Wellington Regional Climate Change Response

Discussion document for Territorial Authorities and Greater Wellington

Note: an underpinning Technical Information document, which gives reference sources and expands on some of the technical details in this document, will be available online at URL.

June 2009

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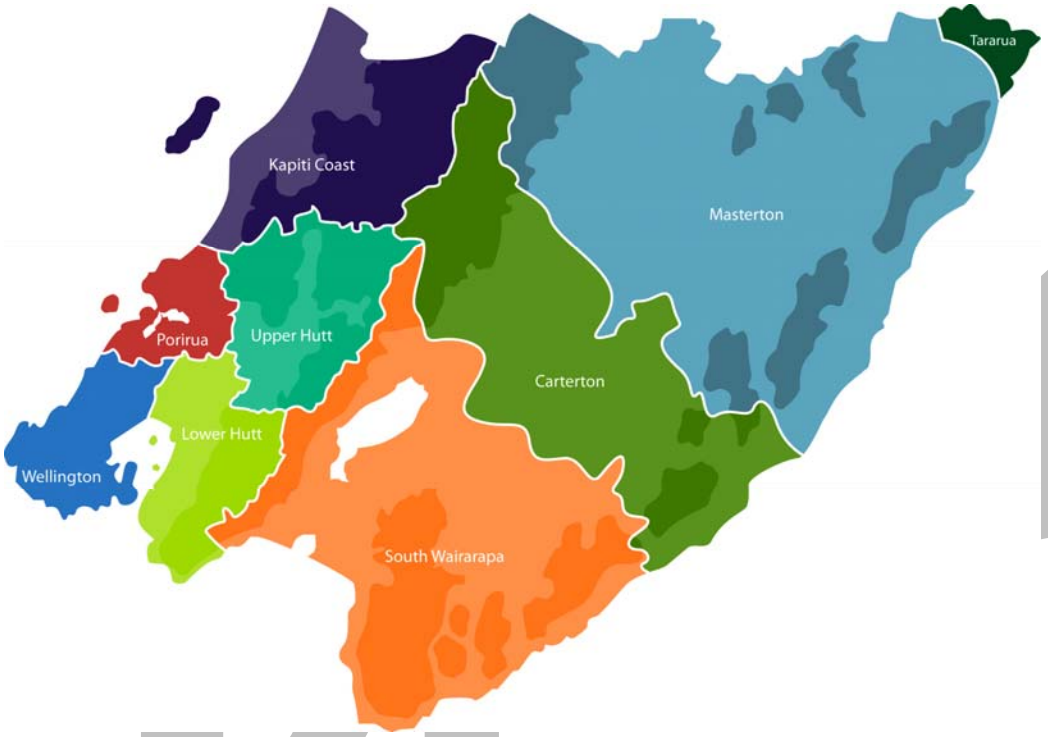
1. Background

1.1 Wellington Region: geographical, socio-economic and political overview



Geography

The Wellington region comprises the southern tip of the North Island, bounded to the south, east and west by water. It covers a land area of 813,005 hectares, including the most densely populated floodplain in New Zealand and one of the largest flood protection schemes. The region has three distinct geographical areas:

- Wairarapa valley – broad, flat, and largely agricultural
- the hills and valleys of the metro area, including Wellington, the two Hutt Valley cities and Porirua
- the coastal plain residential communities of the Kapiti Coast.

A large part of the mountainous area in the region is under indigenous forest in the Tararua, Rimutaka and Haurangi Forest Parks. The largest wetland complex in the lower North Island (Lake Wairarapa/Lake Onoke) has international significance with a number of species of water fowl, waders and other fauna as well as native flora to be found.

Lastly, the region covers a maritime area of 786,700 hectares and has 497 kilometres of coastline.

Weather

The region's weather patterns are characterised by high sunshine hours, a predominantly north-westerly wind pattern which is particularly affected by the geographical formation of Cook Strait. Rainfall varies widely across the region with most areas experiencing dry periods in the summer months.

Socio-economic picture:

The population of the region is 449,000 (Statistics NZ, population recorded in 2006 Census) of which over three quarters live in the four cities at the south western corner. Wellington is the wealthiest and best-educated region on average in Zane is ethnically diverse (second to Auckland in many national statistics related to immigration). Main businesses in the region are central government, universities, crown research institutes, the health sector, and the film industry

Relevant to climate change issues are a number of well-established and active community groups focused on the environment. The region has a long history of active conservation groups – Forest & Bird, the Botanical Society, and a number of community revegetation and stream restoration groups. Sustainable energy and sustainable transport groups have been active for some years and more recently groups such as Transition Towns and climate change action groups have been set up and are active in varying degrees.

1.2 A regional approach

The framework within which local government operates in New Zealand requires local authorities to engage in a range of activities which are significant from a climate change perspective. Such things as land use planning and regulation, public transport provision, planning and provision of vital infrastructure, hazard identification and management – to name but a few – have been the daily business of regional, city and district councils for many years. Despite the fact that these and many other core business activities of councils have not carried the climate change label in the past, they will be at the heart of how local authorities respond to this new challenge.

Broadly speaking, local authorities in the Wellington region share two major climate change objectives:

- Mitigate the negative potential effects of climate change on our communities and our environment through reducing our greenhouse gas (GHG) emissions

- Adapt to those climate change effects which are inevitable, through being innovative and building resilience

In beginning to think about the issues involved in the community's response to climate change, it rapidly became clear that most value would be derived from a fully collaborative effort by councils in the region, rather than each council developing its own strategies and the Greater Wellington Regional Council trying to impose another regional strategy as a second layer. This document is the first result of that collaboration. It has been put together by a Working Party of officers from Greater Wellington and from Kapiti Coast District Council, Porirua City Council, Hutt City Council and Wellington City Council. The four other councils in the region have also had some input to this work. This document will lead to the development of a shared regional approach captured in a shared Plan.

The process of developing the shared Plan will be iterative and will have to connect with the Annual Plan processes of city and district councils and the regional council. In order to achieve a final version of a shared Plan which is signed off by all the constituent councils in the region, the following programme has been established:

Action	Date
Initial discussion document developed	Jan - May 2009
Expert and interest group input Input obtained from broad range of expert and community interest groups for development of draft discussion document.	April/May 2009
Regional Sustainability Committee consideration	June 2009
Input from all councils in region – officer level Discussion of approach and potential goals and strategies for inclusion in Plan discussed with council officers.	June/July 2009 *You are here*
Draft community action plan developed Regional Emissions Reduction and Adaptation Working Group to develop first draft of Plan following input.	July/Aug 2009
Draft emissions reduction goals and action plan discussed by councils Work plans and funding implications to be discussed and implementation commitments identified as part of early Annual Plan work in all councils	September – December 2009
Community engagement Wide community comment and input on the draft plan to be obtained	September/October 2009
Adjustments to draft Plan Working Group to incorporate results of community engagement into draft plan and revised document to be circulated to all councils	November 2009
Annual Plan process Any initiatives with funding implications to be discussed with their communities by individual councils as part of their Annual Plan process	March – May 2010
Final Regional Climate Change Response Plan to be developed Based on input received and decisions made during Annual Plan process.	June/July 2010
Final Regional Climate Change Response Plan to be formally adopted All councils to sign off on regional plan for response to climate change	August 2010

1.3 Communities for Climate Protection – New Zealand (CCP-NZ)

1.3.1 Programme overview

Eight of the nine councils in the region, including Greater Wellington Regional Council, participate in the Communities for Climate Protection® - New Zealand (CCP®-NZ) Programme. They are thus part of an international campaign by councils in a number of countries to reduce greenhouse gas emissions. The CCP – NZ programme is as follows:

- Milestone 1 - Establish an inventory and forecast for greenhouse gas emissions
- Milestone 2 - Establish emissions reduction goals
- Milestone 3 - Develop and adopt a local action plan
- Milestone 4 - Implement the local action plan
- Milestone 5 - Monitor and report on achievements.

The various councils in the region are at different points in the programme, although all now have a community greenhouse gas emissions inventory for 2006/07. There is an issue as to whether all councils in the region will continue with the programme as it is soon to be run from Australiabecause its funding by central government in New Zealand has been withdrawn. Nevertheless, all of the region's councils which are current participants in CCP-NZ have indicated a desire to continue to address climate change issues.

2. Climate Change – background and science[1]

This section outlines the effects of climate change that our region is likely to experience and gives a brief explanation of the science relating to these effects. It goes on to consider what the potential impacts of addressing these effects might be for our region and the risks of inaction.

These potential climate change effects are the reason for examining ways of reducing local and global greenhouse gas emissions. They also provide background for section 7 which considers adaptation as they will require an adaptive response from the region's residents.

2.1 Regional climate change impacts[2]

2.1.1 Temperature changes

Rising global temperatures are the trigger for all the effects discussed in this section. Projected changes in seasonal and annual mean temperatures for the Wellington region (relative to 1990) are shown in the table below. The first number in each case is a mid-range estimate of the change. The figures in brackets give the range within which the scientific climate models and the IPCC's range of future greenhouse gas emission scenarios indicate the change could lie.

Decade	Summer	Autumn	Winter	Spring	Annual
2040	1.0 (0.2, 2.2)	1.0 (0.3, 2.5)	0.9 (0.2, 2.1)	0.8 (0.1, 1.9)	0.9 (0.3, 2.2)
2090	2.2 (0.9, 5.7)	2.1 (06, 5.1)	2.1 (0.6, 5.1)	1.8 (0.3, 4.8)	2.1 (0.6, 5.2)

2.1.2 Sea level rise

The earliest records of regional sea level come from Wellington Harbour and date back to 1891. The sea level rise (SLR) rate for Wellington is 1.78 mm/yr over the last 100+ years, which is in line with measured global sea level rise. This rate appears to have been accelerating over the last two decades to about 3mm/year, although the cause of this acceleration is not certain. It is therefore not yet clear whether this rate of SLR will continue to increase or if it simply reflects a natural variation and will return to its former rate.

NIWA climate scientists are currently forecasting a sea level rise, based on data in the Intergovernmental Panel on Climate Change 4th Assessment Report (IPCC AR4)[3], of between 0.2m (i.e. the level which would be achieved if the 1.78mm/yr increase rate were to continue undisturbed) and 0.6m. However, the possibility of rise to 1m, or even more by 2100 in the Wellington region, cannot be ruled out. Sea level rise beyond 2100 is uncertain, and to a large extent depends on what action is taken to reduce greenhouse gas emissions globally. However it could reach several metres over the next few centuries.

[1] For a description of what climate change is and its forecast effects on New Zealand as a whole, see underpinning Technical Information document at *INSERT URL*

[2] *Sources for the information in this section can be found through the Technical Information document at URL.*

[3] The IPCC has produced 4 Assessment Reports at approximately 6 year intervals, the latest in 2007. These reports gather together what is known by climate scientists throughout the World about the phenomenon of climate change, assess its implications and give some indications of potential impacts in the various regions of the World. More information can be sourced through the Technical Information document at URL.

Sea level rise uncertainty

Numerous studies published since the IPCC AR4 have attempted to understand and quantify the potential additional contribution of melting polar ice sheets to sea level rise. These recent studies point to a potentially significant additional contribution from this source that could increase total sea level rise by 2100 to between about 0.7m and 1.6m, although even 2m cannot be ruled out entirely.

