credits or to provide opportunities for businesses to exhibit "carbon neutrality", and using the Kyoto Protocol as a mechanism to encourage more sustainable land use. Research results are being used to improve various indigenous forest biomass data sets and forest inventory methods. These include biomass data sets and functions to predict live tree biomass and coarse woody debris decay rates. To improve Kyoto forest inventories and projections, exotic live and dead tree biomass data sets are being prepared, as are functions to predict live tree and coarse woody debris biomass. Forest and soil carbon model validation studies are also underway.

### Energy efficiency, renewables and mitigation of industrial emissions

The Low Carbon Energy Technologies Fund was established to support new low-carbon energy technologies. The aim is to scale up and demonstrate existing research on second-generation biofuels, other low-carbon liquid biofuels and low-carbon energy technologies such as solar, hydrogen and wind power. Projects that have been awarded funding so far include the development of a second-generation, low-carbon "petrol" fuel from industrial flue gas waste, which could be blended with normal petrol to reduce petrol use. Another example is research into a process for developing biofuel from algae.

The Ministry of Agriculture and Forestry has inaugurated professorial chairs at Massey University to study the production and use of biochar in New Zealand. Biochar is a stable form of carbon that has the potential to be incorporated into soil as a permanent carbon store. This would potentially create a major carbon sink that removes carbon dioxide from the atmosphere through plant growth and stores it as inert carbon in soils. Biochar can also be used to make a bioenergy product that can be used to produce heating and generate electricity, and for other applications. (See also the Sustainable Land Management and Climate Change Plan of Action in section 4.3.5.)

New Zealand scientists are investigating the potential of sites for the geo-sequestration of carbon dioxide. New Zealand also collaborates in an Australian cooperative research centre programme on carbon dioxide geo-sequestration.

### Transport

Research and development work to reduce net greenhouse gas contributions from transport includes work on fleet best practice, end-of-life stewardship, second-generation biofuels, and the role of electric cars.

## 8.4.6 Research and development on adaptation to climate change

Although research on climate change impacts has been a high priority for New Zealand, research, development and dissemination of methods for implementing adaptation measures has also been a major focus.

In May 2007, scientists contracted to the Ministry for the Environment updated the guidance manual *Climate Change Effects and Impacts Assessment*, which provides guidance to local government on the expected impacts of climate change and describes a risk management framework for assessing the consequences and determining the appropriate responses. A similar manual has been developed specifically for the coastal margins: *Climate Change and Coastal Hazards: A Guidance Manual for Local Government*. These manuals are aimed primarily at

engineers, although both have been condensed into summary versions providing a shorter overview aimed more at planners. (See also section 6.4.1.)

A feature of the coastal manual is the specific guidance on planning for sea-level rise. The guidance is aligned to the risk management approach and recognises the uncertainties in future projections of sea-level rise. The specific advice can be found at http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/html/page2.html.

Guidance is also being developed for flooding. This will be in two parts: one aimed at demonstrating how to incorporate climate change impacts into flow estimation, the other at how to incorporate climate change impacts into flood planning.

### Adaptation

Significant effort continues to be made into developing and refining research-based information to help local government, the land-based primary sectors, the energy industry and other climate-sensitive sectors to adapt to both natural climate variability and future climate change. Funders of this work include the Ministry for the Environment, the Foundation for Research, Science and Technology, individual local authorities, and the insurance industry. The continuing substantial impacts of a number of extreme meteorological events have increased the demand for such information.

As part of developing adaptation guidance manuals for local government, researchers have:

- developed new climate and sea-level scenarios for New Zealand based on the full range of IPCC global temperature projections for the coming century
- identified local and regional activities likely to be vulnerable to such changes
- developed risk assessment and management methodologies to address such impacts.

Particular attention has been paid to the potential impacts of increases in high-intensity rainfall, which involves providing data that can be used for assessing stormwater drainage capabilities and methods for identifying areas at risk of inundation.

Research is also underway on the implications of climate variability and change (including interdecadal variability) for renewable energy (hydro, wind) generation, to help the energy industry plan for future changes. Research has continued on seasonal climate forecasting, and on methods for mapping climate and soils (and potential climate changes), and using the results to identify which crops are most appropriate to be grown in different regions.

A conference on adapting to climate change was held in May 2009, organised by the New Zealand Climate Change Centre. The conference, called Managing the Unavoidable, brought together a range of scientists and end users of guidance materials. The conference was supported by the Ministry for the Environment, the Ministry of Agriculture and Forestry, the Royal Society of New Zealand and Meridian Energy.[116]

## 8.5 Systematic observations

New Zealand maintains a systematic programme of atmospheric, oceanic and terrestrial measurements of a range of essential climate variables. These measurements build on a historical archive of observations of climate-related parameters. Details of these observations

[116] http://www.confer.co.nz/adaptation09/

are described and tabulated in *New Zealand's Report on the Global Climate Observing System (GCOS)*, included in this report.

### 8.5.1 Atmospheric observing systems

There are two main sources of New Zealand atmospheric observations relevant to climate change: the routine surface and upper air weather observations undertaken by MetService (New Zealand Meteorological Service Ltd), and dedicated climate observations and atmospheric constituent measurements undertaken by NIWA (the National Institute of Water and Atmospheric Research). NIWA is assisted by many voluntary observers, especially for rainfall monitoring. MetService forwards its weather observations to NIWA, where they are archived in the National Climate Database along with NIWA's own measurements. Both MetService and NIWA have certified quality control standards: NIWA's climate monitoring and archiving programme carries ISO9002 certification, and MetService has ISO9001 certification.

#### Support

Funding for the core weather observations is by central government, through a Ministry of Transport contract with MetService. Some extra observations are funded by MetService out of commercial revenue. New Zealand recognises the National Climate Database as a database of national importance, and dedicated climate observations are funded by central government, through a contract to NIWA from the Foundation for Research, Science and Technology (FRST). Additional funding comes through revenue from commercial applications of the data. Atmospheric constituent measurements are also funded by FRST as part of specific research programmes.

#### National climate network

Plans for the national climate network include continuing with gradual automation, and NIWA staff regularly review the network in light of user requirements, including those of MetService. Further planning for climate and atmospheric constituent measurements takes place as part of the FRST proposal and contracting process. The Reference Climate Network is a subset of the national climate network and was established in the late 1980s. Particular attention is paid to continuity of the network. It has recently been extended following a recommendation from the 10th session of the Commission for Climatology of the World Meteorological Organization (WMO). It now consists of 49 stations (including 19 back-up stations) located across mainland New Zealand, the outlying islands (Raoul, Chathams and Campbell) and the Ross Dependency (Scott Base).

#### Availability and exchange

Data in the National Climate Database is freely available to users through a web interface (http://cliflo.niwa.co.nz/). A subset of the observations catalogued in the National Climate Database is submitted to WMO archives. Appropriate weather observations are forwarded to other countries by MetService in real time through WMO networks. NIWA also puts National Oceanic and Atmospheric Administration (NOAA) advanced TIROS operational vertical sounder (ATOVS) data on WMO networks via the Regional ATOVS Retransmission Service.[117] New Zealand provides climate and greenhouse gas monitoring data to international data centres under programmes run by the WMO and the International Council of Scientific Unions. These programmes comprise the Global Climate Observing System (GCOS). Solar radiation data and

[117] The NOAA Advanced TIROS refers to the American National Oceanographic and Atmospheric Administration's Advanced Television Infrared Observation Satellite. See http://www.noaa.gov/

routine weather radar data, while archived nationally, are not currently being submitted to international archives.

## Weather and climate observations

New Zealand has 10 stations providing data to international data centres as part of the Global Surface Network, and four stations that report as part of the Global Upper Air Network. The Global Surface Network stations at Kaitaia, Paraparaumu Aerodrome and Invercargill Aerodrome are operated manually by observers on contract to MetService. The other seven stations are automatic stations owned and operated by MetService. Detailed metadata for these stations is compiled, and site inspections are regularly carried out by NIWA staff and MetService engineers. Copies of inspection reports are available through NIWA's Instrument Systems group in Christchurch. At present, the Global Surface Network station at Tara Hills does not fully meet GCOS standards because surface pressure is not measured at that site.

All four Global Upper Air Network stations measure air temperature, humidity, wind speed and wind direction. Currently, at Chatham and Raoul Islands, temperature and humidity are measured by radiosonde and wind is calculated using Global Positioning System (GPS) modules incorporated into the radiosondes (model Vaisala RS92 SGP). At Paraparaumu and Invercargill, temperature and humidity are measured by radiosonde (model Vaisala RS92K), but wind is calculated using a separate radar tracking system.

A total of 222 stations provide climate observations at 9 am each day to the National Climate Database. Of these, 148 are automatic stations, which also provide information at other times of the day. There are currently 668 stations providing daily rainfall data to the database. In addition, NIWA maintains satellite data archives for:

- the New Zealand region of the NOAA high-resolution picture transmission (HRPT) data (1992 to the present)
- geostationary meteorological satellite and multifunctional transport satellite data products (August 1998 to March 2008)
- SeaStar SeaWiFS HRPT data (May 2000 to the present)
- Terra and Aqua Direct Broadcast data from August 2007 to the present.

There are 117 stations measuring surface global solar radiation. At five of these sites (Kaitaia, Paraparaumu, Lauder, Invercargill and Scott Base) these are complemented by measurements of direct and diffuse radiation.

Although there are no ocean mooring network platforms measuring air temperature, wind speed and direction, and air pressure, these essential climate variables are measured at seven small isolated island or platform locations (Raoul Island, Campbell Island, Enderby Island, South West Cape, Stewart Island, Maui A platform and Mokohinau Island).

## Atmospheric constituents

New Zealand has three stations providing atmospheric constituent data to international data centres as part of the Global Atmospheric Watch. Concentrations and isotope ratios in carbon dioxide, methane and nitrous oxide, as well as aerosol chemistry of iron and sulphur, are monitored at the Baring Head clean air monitoring station. Some of these gases are also monitored at Lauder and at Arrival Heights, Antarctica. Twice-monthly frost point hygrometer flights are made from Lauder under contract from the NOAA GCOS office to measure water vapour profiles into the stratosphere. Vertical ozone profile measurements are made at Lauder using ozonesondes, ozone lidars and a microwave radiometer. Total column

ozone measurements are made at Lauder and at Arrival Heights, Antarctica, using Dobson spectrophotometers.

New Zealand also uses ships of opportunity to collect air samples for analysing the principal greenhouse gases, and Hi Vol sampling of iron between Nelson (New Zealand) and Osaka (Japan). In addition, Microtops sun-photometer readings to measure aerosol optical depth and ozone are made when sky conditions allow; this data is available as part of the Aeronet Maritime Aerosol Network programme. Continuous condensation nuclei measurements are also made between Nelson and Osaka on each voyage.

Continuous *in situ* measurements of carbon dioxide, methane, nitrous oxide and carbon monoxide have recently been initiated at Lauder and are expected to become fully operational within the next year. Near infra-red Fourier transform spectroscopy measurements of column amounts of the same gases are also made at Lauder.

### Response to the GCOS Implementation Plan

A number of actions have been initiated in response to the recommendations on atmospheric essential climate variables within the internationally agreed GCOS Implementation Plan; specifically:

- applying the global climate monitoring principles to all surface climate networks
- implementing a reference network of high-altitude, high-quality radiosondes
- submitting metadata records and inter-comparisons for radiosonde observations to the specified international data centres
- data rescue.

## 8.5.2 Ocean observing systems

New Zealand has five stations contributing to the Global Sea Level Observing System (GLOSS). Of these five GLOSS sites, those at Wellington, Auckland and Bluff are operated by port companies (or the regional authority on behalf of the port company); the site at Waitangi, Chatham Islands, is operated by the Pacific Tsunami Warning Center; and the site at Scott Base, Antarctica, is operated by NIWA and Antarctica New Zealand.

New Zealand does not have a formal, nationally administered network of sea-level gauges. Instead, sea-level gauges are mostly operated independently by various agencies, with some national coordination of daily downloads of data, post-processing and archiving undertaken through voluntary partnerships with either Land Information New Zealand (LINZ) or NIWA. NIWA coordinates and archives a loose network of 22 coastal sea-level recorders, including the GLOSS site at Scott Base, Antarctica.[118] There are sea-level recorders at 16 major ports operated by port companies or regional authorities, and a further 14 sea-level stations in major or minor ports and estuaries that are operated independently by port companies or local/regional authorities. Three stations are operated on the Chatham Islands: two by the Pacific Tsunami Warning Center (including a GLOSS site at Waitangi Harbour), and one by LINZ and the Institute of Geological and Nuclear Sciences (GNS). The Pacific Tsunami Warning Centre site at Owenga on the Chatham Islands will soon (2009) be decommissioned and only the adjacent LINZ/GNS tsunami gauge will operate there. LINZ also operates a site at Cape Roberts, Antarctica.

[118] http://www.niwa.co.nz/services/free/sealevels

In addition, long-term tide gauge records (since about 1900) are held by LINZ and the University of Otago (School of Surveying) for the four main ports of Auckland, Wellington, Lyttelton (Christchurch) and Dunedin, along with shorter records from several other ports and open-coast gauges. The open-coast gauges in the NIWA network provide a valuable data set of ocean tides, storm surges and long waves. The earliest site commenced in 1971, with a major expansion of sites from 1994 to 1998.

Sea-surface temperature is measured at nine coastal stations. Since the mid-1980s, MetService has maintained a network of free-drifting buoys in the Tasman Sea, and since 2002 these have been a combined meteorological/oceanographic drifting buoy, SVPB type. The SVPB buoys measure sea-surface temperature and sea-level pressure, and ocean current is derived from their drift. All buoys report via satellite using Argos transmitters. MetService also works collaboratively with the Global Drifter Centre in Miami to deploy buoys under the Southern Ocean Buoy Programme in the Pacific Ocean south of 40°S. These buoys are also of the SVPB type, and between 20 and 40 buoys are deployed annually during the southern summer months.

Ocean waves are routinely monitored around the New Zealand coast at five sites operated by NIWA and/or regional councils, and at a further six sites operated by ports. Remote coastal video cameras have been installed for long-term monitoring of beach conditions and erosion at seven sites.[119]

Under MetService's Voluntary Observing Ships (VOS) scheme, New Zealand seeks to upgrade or recruit ships to make climate-quality observations under the VOSClim (VOS Climate Project). Extensive metadata is collected for each VOSClim ship, including instrument type, location and exposure. The real-time observations are monitored by the UK Real Time Monitoring Centre, and the observations, the metadata, the co-located model data and the delayed mode (IMMT) data are all supplied to the US Data Assembly Centre for archiving for future research and climate applications.

## Water column observations

NIWA has annually contributed and deployed two profiling floats under the Argo programme. Of the total 16 Argo floats deployed, nine are still active (for further information see http://sio-argo.ucsd.edu/weqpac_web.html). The data from the New Zealand floats is administered by the Scripps Institution of Oceanography and is available from the Argo Global Data Assembly Centers. NIWA intends to continue to purchase and deploy Argo floats at the rate of two per year. NIWA is also deploying buoys in the Southern Hemisphere from the R/V (research vessel) *Kaharoa* in an ongoing collaboration with the University of Washington and the Scripps Institution of Oceanography. These voyages, dating back to 2004, have deployed around 550 floats, primarily in the South Pacific but also in the eastern tropical Pacific and Indian Oceans. In addition, some deployments in the Southern Ocean have been made from *R/V Tangaroa*.

New Zealand maintains two global reference mooring network sites (Ocean SITES) in deep waters (approximately 3000 metres) to the east of the country. These provide long-term time-series biophysical data (currents, temperature, salinity, fluorometry, particle flux) in subtropical and subantarctic waters on either side of the subtropical front north and south of Chatham Rise. Measurements have now been in progress for nine years and have included a repeated, across-front transect measuring currents, nutrients, fluorometry and, more recently, bio-optics. A third site, to the northeast of New Zealand, which is not part of the global reference mooring network, provided current and temperature data in the subtropical inflow region of the East Auckland Current to the northeast of New Zealand and was in place for 6.5 years (1998–2005).

[119] http://www.niwa.co.nz/services/free/cam-era

Time-series data of currents, temperature, light and fluorometry have also been collected at a shallow mooring site (approximately 40 metres) in the Firth of Thames, Hauraki Gulf, since 1998. Meteorological and water column observations (wind speed and direction, barometric pressure, air and sea temperature, salinity, turbidity, waves, currents) have been made since 2007 at a site approximately 30 metres deep located in the centre of Golden Bay, at the northern tip of the South Island. A new mooring deployment close to the Firth of Thames site (CSMART) was initiated in early 2009 to measure meteorological and water column parameters, including bio-optics.

Although New Zealand does not formally participate in providing carbon inventory survey line data to the International Ocean Colour Coordinating Group, measurements of $pCO_2$ (partial pressure of $CO_2$), pH, alkalinity and supporting data are routinely measured on cruises out of Dunedin as part of the Munida time-series programme. These surface measurements have been made every two months for the last 10 years, in accordance with the GCOS climate monitoring principles. The ocean carbon data will be submitted to the Carbon Dioxide Information Analysis Centre – Ocean $CO_2$.

### 8.5.3 Terrestrial observing systems

There are approximately 500 stream-flow gauges in operation around New Zealand, and about 300 groundwater monitoring sites, operated by NIWA and by regional and district councils. The NIWA stream-flow monitoring stations and a river water quality network of over 70 river locations, and their databases, are known as the Water Resources Archive.

End-of-summer snowline elevations and photographic images of 50 glaciers from special aircraft flights have been available annually since 1979, and the terminus positions of key glaciers in the Southern Alps are available from 1800 to the present. The New Zealand snow cover network is currently being expanded. There are existing snow-monitoring sites (operated for commercial clients) at Rose Ridge and Panorama Ridge, and existing climate sites at Chateau Tongariro on Mt Ruapehu, Arthur's Pass Village and Mount Cook Village, which have been upgraded to observe snow. New climate and snow sites have been established within Nelson Lakes National Park, the Murchison Mountains in Fiordland National Park, Albert Burn, the Ivory Glacier and at Mt Potts. Future additional sites are planned for Mueller, Rolleston, Lake Heron, Brewster Glacier and Ruapehu ridge. Although data from these sites is archived in the National Climate Database, it is not currently being submitted to international data archives.

New Zealand's Land Use and Carbon Analysis System (LUCAS) is being implemented to meet New Zealand's reporting requirements under the Kyoto Protocol. It includes a soil carbon monitoring system and the collection of native forest, shrubland, and planted forest measurements from permanent plots. Carbon stock changes are derived from these time-sequence measurements. As part of developing LUCAS, the national Land Cover Database has been updated using SPOT satellite images for the period 1990–2008.

The National Vegetation Survey database maintained by Landcare Research holds records from approximately 45,000 vegetation survey plots around New Zealand, including 12,000 permanent plots. Landcare Research also maintains five New Zealand long-term ecological research and monitoring sites, and also monitors the presence or range of self-advective fungal and insect species. The Ministry of Agriculture and Forestry maintains a planted forest cover database, and keeps records of carbon absorbed in new planting and lost through logging, fires and vegetation clearance.

A more comprehensive lake-monitoring network is being developed. Monitoring of Lake Taupo has resumed in collaboration with Ngati Tuwharetoa[120] and Environment Waikato,[121] and the data will be submitted to the GLEON database.[122] Measurements at Lake Rotorua and Lake Rotoiti are also being submitted to the GLEON database. Buoys have also been installed, or are about to be installed, in Lakes Tarawera, Tutira, Ngaroto and Waikaremoana.

Although there are no permafrost measurement sites in New Zealand, New Zealand is supporting measurements in Antarctica by the US Department of Agriculture and the University of Insubria (Italy). Seven soil climate-monitoring stations that monitor temperature to about 1.2 metres' depth are operated in the McMurdo Dry Valleys and Ross sea coast by Landcare Research in collaboration with the US Department of Agriculture (data is available at http://www.wcc.nrcs.usda.gov/scan/Antarctica/antarctica.html). Continuous monitoring data goes back as far as 1999. Two permafrost boreholes, with continuous temperature monitoring to 29.5 metres' depth, have now provided one full year of data. It is intended that the data from the permafrost boreholes will be made available to the GTN-p database. A study is underway to estimate New Zealand's permafrost in the Mt Cook area.

### 8.5.4 Observation, data and monitoring system support for developing countries

MetService, under a New Zealand government contract, provides general advice and technical assistance to the Cook Islands, Kiribati, Fiji, Tuvalu, Samoa, Tokelau, Tonga and Niue to ensure the continuity and integrity of climate data gathered in these countries as part of the Pacific Island GCOS programme. MetService, under a joint New Zealand–US GCOS Technical Support Programme, also provides general assistance and routine in-country technical preventive and emergency maintenance support to Global Upper Air Network stations in the Solomon Islands (Honiara), Papua New Guinea (Port Moresby), Vanuatu (Bauerfield) and Fiji (Nadi). The Technical Support Programme is supported under the New Zealand–US climate change partnership.

MetService, under a joint New Zealand–Met Office UK Pacific Trust Fund partnership, also provides technical assistance for the management and operation of the Global Upper Air Network stations in Tuvalu (Funafuti) and Kiribati (Tarawa). Targeted in-country technical training and observing practices are routinely carried out. MetService provides facilities for the global telecommunications systems (GTS) by maintaining a regional telecommunication hub on the GTS in Wellington for the purpose of relaying observations to and from Australia and the South Pacific Islands' national meteorological centres, and relaying forecasts, analyses and other products to and from Australia and New Zealand to Pacific Islands national meteorological centres. MetService also hosts the Pacific regional RAdio-InterNET (RANET) hub, serving as a back-up telecommunications system to the GTS.

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120 Ngati Tuwharetoa is an iwi whose tribal area covers a part of the central North Island, including Lake Taupo. An iwi is one of the larger collective Māori groupings and is sometimes described as a tribe. Māori are the indigenous people of New Zealand.

121 Environment Waikato is the regional council for the Waikato region in the North Island of New Zealand.

122 http://lakes.gleon.org/

# Education training and public awareness

9

# 9 Education, training and public awareness

This chapter outlines the activities that have been undertaken over the last four years to increase New Zealanders' awareness and understanding of climate change and encourage long-term behavioural change.

## 9.1 Public awareness campaigns and behavioural change

Since 2005, a number of public awareness campaigns have been introduced to improve New Zealanders' understanding of climate change and inspire people to take individual action. These campaigns were part of the key steps that comprised the Government's Towards a Sustainable New Zealand programme. They have been focused on informing New Zealanders about the actions they can take to reduce greenhouse gas emissions and ways to become more sustainable.

### 9.1.1 Household sustainability

The Household Sustainability Campaign was established in February 2007 and focused on practical ways for New Zealanders to improve energy efficiency and reduce waste and water usage in their homes. It also encouraged people to think about alternative modes of transport and offered tips for renovating the home to help with energy efficiency and insulation.

The programme was designed to build on a broad constituency of people who understood sustainability and were "ready to act". It also built on existing regional and community-based programmes. Key elements of the programme included:

- building partnerships with regional and local organisations to promote sustainable action
- an internet-based sustainability portal linking households to initiatives run by central government with other partners
- implementing a sustained cross-government information and awareness-raising programme
- designing a research programme to inform development of the programme and measure New Zealanders' changing knowledge of, attitudes and behaviour towards, sustainability.

The sustainability portal can be viewed at http://www.sustainability.govt.nz.

### 9.1.2 Business Partnerships for Sustainability

The Business Partnerships for Sustainability programme was designed with the aim of positioning New Zealand as a world-leading exponent of smart, innovative and business-savvy responses to environmental issues, leveraging off its "clean, green image" and reputation for business integrity. It also promoted awareness of the competitive advantages of sustainability.

The programme was established in 2007 and has worked through existing networks such as the New Zealand Business Council for Sustainable Development, the Chambers of Commerce and the Sustainable Business Network to enhance business sustainability programmes. Initial meetings

with business were held in June and July 2007, led by the Ministry for the Environment and Ministry of Economic Development. These Sustainable Business Workshops addressed:

- ways to improve information services for business on how consumer preferences are evolving in key market segments
- the investigation of New Zealand's market leadership potential in selected areas.

For more information on the Business Partnerships for Sustainability programme, go to: http://www.mfe.govt.nz/issues/sustainability/business-partnerships.html.

