

# Adapting to Climate Change in New Zealand



## **Stocktake Report from the Climate Change Adaptation Technical Working Group**

The information provided in this report represents the best information available to the Group and our expert judgement. The gaps in knowledge and work programmes signify those present as of 31 May 2017.

This Stocktake Report constitutes the Interim Report of the Climate Change Adaptation Technical Working Group as per their terms of reference.

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# Executive summary

Global climate has already changed as a result of greenhouse gas emissions from human activities and it will continue to do so. While we are uncertain about the exact speed and scale of change, we know that planning for the future means planning for a different climate.

In New Zealand we will experience increased frequency and intensity of extreme events such as higher temperatures flooding, droughts and wildfires, increased sea-level rise, and warmer and more acidic oceans. This will threaten our coastal communities, cities, infrastructure, human health, biodiversity, oceans and resource-based economy (Intergovernmental Panel on Climate Change (IPCC), 2014). These changes may also bring opportunities and we need to plan how we can best position ourselves to take advantage of these.

In November 2016 the Minister for Climate Change Issues established the Climate Change Adaptation Technical Working Group and asked us to advise the Government on New Zealand's choices for how to build resilience to the effects of climate change. This stocktake report summarises the expected impacts of climate change on New Zealand over the medium and long term, takes stock of existing work on adaptation, and identifies gaps in knowledge and work programmes. This report is a stepping-stone and has informed our second report on New Zealand's options for building resilience to the effects of climate change.

## What is adaptation?

*Adaptation* is an ongoing process of adjusting to the actual and expected changes in the environment resulting from greenhouse gas emissions already released into the atmosphere and those that may be released in the future. Adaptation is an ongoing process as the climate will continue to change throughout this century and beyond. It is different from but linked to *mitigation*, which is about reducing greenhouse gas emissions to limit further climate change, and increasing the ability of natural processes to absorb emissions, for example, by planting trees.

This report focuses on adaptation but acknowledges that the two are closely linked, as the extent of adaptation required in the long term will depend on the global level of mitigation achieved in the future. Adaptation and mitigation can be mutually reinforcing.

By ratifying the Paris Agreement in 2016, New Zealand confirmed it will *plan for* and *take action* to adapt to the impacts of climate change.

We have options for how we can adapt. Decisions we make today about infrastructure, urban development, biodiversity, and land and water management will have implications for how our future generations can adapt. Many activities that build resilience in the short term may have immediate co-benefits. For example, restoring wetlands and mangroves will help provide coastal protection from sea-level rise for a time, while also contributing to biodiversity conservation goals.

Finding the most appropriate adaptation actions will, however, be a delicate balancing act. It is therefore important to consider and be ready to manage downstream consequences – co-benefits may be temporary or increase vulnerability rather than resilience in the long term. For example, planting more trees in areas exposed to more rainfall can help protect the land from soil erosion and at the same time absorb emissions. On the other hand, such measures could increase our exposure to pests, wildfire and water stress. So regardless of how we approach our adaptation to a changing climate it needs to be deliberate and well planned.

## Climate-related changes New Zealand can expect

Natural variations have always played a part in New Zealand's climate, and will continue to do so. Climate change is expected to shift the range and the pattern of this variability. This will be driven by the greenhouse effect changing the temperature range, the greater water-holding capacity of the atmosphere resulting in more intense rainfall, and by an accelerating rate of sea-level rise from the polar ice sheets. Sea-level rise is one of the major and most certain consequences of climate change. Over the last 100 years, the sea level around New Zealand has risen at an average rate of 1.8 mm per year. Since satellite measurements began in 1993, the average global sea level has risen by about 3.3 mm per year. The IPCC Fifth Assessment Report projects that global sea level will rise by 0.2–0.4 m by 2060 and 0.3–1.0m by 2100, depending on the emissions scenario. However, the collapse of parts of the Antarctic ice sheets could substantially increase this range. The acceleration of sea-level rise will have implications on the ability of natural and human systems to adapt. The following table outlines the changes we can expect to see to our climate and oceans over the medium and long term.

## Projected magnitude and variation of climate-related changes for New Zealand<sup>1</sup>

Climate variable	Description of change	Timeframe of change <sup>2</sup>		
		Now	2040	2090
<b>Average temperature</b>	Only for low carbon scenario does warming peak and then decline slightly during the 21st century Warming greatest at higher elevations. Warming greatest summer/autumn & least winter/spring	New Zealand has already warmed by 0.9°C	+0.7°C to +1.0°C	+0.7°C to +3.0°C 2110: +0.7°C to +3.7°C
<b>Daily temperature extremes: frosts</b>	Decrease in cold nights (0°C or lower) Number of days of frost decrease greatest in the coldest regions	Significant reduction in frequency of cold nights in many locations	30% to 50% decrease	30% to 90% decrease
<b>Daily temperature extremes: hot days</b>	Increase in hot days (maximum temperature of 25°C or higher)	No significant changes observed yet	40% to 100% increase	40% to 300% increase
<b>Ocean warming<sup>3</sup></b>	Progressive increase Higher temperature increase in north Tasman Sea (projected to exceed 3°C by 2100)	1909–2009: warmed 0.71°C		Mean sea surface expected to increase by 2.5°C [RCP8.5]
<b>Ocean acidification (lowering pH)</b>	Increase, with a rate of change that is unprecedented in the last 25 million years	Increasingly acidic Subantarctic waters (since 1998)		pH surface water will decline by 0.33 [RCP8.5]
<b>Sea-level rise</b>	Progressive increase faster than over the last century, and continuing for many centuries Relative sea-level rise will vary at different locations around New Zealand.	1915–2015: rate of 1.8 mm per year on average	2060: 0.2 m to 0.4 m rise 2100: 0.3 m to 1.0 m rise The collapse of parts of the Antarctic ice sheets could substantially increase the upper end of this range	
<b>Average rainfall</b>	Varies around the country and with season. Annual pattern of increases in west/south of New Zealand, and decreases in north and east Winter decrease: Gisborne, Hawke's Bay and Canterbury Winter increase: Nelson, West Coast, Otago and Southland	Rainfall decrease in Northland and rainfall increase in the SW South Island.	Substantial variation around the country, increasing in magnitude with increasing emissions.	

<sup>1</sup> Ministry for the Environment, 2016, *Climate Change Projections for New Zealand*.

<sup>2</sup> Magnitude of change considers scenarios based on Representative Concentration Pathways (RCPs) Four scenarios are considered ranging from a low emissions world where net anthropogenic global carbon dioxide emissions stop after 2080 (RCP2.6) to a high emissions, no mitigation scenario (RCP8.5). Changes are relative to 1995 levels.

<sup>3</sup> Law, C.S., Rickard, G.J., Mikaloff-Fletcher, S.E., Pinkerton, M.H., Gorman, R., Behrens, E., Chiswell, S.M., Bostock, H.C., Anderson, O. and Currie, K. (2016) *The New Zealand EEZ and South West Pacific. Synthesis Report RA2, Marine Case Study. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100*. MBIE contract C01X1225. 41pp.



Climate variable	Description of change	Timeframe of change <sup>2</sup>		
		Now	2040	2090
<b>Daily rainfall extremes: dry days<sup>4</sup></b>	More dry days throughout North Island, and in inland South Island Dry days most marked in north and east of North Island (winter and spring)	More dry days in Northland. Fewer dry days in SW South Island (since 1930)		Up to 10 or more dry days per year (~5% increase).
<b>Daily rainfall extremes: very wet days</b>	Increased extreme daily rainfall, especially where mean rainfall increases Strongest increases in western regions, and in south of South Island	Increases in the west of both islands, decreases in the east and Northland (since 1930)		More than 20% increase in 99th percentile of daily rainfall [RCP8.5] in SW of South Island
<b>Snow and Ice</b>	Decrease Large decreases confined to high altitude or southern regions of the South Island	Decrease in the length of many New Zealand glaciers		Snow days per year reduce by 30 days or more [RCP8.5]. Loss of many glaciers [RCP8.5]
<b>Drought</b>	Increase in severity and frequency Increases most marked in already dry areas	Increase in the risk of severe drought in some areas. The worst drought in the New Zealand record occurred in summer 2012–13.		Up to 50 mm+ increase per year, on average, in July–June potential evapotranspiration deficit (PED) [RCP8.5]
<b>Extreme wind speeds</b>	Increases in southern half of North Island and the South Island		Up to 10% or more in parts of the country	
<b>Storms</b>	Poleward shift of mid-latitude cyclones and possible small reduction in frequency. The most severe Ex-tropical cyclones are expected to be stronger. Their frequency is expected to decrease slightly or remain unchanged.	More analysis needed		

## The impacts of climate-related changes for New Zealand

Changes to our climate and oceans pose a number of risks and opportunities to our people, infrastructure, natural environment and economy.

<sup>4</sup> Defined as days with precipitation below 1 millimetre/day. Salinger, M.J. and Griffiths, G.M. (2001), Trends in New Zealand daily temperature and rainfall extremes. *International Journal of Climatology*, 21: 1437–1452. Porteous, A. and Mullan, B. (2013), *The 2012–13 drought: an assessment and historical perspective*. NIWA client report for Ministry for Primary Industries, June 2013, 57p.

In terms of risks, climate change will amplify existing risks and create new risks which will be unevenly distributed across natural and human systems (IPCC 2014). Applied to a climate setting, these risks depend on:

- how **exposed** people, infrastructure, the natural environment and the economy are to the change.
- their **vulnerability** to those hazards, that is their ability to cope and adapt to the change.

The implications of climate change for New Zealand's economy and society over the long term will depend on what actions we take now. Adaptation has the potential to reduce the risks from climate change.

## Impacts on the natural environment

Climate change could have a significant impact on our terrestrial, freshwater, coastal and marine ecosystems, which are already under pressure from existing stressors (such as land use intensification). The range of ecosystems and species will change, as well as the timing of annual and seasonal events (eg, beech masting), and ecosystem functions (eg, food webs). Native species that have highly specialised habitat requirements, such as frogs and lizards, are particularly at risk. Indirectly, climate change will increase the extent and abundance of invasive species, already a key driver of extinction in New Zealand.

Climate change will also impact on essential ecosystem services we rely on, including the availability of clean fresh water, access to kai moana, soil stability, flood protection, pollination, carbon storage and coastal protection.

## Impacts on the built environment

Most of New Zealand's major urban centres and the majority of our population are located on the coast or floodplains of major rivers. Our communities, homes, commercial assets and infrastructure are exposed to flooding, sea-level rise, storm surge and inundation from rising ground water levels.

The mid-range projected sea-level rise over the next 50 years is 30 cm. Such a rise in sea level would have impacts on all coastal areas to varying extents. Under this scenario, in Wellington a one in 100 year inundation event would become an annual event, in Dunedin this would become a one in two year event, and in Auckland a one in four year event. We can also expect to see more damage and disruption to assets and critical infrastructure in parts of these areas. This is significant considering central and local government own over \$200 billion in infrastructure assets.

## Impacts on society and culture

Climate change is increasingly being recognised as a serious emerging risk to public health. Some of the potential impacts will be direct, such as injury and illness from extreme weather events, while others will be indirect, such as increased incidences of existing and new diseases.

For Māori, their reliance on the environment as a cultural, social and economic resource makes them exposed to climate change impacts. Different iwi face different risks, and some are more vulnerable than others. There are numerous marae, cultural heritage and food gathering sites in coastal low-lying areas that are at risk of being lost by sea erosion and inundation.

There will be some groups and locations in New Zealand that will be more vulnerable to climate-related risks and have less capacity to adapt. More research is needed to understand which these groups are and where such hotspots are located.

## Impacts on the economy

Agriculture, fisheries, forestry and tourism are significant contributors to New Zealand's economy, and are all dependent on climate-sensitive natural resources. These sectors are exposed to the direct impacts of a changing climate (eg, changes to water availability and quality) as well as indirect impacts that compound and cascade through the economy (eg, increased biosecurity threats and disruption to supply chains). In addition, many of our industries are trade-intensive. The IPCC (2014) suggest that the flow-on effects of climate change impacts and responses outside our region could outweigh some of the direct impacts within New Zealand. More research is needed on this.

Climate change will also impact on the insurance and finance sector which will have broader economic implications. More extreme weather events will raise the number and value of claims insurers pay, which will inevitably be reflected in the premiums charged and willingness to provide cover. For banks, this could result in the offer of shorter term mortgages which may become less affordable. Unavailability or unaffordability of insurance cover will reshape the distribution of vulnerable groups.<sup>5</sup>

Businesses, such as manufacturing and retail, are expected to be indirectly affected through changes to consumer behaviour, disruption to supply of products and services, and/or damage to commercial assets. But climate change can also present new business opportunities. For example, regions may be able to sustain different types of crops than they have been able to grow previously, although climate ranges will be continually changing.

While the potential costs of climate change impacts on the New Zealand economy are not known, we do know our exposure to the impacts are high in many areas (eg, in coastal floodplains and to our major economic sectors), and as such the costs are likely to be significant. For example, the economic impact of the 2012–13 drought, which climate change is assessed to have made a

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<sup>5</sup> 2013 and 2014 were among the most expensive years for weather-related events.

contribution, is estimated to be a minimum of \$1.5 billion. Another example shows the costs of weather events to our land transport network in the last 10 years have increased from \$20 million per annum to over \$90 million per annum.

## Defining effective adaptation

While the potential impacts of climate change may appear overwhelming, well-planned adaptation can substantially reduce these risks, avoid losses and maximise opportunities. This can be achieved by taking action to reduce the exposure of our natural, built, social and economic systems to the impacts; and ensuring these systems have sufficient capacity to adapt.

To review what New Zealand is currently doing to adapt we have developed a framework identifying key characteristics and attributes of an effective adaptation approach. The characteristics include that we are:

- **informed** about how our climate is changing and what it means for us
- **organised** in our approach
- taking **dynamic action** to proactively manage the environmental, economic and social risks.

We then assessed the information provided by sector representatives against the key characteristics of effective adaptation. For each sector, we rated each characteristic as ‘maintain’, ‘more work required’, ‘significant work required’, or ‘not present’.

## Stocktake of what New Zealand sectors are doing to adapt to climate change

Our Terms of Reference require us to undertake a stocktake of existing work on adaptation by central and local government. In addition to this, we have also drawn on our expertise within the Group to consider what other sectors of society are doing on adaptation. We chose to extend the scope of the stocktake as we recognise that New Zealand will not successfully adapt through central and local government alone.

Central and local government on behalf of communities is responsible for managing risks to public goods and assets (including the environment), delivering government services, and creating the institutional, market and regulatory frameworks that can promote resilience and adaptation.

**Central government** has played a key role in funding research which provides the basis for building New Zealanders’ understanding of climate-related changes and the impacts on different sectors of society. Central government agencies’ understanding of how climate change will impact on their responsibilities and operations are less clear.

There is some misalignment in how climate change adaptation and resilience objectives are incorporated into legislation and policy. As a result, the response of central government agencies to adaptation is not coordinated and there is little alignment of legislation, adaptation goals or agreement of priorities.

Agencies consider and act on the impacts of climate change to varying degrees – some have taken positive initial steps (eg, the National Infrastructure Plan and National Civil Defence Emergency Management Plan both highlight the importance of integrating climate risks into decision-making). Other government activities are running the risk of increasing New Zealand's future vulnerability as climate impacts are not being considered (eg, accelerated urban development). In general, most of central government's action on adaptation has been reactive to climate-related events and principally within a natural hazard management response framework, when ongoing impacts will also encompass wider considerations such as human and natural ecosystems health.

**Local government** has responsibilities for preparing communities for and managing the risks of climate change. However, this brings with it inefficiencies when central government statutory frameworks and national adaptation goals and priorities are not aligned or missing.

The majority of councils appear to have a good understanding of climate change and are able to clearly articulate the potential impacts on their responsibilities.

The extent and scope of action on adaptation varies considerably. For example, some regions are already experiencing difficult climate-related impacts, including significant flooding risks in South Dunedin and coastal erosion and inundation impacts in the Hawke's Bay. Overall, councils are at different stages of planning, and have different approaches to managing climate risks which can create confusion for the public, and result in litigation of decisions.

Many councils realise the importance of acting on adaptation and would like to do more, but identified barriers including lack of leadership and support from central government; limited community buy-in; and resourcing constraints (funding, capacity and capability). There are a few councils that are starting to innovate with community processes and tools for managing climate risks.

**Infrastructure providers** include private and/or public organisations responsible for the design, construction, operation and maintenance of electricity generation and transmission; water, wastewater and stormwater (three waters); flood management; and communications and transportation networks (including ports and airports). Infrastructure assets generally have a long design life. It is the provider's responsibility to ensure they consider climate-related change and the long-term impacts this will have.

A good level of information is available to infrastructure providers on climate change through climate projections supplied by government, and applied through industry standards. Some providers have displayed a good understanding of the risks, however many consider climate change adaptation as part of a broader goal around resilience to natural hazards. This limits the consideration of the changing nature of climate-related risks.

Given the long lifetime of infrastructure, it is important that climate change adaptation is factored into infrastructure decisions now. Many local authorities, which are significant providers of infrastructure assets, are approaching a period of infrastructure renewal. This is an opportunity to integrate consideration of climate change impacts and their consequences over the lifetime of the assets.

In the majority of cases, infrastructure decisions do not currently consider climate change impacts. There are a number of challenges to incorporating climate change adaptation into infrastructure decision-making. These include: most approaches to addressing service provision involving 'locked in' practices and measures developed over the last century, and a perception that climate change adaptation will cost more, even though it may not be significant compared with the large capital costs and longevity of infrastructure investment.

**The finance and insurance sector** includes New Zealand's insurance, banking and investment providers. The sector is experienced in dealing with natural hazards and understands that climate change will exacerbate this. It is calling for a more coordinated and proactive response focused on reducing the potential impact of disasters before they strike.

The mismatch in the duration of insurance cover (annual) and lending (spanning decades) creates complexity in creating a coordinated response for businesses and homeowners in locations significantly affected by climate change. While the sector has not yet implemented any direct measures to deal with climate change impacts, it knows how insurance products would be changed when risks become too large. A key concern for the insurance industry is that action taken on a specific risk can result in precipitous action by others in the industry and some government policy settings, for example the Earthquake Commission (EQC).

**The health sector** is becoming increasingly aware of the risks of climate change on public health in New Zealand, but more work is needed. The sector is not organised for adapting to climate change with no clear goals or understanding of what is expected of them and no plan for how to go about adaptation. Some District Health Boards are addressing the impacts of climate change on public health in their planning and decision-making. This has mainly been through their emergency response and infrastructure planning.

For the **primary sector**, there is a lot of information available on the impacts and implications of climate change. This has helped facilitate a basic understanding of climate change for the sector. However, there are gaps in research on some of the impacts, for example, pests and diseases. The sector has a long history of adapting to seasonal and annual variability in climate-related conditions, including coping with the current frequency of extreme events. The challenge the sector will face as a result of climate change is increased range in that variability, changes to baseline rainfall and temperatures and an increase in the frequency of extreme events. Where measures that increase resilience have been incorporated, climate change is often not a key driver.

In the remaining **business sector**, the majority of businesses surveyed understand the future trends in climate that New Zealand can expect to experience.

While no overall plans for adaptation in this sector were indicated, the majority of survey respondents noted intent to manage climate change impacts in the future. However, information on how they intend to do this was not supplied.

Some businesses have an understanding of climate change risks, but often due to uncertainty and perceived costs involved, more immediate issues take priority. The private sector is driven by market conditions and as such has the ability to respond much more quickly to change, compared with the government. Increased range in climate variability may however challenge that agility.

Many **iwi/hapū** organisations recognise that if this generation does not take action then a higher burden will fall on future generations. Considerable work has been undertaken by Māori authorities and governance structures in generating iwi and hapū plans that identify climate change issues and implications. However, few of these have been mainstreamed by local government. Supporting vulnerable whānau and Māori land owners and business to adapt to climate change is a key area of focus for iwi.

In **civil society**, academics and the research community (funded by government) supply information to all sectors of society to help enable proactive and purposeful adaptation. Current research includes refinement of the range of expected impacts and how to implement appropriate adaptation. More work is required to understand if and how civil society can adapt to climate change.

## A stocktake of current gaps in knowledge and work programmes

For effective adaptation to develop in New Zealand three characteristics and their attributes need to be in place – being **informed** about how our climate is changing and what this means for us; being **organised**; and taking **dynamic action**, to proactively reduce exposure to the environmental, economic and social and cultural consequence of climate change. Once each of these steps have started it is important that they continue. As our climate continually evolves, so must our adaptation approach.

The stocktake shows that New Zealand is in the early stages of planning for climate change impacts, with many positive initial steps being taken across nearly all sectors. The majority of sectors appear to be in the phase of becoming informed about the potential impacts and understanding what it means for them, while others have progressed to the organised phase.