There is as yet insufficient convergence or technical consistency amongst those studies to assign probabilities to any of the recent higher projections, let alone provide a 'best estimate'. A wide range of possible answers remains. It is worth noting that none of the recent studies suggests sea level rise at the lower end of the range given in the AR4. The most robust information that can be drawn from the recent studies is that at present, the quantitative *range* presented in the AR4 should probably be regarded as a lower bound, and no specific figure represents a reliable upper bound for sea level rise by the year 2100.

In addition to the potential relating to ice sheet melt, recent information indicates that actual greenhouse gas emissions since 2000 have been greater than even the most carbon-intensive scenario envisaged by the IPCC in making its forecasts. This factor also implies more rapid thermal expansion of the oceans although, once again, the rate is uncertain.

As a result of this uncertainty, the Ministry for the Environment suggests councils would be prudent to plan for at least 0.8m of SLR, and emphasises the "at least" part of that advice. If such levels are reached this century, early effects as the level begins to rise will be felt well before the end of the century. Planning to respond to it should, therefore, begin as soon as possible.

SLR of this magnitude will have major implications for 6 of the 9 constituent councils (including Greater Wellington). Even the councils which do not have much infrastructure located on coastlines will feel the effects of sea level rise as it will impinge on inland flood levels. Many rivers and streams in the region start in steep high country but then run across relatively flat floodplains. Sea level rise will mean that low-lying inland areas will be subject to greater inundation as flood waters back up, seeking an outlet other than the sea. Coastal properties and infrastructure will be put at risk.

The effects of sea level rise will be compounded by storm surge effects. During a storm, sea level rises as a result of a combination of air pressure changes, and wind and wave action – the more intense the storm the greater the surge. Thus, the storm surge effect will be additional to any sea level rise caused by thermal expansion of the oceans or eventual melting of ice sheets and glaciers. Storm surges of 1m (including wave action) are not uncommon in the Wellington region.

Sea level rise compounded by storm surge will have major effects on our vital road and rail links. One metre of SLR will mean that roads at the following points may be adversely affected:

- Paekakariki – Pukerua Bay (Centennial Highway)
- Porirua – Mana (State Highway 1)
- Pauatahanui Inlet (both sides)
- Porirua – Titahi Bay
- Wellington – Hutt Valley (SH 1 and 2)

- Petone foreshore
- Hutt Valley – Eastbourne
- Wellington south coast
- South Wairarapa coast (Cape Palliser Road)

Rail corridors probably affected at this level of SLR are:

- Wellington – Hutt Valley – both main trunk and suburban lines
- Main trunk line at Porirua – Mana

.
At more than 1m of SLR, more roads will be affected. The main trunk rail line between Pukerua Bay and Paekakariki may be undermined over time, especially by storm surges and wave action.

2.1.3 Rainfall changes

By 2040 (compared with 1990 levels):

- Annual *mean* rainfall will probably increase in the western half of the region and over the Tararua ranges, and decrease in the Wairarapa (up to 5% in eastern part of area).

By 2090 (compared with 1990 levels):

- Extreme rainfall events that cause flooding are projected to increase in intensity with rising temperatures, with up to 8% more rainfall in extreme events for each degree Celsius of warming and even greater increase in flood risk.
- Annual *mean* rainfall will be similar to the 2040 picture with a greater decrease in the Wairarapa (up to 7.5% in eastern part of area) and more significant increase in parts of the Kapiti Coast area.
- Seasonal *mean* rainfall
    - In the Wairarapa, rainfall may be significantly lower in winter and spring (up to 10% in winter) and higher in summer and autumn (up to 5% in autumn).
    - In the Wellington city area, residents will likely experience wetter weather in summer and autumn (particularly in autumn) and drier in winter and spring (up to 7.5% in winter).
    - In the Porirua/Kapiti area, summer will probably be drier and autumn, winter and spring will be wetter. (Some areas of the Kapiti Coast may experience up to 15% greater rainfall in winter.)

Changes in rainfall will impinge on water supply, flood protection, the viability of agriculture as currently practised in the region, and possibly forestry. *How* this rain falls may also change because the climate models indicate the likelihood of more intense storms and heavier extreme rainfalls even in areas where average rainfall decreases. The implications for flood protection in both metropolitan and rural areas are significant. Although climate change is currently factored into our floodplain management planning, it is becoming more important that this planning incorporates up-to-date climate change information.

The projected increases in rainfall during autumn and winter in the water catchment areas and a drier spring and summer has huge implications for water supply agencies.

The medium to longer term future of pastoral farming in the Wairarapa may be threatened if some of the possible climate change scenarios eventuate. A considerably drier winter and spring in the Wairarapa will not be compensated for by the slightly wetter summer and autumn and water supply issues could become pressing. Pastoral farming practices may have to change if the amount of water available decreases over the next few decades. It is possible that such farming may become non-viable over the longer term and conversion to other forms of farming and/or forestry will have to occur.

2.1.4 Storms

Climate models predict more extreme storms as sea temperatures rise, generating more energy in weather systems. Moreover, warmer air generally contains more water vapour leading to an increased risk of heavier falls when rain occurs. Hence, storms could become more intense although it is presently unclear whether or not they will become more frequent. In the Wellington region, the risk of extreme rainfalls is likely to increase in general, especially in the Tararuas during northwesterly storms, and in the Wellington city area and south Wairarapa during southerly storm events.

Erosion of coasts and slopes will certainly increase if this storm scenario eventuates. As with the effects of sea level rise, land uses may have to change, property values may be affected, and some roading and rail infrastructure may have to be moved or protected. Inland flooding will become a greater problem with similar potential effects.

2.2 What does all of this mean for us?

We can respond to these impacts in two ways: we can try to reduce our emissions and to persuade others to do the same (mitigation); and we can adapt to those impacts which cannot be prevented by mitigation (adaptation). In reality, some of the things we might do will have benefits for both mitigation *and* adaptation. They will also have co-benefits in areas other than climate change. The table below outlines some of the range of multiple benefits from the implementation of initiatives to reduce greenhouse gas emissions and to adapt to those effects of climate change which can no longer be avoided.

Benefits
Environmental
• Vital resources will be more available for future generations to use through demand reduction and migration to renewable sources • If temperature rise can be mitigated ecosystems will be less stressed and more resilient - ensuring better environmental quality into the future • Air and water quality will suffer less degradation over time and potentially improve

Social
• Regional communities will become more responsible, resilient and adaptive • Public health outcomes will improve as a result of better air quality, healthier homes using cleaner heating methods and increased use of active transport modes (walking and cycling) • Relationship networks between commercial, residential and industrial sectors of the community will be strengthened
Economic
• Early identification of issues and longer planning lead times will cushion the negative effect of impacts on vital infrastructure • Reduced energy and waste costs will result in financial savings • Adaptation costs in the medium to long term may be reduced through early mitigation • Unquantified costs of emissions (currently covered largely by taxation or rates) will be reduced in the areas of health, infrastructure maintenance and replacement, degradation of environmental resources and services • New job opportunities could be created in areas of emerging technologies • Enhanced energy security will strengthen the resilience of the region's economy

There are also some risks associated with inaction in the face of climate change.

Risks of inaction
Environmental
• Depleted resources will leave future generations with higher costs and a lower standard of living • Degraded ecosystems will provide fewer services to future generations with negative impacts on health and standards of living • Degraded air quality will mean lower health standards and associated costs • Eutrophied water bodies and water ways will have negative consequences for health of both people and ecosystems and result in higher costs in water treatment
Social
• Competition for increasingly scarce resources and access to costly services may increase inequalities, fracture communities and result in lowered quality of life for many • Degraded ecosystems and water and air quality may result in lowered public health outcomes, particularly in poorer socio-economic groups

Economic
• Delaying planning will lock future generations into solutions to problems which are less optimal and more costly • Failure to mitigate the worst impacts of climate change will inevitably result in very costly infrastructure replacement for future generations as a result of sea level rise and greater flooding • The inundation of vital infrastructure such as road and rail links will have very negative consequences for the region's economy • Total dependence on energy resources external to the region will place the economy at some risk as they become scarcer or more costly

2.3 What do we need to do next?

Sections 5 and 6 discuss what might be done with regard to reducing emissions in the region. Section 7 addresses adaptation. Broadly speaking, we need to do further work on establishing

- which areas will be most affected by sea level rise and when
- potential effects of all aspects of climate change on agriculture as currently practised in the Wairarapa
- areas particularly vulnerable to increasingly intense wind and rainfall

Having established this risk profile for the region, we need to identify which types of planning responses will be required at which trigger points. A framework within which this work might be done is suggested in section 7.

We also need to talk with affected communities about how best we might respond to the risks they face. This process will be initiated by a community engagement period later in 2009 and will be carried on through the Annual Plan consultations of 2010.

3. Roles and Responsibilities

3.1 The legislative framework

There are key pieces of legislation which guide local authorities' responses to climate change. [4]

The purpose of the Resource Management Act 1991 "is to promote the sustainable management of natural and physical resources" (s. 5(1)). The Act requires councils to take climate change into account in their planning activities (s. 7(i)).

The Local Government Act 2002 "provides for local authorities to play a broad role in promoting the social, economic, environmental and cultural well-being of their communities, taking a sustainable development approach" (s. 3(d)).

The Civil Defence Emergency Management Act 2002 requires local authorities to plan and provide for civil defence emergency management within their districts. This means "the application of knowledge, measures and practices that –

(ii) are necessary or desirable for the safety of the public or property; and

(iii) are designed to guard against, prevent, reduce, or overcome any hazard or harm or loss that may be associated with any emergency…" (s4(a))

The Building Act, and the Building Code and regulations it gives rise to, imply recognition of climate change in the provision for energy and water efficient buildings and building components. The Act is currently under review and is likely to be changed to give greater scope for energy and water efficiencies.

The following principles, which broadly fall out of the guiding legislation, should guide the region's response to climate change:

- Sustainability – the ongoing ability of communities and individuals to respond to climate change so that negative effects are avoided or limited while ensuring that future generations can continue to provide for their own needs.

- Consideration of the foreseeable needs of future generations – an expansion of the previous principle which requires responsible actions to balance the needs of present and future taking into account all costs. This principle applies even if the need for climate change response is not yet apparent.

- Avoidance, remedy or mitigation of adverse effects – because climate change effects can affect the ability of socio-ecosystems to respond to non-climatic stresses, potential climate change impacts can and should be analysed and understood in order to be taken into account when making decisions on new activities or developments.

- Application of the precautionary approach – requiring an informed but cautious approach to decisions if the full information on effects is not available, especially if there is a high level of uncertainty or if the decision will be effectively irreversible.

[4] Checklists produced by the Ministry for the Environment relating to these legal requirements can be sourced through the Technical Information document at URL.

- Stewardship/kaitiakitanga – sound planning decision-making in the interests of the community to avoid or mitigate loss of value or quality of resources over time. It relates especially to asset management, land and water use, biosecurity and biodiversity.

- Consultation and participation – informed input into decision-making processes. This carries an obligation to provide sufficient information to make the consultation effective.

- Financial responsibility – transparent identification of reasons for any changes especially to assets and associated costs.

- Liability – for financial impacts of decisions which are shown to have been made where contra-indicating information existed.

3.2 Central government policy framework

The current central government has confirmed its policy target of 50% reduction of emissions by 2050 on 1990 levels. As details of implementation have not yet been announced, we have worked from the previous government's action plans for various sectors, which are generally less ambitious than "50 by 50". We have made the assumption that even if these particular measures are discontinued, a comparable set of initiatives will be announced to deliver on the stated 50% target.