### 9.1.3 Govt$^3$

Govt$^3$ stands for the three foundations of sustainability: economic, social and environmental. The Govt$^3$ programme helped government organisations take practical steps to reduce their impact on the environment. Led by the Ministry for the Environment, the programme ran from 2005 until 2009, providing advice, guidance and tools to 58 state sector agencies. It promoted practical action and took a "learning by sharing" approach, whereby participating agencies learned from each other's experiences. It included regular network meetings and workshops, collaborations between government agencies and sectors, and the development of case studies and technical information.

Govt$^3$ has been discontinued, partly as a result of a reprioritisation of work programmes at the Ministry for the Environment, but also because there is a general expectation from the Government that state agencies will now undertake such environmental initiatives as part of their normal business. The end of the Ministry's leadership of Govt$^3$ does not therefore mean the end of the state sector's environmental responsibilities, which include:

- taking a "whole-of-life" approach when procuring goods and services
- minimising waste sent to landfill
- using resources such as energy and water more efficiently
- improving planning, design and construction when commissioning or operating buildings
- adopting transport policies that minimise agencies' environmental impact.

Govt$^3$ successfully established a culture of minimising the environmental impact of operations in the state sector. Highlights in 2007/08 (measured as average use per full-time equivalent for agencies with comparable data) include:

- energy use in buildings reduced by 10 per cent
- kilometres travelled for ground transport reduced by 4 per cent, and domestic air travel reduced by 4 per cent
- waste to landfill reduced by 16 per cent
- paper consumption reduced by 9 per cent, and virgin paper use reduced by 23 per cent.

### 9.1.4 Enhanced Sustainable Government Procurement

The purpose of the Enhanced Sustainable Government Procurement project is to make sustainability a core component of government procurement policy and practice. The project was established in 2007, led by the Ministry of Economic Development, and was aimed at ensuring the Government was leading by example when making purchasing decisions.

In August 2007, a National Framework for Sustainable Procurement was implemented, and standards were established for paper, timber and wood products; travel; and light fittings for public service departments. In 2008, a carbon-costing methodology and policy in all public service departments was also implemented.

The expected benefits of Enhanced Sustainable Government Procurement include:

- government activity producing less carbon and waste
- operational cost savings through better demand and waste management, and the use of more goods and services that are energy, water and resource efficient
- dissemination of knowledge and methods for incorporating sustainability considerations into procurement, both within and beyond the public sector
- improved availability of sustainable and innovative goods and services in New Zealand
- increased supply opportunities for innovative and sustainable New Zealand firms
- New Zealand firms gaining a competitive advantage by adopting sustainable practices and credentials.

### 9.1.5 Other public awareness initiatives

Other major government initiatives on climate change include the New Zealand Emissions Trading Scheme, the Sustainable Land Management and Climate Change Plan of Action, the New Zealand Energy Strategy, and the New Zealand Energy Efficiency and Conservation Strategy.

The Sustainable Land Management and Climate Change Plan of Action provides a platform for the Government to work in partnership with the agricultural, horticultural and forestry sectors, Māori and local government on climate change issues. This is critical to secure the changes in land-use practices needed for New Zealand to successfully adapt to changes in climate, reduce agricultural emissions and secure new forest planting.

In partnership with these sectors, the Plan of Action will deliver a communications programme to facilitate the delivery of factual information and key messages to the sectors and ensure sustained action over the medium to long term. A number of activities to improve public awareness and information about energy efficiency, the benefits of energy efficiency (for people's health, wealth and the environment), and existing government initiatives to promote energy efficiency have been undertaken.

The ENERGYWISE project, run by the Energy Efficiency and Conservation Authority, helps to educate people on how to make their homes more energy efficient and, in turn, make less of an impact on the environment. It sets out easy and cost-effective ways of doing this, encouraging people to do what they can, where they can. Government funding is also available to help people improve energy efficiency in their homes. Assistance is available to install insulation, clean heating systems, general energy efficiency measures, and solar water heating systems.

The Ecowise Travel Guide is a leaflet for tourists explaining how to reduce their greenhouse gas emissions and environmental impact when travelling in New Zealand. The leaflet is available on the New Zealand Tourism website (http://www.tourism.net.nz).

The Ministry of Transport ran a campaign called Choke the Smoke, which involved the introduction of a visible smoke check from October 2006 for vehicles when they are taken for a warrant or certificate of fitness. The information campaign tells the public about the changes

and why it is important to ensure vehicle emissions are reduced. It also outlines other measures that motorists can take to reduce their carbon footprint. More information can be found at http://www.transport.govt.nz/choke-the-smoke-index/.

### 9.1.6 Measuring behavioural change

In 2008, the Household Sustainability programme team conducted a survey aimed at providing a "snapshot" of New Zealanders' attitudes and behaviour in relation to being environmentally sustainable. Subjects of the survey included: using water efficiently, organic waste reduction, managing electrical waste, energy efficiency, transportation, building and renovating sustainably, and taking sustainability into account for purchasing decisions.

The survey was based on the UK's Department of Environment, Food and Rural Affairs' (Defra) framework for pro-environmental behaviours. Defra's approach prioritises specific actions or behaviours, based on evidence of their potential environmental impact and knowledge of households' willingness and ability to act. With the cooperation of Defra's Behaviours Unit, this research uses a similar method to segment the population based on pro-environmental behaviours and attitudes, as used in Defra's *Survey of Public Attitudes and Behaviours Toward the Environment 2007*.

The survey also served as an update to the results of the Household Sustainability Benchmark Survey, which was completed in November 2007. This survey covered New Zealanders' beliefs, attitudes and behaviour towards becoming sustainable, including: heating and general energy use, rubbish and waste, water use, purchasing groceries and other items, transport, and major purchases. The overarching objective of the benchmark survey was to measure the current situation as it relates to household sustainability in order to:

- measure New Zealanders' beliefs about, and attitudes and behaviour towards, becoming sustainable (or engaging in actions that are sustainable)
- inform the development of the Ministry for the Environment's information, awareness and public education programme based on the results of the survey (priority groups, key messages, communication channels, etc.)
- establish a benchmark for future monitoring and evaluation.

More information on the Household Sustainability Benchmark Survey can be found at http://www.mfe.govt.nz/publications/sus-dev/household-sustainability-benchmark-survey-feb08/html/index.html.

## 9.2 Education and public engagement

### 9.2.1 2020 target engagement

In July 2009, the Government announced that it was going to set a mid-term emissions reductions target for New Zealand and wanted to consult with the public about what it should be. The Minister Responsible for Climate Change Issues, Dr Nick Smith, held a series of public meetings around the country at which he discussed the key issues and invited public feedback. Over 1600 people attended these meetings and aired their views about the target. Members of the public also took part in an online forum with the Minister.[123]

[123] The transcript of the online discussion is available at http://www.r2.co.nz/20090720/

The Ministry for the Environment produced a brochure about the local and international aspects of climate change and encouraged the public to read it before the public meetings. The brochure can be read at http://www.mfe.govt.nz/publications/climate/nz-2020-emissions-target/index.html. After careful consideration, the Government decided that New Zealand is prepared to take on a responsibility target range of between 10 per cent and 20 per cent below 1990 levels by 2020, if there is a comprehensive global agreement. More details can be found at http://www.beehive.govt.nz/release/2020+target+balances+economy+amp+environment, and in section 4.3.1.

## 9.2.2 Raising awareness in schools

Students and teachers continue to be a key audience for building awareness of climate change because efforts in this area reach a wide audience. New Zealand has more than 2000 schools and each has an impact on the environment. The message conveyed to the schools as part of this work is that even by taking small actions, the education sector can make a real contribution.

Following are some of the programmes aimed at raising awareness of climate change and the steps schools can take to reduce its effects.

### Enviroschools

The Enviroschools programme takes a whole-school approach by involving students in planning, designing and taking action to create a sustainable school environment. It has been successful in educating more than 195,000 children each year about developing environmentally friendly habits for a sustainable future.

The Enviroschools Foundation comprises a governing trust board and a national management team. Their role involves strategic planning, building and maintaining a network of partnerships, and providing core support services to regions, including programme development, resources and professional development. Its purpose is to support the creation of sustainable schools such that the school grounds, operation, management and curriculum are all part of the sustainability process.

### Youth Environment Forum

The annual Youth Environment Forum was established in 2004. It provides an opportunity for up to 45 young people aged between 15 and 18 to take part in practical environmental projects, voice their opinion on environmental issues and learn firsthand about environmental management. The forum is hosted by the Ministry for the Environment in partnership with the Sir Peter Blake Trust, and many of the resulting projects have been focused on climate change.

Previous forum projects have included recycling cell phone and computer waste, household sustainability, climate change adaptation and coastal restoration. The delegates are encouraged to take what they learn from field trips, workshops and other activities back into their schools and communities.

### Schoolgen

Genesis Energy's Schoolgen programme, which receives financial backing from the Government, promotes energy awareness in schools. Through Schoolgen, Genesis Energy has installed photovoltaic solar panels in almost 33 schools around New Zealand.[124] The programme makes

[124] http://www.schoolgen.co.nz/

students and teachers more aware of what energy is, how energy is used, and how energy can be wasted. It teaches students about renewable energy, electricity generation, energy efficiency and climate change through classroom learning sessions on the solar panels they install.

### 9.2.3 World Environment Day 2008

When New Zealand hosted World Environment Day in June 2008, climate change was the central theme of the event. The theme, "Kick the Carbon habit – working towards a low-carbon economy", was an important recognition of today's global interdependence and the responsibility we all share for securing human welfare. Five core events were run and organised by the Ministry for the Environment, and more than 120 community events were subsidised by the Ministry.

A number of high-profile international guests and journalists were in New Zealand to help celebrate World Environment Day 2008. Dr Rajendra Pachauri, Chair of the IPCC; Achim Steiner, Executive Director of the United Nations Environment Programme; and President Tong of Kiribati were among the high-profile international guests who attended World Environment Day events. In partnership with New Zealand as the host country, the United Nations Environment Programme (UNEP) organised:

- the Art for the Environment Exhibition, with works from renowned international artists
- a photographic exhibition from the UNEP International Photographic Competition on the Environment
- an international children's painting competition.

In addition to these international events, and in conjunction with environmentally focused organisations throughout the country, a coordinated programme of national and regional events was developed and promoted through the World Environment Day website. Following is a selection of these.

- The Green Ribbon Awards, which are hosted annually on World Environment Day by the Ministry for the Environment, were held on 3 June at the Wellington Town Hall. The awards acknowledge the outstanding contribution New Zealanders are making to sustaining, protecting and enhancing our environment.[125]
- A business breakfast organised by the Business Council for Sustainable Development was held in Auckland on 4 June. The topic was "The challenges and opportunities for business presented by climate change". This was followed by a business symposium presented by the Victoria University of Wellington Institute of Policy Studies, in collaboration with the New Zealand Climate Change Research Institute. Achim Steiner also presented the lunchtime lecture, "Are we glimpsing the emergence of a green global economy?" at Auckland University.
- The first annual Hillary Symposium was held in Christchurch on 5 June. It marked the official launch of the Hillary Institute's theme for the next four years – climate change. Dr Rajenda Pachauri led the symposium.

[125] http://www.mfe.govt.nz/withyou/awards/green-ribbon.html

- "Lunchtime talk: How do we decarbonise the world?" was a panel discussion hosted by the Institute of Policy Studies and Climate Change Research Institute, and the School of Government, Victoria University of Wellington. Speakers at the discussion included Achim Steiner, Dr Rajendra Pachauri, President Anote Tong, and the Honourable David Parker, the former Minister Responsible for Climate Change Issues.

Schools and community groups also organised their own events and educational programmes to mark the occasion. Many of these had a long-term goal and will continue to be a part of the participants' regular activities. Tree planting, beach clean-ups, art exhibitions and debating competitions were just a few of the ways that New Zealand communities celebrated World Environment Day.

New Zealand's hosting of World Environment Day 2008 received a large amount of media coverage. In the lead-up to World Environment Day, a number of pieces were published or broadcast across all media. Media coverage focused on specific events, including those attended by New Zealand Government and UNEP officials. Numerous stories appeared, particularly in the print media, ahead of World Environment Day and there was good uptake of local news stories in regional "green pages".

### 9.2.4 Sustainable Management Fund

The Ministry for the Environment's Sustainable Management Fund is designed to encourage greater awareness of the environment by funding projects that support the Government's main environmental priorities. The fund encourages proactive partnerships and promotes community action towards meeting the challenges of climate change.

The climate change category was established in the 2005/06 funding round. The purpose of this category is to fund practical initiatives that increase the capacity of communities to adapt to the effects of climate change and to help understand their vulnerability to climate change impacts. Examples of some of the projects funded last year include a community-based carbon management and environmental offset scheme, a native forest revegetation project, and a dune restoration programme aimed at empowering coastal communities to adapt to climate change.

Twenty-seven applications have been funded since the introduction of the category. The total Sustainable Management Fund funding granted for these projects is $2.7 million. More details on the fund can be found at http://www.mfe.govt.nz/withyou/funding/smf/ index.html.

### 9.2.5 Sustainable Farming Fund

The Ministry of Agriculture and Forestry's Sustainable Farming Fund is designed to support the financial, environmental and social performance of New Zealand's productive land-based sectors. The Sustainable Farming Fund was boosted in 2007 to include a climate change dimension, covering adaptation and mitigation. The Sustainable Farming Fund selects projects that are:

- based around solving problems, or taking up opportunities, related to sustainable resource use
- defined and driven by a farmer, grower or forester-led Community of Interest. These are groups of stakeholders drawn together by common problems or opportunities.

More information can be found here http://www.maf.govt.nz/sff/

### 9.2.6 Emissions Trading Scheme

Officials from the Treasury, the Ministry of Agriculture and Forestry, the Ministry for the Environment, the Ministry of Transport, and Te Puni Kōkiri have worked together to develop key messages and to help stakeholders to fully understand the broad implications of the New Zealand Emissions Trading Scheme (NZ ETS) as government policy has been developed. A number of information sheets about the NZ ETS were published outlining how it would affect different sectors. These information sheets are available online at http://www.mfe.govt.nz/publications/climate/#emissions.

A Parliamentary Select Committee reviewed the NZ ETS in 2009. As part of this process, members of the public were invited to make submissions to the committee. The review provided a forum for public input and participation in the policy process.

The Ministry for the Environment hosted a Voluntary Carbon Markets Workshop in August 2008. The workshop was attended by more than 100 people from New Zealand's industrial, energy, financial, legal and consulting sectors. The purpose of the workshop was to:

- share the experiences of those involved in the voluntary carbon market in New Zealand
- identify opportunities for New Zealand businesses in the voluntary carbon market
- encourage debate around the drivers to enter, and the challenges posed by, the voluntary carbon market
- encourage credible and innovative responses to these challenges and opportunities.

The presentations and debate were extremely informative and insightful and showed the need for further discussion on such challenging issues as whether emissions reduction efforts with double beneficiaries can be considered credible, and whether the proposed NZ ETS will make covered sectors "carbon neutral".

### 9.2.7 Educating the media

The Ministry for the Environment has been proactive in educating media outlets about climate change so that journalists can present current affairs on climate issues in a more informed way. An example is a workshop held between Radio New Zealand and the Ministry for the Environment on what the Government's climate change policy is and how the NZ ETS would work. The purpose was to help journalists to understand where arguments for and against the policy are coming from.

Discussions are also progressing with the television network TVNZ over potential programmes on climate change, with particular focus on the actions householders and businesses can take to reduce their climate change impact and adapt to the climatic changes that New Zealand will likely experience. This will heighten consumer awareness already achieved through television programmes such as *Wa$ted* and *Mitre10 Dream Home*.

*Mitre 10 Dream Home* is a reality television series that follows the experience of two couples in creating their dream home. The Energy Efficiency and Conservation Authority and its ENERGYWISE programme played an important role in the development of the series. *Wa$ted* is another reality television series aimed at encouraging people to adopt environmentally friendly habits. The programme helps New Zealand families to audit their waste and energy usage while showing them the long-term impacts of their behaviour and how to minimise their impact. *Wa$ted* is supported by the Energy Efficiency and Conservation Authority and the Ministry for the Environment.

Government climate scientists from our two chief meteorological agencies have made themselves available to the media to publicly comment on climate change issues. These are primarily scientists from MetService and NIWA.

### 9.2.8 Educating businesses

The government agency New Zealand Trade and Enterprise runs sustainability workshops through its Enterprise Training Scheme, a programme for up-skilling businesses. These workshops are designed to educate small- to medium-sized companies about sustainable business practices and to help them develop more sustainable strategies and processes. They are run in many centres around the country at no cost.[126]

### 9.2.9 Climate change adaptation work programme

The Government's climate change adaptation work programme has developed a range of informative guidance materials on the impacts of climate change and how New Zealanders can adapt to, and prepare for, these impacts. These publications are discussed in section 6.4.1. The Quality Planning website at http://www.qualityplanning.org.nz/plan-topics/climate-change.php provides information on expected climate change impacts in New Zealand and advice on methods for considering and addressing climate change effects under the Resource Management Act.

The Ministry of Agriculture and Forestry is working closely with land-based sectors, local government and Māori under the Plan of Action to ensure effective change can occur on the ground. Action to date includes raising awareness; working with industry groups and education providers; and developing case studies, fact sheets, learning packages and information sheets.

### 9.2.10 International engagement

The New Zealand Government has been active in promoting climate change to a broader regional audience. In 2007, following the release of the IPCC's Fourth Assessment Report, two of New Zealand's lead authors and contributors promoted the report at workshops around the Pacific. Their attendance was supported financially by the New Zealand Ministry for the Environment. The workshops were organised by the Secretariat of the Pacific Islands GeoScience Commission (SOPAC)[127] and the South Pacific Regional Environment Programme (SPREP).[128]

At the workshops, scientists from MetService and NIWA gave presentations and participated in panel discussions about the Fourth Assessment Report and what it means for Pacific Island communities. The workshops provided an opportunity for senior government representatives, non-government organisations and members of the public to discuss the most recent scientific findings on climate change, the likely impacts of climate extremes and changes, and the Pacific region's response. Workshop participants also discussed the best ways to progress IPCC outreach activities in the Pacific with other regional stakeholders, including SPREP, SOPAC, the Australian Greenhouse Office and the Australian Bureau of Meteorology.

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126 http://www.nzte.govt.nz/access-international-networks/Explore-opportunities-in-growth-industries/new-global-business-trends/Pages/Sustainability.aspx

127 http://www.sopac.org/tiki-index.php

128 http://www.sprep.org/

## 9.3 Websites and publications

An increase in awareness of environmental issues, as shown through research and evaluation, has brought about a stronger demand for information on practical actions that New Zealanders can take to reduce the effects of climate change. The Government has provided information on the science and impacts of climate change and specific actions that people can take to reduce greenhouse gas emissions through a variety of websites and publications. Two key websites are the sustainability website (http://www.sustainability.govt.nz) and the climate change website (http://www.climatechange.govt.nz).

### 9.3.1 Publications

#### Guidance manuals for local government

The Ministry for the Environment has produced several manuals to guide local authorities on how to plan for the expected impacts of climate change. The two most important are *Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand*, and *Coastal Hazards and Climate Change*. More detail on these manuals can be found in chapter 6.

#### Climate Change and Long-term Council Community Planning

This publication provides an overview of how local authorities can incorporate climate change into Long-term Council Community Plans and provides links to more detailed information and guidance. The Plans set out the activities for councils and provide a long-term focus for their decision-making. The Ministry for the Environment has also released information on its website that provides guidance to local government about climate change. This can be found at http://www.mfe.govt.nz/publications/climate/ climate-change-long-term-planning/index.html.

#### Climate change publications for the general public

The Ministry for the Environment has developed three booklets to educate the general public about climate change: *Understanding Climate Change*, *Taking Action on Climate Change* and *Preparing for and Adapting to Climate Change*. These publications explore the science of climate change and its potential impact, and provide tips for reducing emissions. They were distributed at no charge to local government, libraries, non-government agencies, at events, and to other government agencies to provide to their stakeholders. They are also available online: http://www.mfe.govt.nz/publications/climate/#general.

#### New Zealand's 2020 Emissions Target

This brochure provides information about climate change and New Zealand's emissions to help people develop an informed opinion about what New Zealand's 2020 emissions target should be. The Ministry for the Environment produced the publication for a series of public meetings held by the Minister Responsible for Climate Change Issues around the country in July 2009 (see also section 9.2.1). The brochure sets out the causes and likely impacts of climate change, provides an introduction to the international response to climate change, and gives details of New Zealand's emission trends and profile, as well as detailing other countries' announced targets. It is available at: http://www.mfe.govt.nz/publications/climate/nz-2020-emissions-target/index.html. The Minister's PowerPoint presentations are also available online at: http://www.mfe.govt.nz/issues/climate/emissions-target-2020/index.html.

### ENZ 07

Climate change was a feature in the *Environment New Zealand 2007* report, which was launched in December 2007. This report is the second national-level state of New Zealand's environment report. It takes the pulse of the physical well-being of New Zealand's land, water, air, plants and animals, and measures the impact of transport, energy, waste and our consumption on the environment. It identifies trends in, and selected pressures on, our natural resources and introduces benchmark environmental indicators, as well as 80 specific measures to capture hard data, which will be used to build a clear picture of trends and pressures over time.

Although not dedicated to climate change policy, significant components of the analysis are directly related to the issue. It also provides a wider environmental context for developing the future direction of climate change policy. The *Environment New Zealand 2007* report can be found at http://www.mfe.govt.nz/publications/ser/enz07-dec07.

## 9.3.2 Other resources and educational tools

### Climate change DVD

With the support of the Government, the non-governmental organisation Communities for Climate Protection has developed a DVD for councils to support them in educating their communities about climate change. The DVD, *Climate Change: We Can Make a Difference*, looks at the science of climate change and emphasises the importance of acting now.

### Online carbon footprint calculators

The carboNZero programme was established in 2001 by Landcare Research, a Crown research institute. The goal of the programme is to provide robust tools for individuals and organisations to reduce their greenhouse gas emissions or carbon footprint with the highest level of credibility and integrity. As part of the programme, Landcare Research developed online tools to educate consumers and encourage them to reduce their emissions. These online calculators can be used to calculate the approximate carbon footprint of homes, schools and businesses. They are available at http://www.carbonzero.co.nz/calculators/index.asp.

## 9.3.3 Websites

### Climate change website

The Government's Climate Change Solutions website was established in November 2008 as a key source for climate change information. The website contains information about climate change, including the causes of, the evidence for, and the effects of climate change. It describes the key government policies to reduce emissions and the work being done to help people prepare for, and adapt to, climate change. It also acts as a portal to a number of other government and non-government organisations involved in climate change work. The climate change website can be found at http://www.climatechange.govt.nz.

### Sustainability website

The sustainability website has been active since February 2007 and has information on how climate change will affect New Zealand, how New Zealand contributes to climate change, what New Zealanders can do about climate change, and what they need to do to be prepared. It also outlines what the Government is doing about climate change. The site is a key resource for the kind of grassroots action – both small and large – people can take on a wide range of environmental issues. The site can be found at: http://www.sustainability.govt.nz.

## 4 Million Careful Owners

The 4 Million Careful Owners website and brand are no longer in use. From its inception in December 2003, the website housed information about climate change, ways to take action, and examples of initiatives underway across New Zealand to reduce greenhouse gas emissions and the effects of climate change. The website was designed to be interactive and contained educational information and tools for schools to use. With the development of the Government's new public education programmes this website has been subsumed by the sustainability and climate change websites.

## Online ecolabel directory

The Ministry of Economic Development has created an online directory to improve the availability of information about ecolabels and other sustainability indicators to consumers, suppliers and other organisations. It provides summary information about each label, and users are encouraged to access further detail from ecolabel owner websites using the links provided. The directory is available at: http://www.med.govt.nz/ ecolabels.

## Environmental sustainability and cars

The Land Transport Agency has developed two websites for consumers and businesses to encourage them to consider environmental sustainability when purchasing a car, and to promote actions to cut down on fuel use while driving: see http://www.rightcar.govt.nz/ and http://www.fuelsaver.govt.nz/.