### Informed

New Zealand has generated a significant amount of information about what is happening to our climate, but the challenge is for this information to be readily available to sectors in forms that are relevant to their decision-making. There are gaps in our knowledge, including the potential costs to the economy over the medium and long term if no action is taken to adapt now, potential

biosecurity threats to our sectors and natural systems and the impacts of climate change on pluvial flooding.

The lack of a nationwide assessment of the climate-related risks means that it is difficult for New Zealand to develop a planned approach for climate change adaptation because priorities for action cannot yet be articulated. This would be the first step towards an aligned approach across all sectors to help stimulate action in a systematic way.

## Organised

Climate change adaptation is not currently integrated into many central government agency objectives. In the absence of coordinated leadership on climate change adaptation, other sectors operate within regulatory frameworks and policies which are not well aligned. This makes it difficult for central and local government and sectors to proactively organise themselves and take action.

Additional organisation gaps identified include:

- An overarching strategy or plan for how New Zealand can adapt to climate change.
- Coordinating mechanism(s) across and within sectors on climate change adaptation.
- Enabling tools to help facilitate adaptation, including the use of national direction tools.
- Resource scarcity, including expertise and funding across all sectors.
- Role clarity within and across sectors.

## Dynamic action

We have seen a few examples of proactive adaptive action where there is high exposure and potentially large costs (eg, investment in flood risk management and some roading projects). However, overall there is limited evidence of proactive action that reduces medium and long-term risks. In most cases, actions have been reactive and part of a sector's natural hazard management response, rather than considering wider impacts, their changing characteristics and their compounding and cascading effects within and across sectors.

## Next steps

The next step is to use this stocktake report as a basis for our second report on options for how New Zealand can address the challenges identified and build resilience to the effects of climate change while growing our economy sustainably.



# 1 New Zealand's climate is changing

New Zealand is already being affected by climate change. Changes to our environment will increase in magnitude and frequency over time. This will affect all of us in some way during our lifetimes, and our response will directly affect future generations.

Global climate has already changed as a result of greenhouse gas emissions from human activities, and it will continue to do so. While we are uncertain about the exact speed and scale of change, we know that planning for the future means planning for a different climate.

In New Zealand we will experience increased frequency and intensity of extreme events such as flooding, droughts and wildfires, increased sea-level rise, and warmer and more acidic oceans. This will threaten our coastal communities, cities, infrastructure, human health, biodiversity, oceans and resource-based economy (Intergovernmental Panel on Climate Change (IPCC), 2014). These changes may also bring opportunities and we need to plan how we can best position ourselves to take advantage of these.

## 1.1 What is climate change adaptation?

There are two important and complementary approaches to New Zealand's response to climate change.

- **Mitigation** – about reducing greenhouse gas emissions to limit further climate change and increasing sinks, such as planting trees, which absorb these gases.
- **Adaptation** – about an ongoing process of adjusting to the actual and expected changes in the environment resulting from greenhouse gas emissions which have already been released into the atmosphere, and those that may be released in the future. Adaptation is an ongoing process as the climate will continue to change throughout this century and beyond.

This report focuses on adaptation but acknowledges that the two parts are closely linked because:

- the extent of adaptation we need in the long term, will depend on the global level of mitigation achieved in the future
- the way we adapt may affect mitigation efforts. For example, planting more trees in areas exposed to more rainfall can help protect the land from soil erosion and at the same time absorb emissions. On the other hand, such measures could also increase our exposure to pests, wildfire and water stress. So regardless of how we approach our response to a changing climate it needs to be deliberate and well planned.

## 1.2 How can New Zealand adapt to climate change?

By ratifying the Paris Agreement in 2016 New Zealand confirmed it will ‘plan for’ and ‘take action’ to adapt to the impacts of climate change.

We have choices about how we can adapt. Decisions we make today about infrastructure, urban development, biodiversity and land and water management will have implications for how our future generations can adapt.

Many activities that build resilience in the short term may have immediate co-benefits (eg, flood protection work can reduce present economic losses). But it can be a delicate balancing act and we need to consider or be ready to manage downstream consequences – co-benefits may be temporary or increase vulnerability rather than resilience in the long term. For example, investment in irrigation can reduce short-term vulnerability to drought but in the long term may encourage land intensification thereby placing greater pressure on water resources. Structural protection works may also build a false sense of security and further demands for protection thus locking in exposure to risk over the long term.

In November 2016 the Minister for Climate Change Issues established the Climate Change Adaptation Technical Working Group and asked us to advise the Government on the options New Zealand has for how to build resilience to the effects of climate change. This is our first report where we:

- **look at the climate-related changes New Zealand can expect over the medium and long term (Chapter 2), and the potential impacts this will have on the natural and built environment, the economy and society (Chapter 3).** For example, climate change driven sea-level rise will intensify coastal erosion and inundation. This may lead to low-lying areas being covered by water, seawaters entering some of our groundwater resources, and increased damage to properties and infrastructure near the coast
- **define the key characteristics and attributes of effective adaptation (Chapter 4)**
- **take stock of the existing work on adaptation by central and local government (Chapter 5).** Our Terms of Reference requires us to undertake a stocktake of existing work on adaptation by central and local government. In addition to this, we have also drawn on our expertise within the Group to consider what other sectors of society are doing on adaptation. We chose to extend the scope of the stocktake as we recognise that New Zealand will not successfully adapt through central and local government alone
- **outline gaps in knowledge and work programmes (Chapter 6)** based on the stocktake. This information provided in this DRAFT report represents the best information available to the Group and our expert judgement. The gaps in knowledge and work programmes identified are a work in progress. We propose to test this information with key, targeted groups
- **outline what will come next (Chapter 7).**

This report is a stepping-stone that will inform our second report, a draft of which will be produced in November 2017 with the final report due to the Minister of Climate Change Issues in March 2018. Our second report will consider and provide recommendations on what New Zealand’s choices are for building resilience to the effects of climate change (see [Appendix 1](#) for the Group’s Terms of Reference). The report is organised as follows:

<p>NZ's climate is changing</p> <p>Chapter 1</p>	<p>Climate related changes NZ can expect</p> <p>Chapter 2</p>	<p>Impacts of climate related changes for NZ</p> <p>Chapter 3</p>	<p>RESPONSE</p>	<p>Defining effective adaptation</p> <p>Chapter 4</p>	<p>Stock take of what NZ sectors are doing to adapt to climate change</p> <p>Chapter 5</p>	<p>Current gaps in knowledge and work programme</p> <p>Chapter 6</p>	<p>NEXT STEPS</p> <p>chapter 7</p>
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## 2 Climate-related changes New Zealand can expect

NZ's climate is changing Chapter 1	<b>Climate related changes NZ can expect Chapter 2</b>	Impacts of climate related changes for NZ Chapter 3	<b>RESPONSE</b>	Defining effective adaptation Chapter 4	Stock take of what NZ sectors are doing to adapt to climate change Chapter 5	Current gaps in knowledge and work programme Chapter 6	<b>NEXT STEPS</b> chapter 7

New Zealand's average temperature has increased by around 1°C over the last century, and will continue to increase. This section summarises the climate-related changes New Zealand can expect as a result, over the medium and long term. The information in this section comes from a variety of sources, including the Ministry for the Environment's 2016 report *Climate Change Projections for New Zealand*<sup>6</sup> and the IPCC Fifth Assessment Report.<sup>7</sup>

### 2.1 Climate-related changes over the medium and long term

Table 2.1 and Figure 2.1 show the projected changes in climate-related variables as a result of climate change, and the spatial distribution of these changes. Where possible, we have set out the projected impact across time, with a snapshot of now, 2040 and 2090. More detailed regional impacts of climate change can be found on the Ministry for the Environment's website.<sup>8</sup>

<sup>6</sup> <http://www.mfe.govt.nz/publications/climate-change/climate-change-projections-new-zealand>

<sup>7</sup> <https://www.ipcc.ch/report/ar5/>

<sup>8</sup> <http://www.mfe.govt.nz/climate-change/how-climate-change-affects-nz/how-might-climate-change-affect-my-region>

**Table 2.1: Projected magnitude and variation of climate-related changes for New Zealand<sup>9</sup>**

Climate variable	Description of change	Timeframe of change <sup>10</sup>		
		Now	2040	2090
<b>Average temperature</b>	Only for low carbon scenario does warming peak and then decline slightly during the 21st century Warming greatest at higher elevations. Warming greatest summer/autumn & least winter/spring	New Zealand has already warmed by 0.9°C	+0.7°C to +1.0°C	+0.7°C to +3.0°C 2110: +0.7°C to +3.7°C
<b>Daily temperature extremes: frosts</b>	Decrease in cold nights (0°C or lower) Number of days of frost decrease greatest in the coldest regions	Significant reduction in frequency of cold nights in many locations	30% to 50% decrease	30% to 90% decrease
<b>Daily temperature extremes: hot days</b>	Increase in hot days (maximum temperature of 25°C or higher)	No significant changes observed yet	40% to 100% increase	40% to 300% increase
<b>Ocean warming<sup>11</sup></b>	Progressive increase Higher temperature increase in north Tasman Sea (projected to exceed 3°C by 2100)	1909–2009: warmed 0.71°C		Mean sea surface expected to increase by 2.5°C [RCP8.5]
<b>Ocean acidification (lowering pH)</b>	Increase, with a rate of change that is unprecedented in the last 25 million years	Increasingly acidic Subantarctic waters (since 1998)		pH surface water will decline by 0.33 [RCP8.5]
<b>Sea-level rise</b>	Progressive increase faster than over the last century, and continuing for many centuries Relative sea-level rise will vary at different locations around New Zealand	1915–2015: rate of 1.8 mm per year on average	2060: 0.2 m to 0.4 m rise 2100: 0.3 m to 1.0 m rise. The collapse of parts of the Antarctic ice sheets could substantially increase the upper end of this range.	
<b>Average rainfall</b>	Varies around the country and with season. Annual pattern of increases in west/south of New Zealand, and decreases in north & east Winter decrease: Gisborne, Hawke's Bay and Canterbury Winter increase: Nelson, West Coast, Otago and Southland	Rainfall decrease in Northland and rainfall increase in the SW South Island	Substantial variation around the country, increasing in magnitude with increasing emissions	

<sup>9</sup> Ministry for the Environment, 2016, *Climate Change Projections for New Zealand*.

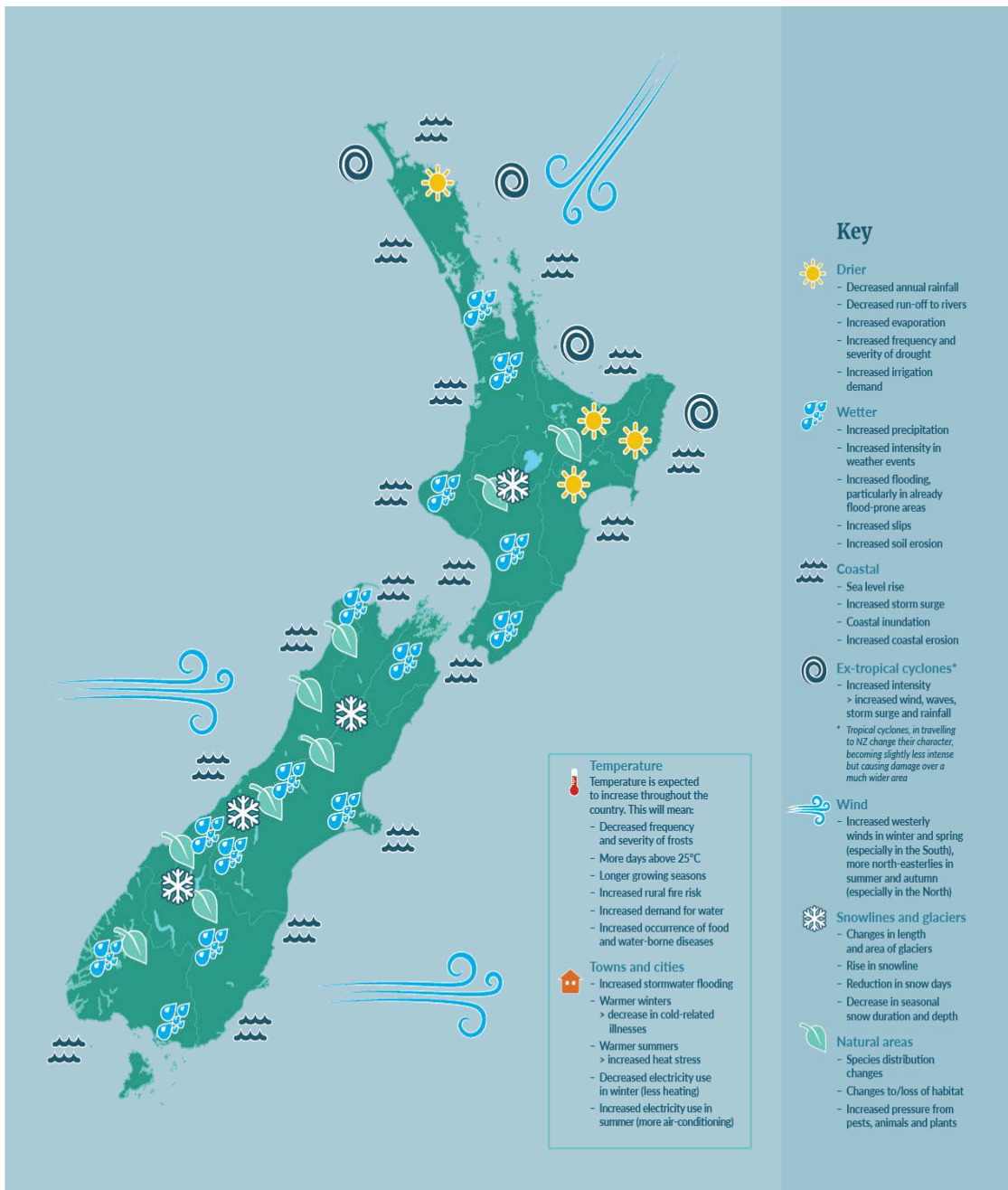
<sup>10</sup> Magnitude of change considers scenarios based on Representative Concentration Pathways (RCPs). Four scenarios are considered ranging from a low emissions world where net anthropogenic global carbon dioxide emissions stop after 2080 (RCP2.6) to a high emissions, no mitigation scenario (RCP8.5). Changes are relative to 1995 levels.

<sup>11</sup> Law, C.S., Rickard, G.J., Mikaloff-Fletcher, S.E., Pinkerton, M.H., Gorman, R., Behrens, E., Chiswell, S.M., Bostock, H.C., Anderson, O. and Currie, K. (2016) *The New Zealand EEZ and South West Pacific. Synthesis Report RA2, Marine Case Study. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100*. MBIE contract Co1X1225. 41pp.

Climate variable	Description of change	Timeframe of change <sup>10</sup>		
		Now	2040	2090
<b>Daily rainfall extremes: dry days<sup>12</sup></b>	More dry days throughout North Island, and in inland South Island Dry days most marked in north and east of North Island (winter and spring)	More dry days in Northland. Fewer dry days in SW South Island (since 1930)		Up to 10 or more dry days per year (~5% increase)
<b>Daily rainfall extremes: very wet days</b>	Increased extreme daily rainfall, especially where mean rainfall increases Strongest increases in western regions, and in south of South Island	Increases in the west of both islands, decreases in the east and Northland (since 1930)		More than 20% increase in 99th percentile of daily rainfall [RCP8.5] in SW of South Island
<b>Snow and Ice</b>	Decrease Large decreases confined to high altitude or southern regions of the South Island	Decrease in the length of many New Zealand glaciers		Snow days per year reduce by 30 days or more [RCP8.5] Loss of many glaciers [RCP8.5]
<b>Drought</b>	Increase in severity and frequency Increases most marked in already dry areas	Increase in the risk of severe drought in some areas. The worst drought in the New Zealand record occurred in summer 2012–13		Up to 50 mm+ increase per year, on average, in July–June potential evapotranspiration deficit (PED) [RCP8.5]
<b>Extreme wind speeds</b>	Increases in southern half of North Island and the South Island		Up to 10% or more in parts of the country	
<b>Storms</b>	Poleward shift of mid-latitude cyclones and possible small reduction in frequency. The most severe Ex-tropical cyclones are expected to be stronger. Their frequency is expected to decrease slightly or remain unchanged.	More analysis needed		

<sup>12</sup> Defined as days with precipitation below 1 millimetre/day. Salinger, M.J. and Griffiths, G.M. (2001), Trends in New Zealand daily temperature and rainfall extremes. *International Journal of Climatology*, 21: 1437–1452. Porteous, A. and Mullan, B. (2013), *The 2012–13 drought: an assessment and historical perspective*. NIWA client report for Ministry for Primary Industries, June 2013, 57p.

Figure 2.1: Shows the spatial distribution of climate-related changes across New Zealand



## 2.1.1 Climate-related changes in weather patterns, oceans and coastal areas

As set out above ([Chapter 1](#)) we cannot be certain about the extent to which global emissions will reduce, and if so by how much. Therefore we work with ‘low’ and ‘high’ emissions scenarios to reflect a plausible range of outcomes.



## Temperature

By 2040, New Zealand is projected to experience a temperature increase of between 0.7°C (under a low emissions scenario) and 1.0°C (under a high emissions scenario), relative to 1995. This range widens towards the end of the century, with temperatures projected to increase by up to 3.0°C by 2090 and 3.7°C by 2110 (under a high emissions scenario). Across the country, we expect to see slight differences from north to south, from east to west, and across seasons. The greatest warming will be in the northeast, and generally highest in summer and autumn and lowest in winter and spring. The frequency of hot days is expected to increase (up to 100 per cent by 2040 and up to 300 per cent by 2090, relative to 1995) and the frequency of frosts is expected to decrease (up to 50 per cent by 2040 and up to 90 per cent by 2090).

## Rainfall

New Zealand will experience changing rainfall patterns as a result of climate change. These will vary around the country and with season, and are associated with changing circulation patterns (New Zealand is expected to receive more north-easterly airflow in the summer and stronger westerly flow in winter). The overall pattern for changes in annual rainfall is a reduction in the north and east of the North Island, and increases almost everywhere else, especially on the South Island West Coast. Seasonally, decreased spring rainfall is expected in the north and east of the North Island, and in the south and east of the South Island. During summer, increased rainfall is projected in the north and east of the North Island, and increased winter rainfall is expected in many parts of the South Island. The largest rainfall changes by the end of the century will be for particular seasons rather than annually. We expect New Zealand to see a decrease in the number of snow days, and to experience rising snowlines.

## Oceans

Climate change is projected to drive changes to the oceans around New Zealand by increasing sea level, temperature and acidity. In terms of temperature, our ocean surface temperatures have warmed by about 0.71°C in the 100 years up to 2009, and under a high emissions scenario by 2110 the mean sea surface temperature is expected to increase by 2.5°C, and by more than 3°C in the north Tasman Sea.<sup>13</sup> In addition, New Zealand's sub-Antarctic waters have become more acidic since measurements were first taken in 1998, and the pH of surface water is expected to decline by 0.33 under the highest emissions scenario by 2100, a rate of change that is unprecedented in the last 25 million years.

## Sea-level rise

Sea-level rise is one of the major and most certain consequences of climate change. Over the last 100 years, the sea level around New Zealand has risen at an average rate of 1.8 mm per year. Since satellite measurements began in 1993, the average global sea level has risen by about 3.3 mm per year. The IPCC Fifth Assessment Report projects that global sea level will rise by 0.2–0.4 m by 2060 and 0.3–1.0 m by 2100, depending on the emissions scenario. However, the collapse of parts

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<sup>13</sup> CCII Marine Case Study ([http://ccii.org.nz/wp-content/uploads/2017/04/RA2\\_MarineCaseStudySynthesisReport.pdf](http://ccii.org.nz/wp-content/uploads/2017/04/RA2_MarineCaseStudySynthesisReport.pdf)).



of the Antarctic ice sheets could substantially increase this range. The stability of the polar ice sheets is a very active area of research and recent developments are expected to be captured in the IPCC Special report on “*the Oceans and the Cryosphere in the Context of Climate Change*” (due in 2019).

While published projections of future sea-level rise are usually the global average, the amount of sea-level rise experienced in different regions will vary. According to the IPCC Fifth Assessment Report, sea-level rise in our region is expected to be up to 10 per cent more than the global average, depending on whether more ice melts from the Greenland or Antarctic ice sheets. The melting of the Greenland ice sheet would result in New Zealand experiencing a greater sea-level rise than the global average, while the reverse is true if melting is mainly from the Antarctic ice sheet. This is because in the area around a melting ice sheet, the gravitational attraction between ice and ocean water is reduced, and the land tends to rise as the ice melts. However, in regions further away from the melting ice sheet, sea-level rise is greater than the global average.<sup>14</sup>

Climate change is also expected to affect New Zealand’s coastal areas through:<sup>15</sup>

- increased coastal erosion
- more frequent and extensive coastal flooding
- higher storm surges
- saltwater intrusion into coastal aquifers and further inland in estuaries
- changes in surface water quality, groundwater characteristics and sedimentation.