Central government currently has a number of initiatives, policies and strategies in place or under development which will impinge on our response to climate change. These are:

- The Emissions Trading Scheme
- The NZ Energy Strategy and NZ Energy Efficiency and Conservation Strategy
- The NZ Transport Strategy
- The NZ Waste Minimisation Strategy
- The National Policy Statement on Freshwater (currently with Board of Inquiry)
- The NZ Coastal Policy Statement (under review by a Board of Inquiry, but will have a significant impact on planning responsibilities for adaptation)
- A National Policy Statement on Flood Risk (under development)

3.3 Local authority functions with implications for climate change

As noted earlier (Section 1.2), a great many core business activities of local authorities are related to climate change, whether or not they carry that label. For many years, councils have been charged with ensuring that our environment is managed sustainably and much of their daily activities are designed to do just that. Councils around New Zealand, and ours are no exception, are already engaged every day in programmes and initiatives which will have considerable positive impacts on greenhouse gas emissions levels and will assist their communities to adapt to climate change.

The questions at the heart of this document are - Are we doing enough? Are there other things local authorities could do which would add value to central government initiatives? Can we identify gaps in the central government response to climate change which our communities want us to fill?

The table below shows activity areas for local authorities and their relevance to climate change.[5]

3.3.1 Greater Wellington Regional Council activities

Function	Relationship to climate change response
Resource management Planning Resource consent service Compliance and enforcement Pollution prevention and control State of the environment monitoring Community education and community engagement	• Resources, e.g. water, may become increasingly scarce • New technology infrastructure will be required e.g. new clean energy sources • New environmental indicators may be required • Community education and engagement programmes offer significant opportunities
Transport Regional network planning Encouraging sustainable transport choices Public transport services	• 48% of the region's CO2 emissions result from land transport • Sea level rise will very probably affect roading and rail networks
Water supply Collection, treatment and delivery Infrastructure Planning Conservation programmes	• Changing rainfall patterns may affect supply • Increasing storm intensity may have physical impacts in catchments • Increasing storm intensity may affect water quality in catchments
Parks and forests Parks network planning Environmental protection and enhancement	• Forests and regenerating scrub sequester carbon

[5] Details of these functions and their relevance to climate change response can be found in the Technical Information document at URL.

Safety and flood protection Floodplain management planning Flood protection infrastructure Environmental enhancement of river corridors Flood warning service Civil defence and emergency management Harbour management	• Likelihood of increased frequency of adverse weather events and more extreme events and flooding • Sea level rise will create new harbour hazards • Riparian management has some impact on nitrous oxide emissions
Land management Pest animal and plant management Biodiversity Soil conservation	• Likely increase in range and number of pest plants and animals due to habitat change • Temperature and other climatic changes may affect ability to function of native ecosystems • Possible increased frequency and/or intensity of eroding rainfall
Regional sustainable development Regional resilience	• Physical and social impacts of climate change
Community Democratic processes	• Threat to democracy from potential size and range of climate change effects

3.3.2 City and district councils in the region – existing functions

City and district councils have responsibility for the sustainable management of land within the region, in accordance the Resource Management Act 1991. This includes preparation and implementation of district plans, processing of resource consents, enforcement, monitoring and investigation. They regulate many activities: some regulatory actions are based on rules set by central government legislation, others by Greater Wellington Regional Council in its Plans, and in the Regional Land Transport Strategy.

Function	Relationship to climate change response
Transport Transport policy and planning Parking services and enforcement Road construction and maintenance	• 48% of the region's CO2 emissions result from land transport • Sea level rise will have major impacts on coastal transport infrastructure

Urban development Planning policy and development control Building control	• Likely need for development of renewable energy sources • Urban form influences the use of transport modes • Councils have a key role in enforcement and monitoring of insulation and other "green building" requirements
Stormwater, sewage and waste water Reticulation, treatment and disposal	• Considerable energy with associated emissions is used in pumping and at treatment plants • Infrastructure networks may be widely affected by some climate change effects, especially sea level rise and increased storm intensity
Solid waste Waste minimisation Landfill management	• Methane is produced by decomposing waste
Council housing and other facilities Building and maintenance	• Green building standards could be applied
Green and open space management Forestry management	• Forests and regenerating scrub sequester carbon • Increased storm intensity will affect existing forest areas
Water supply Reticulation of water to households and businesses	• A great deal of electricity is required to pump water to its final destination • Changes in rainfall patterns and quantum may affect security of supply.

4. Wellington region greenhouse gas emissions

In developing a shared regional approach to climate change response, it was agreed that the existing regional greenhouse gas emissions inventory based on 2001 data supplied by CCP-NZ (see Section 1.3) was not recent or complete enough to achieve the high standards the participating councils wished to achieve. There has been a great deal of technical development in emissions inventory methodologies since the ICLEI data was produced and the Wellington regional group agreed to adopt an inventory for 2006/07 established by Landcare Research Ltd with input and peer review by NIWA.

For the purposes of planning the region's climate change response, that inventory now forms the baseline and progress towards achieving emissions reductions will be measured against the 2006/07 base year.

4.1 Regional GHG emissions profile

The full greenhouse gas inventory for the region for 2006/07 can be viewed at URL

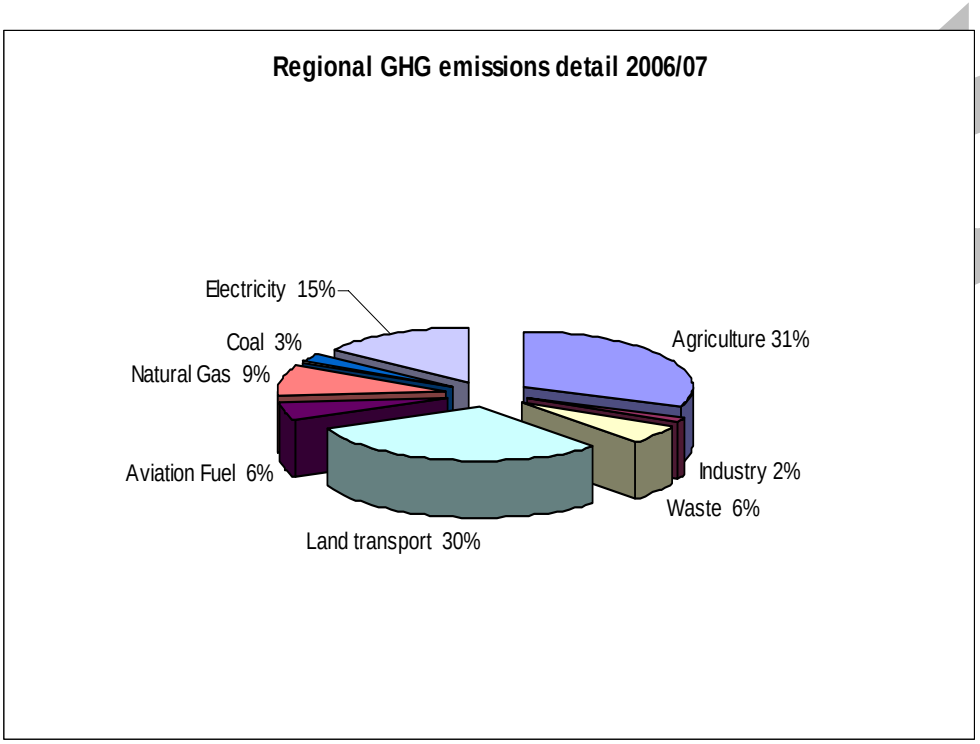
In order to gain some understanding of the region's historic footprint and its trends in greenhouse gas (GHG) emissions, the regional Working Group has "backcast" an inventory for 1990. This has been established by

- Ascertaining the percentage of national population resident in the Wellington region in 1990 and in 2006 according to census figures
- Ascertaining the percentage of national GHG emissions contributed by the Wellington region in 2006
- Assuming that the region contributed the same proportion of the national GHG total in 1990 as in 2006
- Adjusting the final figure for the small difference in population as a proportion of national total between the two years.

This process has produced an estimated GHG inventory figure of 3.2 million tonnes of CO2 equivalent for the region for 1990. The multiple assumptions made make this figure very much an estimate only but the Working Group and peer reviewers felt it was worth doing the exercise, especially given the very small difference in population as a proportion of the national total. This work has enabled the Working Group to determine that the region's emissions are on a growth trajectory. While most of this can probably be attributed to population growth, growth in emissions appears to be outstripping population growth by more than 5%. A graph representing this trajectory can be found in Section 4.4 below.

The regional GHG footprint for 2006/07 comes to 3.8 million tonnes of CO2 equivalent[6] (3.8M t CO2e). Some 1.1 million tonnes were sequestered by forestry in the region in 2006/07 leaving a net footprint of 2.7 million tonnes of CO2 equivalent.

The following pie chart shows the relative emissions footprint of the major sources of GHG in the region. The analysis is based on the four sectors used by the Intergovernmental Panel on Climate Change (IPCC) – agriculture, energy, waste and industrial processes. It should be noted that the industrial processes category only covers emissions from the chemical transformation of one product into another (e.g. the reduction of iron sand in steel manufacture produces CO2). Emissions from the energy for heating used in the processes are accounted for in the energy category and sub-categories. Land transport covers petrol, diesel and LPG emissions. A small proportion of transport energy relating to public transport powered by electricity is captured in the electricity category. Waste includes both liquid and solid waste.



[6] The major greenhouse gases emitted by human activities are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Internationally, it is an accepted convention that all gases' emissions are converted to CO2 equivalents for the sake of simplicity. The conversion factors (so-called global warming potentials) for each gas depend on how effective a gas is in absorbing heat radiation, and how long it remains in the atmosphere once it has been emitted.

The table below shows both tonnages and proportions of emissions (discrepancies due to rounding).

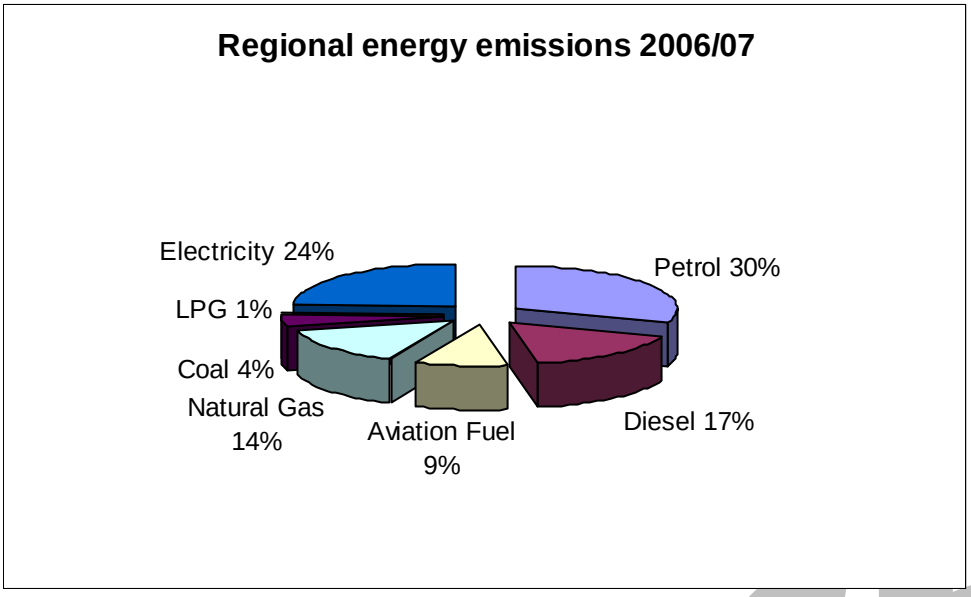
Sector	CO2	% of total
Agriculture	1,174,150	31%
Industry	66,070	2%
Waste	219,680	6%
Energy - transport		
Land transport	1,131,349	30%
Aviation Fuel	212,049	6%
Energy - other		
Natural Gas	340,549	9%
Coal	103,328	3%
Electricity	566,338	15%
Total	**3,813,513**	

The picture painted by this analysis of the regional inventory is quite different from that for the country as a whole. A larger proportion of the region's population lives in the urban centres than is true for NZ as a whole and there is comparatively minimal industrial activity.