## Other key website links

- At http://www.mfe.govt.nz/issues/climate – all of the climate change issues from mitigation to impacts and assessment are described.
- At http://www.mfe.govt.nz/issues/climate/resources/adaptation/index.html#schools – information is provided for schools about what they can do to adapt to the impacts of climate change.
- At https://www.eur.govt.nz/eats/nz – the Emission Unit Register allows people to manage the accounting, reporting and reconciliation of emission unit holdings and transactions as part of the NZ ETS and to meet New Zealand's commitments and obligations under the Kyoto Protocol.
- At http://www.maf.govt.nz/climatechange – the Ministry of Agriculture and Forestry's website explains what climate change means for the rural sector and has links to forestry and agriculture in the NZ ETS, sustainable forestry and sustainable land management, international climate change, and legislation and regulation.
- At http://www.climatechange.govt.nz/carbon-reports/reports.html#greenhousegas – New Zealand's actual and projected greenhouse gas emissions, by sources and removals by sinks, are shown.
- At http://www.climatechange.govt.nz/emissions-trading-scheme/index.html – the NZ ETS is described in detail.
- At http://www.transit.govt.nz/planning/climate.jsp – Transit New Zealand outlines its climate change adaptation planning.

Links to other government ministries and departments with important climate change programmes are available at http://www.climatechange.govt.nz/reducing-our-emissions/who-does-what.html.

# Annex A: Summary of emissions and removals from New Zealand's 2007 national inventory

Common Reporting Format for the provision of inventory information by Annex I Parties to the UNFCCC.

**Table A.1: Emission trends ($CO_2$ – Part 1 of 2)**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | Base year (1990) | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) |
| **1. Energy** | **22,593.02** | **22,999.98** | **24,719.15** | **24,075.12** | **24,271.89** | **24,180.93** | **25,205.05** | **27,556.99** | **26,026.65** | **27,098.59** |
| A. Fuel Combustion (Sectoral Approach) | 21,953.11 | 22,273.51 | 24,023.50 | 23,407.63 | 23,554.30 | 23,495.74 | 24,505.46 | 26,800.33 | 25,299.20 | 26,419.47 |
| 1. Energy Industries | 6,006.15 | 6,099.19 | 7,452.38 | 6,522.76 | 5,399.31 | 4,670.56 | 5,236.55 | 6,840.30 | 5,137.73 | 6,394.07 |
| 2. Manufacturing Industries and Construction | 4,527.24 | 4,923.62 | 4,623.58 | 4,767.03 | 5,108.63 | 5,031.21 | 5,528.13 | 5,904.49 | 5,976.96 | 5,465.66 |
| 3. Transport | 8,616.96 | 8,623.48 | 9,086.85 | 9,441.46 | 10,132.76 | 10,855.47 | 10,935.36 | 11,289.55 | 11,476.63 | 11,695.58 |
| 4. Other Sectors | 2,802.76 | 2,627.22 | 2,860.69 | 2,676.37 | 2,913.60 | 2,938.49 | 2,805.43 | 2,765.98 | 2,707.88 | 2,864.15 |
| 5. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| B. Fugitive Emissions from Fuels | 639.91 | 726.47 | 695.64 | 667.49 | 717.59 | 685.20 | 699.59 | 756.66 | 727.46 | 679.12 |
| 1. Solid Fuels | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE |
| 2. Oil and Natural Gas | 639.91 | 726.47 | 695.64 | 667.49 | 717.59 | 685.20 | 699.59 | 756.66 | 727.46 | 679.12 |
| **2. Industrial Processes** | **2,731.64** | **2,867.48** | **2,984.73** | **3,052.80** | **2,937.20** | **3,016.00** | **2,981.75** | **2,921.62** | **3,019.50** | **3,214.75** |
| A. Mineral Products | 547.53 | 557.92 | 633.17 | 630.86 | 609.84 | 658.27 | 630.08 | 679.10 | 635.22 | 711.40 |
| B. Chemical Industry | 429.96 | 446.78 | 401.95 | 427.98 | 449.62 | 422.77 | 409.74 | 440.81 | 479.14 | 526.01 |
| C. Metal Production | 1,754.14 | 1,862.77 | 1,949.62 | 1,993.96 | 1,877.75 | 1,934.96 | 1,941.93 | 1,801.71 | 1,905.14 | 1,977.34 |
| D. Other Production | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| E. Production of Halocarbons and $SF_6$ | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| F. Consumption of Halocarbons and $SF_6$ | | | | | | | | | | |
| G. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **3. Solvent and Other Product Use** | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE |
| **4. Agriculture** | | | | | | | | | | |
| A. Enteric Fermentation | | | | | | | | | | |
| B. Manure Management | | | | | | | | | | |
| C. Rice Cultivation | | | | | | | | | | |
| D. Agricultural Soils | | | | | | | | | | |
| E. Prescribed Burning of Savannas | | | | | | | | | | |
| F. Field Burning of Agricultural Residues | | | | | | | | | | |
| G. Other | | | | | | | | | | |
| **5. Land Use, Land-Use Change and Forestry[(1)]** | **-18,194.00** | **-17,326.36** | **-15,212.18** | **-14,974.00** | **-15,971.87** | **-15,958.28** | **-16,723.85** | **-18,684.68** | **-18,920.57** | **-19,203.66** |
| A. Forest Land | -18,673.84 | -17,829.45 | -15,741.51 | -15,537.54 | -16,574.61 | -16,550.02 | -17,306.99 | -19,311.81 | -19,591.68 | -19,918.75 |
| B. Cropland | -478.29 | -479.99 | -481.50 | -482.52 | -483.23 | -487.04 | -490.70 | -491.12 | -491.54 | -491.96 |
| C. Grassland | 833.51 | 857.64 | 884.58 | 919.00 | 958.09 | 950.08 | 944.32 | 987.91 | 1,031.50 | 1,075.08 |
| D. Wetlands | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 |
| E. Settlements | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 |
| F. Other Land | 26.74 | 27.56 | 28.37 | 29.19 | 30.01 | 30.82 | 31.64 | 32.45 | 33.27 | 34.08 |
| G. Other | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE |
| **6. Waste** | **12.91** | **12.91** | **12.90** | **12.78** | **12.78** | **12.62** | **12.25** | **12.16** | **12.05** | **11.41** |
| A. Solid Waste Disposal on Land | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO |
| B. Waste-water Handling | | | | | | | | | | |
| C. Waste Incineration | 12.91 | 12.91 | 12.90 | 12.78 | 12.78 | 12.62 | 12.25 | 12.16 | 12.05 | 11.41 |
| D. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| **7. Other *(as specified in Summary 1.A)*** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total $CO_2$ emissions including net $CO_2$ from LULUCF** | **7,143.57** | **8,554.01** | **12,504.60** | **12,166.71** | **11,250.00** | **11,251.27** | **11,475.19** | **11,806.09** | **10,137.63** | **11,121.10** |
| **Total $CO_2$ emissions excluding net $CO_2$ from LULUCF** | **25,337.57** | **25,880.37** | **27,716.78** | **27,140.71** | **27,221.88** | **27,209.55** | **28,199.04** | **30,490.77** | **29,058.20** | **30,324.75** |
| | | | | | | | | | | |
| **Memo Items:** | | | | | | | | | | |
| **International Bunkers** | **2,368.07** | **2,190.12** | **2,170.07** | **2,239.94** | **2,786.98** | **2,702.23** | **2,717.16** | **2,827.19** | **2,780.47** | **2,762.34** |
| Aviation | 1,338.17 | 1,277.75 | 1,306.31 | 1,327.12 | 1,439.10 | 1,571.00 | 1,640.65 | 1,710.77 | 1,706.14 | 1,846.61 |
| Marine | 1,029.90 | 912.38 | 863.76 | 912.82 | 1,347.88 | 1,131.24 | 1,076.51 | 1,116.42 | 1,074.33 | 915.73 |
| **Multilateral Operations** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **$CO_2$ Emissions from Biomass** | 2,601.53 | 2,793.90 | 2,663.03 | 2,693.75 | 3,168.15 | 3,198.42 | 3,142.70 | 2,957.60 | 3,088.86 | 3,802.58 |

All footnotes for this table are provided at the end of the table on page 184.

### Table A.1: Emission trends ($CO_2$ – Part 2 of 2)

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Change from base to latest reported year |
|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | % |
| **1. Energy** | **27,908.10** | **29,725.00** | **29,817.34** | **31,417.18** | **30,739.49** | **32,349.66** | **32,743.51** | **31,559.93** | **39.69** |
| A. Fuel Combustion (Sectoral Approach) | 27,271.30 | 29,040.87 | 29,150.86 | 30,718.62 | 29,804.99 | 31,381.90 | 31,743.53 | 30,503.89 | 38.95 |
| 1. Energy Industries | 6,061.79 | 7,280.48 | 6,472.07 | 7,699.40 | 7,290.11 | 9,318.40 | 9,325.92 | 7,845.32 | 30.62 |
| 2. Manufacturing Industries and Construction | 5,734.96 | 5,881.84 | 6,221.17 | 6,016.57 | 5,082.13 | 4,746.25 | 5,043.79 | 5,313.75 | 17.37 |
| 3. Transport | 12,273.14 | 12,640.00 | 13,210.90 | 13,820.98 | 14,170.26 | 14,326.48 | 14,541.45 | 14,661.44 | 70.15 |
| 4. Other Sectors | 3,201.41 | 3,238.54 | 3,246.73 | 3,181.67 | 3,262.49 | 2,990.77 | 2,832.37 | 2,683.39 | -4.26 |
| 5. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| B. Fugitive Emissions from Fuels | 636.80 | 684.13 | 666.48 | 698.55 | 934.49 | 967.76 | 999.97 | 1,056.04 | 65.03 |
| 1. Solid Fuels | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | 0.00 |
| 2. Oil and Natural Gas | 636.80 | 684.13 | 666.48 | 698.55 | 934.49 | 967.76 | 999.97 | 1,056.04 | 65.03 |
| **2. Industrial Processes** | **3,174.28** | **3,270.07** | **3,278.65** | **3,483.90** | **3,450.80** | **3,499.06** | **3,498.43** | **3,670.62** | **34.37** |
| A. Mineral Products | 702.01 | 700.93 | 698.96 | 689.68 | 660.17 | 749.55 | 713.59 | 860.38 | 57.14 |
| B. Chemical Industry | 512.50 | 555.32 | 537.68 | 572.60 | 553.70 | 558.50 | 616.86 | 584.95 | 36.05 |
| C. Metal Production | 1,959.77 | 2,013.81 | 2,042.01 | 2,221.63 | 2,236.93 | 2,191.01 | 2,167.98 | 2,225.29 | 26.86 |
| D. Other Production | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| E. Production of Halocarbons and $SF_6$ | | | | | | | | | |
| F. Consumption of Halocarbons and $SF_6$ | | | | | | | | | |
| G. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| **3. Solvent and Other Product Use** | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | 0.00 |
| **4. Agriculture** | | | | | | | | | |
| A. Enteric Fermentation | | | | | | | | | |
| B. Manure Management | | | | | | | | | |
| C. Rice Cultivation | | | | | | | | | |
| D. Agricultural Soils | | | | | | | | | |
| E. Prescribed Burning of Savannas | | | | | | | | | |
| F. Field Burning of Agricultural Residues | | | | | | | | | |
| G. Other | | | | | | | | | |
| **5. Land Use, Land-Use Change and Forestry[(1)]** | **-20,026.32** | **-20,409.44** | **-20,084.30** | **-21,291.41** | **-24,911.95** | **-25,337.90** | **-23,940.25** | **-23,915.12** | **31.45** |
| A. Forest Land | -20,785.40 | -21,212.49 | -20,860.61 | -22,006.78 | -25,646.16 | -26,039.91 | -24,595.71 | -24,565.23 | 31.55 |
| B. Cropland | -492.38 | -492.79 | -497.57 | -504.45 | -506.42 | -511.53 | -517.53 | -520.99 | 8.93 |
| C. Grassland | 1,118.67 | 1,162.25 | 1,139.48 | 1,084.59 | 1,104.59 | 1,076.68 | 1,035.31 | 1,032.61 | 23.89 |
| D. Wetlands | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| E. Settlements | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 97.16 | 0.00 |
| F. Other Land | 34.90 | 35.72 | 36.53 | 37.35 | 38.16 | 38.98 | 39.80 | 40.61 | 51.86 |
| G. Other | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | 0.00 |
| **6. Waste** | **5.89** | **5.89** | **5.31** | **4.73** | **4.48** | **3.63** | **2.42** | **0.93** | **-92.78** |
| A. Solid Waste Disposal on Land | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | 0.00 |
| B. Waste-water Handling | | | | | | | | | |
| C. Waste Incineration | 5.89 | 5.89 | 5.31 | 4.73 | 4.48 | 3.63 | 2.42 | 0.93 | -92.78 |
| D. Other | NO | NO | NO | NO | NO | NO | NO | NO | 0.00 |
| **7. Other *(as specified in Summary 1.A)*** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **0.00** |
| | | | | | | | | | |
| **Total $CO_2$ emissions including net $CO_2$ from LULUCF** | **11,061.95** | **12,591.52** | **13,017.01** | **13,614.40** | **9,282.81** | **10,514.45** | **12,304.10** | **11,316.37** | **58.41** |
| **Total $CO_2$ emissions excluding net $CO_2$ from LULUCF** | **31,088.27** | **33,000.95** | **33,101.31** | **34,905.81** | **34,194.76** | **35,852.35** | **36,244.36** | **35,231.49** | **39.05** |
| | | | | | | | | | |
| **Memo Items:** | | | | | | | | | |
| **International Bunkers** | **2,480.57** | **2,609.41** | **2,913.20** | **3,248.83** | **3,338.96** | **3,612.06** | **3,597.23** | **3,589.97** | **51.60** |
| Aviation | 1,733.15 | 1,798.68 | 1,860.47 | 2,394.40 | 2,611.08 | 2,629.97 | 2,640.66 | 2,611.91 | 95.18 |
| Marine | 747.42 | 810.73 | 1,052.73 | 854.43 | 727.88 | 982.10 | 956.57 | 978.06 | -5.03 |
| **Multilateral Operations** | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| **$CO_2$ Emissions from Biomass** | 3,883.80 | 3,919.33 | 4,154.55 | 4,206.84 | 4,396.49 | 4,670.61 | 4,705.19 | 4,822.42 | 85.37 |

All footnotes for this table are provided at the end of the table on page 184.

## Table A.2: Emissions trends ($CH_4$ – Part 1 of 2)

Inventory 2007 Submission 2009 v1.2 NEW ZEALAND

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | Base year (1990) | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) |
| **1. Energy** | 34.11 | 28.94 | 28.23 | 27.48 | 29.72 | 32.46 | 32.73 | 34.77 | 38.54 | 40.78 |
| A. Fuel Combustion (Sectoral Approach) | 5.97 | 5.68 | 5.32 | 5.16 | 5.02 | 4.84 | 4.60 | 4.53 | 4.38 | 4.23 |
| 1. Energy Industries | 0.26 | 0.28 | 0.31 | 0.29 | 0.24 | 0.19 | 0.22 | 0.27 | 0.20 | 0.26 |
| 2. Manufacturing Industries and Construction | 0.37 | 0.40 | 0.37 | 0.38 | 0.46 | 0.47 | 0.48 | 0.47 | 0.50 | 0.58 |
| 3. Transport | 3.34 | 3.35 | 3.29 | 3.22 | 3.05 | 2.90 | 2.67 | 2.55 | 2.43 | 2.19 |
| 4. Other Sectors | 2.00 | 1.65 | 1.34 | 1.27 | 1.27 | 1.28 | 1.24 | 1.24 | 1.25 | 1.20 |
| 5. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| B. Fugitive Emissions from Fuels | 28.15 | 23.25 | 22.91 | 22.31 | 24.70 | 27.62 | 28.13 | 30.24 | 34.15 | 36.55 |
| 1. Solid Fuels | 12.96 | 8.73 | 9.04 | 8.61 | 10.19 | 13.47 | 13.94 | 13.88 | 16.26 | 16.84 |
| 2. Oil and Natural Gas | 15.19 | 14.52 | 13.87 | 13.71 | 14.52 | 14.15 | 14.19 | 16.36 | 17.89 | 19.71 |
| **2. Industrial Processes** | **0.96** | **1.64** | **1.39** | **1.56** | **1.96** | **2.75** | **3.69** | **3.81** | **3.59** | **4.13** |
| A. Mineral Products | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| B. Chemical Industry | 0.96 | 1.64 | 1.39 | 1.56 | 1.96 | 2.75 | 3.69 | 3.81 | 3.59 | 4.13 |
| C. Metal Production | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO |
| D. Other Production | | | | | | | | | | |
| E. Production of Halocarbons and $SF_6$ | | | | | | | | | | |
| F. Consumption of Halocarbons and $SF_6$ | | | | | | | | | | |
| G. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **3. Solvent and Other Product Use** | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **4. Agriculture** | **1,067.70** | **1,067.56** | **1,045.34** | **1,053.20** | **1,081.82** | **1,089.94** | **1,100.96** | **1,125.64** | **1,101.46** | **1,115.83** |
| A. Enteric Fermentation | 1,039.00 | 1,038.64 | 1,016.59 | 1,023.80 | 1,051.04 | 1,058.39 | 1,068.73 | 1,092.70 | 1,068.94 | 1,083.52 |
| B. Manure Management | 27.56 | 27.87 | 27.81 | 28.31 | 29.68 | 30.64 | 31.16 | 31.74 | 31.48 | 31.29 |
| C. Rice Cultivation | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| D. Agricultural Soils | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO |
| E. Prescribed Burning of Savannas | 0.13 | 0.15 | 0.11 | 0.11 | 0.08 | 0.05 | 0.07 | 0.06 | 0.03 | 0.03 |
| F. Field Burning of Agricultural Residues | 1.02 | 0.90 | 0.83 | 0.97 | 1.01 | 0.86 | 1.00 | 1.14 | 1.01 | 0.99 |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| **5. Land Use, Land-Use Change and Forestry** | **2.38** | **2.32** | **2.79** | **2.79** | **3.17** | **2.68** | **2.93** | **2.57** | **2.42** | **2.35** |
| A. Forest Land | 1.06 | 1.01 | 1.48 | 1.48 | 1.86 | 1.37 | 1.61 | 1.26 | 1.11 | 1.04 |
| B. Cropland | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| C. Grassland | 1.31 | 1.31 | 1.31 | 1.31 | 1.31 | 1.31 | 1.31 | 1.31 | 1.31 | 1.31 |
| D. Wetlands | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO |
| E. Settlements | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| F. Other Land | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| G. Other | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE |
| **6. Waste** | **108.10** | **109.63** | **108.01** | **109.10** | **108.36** | **99.27** | **100.30** | **99.83** | **96.70** | **90.09** |
| A. Solid Waste Disposal on Land | 98.25 | 99.52 | 97.81 | 98.79 | 97.89 | 88.66 | 89.54 | 88.97 | 85.94 | 79.44 |
| B. Waste-water Handling | 9.85 | 10.11 | 10.21 | 10.31 | 10.47 | 10.61 | 10.76 | 10.86 | 10.76 | 10.65 |
| C. Waste Incineration | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| **7. Other *(as specified in Summary 1.A)*** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| | | | | | | | | | | |
| **Total $CH_4$ emissions including $CH_4$ from LULUCF** | **1,213.26** | **1,210.09** | **1,185.77** | **1,194.12** | **1,225.03** | **1,227.10** | **1,240.61** | **1,266.62** | **1,242.70** | **1,253.17** |
| **Total $CH_4$ emissions excluding $CH_4$ from LULUCF** | **1,210.88** | **1,207.76** | **1,182.98** | **1,191.33** | **1,221.85** | **1,224.42** | **1,237.68** | **1,264.05** | **1,240.28** | **1,250.82** |
| | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Memo Items:** | | | | | | | | | | |
| **International Bunkers** | 0.13 | 0.12 | 0.12 | 0.12 | 0.17 | 0.15 | 0.15 | 0.15 | 0.15 | 0.14 |
| Aviation | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 |
| Marine | 0.10 | 0.09 | 0.08 | 0.09 | 0.13 | 0.11 | 0.10 | 0.10 | 0.10 | 0.08 |
| **Multilateral Operations** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | |

All footnotes for this table are provided at the end of the table on page 184.

## Table A.2: Emission trends ($CH_4$ – Part 2 of 2)

Inventory 2007 Submission 2009 v1.2 NEW ZEALAND

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Change from base to latest reported year |
|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | % |
| **1. Energy** | 41.05 | 43.09 | 42.75 | 41.96 | 40.48 | 41.00 | 47.52 | 39.61 | 16.12 |
| A. Fuel Combustion (Sectoral Approach) | 5.75 | 5.76 | 5.83 | 5.98 | 6.01 | 6.03 | 6.00 | 6.04 | 1.24 |
| 1. Energy Industries | 0.25 | 0.29 | 0.25 | 0.24 | 0.18 | 0.24 | 0.25 | 0.27 | 4.94 |
| 2. Manufacturing Industries and Construction | 0.52 | 0.53 | 0.57 | 0.56 | 0.58 | 0.60 | 0.60 | 0.62 | 68.96 |
| 3. Transport | 2.23 | 2.29 | 2.41 | 2.52 | 2.58 | 2.55 | 2.57 | 2.63 | -21.25 |
| 4. Other Sectors | 2.75 | 2.65 | 2.60 | 2.66 | 2.67 | 2.65 | 2.58 | 2.52 | 25.89 |
| 5. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| B. Fugitive Emissions from Fuels | 35.29 | 37.33 | 36.93 | 35.98 | 34.46 | 34.96 | 41.52 | 33.57 | 19.27 |
| 1. Solid Fuels | 16.19 | 16.97 | 16.86 | 15.82 | 14.85 | 14.57 | 21.44 | 12.47 | -3.78 |
| 2. Oil and Natural Gas | 19.10 | 20.36 | 20.07 | 20.16 | 19.61 | 20.39 | 20.08 | 21.10 | 38.94 |
| **2. Industrial Processes** | **4.82** | **4.26** | **4.56** | **1.94** | **2.18** | **0.69** | **0.81** | **0.87** | **-9.44** |
| A. Mineral Products | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| B. Chemical Industry | 4.82 | 4.26 | 4.56 | 1.94 | 2.18 | 0.69 | 0.81 | 0.87 | -9.44 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C. Metal Production | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | IE,NA,NE, NO | 0.00 |
| D. Other Production | | | | | | | | | |
| E. Production of Halocarbons and $SF_6$ | | | | | | | | | |
| F. Consumption of Halocarbons and $SF_6$ | | | | | | | | | |
| G. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| **3. Solvent and Other Product Use** | | | | | | | | | |
| **4. Agriculture** | **1,150.68** | **1,157.98** | **1,149.67** | **1,165.15** | **1,164.38** | **1,174.89** | **1,178.54** | **1,146.17** | **7.35** |
| A. Enteric Fermentation | 1,116.99 | 1,123.62 | 1,114.94 | 1,129.23 | 1,128.84 | 1,139.89 | 1,143.31 | 1,110.78 | 6.91 |
| B. Manure Management | 32.66 | 33.22 | 33.55 | 34.80 | 35.04 | 34.38 | 34.69 | 34.72 | 25.99 |
| C. Rice Cultivation | NO | NO | NO | NO | NO | NO | NO | NO | 0.00 |
| D. Agricultural Soils | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | 0.00 |
| E. Prescribed Burning of Savannas | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | -68.00 |
| F. Field Burning of Agricultural Residues | 0.98 | 1.11 | 1.13 | 1.07 | 0.46 | 0.58 | 0.50 | 0.63 | -38.46 |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO | 0.00 |
| **5. Land Use, Land-Use Change and Forestry** | **2.09** | **1.91** | **1.87** | **2.30** | **2.14** | **2.37** | **2.28** | **2.96** | **24.50** |
| A. Forest Land | 1.03 | 0.99 | 0.72 | 0.74 | 0.63 | 0.94 | 0.79 | 1.61 | 51.80 |
| B. Cropland | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| C. Grassland | 1.05 | 0.92 | 1.15 | 1.56 | 1.51 | 1.43 | 1.49 | 1.34 | 2.38 |
| D. Wetlands | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | 0.00 |
| E. Settlements | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| F. Other Land | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| G. Other | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | 0.00 |
| **6. Waste** | **90.82** | **88.48** | **86.19** | **85.63** | **82.58** | **80.17** | **78.16** | **78.12** | **-27.74** |
| A. Solid Waste Disposal on Land | 80.25 | 77.99 | 76.05 | 75.38 | 72.45 | 70.28 | 68.56 | 68.47 | -30.30 |
| B. Waste-water Handling | 10.57 | 10.49 | 10.14 | 10.25 | 10.13 | 9.89 | 9.60 | 9.64 | -2.16 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C. Waste Incineration | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -87.43 |
| D. Other | NO | NO | NO | NO | NO | NO | NO | NO | 0.00 |
| **7. Other *(as specified in Summary 1.A)*** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **0.00** |
| | | | | | | | | | |
| **Total $CH_4$ emissions including $CH_4$ from LULUCF** | **1,289.46** | **1,295.72** | **1,285.05** | **1,296.97** | **1,291.74** | **1,299.11** | **1,307.31** | **1,267.72** | **4.49** |
| **Total $CH_4$ emissions excluding $CH_4$ from LULUCF** | **1,287.37** | **1,293.82** | **1,283.18** | **1,294.67** | **1,289.61** | **1,296.74** | **1,305.03** | **1,264.76** | **4.45** |
| | | | | | | | | | |
| **Memo Items:** | | | | | | | | | |
| **International Bunkers** | 0.12 | 0.13 | 0.15 | 0.15 | 0.14 | 0.16 | 0.16 | 0.16 | 21.30 |
| Aviation | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 93.87 |
| Marine | 0.07 | 0.08 | 0.10 | 0.08 | 0.07 | 0.09 | 0.09 | 0.09 | -7.08 |
| **Multilateral Operations** | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | |

All footnotes for this table are provided at the end of the table on page 184.