## 2.1.2 Changes in extreme weather events

Natural variations have always played a part in New Zealand weather, and will continue to do so. Climate change is expected to shift the range and the pattern of variability.

We expect New Zealand to experience more frequent extreme weather events, such as droughts (especially in the east) and floods.

The projected change in frequency and intensity of droughts increases over time and is more pronounced under a high emissions scenario. Increased droughts may combine with strong winds, high temperatures and low humidity to produce dangerous fire weather situations. Fire risk is expected to increase as a result of climate change.

An increase in the frequency of extreme rainfall events is also projected, with the strongest increases in the west and south, and increased flooding of rivers is expected to occur as a result of this (Royal Society of New Zealand (RSNZ), 2016). Ex-tropical cyclones are expected to be stronger and cause more damage as a result of heavy rain and strong winds. Extreme wind speeds could increase by 10 per cent or more in parts of the country.

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<sup>14</sup> IPCC AR5 Working Group 1: The Physical Science Basis (<https://www.ipcc.ch/report/ar5/wg1/>).

<sup>15</sup> Royal Society of New Zealand, 2016, *Climate change implications for New Zealand*.

### 2.1.3 Medium and long term impacts

The medium and long term impacts of climate change depend on future global emissions of greenhouse gases and, for sea-level rise, on the stability of ice sheets that are grounded below sea level (eg, West Antarctica). However, generally speaking the impacts become greatest under the highest emissions scenario as time goes on. The range of projected changes for a particular variable also widens over the long term compared to the medium term, as the difference between the low emissions scenario and the high emissions scenario becomes greater over time.

# 3 The impacts of climate-related changes for New Zealand

NZ's climate is changing Chapter 1	Climate related changes NZ can expect Chapter 2	<b>Impacts of climate related changes for NZ</b> Chapter 3	<b>RESPONSE</b>	Defining effective adaptation Chapter 4	Stock take of what NZ sectors are doing to adapt to climate change Chapter 5	Current gaps in knowledge and work programme Chapter 6	<b>NEXT STEPS</b> chapter 7
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This section explores the flow-on impacts on New Zealanders resulting from the climate-related changes, across our economy and society. These impacts will be a combination of risks and some opportunities.

Risk is often expressed in terms of a combination of the consequences of an event and the likelihood of that event occurring. The IPCC describes climate risks as:

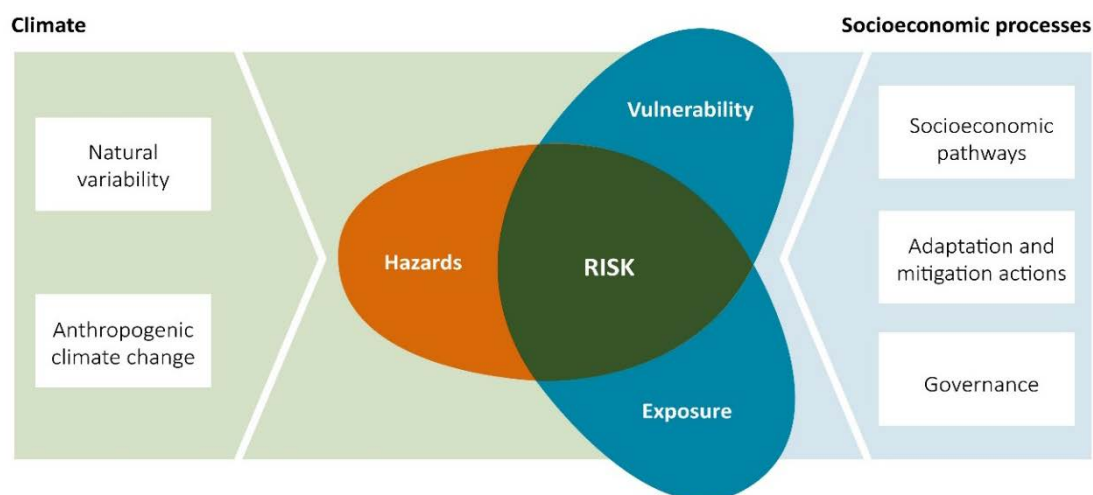
“Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development.” (IPCC, 2014)

Applied to a climate setting, these factors depend on:

- how **exposed** people, infrastructure, the natural environment and the economy are to the change
- their **vulnerability** to those hazards, that is their ability to cope and adapt to the change.

This is illustrated in Figure 3.1.

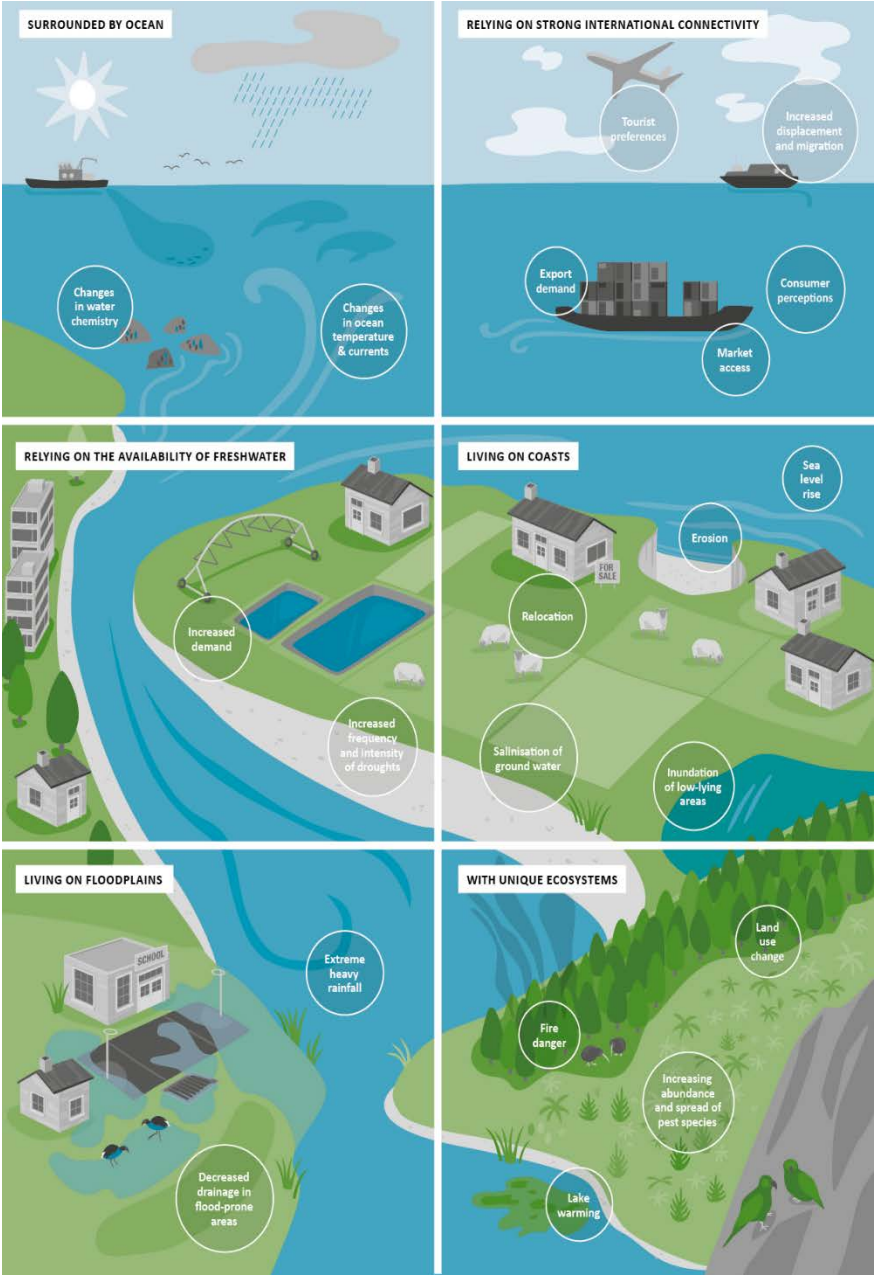
**Figure 3.1: Climate change risks as the confluence of three drivers (Renwick et al (2016) based on IPCC (2014))**



Although there is a large body of information on the expected changes to our climate, less is known about the impacts of these changes on our natural environment, society, communities and for the different sectors of the economy. These are gaps we have identified in our current knowledge.

The impacts of climate change on New Zealand’s economy and society over the long term will depend on what actions we take now. Examples of this are illustrated in Figure 3.2. Adaptation has the potential to reduce the risks from climate change, and the more adaptation that takes place the greater this reduction will be (IPCC, 2014).

**Figure 3.2: Examples of impacts of climate change for New Zealand<sup>16</sup>**



<sup>16</sup> Ibid.

## 3.1 Impacts on the natural environment

Our natural environment is already subject to multiple pressures, such as habitat loss, pollution, intense resource use and invasive species. It will be impacted substantially if it cannot cope with the increasing rate of climate change. Both the compounding effect and the interaction of climate change with other stressors, such as invasive species, has the potential to have a significant impact on our terrestrial, freshwater, coastal and marine ecosystems.

### 3.1.1 Biodiversity

Many aspects of New Zealand's biodiversity will be impacted by climate change in some way. New Zealand has a number of unique indigenous ecosystems, and changing temperatures and water availability as a result of climate change will have impacts on where species can survive (RSNZ, 2016). The range of ecosystems and species will change, as will the timing of annual and seasonal events (eg, beech masting), and ecosystem functions (eg, food webs).<sup>17</sup> Indirectly, climate change will increase the range and abundance of invasive pests and weed species which is currently a key driver of extinction.

Many of New Zealand's unique species are highly specialised (eg, tuatara<sup>18</sup>), limited in number (eg, takahe) and/or have specialised habitat requirements (eg, frogs and lizards). These factors will reduce their capacity to adapt to a changing climate.

There is uncertainty around where the greatest risks are, but there is a clear possibility that climate change will be a significant driver of biodiversity loss throughout this century and beyond (DOC, 2017).

There are some ecosystems that are particularly sensitive to climate change.

- **Alpine and sub-alpine ecosystems** – as temperature rises, tree lines are expected to increase in altitude. This and the introduction of invasive pests may also result in a loss of alpine species.
- **Freshwater ecosystems** – species and ecosystems will be affected by increased flood frequency, drought, sea-level rise, erosion and higher temperatures. Increased rainfall intensity will increase sedimentation and have further impacts on aquatic ecosystems.
- **Coastal ecosystems** – rising sea levels are expected to result in loss of sand dunes, wetlands, mangroves and estuaries.
- **Marine ecosystems** – increased temperature, wave action, turbidity, sedimentation and a reduction in dissolved oxygen will interact with pest invasion and ocean acidification, and threaten many marine species and ecosystem functions.

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<sup>17</sup> For example, red-billed gulls were declared nationally vulnerable in 2014 due to climate-driven changes to the availability of krill which they feed on.

<sup>18</sup> Warmer temperatures have resulted in changes in tuatara sex ratios to increasingly male.

### 3.1.2 Fresh water

*The New Zealand Government Environment Report on Our Fresh Water (2017)* states that climate change is projected to increase pressure on water flows and water availability. Higher temperatures and lower rainfall, along with increased frequency and intensity of droughts, are expected to reduce soil moisture, groundwater supplies and river flows for some areas. Greater variability in river flows over time is expected, as the frequency and intensity of droughts and floods are expected to increase over time (Prime Minister's Science Advisory Committee (PMCSA), 2017).<sup>19</sup>

Changes in seasonal rainfall patterns and extreme weather events will create secondary effects of erosion and sedimentation to waterways, affecting freshwater ecosystems. In addition, rising sea levels are expected to cause salinisation of groundwater<sup>20</sup> and coastal wetlands. Lower river flows in summer will raise water temperatures and exacerbate water quality problems, such as through increased algae growth leading to more algal blooms and eutrophication of lakes. Intensified stratification in deep lakes may occur, along with wind driven mixing in shallow lakes (PMCSA, 2017).

### 3.1.3 Oceans and coasts

The New Zealand Government's Environment Report on our Marine Environment (2016) identified ocean acidification and warming as top issues facing our oceans. It noted that marine and coastal species with carbonate shells like pāua, mussels, and oysters, and the plankton that support all life in the oceans are particularly vulnerable to climate change with increased acidity interfering with the formation of shells (Climate Changes, Impacts & Implications for New Zealand (CCII) RA2 Marine case study).<sup>21</sup>

Ocean warming and acidification caused by climate change pose a risk to many ecologically important species in the New Zealand region, including deepwater coral reefs that form habitat for many marine species. The north Tasman Sea is expected to experience greater warming than the rest of our surrounding ocean, and this could drive regional change in marine ecosystems in the form of fewer temperate species, increased sub-tropical species and more nutrient-poor conditions (CCII RA2 Marine case study). Some species that presently live in lower latitude regions may migrate into New Zealand waters in response to rising temperatures and changing

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<sup>19</sup> The Prime Minister's Chief Science Advisor Sir Peter Gluckman recently released a report on freshwater which confirms the climate change impacts on our waterways. PMCSA, 2017, *New Zealand's fresh waters: Values, state, trends and human impacts*.

<sup>20</sup> DOC, 2016, *Freshwater conservation under a changing climate*.

<sup>21</sup> Law, C.S., Rickard, G.J., Mikaloff-Fletcher, S.E., Pinkerton, M.H., Gorman, R., Behrens, E., Chiswell, S.M., Bostock, H.C., Anderson, O. and Currie, K. (2016) *The New Zealand EEZ and South West Pacific. Synthesis Report RA2, Marine Case Study. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100*. MBIE contract C01X1225. 41pp.

ecological community structures.<sup>22</sup> Work is underway to characterise impacts on fish in the New Zealand region.<sup>23</sup>

### 3.1.4 Other ecosystem services

Other ecosystem services that we expect to be affected by climate change are soil stability, flood protection, pollination, carbon storage, and coastal protection.

## 3.2 The built environment

### 3.2.1 Physical infrastructure

The built environment provides the systems on which people and their activities rely for living, mobility and well-being. For example, infrastructure necessary for the transport of goods and people, energy supply, clean water, communication and emergency responses to disasters. It also encompasses communities' social and cultural assets – our homes, marae, schools, hospitals, prisons, libraries, swimming pools, nature reserves and national parks, and recreational facilities.

Most of New Zealand's major urban centres and the majority of our population are located on the coast or floodplains of major rivers.<sup>24</sup> Our communities, homes, commercial assets and infrastructure are exposed to flooding, sea-level rise, storm surge and inundation from rising groundwater levels. For example, as sea level continues to rise, areas of low-lying coastal land that currently flood during storms or king tides will experience more frequent and severe inundation.

The mid-range projected sea-level rise over the next 50 years is 30 cm. This 30 cm sea-level rise would have impacts on all coastal areas to varying extents. Under this scenario, in Wellington a one in 100 year inundation event would become an annual event, in Dunedin this would become a one in two year event, and in Auckland would become a one in four year event. The combination of higher sea levels and more frequent extreme rainfall events will also lead to increased flooding, in particular where rivers meet the coast. Communities can expect to see more damage caused to assets and property in parts of these areas, and consequently: increased costs to manage and maintain urban facilities; more frequent disruption to business operations; and potential

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<sup>22</sup> Molinos G.J., Halpern B.S., Schoeman D.S., Brown C.J., Kiessling W., Moore P.J., Pandolfi J.M., Poloczanska E.S., Richardson A.J. and Burrows M.T. (2015). Climate velocity and the future global redistribution of marine biodiversity, *Nature Climate Change*, doi:10.1038/nclimate2769.

<sup>23</sup> Renwick J.A., Hurst R.J., and Kidson J.W. (1998). Climatic influences on the recruitment of southern gemfish (*Rexea solandri*, Gempylidae) in New Zealand waters. *International Journal of Climatology* 18: 1655–1667; Beentjes M.P. & Renwick J.A. (2001). The relationship between red cod, *Pseudophycis bachus*, recruitment and environmental variables in New Zealand. *Environmental Biology of Fishes* 61: 315–328.; Dunn M., Hurst R., Renwick J., Francis C., Devine J., and McKenzie A. (2009). Fish abundance and climate trends in New Zealand. *New Zealand Aquatic Environment and Biodiversity*. Report No. 31. NIWA, Wellington.

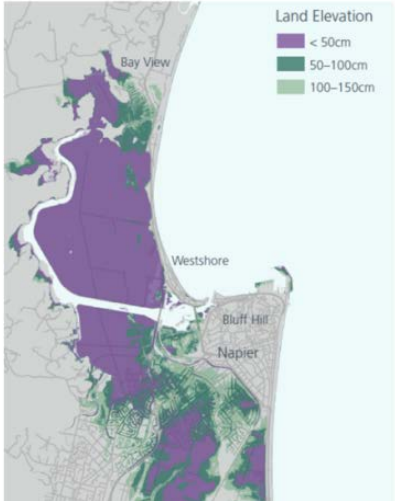
<sup>24</sup> Two-thirds of our population live in areas prone to flooding (Royal Society of NZ, 2016), while 75 per cent of New Zealanders live within 10 km of the coast (Statistics New Zealand, 2006, *Are New Zealanders Living closer to the coast*).



reduction in the land values. These risks will increase with ongoing development and population growth, if property and asset exposure increases. In addition, where the sea is connected to water tables and the land is reclaimed, surface ponding will increase the risk of ground settlement and liquefaction (PCE, 2015, page 40).

**Figure 3.3: Houses and roads in urban areas that are less than 50 cm above mean high water spring (PCE, 2016)**

Urban area	Houses	Roads (km)
Dunedin	2,683	35
Napier	1,321	37
Christchurch	901	40
Whakatane	276	9
Auckland	108	9
Wellington/Hutt	103	2
Tauranga	77	3
Nelson	64	6
Motueka	45	4



As noted in the PCE’s report, this inventory (the table in Figure 3.3) is “a necessary early step in assessing what is at risk as the sea rises”. The actual impact on the built environment may be larger than this. The impact of disruption to New Zealand society and businesses as a result of climate change is also not captured by this illustrative table.

### 3.2.2 Critical infrastructure

Critical infrastructure provides a backbone to well-functioning societies and economies, whether it is reliable electricity, clean drinking water, or transport networks. Central and local government own over \$200 billion of infrastructure assets.<sup>25</sup> Significant elements of our critical infrastructure, including lifelines utilities,<sup>26</sup> are at risk of being damaged, disrupted or rendered inoperable by climate change impacts. Key impacts are identified in Table 3.1.

<sup>25</sup> Treasury, 2015, *Thirty Year New Zealand Infrastructure Plan 2015* <http://www.infrastructure.govt.nz/plan/2015/>

<sup>26</sup> Organisations that provide essential infrastructure to the community for example, roads, water supply.



**Table 3.1: Description of vulnerability of particular infrastructure to impacts of climate change**

Infrastructure	Potential impacts
Transport – roads, rail, ports and airports	<p>Top impacts identified by NZ Transport Agency (NZTA) (2009) are:</p> <ul style="list-style-type: none"> <li>• Sea-level rise/storm surge – increasing threat nationally to ports, airports<sup>27</sup> and low-lying coastal networks, with a higher risk on the western seaboard</li> <li>• Increased magnitude and frequency of flooding and rainfall-induced landslips, caused by heavier and/or more frequent extreme rainfall</li> <li>• Increased heat buckling on the rail network due to higher temperatures (highest risk predicted in the northern part of the North Island)</li> <li>• Stronger winds – higher risk to roads and ports in eastern coastal areas of the North and South Islands, and the Canterbury Plains.</li> </ul>
Electricity transmission and generation	<p>Increased intensity of storm events, snow and high wind risks damage to substations and transmission lines (CCII RA4 Synthesis Report). Over 80% of our electricity comes from climate-dependent wind and hydro generation which makes our electricity system vulnerable to a variable climate (eg, higher temperatures, and greater variability of rainfall and wind). There may be seasonal changes in both electricity demand and supply, with more demand for air conditioning in summer, but less demand for heating in winter. There is expected to be greater potential for hydro generation in winter due to increased proportion of precipitation falling as rain rather than snow (IPCC, 2014).</p>
Water (including stormwater, flood protection and wastewater)	<p>Sea-level rise will cause seawater to run up stormwater pipes, significantly affecting drainage capability. This could cause flooding well inland in low-lying areas. Land drainage, stormwater systems and flood protection may not cope with more intense and frequent heavy rain events. There may be overloading of sewer networks (through increased inflow/infiltration) leading to increases in wastewater overflows. There is also increased potential for inundation of pump stations located in low lying areas (Parliamentary Commissioner for the Environment (PCE), 2015).</p>
Telecommunications	<p>Increased intensity of storms (including flooding) and high winds risks damage to above ground structures increasing maintenance and repair costs (CCII RA4 Synthesis Report).</p>

It is noted that an impact on any one of these services is expected to impact on another, due to the interconnected nature of our infrastructure networks. These impacts could be significant, for example, the road and three waters infrastructures comprise more than \$100 billion of community assets.<sup>28</sup> With the exception of the 2009 NZTA report, no nation-wide assessment has been done on the risk of climate change to these assets.<sup>29</sup> This is a critical information gap.