4.2 Regional GHG emissions profile: sources

As can be seen from the previous table, transport, agriculture and electricity are responsible for 82% of the region's GHG footprint. Once the energy emissions are separated into transport and other sources, agricultural emissions make up the single biggest segment (31%) even though this is a much smaller percentage than the national average of 48%. Although waste disposal contributes only 6% to the total, it is the one sector where responsibility is the sole province of local government so savings may be more readily achievable.

Energy emissions are the biggest group of emissions at the IPCC sector level. A detailed break down is shown in the pie chart on the next page. As can be seen, transport related emissions constitute 57% of all energy emissions in the region and land transport, in particular, contributes at least 48%. The exact contribution of transport to the footprint has not been identified as the emissions relating to electric public transport – trolley buses and some trains – is included in the energy category. However, this contribution would be proportionately relatively small.



Despite petrol being the greatest source of GHG producing 30% of all energy emissions, the fastest growing transport sector is the heavy commercial vehicle fleet which uses diesel. When aviation emissions are added, the total for all forms of transport is 1.3 million tonnes of CO2 or 57% of all the region's energy emissions. It is worth noting that the comparison with other regions does highlight the maturity of our public transport system and its relatively high uptake by the community.

4.3 Regional GHG emissions per capita

All of this adds up to an average carbon footprint per head for the region's residents of 8t CO2 a year. This reduces to 6t per year when the forestry sequestration is factored in. The following table shows how our individual totals compare to national emissions' footprints.

Segment	Wellington region tonnes CO2 per capita	NZ tonnes CO2 per capita
Total	***8***	***18.5***
Agriculture	2	9
Energy total	5	9
transport	2	3
electricity	1	2
Waste	0.4	0.5
Industrial processes	0.1	1

Compared with the national figures and, indeed, with figures for other developed countries (see below and Technical Information document URL), our region's residents might be tempted to feel pleased with themselves. However, most estimates of what is a sustainable level of emissions for the planet arrive at a figure of 1 – 2 tonnes CO2 per head per year. Further, Wellington imports many carbon-intensive products that have caused emissions elsewhere; regional delineations are very artificial given the flow of goods and services across regional boundaries.

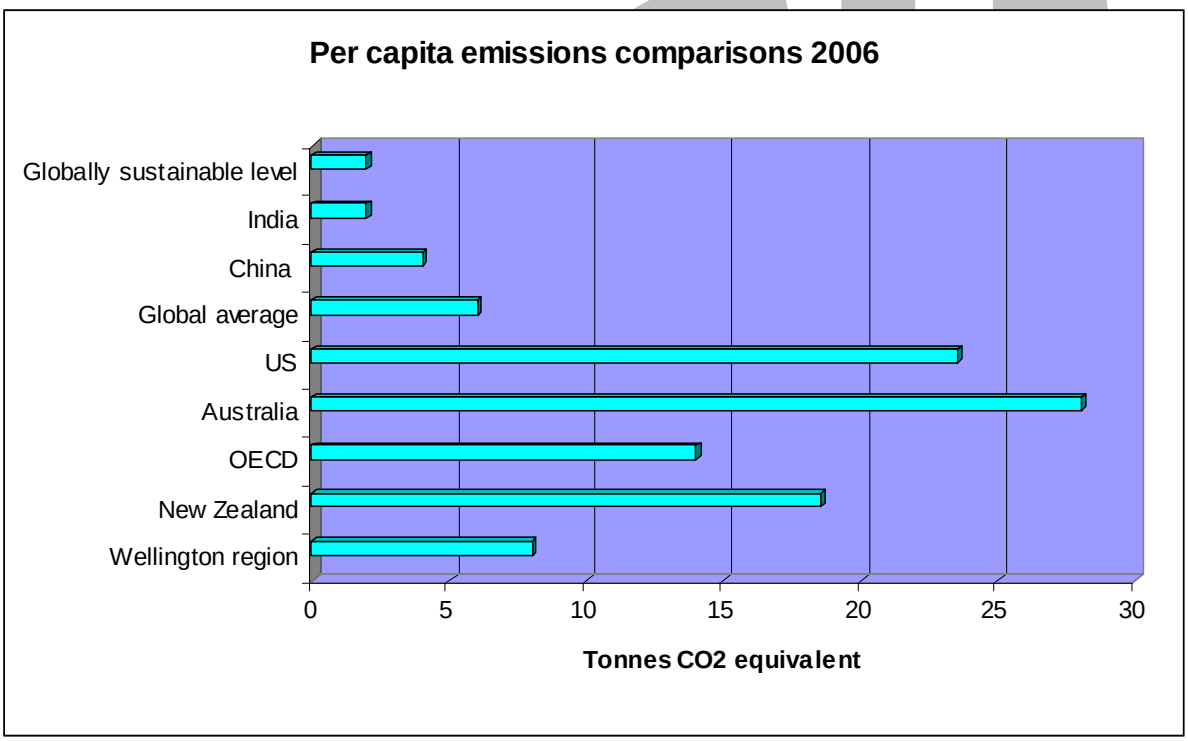
4.3.1 Comparisons with other regions

The following table compares the region's emissions to those of the Auckland and Canterbury regions. The smaller per capita emissions total in the Wellington region is probably a reflection of the fact that we have less agriculture than Canterbury, and higher active mode and public transport use than Auckland.

Region	Most recent emissons total in tonnes CO2 e/yr	Per capita emissions	Inventory year
Wellington	3.8 m	8 t	2006/7
Auckland	11.9 m	9 t	2006
Canterbury	4.8 m	10 t	2001

4.3.2 Global comparisons

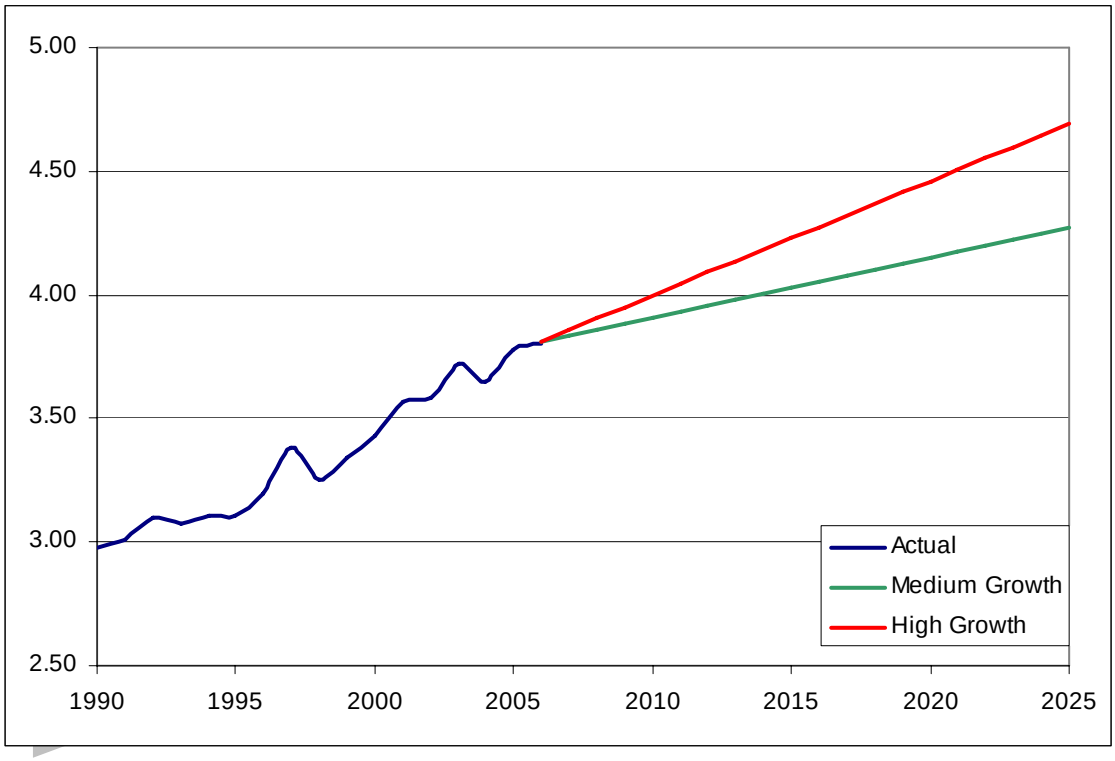
The regional average per head footprint compares globally as shown below. What is thought to be the globally sustainable level of 2t per head is shown as a reference point at the top of the graph.



4.4 Regional "business as usual" emissions forecast for 2026

The region's population is predicted to grow from 470,240 in 2006 to somewhere between 500,000 and 545,000 by 2026. New Zealand's per capita greenhouse gas emissions have been rising steadily since 1990 at roughly 5% above the population growth rate in the 16 years between 1990 and 2006.

The graph below shows the historic trajectory of regional GHG emissions from the estimated "backcast' total in 1990 to 2006, and the expected trajectory out to 2025 *if nothing were done to reduce them*.



5. Reducing community emissions

Given the major contributions of transport, electricity usage and agriculture to the region's footprint, the response plan will focus most of its emissions reduction attention in these areas, particularly the first two. Alongside emissions reduction efforts, the region will aim to greatly increase its forestry plantations, as one effective means of mitigating some of the effects of GHG emissions.

5.1 Regional emissions: what do we need to do?

This section discusses various approaches to reducing regional emissions and some of the challenges associated with them.

5.1.1 Adopt new technologies

Switching to new technologies to achieve the same services (transport, power etc) for lower emissions is a relatively simple way to make a positive impact on the region's greenhouse gases. There are issues of affordability involved which are discussed below, but many well-proven technologies already exist to assist us in this area. We have the advantage of being a nation of early adopters if change is made easy or attractive for us. So, why is there a significant lack of uptake of these measures at all levels?

In the early 1970s, the installation rates in New Zealand for solar hot water systems and wood burners were very similar. By the end of the decade, solar hot water installations were few and far between, but the market for wood burners had increased very significantly. During the 1990s many gas-fired hot water systems were installed while solar continued to languish. Given that the installation costs of both gas and solar systems were comparable at that time, it seems counter-intuitive that home-owners would not opt for the system which would cost them far less to run, solar energy being free. This paradox is explained in part by the bad reputation acquired by solar systems in those early 1970s days when the systems were often supplied and installed by fly-by-night operators who were nowhere to be found when maintenance or repairs were needed and sometimes were simply not competent to install systems which had high technical demands. Similar hurdles will have to be overcome if many of the new energy technologies are to be adopted widely. A negative reputation or image can completely undermine their likely uptake even when lifetime costs are distinctly in their favour.