**Table A.3: Emissions trends ($N_2O$ – Part 1 of 2)**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | Base year (1990 ) | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) |
| **1. Energy** | **0.46** | **0.46** | **0.49** | **0.51** | **0.55** | **0.58** | **0.59** | **0.61** | **0.62** | **0.66** |
| A. Fuel Combustion (Sectoral Approach) | 0.46 | 0.46 | 0.49 | 0.51 | 0.55 | 0.58 | 0.59 | 0.61 | 0.62 | 0.66 |
| 1. Energy Industries | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 |
| 2. Manufacturing Industries and Construction | 0.12 | 0.12 | 0.12 | 0.12 | 0.14 | 0.14 | 0.14 | 0.13 | 0.13 | 0.16 |
| 3. Transport | 0.24 | 0.24 | 0.26 | 0.28 | 0.31 | 0.34 | 0.35 | 0.37 | 0.38 | 0.39 |
| 4. Other Sectors | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 5. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| B. Fugitive Emissions from Fuels | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO |
| 1. Solid Fuels | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE |
| 2. Oil and Natural Gas | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO |
| **2. Industrial Processes** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** |
| A. Mineral Products | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| B. Chemical Industry | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| C. Metal Production | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| D. Other Production | | | | | | | | | | |
| E. Production of Halocarbons and $SF_6$ | | | | | | | | | | |
| F. Consumption of Halocarbons and $SF_6$ | | | | | | | | | | |
| G. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **3. Solvent and Other Product Use** | 0.13 | 0.14 | 0.14 | 0.14 | 0.14 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| **4. Agriculture** | **32.55** | **32.63** | **32.23** | **32.95** | **34.17** | **34.97** | **35.32** | **35.94** | **35.61** | **36.22** |
| A. Enteric Fermentation | | | | | | | | | | |
| B. Manure Management | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.15 | 0.15 | 0.16 | 0.17 | 0.17 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C. Rice Cultivation | | | | | | | | | | |
| D. Agricultural Soils | 32.40 | 32.48 | 32.09 | 32.80 | 34.00 | 34.79 | 35.14 | 35.75 | 35.42 | 36.03 |
| E. Prescribed Burning of Savannas | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F. Field Burning of Agricultural Residues | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| **5. Land Use, Land-Use Change and Forestry** | **0.02** | **0.02** | **0.02** | **0.03** | **0.03** | **0.03** | **0.03** | **0.03** | **0.03** | **0.04** |
| A. Forest Land | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| B. Cropland | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 |
| C. Grassland | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| D. Wetlands | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO |
| E. Settlements | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| F. Other Land | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| G. Other | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE |
| **6. Waste** | **0.50** | **0.51** | **0.51** | **0.52** | **0.52** | **0.52** | **0.53** | **0.53** | **0.53** | **0.54** |
| A. Solid Waste Disposal on Land | | | | | | | | | | |
| B. Waste-water Handling | 0.50 | 0.50 | 0.51 | 0.51 | 0.51 | 0.52 | 0.52 | 0.53 | 0.53 | 0.53 |
| C. Waste Incineration | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| D. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| **7. Other *(as specified in Summary 1.A)*** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| | | | | | | | | | | |
| **Total $N_2O$ emissions including $N_2O$ from LULUCF** | **33.66** | **33.76** | **33.40** | **34.14** | **35.41** | **36.25** | **36.62** | **37.27** | **36.95** | **37.61** |
| **Total $N_2O$ emissions excluding $N_2O$ from LULUCF** | **33.64** | **33.74** | **33.37** | **34.11** | **35.38** | **36.22** | **36.59** | **37.24** | **36.92** | **37.57** |
| | | | | | | | | | | |
| **Memo Items:** | | | | | | | | | | |
| **International Bunkers** | **0.07** | **0.06** | **0.06** | **0.06** | **0.08** | **0.07** | **0.07** | **0.08** | **0.08** | **0.08** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Aviation** | **0.04** | **0.04** | **0.04** | **0.04** | **0.04** | **0.04** | **0.05** | **0.05** | **0.05** | **0.05** |
| **Marine** | **0.03** | **0.02** | **0.02** | **0.02** | **0.04** | **0.03** | **0.03** | **0.03** | **0.03** | **0.02** |
| **Multilateral Operations** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | |

**Table A.3: Emission trends ($N_2O$ – Part 2 of 2)**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Change from base to latest reported year |
|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | % |
| **1. Energy** | **0.70** | **0.73** | **0.76** | **0.81** | **0.82** | **0.87** | **0.87** | **0.84** | **82.20** |
| A. Fuel Combustion (Sectoral Approach) | 0.70 | 0.73 | 0.76 | 0.81 | 0.82 | 0.87 | 0.87 | 0.84 | 82.20 |
| 1. Energy Industries | 0.03 | 0.03 | 0.03 | 0.06 | 0.07 | 0.09 | 0.09 | 0.05 | 157.30 |
| 2. Manufacturing Industries and Construction | 0.14 | 0.15 | 0.15 | 0.16 | 0.16 | 0.17 | 0.17 | 0.17 | 48.76 |
| 3. Transport | 0.41 | 0.43 | 0.45 | 0.47 | 0.48 | 0.50 | 0.51 | 0.52 | 115.27 |
| 4. Other Sectors | 0.12 | 0.12 | 0.13 | 0.12 | 0.11 | 0.11 | 0.10 | 0.10 | 16.01 |
| 5. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| B. Fugitive Emissions from Fuels | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | NA,NE,NO | 0.00 |
| 1. Solid Fuels | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | 0.00 |
| 2. Oil and Natural Gas | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | 0.00 |
| **2. Industrial Processes** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **NA,NO** | **0.00** |
| A. Mineral Products | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| B. Chemical Industry | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| C. Metal Production | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| D. Other Production | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| E. Production of Halocarbons and $SF_6$ | | | | | | | | | |
| F. Consumption of Halocarbons and $SF_6$ | | | | | | | | | |
| G. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| **3. Solvent and Other Product Use** | 0.15 | 0.15 | 0.18 | 0.17 | 0.16 | 0.14 | 0.13 | 0.14 | 4.48 |
| **4. Agriculture** | **37.65** | **38.99** | **39.89** | **40.86** | **41.09** | **41.44** | **41.10** | **39.87** | **22.51** |
| A. Enteric Fermentation | | | | | | | | | |
| B. Manure Management | 0.18 | 0.19 | 0.19 | 0.19 | 0.19 | 0.18 | 0.17 | 0.19 | 52.35 |
| C. Rice Cultivation | | | | | | | | | |
| D. Agricultural Soils | 37.45 | 38.78 | 39.67 | 40.65 | 40.88 | 41.25 | 40.92 | 39.67 | 22.45 |
| E. Prescribed Burning of Savannas | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -68.00 |
| F. Field Burning of Agricultural Residues | 0.02 | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | -41.44 |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO | 0.00 |
| **5. Land Use, Land-Use Change and Forestry** | **0.04** | **0.04** | **0.04** | **0.04** | **0.04** | **0.05** | **0.05** | **0.05** | **200.76** |
| A. Forest Land | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 51.80 |
| B. Cropland | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 1,706.09 |
| C. Grassland | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 2.38 |
| D. Wetlands | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | IE,NE,NO | 0.00 |
| E. Settlements | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| F. Other Land | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| G. Other | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | IE,NE | 0.00 |
| **6. Waste** | **0.54** | **0.54** | **0.55** | **0.57** | **0.58** | **0.58** | **0.58** | **0.58** | **16.33** |
| A. Solid Waste Disposal on Land | | | | | | | | | |
| B. Waste-water Handling | 0.53 | 0.54 | 0.54 | 0.56 | 0.58 | 0.57 | 0.57 | 0.58 | 16.76 |
| C. Waste Incineration | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -23.88 |
| D. Other | NO | NO | NO | NO | NO | NO | NO | NO | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **7. Other *(as specified in Summary 1.A)*** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **0.00** |
| | | | | | | | | | |
| **Total $N_2O$ emissions including $N_2O$ from LULUCF** | **39.07** | **40.45** | **41.42** | **42.46** | **42.69** | **43.07** | **42.73** | **41.49** | **23.26** |
| **Total $N_2O$ emissions excluding $N_2O$ from LULUCF** | **39.04** | **40.41** | **41.38** | **42.41** | **42.65** | **43.02** | **42.68** | **41.44** | **23.17** |
| | | | | | | | | | |
| **Memo Items:** | | | | | | | | | |
| **International Bunkers** | **0.07** | **0.07** | **0.08** | **0.09** | **0.09** | **0.10** | **0.10** | **0.10** | **51.25** |
| Aviation | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 93.87 |
| Marine | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | -7.08 |
| **Multilateral Operations** | NE | NE | NE | NE | NE | NE | NE | NE | 0.00 |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | |

All footnotes for this table are provided at the end of the table on page 184.

## Table A.4: Emission trends (HFCs, PFCs and $SF_6$ – Part 1 of 2)

Inventory 2007 Submission 2009 v1.2 NEW ZEALAND

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | Base year (1990) | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) |
| **Emissions of HFCs[2] – (Gg $CO_2$ equivalent)** | **NA,NO** | **NA,NO** | **1.43** | **2.86** | **62.48** | **148.30** | **214.03** | **123.87** | **300.40** | **300.04** |
| HFC-23 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-32 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-41 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-43-10mee | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-125 | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 |
| HFC-134 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-134a | NA,NO | NA,NO | 0.00 | 0.00 | 0.04 | 0.09 | 0.14 | 0.06 | 0.17 | 0.15 |
| HFC-152a | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HFC-143 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-143a | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 |
| HFC-227ea | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HFC-236fa | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| HFC-245ca | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| Unspecified mix of listed HFCs[3] – (Gg $CO_2$ equivalent) | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| | | | | | | | | | | |
| **Emissions of PFCs[2] – (Gg $CO_2$ equivalent)** | **642.22** | **318.03** | **296.59** | **199.58** | **188.15** | **150.26** | **265.89** | **164.47** | **104.96** | **61.20** |
| $CF_4$ | 0.08 | 0.04 | 0.04 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 |
| $C_2F_6$ | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_3F_8$ | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 | 0.00 | 0.00 | 0.01 | NA,NO |
| $C_4F_{10}$ | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| c-$C_4F_8$ | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| $C_5F_{12}$ | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| $C_6F_{14}$ | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| Unspecified mix of listed PFCs[3] – (Gg $CO_2$ equivalent) | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| | | | | | | | | | | |
| **Emissions of $SF_6$[2] – (Gg $CO_2$ equivalent)** | **15.20** | **15.77** | **16.49** | **16.92** | **17.28** | **17.88** | **17.66** | **18.16** | **16.90** | **16.06** |
| $SF_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

All footnotes for this table are provided at the end of the table on page 184.

## Table A.4: Emission trends (HFCs, PFCs and $SF_6$ – Part 2 of 2)

Inventory 2007 Submission 2009 v1.2 NEW ZEALAND

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Change from base to latest reported year |
|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | % |
| **Emissions of HFCs[2] – (Gg $CO_2$ equivalent)** | **304.28** | **346.24** | **482.82** | **643.94** | **449.75** | **675.47** | **612.40** | **856.63** | **100.00** |
| HFC-23 | NA,NO | NA,NO | NA,NO | 0.00 | NA,NO | NA,NO | 0.00 | NA,NO | 0.00 |
| HFC-32 | NA,NO | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 100.00 |
| HFC-41 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| HFC-43-10mee | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| HFC-125 | 0.02 | 0.02 | 0.03 | 0.05 | 0.04 | 0.06 | 0.05 | 0.08 | 100.00 |
| HFC-134 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| HFC-134a | 0.16 | 0.16 | 0.20 | 0.22 | 0.17 | 0.21 | 0.24 | 0.27 | 100.00 |
| HFC-152a | NA,NO | 0.00 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| HFC-143 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| HFC-143a | 0.01 | 0.02 | 0.03 | 0.06 | 0.03 | 0.06 | 0.04 | 0.07 | 100.00 |
| HFC-227ea | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HFC-236fa | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| HFC-245ca | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| Unspecified mix of listed HFCs[3] – (Gg $CO_2$ equivalent) | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| | | | | | | | | | |
| **Emissions of PFCs[2] – (Gg $CO_2$ equivalent)** | **57.68** | **60.55** | **78.92** | **101.53** | **84.34** | **58.98** | **90.56** | **41.67** | **-93.51** |
| $CF_4$ | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | -93.69 |
| $C_2F_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -93.96 |
| $C_3F_8$ | NA,NE,NO | NA,NO | 0.00 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | 100.00 |
| $C_4F_{10}$ | NA,NE,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| c-$C_4F_8$ | NA,NE,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| $C_5F_{12}$ | NA,NE,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| $C_6F_{14}$ | NA,NE,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| Unspecified mix of listed PFCs[3] – (Gg $CO_2$ equivalent) | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 0.00 |
| | | | | | | | | | |
| **Emissions of $SF_6$[2] – (Gg $CO_2$ equivalent)** | **10.52** | **10.87** | **14.89** | **17.57** | **22.25** | **18.95** | **15.39** | **14.70** | **-3.30** |
| $SF_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -3.30 |

All footnotes for this table are provided at the end of the table on page 184.

## Table A.5: Emissions trends summary (Part 1 of 2)

Inventory 2007 Submission 2009 v1.2 NEW ZEALAND

| GREENHOUSE GAS EMISSIONS | Base year (1990) | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) |
| $CO_2$ emissions including net $CO_2$ from LULUCF | 7,143.57 | 8,554.01 | 12,504.60 | 12,166.71 | 11,250.00 | 11,251.27 | 11,475.19 | 11,806.09 | 10,137.63 | 11,121.10 |
| $CO_2$ emissions excluding net $CO_2$ from LULUCF | 25,337.57 | 25,880.37 | 27,716.78 | 27,140.71 | 27,221.88 | 27,209.55 | 28,199.04 | 30,490.77 | 29,058.20 | 30,324.75 |
| $CH_4$ emissions including $CH_4$ from LULUCF | 25,478.40 | 25,411.86 | 24,901.14 | 25,076.56 | 25,725.56 | 25,769.11 | 26,052.76 | 26,599.10 | 26,096.62 | 26,316.62 |
| $CH_4$ emissions excluding $CH_4$ from LULUCF | 25,428.52 | 25,363.06 | 24,842.56 | 25,017.90 | 25,658.92 | 25,712.75 | 25,991.32 | 26,545.03 | 26,045.84 | 26,267.23 |
| $N_2O$ emissions including $N_2O$ from LULUCF | 10,435.00 | 10,465.27 | 10,353.47 | 10,583.38 | 10,978.12 | 11,237.01 | 11,352.77 | 11,553.43 | 11,454.44 | 11,657.98 |
| $N_2O$ emissions excluding $N_2O$ from LULUCF | 10,429.35 | 10,459.13 | 10,345.75 | 10,575.05 | 10,968.38 | 11,227.72 | 11,342.37 | 11,543.18 | 11,443.94 | 11,647.02 |
| HFCs | NA,NO | NA,NO | 1.43 | 2.86 | 62.48 | 148.30 | 214.03 | 123.87 | 300.40 | 300.04 |
| PFCs | 642.22 | 318.03 | 296.59 | 199.58 | 188.15 | 150.26 | 265.89 | 164.47 | 104.96 | 61.20 |
| $SF_6$ | 15.20 | 15.77 | 16.49 | 16.92 | 17.28 | 17.88 | 17.66 | 18.16 | 16.90 | 16.06 |
| **Total (including LULUCF)** | **43,714.39** | **44,764.94** | **48,073.73** | **48,046.01** | **48,221.59** | **48,573.82** | **49,378.30** | **50,265.11** | **48,110.94** | **49,472.99** |
| **Total (excluding LULUCF)** | **61,852.85** | **62,036.37** | **63,219.60** | **62,953.02** | **64,117.09** | **64,466.46** | **66,030.31** | **68,885.49** | **66,970.23** | **68,616.31** |

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | Base year (1990) | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) |
| 1. Energy | 23,452.84 | 23,750.84 | 25,465.10 | 24,809.33 | 25,066.92 | 25,042.72 | 26,075.27 | 28,477.39 | 27,027.43 | 28,160.81 |
| 2. Industrial Processes | 3,409.22 | 3,235.72 | 3,328.44 | 3,304.93 | 3,246.19 | 3,390.23 | 3,556.89 | 3,308.12 | 3,517.08 | 3,678.69 |
| 3. Solvent and Other Product Use | 41.54 | 42.78 | 43.09 | 43.71 | 44.33 | 44.95 | 45.88 | 46.19 | 46.50 | 46.81 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4. Agriculture | 32,511.08 | 32,534.11 | 31,943.20 | 32,331.50 | 33,310.35 | 33,728.91 | 34,069.97 | 34,780.45 | 34,171.11 | 34,660.80 |
| 5. Land Use, Land-Use Change and Forestry[4] | -18,138.46 | -17,271.43 | -15,145.88 | -14,907.01 | -15,895.50 | -15,892.64 | -16,652.01 | -18,620.37 | -18,859.29 | -19,143.31 |
| 6. Waste | 2,438.18 | 2,472.91 | 2,439.78 | 2,463.55 | 2,449.30 | 2,259.65 | 2,282.30 | 2,273.33 | 2,208.12 | 2,069.20 |
| 7. Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Total (including LULUCF)[4]** | **43,714.39** | **44,764.94** | **48,073.73** | **48,046.01** | **48,221.59** | **48,573.82** | **49,378.30** | **50,265.11** | **48,110.94** | **49,472.99** |

All footnotes for this table are provided at the end of the table on page 184.

## Table A.5: Emissions trends summary (Part 2 of 2)

Inventory 2007 Submission 2009 v1.2 NEW ZEALAND

| GREENHOUSE GAS EMISSIONS | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Change from base to latest reported year |
|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | $CO_2$ equivalent (Gg) | (%) |
| $CO_2$ emissions including net $CO_2$ from LULUCF | 11,061.95 | 12,591.52 | 13,017.01 | 13,614.40 | 9,282.81 | 10,514.45 | 12,304.10 | 11,316.37 | 58.41 |
| $CO_2$ emissions excluding net $CO_2$ from LULUCF | 31,088.27 | 33,000.95 | 33,101.31 | 34,905.81 | 34,194.76 | 35,852.35 | 36,244.36 | 35,231.49 | 39.05 |
| $CH_4$ emissions including $CH_4$ from LULUCF | 27,078.60 | 27,210.19 | 26,986.05 | 27,236.37 | 27,126.62 | 27,281.24 | 27,453.53 | 26,622.17 | 4.49 |
| $CH_4$ emissions excluding $CH_4$ from LULUCF | 27,034.75 | 27,170.16 | 26,946.73 | 27,188.17 | 27,081.72 | 27,231.57 | 27,405.59 | 26,560.06 | 4.45 |
| $N_2O$ emissions including $N_2O$ from LULUCF | 12,113.19 | 12,538.25 | 12,839.50 | 13,161.25 | 13,234.66 | 13,351.93 | 13,245.82 | 12,862.64 | 23.26 |
| $N_2O$ emissions excluding $N_2O$ from LULUCF | 12,102.20 | 12,527.05 | 12,827.77 | 13,148.03 | 13,221.18 | 13,337.38 | 13,230.85 | 12,845.63 | 23.17 |
| HFCs | 304.28 | 346.24 | 482.82 | 643.94 | 449.75 | 675.47 | 612.40 | 856.63 | 100.00 |
| PFCs | 57.68 | 60.55 | 78.92 | 101.53 | 84.34 | 58.98 | 90.56 | 41.67 | -93.51 |
| $SF_6$ | 10.52 | 10.87 | 14.89 | 17.57 | 22.25 | 18.95 | 15.39 | 14.70 | -3.30 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total (including LULUCF)** | **50,626.21** | **52,757.61** | **53,419.19** | **54,775.05** | **50,200.42** | **51,901.03** | **53,721.80** | **51,714.18** | **18.30** |
| **Total (excluding LULUCF)** | **70,597.69** | **73,115.82** | **73,452.44** | **76,005.05** | **75,053.99** | **77,174.70** | **77,599.14** | **75,550.19** | **22.15** |

| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **Change from base to latest reported year** |
|---|---|---|---|---|---|---|---|---|---|
| | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **$CO_2$ equivalent (Gg)** | **(%)** |
| 1. Energy | 28,987.28 | 30,855.88 | 30,951.43 | 32,550.05 | 31,845.21 | 33,479.00 | 34,010.64 | 32,653.10 | 39.23 |
| 2. Industrial Processes | 3,648.00 | 3,777.28 | 3,951.10 | 4,287.59 | 4,052.82 | 4,266.87 | 4,233.76 | 4,601.88 | 34.98 |
| 3. Solvent and Other Product Use | 47.12 | 47.43 | 56.11 | 52.39 | 48.36 | 44.33 | 40.30 | 43.40 | 4.48 |
| 4. Agriculture | 35,835.96 | 36,403.89 | 36,509.36 | 37,136.19 | 37,188.73 | 37,519.09 | 37,491.19 | 36,430.00 | 12.05 |
| 5. Land Use, Land-Use Change and Forestry[4] | -19,971.47 | -20,358.21 | -20,033.25 | -21,230.00 | -24,853.57 | -25,273.67 | -23,877.33 | -23,836.01 | 31.41 |
| 6. Waste | 2,079.33 | 2,031.33 | 1,984.44 | 1,978.83 | 1,918.86 | 1,865.41 | 1,823.25 | 1,821.80 | -25.28 |
| 7. Other | NA | NA | NA | NA | NA | NA | NA | NA | 0.00 |
| **Total (including LULUCF)[4]** | **50,626.21** | **52,757.61** | **53,419.19** | **54,775.05** | **50,200.42** | **51,901.03** | **53,721.80** | **51,714.18** | **18.30** |

[1] The signs for removals are always negative (-) and for emissions positive (+).

[2] Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as $CO_2$ equivalent emissions.

[3] In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (ie, mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of $CO_2$ equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

[4] Includes net $CO_2$, $CH_4$ and $N_2O$ from LULUCF.

# Annex B: Supplementary information under Article 7.2 of the Kyoto Protocol

## National system

### National entity contact

| Title | National focal point | National inventory compiler |
|---|---|---|
| **Name** | Helen Plume | Sonia Petrie |
| **Organisation** | Ministry for the Environment | Ministry for the Environment |
| **Address** | Environment House<br>23 Kate Sheppard Place<br>PO Box 10362<br>Wellington<br>New Zealand | Environment House<br>23 Kate Sheppard Place<br>PO Box 10362<br>Wellington<br>New Zealand |
| **Email** | helen.plume@mfe.govt.nz | sonia.petrie@mfe.govt.nz |
| **Phone** | +64 4 439 7627 | +64 4 439 7498 |
| **Fax** | +64 4 439 7700 | +64 4 439 7700 |
| **Website** | http://www.mfe.govt.nz | http://www.mfe.govt.nz |

### Roles and responsibilities and institutional, legal and procedural arrangements in inventory preparation

The Climate Change Response Act 2002 enables New Zealand to meet its international obligations under the Climate Change Convention and the Kyoto Protocol. A prime ministerial directive for the administration of the Climate Change Response Act names the Ministry for the Environment as New Zealand's "inventory agency". The Climate Change Response Act specifies that the primary functions of the inventory agency are to:

- estimate annually New Zealand's human-induced emissions by sources, and removals by sinks, of greenhouse gases
- prepare the following reports for the purpose of discharging New Zealand's obligations:
  - New Zealand's annual inventory report under Article 7.1 of the Protocol, including (but not limited to) the quantities of long-term certified emission reduction units and temporary certified emission reduction units that have expired or have been replaced, retired or cancelled

- New Zealand's National Communication (or periodic report) under Article 7.2 of the Protocol and Article 12 of the Convention
- New Zealand's report for the calculation of its initial assigned amount under Article 7.4 of the Protocol, including its method of calculation.