### 3.3 Economic impacts

Agriculture, horticulture, fisheries, aquaculture, forestry and tourism sectors are all significant contributors to New Zealand’s economy, and all are dependent on natural resources and the ability to function within the current climate range. They are therefore exposed to the direct impacts of climate change that are outside their ability to adapt, and to those that compound and

<sup>27</sup> Many of our airports are located in low lying areas, such as Wellington, Napier, Nelson and Dunedin.

<sup>28</sup> Office of the Auditor-General, 2014.

<sup>29</sup> Based on the literature reviewed as well as conversations with Treasury’s National Infrastructure Unit.

cascade through the economy from other sectors. Climate change has therefore the potential to have negative impacts on New Zealand's economy as a whole.

New Zealand society will also be affected by indirect impacts of climate change, which are those that require adaptation in one place as a result of climate change somewhere else. New Zealand is an open economy which has important trading links with Europe, Australia, the US and China. Climate change-related impacts on our trading partners and on the rest of the world will affect New Zealand's ability to sell goods overseas, as well as have an effect on migration and social and cultural ties (RSNZ, 2016). For example, the primary sector may experience impacts as a result of changing demand internationally for our products, while our tourism industry may be affected by changing tourist behaviour (RSNZ, 2016). Examples of how we expect sectors of New Zealand's economy to be affected by climate change are discussed below.

### 3.3.1 Primary industries

The primary industries play a fundamental role in New Zealand's food security and economy, directly accounting for 6 per cent of GDP and contributing to just over half of New Zealand's export earnings.<sup>30</sup> The primary industries are particularly exposed to the impacts of climate change. For example, they are strongly linked to freshwater availability, and climate change is expected to increase competition for freshwater resources (RSNZ, 2016). While the severity of impacts will vary by sector and region, the risks and costs from extreme weather and wildfires are expected to increase across all land based sectors and supply chains.<sup>31</sup> All primary sectors will be affected by impacts which interfere with the ability to get primary products from the farm to processing facilities and then to markets or ports. Climate change impacts may affect transport (for example due to storms and slips closing routes) and also the operation of processing facilities (for example interruption to the supply of energy or water required for processing). [Table 3.2](#) outlines key impacts for each sector.

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<sup>30</sup> Treasury, 2016, NZ Economic and Financial Overview.

<sup>31</sup> SLMACC, 2012, Impacts of climate change on land-based sectors and adaptation options – stakeholder report.

**Table 3.2: Key impacts for each sector<sup>32</sup>**

Sector	Impact
<b>Agriculture and horticulture</b>	<ul style="list-style-type: none"> <li>• Rainfall changes, and rising humidity and temperatures are expected to shift agricultural and horticultural production zones and timing of some activities, and to reduce crop quality and yield</li> <li>• Some areas are expected to benefit from climate change and increases in atmospheric carbon dioxide in the short term, if farm management practices change to make the most of increased pasture production</li> <li>• Some regions face increased drought and flooding risk</li> <li>• Higher temperatures will increase the range and incidence of many pests and diseases, with a risk of new invasive species establishing</li> <li>• Erosion could become an increasing problem on farms</li> <li>• There are some short-term opportunities, particularly where impacts may be mitigated by commodity price rises<sup>33</sup></li> <li>• Potential for increased demand for irrigation and fertiliser, leading to other downstream issues (PMCSA, 2017)</li> <li>• Increased temperature will lead to early flowering, increasing the chance of frost damage in spring</li> <li>• Increased flooding and ponding increases the risks of surface water contaminating produce</li> </ul>
<b>Forestry</b>	<ul style="list-style-type: none"> <li>• Foresters could benefit from increased <i>Pinus radiata</i> growth in cooler regions due to enhanced carbon dioxide levels; where other elements, water and nutrients are less limiting</li> <li>• Significantly increased fire risk in some areas</li> <li>• The impact of pests on forest health, habitat loss and unstable land have been identified as primary risks for foresters<sup>34</sup></li> <li>• Forestry sector is more exposed than some sectors to climate risks due to the long production cycles<sup>35</sup></li> </ul>
<b>Fisheries and aquaculture</b>	<ul style="list-style-type: none"> <li>• Primary production in open ocean surface water is projected to decline by an average of six per cent from present levels by 2100 under a high global emissions scenario, as a result of ocean warming and acidification<sup>36</sup></li> <li>• Growers and harvesters of shellfish species, such as pāua, mussels and oysters, will be particularly vulnerable to changes in water temperature, acidification and land-based runoff<sup>37</sup></li> <li>• Finfish aquaculture will have to adapt to rising temperatures and reduced oxygen levels</li> </ul>
<b>Mining</b>	<ul style="list-style-type: none"> <li>• Production affected by access to critical climate-sensitive inputs such as energy and water</li> <li>• Disruption to supply chain (eg, delivery of fuels and electricity)</li> </ul>

<sup>32</sup> Information primarily sourced from:

- NZ Climate Change Centre, 2014, IPCC Fifth Assessment Report, NZ findings
- Sustainable Land Management and Climate Change (SLMACC), 2012, *Impacts of Climate Change on Land-based Sectors and Adaptation Options*
- CCII RA4 Synthesis Report (<http://ccii.org.nz/wp-content/uploads/2017/01/RA4-Synthesis-report.pdf>).

<sup>33</sup> NZ Climate Change Centre, IPCC Fifth Assessment Report, NZ findings.

<sup>34</sup> CCII Synthesis Report R4.

<sup>35</sup> Ibid.

<sup>36</sup> CCII Synthesis Report: Marine Case Study.

<sup>37</sup> Oregon and Washington State lost 80 per cent of their shellfish hatcheries' production in 2008 due to the impacts of ocean acidification caused by the upwelling of deepwaters (DoC 2017).

## Biosecurity

Climate change is expected to impact New Zealand's biosecurity. Warmer average temperatures could enable new pests and diseases to establish themselves in New Zealand, should they make landfall. An increase in potential biosecurity threats has implications for New Zealand's primary industries, as well as for our native biodiversity and for human health. The potential establishment of subtropical pests is one of the biggest concerns.<sup>38</sup> Ministry for Primary Industries (MPI) suggest in their 2015 report that north-east Asia is expected to dominate pest import pathways in the future, but there are also increasing risks associated with India, South America and other emerging economies. Changes in climate, shipping routes, the commodities traded and international pest distributions will shape New Zealand's future biosecurity risks (MPI, 2015). Particular threats are to the forestry industry due to its long lifecycle. Changes in the timing of annual and seasonal events as a result of climate change (such as beech masting), will also have significant impacts on pest management.

The CCII research programme<sup>39</sup> identified biosecurity management as an area where more research is needed to test its sensitivity to climate change.

### 3.3.2 Tourism

Tourism, a major growth industry in New Zealand, is already one of the largest single sources of foreign-exchange revenue. The sensitivity of tourism to climate change impacts depends on a range of factors including:<sup>40</sup>

- how tourists respond to certain climatic conditions
- how important weather and weather-related natural hazards are to tourism businesses in terms of carrying out specific activities
- how infrastructure or wider natural resources relevant to the operation of tourism businesses might be affected by climatic events.

Much of the research on the impacts of climate change on tourist behaviour relates to the effect of climate change mitigation policies, which is out of scope for this report. Less information is available on how the impacts of climate change in a particular region will affect tourism behaviour in and of themselves. The ski industry is one of the most climate dependent tourism subsectors, and as such more information is available regarding the impacts of climate change on this subsector than on others. While it is hard to predict future tourist behaviour in the short term, climate change may bring benefits for ski tourism due to less snow in Australia. However, in the long term, higher temperatures and fewer snow days will negatively impact the industry, particularly those in lower elevation sites. Tourism at Fox and Franz Josef Glaciers will also be at

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<sup>38</sup> MPI, 2015, *Effects of climate change on current and potential biosecurity pests and diseases in New Zealand*.

<sup>39</sup> Lawrence, J., Blackett, P., Cradock-Henry, N., Flood, S., Greenaway, A. and Dunningham, A. (2016) *Synthesis Report RA4: Enhancing capacity and increasing coordination to support decision making. Climate Change Impacts and Implications (CCII) for New Zealand to 2100*. MBIE contract C01X1225. 74 pp.

<sup>40</sup> A national-level screening exercise to assess tourism's vulnerability to climate change (<http://www.lincoln.ac.nz/PageFiles/6750/NationalScreeningOverview.pdf>).

risk as glaciers further recede. This will impact regional economies, and individuals and communities with livelihoods dependent on the industry.<sup>41</sup>

### 3.3.3 Financial and insurance services

More extreme weather events caused by climate change will raise the number and value of claims insurers pay, which will inevitably be reflected in the premiums insurers charge and their willingness to provide cover.<sup>42</sup> Insurance covers risks which are uncertain, and as such insurers are expected to retreat from certain locations (eg, at the coast) once the risks are sufficiently probable.<sup>43</sup> Households may find it difficult or more expensive to access insurance cover in the face of increased flood risk, or fruit growers may find it more expensive to insure against weather-related damage.

For banks, it is expected that this will result in the offer of shorter-term mortgages which may become less affordable. Lending to business in sectors or locations especially exposed or vulnerable will reduce. In addition, climate change could give rise to home loan defaults due to the loss of insurance cover.<sup>44</sup> Unavailability or unaffordability of insurance cover will reshape the distribution of vulnerable groups.<sup>45</sup>

Fund managers will likely factor into their investment decision the impacts of climate change on the businesses they invest in and their adaptive capacity.

Apart from the recent report by Motu and Deep South (2017) on insurance, housing and climate adaptation, there has been little detailed research on this issue in New Zealand, although there is a growing body of literature and attention overseas, for example, reinsurer Munich Re and Lloyd's London.

### 3.3.4 Other business

Other businesses such as production, manufacturing, and retail are expected to be indirectly affected by climate change in one way or another. This could be by: changing consumer behaviour; disruption to transport networks and supply chains of goods and services during extreme weather events; or damage to infrastructure and commercial assets by extreme weather events or sea-level rise. Climate change also has the potential to have negative impacts on New Zealand's economy as a whole, which will have flow-on effects for individual businesses.

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<sup>41</sup> PMCSA, *New Zealand's Changing Climate and Oceans*.

<sup>42</sup> 2013 and 2014 were among the most expensive years for weather-related events.

<sup>43</sup> *Insurance, housing and climate adaptation* (Motu and Deep South, 2017).

<sup>44</sup> Ibid.

<sup>45</sup> 2013 and 2014 were among the most expensive years for weather-related events.

### 3.3.5 The cost of climate change impacts

While the potential costs of climate change impacts for New Zealand are not known, we do know that our exposure to the impacts of climate change is high, particularly in certain areas (eg, at the coast, within the built environment and to our major economic sectors), and as such the costs will be significant. For example, the value of assets that will be affected by sea-level rise is estimated to be in the billions of dollars, and the costs of weather events to the land transport network have increased in the last 10 years from about \$20 million per annum to over \$90 million per annum.<sup>46</sup> The associated costs of three extreme events in New Zealand to which climate change is assessed to have made a contribution are:<sup>47</sup>

- **2011 flooding in Golden Bay:** estimated cost \$16.8 million
- **2012–2013 drought which affected the entire North Island and the west coast of the South Island: It was one of the most severe experienced in these areas in at least 40 years. The economic impact of the drought is estimated to be a minimum of \$1.5 billion (Treasury)**
- **2014 flooding in Northland:** estimated cost \$15.1 million.

The increased frequency and intensity of large extreme events has the potential to increase the scale of costs significantly, especially if the coping capacity between events is challenged. The much greater frequency of smaller events could represent an even greater cumulative cost.<sup>48</sup>

Overall, the costs to New Zealand of climate change impacts and adapting to them are expected to be higher than the costs of reducing greenhouse gas emissions. While adapting to climate change cannot be avoided, adaptation is not a substitute for reducing emissions.

## 3.4 Social and cultural impacts

Our exposure to climate change will impact on New Zealand society and culture. Climate change could lead to large changes to our society, including potential social disruption and conflict over changing patterns in the value of land in coastal areas<sup>49</sup> and/or increasing competition for resources, for example, access to clean water and kai moana. It may also exacerbate equity issues for at risk groups in society and for future generations.<sup>50</sup>

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<sup>46</sup> MoT, Sector Report, *Managing Climate Related Risks for Land Transport Infrastructure*.

<sup>47</sup> Figures obtained from Insurance Council of New Zealand (<http://www.icnz.org.nz/statistics-data/cost-of-disaster-events-in-new-zealand/>).

<sup>48</sup> <https://eos.org/scientific-press/small-storms-over-time-can-cost-more-than-extreme-events>

<sup>49</sup> Bengtsson et al., *Climate change impacts in New Zealand: a cross-disciplinary assessment of the need to adapt buildings, with focus on housing*, 2007, <http://www.cmnzl.co.nz/assets/sm/2245/61/008-BENGTSSONJonas.pdf>

<sup>50</sup> New Zealand College of Public Health Medicine, 2013, *Climate Change and Health in New Zealand*, [http://www.nzcphm.org.nz/media/74098/1.\\_nzcphm\\_climate\\_change\\_policy\\_\\_final\\_comms\\_version2\\_.pdf](http://www.nzcphm.org.nz/media/74098/1._nzcphm_climate_change_policy__final_comms_version2_.pdf)

### 3.4.1 Public health

Climate change is increasingly being recognised as a serious emerging risk to public health globally and in New Zealand. Some of the potential impacts will be direct, such as injury and illness from extreme weather events or increased heat-related deaths (although winter-related deaths are expected to decline).

There are also indirect risks including increased incidences of existing and new diseases.<sup>51</sup> Climate change brings changes to disease vectors worldwide. A warmer and wetter New Zealand means that we will experience diseases not currently present in New Zealand and potentially more frequent pandemics. These impacts will lead to intensified pressures on our health system. Other indirect risks include increasing stress and mental health issues, for example, as a consequence of extreme weather events, sea-level rise or loss of livelihoods.<sup>52</sup>

### 3.4.2 Risks to emergency services and lifelines operational capability and capacity

There will be greater resourcing pressure on our emergency services and lifelines to manage public safety with increased frequency and severity of floods, wildfires, landslips and extreme storms.<sup>53</sup> New Zealand is also expected to increase support to low-lying Pacific Island communities which are highly vulnerable to the impacts of climate change. Such support includes providing post-disaster recovery assistance and risk reduction for enhancing resilience.<sup>54</sup>

### 3.4.4 Cultural heritage sites

Cultural heritage will be affected by climate change, particularly through ongoing loss of coastal archaeological sites to sea erosion and inundation.<sup>55</sup> For example, there are numerous Māori cultural heritage and food gathering sites in coastal low-lying areas which are deeply connected with Māori identity, and these sites are more exposed to the impacts of climate change as a result of their location.

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<sup>51</sup> For example: potential increase in food and water borne disease (such as giardiasis and salmonellosis) as a result of changing rainfall, drought and temperature patterns; potential increase in respiratory illnesses as a result of changes in the pollen season; increases in mosquito vectors establishing in warmer regions (eg, malaria).

<sup>52</sup> New Zealand College of Public Health Medicine, 2013, *Climate Change and Health in New Zealand*, [http://www.nzcphm.org.nz/media/74098/1.\\_nzcphm\\_climate\\_change\\_policy\\_\\_final\\_comms\\_version2\\_.pdf](http://www.nzcphm.org.nz/media/74098/1._nzcphm_climate_change_policy__final_comms_version2_.pdf)

<sup>53</sup> NZ Defence Force, 2010, *Impact paper: Climate change and the New Zealand Defence Force*.

<sup>54</sup> RSNZ, 2016; IPCC 2014.

<sup>55</sup> Bickler S, Clough R & Macready S, 2013, The impact of climate change on the archaeology of New Zealand's coastline, [http://www.doc.govt.nz/documents/science-and-technical/sfc322high\\_res.pdf](http://www.doc.govt.nz/documents/science-and-technical/sfc322high_res.pdf)

### 3.4.5 Vulnerable groups

The impacts of climate change will not be evenly distributed around New Zealand. Vulnerability to climate change depends on level of exposure to the change and ability to cope and adapt to the change. For example, those who live on floodplains may be more exposed to climate-related changes we can expect in the future. The most vulnerable will be those who do not have the resources to adapt. Based on this, communities we consider could be more vulnerable to the expected impacts of climate change include:

- **Māori** – their significant reliance on the environment as a cultural, social and economic resource makes Māori vulnerable to the impacts, some of which they are already experiencing,<sup>56</sup> as their livelihoods are exposed to the impacts of climate change on the natural environment. For example, the Māori economy relies heavily on primary industries. Different Māori communities face different climate change risks, as some communities will be more vulnerable to the impacts of climate change than others. As summarised by the Climate Change Iwi Leaders Group:

“The climate is changing where Iwi in the South talk of the Titi (mutton birds) having today a 4 in 7 bad year where once it was 1 in 7 and they call for a much more holistic (kaitiakitanga) solution to climate change. Iwi in the East talk about their roadways being washed away and serious soil erosion. While an Iwi in the North talks about all 14 of their marae facing inundation from rising sea levels and flooding. Iwi in the West talk too about flooding while those Iwi in the Central North Island call on government to help with new afforestation. And meanwhile the science tells us that these issues are only going to get worse..... The legacy of our generations is at stake.”<sup>57</sup>

- **communities in low lying areas** – people living close to the coast and on floodplains are more exposed to flooding and other coastal hazards, the frequency and intensity of which are expected to increase as a result of climate change. Not all of these communities are equally vulnerable as their ability to adapt will differ
- **rural communities dependent on non-reticulated water resources (eg, rain water tanks)** – increased pressure on freshwater resources is an expected impact of climate change (RSNZ, 2016), and the effects of changing hydrological regimes on drinking water availability are expected to seriously affect these places and populations.<sup>58</sup>

There is very little research on which groups and locations in New Zealand are at the greatest risk from climate change impacts. This is an information gap.

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<sup>56</sup> For example, erosion at the coast revealed human bones from a sacred Māori burial site in the Waimea inlet in January of this year.

<sup>57</sup> CCILG submission on the NZ ETS Review, 2016.

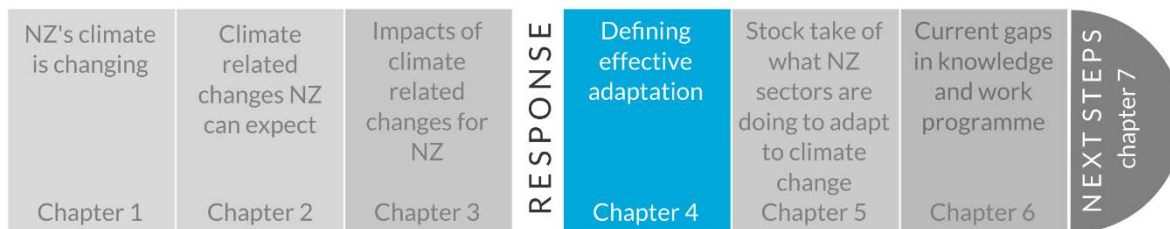
<sup>58</sup> RSNZ 2016; MoH 2016.



### 3.4.6 Intergenerational equity

A significant question around climate change impacts is where the costs will fall and who will bear them – current or future generations? How we address and provide for intergenerational equity in our systems and decision-making around climate change impacts is a gap in our current understanding. What we do know is that costs of adapting will increase over this century. Not addressing these would also place a financial burden on future generations. A case study on youth perspectives in this regard can be found in [Section 5.9](#).

## 4 Defining effective adaptation



We have defined effective adaptation to mean that New Zealand’s current and future communities are able to reduce the risks from climate change impacts over the medium and long term by:

- reducing the exposure and vulnerability of our natural, built, economic, social and cultural systems
- maintaining or improving the capacity of our natural, built, economic and social and cultural systems to adapt.

To review what New Zealand is currently doing to adapt we have created a framework of what we consider to be key characteristics and attributes to achieve effective adaptation (Table 4.1). The framework is based on the findings of the extensive global literature on adaptation reviewed by the IPCC (2014) and the collective experience of adaptation and risk management experts on the Group. The attributes that describe these characteristics reflect the best information available to the Group and our expert judgement.