In addition to these challenges of reliability (or perceptions of reliability) must be added the difficulties experienced by many households in meeting the up-front costs of investment in newer technologies. Many mitigation technologies, particularly in the heating and transport areas, offer very considerable co-benefits in health and savings on running costs. Indeed, many of these technologies pay back their investment cost over relatively short time frames. However, lower socio-economic households and those who live in rental accommodation, for example, may miss out on the efficiencies gains as well as the co-benefits through lack of access to funds – either their own or their landlord's - to cover the initial out-lay.

On the positive side, local and regional governments are in a unique position to work with communities to educate and facilitate change. We won't be successful in reducing emissions unless individuals act and it is possible that the councils' most effective activity will be in the areas of advocacy, information-sharing and facilitation.

5.1.2 Work with uncertainty

Planning to address climate change in a context of such uncertainty, complexity and urgency presents challenges faced in few other situations[7]. Almost all the top climate scientists around the world agree that climate change accelerated by human activity is occurring. There is little clarity, however, about how fast this is happening and what the full range of effects is likely to be. Since the publication of the last IPCC Assessment Report, however, most of the new research indicates a worsening trend rather than giving any comfort.

The uncertainty inherent in the science, and in foreseeing the responses of people and the biosphere to whatever scenarios play out, is exacerbated by the current highly volatile global economic situation. Further, at this particular point in our regional planning exercise the newly-elected government is still reviewing which policies and strategies it will adopt in relation to climate change (see Section 3.2 above). All of this plays out in a complex situation of multiple outcomes, sectors, purposes and time scales.

Uncertainty in the science is to be expected given that climate science – the discipline which pulls together data and theories from a range of other sciences – is in its infancy. To quote Gareth Morgan[8], "…given the stakes involved, and with due deference to the 'precautionary principle' of responsible policy-making, we can't wait for full scientific certainty before we act …Probability will have to do…" Put simply, the stakes are too high for us to run the risk of delay. Even the most benign scenarios of the IPCC imply serious damage to some parts of our environment with subsequent effects on our society and economy.

Whether or not the risks play out as the scientific community is presently suggesting, many of the initiatives which would make good sense in combating climate change also have very significant co-benefits in other areas, such as health, security and environmental sustainability: they are worth doing for those reasons even without the climate change motivation.

5.1.3 Fund the initiatives

As this climate change response is being developed, the region, the country and the world are experiencing a major financial and economic down-turn. In this context in a country and region with a relatively small population, it is likely that funding any of the major initiatives proposed here will be a challenge. In thinking about the affordability of any initiatives, it will be important to balance financial costs with potential financial and other benefits and to consider any hidden costs involved in not acting. It will also be important to increase the effectiveness of any initiatives we might put in place by working together across the region, with other regions and with central government. Finding smart things to do and smart ways of doing them will be key to success in the context of an economic downturn. In this regard, the economic opportunities created by some initiatives could provide a much-needed stimulus to the region's economy as the situation begins to improve. Similarly, the financial savings which will accrue from using less energy will no doubt be well received by residents.

5.1.4 Develop renewable energy sources

The largest gains for emissions reduction in area of non-transport energy will come from a transition to 90% renewable electricity by 2030. Whether this target will continue to be government policy remains to be seen. However, neither the 90% renewable energy by 2025 nor our own 50% reduction in total emissions by 2050 targets will be achieved without central government action.

[7] Pearman, G.I. (2009). Climate Change and Security: Why this is on the agenda and should be. Proceedings of the symposium, Climate Change and Security: Planning for the future, Wellington, 14 November, 2008. *Policy Quarterly*. (2009) In press

[8] Morgan, Gareth and McCrystal, John (2009). Poles Apart: Beyond the shouting, who's right about climate change? Random House. ISBN 978 1 86979 045 5

The next few decades offer a very significant opportunity to maximise the potential for renewable energy generation which exists in the region – wind, marine and solar. A recent survey of the potential for marine energy generation around New Zealand indicates that the resource in Cook Strait is considerably greater than any other in the country, annual sunshine hours are high and our wind resource is well recognised! However, trying to promote switching by households to renewable energy sources when technology acquisition and installation costs remain comparatively high despite the obvious paybacks over time presents a challenge. Similarly, despite the growing recognition of the size of the marine resource, encouraging investment in it will be difficult in the current economic climate.

5.1.5 Convert transport to clean renewable energy sources

Nationally, the most significant decrease in emissions is projected to come from changes to the vehicle fleet, through improved fuel economy, transition to electric vehicles, and use of biofuels. Central government actions will primarily drive these reductions, although local government has a supporting role to play. In developing this document, we have assumed that central government will implement policies to transition the vehicle fleet and achieve 50% reductions by 2050.

One area in which regional government plays a critical role is provision of public transport[9]. To meet a target of 50% emissions reductions by 2050, significant increases in funding will be required for public transport infrastructure and operations. The already high rate of public transport usage in the Wellington region offers correspondingly less scope for reducing vehicle use compared to other regions. Again, we have assumed that central government will play its part in delivering this change.

5.1.6 Target nitrous oxide emissions from agriculture

Agriculture presents a particular challenge where emissions reductions are concerned. Unlike the energy, transport and waste areas, technologies for reducing agricultural emissions are in their earliest infancy. It is not simply a matter of deciding to change behaviours or investment priorities – the options are just not yet available to any great extent. While New Zealand is actively pursuing ways to reduce the greatest contributor to these emissions – methane from burping cattle and sheep– through its agricultural research programmes, the results of this research cannot be relied upon to deliver results within current planning timeframes.

Nitrous oxide emissions, however, are a little more susceptible to reductions initiatives. N2O emissions constitute 32% of the region's agricultural emissions. A number of methodologies have been identified to assist with this and it is our intention to discuss these with the farming community during the next few months to establish how useful they are in our region.

5.1.7 Reduce emissions from landfills

The contribution made by liquid and solid waste to the region's GHG footprint is relatively small. However, local government is effectively almost fully in control of these emissions since it operates the waste water treatment plants and landfills. It is therefore fully within the power of local government to reduce this footprint. Most landfill emissions result from decay of organic waste which produces methane in significant quantities. Diversion of this waste stream and capture of the gas produced would mean a significant reduction in emissions. Greater Wellington, while not an operator of a landfill, can contribute in this area by ensuring private cleanfill operators are not accepting organic waste in breach of their consent conditions.

[9] *Details on the funding formulae for public transport can be found in the Technical Information Document at URL.*

5.1.8 Increase the amount of biomass in the region

Growing plants, especially trees, sequester large amounts of carbon which they extract from carbon dioxide. While the preferred way of reducing our regional GHGs would be through reduction of emissions, the contribution forestry, both exotic and native, can make by offsetting emissions should not be overlooked. As climate change impinges on the viability of some forms of farming in the region, forestry may offer a good alternative. Research into the most suitable forestry species under changed climate conditions in the region will need to be conducted and care must be taken not to end up in a situation of negative outcomes for biodiversity.

5.2 Reduction Goals

5.2.1 The global and national context

The Kyoto Protocol is an agreement under which, during the 2008 to 2012 period, industrialized countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 (but note that, compared to the emissions levels that would be expected by 2010 without the Protocol, this limitation represents a 29% cut). National limitations range from 8% reductions for the European Union and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

These reductions are needed to stabilise greenhouse gas concentrations at 450parts per million (ppm), the level at which climate scientists believe we have about a 50/50 chance of limiting warming to no more than 2°C above pre-industrial levels. 2°C is estimated to be the maximum "safe" level of warming for the planet, i.e. a level that most vital ecosystems and human societies can adapt to without collapsing. This would require global emissions to peak by 2020 and to be reduced by about 50% below 2000 levels by 2050. The implication of this is that developed countries as a group, which have better technology, higher per capita emissions and are generally more wealthy, would have to reduce their emissions by 25-40% below 1990 levels by 2020, and by 80-95% below 1990 levels by 2050. National reductions targets and, by extension, regional targets, should be set within this context also taking into account the specific shape and size of the regional carbon footprint.

The range of percentages for regional reduction goals shown in the table below refer to the base year of 2006/07. Major assumptions about the state of the economy, the nature of political regimes and, most particularly, the development of new technologies underpin these. Details of these assumptions are included with the initiatives tables in Section 6.

The regional Emissions Reductions and Adaptation Working Group has developed these draft ranges for reductions in community emissions on the basis that their achievement is *theoretically* possible with combined action from central government, local government and the community itself. However, this needs some serious reality checking against input from key community groups of experts and stakeholders, as well as from the councils involved. They are included here as a point from which to begin discussions only.

Current central government policy documents such as NZ Energy Strategy, NZ Energy Efficiency and Conservation Strategy, NZ Transport Strategy and NZ Waste Minimisation Strategy have been considered and their targets included in these proposed goals, in most cases. Achieving a large proportion of many of these goals will be the major responsibility of central government, rather than the region's local

government. However, local government can do much to support central government in achieving its targets and those supporting initiatives are included in Section 6. Until such time as the region's councils have made their decisions as to which initiatives they will take up, and until the Working Group has had time to verify the likely effects of the most promising initiatives, the exact allocation of responsibility between central government, local government and the community will be unclear.

The eventual climate change response plan will indicate how much responsibility for the achievement of these targets will fall to local government.

5.2.2 Possible ranges for emissions reduction goals

It should be noted that globally, national governments have set reduction goals for 2050 of 80% in both the USA and the UK, compared to 1990 levels. The EU has a reduction goal of 20% reduction compared to 1990 emissions by 2020 with an aspiration to increase this to 30% if other developed countries contribute.

In light of this, the reduction goals proposed here are not overly ambitious. Given that NZ emissions continue to rise on 1990 levels (New Zealanders' per capita carbon footprint was estimated by the Ministry for the Environment in 2006 as the 5th biggest in the world), serious measures need to be taken to reduce our GHG emissions. Failure to "show willing" in this regard will undermine our ability to influence the major players in the northern hemisphere whose emissions are responsible for the serious issues we will have to face as a result of climate change effects over the next 50 – 100 years and beyond.

Ranges for potential emissions reductions

Sector	% reduction 2025	% reduction 2050
Transport	15-25%	45-55%
Electricity and other energy	25-35%	65-75%
Waste	25-35%	70-80%
Agriculture	5-15%	15-25%
Industry	15-25%	45-550%
TOTAL	**15-25%**	**45-55%**
	% increase 2025	% increase 2050
Forestry	70 - 90%	180 - 250%
NET		

5.2.3 Caveats for discussion

These goals have been proposed as part of the achievement of Milestone 2 of the CCP-NZ programme. There are three issues with setting such goals for the region.

First, in the absence of any clear indication as to how central government will achieve its 2050 target, we have made some assumptions about the level of its action. This means a rather large component of the reduction goal is outside the control of the local authorities in the region, although opportunities exist and could be created to work with central government to develop appropriate solutions.

Secondly, some of the figures in the inventory are derived by applying national averages to the regional population. As yet, sources of information which has been adjusted for regional factors are lacking for these focus areas. Such national averages will not be sensitive to any gains we may make at a regional level in emissions reductions.

Thirdly, quantifying with any accuracy the likely impacts of initiatives on emissions percentages will require a fairly major modelling task which will slow the process of putting a response plan in place and may be beyond the resources of local government in the region in the current economic circumstances. Targets will need to be measurable but need not be focused on percentage reductions of emissions totals.

As a result of these issues, setting percentage reductions goals as required by the CCP-NZ programme may be a case of setting ourselves up to fail. The response of the professional experts with whom we have discussed our ideas was to suggest a move away from percentage reduction goals and towards targets that will be indicators for emissions reductions (e.g. the proportion of electric vehicles in the region, trends in the number of solar HW consents, percentage of landfill gas capture) which will be more within the sphere of influence of local authorities.