In carrying out its functions, the inventory agency must:

- identify source categories
- collect data by means of:
  - voluntary collection
  - collection from government agencies and other agencies that hold relevant information
  - collection in accordance with regulations made under the Act (if any)
- estimate the emissions and removals by sinks for each source category
- undertake assessments on uncertainties
- undertake procedures to verify the data
- retain information and documents to show how the estimates were determined.

Section 36 of the Climate Change Response Act provides for the authorisation of inspectors to collect the information needed to estimate emissions or removals of greenhouse gases.

## Inventory roles and responsibilities

The Ministry for the Environment is New Zealand's single national entity for the greenhouse gas inventory, responsible for the overall development, compilation and submission of the inventory to the UNFCCC secretariat. The Ministry coordinates all of the Government agencies and contractors involved in the inventory. The national inventory compiler is based at the Ministry. Arrangements with other government agencies have evolved over time as resources and capacity have allowed, and as a greater understanding of the reporting requirements has been attained.

The Ministry for the Environment calculates estimates of emissions for the waste sectors, and emissions and removals from the land use, land-use change and forestry (LULUCF) sector.

The Ministry of Economic Development collects and compiles all emissions from the energy sector and carbon dioxide emissions from the industrial processes sector. Emissions of the non-carbon dioxide gases from the industrial processes sector are obtained through industry surveys by consultants, contracted to the Ministry for the Environment.

The Ministry of Agriculture and Forestry compiles emissions from the agricultural sector and provides data to the Ministry for the Environment to estimate emissions and removals from the LULUCF sector. Estimates provided by the Ministry of Agriculture and Forestry are underpinned by the research and modelling of researchers at New Zealand's Crown research institutes and universities.

New Zealand's national statistical agency, Statistics New Zealand, provides many of the official statistics for the agricultural sector through regular agricultural censuses and surveys. Statistics New Zealand also provides statistics on fuel consumption through the *Deliveries of Petroleum Fuels by Industry Survey* and the *New Zealand Coal Sales Survey*. Population census data from Statistics New Zealand is used in the waste and solvent and other product use sectors.

Consultants are used to provide essential data for the industrial processes, solvent and other product use, waste, agriculture and LULUCF sectors of the inventory.

Where an expert in a relevant sector is identified outside the Ministry for the Environment, or any of the other key contributing government departments, a contract is established to ensure the inventory can be completed in an accurate and timely manner and to a standard that meets the satisfaction of the Minister responsible for Climate Change Issues. The contracts are legally binding and require transparency in their work and processes. Legislation relating to the public sector accountability framework is extensive and includes the:

- Public Finance Act 1989
- Public Audit Act 2001
- Official Information Act 1982
- Ombudsman Act 1975
- Public Records Act 2005
- Crown Entities Act 2004.

Contractors for the annual greenhouse gas inventory are selected for being experts in their fields. Although it is preferable to use the same contractor each year, contractors are reviewed annually. Through this competitive process the best contractor is selected, ensuring inventory data is of the highest quality in accordance with good practice guidance.

## Inventory preparation processes

Consistent with the UNFCCC's reporting guidelines, each inventory report is published 15 months in arrears of the calendar year reported, allowing time for data to be collected and analysed. Sector-based data analysis, data entry into the UNFCCC common reporting format database, and quality checking occur over the period October to December. The national inventory report is also updated over this three-month time period.

Once the sector-based emissions estimates are updated, the national inventory compiler at the Ministry for the Environment calculates the inventory uncertainty, undertakes the key category assessment and further quality checking, and finalises the national inventory report. The inventory is reviewed within the Ministry for the Environment, Ministry of Economic Development and Ministry of Agriculture and Forestry before being approved and submitted to the UNFCCC secretariat.

The inventory and all required data for the submission to the UNFCCC secretariat are stored on the Ministry for the Environment's central computer network in a controlled file system. The inventory submission is available from the websites of the Ministry for the Environment and the UNFCCC.

Following the annual submission of the national inventory, a post-inventory review is undertaken. The review focuses on the lessons learnt and how improvements can be incorporated into the inventory for the following year. Questions asked include:

- Was the timing of activities suitable?
- What activities went well?
- What activities could be improved?

The review encompasses key contributors to the inventory.

## Activity data, emission factors and methods

The guiding documents in inventory preparation are the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*,[129] the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*[130] (the Good Practice Guidance), *Good Practice Guidance for Land Use, Land-Use Change and Forestry*,[131] and the Climate Change Convention guidelines on reporting and review.[132] The concepts contained in the Good Practice Guidance are implemented in stages, according to sector priorities and national circumstances.

### Energy

Greenhouse gas emissions from the energy sector are calculated using the IPCC Tier 1 approach. Activity data is compiled from industry-supplied information via the Ministry of Economic Development and Statistics New Zealand. New Zealand-specific emission factors are used for carbon dioxide emission calculations. Applicable IPCC default factors are used for non-carbon dioxide emissions where New Zealand emission factors are not available.

### Industrial processes and solvent and other product use

Activity data and carbon dioxide emissions are supplied directly to the Ministry of Economic Development by industry sources. The IPCC Tier 2 approach is used and emission factors are New Zealand specific. Activity data for the non-carbon dioxide gases is collected via an industry survey. Emissions of hydrofluorocarbons and perfluorocarbons are estimated using the IPCC Tier 2 approach, and sulphur hexafluoride emissions from large users are assessed via the Tier 3a approach from the IPCC 2006 guidelines.[133]

### Agriculture

Livestock population data is obtained from Statistics New Zealand through the agricultural production census and surveys. A Tier 2 (model) approach is used to estimate methane emissions from dairy cattle, non-dairy cattle, sheep and deer. This method uses New Zealand animal productivity data to estimate dry-matter intake and methane production. The same dry-matter intake data is used to calculate nitrous oxide emissions from animal excreta. A Tier 1 approach is used to calculate methane and nitrous oxide emissions from livestock species present in insignificant numbers.

### Land Use, Land-use Change and Forestry (LULUCF)

The LULUCF sector is completed using a mix of IPCC Tier 2 and Tier 1 approaches. A Tier 2 approach is used for the planted forest subcategory of forest land. Changes in planted forest stocks are assessed from national forest survey data and computer modelling of the planted forest estate. A Tier 1 approach is used for the cropland, grassland, wetland, settlements and other land categories. Changes in land area for these categories are based on modified national land-cover databases reclassified to the IPCC LULUCF categories. Results from the Land Use and Carbon Analysis System (LUCAS), as described in New Zealand's national greenhouse gas

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129 http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

130 http://www.ipcc-nggip.iges.or.jp/public/gp/english/

131 http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

132 http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600003988#beg

133 *2006 IPCC Guidelines for National Greenhouse Gas Inventories* http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

inventory, will improve the reporting in the LULUCF sector and will provide better consistency with reporting under the Kyoto Protocol in the 2010 inventory submission.

### Waste

Emissions from the waste sector are estimated using waste survey data combined with population data from Statistics New Zealand. Calculation of emissions from solid waste disposal uses the model from the IPCC 2006 guidelines. A mix of New Zealand-specific and IPCC default parameters is used. Methane and nitrous oxide emissions from domestic and industrial wastewater handling are calculated using a refinement of the IPCC methodology. There is no incineration of municipal waste in New Zealand. Emissions from incineration from medical, quarantine and hazardous wastes are estimated using the Tier 1 approach consistent with the 2006 IPCC guidelines.

## Process and results of key category identification

The IPCC's *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* identifies a key category as "one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both". Key categories identified within the inventory are used to prioritise inventory improvements.

The key categories in the New Zealand inventory have been assessed using the Tier 1 level and trend methods from the IPCC good practice guidance. The methods identify sources of emissions and removals that sum to 95 per cent of the total level of emissions, and 95 per cent of the trend of the inventory in absolute terms.

In accordance with the *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, the key category analysis is performed once for the inventory excluding LULUCF categories and is then repeated for the inventory including the LULUCF categories. Non-LULUCF categories that are identified as key in the first analysis but that do not appear as key when the LULUCF categories are included, are still considered to be key categories.

The key categories identified in the 2007 year are summarised in table B.1. The major contributions to the level analysis including LULUCF (table B.2) were methane from enteric fermentation in domestic livestock (23.0 per cent), carbon dioxide from conversion to forest land (15.0 per cent) and carbon dioxide from road transportation (13.1 per cent).

The key categories that were identified as having the largest relative influence on New Zealand's emissions trend in 2007, including LULUCF (table B.3), were carbon dioxide emissions from road transportation (20.5 per cent), methane emissions from enteric fermentation in domestic livestock (18.7 per cent), and carbon dioxide emissions from forest land remaining forest land (12.2 per cent).

## Table B.1: Summary of key categories for 2007 (including and excluding LULUCF activities)

| Quantitative method used: Tier 1 | | |
|---|---|---|
| **IPCC source categories** | **Gas** | **Criteria for identification** |
| **Energy sector** | | |
| $CO_2$ emissions from stationary combustion – solid | $CO_2$ | level, trend |
| $CO_2$ emissions from stationary combustion – liquid | $CO_2$ | level, trend |
| $CO_2$ emissions from stationary combustion – gas | $CO_2$ | level, trend |
| Mobile combustion – road vehicles | $CO_2$ | level, trend |
| Mobile combustion – aviation | $CO_2$ | level |
| Fugitive emissions from oil and gas operations | $CO_2$ | level, trend |
| Fugitive emissions from geothermal operations | $CO_2$ | trend |
| **Industrial processes sector** | | |
| Emissions from cement production | $CO_2$ | level, trend |
| Emissions from the iron and steel industry | $CO_2$ | level |
| PFCs from aluminium production | PFCs | trend |
| Ammonia production | $CO_2$ | qualitative |
| Consumption of halocarbons and $SF_6$ – refrigeration & air conditioning | HFCs & PFCs | level, trend |
| **Agricultural sector** | | |
| Emissions from enteric fermentation in domestic livestock | $CH_4$ | level, trend |
| Emissions from manure management | $CH_4$ | level |
| Direct emissions from agricultural soils | $N_2O$ | level, trend |
| Emissions from agricultural soils – animal production | $N_2O$ | level, trend |
| Indirect emissions from nitrogen used in agriculture | $N_2O$ | level |
| **LULUCF sector** | | |
| Forest land remaining forest land | $CO_2$ | trend |
| Conversion to forest land | $CO_2$ | level, trend |
| Conversion to grassland | $CO_2$ | trend |
| Cropland remaining cropland | $CO_2$ | level |
| Conversion to cropland | $CO_2$ | trend |
| **Waste sector** | | |
| Emissions from solid waste disposal sites | $CH_4$ | level, trend |

**Table B.2 (a & b): Key category analysis for 2007 – Tier 1 level assessment including LULUCF (a) and excluding LULUCF (b)**

| (a) Tier 1 Category Level Assessment – including LULUCF | | | | |
|---|---|---|---|---|
| **IPCC categories** | **Gas** | **2007 estimate (Gg $CO_2$-e)** | **Level assessment** | **Cumulative total** |
| Emissions from enteric fermentation in domestic livestock | $CH_4$ | 23326.38 | 23.0 | 23.0 |
| Conversion to forest land | $CO_2$ | 15253.73 | 15.0 | 38.0 |
| Mobile combustion – road vehicles | $CO_2$ | 13281.35 | 13.1 | 51.1 |
| Forest land remaining forest land | $CO_2$ | 9311.50 | 9.2 | 60.3 |
| Emissions from stationary combustion – gas | $CO_2$ | 8723.65 | 8.6 | 68.9 |
| Emissions from agricultural soils – animal production | $N_2O$ | 7346.67 | 7.2 | 76.1 |
| Emissions from stationary combustion – solid | $CO_2$ | 4473.87 | 4.4 | 80.5 |
| Indirect emissions from nitrogen used in agriculture | $N_2O$ | 3270.66 | 3.2 | 83.8 |
| Emissions from stationary combustion – liquid | $CO_2$ | 2644.94 | 2.6 | 86.4 |
| Direct emissions from agricultural soils | $N_2O$ | 1680.74 | 1.7 | 88.0 |
| Emissions from the iron and steel industry | $CO_2$ | 1646.24 | 1.6 | 89.7 |
| Emissions from solid waste disposal sites | $CH_4$ | 1437.95 | 1.4 | 91.1 |
| Mobile combustion – aviation | $CO_2$ | 915.10 | 0.9 | 92.0 |
| Consumption of halocarbons and $SF_6$ – refrigeration and air conditioning | HFCs & PFCs | 779.64 | 0.8 | 92.7 |
| Fugitive emissions from oil and gas operations | $CO_2$ | 754.57 | 0.7 | 93.5 |
| Emissions from manure management | $CH_4$ | 729.10 | 0.7 | 94.2 |
| Emissions from cement production | $CO_2$ | 687.90 | 0.7 | 94.9 |
| Cropland remaining cropland | $CO_2$ | 649.67 | 0.6 | 95.5 |
| Emissions from aluminium production | $CO_2$ | 579.05 | 0.6 | 96.1 |
| Conversion to grassland | $CO_2$ | 436.83 | 0.4 | 96.5 |
| Fugitive emissions from oil and gas operations | $CH_4$ | 378.72 | 0.4 | 96.9 |
| Fugitive emissions from geothermal operations | $CO_2$ | 301.47 | 0.3 | 97.2 |
| Mobile combustion – marine | $CO_2$ | 300.11 | 0.3 | 97.5 |

| | | | | |
|---|---|---|---|---|
| Fugitive emissions from coal mining and handling | $CH_4$ | 261.83 | 0.3 | 97.7 |
| Emissions from hydrogen production | $CO_2$ | 224.90 | 0.2 | 98.0 |
| Emissions from wastewater handling | $CH_4$ | 202.49 | 0.2 | 98.2 |
| Emissions from wastewater handling | $N_2O$ | 179.19 | 0.2 | 98.3 |
| Emissions from ammonia/urea production | $CO_2$ | 360.06 | 0.4 | 98.7 |
| Mobile combustion – rail | $CO_2$ | 164.88 | 0.2 | 98.9 |
| Mobile combustion – road vehicles | $N_2O$ | 147.48 | 0.1 | 99.0 |

**(b) Tier 1 Category Level Assessment – excluding LULUCF**

| IPCC categories | Gas | 2007 estimate (Gg $CO_2$-e) | Level assessment | Cumulative total |
|---|---|---|---|---|
| Emissions from enteric fermentation in domestic livestock | $CH_4$ | 23326.38 | 30.9 | 30.9 |
| Mobile combustion – road vehicles | $CO_2$ | 13281.35 | 17.6 | 48.5 |
| Emissions from stationary combustion – gas | $CO_2$ | 8723.65 | 11.6 | 60.1 |
| Emissions from agricultural soils – animal production | $N_2O$ | 7346.67 | 9.7 | 69.8 |
| Emissions from stationary combustion – solid | $CO_2$ | 4473.87 | 5.9 | 75.7 |
| Indirect emissions from nitrogen used in agriculture | $N_2O$ | 3270.66 | 4.3 | 80.1 |
| Emissions from stationary combustion – liquid | $CO_2$ | 2644.94 | 3.5 | 83.6 |
| Direct emissions from agricultural soils | $N_2O$ | 1680.74 | 2.2 | 85.8 |
| Emissions from the iron and steel industry | $CO_2$ | 1646.24 | 2.2 | 88.0 |
| Emissions from solid waste disposal sites | $CH_4$ | 1437.95 | 1.9 | 89.9 |
| Mobile combustion – aviation | $CO_2$ | 915.10 | 1.2 | 91.1 |
| Consumption of halocarbons and $SF_6$ – refrigeration and air conditioning | HFCs & PFCs | 779.64 | 1.0 | 92.1 |
| Fugitive emissions from oil and gas operations | $CO_2$ | 754.57 | 1.0 | 93.1 |
| Emissions from manure management | $CH_4$ | 729.10 | 1.0 | 94.1 |
| Emissions from cement production | $CO_2$ | 687.90 | 0.9 | 95.0 |

**Table B.3: Key category analysis for 2007 – Tier 1 trend assessment including LULUCF (a) and excluding LULUCF (b)**

| (a) Tier 1 Category Trend Assessment – including LULUCF | | | | | | |
|---|---|---|---|---|---|---|
| **IPCC categories** | **Gas** | **Base year estimate (Gg $CO_2$-e)** | **2007 estimate (Gg $CO_2$-e)** | **Trend assessment** | **Contribution to trend** | **Cumulative total** |
| Mobile combustion – road vehicles | $CO_2$ | 7516.28 | 13281.35 | 0.032 | 20.5 | 20.5 |
| Emissions from enteric fermentation in domestic livestock | $CH_4$ | 21818.97 | 23326.38 | 0.029 | 18.7 | 39.1 |
| Forest land remaining forest land | $CO_2$ | 5614.43 | 9311.50 | 0.019 | 12.2 | 51.3 |
| Emissions from agricultural soils – animal production | $N_2O$ | 6853.06 | 7346.67 | 0.009 | 5.8 | 57.0 |
| Emissions from solid waste disposal sites | $CH_4$ | 2063.21 | 1437.95 | 0.009 | 5.7 | 62.7 |
| Direct emissions from agricultural soils | $N_2O$ | 487.19 | 1680.74 | 0.009 | 5.5 | 68.3 |
| Conversion to forest land | $CO_2$ | 13059.41 | 15253.73 | 0.007 | 4.5 | 72.8 |
| Emissions from stationary combustion – gas | $CO_2$ | 7691.22 | 8723.65 | 0.006 | 4.0 | 76.8 |
| Consumption of halocarbons and $SF_6$ – refrigeration and air conditioning | HFCs & PFCs | 0.00 | 779.64 | 0.006 | 4.0 | 80.8 |
| PFCs from aluminium production | PFCs | 642.22 | 40.27 | 0.006 | 3.9 | 84.7 |
| Emissions from stationary combustion – solid | $CO_2$ | 3139.65 | 4473.87 | 0.005 | 3.0 | 87.7 |
| Emissions from stationary combustion – liquid | $CO_2$ | 2505.28 | 2644.94 | 0.004 | 2.3 | 90.0 |
| Fugitive emissions from oil and gas operations | $CO_2$ | 263.75 | 754.57 | 0.003 | 2.2 | 92.2 |
| Fugitive emissions from geothermal operations | $CO_2$ | 376.16 | 301.47 | 0.001 | 0.8 | 93.1 |
| Conversion to grassland | $CO_2$ | 482.70 | 436.83 | 0.001 | 0.8 | 93.9 |
| Emissions from cement production | $CO_2$ | 441.67 | 687.90 | 0.001 | 0.7 | 94.6 |
| Conversion to cropland | $CO_2$ | 37.35 | 128.68 | 0.001 | 0.4 | 95.0 |

| (b) Tier 1 Category Trend Assessment – excluding LULUCF | | | | | | |
|---|---|---|---|---|---|---|
| **IPCC Categories** | **Gas** | **Base year estimate (Gg $CO_2$-e)** | **2007 estimate (Gg $CO_2$-e)** | **Trend assessment** | **Contribution to trend** | **Cumulative total** |
| Mobile combustion – road vehicles | $CO_2$ | 7516.28 | 13281.35 | 0.045 | 26.6 | 26.6 |
| Emissions from enteric fermentation in domestic livestock | $CH_4$ | 21818.97 | 23326.38 | 0.036 | 21.3 | 48.0 |
| Direct emissions from agricultural soils | $N_2O$ | 487.19 | 1680.74 | 0.012 | 7.0 | 55.0 |
| Emissions from solid waste disposal sites | $CH_4$ | 2063.21 | 1437.95 | 0.012 | 7.0 | 62.0 |
| Emissions from agricultural soils – animal production | $N_2O$ | 6853.06 | 7346.67 | 0.011 | 6.6 | 68.6 |
| Consumption of halocarbons and $SF_6$ – refrigeration and air conditioning | HFCs & PFCs | 0.00 | 779.64 | 0.008 | 5.1 | 73.6 |
| PFCs from aluminium production | PFCs | 642.22 | 40.27 | 0.008 | 4.8 | 78.5 |
| Emissions from stationary combustion – gas | $CO_2$ | 7691.22 | 8723.65 | 0.007 | 4.3 | 82.7 |
| Emissions from stationary combustion – solid | $CO_2$ | 3139.65 | 4473.87 | 0.007 | 4.2 | 86.9 |
| Emissions from stationary combustion – liquid | $CO_2$ | 2505.28 | 2644.94 | 0.004 | 2.7 | 89.6 |
| Fugitive emissions from oil and gas operations | $CO_2$ | 263.75 | 754.57 | 0.005 | 2.8 | 92.4 |
| Fugitive emissions from geothermal operations | $CO_2$ | 376.16 | 301.47 | 0.002 | 1.0 | 93.4 |
| Emissions from cement production | $CO_2$ | 441.67 | 687.90 | 0.002 | 1.0 | 94.4 |
| Consumption of halocarbons and $SF_6$ – aerosols and metered dose inhalers | HFCs & PFCs | 0.00 | 75.57 | 0.001 | 0.5 | 94.8 |
| Fugitive emissions from coal mining and handling | $CH_4$ | 272.13 | 261.83 | 0.001 | 0.5 | 95.3 |

## Recalculation of previously submitted inventory data

Activity data, emission factors, methods and modelling techniques used in the inventory compilation process may be refined as government agencies and consultants identify areas for improvement. Re-calculations that may result from the improvement process are regarded as a standard element of inventory compilation. Before the annual inventory is compiled, areas for improvement are identified at a planning session. The quality assurance and quality control (QA/QC) plan is reviewed annually during the inventory debrief and planning phase. Cross-government inventory managers and general managers are consulted when a large improvement is anticipated for adoption. For the 2010 inventory submission and beyond, all recalculations will be required to be approved through a recalculations approval form before changes are made to the inventory data tables.

## QA/QC plan, quality objectives, internal and external evaluation and review processes and their results

### Quality assurance and quality control plan

Quality assurance (QA) and quality control (QC) are an integral part of preparing New Zealand's inventory. The Ministry for the Environment developed a QA/QC plan in 2004, as required by the UNFCCC reporting guidelines, to formalise, document and archive the QA/QC procedures. The plan is updated annually in conjunction with New Zealand's inventory improvement plan.

New Zealand's greenhouse gas inventory QA/QC plan has been designed to improve the transparency, consistency, comparability, completeness and accuracy of New Zealand's annual greenhouse gas inventory in order to meet IPCC good practice. The plan closely follows the definitions, guidelines and processes presented in Chapter 8 "Quality assurance and quality control" of the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. New Zealand's plan is an open document and is subject to modification and improvement when changes in processes are updated, or on advice from independent reviewers.

The QA/QC plan is intended to ensure transparency and the quality of New Zealand's inventory. The principles of the plan include:

- applying greater quality control efforts for key categories and for those categories where data and methodological changes have recently occurred
- periodically checking the validity of all information as changes in sample size, methods of collection, or frequency of data collection occur
- conducting general quality control procedures (Tier 1) on all parts of the inventory over a period of time
- balancing efforts between development and implementation of QA/QC procedures and continuous improvement of inventory estimates
- customising the quality control procedures to the resources available and the particular characteristics of New Zealand's greenhouse gas inventory
- confirming that the national statistical agency and other agencies supplying data to the inventory have implemented QA/QC procedures.

The QA/QC coordinator is defined as the person who is the national inventory compiler for New Zealand. The responsibilities of the role include:

- keeping the QA/QC plan current by updating it as necessary
- ensuring all planned Tier 1 and Tier 2 quality checks are carried out as planned (these may be undertaken in the agencies where the data is compiled)
- ensuring New Zealand's inventory improvement plan is implemented.