We consider being informed, organised and acting in a dynamic way are the key characteristics for effective adaptation:

**Informed:** Climate change will have impacts on all sectors of New Zealand society, and the social, cultural, economic and environmental cost of these impacts is potentially large. Effective adaptation involves all sectors understanding the characteristics of the impacts and what it means for them, and considering these impacts in their decision-making and planning so that they can reduce the risks and take advantage of any opportunities.

**Organised:** The cost of inaction or of unplanned, reactive adaptation measures is expected to be great. Some of the decisions we are making now about investments will determine the magnitude and extent of the impacts we experience in the future. For example, infrastructure assets are long-lived, and it is therefore important to consider the future impacts of climate change on these assets when investing in them. The location of green-fields urban/housing and rural developments also has long-term implications hence it is prudent to take climate change impacts into account in land use planning by not expanding into areas expected to be at risk from increased flooding, coastal erosion and inundation, and drought.

**Dynamic Action:** The amount of adaptation required today is built on a legacy of past infrastructure and planning decisions. It is important we remain flexible so we do not limit our ability to adapt in the future nor increase the costs of responding to adverse events.

**Table 4.1: Characteristics and attributes that could contribute to effective adaptation**

CHARACTERISTIC	ATTRIBUTES
INFORMED	<b>We understand what’s happening:</b> the climate-related changes that New Zealand can expect in the medium and long term as a result of climate change are widely understood
	<b>We understand the impacts of the climate-related changes and what this means for us:</b> the consequences, connections, thresholds, vulnerabilities, risks and opportunities in the natural, built, economic, social and cultural environments in the medium and long term are widely understood
ORGANISED	<b>We know what’s expected of us:</b> our roles and responsibilities are appropriate and widely understood
	<b>We have common goals:</b> a common set of adaptation outcomes, goals and priorities exist
	<b>We have a planned approach:</b> adaptation is factored into strategies, plans and decision-making allowing us to define priorities and set timeframes
DYNAMIC ACTION	<b>We have the tools we need:</b> enabling frameworks, resources and coordinating mechanisms are in place to drive action, and are sufficient and effective
	<b>We are taking anticipatory action:</b> proactive and purposeful in taking practical steps to adapt
	<b>We are being flexible:</b> goals, strategies and plans adjust through a combination of monitoring and situational awareness to deal with uncertainty and the changing risks, issues, opportunities and circumstances that emerge
	<b>We are reducing risks by adapting:</b> the environmental, economic and social and cultural consequences of climate change are being managed

We engaged with representatives of various sectors of society to understand how well climate change adaptation is integrated into their thinking and planning (see [Appendix 2](#) for the division of sectors). This is in addition to an extensive review of published literature on climate change adaptation in New Zealand.

We also looked at other countries’ approaches to adaptation. Regardless of the type of approach taken, there are a number of common themes. These are highlighted in the *Case Study 1: Common themes among other Countries approaches to adaptation*. An overview of adaptation initiatives in other countries is included in [Appendix 6](#).

We then assessed the information they provided against the key characteristics of effective adaptation (identified in [Table 4.1](#)) and rated it as:

<b>Maintain</b> There is evidence that all descriptors of the attribute are in place	<b>More work required</b> There is evidence that most descriptors of the attribute are in place	<b>Significant work required</b> There is evidence that some descriptors of the attribute are in place	<b>Not present</b> There is no evidence that any descriptor of the attribute is in place
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The following sections outline the conclusions of the assessment.

When reading our assessment it is important to recognise that:

- the aim of this assessment is to determine where New Zealand is now as it moves towards effective adaptation. By understanding where New Zealand is now we will be able to identify (in our next report) options for how the country can adapt to climate change
- the assessment represents a snapshot in time. Through the work of the Group it is clear that there is an emerging but increasing trend towards the consideration of climate change adaptation
- the assessment is the qualitative expert judgment of the Group, and is based on the information referenced within this report and provided by sectors
- we have experienced extreme contrasts within some sectors where a few parties are meeting the attribute and others have made little progress. In making our assessment we have made a judgment that reflects the sector as a whole.

The framework considers the key attributes that could contribute towards effective adaptation for New Zealand across all sectors of society. All sectors have complementary but different roles in adapting to climate change. Some sectors will therefore have a greater role to play than others in some attributes. The greater the role in the attribute, the more advanced we would expect the sector to be. For example, central government is primarily responsible for policy frameworks. Amongst other roles, it is responsible for providing robust information on how New Zealand's environment may change, and distributing and making this accessible to other sectors.

For effective adaptation we would expect to see evidence of the attributes being addressed in a logical sequence. For example, informed attributes being addressed before a response is organised and action is widespread across all sectors. We would also expect the public sector to provide direction (information) for an organised approach, and coordinated and ongoing (dynamic) action.

#### CASE STUDY 1: COMMON THEMES AMONG OTHER COUNTRIES' APPROACHES TO ADAPTATION

- Having a strong scientific evidence base, providing robust information and raising awareness
- The importance of coordination, collaboration, cooperation and partnerships between central government and other levels of government, and across sectors and society. Shared responsibilities are important while acknowledging the importance of national leadership
- Identification of priority sectors, including assisting and prioritising vulnerable people and regions
- The need to anticipate the risk, be proactive and comprehensive
- Factoring and integrating climate risk into decision-making
- Taking a long-term view and building resilience
- The importance of monitoring and evaluating progress towards building resilience with feedback into review of a strategy or plan
- Looking for and taking advantage of opportunities for adaptation.

# 5 Stocktake of what New Zealand sectors are doing to adapt to climate change

NZ's climate is changing	Climate related changes NZ can expect	Impacts of climate related changes for NZ	RESPONSE	Defining effective adaptation	Stock take of what NZ sectors are doing to adapt to climate change	Current gaps in knowledge and work programme	NEXT STEPS chapter 7
Chapter 1	Chapter 2	Chapter 3		Chapter 4	Chapter 5	Chapter 6	

In accordance with our Terms of Reference, we have undertaken a stocktake of existing work on adaptation by both central and local government. In addition to this, we have also drawn on our expertise within the Group to consider what other sectors of society are doing on adaptation. We chose to extend the scope of the stocktake as we recognise that New Zealand will not successfully adapt through central and local government alone. We also acknowledge that there are some sectors, for example infrastructure and transport that span both the public and private sector. Where this is the case these have been considered as a standalone sector.

## 5.1 Central government

### Key findings

- Central government has played a key role in funding research which provides the basis for building New Zealanders’ understanding of climate-related changes and the impacts this will have on different sectors of society. Central government’s agencies understanding of how climate change will impact on their responsibilities and operations are less clear.
- There is some misalignment in how climate change adaptation and resilience objectives are incorporated into legislation and policy. As a result, central government agencies response to adaptation is not currently coordinated and there is little alignment of adaptation goals or agreement of priorities.
- Actions that central government agencies have taken to adapt have generally been reactive and have been part of a natural hazard management response after climate-related impacts have been felt.

## 5.1.1 Role in climate change adaptation

Central and local government, on behalf of communities, is responsible for managing risks to public goods and assets (including the environment), delivering government services, and creating the institutional, market and regulatory environment that promotes resilience and action.<sup>59</sup> Central government's main responsibilities for climate change adaptation are:

- governance in setting the statutory and policy frameworks
- funding research and ensuring it is relevant to and shared with end users
- providing information and guidance to support decision-making
- preparation for, and response to, major natural hazard events
- owning, managing and investing in major infrastructure (eg, schools, hospitals, recreational infrastructure on public conservation land)<sup>60</sup>
- agreeing funding decisions across policy domains
- monitoring policy effectiveness and advising on future needs.

## 5.1.2 Engagement undertaken

To understand what central government is currently doing on climate change adaptation, a survey was sent to 35 government agencies (see [Appendix 3](#)). We received responses from 25 of those agencies.

## 5.1.3 Work towards effective adaptation

### Informed

Central government understand the climate-related changes New Zealand can expect in the medium and long term	MAINTAIN
Central government understand the impacts of the climate-related changes and what this means for them	MORE WORK REQUIRED

In 2015/16 the government invested a total of \$50.3M in climate change-related research including \$14M in Crown Research Institutes and \$3.5M in the National Science Challenge<sup>61</sup>. Recent research programmes on adaptation include:

<sup>59</sup> Australian Resilience Strategy, 2015.

<sup>60</sup> Infrastructure and transport and discussed in detail in section 5.3. as these assets are owned by both the private and public (central and local government) sector.

<sup>61</sup> New Zealand's Seventh National Communication under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, 2017 (in press).

- **Deep South National Science Challenge (2014–2019)** – the current provider of most adaptation research in New Zealand. Its mission is to transform the way New Zealanders adapt, manage risk and thrive in a changing climate
- **Resilience Science Challenge (2014–2019)** – also has projects relevant to climate change adaptation at the coast and on adaptive governance. Its mission is to inform how New Zealand will build a transformative pathway toward natural hazard resilience
- **Sustainable Land Management and Climate Change (SLMACC) programme** – aims to help the agriculture and forestry sectors address the challenges arising from climate change
- **Climate Change Impacts and Implications (CCII) programme (2012–2016)** – focused on the projected climate conditions and variability, their impacts and implications for New Zealand and their significance for and how to enhance decision-making about them.

Other research has considered climate change impacts on the tourism industry, urban infrastructure, the coastal environment and community vulnerability. In addition, we understand that Land Information New Zealand is currently working on improving its elevation data to enable better flood modelling and sea level recording. A full list of research programmes and information on adaptation is included in [Appendix 4](#). The research undertaken is essential to help sectors (end users) make informed decisions about how to respond to a changing climate, including how to organise themselves and how to take dynamic action.

Engagement with central government has shown that this research has resulted in a relatively clear understanding of the climate-related changes New Zealand can expect but not the full implications of these for New Zealand. This understanding is similarly clear across the majority others sectors (see Sections 5.2 to 5.9).

The impact of climate change on central government agencies roles and operations is less well understood. For example, while the Department of Conservation understands that climate change will have implications on all aspects of their work (eg, pest management, maintenance of recreational infrastructure), they noted that there is limited information on where the greatest risks are. Key information gaps identified by agencies include limited information on vulnerable groups and areas in New Zealand, and limited solution-orientated research, although the latter is now being heavily invested in through the Science Challenges (which builds on past research).

## Organised

Central government plays an important role in negotiating and being party to key international agreements which recognise the importance of, and need for, climate change adaptation. Central government also sets the domestic regulatory framework within which adaptation is currently considered. Table 5.1 outlines the key agreements and statutes relevant to adaptation.



**Table 5.1: Key agreements and statutes relevant to adaptation**

Statute/Agreement	Requirements
<b>International</b>	
The Paris Agreement	To plan for and take action on climate change adaptation
The Sendai Framework for Disaster Risk Reduction	Includes the consideration of climate change effects. Effective from 2015–2030.
<b>Domestic</b>	
The Resource Management Act 1991 (RMA)	To control the use of land in order to manage the risks of natural hazards and have particular regard to the effects of climate change. This includes the consideration of cumulative effects which arise over time or in-combination with other effects regardless of scale, intensity, duration, or frequency
The New Zealand Coastal Policy Statement 2010 (NZCPS)	Includes policies which must be given effect to for managing coastal hazards and climate change under the RMA, including sea-level rise, storm surge and wave height under storm conditions over at least a 100 year timeframe
The National Policy Statement for Freshwater Management 2011	Regional councils must have regard to the reasonably foreseeable impacts of climate change when setting freshwater quality limits and environmental flows under the RMA
The Local Government Act 2002 (LGA)	Outlines the administrative and management responsibilities of regional and district councils for matters such as land management, utility services (three waters) and the provision of services. It requires communities to prepare long-term plans that set outcomes and longer term financial planning. These plans include infrastructure strategies over at least a 30-year period
The Civil Defence Emergency Management Act 2002 (CDEMA)	A risk management approach must be taken when dealing with hazards. It provides a framework for local government to plan and coordinate hazard management. It requires lifeline utilities to be resilient
The Building Act 2004	A consent authority must refuse to grant building consent if the land on which the building work is being carried out is subject to or expected to be subject to natural hazards, unless adequate provision has or will be made to either protect the land, building work, or other property from the natural hazards or natural hazards or restore any damage to that land or other property as a result of the building work. It requires consideration of a 50-year design life, however it is silent on providing for climate change
The Soil Conservation and Rivers Control Act 1941	The objectives of the Act include the prevention and mitigation of soil erosion, and the prevention of damage by floods

There are many other statutes that are indirectly relevant to adaptation, including those that cover the management of biodiversity and public health. While we do not expect all these statutes to explicitly cover adaptation, they do need to be aligned where climate change impacts are relevant. We are currently seeing some misalignment in the regulatory framework. For example, there are inconsistencies in the timeframe for considering climate change effects, with the Building Act requiring a 50 year design life and no express consideration of climate change effects; the NZCPS using a timeframe of at least 100 years; and the LGA requiring 30 year infrastructure plans.



There are many different roles central government agencies take in terms of acting on climate change adaptation across different sectors. Critical agencies include:

- **Treasury and Earthquake Commission (EQC)** – have a role in taking on limited liability for physical damages from natural hazard events
- **Department of the Prime Minister and Cabinet (DPMC)** – responsible for national security including significant risk to New Zealanders, managing large scale civil defence emergencies, and ensuring coordination in disaster risk reduction across New Zealand
- **Ministry of Business, Innovation and Employment (MBIE)** – influences major infrastructure procurement and investment; and administers the Science Challenges
- **Department of Conservation (DOC)** – the lead agency for managing threats (such as climate change) to public conservation land and marine sanctuaries, as well as protecting New Zealand’s native species and ecosystems
- **Ministry of Primary Industries (MPI)** – supports the primary industries sector to manage risks to help improve productivity, and coordinates New Zealand’s biosecurity response
- **Ministry for the Environment (MfE)** – advises on environment risks and sets the framework for local government planning for the environment, including water management
- **Ministry of Health (MoH)** – advises on health risks and sets the framework for managing these
- **Department of Internal Affairs (DIA)** – advises on requirements for local government infrastructure strategies and asset management planning (through the Local Government Act).

All of these critical agencies are considering climate change impacts to varying degrees. There is a lack of co-ordination between agencies and clear lines of responsibility.

Nearly all agencies we surveyed have a goal of building long-term ‘resilience’ for New Zealand. Each agency has their own view on what resilience means for them, and only some explicitly consider climate change adaptation as part of this. Currently, central government does not have a common set of outcomes, goals and priorities for climate change adaptation. This means that messages on climate change from central government are mixed or absent, appear inconsistent and create uncertainty amongst those with specific responsibilities at central and local government.

At a national level, there are a number of strategy documents targeted at certain sectors (or parts of sectors) that highlight the importance of considering climate change in decision-making and planning. These include:

- National Civil Defence Emergency Management Plan Order (2015)
- Thirty Year New Zealand Infrastructure Plan (2015)
- Biosecurity 2025 Direction Statement (2016).

These documents do not however include a clear articulation of the priorities for action, timeframes for delivery, and how this should be monitored to ensure implementation is and remains effective.

One of the consequences of not having a planned approach is that climate change adaptation is not formally factored into decision-making. This creates a risk that new government initiatives are not able to deliver the benefits planned because they could increase New Zealand's exposure to climate risk. For example:

- **the drive to accelerate urban development and housing** – new legislation is proposed to enable major urban development projects to be built more quickly but may not adequately consider future climate change impacts on the areas selected for development
- **climate change mitigation policies** – the New Zealand Emissions Trading Scheme currently promotes planting forests and without considering potential future climate risks this activity has on the potential to increase weed pressure and water loss, particularly in dry eastern catchments
- **irrigation investment** – while investment in irrigation may help strengthen the ability of communities to cope during dry conditions, there is a risk that if adaptation is not adequately factored into allocation and planning decisions, it could increase the intensity of land use and increased vulnerability to the effects of climate change.

Agencies we have spoken to have identified a number of gaps in the development or application of tools they have to act on adaptation, including:

- difficulty for agencies to balance immediate and long-term priorities and emphasised that short-term priorities tend to trump long-term planning
- lack of leadership across agency work programmes/responses
- capacity – the majority of agencies suggested that resourcing constraints were a significant barrier to proactive work on adaptation
- capability – including the lack of specialised skills in the interface between climate and impact modelling, and between vulnerability and risk assessment.

Central government plays an important role in providing tools for others to use to help implement adaptation measures across its relevant responsibilities:

## Providing information and guidance to support decision-making

New Zealand's *Framework for Adapting to Climate Change* (2014) is based around four key pillars including information; roles and responsibilities; research; and action. This framework is very high level and in its current form does not provide enough detail to facilitate action. Some of this detail is provided in guidance to local government, including:

- Climate Change Effects and Impacts Assessment (2008)
- Coastal Hazards and Climate Change (2017)
- Tools for Estimating the Effects of Climate Change on Flood Flow (2010)
- The New Zealand Coastal Policy Statement (NZCPS) Guidance note (2010).

An *Adaptation Framework for the Conservation of Terrestrial Biodiversity in New Zealand* (2014) has also been developed by the Department of Conservation. The resourcing for its implementation is currently being considered. [Appendix 5](#) provides a list of central government frameworks and guidance documents on adaptation and their web links.

## Governance in setting statutory and policy frameworks

Central government also has a number of policy levers it can use to provide greater direction to motivate local government and private sector decisions-making on climate-related risks which are currently under-utilised. Examples include, National Policy Statements and Environmental Standards under the RMA, and the Government Policy Statement on Land Transport.

## Preparation for, and response to, major natural hazard events

Recent flooding, earthquakes and tsunami threats have focused attention on improving New Zealand's regulatory frameworks to reduce disaster impacts and losses. This includes the development of the National Disaster Resilience Strategy (an update of the Civil Defence Emergency Management Strategy) which intends to explicitly cover adaptation. Complementing this is development of national direction to support councils with risk assessment and land use planning in response to changes to the RMA on natural hazards. These will all need to be aligned so there is a cohesive package to guide risk and vulnerability assessments, and ensure there are flexible management approaches for dealing with changing climate-related risk profiles over long timeframes.

It is important to keep in mind that natural hazard management does not address the full range of climate change impacts and opportunities. For example, while it may support New Zealand to prepare for increased frequency and magnitude of extreme storms, it does not address the prolonged effects of sea-level rise and changes in temperature, nor the impacts on human health and pest management.

## Dynamic action

### Central government is taking anticipatory action

### SIGNIFICANT WORK REQUIRED

We found few examples of anticipatory action on adaptation. For example, funding assistance is mainly focused on supporting communities to recover *after* climate-related events occur, such as central government meeting 60 per cent of councils' cost of restoring infrastructure after disaster; the EQC Fund policy settings for flooding and land damage; and MPI's Adverse Events programme that helps rural communities and individuals recover from adverse events (including natural disasters, severe weather and biosecurity incursions).

Other than funding, we have seen a small number of positive examples of central government agencies taking proactive action to adapt including:

- **NZ Defence Force** – its infrastructure plans for estate regeneration include assessment of climate risks and opportunities to build resilience to climate change into new projects<sup>62</sup>
- **Ministry of Health** – supporting DHB public health units detect exotic mosquitoes of public health significance, and monitoring DHB emergency and business continuity plans to ensure they include risks of extreme weather events
- **Department of Conservation** – initiated the 'Battle of Our Birds' as a result of increased frequency of sudden irruptions in pest species populations caused by an increase in mast seeding events in forests.<sup>63</sup>

### Central government is being flexible

### SIGNIFICANT WORK REQUIRED

Central government's frameworks and plans are generally slow to respond to changing risks, issues and opportunities. The Climate Change Impacts and Implications Programme (2016) highlights the need for new tools and practices, including novel communication methods that engage stakeholders and practitioners. In addition, our stocktake identified a lack of formal monitoring of policy effectiveness of adaptation measures which hinders central government's ability to adjust its approach with agility.

### Central government is reducing risks by adapting

### NOT PRESENT

The RMA and the NZCPS stand out as the key statutory frameworks that focus on reducing climate change effects. While these have been used in some localities by local government to anticipate changing climate we found no evidence that climate change risks to New Zealand have been reduced by the actions taken by central government.

<sup>62</sup> Approval has been given for a \$1.7 billion rejuvenation of Defence buildings, infrastructure and facilities.

<sup>63</sup> The irregular seeding of millions of hectares of beech trees, resulting in a rapid expansion of mice and rat numbers affecting wildlife, is partially driven by changes in temperature and weather events.