6. Emissions Reduction Action Plan

Given the complexity of effecting behaviour change in any community, it is likely that a mix of

- facilitation - making it easy
- incentives - making it attractive
- regulation - making it compulsory

will be needed over the full range of goals and objectives we have developed to date to deliver the proposed emissions reduction goals.

The suite of initiatives we are proposing here are presented grouped according to emissions segment – transport, agriculture etc. They should be read in the context of the challenges relating to each sector noted in section 5.1.

6.1 The tables

The tables in this section propose objectives for the region's mitigation actions and suggest possible initiatives through which the objectives might be achieved. It is intended that individual councils might pick up some of these initiatives as appropriate for their circumstances. Alternatively, they may develop other initiatives (and possibly other objectives). Suggested initiatives are grouped according to the activity area of councils: leading, planning, pricing, regulating and funding. The Working Group has indicated where responsibility for the initiative might lie – at the regional and/or TA level.

All elements in these tables require discussion. ERAWG will attempt to develop SMART objectives for the draft plan following input from council officers on this discussion document.

Glossary of acronyms

RC/TA	Regional council/territorial authority
WRS	Wellington Regional Strategy
RPS	Regional Policy Statement
SOVs	Single occupancy vehicles
HOV	High occupancy vehicle
PT	Public transport
RLTS	Regional Land Transport Strategy
TDM	Travel demand management
HERS	Home energy rating system
SMEs	Small to medium enterprises

PV	Photovoltaic
LTCCP	Long Term Council Community Plan

6.2 Transport

The 2008 New Zealand Transport Strategy contains targets aiming at reducing GHG emissions from vehicles through migration of the fleet to cleaner energy sources, reducing the number of car trips which transport one person alone, and increasing the use of public transport and active transport modes such as walking and cycling. Until further notice, this remains the official policy of central government. As noted above, much of this will only be achievable through central government action. Areas where the region's councils could support central government's efforts or fill gaps are in

- planning of road and rail infrastructure,
- provision of public transport,
- urban form and land use planning to manage travel demand and increase the active mode share.

Local government also has a supporting role to play through consents and planning/provision for migration of the fleet to more renewable energy sources.

Goal 1: Reduce regional transport emissions by 15-25% on 2007 levels by 2025

Goal 2: Reduce regional transport emissions by 45-55% on 2007 levels by 2050

6.2.1 Transport Assumptions

1. Central government transport strategies include significant emissions reductions targets, such as the current NZ Transport Strategy 2008, or an equivalent "50 by 50" target.
2. Central government policies are formulated and funded to deliver on these targets.
3. NZ will continue to be an early adopter of new technologies
4. Electric cars will become widely available by 2015 and widely affordable by 2025
5. International trends for uptake of active modes once infrastructure is provided are confirmed in the Wellington region.
6. Urban form and transport network routes influence each other.

Objective	Suggested initiatives to achieve target	RC/TA responsible	Co-benefits
To migrate the regional vehicle fleet to low carbon emission vehicles	Leadership 1. Facilitating/funding research, feasibility studies. 2. Promoting migration of council fleets to cleaner energy vehicles. Planning 3. Integrating at an early stage the planning for necessary infrastructure through regional implementation plan 4. Including facilitation policies and strategies in WRS, RPS Pricing 5. Establishing incentives for lower-carbon vehicles, e.g. differentials in parking or other charges Regulatory processes 6. Fast-tracking of consenting processes. Funding 7. Funding infrastructure including charging facilities	RC/TA RC/TA RC/TAs RC/TAs RC/TA RC RC/TA	• Economic benefit through job creation, possible IP export if fleet migrated early

To reduce kilometres travelled by SOVs.	Leadership 1. Establishing incentives to encourage carpooling and mode shift initiatives amongst council staff 2. Facilitating and advocating for rapid upgrades to high speed broadband networks in region 3. Advocating for flexible employment approaches including work-from-home and "office-free days" schemes 4. Deploying carpooling facilitation schemes. Planning 5. Early planning for rapid increase in bus/HOV lanes 6. Planning for travel mode shift to active modes. Developing plan to improve active mode facilities as incentive. Funding 7. Establishing an increased number of bus/HOV lanes 8. Improving walking and cycling networks and facilities 9. Improving PT as per RLTS – park and ride, integrated ticketing, timetable alignment	RC/TA RC/TA RC/TA RC RC RC RC RC RC	• Improved community resilience through creation of new relationship networks • Significant health benefits from increased active mode share • Downstream economic benefits from improved community health

To increase the use of public transport	Leadership 1. Continuing strong promotion of PT Planning 2. Early planning for rapid increase in bus/HOV lanes Pricing 3. Using fare levels as incentives to increase uptake of PT option Funding 4. Increasing number of bus/HOV lanes 5. Improving PT as per RLTS – park and ride, integrated ticketing, timetable alignment 6. Expanding PT networks, increasing service levels	RC RC RC through contracts RC RC RC	
To increase active transport mode share	Leadership 1. Encouraging active mode uptake amongst council staff (incentives) 2. Strongly promoting co-benefits of active modes 3. Continuing travel planning activities with schools and businesses Planning 4. Integrating planning at an early stage for necessary infrastructure 5. Reviewing existing cycle/walkways and planning safety improvements 6. Including safe cycle and/or walking lanes as part of all roading developments/refurbishments wherever feasible 7. Developing options for new	RC/TA RC/TA RC RC RC RC	• Significant health benefits to community • Economic benefits from improved health – lower health costs, greater productivity

	cycle/walkway networks with a view to inclusion in RLTS	RC	
	Regulatory processes		
	8. Developing subdivision rules requiring provision for safe active modes	TA	
	Funding		
	9. Implementing improvement programme for existing cycle/walkways	RC/TA	
	10. Developing new cycling and/or walking routes with emphasis on safety	RC/TA	
	11. Including active mode routes in new road developments and refurbishments of existing, and in subdivisions	RC/TA	
To manage travel demand (TDM)	Leadership		
	1. Continuing travel planning activities with schools and businesses	RC/TA	
	2. Facilitating where possible the rapid deployment of high-speed broadband networks	RC/TA	
	3. Advocating for flexible employment approaches including work-from-home and "office-free days" scheme	RC/TA	
	Planning		
	4. Integrating planning for urban form and transport	RC/TA	
	5. Strengthening TDM measures in RLTS, District and Regional Plans etc	RC/TA	
	Regulatory processes		
	6. Developing policies and rules for land use and developments which support TDM and increased use of rail by industry and services	RC/TA	

6.3 Non-Transport Energy (including electricity)

Goal 1: Reduce emissions from non-transport energy use on current levels by 25-35% by 2025

Goal 2: Reduce emissions from non-transport energy use on current levels by 65-75% by 2050

6.3.1 Non-transport Energy Assumptions

1. 90% of national electricity supply comes from renewable sources by 2025.
2. Carbon capture and storage is used to reduce emissions from the remaining 10% of electricity sources by 2050
3. Tidal power resource in Cook Strait can be brought on stream by 2025 (including resolution of any environmental and technical barriers).
4. Both tidal and wind energy resources in the region are fully exploited by 2050.
5. Photovoltaic technology advances make this energy source affordable and widely accessible by 2020.
6. Power companies' rates for buying back energy produced at household level (feed-in tariffs) are equal to or better than their sales tariffs by 2015.

Objective	Suggested initiatives to achieve target	RC/TA responsible	Co-benefits
To manage the demand for energy from households (see also goals for efficient homes and businesses)	Leadership 1. Lobbying central government for low energy use standards for appliances 2. Promoting co-benefits of energy efficiency measures to households – insulation, energy efficient devices and appliances, solar hot water, household-level micro-generation, as appropriate. 3. Modelling desired outcomes with council buildings and housing stock.	RC/TA	• Improves resilience of system • Financial benefits to businesses, households
To generate sufficient energy within the region from renewable sources to cover the region's energy usage	Leadership 1. Facilitating and advocating strongly for rapid development of Cook Strait tidal current energy resources 2. Supporting investigation of opportunities for bio-fuel crops in Wairarapa 3. Working closely with energy supply companies to promote uptake of household-level generation 4. Developing effective group to lobby central government on development of regional renewable energy resources Regulatory processes 5. Strengthening district and regional plans, RPS, WRS, to facilitate rapid renewable energy resource development Funding Establishing joint venture or consortium to ensure full and rapid exploitation of Cook Strait tidal current energy	RC/TA RC/TA RC/TA RC/TA RC/TA RC (TA?)	• Major benefits for security of supply • Significant economic benefits in job creation, potential IP export

To heat the region's homes cleanly and efficiently	Leadership 1. Facilitating specific research for this region 2. Promoting co-benefits of energy efficiency measures to households – insulation, energy efficient devices and appliances, solar hot water, household-level micro-generation, as appropriate. 3. Modelling desired outcomes with own buildings and housing stock. 4. Developing effective group to lobby central government on HERS development Planning 5. Developing coordinated regional programme for insulation of homes, accessing government funds or filling the gap. Regulatory processes 6. Developing subdivision rules requiring provision for distributed generation, including at household level. Pricing 7. Providing incentives through fees and charges for new houses or renovations with significant energy efficiency gains Funding 8. Commissioning research. 9. Implementing a warm homes programme including insulation, clean heating methods.	RC/TA RC/TA RC/TA RC/TA RC/TA RC/TA RC/TA RC/TA RC/TA	• Significant health and financial benefits to residents • Significant economic benefits to region through lower health costs, job creation and increased productivity

To encourage businesses to be more energy efficient	Leadership 1. Promoting energy efficiency measures to businesses 2. Facilitating monitoring through developing close, cooperative relationships with businesses, industry, rural sector 3. Sharing expertise with SMEs 4. Developing councils' internal energy efficiency plans and publicising them 5. Leveraging councils' combined purchasing power to demonstrate early use of energy efficient appliances etc 6. Advising businesses on government subsidies and grants for sustainable business initiatives Regulatory processes 7. Developing incentives through green building codes for business refurbishments/new developments Funding 8. Implementing financial support programme for businesses wanting to become more energy efficient	RC/TA RC/TA RC/TA RC/TA RC/TA TA RC/TA RC/TA	• Economic benefits through lowered costs • Marketing advantage to businesses and region
To develop a distributed generation network	Leadership 1. Advocating for and facilitate distributed generation from renewable sources, including at household level, local wind farms, possibly PV arrays etc Regulatory processes 2. Developing subdivision rules requiring provision of enabling infrastructure for distributed generation, including at household level	RC/TA RC/TA	• Improves resilience of system • Financial benefits to businesses, households

	Funding 3. Commissioning research	RC/TA	
To develop resilience of system through multi-source approach	Leadership 1. Advocating with community and central government for development of multiple sources of renewable energy in region – solar, wind, tidal, marine currents 2. Advocating for and facilitating distributed generation from renewable sources, including at household level	RC/TA RC/TA	• Significant security of supply benefits • Financial benefits for households • Household generation has major benefits in disaster recovery situations

6.4 Waste

A small number of private operators are licensed to operate cleanfills but, under the conditions of their licences, these should not be accepting waste which generates emissions. As a result, it is likely that significant reductions in this part of the footprint can be achieved without having to depend on the actions of other agencies.