The QA/QC plan, combined with annual inventory experience, indicates areas for future improvements for the inventory, which are then incorporated into the following inventory and each subsequent inventory thereafter.

## Quality control

For the 2009 inventory submission, the Ministry for the Environment used the IPCC Tier 1 QC check sheets. The Tier 1 checks are based on the procedures suggested in the good practice guidance.[134] All key categories for the 2007 inventory year were checked.

Recent reviews under the UNFCCC have recommended New Zealand intensify the time and resources directed at implementing the QA/QC plan, with the aim of reducing the number of minor errors and inconsistencies. New Zealand responded to the recommendation by changing the inventory compilation schedule to allow more time for quality checking.

For the 2009 inventory submission, all sector-level data was entered into the common reporting format database by January 2009. The earlier deadline allowed two months for further quality checking at the sector level (between data spreadsheets and the common reporting format tables) and checking consistency between the common reporting format tables and the national inventory report.

An additional person was contracted into the inventory team at the Ministry for the Environment from December 2008 through to February 2009 to complete quality checks on key categories for the 2007 inventory year. Checks included ensuring the data from the spreadsheets and models was accurately transferred to the common reporting format database, and that data from the database was accurately represented in the draft national inventory report. No significant errors within the source data spreadsheets or between the spreadsheets and the common reporting format database and the draft national inventory report were identified.

Data in the common reporting format database was checked visually for anomalies, errors and omissions. The Ministry for the Environment used the QC checking procedures included in the database to ensure the data submitted to the UNFCCC secretariat was complete.

## Quality assurance

New Zealand's inventory is progressively improving its quality control and assurance system to ensure quality is built in at all stages of the inventory compilation process. In 2008, KPMG, an audit specialist, developed a risk register for the Ministry to highlight potential risks in the data compilation process. The Ministry for the Environment will continue to use the risk register to help prioritise further improvements to the inventory.

For the 2009 inventory submission, improvements focused on building the capacity of the national inventory system. This involved recruitment within the national inventory team and providing documentation for the national inventory compiler role. This has lowered the risk of losing specialised knowledge of New Zealand's national inventory system.

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134 IPCC, 2000. http://www.ipcc-nggip.iges.or.jp/public/gp/english/

Quality assurance reviews of individual sectors and categories were included in the national inventory plan and commissioned by the Ministry for the Environment. A list of previous quality assurance reviews, their major conclusions and follow-up are included in the MS Excel worksheets available with New Zealand's 2009 inventory submission from the Ministry for the Environment's website.[135]

Most of the energy and agricultural activity data (the two largest components of New Zealand's inventory) is provided by Statistics New Zealand, which conducts its own rigorous quality assurance and quality control procedures on the data.

## Internal review

A review of the complete inventory check is performed to ensure all planned checks have been completed before the inventory is submitted. This review includes checking that all the planned Tier 1 and 2 QC checks have been completed and the results filled out in the appropriate Excel tables, any QA exercises have been completed, and the compulsory checks in the CRF software are complete for all sectors.

Before submitting the inventory to the UNFCCC secretariat, internal review is undertaken by staff within the Ministry for the Environment who have not been involved with the inventory compilation process.

## The UNFCCC annual inventory review

New Zealand's inventory was reviewed in 2001 and 2002 as part of a pilot study of the technical review process. The inventory was subjected to detailed in-country, centralised and desk review procedures. The inventories submitted for the years 2001 and 2003 were reviewed in a centralised review process. The 2004 inventory was reviewed as part of the Kyoto Protocol initial review; this was an in-country review held from 19–24 February 2007. The 2007 and 2008 inventory submissions were reviewed during a centralised review in September 2008. In all cases the reviews were conducted by an international team of experts nominated by parties to the UNFCCC. Review reports are available from the UNFCCC website (http://www.unfccc.int).

New Zealand has consistently met the inventory reporting requirements under the UNFCCC and the Kyoto Protocol. The submission of the inventory to the UNFCCC secretariat has consistently met the required deadline under decision 15/CMP.1. The national system for the greenhouse gas inventory, the national registry and the 1990 (base year) inventory were reviewed by an international expert review team in February 2007. The expert review report concluded that:

- "New Zealand's greenhouse gas inventory is consistent with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance, and adheres to the reporting guidelines under Article 7 of the Kyoto Protocol.
- New Zealand's national system is prepared in accordance with the guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol and reported in accordance with the guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol.
- New Zealand's national registry is fully compliant with the registry requirements as defined by decisions 13/CMP.1 and 5/CMP.1."

[135] http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2009/index.html

New Zealand's consistency in meeting the reporting requirements allowed it to be one of the first four Parties to be eligible to participate in the Kyoto Protocol mechanisms. New Zealand's registry (described in the next section), the official transactions and balance of New Zealand's Kyoto units were operational on 1 January 2008.

### Procedures for the official consideration and approval of the inventory

The finalised inventory submission is signed off by the manager responsible for the team compiling the inventory within the Ministry for the Environment. The final approval is by the director who is the designated management sign-off individual for the Chief Executive Officer at the Ministry for the Environment.

Further information on New Zealand's national system can be found in the initial report under the Kyoto Protocol: http://unfccc.int/files/national_reports/application/pdf/new_zealands_initial_report_under_the_kyoto_protocol.pdf and the latest national greenhouse gas inventory report: http://www.mfe.govt.nz/issues/climate/greenhouse-gas-emissions/index.html.

# National registry

The reporting period covered is up to 31 December 2008.

## Registry administrator


| | |
|---|---|
| Name: | Ms Anita Dahya |
| Position: | Project Manager, Ministry of Economic Development |
| Postal address: | PO Box 1473, 33 Bowen Street, Wellington 6011, New Zealand |
| Phone number: | +64 4 474 2843 |
| Fax number: | +64 4 978 3661 |
| Email address: | anita.dahya@med.govt.nz |


## Consolidated registry with other parties

New Zealand does not maintain a consolidated registry with any other parties.

## Database structure

The registry uses a relational database, which runs on SQL server 2005. The database comprises one schema to store application or program data (including all data pertaining to the user transactions through the Web) and also the data that manages the content of the web application, the business rules and other backend processing data. The hardware supporting SQL server in production meets Microsoft's recommended server specifications. The production SQL server has a C drive of 34 GB and an E drive SAN attached of 30 GB.

## Data exchange

The New Zealand registry was initialised in 2007. During May 2009 the New Zealand registry was successfully re-certified. This has demonstrated that the New Zealand registry performs as per Data Exchange Standards.

## Minimising discrepancies

The New Zealand Registry has a multitude of checks in place to ensure discrepancies in transactions are minimised. For example, the web application interface prevents users from selecting the wrong units to fulfil a notification (where the unit blocks are specified). For the most part, checks in the New Zealand Registry follow the checks performed by the ITL on a given transaction. The New Zealand Registry also has a robust reconciliation and manual intervention process, which allows ease of correction of reconciliation discrepancies.

## Security measures

The Ministry of Economic Development has established a security plan specifically for the New Zealand Emission Unit Register (the Register). The plan has three parts:

- server security, which protects the physical servers and access to the underpinning software and databases
- web application security, which prevents unauthorised access to Register information
- session security, which protects Register data as it is transmitted over the internet.

The server security plan restricts physical and remote access to the servers hosting the Register. Only authorised personnel have access to the data centre where the servers are located. The Ministry of Economic Development must authorise any access to the servers, and photo identification is required. Remote access to the servers is controlled by a firewall and a virtual private network.

The web application security component ensures that access to the Register has been appropriately authorised. Users must log in to the web application using a unique username and password to gain access. There are several security groups that users are assigned to, with different levels of permissions and data access.

Session security ensures the Register data is not intercepted when it is transmitted over the internet. Data transmitted between the Register and users is encrypted using server gated cryptography, regardless of operating system or browser type. An authenticated user session will be automatically terminated (logged out) after 15 minutes of inactivity.

## Information availability

The following information is available via the publically accessible user interface to the Register:

- a list of emission unit holdings and transactions
- a list of transactions between the Register and overseas registers
- a list of accounts in the Register
- a list of account holders in the Register and their legal addresses
- a list of New Zealand projects eligible for emission units.

## Internet address

The internet address for the Register is: http://www.eur.govt.nz.

## Integrity of data storage

To cover Register data security and data recovery in the event of disaster, the system is backed up daily. There is a data recovery site in Auckland, and there is log shipping every 5 minutes to the Auckland data recovery centre, along with a complete copy every night.

## Results of test procedures

There were no significant changes during the 2008 year. The original initialisation occurred in 2007 and information on these procedures was provided in New Zealand's initial report.

# Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17

In the net position report produced in May 2009, New Zealand's net emissions of greenhouse gases over the first commitment period were projected to be 293.2 Mt $CO_2$-e.[136] A total of 6.8 million Kyoto units have been promised to projects under the Projects to Reduce Emissions programme, so the Government's projected liability is 300 million units, 3 per cent under New Zealand's assigned amount (309.6 million units). This includes 85 million tonnes of projected removal units from forests, mostly planted in the mid- to late 1990s. As a result, New Zealand will not need to use the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol to meet its emissions reduction target.

# Policies and measures in accordance with Article 2

## Sustainable development

All of New Zealand's climate change policies promote sustainable development (please refer to chapter 4: Policies and measures).

## Aviation and marine bunker fuels

New Zealand's geographical remoteness, coupled with international tourism being a significant economic earner, makes addressing international aviation emissions a key concern. Airways New Zealand (New Zealand's air navigation service provider) is working together with other countries' air navigation service providers to improve efficiencies on international or long-haul routes through the Asia-Pacific Initiative to Reduce Emissions (ASPIRE). This includes demonstrating the capabilities of advanced Air Navigation Services and Airline fuel optimisation initiatives in current operations (eg, improved air traffic management, continuous climb departures, user preferred routes). The New Zealand Government has also facilitated the bio-fuel trials conducted by Air New Zealand. In terms of estimates of emission from

[136] http://www.mfe.govt.nz/publications/climate/net-position-report-2009/index.html

international aviation, New Zealand revised the allocation between domestic and international aviation emissions in 2008.

The Government plays an active role within the International Maritime Organization's Maritime Environment Protection Committee, where international greenhouse gas emissions are considered. International maritime transport is critical for New Zealand's primary products, which make up two-thirds of exports. A joint inter-departmental project is investigating methods for calculating greenhouse gas emissions from international shipping, and the results of this will contribute to primary sector carbon footprinting analysis.

## Minimising adverse effects

New Zealand's Cabinet and legislative processes to establish and implement climate change response measures include consultation with the Ministry of Foreign Affairs and Trade and with the public. The Ministry provides advice on international aspects of proposed policies, and during the public consultation phase, concerns and issues about the proposed measure can be raised by any person or organisation.

Through the Government's regular trade, economic and political consultations with other governments, including some developing countries, there are opportunities for those who may be concerned about the possible or actual impacts of New Zealand policies to raise concerns and have them resolved within the bilateral relationship. To date there have been no specific concerns raised about any negative impact of New Zealand's climate change response policies.

The New Zealand Government, through NZAID, has regular Official Development Assistance programming talks with partner country governments at which partners have the opportunity to raise concerns about any impacts and to ask for or prioritise assistance to deal with those impacts. NZAID also works with partner developing countries to strengthen governance and enabling environments, which improve their ability to respond to changing circumstances. As a member of the Pacific Islands Forum, New Zealand works closely with developing countries in the Pacific in a wide range of technical, economic and political fields, addressing concerns that are raised in the regional context.

New Zealand maintains a liberalised and open trading environment, consistent with the principles of free trade and investment, ensuring that both developed and developing countries can maximise opportunities in New Zealand's market regardless of the response measures undertaken.

# Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures

The Climate Change Response Act 2002 put in place the legal framework that allowed New Zealand to ratify the Kyoto Protocol and to meet its obligations under the UNFCCC. The Act includes powers for the Minister of Finance to manage New Zealand's holdings of units, which represent New Zealand's target allocation for greenhouse gas emissions under the Protocol. It enables the Minister to trade those units on the international market and establishes a register to record holdings and transfers of units. The Act also establishes a national inventory agency to record and report information relating to greenhouse gas emissions in accordance with international requirements.

The Climate Change Response (Emissions Trading) Amendment Act 2008 established the New Zealand Emissions Trading Scheme. The Act describes the legal details of the scheme. Regulations relating to the emissions trading scheme have also been made under the Climate Change Response Act. The New Zealand Emissions Trading Scheme is described in more detail in Chapter 4.

# Information under Article 10

Activities undertaken by New Zealand in fulfilment of commitments under Article 10 of the Kyoto Protocol are reported on in chapters 4, 6, 7, 8 and 9. The steps taken by New Zealand to promote, finance and facilitate the transfer of technology to developing countries are reported on in chapter 7.

# Financial resources

The steps taken for New Zealand to meet its obligations under Article 11 of the Kyoto Protocol are outlined in Chapter 7: Financial resources and technology transfer.

# Annex C: Summary of policies and measures

**Table C.1: Summary of policies and measures by sector**

| Name of policy or measures | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity or entities | Estimated mitigation in: | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2009 (Gg CO2-e per year) | 2020 (Gg CO2-e per year) | 2040 (Gg CO2-e per year) |
| New Zealand Emissions Trading Scheme | The scheme will cover all sectors and all gases, and will reduce emissions by making emitters pay for any emissions covered under the Kyoto Protocol. | $CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, $SF_6$. | Economic, regulatory | Implemented | The Ministry of Economic Development, the Ministry of Agriculture and Forestry, and the Ministry for the Environment | | 10,000 | |
| Marine Energy and Distributed Generation Funds | Providing financial assistance and support for research into, and deployment of, marine and small-scale electricity generating activities. | $CO_2$, $N_2O$ | Fiscal and information | Implemented | Energy Efficiency and Conservation Authority | | 70 | |
| Efficient Products Programme | This programme develops energy efficiency measures for a range of residential, commercial and industrial products, and allows both New Zealand and Australia to set consistent standards and measures for energy efficiency. | $CO_2$ | Regulatory, voluntary, information | Implemented | Energy Efficiency and Conservation Authority | | 1,400 | |
| Business programmes | Provides information on new technologies and energy management, grants for energy audits and demonstrations of new technology, and one-on-one support for energy-intensive businesses. Grant funding is available for new or under-utilised technology improvements. | $CO_2$ | Voluntary, information, fiscal | Implemented | Energy Efficiency and Conservation Authority | | 32 | |

| Name of policy or measures | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity or entities | Estimated mitigation in: | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2009 (Gg CO2-e per year) | 2020 (Gg CO2-e per year) | 2040 (Gg CO2-e per year) |
| ENERGYWISE homes | Aims to increase energy efficiency in homes by providing information and grants for energy efficiency measures. Also provides information on the funding available to reduce energy consumption, including clean space heating options and solar hot water. | $CO_2$ | Information, fiscal | Implemented | Energy Efficiency and Conservation Authority | | 20 | |
| Electricity efficiency programme | Provides subsidies for efficient electrical products such as light bulbs and electric motors. Subsidies are also available for projects to improve efficient use of electricity in commercial buildings. | $CO_2$ | Fiscal, information | Implemented | Electricity Commission | 89 | | |
| Energy efficiency in government | Supports central and local government entities to implement energy efficiency initiatives within their own operations. Provides information and forums to improve awareness of energy efficiency in the community. Also provides grant funding for energy audits. | $CO_2$ | Fiscal, information | Implemented | Energy Efficiency and Conservation Authority | | NE | |
| Vehicle fuel economy labelling | Allows consumers to make a more informed choice when purchasing a vehicle and to place an appropriate value on fuel economy. | $CO_2$ | Regulatory | Implemented | New Zealand Transport Agency and the Energy Efficiency and Conservation Authority | | 43 | |

| Name of policy or measures | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity or entities | Estimated mitigation in: | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2009 (Gg CO2-e per year) | 2020 (Gg CO2-e per year) | 2040 (Gg CO2-e per year) |
| Renewable transport fuels including biofuels | To encourage greater production of biofuels` and to ensure equal incentives for different types of biofuels between now and 2012, the Government has agreed to provide a grant to biodiesel producers. | $CO_2$ | Fiscal | Implemented | Energy Efficiency and Conservation Authority | | NE | |
| Electric vehicles | Promote uptake of electric vehicles in New Zealand, by exempting them from road-user charges. | $CO_2$ | Fiscal | Implemented | Energy Efficiency and Conservation Authority | | NE | |
| Other transport measures | These include research and driver training to promote more efficient driving practices, and funding to improve and promote the use of public transport in New Zealand. | $CO_2$ | Education and fiscal | Implemented | Ministry of Transport and other agencies across government | | NE | |
| Global Alliance on agricultural emissions | A worldwide virtual network set up for climate change research into agriculture and food production. | $CH_4$, NO | Research | Planned | | | NE | |
| Primary Growth Partnership (PGP) | Provides investment in significant programmes of research and innovation to boost the economic growth and sustainability of New Zealand's primary, forestry and food sectors. | $CH_4$, NO, $CO_2$ | Research, information | Implemented | Foundation for Research, Science and Technology | | NE | |
| Pastoral Greenhouse Gas Research Consortium (PGGRC) | A partnership between the Government and the dairy and fertiliser industries which provides livestock farmers with the information and means to mitigate their greenhouse gas emissions. | $CH_4$, NO | Research, information, education | Implemented | Ministry of Agriculture and Forestry and the Foundation for Research Science and Technology | | NE | |

| Name of policy or measures | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity or entities | Estimated mitigation in: | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2009 (Gg CO2-e per year) | 2020 (Gg CO2-e per year) | 2040 (Gg CO2-e per year) |
| Sustainable Land Management and Climate Change Plan of Action | Initiatives and programmes in the agricultural and forestry sectors that focus on adaptation to climate change, reducing emissions and enhancing sinks, and new business opportunities. | $CH_4$, NO | Research, information, education | Implemented | Ministry of Agriculture and Forestry | | NE | |
| East Coast Forestry Project | The main purpose of this project is to reduce erosion by encouraging tree planting on erosion-prone land. The project also enhances the sequestration of carbon in forest sinks. | $CO_2$ | Voluntary agreement | Implemented | Ministry of Agriculture and Forestry | | | 399 |
| Afforestation Grant Scheme | Aims to increase the area of Kyoto-compliant forest in New Zealand by offering a simpler alternative to the NZ ETS for landowners with small tracts of forest. | $CO_2$ | Fiscal, voluntary agreement | Implemented | Ministry of Agriculture and Forestry | | | 154 |
| Permanent Forest Sinks Initiative | Promotes the establishment of permanent forests on previously unforested land by offering the opportunity to earn assigned amount units for carbon sequestered in permanent forests established after 1 January 1990. | $CO_2$ | Voluntary agreement | Implemented | Ministry of Agriculture and Forestry | | | 84 |
| Increasing the use of wood as a construction material | A range of initiatives designed to increase the use of wood as a construction material, such as: funding full life-cycle analysis research, professorship positions, and funding demonstration buildings. | $CO_2$ | Research, information, education | Implemented | Ministry of Agriculture and Forestry | | NE | |

| Name of policy or measures | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity or entities | Estimated mitigation in: | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2009 (Gg CO2-e per year) | 2020 (Gg CO2-e per year) | 2040 (Gg CO2-e per year) |
| Waste Minimisation Act 2008 | Aims to lower the social costs and risks from waste, reduce the damage to the environment from waste generation and disposal, and increase economic benefits by encouraging more efficient use of materials. It will also contribute to reducing greenhouse gas emissions from the waste sector. | $CH_4$ | Regulatory | Implemented | Ministry for the Environment | | NE | |
| National Environmental Standard for Landfill Methane. | Requires landfill sites with a design capacity greater than 1 million tonnes of refuse to collect and destroy methane emissions. | $CH_4$, $CO_2$ | Regulatory | Implemented | Ministry for the Environment | | NE | |

NE: Not estimated

# New Zealand's report on the **Global Climate Observing System**

# New Zealand's Report on the Global Climate Observing System (GCOS)

# 1 Introduction

New Zealand maintains a systematic programme of atmospheric, oceanic and terrestrial measurements of a suite of essential climate variables. These measurements build on a historical archive of observations of climate-related parameters. The measurement programmes are detailed in this report, which is written in accordance with the revised United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines on global climate change observing systems (Decision 11/CP.13). This report provides an update of the material New Zealand provided on its national Global Climate Observing System (GCOS) activities as part of its *Fourth National Communication* in 2006.

# 2 Common issues

## 2.1 National coordination

A number of agencies in New Zealand undertake observations in support of the GCOS. The Meteorological Service of New Zealand (MetService) undertakes routine surface and upper air weather observations, and these are archived in the National Climate Database. The National Institute of Water and Atmospheric Research (NIWA) makes dedicated atmospheric and hydrological climate observations, and this data is also archived in the National Climate Database as well as in the National Water Resources Archive. NIWA also makes measurements of atmospheric constituents relevant to climate forcing.

NIWA, Land Information New Zealand (LINZ) and the Pacific Tsunami Warning Center make routine oceanic observations and maintain sea-level recording networks around the coast of New Zealand. LINZ coordinates the archiving and submission of quality-assured, sea-level data from ports, including Global Sea Level Observing System (GLOSS) stations, to international databases, and has the responsibility for compiling the national report for New Zealand to the biennial GLOSS Experts Meeting organised by the Intergovernmental Oceanographic Commission.

The New Zealand Ministry of Fisheries contracts out regular surveys of various fish species to set maximum allowable catch limits and quotas. The resulting data sets are useful for assessing climate change impacts on fisheries. Landcare Research maintains the National Vegetation Survey databank and also maintains five New Zealand long-term ecological research and monitoring sites. The Ministry of Agriculture and Forestry and the Ministry for the Environment maintain land-use databases, including planted forest cover databases for New Zealand through the Climate Change Information System and the Land Use and Carbon Analysis System (LUCAS). These two systems are designed to monitor carbon changes resulting from afforestation, as well as deforestation through logging, fires and other forms of vegetation clearance.

Although New Zealand has no national GCOS implementation plan, most specific observation networks are well coordinated nationally. A new national coordinator for GCOS (Greg Bodeker) was appointed in late 2008. The development of an integrated NIWA and MetService observing network plan should further enhance inter-agency communication and coordination of GCOS activities. A new joint initiative, the New Zealand Climate Change Centre, has been formed by New Zealand's Crown research institutes together with Victoria University and Canterbury University, and this will also help in meeting GCOS goals.

## 2.2 Ensuring high-quality climate data

Since the *Fourth National Communication*, a change has been made regarding the accessibility of the data stored in the National Climate Database. Previously, a modest price was charged to most users to support part of the cost of maintaining a data delivery service, but this data is now available at no cost over the internet. This has resulted in an explosive growth in the use of this climate data.

Over the last few years, extensive audits have been undertaken of the main data tables comprising the National Climate Database, and these audits have resulted in the removal of many errors.

Where possible, when updating a climate station from manual readings to automatic data collection there is an overlap for several months, during which time data is collected from both systems. Regular (generally annual) site inspections are conducted to exchange instruments with newly calibrated instruments. Before data is placed in the final data tables it is subjected to numerous quality control procedures, with suspect data flagged for in-depth inspection. Further development of the quality control procedures is planned for the near future.

Funding made available for undertaking GCOS-related measurements does not depend on adhering to the GCOS climate monitoring principles (GCMPs) adopted by the Conference of the Parties (COP) in decision 11/CP.9. Nevertheless, every effort is made to ensure the highest possible data quality, and to ensure errors resulting from changes in technology and observing practices are kept to a minimum.

In a few cases, measurements made by non-government, for-profit organisations (eg, port companies, electric power companies) are not being made freely available outside of those organisations and are not being submitted to international databases. The data is considered commercial proprietary information and there is insufficient incentive to share this data with other external databases.

Currently (mid-2009), volatility in international shipping is compromising New Zealand's ability to find long-term ships to make Voluntary Observing Ship Climate (VOSClim) observations.

## 2.3 Capacity building

MetService, under a New Zealand Government contract, provides general advice and technical assistance to the Cook Islands, Fiji, Kiribati, Niue, Samoa, Tuvalu, Tokelau and Tonga to ensure the continuity and integrity of climate data gathered in these countries as part of the Pacific Island GCOS programme. Under a joint New Zealand–US GCOS Technical Support Programme, MetService also provides general assistance and routine in-country technical preventive and emergency maintenance support to Global Upper Air Network (GUAN) stations in the Solomon Islands (Honiara), Papua New Guinea (Port Moresby), Vanuatu (Bauerfield) and Fiji (Nadi). The Technical Support Programme is supported under the New Zealand – US Climate Change Partnership.