## Overview

The sector's progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
INFORMED	Understand what's happening	Maintain
	Understand what it means for them	More work required
ORGANISED	Know what is expected of them	Significant work required
	Has common goals	Significant work required
	Has a planned approach	Significant work required
	Has the tools they need	Significant work required
DYNAMIC ACTION	Is taking action	Significant work required
	Is being flexible	Significant work required
	Is adapting	Not present

## 5.2 Local government

### Key findings

- Local government has responsibilities to prepare communities for and manage the risks of climate change. They have devolved powers to do this as they are considered best placed to understand what is appropriate for their region (that is, the principle of subsidiarity) based on the local changes they can expect to experience. The majority of councils appear to have a good understanding of climate change and are able to clearly articulate the potential impacts on their responsibilities.
- The extent and scope of action on adaptation varies considerably. Councils are at different stages of planning, have different views on how to manage climate risks, and have different needs. These different approaches can create confusion for the public and litigation of decisions.
- Many councils realise the importance of acting on adaptation and would like to do more but identified barriers including limited community buy-in; resourcing constraints (funding, capacity and capability); and lack of leadership and support from central government. There are a few councils that are starting to innovate with community processes and tools for managing climate risks.

### 5.2.1 Role in climate change adaptation

Local government has responsibilities for preparing communities for and managing the risks of climate change. They have devolved powers to do this as they are considered best placed to understand what is appropriate for their region (that is, the principle of subsidiarity) based on the

local changes they can expect to experience. Local government consists of regional councils, unitary and territorial authorities (city and district councils). Collectively local government is responsible for:

- resource management policy, planning and decision-making
- flood control, stormwater management, flood warning and land drainage, and emergency management
- freshwater management, including the allocation of water quantity and quality
- maintenance of indigenous biological diversity
- responding to sea-level rise and the associated risks to coastal communities
- the operation and maintenance New Zealand’s major infrastructure (water, stormwater, wastewater, flood protection and roads) that provide services to communities<sup>64</sup>
- understanding the needs of local and regional communities, communicating directly with those communities being accountable and responding.

### 5.2.2 Engagement undertaken

To understand what local government is currently doing on climate change adaptation, a questionnaire was sent to 78 local authorities. We received responses from 48 of those agencies (see [Appendix 3](#)). Literature that similarly surveyed local government was also reviewed to inform this section (see [Appendix 7](#)).

### 5.2.3 Work towards effective adaptation

#### Informed

<p><b>Local government understand the climate-related changes New Zealand can expect in the medium and long term</b></p>	<p><b>MAINTAIN</b></p>
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Local government appears to have a good understanding of the climate-related changes they can expect for their region. This understanding comes from regional climate change projections including for groundwater, sea-level rise, ocean acidification and warming; and local government funded research to develop more detailed local information.

<sup>64</sup> Local government owns more than \$120 billion of assets and manages the bulk of New Zealand’s drinking water, wastewater, stormwater (three waters); flood protection and river control infrastructure; and 88 per cent of roads. Infrastructure and transport and discussed in detail in section 5.3, as these assets are owned by both the private and public (central and local government) sector.

<b>Local government understand the impacts of climate-related changes and what this means for them</b>	<b>MORE WORK REQUIRED</b>
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The majority of councils were able to articulate the potential implications on their responsibilities. However, there were a small number of district councils who noted that they do not consider climate change to be an issue for them at present, and as such adaptation was not a priority.

As well as using information provided by central government, we have seen a number of examples of councils commissioning their own research. For example, Northland Regional Council is undertaking a region-wide LiDAR project which will help assess the impact of sea-level rise. In addition, several councils have undertaken coastal hazards assessments (eg, Hawke’s Bay, Kāpiti).<sup>65</sup>

Our survey results showed there is a desire for better data and information on local scale impacts (approximately 50 per cent raised this), and the costs of obtaining this information is a barrier to action on adaptation.

## Organised

<b>Local government know what is expected of them</b>	<b>MORE WORK REQUIRED</b>
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The extent to which each council considers adaptation varies. In part, this is due to the level of exposure to climate-related changes each face, and the level of resources available to them. These different approaches can create confusion for the public, and inconsistencies and litigation of decision-making.

Councils appear to have a good understanding of their responsibilities, however many noted that misalignment across legislation and policy creates confusion regarding what is expected of them in terms of adaptation. As an example, a council noted that the Housing Accords and Special Housing Areas Act 2013 appeared to put priorities on housing supply ahead of natural hazard management considerations under the RMA.

In addressing whether the role of councils is considered appropriate, some have suggested having each unit of local government attempting to adapt to the impacts of climate change using different assessment and implementation approaches is inefficient and creates duplication of effort across New Zealand as there are similar impacts occurring throughout the country (eg, sea-level rise, flooding).

<b>Local government has common goals</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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While there are currently no common goals to help guide action on adaptation across the 78 councils, some regional councils are developing climate change work programmes (for example Canterbury), or strategies (for example The Greater Wellington Climate Change Strategy and Implementation Plan) to help councils in their region to work in an integrated way.

<sup>65</sup> These assessments have not comprehensively assessed climate change risks across whole regions.

In addition, central government is currently considering a proposal by local government to establish a central risk agency that pools and coordinates local government resources to lower the risk and cost of disasters. The proposal aims to harmonise risk practice, improve local government skills, share data and provide best practice risk modelling.

**Local government has a planned approach**

**SIGNIFICANT WORK REQUIRED**

In the majority of cases, councils do not have a plan for how to go about climate change adaptation. However, as established earlier we are starting to see some councils develop climate change work programmes and strategies for their region.

In addition, we are seeing councils working together to plan for climate change risks. For example, Western Bay of Plenty District Council, Tauranga City Council and Bay of Plenty Regional Council are engaging in a collaborative natural hazards work programme over the next two years.

**Local government has the tools they need**

**SIGNIFICANT WORK REQUIRED**

A number of tools are available to councils to help them implement adaptation measures in their areas but many are calling for more support, including:

- **greater public awareness** – lack of community buy-in was raised as a barrier to adaptation by over half of respondents
- **more quality data and information** – particularly in relation to local-scale impacts (approximately 50 per cent of respondents). There is incomplete coverage of land elevation (light detection and ranging (LiDAR)) data which is required for local-scale hazard and risk assessments to consistent national standards. Vulnerability assessments are also required for risk assessments to appropriately address potential social impacts
- **more support in resourcing and capacity** – the cost and/or funding of adaptation is a key barrier, including the issue of liability and who pays (close to 70 per cent of respondents),<sup>66</sup> while over 30 per cent raised the issue of capacity and capability
- **policies and frameworks to be more joined up** across government and better suited to the task (over 40 per cent of respondents)
- **coordinated national leadership and direction** on adaptation wanted by councils, as without it they face issues in their ability to act with a clear mandate and thus engage effectively with communities and prioritise action (approximately 60 per cent of respondents raised this as a barrier).<sup>67</sup>

**Box 1** provides examples of councils' views on the barriers to climate change adaptation.

<sup>66</sup> This is consistent with the Climate Change Impacts and Implications Project (2016)<sup>66</sup> which found that “without the ability to fund climate change adaptation where people and assets are at risk, councils considered it unlikely that measures currently in use would be effective in reducing exposure and vulnerability to climate change”.

<sup>67</sup> As an example, while local councils have suggested that the guidance manuals by central government are useful tools (on the proviso that they are updated regularly), many are calling for more statutory levers as guidance can easily be ignored.



Local government also plays an important role in providing tools to support their communities to adapt. This includes:

*Statutory frameworks and planning*

Over half the councils who responded to our survey considered climate change adaptation in their Regional Policy Statements, and District and Regional Plans. Around a third considered it in their Long Term Plans. Some examples of how adaptation is covered in plans include:

- **adaptation policies and objectives** – some councils include specific policies and objectives for adaptation to climate change in Regional Policy Statements, for example, the notified Regional Policy Statement for Otago
- **natural hazard management** – in the majority of cases, we are starting to see projected climate change impacts being considered in local hazard risk management policies and frameworks. As an example, the Horizons One Plan requires a precautionary approach when assessing the effects of climate change on the scale and frequency of natural hazards with regards to decisions on, amongst other things, water allocation and water takes
- **sea-level rise and land use management** – some councils include specific controls on land use planning and development, for example, the Auckland Unitary Plan (operative in part) places development controls related to anticipated sea-level rise 100 years in the future on both greenfield and brownfield development
- **flood risk management** – some District Plans set minimum floor levels to help protect properties from the risks of floods and/or include flood hazard maps
- **biosecurity** – all regional councils have regional pest management strategies (in accordance with the Biosecurity Act). Some of these strategies factor-in climate risks. For example, climate data is integrated into Canterbury’s Proposed Regional Pest Management Plan which aims to prevent and manage new pest incursions (including those resulting from climate change).

*Education*

Local government also plays an important role in educating communities about climate change risks in their region. For example, Auckland Council introduced the King Tide Initiative which encourages people from the region to photograph the highest tides that naturally occur along the coastline each year. They use these photos to help visualise what their coasts may look like in the future as sea level continues to rise. Other councils provide support to initiatives such as EnviroSchools, to help educate communities. Greater consistency of information provided to communities would strengthen the understanding.

**Dynamic action**

Local government is taking anticipatory action	SIGNIFICANT WORK REQUIRED
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Many councils are still in an early phase of planning for adaptation and few are at the implementation stage. Specific actions councils mentioned in their survey responses vary significantly. Some examples include:

- **sea-level rise and coastal erosion control** – New Plymouth District Council is implementing erosion control measures through a Coastal Erosion Strategy which includes specific consideration of climate change
- **flood protection** – Bay of Plenty Regional Council initiated a River Scheme Sustainability Project. It sets the direction for sustainable management of its major waterways for the next 100 years including under different climate change scenarios
- **water management** – A number of councils are investigating water storage and irrigation infrastructure to help meet their community’s needs as weather patterns evolve, including Greater Wellington (Water Wairarapa project), Environment Canterbury and Northland
- **biosecurity and biodiversity management** – Palmerston North City Council is partnering with communities to regenerate forest remnants and connect them via green corridors, which can increase ecosystem resilience to climate events.

**Local government is being flexible**

**SIGNIFICANT WORK REQUIRED**

The philosophy of continual change and review are well established within local government, and we understand that local government has good experience in amending their policies and practices over time based on changing environmental, economic and social conditions. This has been through the statutory requirement to review their Regional and District Plans every 10 years, and Long Term Plans every three years. To date the processes for making these changes are generally slow to respond to changing risks and opportunities, as they are time based and arbitrary rather than flexible and adaptable.

In terms of being flexible to climate risks, we are starting to see some councils shift their planning practices from static (where decisions do not consider further, future decisions that may be required) to dynamic approaches (where the options for future decisions are also considered) to help deal with uncertainty. For example, the Hutt River Floodplain Management Plan upgrade for the Hutt CBD used dynamic adaptive planning tools to assess the significance of ongoing climate changes.

**Local government is reducing risks by adapting**

**SIGNIFICANT WORK REQUIRED**

While we are seeing some positive steps being taken to adapt to climate change by some councils, they are still in early stages of development implementation for example, the *Hawke’s Bay Clifton to Tangoio Coastal Hazards Strategy to 2120* and the *Otago Regional Council/Dunedin City Council South Dunedin Future programme*. For more information on these programmes, see [Case Study 2: Hawke’s Bay – An Example of Adaptation in Practice](#) and [Case Study 3: South Dunedin: Responding to Climate Driven Challenges](#).

## Overview

The sector's progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
<b>INFORMED</b>	Understand what's happening	<b>Maintain</b>
	Understand what it means for them	<b>More work required</b>
<b>ORGANISED</b>	Know what is expected of them	<b>More work required</b>
	Has common goals	<b>Significant work required</b>
	Has a planned approach	<b>Significant work required</b>
	Has the tools they need	<b>Significant work required</b>
<b>DYNAMIC ACTION</b>	Is taking action	<b>Significant work required</b>
	Is being flexible	<b>Significant work required</b>
	Is adapting	<b>Significant work required</b>

## BOX 1: COUNCILS' VIEWS ON THE BARRIERS TO CLIMATE CHANGE ADAPTATION

The following quotes from responses to our survey give a taste of the complexity of the issue as well as barriers to act on adaptation faced by local government:

“There is currently no central government acknowledgement that significant resources will be required for climate change at a scale that local government is unlikely able to fund. The public perceptions of the risk of climate change are unlikely to be helped if there is no acknowledgement that there will be significant financial risks.”

“Clearer climate change jurisdictional responsibilities and a demonstration of national leadership would be beneficial, with regional and district plans being better aligned and responsive, and less politically contentious.”

“Lack of immediacy of threat compared to expected immediate and long term cost implications to the rate/tax payer”

“It’s not the front of mind issue that some others currently are.”

“Tyranny of the now – sea level rise and climate change is relatively slow so only truly surfaces in the city’s consciousness during related emergencies. Response funding and focus often overshadows reduction strategies”

“Difficult for the organisation to prioritise climate change adaptation work as other issues – including those with strong central government directives take priority – lack of a mandate.”

“The vague and piecemeal approach to climate change adaptation leaves Territorial Authorities without direction and authority to undertake significant adaptation.”

“If the public perception is that central government is not adequately acknowledging climate change, then it is very hard for local government to defend a policy position”

“A stronger policy stance from central government on a precautionary approach to new development in hazard prone areas would give local government a better mandate and more robust defensible position to decline additional development, or only allow development with greater natural hazard mitigation conditions.”

“... we believe it needs to be a matter of urgent priority for central government to develop a government-wide approach to climate change adaptation.”

## CASE STUDY 2: HAWKE'S BAY – AN EXAMPLE OF ADAPTATION IN PRACTICE

Coastal erosion, flooding from the sea (inundation) and tsunami are pressing issues facing the Hawke's Bay in particular the southern stretch of the bay. These issues are being considered in the Clifton to Tangoio Coastal Hazards Strategy 2120 (the Strategy) for the next 100 years.

A Joint Committee has established two collaborative community panels to recommend appropriate responses to the identified risks using a structured decision-making process. This is being supported by a Technical Working Group and the development of an intergenerational funding model.

The region is very susceptible to changes in the climate and the coastline is also highly vulnerable to tsunamis triggered by earthquakes off Chile or in the Hikurangi Trough just off the coast. It is already experiencing disruption such as:

- storm swell events at Te Awanga, Haumoana and Westshore continually erode stretches of gravel beach
- inundation from rising sea/wave/swell levels threatens communities through overtopping the existing gravel barrier ridge.

The Joint Committee working on the Strategy facilitates the coordination of the two territorial authorities that the section of coastline falls in the jurisdiction of (Napier City Council and Hastings District Council), as well as Hawke's Bay Regional Council.

Hawke's Bay is the first region in New Zealand to take this long-term planning approach and there is little central government guidance on long-term approaches (although it is acknowledged that the Coastal Hazards Guidance is being updated). Coastal communities are being consulted on the level of risk they are prepared to live with and the associated cost of minimizing risk.

There are uncertainties with regard to ongoing insurance coverage, particularly in high-risk areas. Managing these uncertainties will require social and financial responses that will be generally perceived as fair by New Zealand community as a whole.

If local government ratepayers choose to cover costs of protecting private land from coastal hazards there may be issues around setting a precedent and unfairly allocating funds from the entire regions rates to coastal areas.

A combination of intervention, from engineering structures, beach re-nourishment and other methods, and retreat from the coast are expected to be used to enable communities to adapt to climate change and the risks of coastal hazards.

Those working on the Strategy are looking for the following from central government:

- national guidance suitable for local applications and circumstances which compliments existing work and efforts in the region
- direction and support on how local government can fund adaptation responses
- discussion of the role of central government in funding adaptation responses
- direction and support on how to manage retreat what it looks like, how to achieve it without splitting up communities, how to enable and incentivize it, how to pay for it.

### CASE STUDY 3: SOUTH DUNEDIN – RESPONDING TO CLIMATE DRIVEN CHALLENGES

South Dunedin is a vibrant and diverse community, which is expected to face many issues in the future due to its low-lying location. The area was converted from marshy wetland in the mid-1800s due to strong demand for level, dry land. As a result there are nearly 2,700 homes less than 50 centimetres above the spring high tide.



Image: Aerial map of South Dunedin overlaid with the natural features of the 1800s, Source Otago Regional Council.

A mixture of sandy and silty soils underlies South Dunedin meaning marshy conditions persist. The soil is very absorbent and the groundwater table sits close to the ground surface, in some cases less than 20cm deep. When heavy rainfall or higher tides occur, groundwater can rise quickly to, at, or even above the level of the land.

Sea level has risen about 14 cm over the last century, relative to the land. It is expected that any long-term rise in sea level will also see a rise in groundwater levels, which will eventually cause permanent ponding of water on the ground surface. This was discovered by modelling done by the Otago Regional Council.

These changes would cause damp housing conditions (leading to chronic health problems), parks and other facilities to be unusable in wet seasons due to drainage issues, and an increased risk of flooding during heavy rainfall due to limited ability for surface water to be absorbed beneath the ground. Otago Regional Council and Dunedin City Council are working together to develop and deliver a programme that responds to the climate driven challenges facing South Dunedin.

Community engagement is developing common understanding of the likelihood and nature of climate driven events as well as the potential environmental, social, cultural and economic impact. International examples of managing rising groundwater are being considered in a South Dunedin context. This information, along with the councils' own science and monitoring, will help identify viable options for the area.

Communities must be confident about the decisions they and their local authorities make about the future. This can be difficult with the current level of uncertainty. Change to the environment is slow and imperceptible in nature and the triggers for adaptation are not expected to be obvious to the public. While this gives councils and the community the benefit of time to adapt to the change it risks a prolonged period of uncertainty in which appropriate action is not taken.

## 5.3 Infrastructure providers

### Key findings:

- A good level of information is available to infrastructure providers on climate change through climate projections supplied by government and industry standards. Some providers have displayed a good understanding of the risks, however many consider climate change adaptation as part of a broader goal around resilience to natural hazards. This limits the consideration of changing risks.
- Given the long lifetime of infrastructure, there is urgency for climate change adaptation to be factored into infrastructure decisions now. Local government, which are significant providers of roads, flood management and three waters infrastructure, are approaching a period of infrastructure renewal. This is an opportunity.
- In the majority of cases, infrastructure decisions do not currently consider climate change adaptation. There are a number of challenges in incorporating climate change adaptation into infrastructure decision-making including most approaches to addressing service provision involved 'locked in' solutions that have been developed over the last century. There is also a perception that climate change adaptation will cost more even though it may not be significant compared with the large capital costs, and longevity of infrastructure investment.

### 5.3.1 Role in climate change adaptation

Infrastructure providers include private and/or public organisations responsible for the design, construction, operation and maintenance of electricity generation and transmission, water, wastewater and stormwater (three waters), flood management and communications, and transportation networks (including ports and airports). Infrastructure assets generally have a long design life. It is the provider's responsibility to ensure that they consider climate-related change and the long-term impacts this will have.

### 5.3.2 Engagement undertaken

To understand what the infrastructure and transport sector is currently doing on climate change adaptation, we analysed the survey responses from central and local government. Survey responses were also provided by six infrastructure providers in the private sector (see [Appendix 3](#)).



### 5.3.3 Work towards effective adaptation

#### Informed

<p><b>The infrastructure and transport sector understand the climate-related changes New Zealand can expect in the medium and long term</b></p>	<p><b>MORE WORK REQUIRED</b></p>
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The sector has a good level of information available to them about climate change through climate projections supplied by government and industry standards. The six providers who responded to our survey showed they had a good understanding of the changes New Zealand can expect. However, this is only a small sample, and we expect that there are a large number of providers within the sector that are not necessarily aware of climate change impacts or understand them in detail.

<p><b>The infrastructure and transport sector understand the impacts of the climate-related changes and what this means for them</b></p>	<p><b>SIGNIFICANT WORK REQUIRED</b></p>
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Few infrastructure providers appear to have commissioned specific studies and assessments into climate impacts and risks. However, the consideration of climate change impacts goes beyond the service performance of any particular infrastructure. There are significant implications for long-term land use planning for the provision of infrastructure through the strategic integration of infrastructure with land use by regional councils.

Many have also commissioned their own research including:

- **Watercare Services Limited** – investing in hydrodynamic and water quality models of the Manukau Harbour to enable the running of various scenarios of sea-level rise and climate change impacts
- **Auckland Airport** – commissioned two studies to better understand and manage the risk of sea-level rise and inundation. One study is on sea-level rise (2016) and the other on the impact of sea-level inundation on their stormwater network
- **The New Zealand Transport Agency** – undertook a two year research project on climate change effects on the land transport network (2008/09). It identified and assessed the impacts of climate change on road, rail, ports and coastal shipping networks, and provided recommendations, including adaptation options, to address information gaps and risks
- **Waikato Regional Council** – developed a coastal inundation mapping tool for projected sea-level rise which informs council infrastructure decisions in the region.

Many stakeholders we spoke to within this sector highlighted they need access to up-to-date information and guidance to consider the implications to them. This includes detailed LiDAR information as well as hazards and sea-level rise data and scenarios with tools deployed that can consider future uncertainties. If tools to assess the future range of climate-related conditions are



unavailable or not routinely used for infrastructure planning, inadequate consideration of future climate risks with costly consequences or no decisions being made can be expected.