Goal ; 25-35% reduction in emissions from waste by 2025

Goal 2: 70-80% reduction in emissions from waste by 2050

6.4.1 Waste Assumptions

1. Porirua City Council's landfill commences gas capture by the end of May 2009.
2. Wainuiomata landfill closes by 2020.
3. Private cleanfills only receive clean fill (i.e. non-emissions producing).
4. Private landfills meet the same standards as council-owned landfills, including capturing landfill gas.

4. There is a growing local market for recycled and reused resources.

5. Cheap or profitable technologies for treatment/use of sewage sludge are available by 2050.

Objective	**Suggested initiatives to achieve target**	**RC/TA responsible**	**Co-benefits**
To ensure landfill gas is collected	Leadership 1. Capturing gas at all council operated landfills. Planning 2. Ensuring all landfill operators have plans to capture landfill gas in place by 2015 Regulatory processes 3. Establishing air quality rules which require landfill gas capture Funding 4. Implementing programme of migration of all council landfills to gas capture	TA RC/TA RC TA	• Improved air quality

Objective	Suggested initiatives to achieve target	RC/TA responsible	Co-benefits
To ensure organic waste is diverted from landfills	Leadership 1. Putting in place diversion schemes at all council landfills	TA	
	2. Supporting community composting schemes	TA	
	3. Modelling desired behaviours at council events	RC/TA	
	4. Advising and supporting schools and businesses	RC/TA	
	Planning 5. Beginning to plan for diversion of organic waste by 2012/22 LTCCPs	TA	
	Pricing 6. Putting in place incentives for diversion of organic waste at source	RC/TA	
	7. Funding 8. Supporting community composting schemes through the various council funding policies	TA	
To use sewage sludge beneficially	Leadership 1. Supporting feasibility studies/pilot programmes to test beneficial uses	RC/TA	
	Planning 2. Planning through LTCCPs as soon as viable beneficial use schemes identified	TA	
	Regulatory processes 3. Changing discharge to land and discharge to water rules to provide incentives for beneficial use of sewage sludge once viable schemes identified	RC	• Reduced water demand • More sustainable resource use

	Funding Providing infrastructure, possibly through JVs	TA	
To reduce construction and demolition waste	Leadership 1. Participating in REBRI and similar schemes for own construction projects 2. Developing collaborative relationships with businesses to promote reduction/reuse/recycling initiatives 3. Modelling desired behaviours at council events 4. Advising and supporting schools and businesses Pricing 5. Developing and applying incentives for diversion of construction waste 6. Providing financial incentives through consent fees, rates	RC/TA TA RC/TA RC/TA TA RC/TA	• More sustainable resource use.

6.5 Agriculture

Our approach to addressing agriculture emissions will be to develop a plan in discussion with the farming community. As a discussion starter, the following suite of possible initiatives which might deliver the proposed goals is noted here.

Goal 1: 5-15% reduction in emissions from agriculture by 2025

Goal 2: 15-25% reduction in emissions from agriculture by 2050

Objective	Suggested initiatives to achieve target	RC/TA responsible	Co-benefits
To reduce N2O emissions to the atmosphere	Leadership 1. Advocating for nitrification inhibitors, better fertiliser management with farmers 2. Sharing knowledge and ideas with farmers. Planning 3. Conducting early research and consultation on incentive schemes Pricing 4. Establishing differential rates or service pricing schemes as incentives to farmers Regulatory processes 5. Requiring emissions reductions measures through rules and consent conditions Funding 6. Establishing grants/loan schemes to assist farmers with infrastructural costs	RC/TA RC/TA RC/TA RC/TA RC/TA RC/TA	• Potential productivity gains for farmers • Improved animal welfare with some initiatives • Costs savings/efficiency gains with fertiliser use • Fresh water quality improvements

6.6 Forestry

This area of focus also requires significant discussion and input from the community. The Working Group has identified forestry as a likely alternative activity to pastoral farming in some areas and a useful erosion control activity in the face of increased rainfall and storm intensity. Thus, increased activity in this area could both assist with emissions reduction and constitute a viable adaptation initiative. One of the issues to be resolved will be that of native versus exotic species and a balance between commercial forestry and one-off revegetation initiatives will need to be established.

Goal 1: 70-90% increase in sequestration by forestry by 2025

Goal 2: 180-250% increase in sequestration by forestry by 2050

Objective	Suggested initiatives to achieve target	RC/TA responsible	Co-benefits
To achieve greater sequestration of carbon through increased forestry activity in region	Leadership		
	1. Increasing all councils' revegetation programmes	RC/TA	
	2. Support community groups and individuals with access to expertise and plants through council nurseries	TA	
	3. Supporting research into appropriate species for planting	RC/TA	
	Planning		• Opportunity to support survival of key native flora and fauna
	4. Identifying suitable areas for reafforestation to be included in Plans	RC/TA	
	5. Establishing forward programmes for reafforestation of council controlled lands	RC/TA	
	Pricing		
	6. Identifying effective pricing incentives to encourage uptake of forestry on appropriate land	RC/TA	
	Regulatory processes		
	7. Facilitating land use change to forestry through rules	RC/TA	

	Funding 8. Including budgets in LTCCPs for revegetation programmes and community support	RC/TA	
To ensure all regional sequestration activity is accounted for	Leadership 1. Working with appropriate central government agencies to ascertain accurate sequestration levels for native forests.	RC	• Opportunity to develop exportable IP

7. Adaptation Action Plan

7.1 Background

It is difficult to present information on potential climate change effects without incurring the accusation of being alarmist. Even the Intergovernmental Panel on Climate Change (IPCC), which is a moderate participant in the debate by virtue of its consensus viewpoint, has developed some potential scenarios which are alarming. By describing the potential risks for our region, the Emissions Reductions and Adaptation Working Group does not mean to imply that all are certain to occur. It should be remembered that our region (and our country) already have systems in place which will make it easier to manage our way through the challenges ahead than for some other regions in New Zealand or, indeed, the world. It is very likely that many of our responses to the challenges posed by climate change will be built on the foundation of systems, mechanisms and characteristics already present in our communities.

7.1.1 The global picture

Due to lags in the climate system response to changes in the Earth's radiation balance resulting from emissions from human activity, some of the climate change effects listed in section 2 are now inevitable even if we were to stop emitting all GHGs today. The Intergovernmental Panel on Climate Change (IPCC) has developed a number of scenarios relating to this. Depending on future emissions of greenhouse gases, global warming could range from about another 1.5°C (or about 2°C relative to pre-industrial conditions) to as much as 6°C with further warming beyond 2100. The lower figure would be achievable if immediate and sustained measures were taken to reduce greenhouse gas emissions and the upper figure is the IPCC projection if all available fossil fuel reserves are used with no constraints on greenhouse gas emissions.

Two degrees of warming may sound small and perhaps even welcome to a population which often envies the climates of more northerly regions. However, other regions of the world will suffer greater effects. Many key ecosystems globally are under major threat even if the world warms by only 2°C, including coral reefs, the Arctic and species depending on sea ice, and some sections of tropical rainforests. These systems are critical to sustaining the environment modern human civilisations have evolved in. From the directly human point of view, hundreds of millions of people, particularly in south and south-east Asia and Australia, will face increased water shortages as glaciers melt and rainfall patterns change, and many low-lying coastal regions are threatened by a combination of sea level rise, increased storms and river flooding (including the Pacific Islands and many of the mega deltas around the world).

7.1.2 The New Zealand picture

The potential economic, political and social results of possibly significant climate changes in other parts of the world where our political allies and trading partners are found would have considerable impacts in New Zealand. In addition to the "knock on" effects of climate change developments in the rest of the world, it is possible our less badly affected country may be seen as a refuge for populations displaced by sea level rise and advancing deserts elsewhere. Should we find ourselves in the position of having to receive large numbers of immigrants, this would inevitably place stress on our communities, especially if resources are already stretched.

NIWA's view is that a minimum of 2°C average warming for New Zealand is already "locked in". Several facts should be kept in mind in relation to this national average figure:

- some areas will experience more than this figure, others less
- there may be quite significant seasonal variation within the average
- any air temperature increase represents an increase in ocean temperature which, in turn, generates much more "energetic" weather – potentially more rain and higher winds with all the damage to our environment that implies
- changes in extremes (rain, storms, high sea levels) can be much more significant than a gradual change in mean climate. Most climate change scenarios predict an increased risk of heavy rainfall, more very hot days and fewer frosts, more droughts and risk of forest fire in eastern regions, more westerly winds and higher storm surges

Even at two degrees of warming, the negative impacts on some of our major economic activities and infrastructure could be considerable – farming, forestry, roading, power lines. For example, during one of the biggest droughts that New Zealand has experienced, in 1997/98, annual average temperatures were only about 1°C above the average. Section 2.1 discussed the potential effects on the region of sea level rise and increased intensity of storms and rainfall. These potential scenarios should be kept in mind when reading this section on adaptation.

It is fairly clear that the effects on coastal properties and vital infrastructure could be very significant although the timeframe for those effects is uncertain. In addition, sources of income such as certain fisheries or types of farming could diminish or possibly disappear. The region's economy may well struggle to fund new road and rail links, should this prove necessary, or even to protect existing ones.

7.1.3 Resilience

Fundamental aspects of our society's culture such as property and democratic rights, or economic and physical freedoms could come under threat as our communities absorb the shocks of this and other climate change consequences. These risks could be exacerbated by how susceptible to damage our communities are and their levels of capacity to adapt. Climate change is already having a multiplier effect on existing stresses and conflicts in some parts of the world, e.g. sub-Saharan Africa. Closer to home, communities in Canterbury are currently deeply divided over the rights to use available water resources. Communities where animosities over resource use and allocation run deep will, by definition, be less resilient than those which are harmonious and able to respond quickly and in a coordinated way to new shocks.

It is in the nature of any system – physical, social or ecological - to seek equilibrium, the state in which it functions best with its major functions and relationships intact. Shocks from outside may throw the system out of equilibrium from time to time and the system will respond by trying to return to its optimum operating state. If, however, there are too many shocks in too short a time, or the shock is so great as to shatter some of the system's vital functions, the system may never recover its previous stable operating state. In this case, a new system will arise with new ways of operating and possibly new components.

The ability of a system to sustain shocks and continue to operate or return rapidly to normal depends on its resilience. Contrary to what might be expected, in general it is those systems

- with multiple connections which are close but flexible (not rigid)
- with a measure of redundancy built in (i.e. more than one way of doing the same thing)
- with components which can serve several purposes (more generalists than specialists)

which are most resilient and survive major shocks better. Such systems may not be the most efficient but they will almost certainly be more resilient than the most efficient ones.

The following chart, from the IPCC AR4, indicates how various aspects of our socio-ecosystem in New Zealand and Australia might react at different levels of temperature rise[10]. As can be seen, the capacity of different aspects to cope or adapt varies widely. Caution should be used in extrapolating from these figures to the level of the Wellington region but the concepts embodied in the graph are worth noting: each system has a range in which it copes and a further range in which it can adapt. Each system has a limit to its adaptive capacity and, at varying higher temperatures, becomes vulnerable to serious damage. A good explanation of how to read the graph is contained in the IPCC's caption.