MetService, under a joint New Zealand – Met Office UK Pacific Trust Fund partnership, also provides technical assistance to the management and operations of the GUAN stations in Tuvalu (Funafuti) and Kiribati (Tarawa). Targeted in-country technical training and observing practices are routinely carried out. MetService provides facilities for the global telecommunications systems (GTS) by maintaining a regional telecommunication hub on the GTS in Wellington for the purpose of relaying observations to and from Australia and South Pacific Islands' national meteorological centres (NMCs), and relaying forecasts, analyses and other products to and from Australia and New Zealand to Pacific Islands NMCs. MetService also hosts the Pacific regional RAdio-InterNET (RANET) hub serving as a back-up telecommunications system to the GTS.

## 2.4 Palaeoclimate data

Several Crown research institutes and universities are engaged in collecting palaeoclimate data with the goals of:

- providing a window into how the Earth's environment was affected by past warm periods

- providing data on natural climate change over time, and the accompanying environmental signals
- extending the context for historical records.

New Zealand is actively involved in the international ANDRILL (Antarctic DRILLing) programme in Antarctica (http://www.andrill.org). Antarctica New Zealand is the project operator, and expertise from Victoria University of Wellington and Webster Drilling and Exploration has been contracted by Antarctica New Zealand to develop, test and operate the drilling system. The goal of ANDRILL is to investigate past Antarctic climate from sediment cores in the McMurdo region. Site survey work and the development of the drilling system began in 2001 and the first drilling season at the ANDRILL McMurdo Ice Shelf drill site was completed in December 2006. The second drilling phase, the ANDRILL Southern McMurdo Sound project, was completed in December 2007. These first two drilling projects include the two deepest drill holes on the Antarctic continent, at 1284.87 and 1138.54 metres below the sea floor, respectively (both with 98 per cent recovery).

The resultant ice cores provide a unique record of the history of the Ross Ice Shelf and Antarctic ice sheets spanning the last 20 million years, comprising numerous cycles of ice advance and retreat under a range of climatic conditions. Some of this data may represent extended periods when the climate was a few degrees warmer and atmospheric carbon dioxide higher than at present, much like that projected for the future under many current climate change scenarios. ANDRILL palaeoclimate data is being integrated with the latest ice sheet models to better predict the future response of Antarctic ice sheets to global warming.

Although understanding of palaeoclimatology in specific marine regions (eg, the Chatham Rise, Campbell Plateau, eastern North Island) is reasonable, knowledge is sparse in other areas of national and international importance (eg, western New Zealand, south of the Campbell Plateau towards Antarctica, and north of New Zealand to the Tasman Front). Decadal and century-scale records are sparse, with the exception of a few spatially restricted localities along East Cape. (For example, core MD97-2121, which shows a rapid sedimentation rate of up to 42 centimetres per thousand years, yields a detailed record of South West Pacific Ocean conditions over the last glacial cycle.)

To better define the temporal resolution of climate variability, ranging from decadal to glacio-eustatic cycles, NIWA is currently expanding studies into western and southern New Zealand marine regions. It is targeting high sedimentation areas (eg, core MD06-2991, with a sedimentation rate of around 10 centimetres per thousand years, off the West Coast of the South Island), and expanding high-resolution annual/decadal to millennial records of ocean climate, as recorded by otoliths, molluscs and deep-sea corals, both temporally and spatially, within New Zealand waters. (For example, a time series from the deep sea coral *keratosis* spp. has been derived from four sites around New Zealand extending back several hundred years.)

# 3 Atmospheric essential climate variables

## 3.1 Programmes

There are two primary sources of New Zealand atmospheric observations relevant to climate change: the routine surface and upper air weather observations undertaken by MetService, and dedicated climate observations and atmospheric constituent measurements undertaken by NIWA. NIWA is assisted by many voluntary observers, especially for rainfall monitoring. MetService forwards its weather observations to NIWA, where they are archived in the National Climate Database along with NIWA's own measurements. MetService and NIWA both pay particular attention to quality control. NIWA's climate monitoring and archiving programme carries ISO9002 certification, and MetService has ISO9001 certification.

NIWA's plans for the national climate network include continuing with gradual automation as funding permits, and NIWA staff regularly review the network in terms of user requirements, including the requirements of MetService. Planning for climate and atmospheric constituent measurements takes place as part of the Foundation for Research, Science and Technology (FRST) proposal and contracting process. The reference climate network is a subset of the national climate network and was established in the late 1980s. It currently consists of 49 stations (including 19 back-up stations) located across mainland New Zealand, the outlying islands (Raoul, the Chathams and Campbell) and the Ross Dependency (Scott Base). This resulted from a recommendation from the 10th session of the Commission for Climatology of the World Meteorological Organization (WMO).

## 3.2 Support

Funding for the core weather observations comes from a Ministry of Transport contract to MetService, with some extra observations funded out of commercial revenue. Dedicated climate observations are funded by a contract to NIWA from FRST, which recognises the climate database as being of national importance. Funding levels allocated by FRST, combined with revenue from commercial applications of the data, provide for the database and recording network to be maintained at their current levels. Atmospheric constituent measurements are also funded by FRST as part of specific research programmes.

## 3.3 Availability and exchange

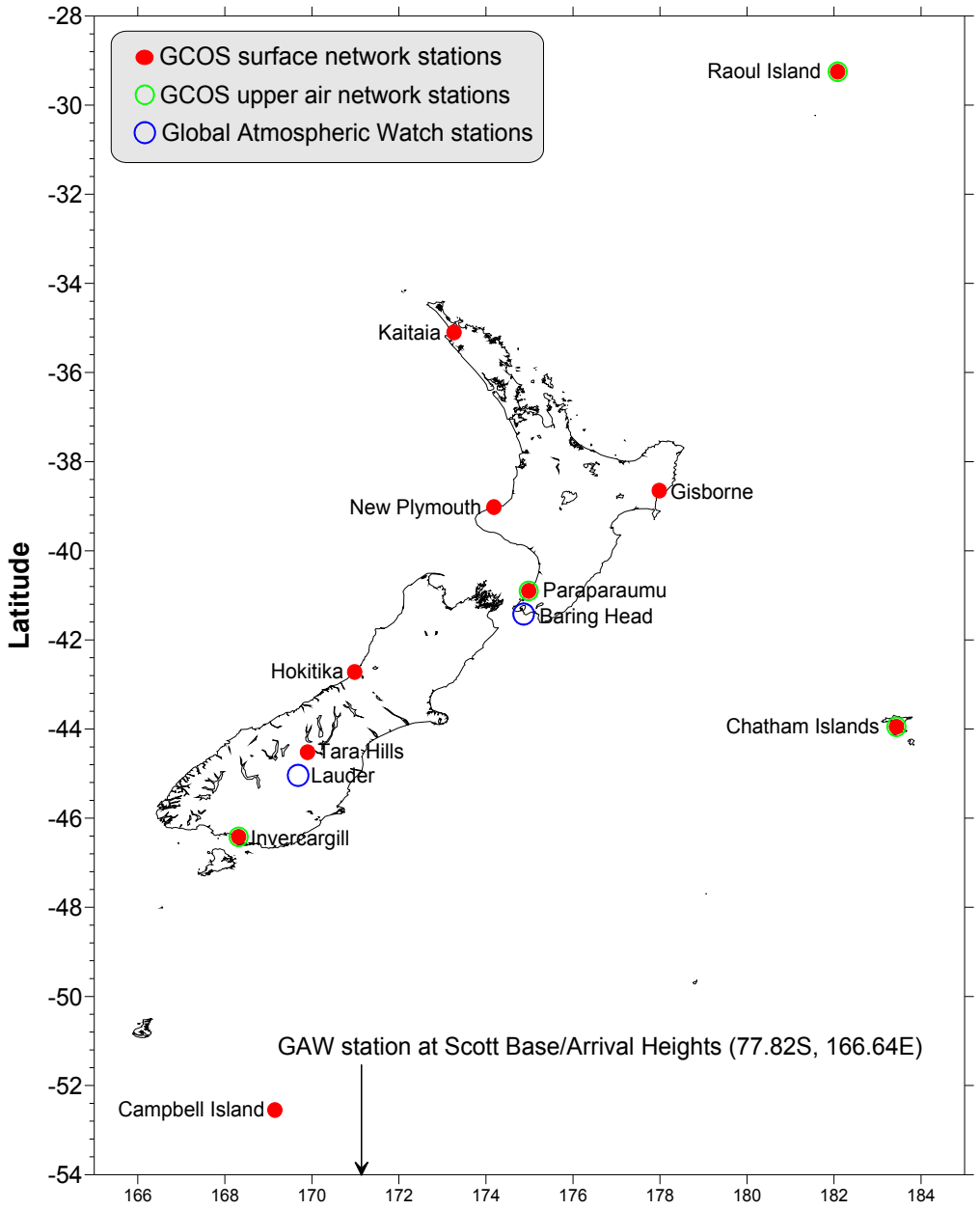
NIWA has developed user-friendly web access to the data stored in the National Climate Database, which is now freely available (http://cliflo.niwa.co.nz/). Only a subset of the observations catalogued in the National Climate Database is submitted to WMO archives. Appropriate weather observations are forwarded to other countries by MetService in real time through WMO networks, and NIWA puts National Oceanic and Atmospheric Administration (NOAA) advanced TIROS (Television Infrared Observation Satellite) operational vertical sounder (ATOVS) data on WMO networks via the regional ATOVS retransmission service. New Zealand provides climate and greenhouse gas monitoring data to international data centres under the joint WMO–International Council of Scientific Unions programmes which comprise GCOS. Solar radiation data, while archived nationally, is not currently being submitted to international archives.

## 3.4 Weather and climate observations

New Zealand has 10 stations providing data to international data centres as part of the Global Surface Network, and four stations that report as part of the Global Upper Air Network (GUAN) (see figure 1). The Global Surface Network stations at Kaitaia, Paraparaumu Aerodrome and Invercargill Aerodrome are operated manually by observers on contract to MetService. The other seven stations are automatic stations owned and operated by MetService. Detailed metadata for these stations is compiled, and site inspections are regularly carried out by NIWA staff and MetService engineers. Copies of inspection reports are available through NIWA's Instrument Systems group in Christchurch. At present the Global Surface Network station at Tara Hills does not fully meet GCOS standards because surface pressure is not measured at this site.

All four GUAN stations measure air temperature, humidity, wind speed and wind direction. Currently, at the Chatham Islands and Raoul Island, temperature and humidity are measured by radiosonde and wind is calculated using Global Positioning System modules incorporated into the radiosondes (model Vaisala RS92 SGP). At Paraparaumu and Invercargill, temperature and humidity are measured by radiosonde (model Vaisala RS92K), but wind is calculated using a separate radar tracking system.

**Figure 1: The location of key New Zealand GCOS site**




**Note:** GAW = Global Atmospheric Watch

A total of 222 stations provide climate observations at 9 am each day to the National Climate Database; 148 of these are automatic stations which also provide information at other times of the day. There are currently 668 stations providing daily rainfall data to the database. In addition, NIWA maintains satellite data archives for:

- the New Zealand region of the NOAA high resolution picture transmission (HRPT) data, (1992 to the present)
- geostationary meteorological satellite and multifunctional transport satellite data products (August 1998 to March 2008)
- SeaStar SeaWiFS HRPT data (May 2000 to the present)
- Terra and Aqua Direct Broadcast data (August 2007 to the present).

There are 117 stations measuring surface global solar radiation. At five of these sites (Kaitaia, Paraparaumu, Lauder, Invercargill and Scott Base), this is complemented by measurements of direct and diffuse radiation.

Although there are no ocean mooring network platforms measuring air temperature, wind speed and direction, and air pressure, these essential climate variables are measured at seven small isolated island or platform locations (Raoul Island, Campbell Island, Enderby Island, South West Cape, Stewart Island, Maui A platform and Mokohinau Island).

## 3.5 Atmospheric constituents

New Zealand has three stations providing atmospheric constituent data to international data centres as part of the Global Atmospheric Watch (GAW) (see figure 1). Concentrations and isotope ratios of carbon dioxide, methane, carbon monoxide and nitrous oxide, as well as aerosol chemistry of iron and sulphur, are monitored at the Baring Head clean air monitoring station. Some of these gases are also monitored at Lauder and at Arrival Heights, Antarctica (see table 1D). Twice-monthly frost point hygrometer flights are made from Lauder under contract from the NOAA GCOS office to measure water vapour profiles into the stratosphere. Vertical ozone profile measurements are made at Lauder using ozonesondes, ozone lidars and a microwave radiometer. Total column ozone measurements are made at Lauder and Arrival Heights using Dobson spectrophotometers.

New Zealand also uses ships of opportunity to collect air samples to analyse for the principal greenhouse gases, and Hi Vol sampling of iron between Nelson in New Zealand and Osaka in Japan. In addition, Microtops sun-photometer readings to measure aerosol optical depth and ozone are made when sky conditions allow, and this data is available as part of the Aeronet Maritime Aerosol Network programme. Continuous condensation nuclei measurements are also made between Nelson and Osaka on each voyage.

Continuous *in situ* measurements of carbon dioxide, methane, nitrous oxide and carbon monoxide have recently been initiated at Lauder. This measurement programme is in its commissioning phase and so the site is not listed in table 1C. It is expected to become fully operational within the next year. Near infra-red Fourier Transform Spectrometer measurements of column amounts of the same gases are also made at Lauder.

## 3.6 Response to GCOS implementation plan

A number of actions have been initiated in response to the recommendations on atmospheric essential climate variables in the GCOS implementation plan, and these are discussed briefly below.

### Applying the global climate monitoring principles (GCMPs) to all surface climate networks

The GCMPs are adhered to because they are incorporated in criteria already in place for the routine management of the surface climate network. A particular focus in recent years has been the infilling of remote data-poor regions and regions sensitive to change, which is now possible due to advances in technology and the conversion of some research observing systems to long-term operations. NIWA and MetService collaborate closely on the surface climate network in all facets, from instrumentation to the location of new sites. The GCMPs are applied to ships that participate in VOSClim; these ships are a subset of the VOS ships that provide high-quality observations.

### Implementing a reference network of high-altitude, high-quality radiosondes

New Zealand has been invited by the WMO to establish a GCOS reference upper-air network site at Lauder. A representative from New Zealand has attended the two network implementation meetings held. At present, funding for establishing this station has not been secured.

### Submitting metadata records and inter-comparisons for radiosonde observations to the specified international data centres

Although metadata records are collected and forwarded to international data centres, it is not practical to conduct inter-comparisons for radiosonde observations on-site in New Zealand. New radiosondes are assessed by international panels before they are implemented.

### Data rescue

NIWA is coordinating the collation of a historical severe weather events searchable database for New Zealand going back to the 1840s, including information on impacts, damage, casualties and disruption. This work is due to be completed in 2011. A project focusing on Pacific Island climate data rescue back to the 1800s is also underway.

## 3.7 Satellite-based measurement programmes

New Zealand does not have a dedicated satellite-based measurement programme of atmospheric essential climate variables, and therefore table 2 has been omitted from this report. However, a number of ground-based measurement programmes contribute data for the validation and interpretation of satellite-based measurements. MetService radiosonde observations are used extensively by global (and NIWA's) numerical weather prediction centres to remove forward model biases from radiative transfer models.

Measurements of atmospheric constituents at Lauder form part of the total carbon column observing network (http://www.tccon.caltech.edu/). Measurements of stratospheric trace gases and aerosols at Lauder and at Arrival Heights support a number of satellite-based measurement programmes in the USA, Europe and Japan. One of these programmes targets the ground-based validation of measurements made from ENVISAT (ENVIronment SATellite). NIWA participates in an international collaboration to provide long-term validation of three of the atmospheric instruments carried on ENVISAT (SCIAMACHY, GOMOS and MIPAS). This includes making correlative measurements of ozone and other atmospheric gases using spectrometers and ozonesondes from several ground-based stations.

In addition, NIWA holds four satellite data direct broadcast archives:

- NOAA HRPT data (in satellite data stream format), from 1992 to the present, for NOAAs 10, 11, 12, 14, 15, 16, 17, 18 and 19
- geostationary meteorological satellite and multifunctional transport satellite data products, from August 1998 to March 2008, including those from the back-up of GMS-5 by GEOS-9
- SeaStar SeaWiFS HRPT data, from May 2000 to the present
- Terra and Aqua Direct Broadcast data (all instruments), from August 2007 to the present.

NIWA has developed a number of data products from these data streams, including 1-kilometre resolution sea-surface temperature analyses, cloud mask, cloud type and estimated rain rate.

These derived data products have been collocated with MetService meteorological radar (three radars), an advanced microwave sounder unit (20 spectral intervals), a high-resolution infrared sounder (HIRS) (20 spectral channels), and an advanced very-high-resolution radiometer (5/6 channels), for NOAA14, NOAA15, NOAA16, NOAA17 and NOAA18. This is called the NIWA ATOVS Collocation Archive, and it is being used to develop algorithms that could be used to monitor the hydrological cycle over an area within a radius of 2000 kilometres from Wellington, and to improve the value of satellite sounder radiances in numerical weather prediction through improved detection of unmodelled, radiative transfer processes. NIWA has also developed high-resolution (1-kilometre) daily and weekly snow-cover analyses for the New Zealand region using a Bayesian method.

**Table 1A: National contributions to surface-based atmospheric essential climate variables**

| Contributing networks specified in the GCOS implementation plan | Essential climate variables | Number of stations or platforms currently operating | Number of stations or platforms operating in accordance with the GCMPs | Number of stations or platforms expected to be operating in 2010 | Number of stations or platforms providing data to the international data centres | Number of stations or platforms with a complete historical record available in international data centres |
|---|---|---|---|---|---|---|
| **GCOS surface network (GSN)** | Air temperature | 10 | 10 | 10 | 10 | 10 |
| | Precipitation | 10 | 10 | 10 | 10 | 10 |
| **Full World Weather Watch / Global Observing System (WWW/GOS) surface network** | Air temperature, air pressure, wind speed and direction, water vapour | 30 | 30 | 30 | 30 | 30 |
| | Precipitation | 20 | 29 | 29 | 29 | 29 |
| **Baseline Surface Radiation Network (BSRN)** | Surface radiation | 1 | 1 | 1 | 1 | 1 |
| **Solar radiation and radiation balance data** | Surface radiation | 94 | 4 | > 94 | 0 | 0 |
| **Ocean-drifting buoys** | Air temperature, air pressure | 12 | 12 | 12 | 12 | 12 |
| **Moored buoys** | Air temperature, air pressure | 0 | 0 | 0 | 0 | 0 |
| **Voluntary Observing Ship Climate Project (VOSClim)** | Air temperature, air pressure, wind speed and direction, water vapour | 1 | 1 | 1 | 1 | 1 |
| **Ocean Reference Mooring Network and sites on small isolated islands** | Air temperature, wind speed and direction, air pressure | 8 | 8 | 8 | 8 | 8 |
| | Precipitation | 7 | 7 | 7 | 7 | 7 |

## Table 1B: National contributions to upper-air atmospheric essential climate variables

| Contributing networks specified in the GCOS implementation plan | Essential climate variables | Number of stations or platforms currently operating | Number of stations or platforms operating in accordance with the GCMPs | Number of stations or platforms expected to be operating in 2010 | Number of stations or platforms providing data to the international data centres | Number of stations or platforms with a complete historical record available in international data centres |
|---|---|---|---|---|---|---|
| **GCOS Upper Air Network (GUAN)** | Upper-air temperature, upper-air wind speed and direction, upper-air water vapour | 4 | 4 | 4 | 4 | 4 |
| **Full WWW/GOS Upper Air Network** | Upper-air temperature, upper-air wind speed and direction, upper-air water vapour | 8 | 8 | 8 | 8 | 12 |

## Table 1C: National contributions to atmospheric composition observations

| Contributing networks specified in the GCOS implementation plan | Essential climate variables | Number of stations or platforms currently operating | Number of stations or platforms operating in accordance with the GCMPs | Number of stations or platforms expected to be operating in 2010 | Number of stations or platforms providing data to the international data centres | Number of stations or platforms with a complete historical record available in international data centres |
|---|---|---|---|---|---|---|
| **World Meteorological Organization / Global Atmosphere Watch (WMO/GAW) Global Atmospheric $CO_2$ & $CH_4$ Monitoring Network** | Carbon dioxide | 1 | 1 | 4 | 1 | 1 |
| | Methane | 3 | 3 | 5 | 2 | 2 |
| | Other greenhouse gases | 4 | 4 | 4 | 3 | 3 |
| **WMO/GAW ozonesonde network** | Ozone | 1 | 1 | 1 | 1 | 1 |
| **WMO/GAW column ozone network** | Ozone | 2 | 2 | 2 | 2 | 2 |
| **WMO/GAW aerosol network** | Aerosol optical depth | 3 | 3 | 3 | 3 | 3 |
| | Other aerosol properties | 4 | 4 | 4 | 4 | 4 |

**Table 1D: Greenhouse gases and related species surface measurements at New Zealand Global Atmosphere Watch stations**

| Species | Baring Head | Arrival Heights | Lauder |
|---|---|---|---|
| $CO_2$ | 1970–present | 1970–present | 2007–present |
| $^{13}CO_2$ | 1998–present | 1998–present | 2007–present |
| $^{14}CO_2$ | 1954–present | Not measured | Not measured |
| $CH_4$ | 1989–present | 1989–present | 2007–present |
| $^{13}CH_4$ | 1990–present | 1992–present | Not measured |
| $^{14}CH_4$ | 1990–present | 1988–1993 | Not measured |
| $N_2O$ | 1996–present | 1996–present | 2007–present |
| $O_2$ | 1999–present | Not measured | Not measured |
| $O_3$ | 1991–present | 2003–present | 2003–present |
| CO | 1989–present | 1989–present | Not measured |
| $^{13}CO$ | 1990–present | 1991–present | Not measured |
| $^{14}CO$ | 1990–present | 1991–present | Not measured |

# 4 Oceanic essential climate variables

## 4.1 Surface ocean observations

Of the five GLOSS sea-level sites (see table 3A), those at Wellington, Auckland and Bluff are operated by port companies (or the regional authority on behalf of the port company); the site at Waitangi, in the Chatham Islands, is operated by the Pacific Tsunami Warning Center (PTWC); and the site at Scott Base, Antarctica, is operated by NIWA and Antarctica New Zealand.