**Organised**

<b>The infrastructure and transport sector know what is expected of them</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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Infrastructure providers are responsible for maintaining New Zealand’s infrastructure and transport network in the face of climate change impacts over the long term. This responsibility is understood by many within the sector but focus tends to be on hazard risk management in the near term.

One stakeholder told us that priorities from central government can be unclear and it is not always obvious how policies fit together. For example, it was considered that recent policy changes to provide for additional land for housing and to improve freshwater management could better integrate considerations of climate change-related risks.

<b>The infrastructure and transport sector has common goals</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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The National Infrastructure Plan (NIP) (2015) establishes a goal that New Zealand’s infrastructure is resilient, coordinated and contributes to a strong economy and high living standards. Adaptation is identified as a key element to achieving this. The NIP however provides no detail on how to go about this. The NIP suggests that the infrastructure response to the impacts of climate change would be explored further in the near future but we are not aware that this has been done yet.

In addition, the Government Policy Statement for Land Transport that sets out the government’s priorities for expenditure from the National Land Transport Fund over the next 10 years also includes an objective on resilience in its network, but does not explicitly cover climate change impacts and adaptation. This reiterates the current focus on immediate hazard management rather than on how climate change affects infrastructure provision over its design life.

<b>The infrastructure and transport sector has a planned approach</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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While there is a common goal around building resilience in our infrastructure, we have seen little evidence of a plan for how adaptation in infrastructure investment and planning will be carried out.

<b>The infrastructure and transport sector has the tools they need</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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Many infrastructure providers highlighted the main tools that motivate their action on adaptation are the policies and rules in statutory documents set by central and local government. For example:

- **the Civil Defence Emergency Management Act (CDEMA)** – considers infrastructure managed by this sector as critical lifeline utilities, and is therefore much more heavily regulated for risk management compared to some sectors. While CDEMA requirements are not future focused and have no express requirement to adapt, we are seeing some instances of adaptation being integrated into emergency preparedness for natural hazards.
- **rules and policies in planning documents under the RMA** – influence where infrastructure may be built and how it is designed. For example, Watercare’s projects are being designed to consider the potential for sea-level rise of one metre over the next 100 years, as established in the Auckland Unitary Plan.

Some infrastructure providers identified gaps in the tools available to them, including:

- **the lack of nation-wide science on hazards risk and climate change guidance** – with much of the current guidance out-of-date
- **limited funding, resourcing and capability** – to consider and apply climate change adaptation
- **the lack of consistent terminology** – there is a wide range of language, definitions and theory associated with related fields of risk management, resilience and climate change adaptation which reduces the potential for shared understanding and collaboration. We understand that this issue is being considered by local government as part of the proposed Local Government Risk Agency.

**Dynamic action**

The infrastructure and transport sector is taking anticipatory action	SIGNIFICANT WORK REQUIRED
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We have found only a few examples of infrastructure investment decisions that directly consider climate change adaptation including:

- **the New Zealand Transport Agency** – implemented a business improvement project which aims to build resilience into the state highway network (one example is that NZTA raised and widened the State Highway 16 causeway in West Auckland based on a 50 year prediction of sea-level rise)
- **Wellington Water** – plans to increase the capacity of stormwater pipes when they are due for replacement by using climate change scenarios
- **Auckland Airport** – developing an adaptation management plan based on research it commissioned on the risks of sea-level inundation on their operations.

It’s important to note that these examples are not reflective of the whole sector’s response to adaptation, and we are aware that many infrastructure providers (if not the majority) do not

currently integrate climate change impacts into their decision-making. For example, we have seen no evidence of the New Zealand Transport Agency’s climate change impact assessment (2008/09) for land transport being used to anticipate future changes.

<b>The infrastructure and transport sector is flexible</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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We have seen some good examples of the sector implementing risk-based approaches to ensure they can be flexible to changing overtime. An example of this is included in the [Case Study 4: Transpower – Managing Transmission System Uncertainty](#). In addition, providers we surveyed noted they monitor trends in climate conditions that might impair their operations which will help facilitate their ability to respond to change over time.

#### CASE STUDY 4: TRANSPOWER – MANAGING TRANSMISSION SYSTEM UNCERTAINTY<sup>68</sup>

New Zealand design standards require infrastructure to withstand specified probabilities of earthquake and wind events. These levels are then compared against the proposed function of the asset, as some assets are more critical than others. Technical and economic considerations for the asset are then taken into account.

For example, transmission lines are very robust and simple, and fast and cheap to reinstate (between 24 and 72 hours). Multiple lines run between substations and provide functional diversity. Substations are, by comparison: geographically concentrated; have more component parts that perform a single function; are very expensive; and have long replacement times. For example, delivery of a power transformer will take over a year from date of order and weighs several hundred tonnes, a significant logistical exercise to replace. Even a spare takes two to four weeks to get on site. Substations therefore have more stringent design standards than transmission lines.

Not all lines or assets are created economically equal either. The core grid (220 kV) and anything greater than 150 MW are designed to deterministic standards (two of everything), so if one part is 'lost' the other parts can continue running with no interruption. For investment in anything less than 220 kV or 150 MW, the criteria are purely economic. Sensitivity analysis of \$20K/MWh (megawatt hour), \$5K/MWh and \$35K/MWh can be used to highlight what is at risk in the event of non-delivery due to different load concentrations.

The Research Project: *The Climate Change Impacts and Implications for New Zealand to 2100, Synthesis Report (RA4)* suggested that this same process could be used to consider climate change risk on the transmission system. For example, for heat, snow and ice, wind, sea-level rise, flood events, and related landslips. Redundancy, criticality of asset, and diversity of system design are the factors that enable Transpower to manage uncertainty and dynamic change in their system. However, distribution companies are more at risk, because they have more limited funding to manage the logistics costs of such a protocol.

**The infrastructure and transport sector is reducing risks by adapting**

**SIGNIFICANT WORK REQUIRED**

While our survey responses have shown some steps are being taken which will help reduce New Zealand's exposure to the risks of climate change, this is not reflective of the sector's response to adaptation as a whole. We can conclude that the majority of infrastructure providers do not currently integrate climate change impacts into their decision-making and there is limited adaptation taking place in this sector.

<sup>68</sup> CCII Synthesis Report R4.

## Overview

The sector's progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
INFORMED	Understand what's happening	More work required
	Understand what it means for them	Significant work required
ORGANISED	Know what is expected of them	Significant work required
	Has common goals	Significant work required
	Has a planned approach	Significant work required
	Has the tools they need	Significant work required
DYNAMIC ACTION	Is taking action	Significant work required
	Is being flexible	Significant work required
	Is adapting	Significant work required

## 5.4 Finance and insurance

### Key findings:

- The sector is experienced in dealing with natural hazards and understands that climate change will exacerbate this. It is calling for a more coordinated and proactive response within and across sectors to reduce the potential impact of climate-related changes before they occur.
- The mismatch in the duration of insurance cover (annual), lending (spanning decades), infrastructure investment and planning decisions creates complexity in creating a coordinated response for businesses and homeowners in locations significantly affected by climate change.
- While the sector is quite active in mitigation, parts of the sector are also starting to implement direct measures to deal with climate change impacts. A key concern for the insurance industry is that overt action by one organisation can result in precipitous action by others in the sector and potentially affect government policy settings (EQC).

### 5.4.1 Role in climate change adaptation

The key responsibilities of the finance sector (including New Zealand's insurance, banking and investment providers) are:

- sharing their knowledge and expertise
- providing products that enable adaptation and recovery (for example, insurance)
- sending signals about risk through terms and availability
- influencing others through their capital management.

## 5.4.2 Engagement undertaken

To inform this section, we spoke to key stakeholders within the industry and reviewed relevant published literature.

## 5.4.3 Work towards effective adaptation

### Informed

<b>The finance and insurance sector understand the climate-related changes New Zealand can expect in the medium and long term</b>	<b>MORE WORK REQUIRED</b>
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Industry stakeholders told us they are aware of the potential climate-related changes. Increased consistency, granularity and availability of data are needed, for example, nationally consistent LiDAR.

<b>The finance and insurance sector understand the impacts of the climate-related changes and what this means for them</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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The sector also appears to understand what it means for them in general terms, but not at a sufficient level to inform their investments and market response. This reflects the broader understanding of impacts in the built and economic environments. As highlighted by Mark Carney, Governor of the Bank of England in his December 2016 speech, “without the necessary information, market adjustments to climate change will be incomplete, late, and potentially destabilising”.<sup>69</sup>

### Organised

<b>The finance and insurance sector know what is expected of them</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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Some within the finance sector have an understanding that they play a role in helping facilitate adaptation in New Zealand.

<b>The finance and insurance sector has common goals</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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There is no set of common goals for how to address climate change adaptation within the sector. However, there are calls from the insurance industry for a more coordinated strategy for managing hazard risk (including climate-related risks) that is focused on reducing the potential impact of disasters before they strike.<sup>70</sup>

<sup>69</sup> Belinda Storey, Ilan Noy, Wilbur Townsend, Suzi Kerr, Rhian Salmon, David Middleton, Olga Filippova and Vanessa James, 2017, *Insurance, Housing and Climate Adaptation: Current knowledge and Future Research*, Motu note 27.

<sup>70</sup> Insurance Council of New Zealand, 2014, *Protecting New Zealand from Natural Hazards Position paper*.

Without these common goals some within the sector are concerned that competition may trigger rapid change in the availability and terms of products, especially for insurance (and therefore lending) in high risk locations. However, greater cooperation in the sector may breach competition rules.

<b>The finance and insurance sector has a planned approach</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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The sector knows what it would do in response to increasing risk and the types of changes that would be made to their products to reflect this. What it doesn't know is when and how fast these changes will need to be implemented as a result of climate change. It also recognises that these changes will have consequential impacts on other sectors and that signalling and alignment are important.

<b>The finance and insurance sector has the tools they need</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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The sector can adjust its existing products to manage increasing risks caused by climate change. Insurers can adjust their exposure to risks by increasing the minimum excess a customer has to pay which is typically their first response, and from there they could increase premiums or reduce cover. Ultimately they may not offer any cover. Given that contracts are renewed annually, insurers are able to adapt relatively quickly to changing risk profiles. [Case Study 5: Climate change adaptation and the insurance sector – Insurance Australia Group \(IAG\)](#) shows how the IAG currently addresses hazard risks in their operations.

For the banking sector, they currently view environmental risk on a case-by-case basis when determining lending decisions. In the case of coastal properties vulnerable to erosion and storm surges, the banking sector expect a gradual reduction in the extent to which they could lend against those properties and/or they would require more equity or shorter mortgage terms.<sup>71</sup>

Mortgages are generally granted with repayment periods spanning decades which could increase their exposure if a home is lost or significantly damaged. To reduce some of this exposure, insurance is a requirement for residential mortgages in New Zealand, and failing to maintain insurance can trigger default. However, there is a general absence of compliance checks and lack of understanding of how well properties are insured. These leave a risk that many homes may be underinsured which increases banks' exposure to losses.

Overall, the mismatch in cover and lending duration generates complexity in creating a coordinated response to businesses and homeowners in locations significantly affected by climate change.

Investment managers will likely factor into their decisions the impact of climate change on, and the adaptive capacity of the businesses they invest in.

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<sup>71</sup> CCII project, 2016.

Stakeholders within the sector have identified the following gaps in their tools to adapt to climate change:

- lack of national direction and objectives
- lack of coordination within and across sectors – some have expressed a desire to work more in concert on this issue but in reality this is difficult due to competition.

**Dynamic action**

<b>The finance and insurance sector is taking anticipatory action</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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To date, the actions the finance sector have been focused on are the natural hazards that climate will exacerbate rather than its broader social or economic impacts. This includes:

- working with government to help get the right policy frameworks in place to support proactive action to reduce risks
- some insurers are increasingly reflecting risk in their pricing and cover (although providing cover remains their primary role) to create greater equity across high and low risk locations, and help discourage development in more hazardous locations
- some banks are starting to factor environment issues into their lending decisions.

<b>The finance and insurance sector is being flexible</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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The sector already has products available to them to deal with increasing risk, and the mechanisms to monitor and respond to those impacts. These are typically focused on the short term. We expect they will adapt their response relatively quickly to climate change impacts as they grow.

<b>The finance and insurance sector is reducing risks by adapting</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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The sector has not yet made material changes as a result of its understanding of climate change risks.



## Overview

The sector's progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
<b>INFORMED</b>	Understand what's happening	<b>More work required</b>
	Understand what it means for them	<b>Significant work required</b>
<b>ORGANISED</b>	Know what is expected of them	<b>Significant work required</b>
	Has common goals	<b>Significant work required</b>
	Has a planned approach	<b>Significant work required</b>
	Has the tools they need	<b>Significant work required</b>
<b>DYNAMIC ACTION</b>	Is taking action	<b>Significant work required</b>
	Is being flexible	<b>Significant work required</b>
	Is adapting	<b>Significant work required</b>

## CASE STUDY 5: CLIMATE CHANGE ADAPTATION AND THE INSURANCE SECTOR – INSURANCE AUSTRALIA GROUP (IAG)

Climate change became part of IAG's agenda in the early 2000's when they were exposed to a number of large losses due to weather events. IAG expects the impacts of climate change will only increase the frequency and impact of weather-related natural hazards, and will begin to have a wider effect on New Zealand homes and businesses.

IAG already builds this type of risk into its products and services. There are number of tools they can use to reflect risk while still insuring properties that are highly exposed to natural hazards. These tools include:

- applying a special excess for a specific hazard (eg, flood) so that the customer takes responsibility for the first part of any claim
- increasing the premium to reflect the known risk and to offset the costs associated with more complex and more frequent claims
- applying restrictions to the amount they will pay or what costs they will pay for when a claim arises, whether caused by the hazard or not
- excluding the hazard (eg, flood) but still providing cover for other types of loss such as fire
- downgrading cover by only insuring a house for its market value rather than replacement on a like-for-like basis.

IAG's preferred approach is to use these tools progressively and in combination so they can continue to provide cover. It is still extremely rare that they decline cover outright and they do not expect to see that change anytime soon. If, when and how firmly these tools are used will vary across the country, reflecting the uncertain impact on natural hazards and uncertain pace and scale at which they are changing.

Some examples of specific high-risk areas within New Zealand where IAG already applies special terms to its insurance contracts are:

- Haumoana (Hawke's Bay) – this area has a high risk to erosion and coastal inundation. In response, insurance is considered on a case-by-case basis with many risks in the most extreme locations being declined where the council is unlikely to issue consent for future building/repairs to be undertaken
- Matata (east coast of the North Island) – this area has high risk of heavy rainfall causing landslides and debris flow. In response, a combination of underwriting tools on a case-by-case basis ranging from increased excesses where the council has measures in place to remediate the risk of future events to declining cover where no remediation has been undertaken
- Ohope (eastern Bay of Plenty) – high risk of inundation and coastal erosion. In response, a combination of underwriting tools on a case-by-case basis
- Port Hills (Canterbury) – high risk of land instability and rock fall. In response, IAG decline new insurance in mass movement areas although there are currently no restrictions on insurance for existing customers.

In addition to signalling risks in the pricing of insurance, IAG has also previously worked in partnership with Thames Coromandel District Council and Environment Waikato to proactively reduce both current and future flood risks on the Thames Coast.

## 5.5 Health providers

### Key findings:

- The health sector is becoming increasingly aware of the risks of climate change on public health in New Zealand, but more work on what this means for the sector is needed.
- The sector is not organised for adapting to climate change with no clear goals, unclear understanding of what is expected of them and no plan for how to go about adaptation.
- Some District Health Boards (DHBs) are addressing the impacts of climate change on public health in their planning and decision-making. This has mainly been through their emergency response and infrastructure planning.

### 5.5.1 Role in climate change adaptation

The key responsibilities of the health sector in terms of adaptation are:

- providing primary care and community services to support wellness (including physical, mental and social well-being) and prevent illness, services to help manage long-term conditions, or urgent help to deal with accidents or acute illness<sup>72</sup>
- understanding climate change risks on public health and critical health assets, and factoring this into planning and decision-making
- sharing knowledge on public health and equity consequences of climate change.

### 5.5.2 Engagement undertaken

To inform this section, we engaged with the Ministry of Health and OraTaiao<sup>73</sup> (the New Zealand Climate and Health Council). We also sent surveys to DHBs and received two responses.

### 5.5.3 Work towards effective adaptation

#### Informed

**The health sector understand the climate-related changes New Zealand can expect in the medium and long term**

**MORE WORK REQUIRED**

There is a varied level of understanding and awareness of the impacts of climate change across the health sector.

<sup>72</sup> New Zealand Health Strategy 2016.

<sup>73</sup> OraTaiao: The New Zealand Climate and Health Council comprises of health professionals in Aotearoa.

**The health sector understand the impacts of the climate-related changes and what this means for them**

**MORE WORK REQUIRED**

There is varied understanding of the implications of climate change on the health sector. DHBs generally appear to know very little about the implications of climate change, however some have appointed sustainability officers with part of their work focused on climate change. On the other hand, public health units which are part of DHBs, tend to hold greater institutional knowledge about climate change and health.

We are seeing some positive steps towards improving the health sector's understanding of climate change impacts on public health, with a growing body of research on this issue and the establishment of OraTaiao which runs awareness days at hospitals around the country on climate change impacts and health. However, more work and resourcing are needed to improve this understanding.

There are a number of information gaps within the sector, including:

- the impacts of climate change on existing health inequities, by ethnicity and socioeconomic status
- the extent of psychosocial impacts caused by climate change in New Zealand
- the impacts of climate change on Hauora Māori.

## Organised

**The health sector know what is expected of them**

**SIGNIFICANT WORK REQUIRED**

There is limited understanding on what is expected of the sector in terms of adaptation. While we can find many examples of health organisations working towards reducing greenhouse gas emissions and waste, there is less acknowledgment for the need to implement strategies for adaptation.

**The health sector has common goals**

**NOT PRESENT**

There are no common goals for climate change adaptation and plans for how to go about it within the sector. While New Zealand's Health Strategy (2016) acknowledges that climate change has health and social consequences, it provides no other further information on this.

**The health sector has a planned approach**

**SIGNIFICANT WORK REQUIRED**

There is no requirement or direction for hospitals to be planning for the health effects of climate change. We are seeing some DHBs start to incorporate climate change into their plans, most notably Waitemata and MidCentral. However, many are yet to do so. For those that have, the key focus areas include sustainability, emergency response, food and water safety, and security.

<b>The health sector has the tools they need</b>	<b>NOT PRESENT</b>
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A recent UNFCCC report on Human Health and Adaptation found there are a number of challenges in advancing climate change action to address health risks in countries. These include the availability of and access to funding for health and adaptation. This finding is consistent with messages we received from stakeholders within the sector who highlighted that resourcing and capacity are significant barriers to adaptation.

**Dynamic action**

<b>The health sector is taking anticipatory action</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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There are only a few actions being taken on adaptation in the health sector including:

- introduction of exotic mosquitos is considered by some as a priority risk in the health sector and it is acknowledged that with a changing climate this risk is elevated. DHBs including Canterbury, Nelson Marlborough, Tairāwhiti and Whanganui have mosquito monitoring in place within their region
- Waikato DHB has invested in ‘virtual health’ which uses a number of different media to enable access to health care. This is expected to reduce the need for travel in the delivery of health care, and shows adaptability to innovations that could assist climate change adaptation.
- The West Coast DHB has been mindful of climate change effects in the design of their new Grey Base Hospital. The ground floor of the building has been constructed to be sensitive to sea-level rise and increased rainfall depth.

<b>The health sector is being flexible</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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<b>The health sector is reducing risks by adapting</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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While we are seeing a few positive examples of steps taken to proactively address adaptation within the sector, these are limited in their response to the scope and main threats to health from climate change.

## Overview

The sector's progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
INFORMED	Understand what's happening	More work required
	Understand what it means for them	More work required
ORGANISED	Know what is expected of them	Significant work required
	Has common goals	Not present
	Has a planned approach	Significant work required
	Has the tools they need	Not present
DYNAMIC ACTION	Is taking action	Significant work required
	Is being flexible	Significant work required
	Is adapting	Significant work required

## 5.6 Primary sector

### Key findings:

- There is a lot of information available on the impacts and implications of climate change for the primary sector. This has helped facilitate a reasonable understanding of climate change for the sector. However, there are gaps in research on some of the implications, for example, economic, social, pests and diseases.
- The sector has a long history of adapting to seasonal and annual variability in climate-related conditions, including coping with extreme events. The challenge the sector will face as a result of climate change is increased range in that variability, changes to baseline rainfall and temperatures, and an increase in the frequency of extreme events.
- Where measures that increase resilience have been incorporated into practice, climate change is often not a key driver.