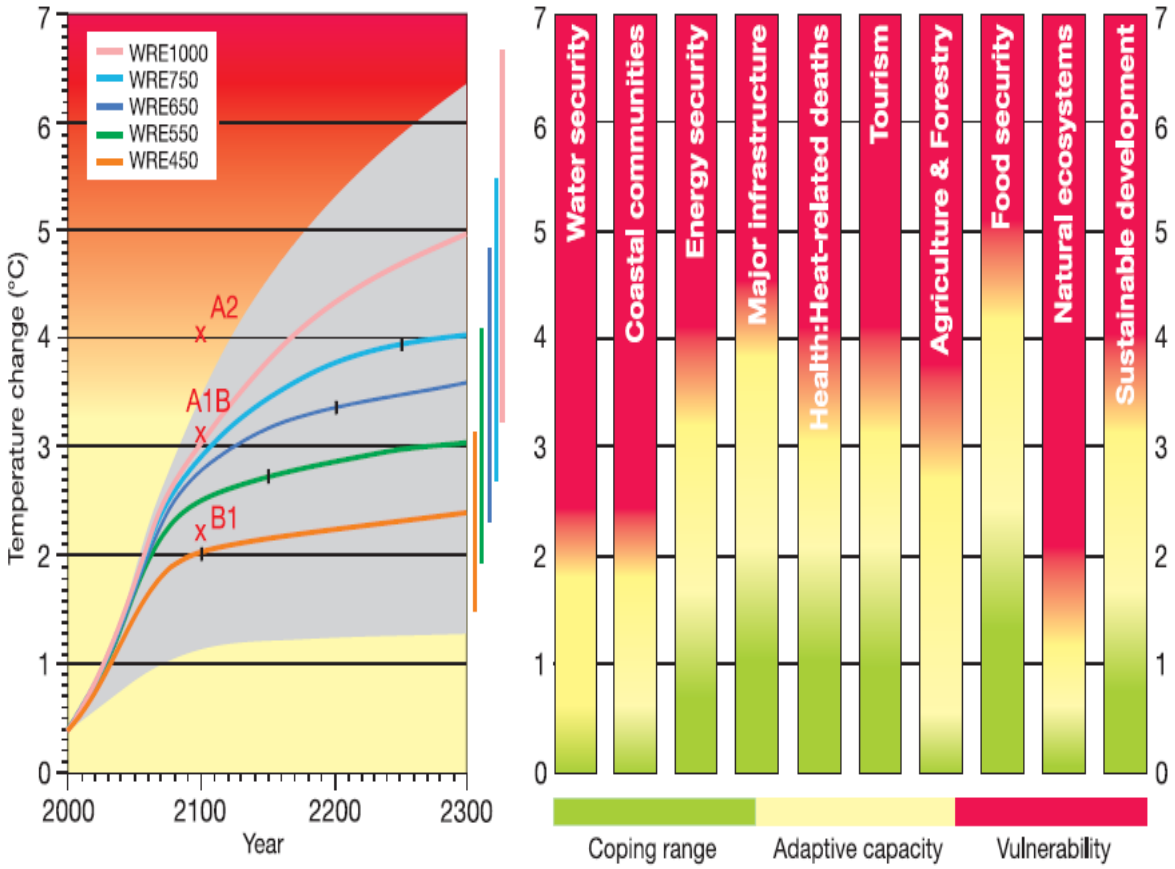


Figure 11.4. *Vulnerability to climate change aggregated for key sectors in the Australia and New Zealand region, allowing for current coping range and adaptive capacity. Right-hand panel is a schematic diagram assessing relative coping range, adaptive capacity and vulnerability. Left-hand panel shows global temperature change taken from the TAR Synthesis Report (Figure SPM-6). The coloured curves in the left panel represent temperature changes associated with stabilisation of CO_2 concentrations at 450 ppm (WRE450), 550 ppm (WRE550), 650 ppm (WRE650), 750 ppm (WRE750) and 1,000 ppm (WRE1000). Year of stabilisation is shown as black dots. It is assumed that emissions of non-CO_2 greenhouse gases follow the SRES A1B scenario until 2100 and are constant thereafter. The shaded area indicates the range of climate sensitivity across the five stabilisation cases. The narrow bars show uncertainty at the year 2300. Crosses indicate warming by 2100 for the SRES B1, A1B and A2 scenarios.*

[10] A link to this report and fuller explanation of the graph can be found at *URL*.

7.2 Planning for adaptation

As with earthquakes in our seismically risky region, we all hope that the worst scenarios of climate change will not eventuate. However, just as we know a major earthquake *will* occur at some uncertain future date, so we are certain that our rainfall patterns will change and our sea levels will rise even though we don't know how fast or how high. If global actions to mitigate emissions are not successful in limiting global warming to very little beyond what has already occurred, the potential scale of impacts on our environment, our economy and our communities could ultimately be as significant as those of a major earthquake. Clearly, the more gradual nature of climate change effects allows for adaptation over longer periods of time than is the case with catastrophic earthquake but this gradual nature of climate change does not lessen the need for preparation and planning.

Even the more benign climate change projections contain elements which will challenge our normal way of operating in this region.

Critical to success in planning for adaptation will be the adoption of very long time horizons. We are very familiar with 10 year funding plans through the LTCCP process and those in charge of establishing and reviewing Asset Management Plans are required to consider longer horizons of up to 100 years depending on the renewal rotation of the asset under consideration. Because of the combination of uncertainty as to when some impacts will be felt and the potential magnitude of some effects, it will be important for councils and their communities to look out to the hundred year horizon in *almost all* of their planning exercises to try and ensure that their decisions are resilient against and compatible with the range of projected changes, and/or that it will be possible for future generations to adapt to changes as time goes on. In the case of coastal planning, an even longer time horizon will be necessary because of the likely ongoing sea level rise over several centuries.

Adapting to the sorts of gradual changes we anticipate as a result of climate change generally requires people to forego short-term (mostly private) opportunities for the sake of avoiding future (mostly social) risks and costs. The discussion and development of a shared regional adaptation framework which addresses this issue and provides some principles by which such conflicts can be resolved would make a major contribution to the resilience of our region. The long-term planning horizon discussed above would be crucial to such a framework.

Not all climate change impacts require an immediate response although some that do are already a problem under current conditions. Others also require immediate attention, even though the effects may not be felt immediately, because they essentially lock a community into a situation where it will be increasingly difficult to adapt to future changes because of financial cost or because of social or environmental stress. There will be other effects where no action is required (or even possible) now, even though they may become significant issues in future. In thinking about possible adaptation responses, we have tried to identify where a response is necessary now, and where we simply need to monitor the situation to identify the point at which a decision on response will be necessary.

7.2.1 Overarching initiatives

Ideally, the following overarching initiatives should be initiated as a regional collaboration as soon as practicable in order to underpin the development of an adaptation framework for the region.

Step 1: A region-wide vulnerability assessment to establish areas most at risk from sea level rise, increased flooding and higher wind speeds.

Step 2: A risk analysis to identify vital infrastructure and facilities in the identified areas of greatest vulnerability and to establish trigger points for planning responses.

Step 3: An economic and social analysis to establish priorities for safeguarding infrastructure and facilities.

Ongoing: Support for research and analysis in the areas of health, biodiversity and social impacts resulting from climate change.

In parallel with the completion of Steps 1 – 3, a shared regional adaptation response framework could be developed. Such a framework would provide a common understanding of the challenges likely to be faced and of the issues that need to be considered in developing responses, together with tools for evaluating options, both for specific climate change adaptation initiatives and for initiatives that may have climate change implications in the future, in individual jurisdictions or across jurisdictions. It would:

- support consistent approaches across the region in addressing climate change impacts – particularly important where property, resource allocation and land-use issues require resolution
- provide a set of "rules of engagement" for the development of the major cross-jurisdictional responses likely to be necessary as climate change plays out e.g. major engineering and infrastructure initiatives..
- enable early identification of some of the "private good now/public good later" conflicts thus allowing resolution of issues to take place before their urgency becomes a major stress on the community.
- facilitate early scoping and assessment of options in situations where the community is at risk of becoming "locked in" to less desirable outcomes.

The framework would lay out a planning regime and provide for coordination with all other relevant council policy and planning reviews – RPS, RLTS, LTCCP, District Plans etc. The framework itself would be subject to regular review.

7.2.2 Initiatives by area of effects

Suggested initiatives to support the community to adapt to specific climate change effects which cannot be mitigated through emissions reduction are shown in the following table. The Working Group has assessed the risk level against the 2100 time horizon based on advice from subject experts. As with the suggested initiatives in section 6, it is intended that councils will treat this as a menu from which to choose actions. Individual councils are not expected to initiate all of these actions and the Working Group anticipates that some councils may develop different initiatives. The Working Group has also attempted to indicate when action would need to be commenced on individual initiatives in order to be effective.

Area of effects and level of certainty as to risk	Estimated time horizon of risk	Suggested initiatives	Action initiation
Sea level rise (base plus storm surge) leading to coastal erosion, inundation of coastal areas, salination of soils and aquifers *Risk level:* *Highly likely to 0.6m* *Likely to 1 m* *Possible to 2m*	Probably already begun and increasing out to 2100 and beyond	▪ Increase dune and shoreline vegetation protection ▪ Place limits or bans on development in most vulnerable areas ▪ Migrate residents from vulnerable areas ▪ Change land use as salination takes effect ▪ Plan alternatives to vulnerable water aquifers ▪ Migrate critical roads and railway tracks away from coastal strips	Early Early and ongoing Medium to long term As needed Early for medium to long-term implementation Long term

Increased floods and erosion *Risk level:* *Likely*	Increasing out to 2100	▪ Change land use rule to prevent erosion of slopes ▪ Review and strengthen building consent conditions ▪ Encourage catchment sensitive farming regimes ▪ Facilitate riparian planting and fencing projects ▪ Strengthen flood protection schemes where this is feasible and cost effective long term ▪ Place limits or bans on development in most vulnerable areas ▪ Migrate residents from vulnerable areas ▪ Migrate critical roads and railway tracks away from vulnerable areas	Early Early Early Early Medium to long term Early to medium Long term (medium term planning) Long term (medium term planning)
Changing health problems /new diseases *Risk level:* *Possible to likely*	Long term	▪ Support research and analysis and monitoring programmes to detect early warning signs of increased risk	Early and ongoing
Increased pest flora and fauna *Risk level:* *Likely*	Medium to long term	▪ Strengthen defence of Key Natural Ecosystems ▪ Identify key species (especially endemic) and establish programmes to ensure their survival	Early Early

Negative social impacts *Risk level:* *Possible to likely*	Medium to long term	Strengthening networks ▪ Support community groups with a community project focus ▪ Research types of groups and projects which promote network development ▪ Identify communities/neighbourhoods where social networks are weak and initiate network development ▪ Use civil defence and environmental care networks as basis to build other neighbourhood networks ▪ Devolve decision–making to neighbourhood/community level where possible. Support with skills development Strengthening democracy ▪ Establish civic skills/understanding programmes through schools ▪ Research international models of high community participation in democratic processes ▪ Devolve decision–making to neighbourhood/community level where possible. Support with skills development ▪ Ensure significant community involvement in planning for adaptation measures	 Early Early Early to medium term Early to medium term Early to medium term Early Early Early to medium term Early to medium term
Threats to energy security *Risk level:* *Possible*	Medium to long term (closely linked to peak oil)	▪ Develop renewable energy sources in region ▪ Support and encourage distributed energy generation including at household level	Early to medium term Early to medium term

Threats to food security *Risk level:* *Could occur but unlikely by 2100*	Long term	▪ Support and encourage community garden initiatives ▪ Share advice and expertise with individual households developing vegetable gardens and other food supplies ▪ Ensure local rules support sustainable harvesting of vulnerable wild food resources	Early *Note: while risk is low and long term, this could be a key community network-building strategy* Medium to long term Medium to long term