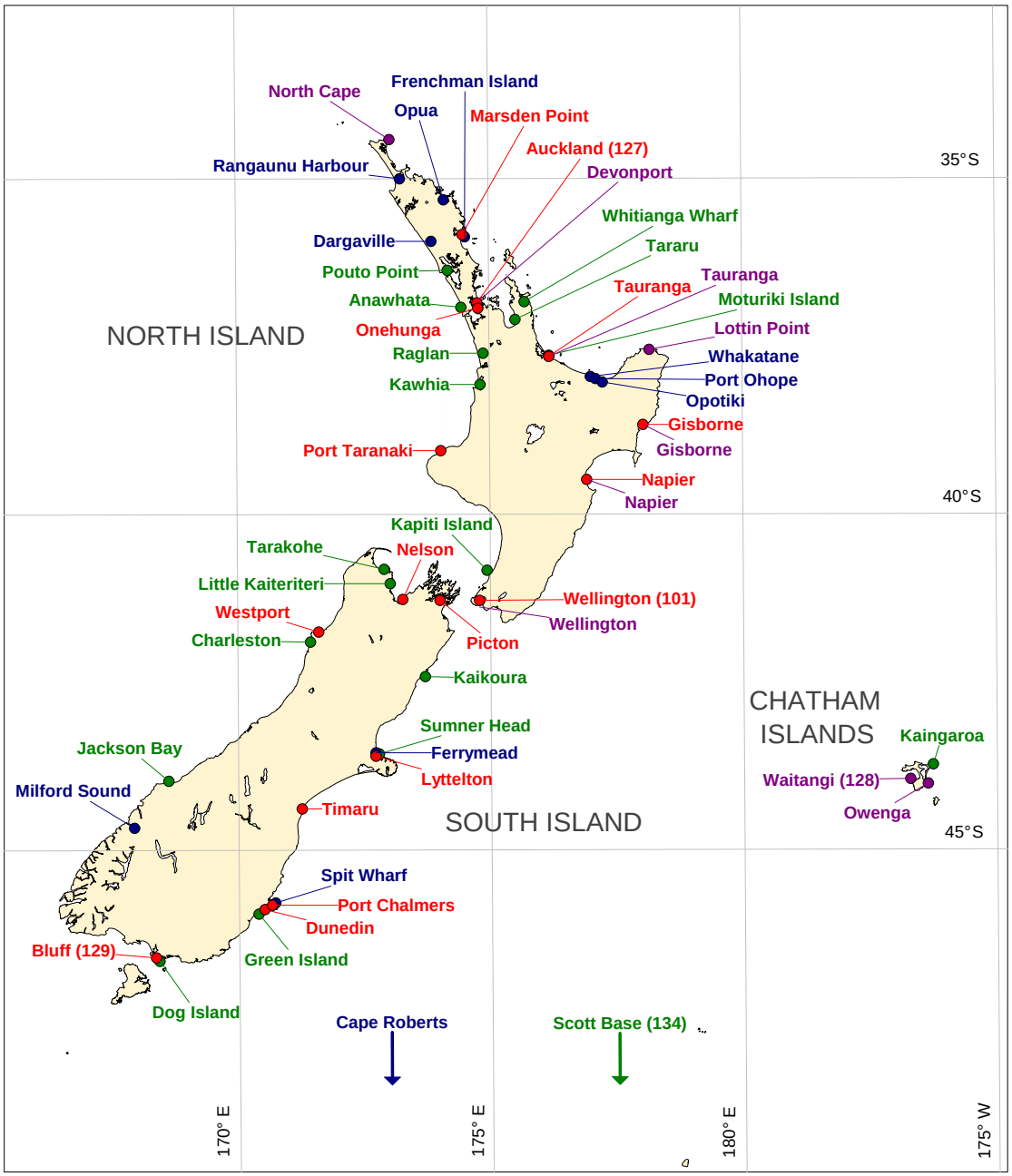
New Zealand does not have a formal, nationally administered network of sea-level gauges. Instead, sea-level gauges are mostly operated independently by various agencies, with some national coordination of daily downloads of data, post-processing and archiving undertaken through voluntary partnerships with either Land Information New Zealand (LINZ) or NIWA. NIWA coordinates and archives a loose network of 22 coastal sea-level recorders, including the GLOSS site at Scott Base (http://www.niwa.co.nz/services/free/sealevels). There are sea-level recorders at 16 major ports operated by port companies or regional authorities. There are a further 14 sea-level stations in major or minor ports and estuaries that are operated independently by port companies or local/regional authorities. There are three stations operated on the Chatham Islands: two by the PTWC (including a GLOSS site at Waitangi Harbour) and one by LINZ and the Institute of Geological and Nuclear Sciences (GNS). The PTWC site at Owenga on the Chatham Islands will soon be decommissioned and only the adjacent LINZ/GNS tsunami gauge will operate there. LINZ also operates a site at Cape Roberts, Antarctica. The locations of sea-level stations in New Zealand are shown in figure 2.

A project is underway, coordinated by LINZ, to develop a real-time tsunami detection and warning system with an optimised network of sea-level gauges. In addition, long-term tide gauge records since around 1900 are held by LINZ and the University of Otago (School of Surveying) for the four main ports of Auckland, Wellington, Lyttelton and Dunedin, and shorter records are held from several other ports and open-coast gauges (also held by NIWA in some cases).

LINZ coordinates the submission of data to international data centres from the GLOSS sites located at ports (sites 101, 127 and 129); NIWA coordinates the data from Scott Base (site 134); and the PTWC coordinates the data from the Chatham Island gauge (site 128). Sea-level data from GLOSS sites 101 and 129 is regularly submitted by LINZ to the University of Hawaii Sea Level Center. Data for the Auckland station (site 127) was last submitted in 2000, and discussions are currently underway about providing international access to more recent Auckland data. Quality-assured data from Scott Base is now available in GLOSS databases up to the start of 2007.

In terms of ocean tides, storm surges and long waves, the open-coast gauges in the NIWA network provide a valuable data set. The earliest site commenced in 1971, with a major expansion of sites from 1994 to 1998. A tsunami detection and monitoring network is operated by GNS Science (http://www.geonet.org.nz/tsunami/gauges/index.html). Currently eight sites are operating, and the data is publicly available from the LINZ site: http://www.linz.govt.nz/hydro/tidal-info/gauges/index.aspx.

**Figure 2: Sea-level monitoring sites in and around New Zealand**



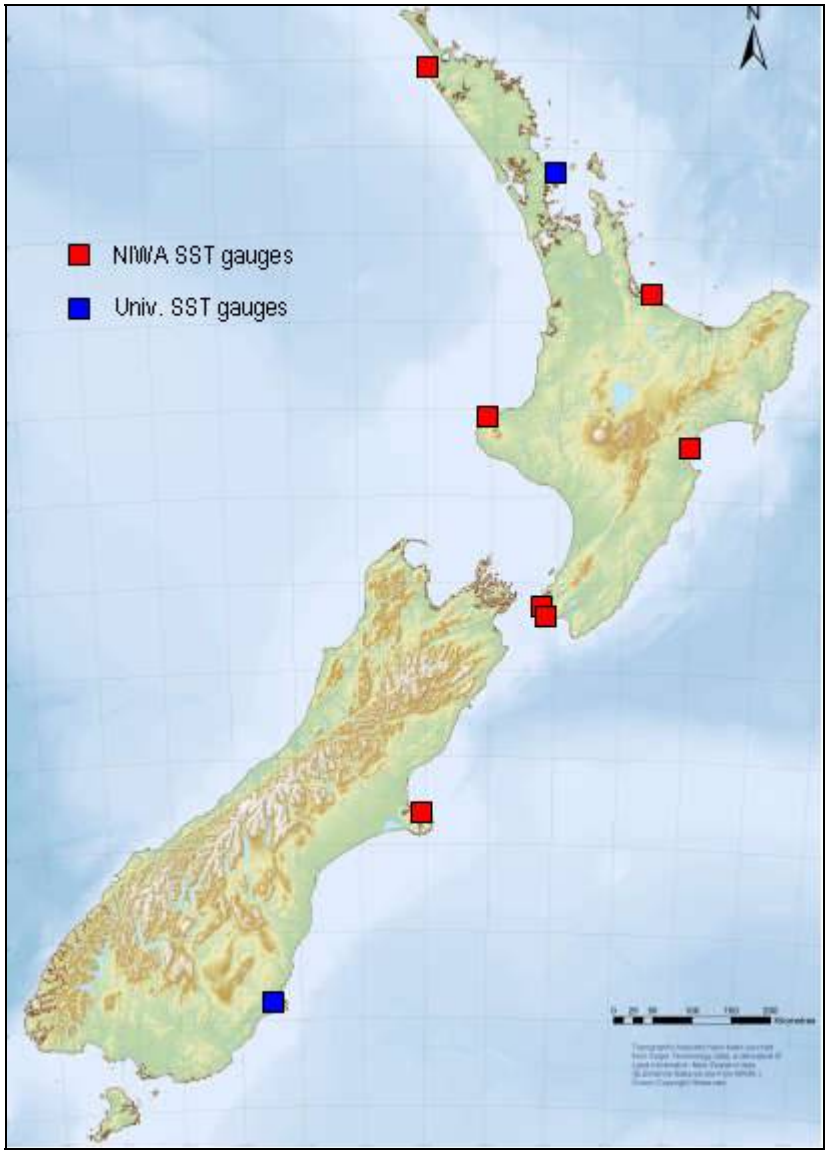

**Notes:** Major port sites are shown in red, open coast sites are shown in green, tsunami monitoring sites are shown in purple, and other sites are shown in blue. Names of GLOSS stations are appended with their GLOSS ID number.

Sea-surface temperature is measured at nine coastal stations. Figure 3 shows the locations of seven gauges in the NIWA sea-surface temperature data-logger network and two sites measured by the marine science laboratories of the University of Otago and University of Auckland.

Since the mid-1980s, MetService has maintained a network of free-drifting buoys in the Tasman Sea (see table 3A). Until about 2002 the network consisted of FGGE-type buoys, which measured air temperature and sea-level pressure, with a few buoys measuring wind speed and direction. Since 2002, a combined meteorological/oceanographic drifting buoy, SVPB type, has

been deployed. SVPB buoys measure sea-surface temperature and sea-level pressure, and ocean current is derived from their drift. All buoys report via satellite using Argos transmitters. Prior to 2007, MetService maintained seven operational buoys in the Tasman Sea, and this was increased to 12 buoys in 2007/08. MetService also works collaboratively with the Global Drifter Center in Miami to deploy buoys under the Southern Ocean Buoy Programme in the Pacific Ocean south of 40° S. These buoys are of the SVPB type, and between 20 and 40 buoys are deployed annually during the southern summer months.

**Figure 3: Locations of long-term sea-surface temperature monitoring sites**




Ocean waves are routinely monitored around the New Zealand coast at five sites operated by NIWA and/or regional councils, and at a further six sites operated by ports. Remote coastal video cameras have been installed for long-term monitoring of beach conditions and erosion at seven sites (http://www.niwa.co.nz/services/free/cam-era).

The Ministry of Fisheries contracts out regular surveys of various fish species to set maximum allowable catch limits and quotas. The resulting data sets may also be relevant for assessing climate change impacts on fisheries.

Under MetService's Voluntary Observing Ships (VOS) Scheme, New Zealand seeks to upgrade or recruit new ships to make climate quality observations under the VOSClim (VOS Climate Project). Extensive metadata is collected for each VOSClim ship, which details instrument type, location, exposure, etc. The real-time observations are monitored by the UK Real Time Monitoring Centre, and the observations, the metadata, the co-located model data and the delayed mode data are all supplied to the US Data Assembly Centre for archiving for future research and climate applications.

## 4.2 Water column observations

NIWA has annually contributed and deployed two profiling floats under the Argo programme. Of the 16 Argo floats deployed, nine are still active (for further information, see http://sio-argo.ucsd.edu/weqpac_web.html). The data from the New Zealand floats is administered by the Scripps Institution of Oceanography and is available from the Argo Global Data Assembly Centers. NIWA intends to continue to purchase and deploy Argo floats at the rate of two per year.

NIWA is also deploying buoys in the Southern Hemisphere from the research vessel (R/V) *Kaharoa* in an ongoing collaboration with the University of Washington and the Scripps Institution of Oceanography. These voyages, dating back to 2004, have deployed around 550 floats, primarily in the South Pacific but also in the eastern tropical Pacific and Indian Oceans. In addition, some deployments in the Southern Ocean have been made from R/V *Tangaroa.*

New Zealand maintains two global reference mooring network sites (Ocean SITES) in deep waters (about 3000 metres) to the east of the country. These provide long-term, time-series biophysical data (currents, temperature, salinity, fluorometry and particle flux) in subtropical and subantarctic waters on either side of the Subtropical Front, north and south of Chatham Rise. Measurements have now been in progress for nine years and have included a repeated, across-front transect measuring currents, nutrients, fluorometry and, more recently, bio-optics. A third site to the northeast of New Zealand, which is not part of the global reference mooring network, supplied current and temperature data in the subtropical inflow region of the East Auckland Current to the northeast of New Zealand and was in place for 6.5 years (1998–2005).

Time-series data of currents, temperature, light and fluorometry have also been collected at a shallow mooring site (about 40 metres) in the Firth of Thames, in the Hauraki Gulf, since 1998. Meteorological and water column observations (wind speed and direction, barometric pressure, air and sea temperature, salinity, turbidity, waves and currents) have been made since 2007 at a site approximately 30 metres deep located in the centre of Golden Bay, at the northern tip of the South Island, as a joint project funded by NIWA and local government. A new mooring deployment close to the Firth of Thames site (CSMART) was initiated in early 2009 to measure meteorological and water column parameters, including bio-optics.

Although New Zealand does not formally participate in providing carbon inventory survey line data to the International Ocean Colour Coordinating Group (see last row of table 3B), measurements of $pCO_2$ (partial pressure of $CO_2$), pH, alkalinity and supporting data are routinely taken on cruises out of Dunedin as part of the Munida time-series programme. These surface measurements, done in accordance with the GCMPs, have been made every two months for the last 10 years. The ocean carbon data will be submitted to the Carbon Dioxide Information Analysis Centre – Ocean $CO_2$.

## 4.3 Response to GCOS implementation plan

A number of actions have been initiated in response to the recommendations on oceanic essential climate variables in the GCOS implementation plan, including the following.

### Improving metadata acquisition and data management for the VOSClim subset of the VOS

The observations made by VOSClim ships adhere to the GCOS climate monitoring principles. The collection of metadata for VOSClim is well documented under the VOSClim project, and MetService collects the full range of variables for its VOSClim ship. MetService's VOSClim ship is regularly inspected to maintain instrument standards, and monthly monitoring of the real-time reports is carried out by the Regional Specialised Monitoring Centre in the UK, with feedback provided to the ship on any variables that are flagged as suspect.

### Ensuring high-frequency (hourly or less) sea-level observations are available for all coastal tide gauges (including historical records), corrected for sea-level pressure and submitted to the specified international data centres

Quality-assured, sea-level data from GLOSS sites 101 and 129 is submitted by LINZ each month to the University of Hawaii Sea Level Center. Data has not been submitted from GLOSS site 127 (Auckland) for several years. Data from other sea-level gauges is being made available to the Permanent Service for Mean Sea Level by LINZ as time permits.

### Developing a robust programme to observe sea-surface salinity that includes VOS ships, research ships, reference moorings and drifting buoys

NIWA's larger research vessel, R/V *Tangaroa*, is equipped to make underway measurements of sea-surface temperature and salinity. Efforts are being made to maintain and calibrate the sensors so that the salinity data is accurate and stable. Once this is achieved, underway data could be collected from some research voyages. MetService VOS and drifting buoy programmes are robust, operational programmes with proven track records. VOS ships are issued with calibrated instruments (which are traceable to WMO and international standards), there is an ongoing programme of inspection, and data quality is monitored according to VOS quality control guidelines.

Delayed mode data is collected and submitted to the global climate centres at three-monthly intervals under the Marine Climatological Summaries Scheme. Extensive metadata is collected for each VOS ship and submitted to WMO quarterly. MetService drifting buoy programme is a national programme of the Data Buoy Co-operation Panel, and so MetService buoys comply with international specifications for instrument types and standards. Metadata is submitted to the Joint WMO-IOC technical commission for Oceanography and Marine Meteorology for each buoy, and real-time buoy data is monitored using international buoy quality control tools, with bad data removed from the global telecommunication system as required.

### Implementing a programme for measuring surface $pCO_2$

Surface $pCO_2$ is measured as part of the ongoing Munida time-series programme on a 60 kilometre-long transect that includes the Southland Current and subantarctic waters. These measurements have been made every two months since 1998. Surface $pCO_2$ has also been

measured during eight ocean cruises in the New Zealand exclusive economic zone and South West Pacific, but this open ocean work has been discontinued due to resource constraints.

### Improving in situ sea-ice observations from buoys, visual surveys (Ship of Opportunity Programme [SOOP] and aircraft) and upward-looking sonars, and implementing observations in the Arctic and Antarctic

Data has been collected on an opportunistic basis, with no routine contributions to Antarctic sea-ice observations from buoys, visual surveys or upward-looking sonar. However, in the future the intention is to contribute land-fast sea-ice data from McMurdo Sound to the Antarctic Fast-Ice Network.

### Performing the 41 SOOP XBT/XCTD trans-oceanic sections

NIWA assists Australian (Commonwealth Scientific and Research Organization) and US (Scripps Institution of Oceanography) research institutions to maintain three high-resolution XBT (expendable bathythermograph) sections in the Tasman–Coral Sea area to monitor ocean temperature changes in the upper 800 metres. The lines are PX34, PX06 and PX31. Details can be found at: http://www-hrx.ucsd.edu/index.html.

### Supporting data rescue projects and implementing regional, specialised and global data and analysis centres

A research project between NIWA and the University of Otago (School of Surveying) is underway to rescue historical sea-level data for a few New Zealand ports where paper copies are available.

## 4.4 Satellite-based measurement programmes

New Zealand does not have a dedicated satellite-based measurement programme of oceanic essential climate variables and so table 4 has been omitted from this report. However, the NIWA Sea-surface temperature Archive (NSA) contains 1-kilometre resolution sea-surface temperatures retrieved from all NOAA orbits over the South West Pacific region (1993 to the present).

## Table 3A: National contributions to the oceanic essential climate variables – surface

| Contributing networks specified in the GCOS implementation plan | Essential climate variables | Number of stations or platforms currently operating | Number of stations or platforms operating in accordance with the GCMPs | Number of stations or platforms expected to be operating in 2010 | Number of stations or platforms providing data to the international data centres | Number of stations or platforms with a complete historical record available in international data centres |
|---|---|---|---|---|---|---|
| **Global surface drifting buoy array on 5 x 5 degree resolution** | Sea-surface temperature, sea-level pressure, position-change based current | 12 | 12 | 12 | 12 | 12 |
| **GLOSS Core Sea-level Network** | Sea level | 5 | 5 | 5 | 4 | 4 |
| **Voluntary observing ships (VOS)** | All feasible surface essential climate variables | 43 | 31 | 35 | 43 | 32 |
| **Ship of Opportunity Programme (SOOP)** | All feasible surface essential climate variables | 0 | 0 | 0 | 0 | 0 |

## Table 3B: National contributions to the oceanic essential climate variables – water column

| Contributing networks specified in the GCOS implementation plan | Essential climate variables | Number of stations or platforms currently operating | Number of stations or platforms operating in accordance with the GCMPs | Number of stations or platforms expected to be operating in 2010 | Number of stations or platforms providing data to the international data centres | Number of stations or platforms with a complete historical record available in international data centres |
|---|---|---|---|---|---|---|
| **Global reference mooring network** | All feasible surface and subsurface essential climate variables | 2 | 2 | 2 | 0 | 0 |
| **Global tropical moored buoy network** | All feasible surface and subsurface essential climate variables | 0 | 0 | 0 | 0 | 0 |
| **Argo network** | Temperature, salinity, current | 9 | 9 | 11 | 9 | 16 |
| **Carbon inventory survey lines (excl. XBTs)** | Temperature, salinity, ocean tracers, biogeochemistry variables | 2 | 2 | 2 | 2 | 2 |

# 5 Terrestrial essential climate variables

## 5.1 Surface terrestrial observations

There are approximately 500 stream-flow gauges in operation around New Zealand and about 300 groundwater monitoring sites. More than half of the stations are operated by NIWA, with the remainder operated by regional and district councils. More than half of the NIWA stations are funded by the Foundation for Research, Science and Technology (FRST) in conjunction with the Climate Network, as described in section 3.4 above. The NIWA stream-flow monitoring stations and a river water quality network of over 70 river locations and their databases are known as the Water Resources Archive.

End-of-summer snowline elevations and photographic images of 50 glaciers from special aircraft flights are available annually, dating from 1979, and the terminus positions of key glaciers in the Southern Alps are available from 1800 to the present. The New Zealand snow cover network is currently being expanded. There are existing snow-monitoring sites (operated for commercial clients) at Rose Ridge and Panorama Ridge, and existing climate sites at Chateau Tongariro on Mt Ruapehu, Arthur's Pass Village and Mount Cook Village, which have been upgraded to observe snow. New climate and snow sites have been established in Nelson Lakes National Park, the Murchison Mountains in Fiordland National Park, Albert Burn, the Ivory Glacier and at Mt Potts. Future additional sites are planned for Mueller, Rolleston, Lake Heron, Brewster Glacier and Ruapehu ridge. Although data from these sites is archived in the National Climate Database, it is not currently being submitted to international data archives.

To meet its Kyoto Protocol commitments, New Zealand has developed the Land Use and Carbon Analysis System (LUCAS). LUCAS comprises components for measuring and reporting land use and land-use change and soil carbon through a combination of permanent forest sample plots and remote sensing-based mapping. LUCAS has so far established several snapshots of land use using Landsat and SPOT satellite data. These include the 1990 and 2008 land-use databases required to establish New Zealand's position at the beginning of the Kyoto Protocol First Commitment Period (CP1). Other data sets used include the two national Land Cover Databases developed using SPOT and Landsat satellite imagery, in 1995/96 and 2001/02 respectively. Carbon stock changes will be calculated from these time-sequence measurements.

The Ministry of Agriculture and Forestry and the Ministry for the Environment also maintain land-use databases (including planted forest cover databases) for New Zealand through the Climate Change Information System and LUCAS. These two systems are designed to monitor carbon changes resulting from afforestation, as well as deforestation through logging, fires and other forms of vegetation clearance.

The National Vegetation Survey database maintained by Landcare Research holds records from approximately 45,000 vegetation survey plots around New Zealand, including 12,000 permanent plots. Landcare Research also maintains five New Zealand long-term ecological research and monitoring sites, and also monitors the presence or range of self-advective fungal and insect species.

A more comprehensive lake-monitoring network is being developed. Monitoring of Lake Taupo has resumed in collaboration with Ngati Tuwharetoa and Environment Waikato, and the data

will be submitted to the GLEON database (http://lakes.gleon.org/). Measurements at Lake Rotorua and Lake Rotoiti are being submitted to the GLEON database. Buoys have also been installed – or are about to be installed – in Lakes Tarawera, Tutira, Ngaroto and Waikaremoana.

Although there are no permafrost measurement sites in New Zealand, New Zealand is supporting measurements in Antarctica by the US Department of Agriculture and the University of Insubria (Italy). Seven soil climate monitoring stations that monitor temperature to about 1.2 metres' depth are operated in the McMurdo Dry Valleys and Ross sea coast by Landcare Research in collaboration with US Department of Agriculture (data is available at http://www.wcc.nrcs.usda.gov/scan/Antarctica/antarctica.html). Continuous monitoring data goes back as far as 1999. Two permafrost boreholes, with continuous temperature monitoring to 29.5 metres' depth, have now provided one full year of data. It is intended that the data from the permafrost boreholes will be made available to the Global Terrestrial Network for Permafrost database. A study is underway to estimate New Zealand's permafrost in the Mt Cook area.

## 5.2 Response to GCOS implementation plan

A number of actions have been initiated in response to the recommendations on terrestrial essential climate variables within the GCOS implementation plan, as follows.

### Strengthening existing sites for observing snow cover and snowfall, and recovering and submitting historical data to the specified international data centres

A new focus in recent years has been on infilling remote data-poor regions and regions sensitive to change. The development of a National Snow and Ice Monitoring Network for New Zealand has led this drive and has resulted in the upgrading of selected existing stations to measure snow that is very sensitive to change, and the establishment of new snow and climate stations in remote alpine regions not previously captured by the NIWA network.

### Maintaining sites for observing glaciers and adding additional sites and infrastructure in Africa, the Himalayas, New Zealand and South America

The end-of-summer snowline elevations and photographic images of 50 glaciers from special aircraft flights will continue for the foreseeable future. Some new index glaciers will be added.

## 5.3 Satellite-based measurement programmes

New Zealand does not have a dedicated satellite-based measurement programme of terrestrial essential climate variables and so table 6 has been omitted from this report. However, glaciers in the Southern Alps are monitored as part of the international satellite project GLIMS (Global Land Ice Mapping from Space).

**Table 5: National contributions to the terrestrial domain essential climate variables**

| Contributing networks specified in the GCOS implementation plan | Essential climate variables | Number of stations or platforms currently operating | Number of stations or platforms operating in accordance with the GCMPs | Number of stations or platforms expected to be operating in 2010 | Number of stations or platforms providing data to the international data centres | Number of stations or platforms with a complete historical record available in international data centres |
|---|---|---|---|---|---|---|
| **GCOS baseline river discharge network (GTN-R)** | River discharge | 33 | 33 | 33 | 33 | 41 |
| **GCOS baseline lake level, area and temperature network (GTN-L)** | Lake level, area and temperature | 3 | 3 | 6 | 0 | 0 |
| **WWW/GOS synoptic network** | Snow cover | 10 | 10 | 15 | 0 | 0 |
| **GCOS glacier monitoring network (GTN-G)** | Glaciers' mass balance and length; ice sheet mass balance | 50 | 50 | 50 | 50 | 50 |
| **GCOS permafrost monitoring network (GTN-P)** | Permafrost borehole temperatures and active-layer thickness | 9 | 9 | 9 | 7 | 7 |