### 5.6.1 Role in climate change adaptation

An important component in considering and planning the sustainability of the farm business is understanding the risks posed by climate change on the business and farming family. It is in the interests of farmers to take responsibility for planning to protect the longer term interests of their family and business from those risks. Reducing exposure to risk also has wider societal benefits by reducing the call on government assistance for recovery from extreme events.

Industry bodies have a role (alongside government) in supporting research to facilitate climate change adaptation in their sector, and communicating the risks of climate change to their members.

A range of central government recovery assistance measures (including mentoring/advice and financial assistance) are available to farmers following localised, medium-scale and large-scale adverse events (including extreme weather events and biosecurity incursions).

## 5.6.2 Engagement undertaken

To understand what the primary sector is currently doing on climate change adaptation, a survey was sent to 14 primary industry bodies, businesses and representatives. We received 7 responses (see [Appendix 3](#)). Literature that considered primary industries response to climate change was also reviewed to inform this section.

## 5.6.3 Work towards effective adaptation

### Informed

<b>The primary sector understand the climate-related changes New Zealand can expect in the medium and long term</b>	<b>MAINTAIN</b>
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The primary sector as a whole has a reasonable understanding of expected climate-related changes.

Research on ocean-related climate change, ocean acidification and seafood sector adaptation is under current investigation by the industry.<sup>74</sup> The aquaculture industry is collaborating with MPI, Regional Councils and the National Institute of Water and Atmospheric Research (NIWA) to improve monitoring of seawater on a national scale.

<b>The primary sector understand the impacts of the climate-related changes and what this means for them</b>	<b>MORE WORK REQUIRED</b>
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A wide range of central government funded research on the implications of climate change for the primary sector and options for how to adapt has been undertaken. Most of this information has been collated into one website for ease of accessibility (climate cloud).<sup>75</sup> There are gaps in that research. For example the economic and social implications of climate change on the primary sector and implications regarding pests and diseases are still poorly understood.

<sup>74</sup> <http://www.mpi.govt.nz/news-and-resources/science-and-research/fisheries-research/>

<sup>75</sup> <http://climatecloud.co.nz/Pages/default.aspx>

A review of existing research on the impacts and implications of climate change on the primary sector is currently underway to identify key messages, areas of focus, outcomes achieved to date and gaps in knowledge. This review will be completed in June 2018.<sup>76</sup>

**Organised**

<b>The primary sector knows what is expected of them</b>	<b>MORE WORK REQUIRED</b>
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The role of farmers and growers in protecting their family and business from the risks of climate change is articulated in a number of government and industry body documents.

As described below there is evidence of some farmers and growers proactively adapting to climate change.<sup>77</sup> This suggests some are aware of this expectation, while others are not aware, or if aware, not yet prepared to take steps to adapt.

<b>The primary sector has common goals</b>	<b>SIGNIFICANT WORK REQUIRED</b>
<b>Individuals, industry bodies and businesses in the primary sector have a planned approach</b>	<b>SIGNIFICANT WORK REQUIRED</b>

At the individual, industry body and business levels within the primary sector there appears to be an ad hoc, rather than planned approach, to adaptation. A number of primary industry bodies and businesses have noted that adaptation to climate change is not always considered a priority for their sectors compared to issues around financial viability, biosecurity and more immediate environmental issues (such as water quality and availability).

<b>The primary sector has the tools they need</b>	<b>MORE WORK REQUIRED</b>
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There are some enabling tools being provided. Examples include:

- **Beef and Lamb NZ’s Land Environment Plans** – which encourage farmers to consider the impact of extreme weather events on whole farms systems
- **the kiwifruit industry** – developed a tool to support growers when making decisions around irrigation that incorporates forecast meteorological data.

In 2010 a five step Adaptation Toolbox was developed by government to help individuals identify and manage risks from a changing climate. This tool box has not been updated and is currently not operational.

<sup>76</sup> *Mind the Gaps: Synthesis and Systematic Review of Climate Change Adaptation in New Zealand’s Primary Industries* study lead by Landcare Research with other collaborators assessing SLMACC adaptation research projects from 2008 to current projects, to be completed by June 2018.

<sup>77</sup> SLMACC, 2012, Impacts of climate change on land-based sectors and adaptation options – stakeholder report.



## Dynamic action

<b>The primary sector is taking anticipatory action</b>	<b>MORE WORK REQUIRED</b>
<b>The primary sector is being flexible</b>	<b>MORE WORK REQUIRED</b>

Action undertaken by the primary sector in response to climate change varies considerably across sectors and individual farmers. Adaptation to climate change is not the only driver for any action but one of a suite of drivers.

Farmers and growers continually adapt their practices to accommodate changes in the environmental conditions they experience. There is evidence of some farmers taking a longer term view to this approach. Others have suggested that they take a wait and see approach, in light of uncertainty around projections and impacts as well as the costs of adaptation measures.<sup>78</sup> A 2009 survey of farmers' attitudes and behaviours found 39 per cent of farmers were working to become more resilient to severe weather patterns.<sup>79</sup> There is no more recent survey data available.

There is investment occurring across the sector into the development of breeds and species that are more resilient to the impacts and implications of climate change (eg, increased drought tolerance, and to increased threats from pests). Some representatives of the forestry industry have noted that restrictions on genetic modification are hindering progress on some potential adaptation responses.

<b>The primary sector is reducing risks by adapting</b>	<b>MORE WORK REQUIRED</b>
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Examples of farmers reducing current climate risk include irrigation developments and afforestation on erosion prone country, changes to livestock mix and use of improved genetics both in livestock and feed. We do not have the data/evidence to determine the extent to which this or other de-risking is occurring or has long-term efficacy under a changing climate.

Under the Primary Sector Recovery Policy, the New Zealand Government currently helps rural communities and individuals recover from adverse events, including severe weather and biosecurity incursions. This policy is currently being reviewed to ensure it is fit for purpose and is due to be completed mid-2018. This review could provide insights on the extent to which proactive adaptation responses by the primary sector reduce the need for government support.

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<sup>78</sup> CCII RA4 Synthesis Report (<http://ccii.org.nz/wp-content/uploads/2017/01/RA4-Synthesis-report.pdf>)

<sup>79</sup> Reference: Neilson, 2009 Sustainable Land Management and Climate Change Technology Transfer: Setting Benchmark Measures.

## Overview

The sector's progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
INFORMED	Understand what's happening	Maintain
	Understand what it means for them	More work required
ORGANISED	Know what is expected of them	More work required
	Has common goals	Significant work required
	Has a planned approach	Significant work required
	Has the tools they need	More work required
DYNAMIC ACTION	Is taking action	More work required
	Is being flexible	More work required
	Is adapting	More work required

## 5.7 Other business

### Key findings:

- The majority of businesses surveyed understand the future trends in climate that New Zealand can expect to experience.
- While we are not aware of any overall plans for adaptation in this sector, the majority of survey respondents have noted their intent to manage climate change impacts in the future. However, we do not have information on how they intend to do this.
- The private sector is driven by market conditions and as such has the ability to respond much more quickly to change compared with the Government. Increased range in climate variability may however challenge that ability.

### 5.7.1 Role in climate change adaptation

Businesses have a role in understanding climate risks to their assets and activities, and are generally best placed to manage these risks.

### 5.7.2 Engagement undertaken

A survey on adaptation was sent to a number of businesses, primarily through Business New Zealand and the Sustainable Business Council. Seventeen responses were received from a range of business types. Sectors covered included energy, consulting, tourism, technology, manufacturing and consumer goods.

## 5.7.3 Work towards effective adaptation

### Informed

<b>The business sector understand the climate-related changes New Zealand can expect in the medium and long term</b>	<b>MORE WORK REQUIRED</b>
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Of the businesses which responded to this survey, over 85 per cent were concerned about the impacts of climate change in New Zealand. Most of those businesses which expressed concern also noted a general understanding of the future trends in climate that New Zealand can expect to experience.

<b>The business sector understand the impacts of the climate-related changes and what this means for them</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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In the majority of cases, businesses have not yet fully considered the implications of climate change.<sup>80</sup> This is confirmed through surveys undertaken in the Climate Change Impacts and Implications Project (2016) which concluded ‘serious questions regarding the capacity of private interests to manage changing risk profiles over time remain largely unanswered, since they are yet to consider them’.

The lack of nationally consistent climate hazard data was noted as a gap in information for business.

Responses received from the surveys however did illustrate some understanding of the impacts of future expected changes in climate.

### Organised

<b>The business sector know what is expected of them</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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We have seen little evidence of businesses factoring climate change impacts in their planning and decision-making. This may be because it is unclear that this is expected of them.

<b>The business sector has common goals</b>	<b>NOT PRESENT</b>
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There are no common goals on adaptation for this sector.

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<sup>80</sup> In the majority of cases, the businesses that responded were more focused on climate change mitigation (including ways to reduce their emissions or how a transition to a low carbon economy may impact on their operations).

<b>The business sector has a planned approach</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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We are not aware of any overall plans for adaptation in this sector. However, 86 per cent of respondents to our survey noted they have plans to manage climate change impacts in the future. We do not have information on how they intend to do this.

<b>The business sector has the tools they need</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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Some businesses have thought about the tools they need to adapt however they have also identified barriers to acting on climate change adaptation, including:

- the perception that acting on it will cost more (rather than save money in the long run)
- resourcing insufficiencies, including time and lack of qualified support and data
- some customers do not believe that climate change will affect them
- “there is not yet a complete picture of adaptation required”.

## Dynamic action

<b>The business sector is taking anticipatory action</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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We have only seen some examples of businesses actively thinking about how they could adapt to the impacts of climate change. This includes:

- educating the public on biodiversity loss and actions that can be taken to address this (Wellington Zoo)
- planning to help improve the resilience of their freight transport
- encouraging clients to factor the impacts of climate change into their planning
- advocacy, including developing education and training materials
- looking at what other business areas/opportunities they might participate in, and planning for change overtime.

While these are positive examples of early steps being taken, many of these examples are of the business helping others to adapt, for example through the work of the Sustainable Business Council. We are confident to conclude that the majority of businesses are not currently factoring climate change impacts in their decisions.

<b>The business sector is being flexible</b>	<b>NOT PRESENT</b>
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Businesses are generally much quicker to respond to market conditions and changes compared to the public sector.

The business sector is reducing risks by adapting	NOT PRESENT
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Examples of businesses adapting to climate change are generally limited to those outlined above.

## Overview

The sector’s progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
INFORMED	Understand what’s happening	More work required
	Understand what it means for them	Significant work required
ORGANISED	Know what is expected of them	Significant work required
	Has common goals	Not present
	Has a planned approach	Significant work required
	Has the tools they need	Significant work required
DYNAMIC ACTION	Is taking action	Significant work required
	Is being flexible	Not present
	Is adapting	Not present

## 5.8 Iwi/Māori

### Key findings:

- Climate change is a significant issue for iwi/hapū, with many recognising that if this generation does not take action then a higher burden will fall on future generations.
- Considerable work has been undertaken by Māori authorities and governance structures in generating iwi and hapū plans that identify climate change issues and implications.
- Supporting vulnerable whānau and Māori land owners and business to adapt to climate change is a key area of focus for iwi.

### 5.8.1 Role in climate change adaptation

In terms of responsibilities, there are a number of roles iwi could take on adaptation, including:

- considering climate change adaptation in their role as kaitiaki and business leaders to ensure a sustainable future
- sharing knowledge, including Māori environmental knowledge, to complement the management of climate change impacts
- understanding and managing climate change risks in marae, homes and communities, as well as considering it in business and investment decisions.

## 5.8.2 Engagement undertaken

To inform this section we reviewed relevant literature and engaged with the Climate Change Iwi Leaders Group and Ngāi Tahu. This does not represent all iwi.

## 5.8.3 Work towards effective adaptation

### Informed

Iwi/Māori understand the climate-related changes New Zealand can expect in the medium and long term	MORE WORK REQUIRED
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Although there is some isolated understanding (for example, as outlined in the case study 6 on Ngāi Tahu), overall Iwi/Māori do not appear to have a good understanding of potential climate-related changes.

Iwi/Māori understand the impacts of the climate-related changes and what this means for them	MORE WORK REQUIRED
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Māori have a strong understanding of the intergenerational equity issues caused by climate change and the need for long-term solutions, however more work is required for Māori to understand how changes will impact them.

A number of studies have been undertaken to better understand the impacts on iwi, including:

- **NIWA** – carried out a number of studies on how they expect Māori society to be affected by climate change, including a series of place-based studies examining coastal Māori community adaptation and vulnerability
- **Ngāti Kahungunu** – working in partnership with GNS Science to explore the connections between science and mātauranga-a-iwi. The group are focusing on issues important to the Hawke’s Bay and Wairarapa iwi including the effects of climate change. Through interactive marae-based learning, participants are developing their understanding on issues critically important to iwi development, resilience, and environmental sustainability
- **the Deep South Science Challenge** – currently underway has a particular focus on Māori and adaptation. The Mātauranga science projects are built around four research themes: understanding climate change – linkages, pressure points and potential responses; exploring adaptation options for Māori communities; assistance to Māori business to aid decision-making and long-term sustainability; and products, services and systems derived from mātauranga Māori.

These studies indicate a need for further investment in science and research on the impacts on Māori and on how to enable adaptation for communities.

## Organisation

**Iwi/Māori know what is expected of them**

**SIGNIFICANT WORK REQUIRED**

While we have seen many examples of a role being taken on adaptation, a consistent message we have heard is that there are mixed messages from government on the importance of acting on climate change adaptation which creates confusion on what is expected of them.

**Iwi/Māori have common goals**

**NOT PRESENT**

There is no common set of outcomes and goals for climate change adaptation across Māori.

**Iwi/Māori have a planned approach**

**NOT PRESENT**

Considerable work has been done by Māori authorities and governance structures in generating iwi and hapū plans that identify climate change issues and implications. These documents provide important mechanisms for communicating Māori approved positions, interests and visions about climate change adaptation and the wider management and protection of natural and physical resources.<sup>81</sup> Key themes in many of these documents are education, planning and monitoring, environmental degradation, tribal self-determination, cooperation and collaboration. However, we are not aware of an overarching plan for adaptation.

**Iwi/Māori have the tools they need**

**SIGNIFICANT WORK REQUIRED**

Māori have identified a number of gaps in the development or application of tools they need to adapt. These include:

- understanding of the impacts of climate change and how to enable adaptation in Māori communities
- the need for a longer term view in government policies on climate change
- consistent messages from across government on climate change adaptation
- resourcing and capacity to consider and take action on climate change adaptation.

## Dynamic action

**Iwi/Māori are taking anticipatory action**

**SIGNIFICANT WORK REQUIRED**

Iwi appear to be in the early stages of acting on adaptation, including collecting information on the potential impacts on them and thinking about options for how they can respond. We have not undertaken an extensive assessment of work programmes underway by iwi. However, we are aware of a few.

<sup>81</sup> Rouse, HL, Bell RG, Lundquist CJ, Blackett PE, Hicks BM & King DN, 2016, *Coastal adaptation to climate change in Aotearoa-New Zealand*.

The Climate Change Iwi Leaders Group (CCILG)<sup>82</sup> has initiated a five year work programme aimed at ‘preparing our people to meet the challenges and the opportunities of climate change head on’. The project is broader than adaptation and also considers mitigation. The project is at an early stage but will include an element of education and learning programmes, research into the expected impacts at the local scale and identifying specific tools to enable resilience. Ngāi Tahu is currently developing a climate change strategy as set out in the [Case Study 6: Ngāi Tahu](#).

<b>Iwi/Māori are being flexible</b>	<b>SIGNIFICANT WORK REQUIRED</b>
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More work is required to understand what is needed for managing the cultural and economic impact of the risks and opportunities of climate change.

<b>Iwi/Māori are reducing risks by adapting</b>	<b>NOT PRESENT</b>
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Although we can see there is a focus on thinking about adaptation and how to go about it, we have seen few examples of actions currently being taken to reduce the risks.

### Overview

The sector’s progress towards an effective adaptation system is considered as:

Characteristic	Attribute	Rating
<b>INFORMED</b>	Understand what’s happening	<b>More work required</b>
	Understand what it means for them	<b>More work required</b>
<b>ORGANISED</b>	Know what is expected of them	<b>Significant work required</b>
	Has common goals	<b>Not present</b>
	Has a planned approach	<b>Not present</b>
	Has the tools they need	<b>Significant work required</b>
<b>DYNAMIC ACTION</b>	Is taking action	<b>Significant work required</b>
	Is being flexible	<b>Significant work required</b>
	Is adapting	<b>Not present</b>

<sup>82</sup> CCILG is a national grouping with its membership identified by the Iwi Chairs Forum which is made up of the Chairs of Tribal Iwi Authorities drawn from Iwi throughout New Zealand and bisecting the country’s geographical characteristics.



## CASE STUDY 6: NGĀI TAHU

In 2016 Ngāi Tahu tribal governance identified the need to develop a strategy to give Ngāi Tahu direction in ensuring resilience in the face of the impacts of climate change.

Ngāi Tahu currently has around 55,000 registered whānau members from many walks of life, and a broad range of tribal business interests. The iwi is kaitiaki of a takiwā that showcase a broad, diverse range of landscapes, freshwater and marine environments, and the species that inhabit them. This diverse set of circumstances means developing a strategy that captures all the aspects necessary to combat and adapt to climate change is no small feat. However, it is because of that diversity and the risks and opportunities posed, that makes this a high priority kaupapa for Ngāi Tahu.

Te Rūnanga o Ngāi Tahu staff began engaging with whānau to get a grasp of what particular aspects of climate change were having the greatest impact, and what pressures or opportunities were being seen across the takiwā. Parallel to this process a report by NIWA was commissioned. The report contained no unique scientific data, but applied existing knowledge to help Ngāi Tahu understand how their tūrangawaewae and the resources they rely on to sustain themselves physically, economically, and culturally are expected to be affected as the climate changes. These processes provided some indications of the current situation, some pathways forward, and direction as to the values and aspirations Ngāi Tahu whānau want to see supported.

Te Rūnanga o Ngāi Tahu are guided by the whakatauki 'Mō tātou, ā, mō kā uri, ā muri ake nei' – For us, and our children after us. This strategy will be an important step to ensuring that iwi will continue to thrive by making decisions that will sustain the growing tribal membership for generations to come.

## 5.9 Civil society

### Key findings:

- Academics and the research community supply information to all sectors of society to help enable proactive and purposeful adaptation. Current research includes refinement of the range of expected impacts and how to implement appropriate responses.
- We do not currently have the information to determine whether community groups, Non-Government Organisations and/or the public understand the climate-related changes New Zealand can expect or the possible implications it has for them.
- Engagement with civil society is required to understand how civil society is organised to act and are acting to adapt to climate change.

## 5.9.1 Role in climate change adaptation

Civil society and their role in climate change adaptation include:

- **academics and the research community** – provide information through commentaries and dialogue with all sectors of society to help enable proactive and purposeful adaptation
- **community organisations and Non-Governmental Organisations (NGOs)** – have a critical place in encouraging change by raising awareness (CCII R4), as well as respond to the impacts. They are usually formed by groups of individuals that aim to promote or express a common purpose through ideas and actions from local through to international levels
- **the public** – has a key role in being informed about climate change impacts when making property purchase decisions (for example, decisions about where they live and invest). Public agencies are mandated to provide risk reduction information that inform those decisions.

## 5.9.2 Work towards effective adaptation

### Informed

Extensive research has been undertaken on climate change adaptation, with key focus areas being on primary industries; biodiversity, biosecurity and conservation; governance and institutions that influence adaptation decision-making; and barriers and enablers to adaptation decision-making and coastal issues.

Early research on adaptation focused on establishing the expected climate-related changes (under a range of plausible scenarios of future climate) and the impacts this would have at more detailed regional scale. This basic information and its ongoing updating is a necessary foundation for action.

Research is now focused on identifying and assessing potential solutions; the decision-making processes required to implement them; and the barriers to this occurring. The current state of adaptation research includes continued refinement of the range of changes expected, together with research on how to implement appropriate responses, and some recent focus on improving understanding of the issues. This shift in research emphasis has begun to be reflected in international advice for policy makers. For example, the Intergovernmental Panel on Climate Change has introduced a larger element of social science research, risk and adaptive management approaches, and the importance of engagement with communities in its programme for the Sixth Assessment cycle (2016–2022).

Community groups, non-governmental organisations and the public have understanding of climate change but what it means for them varies significantly across the country. Recent studies on public perceptions of climate change in New Zealand show that while New Zealanders are concerned about climate change, this concern ranks lower for climate change than for other more personally or locally relevant concerns including healthcare, cost of living and education. This may be because New Zealanders consider climate change a future risk rather than something that concerns them today. Understanding what drives these priorities will be important.

Additionally, we see that that they are much more focused on climate change mitigation (and have an understanding of steps they can individually take to reduce emissions) and there is less of an understanding on adaptation (and the options available to adapt), in part because it is public authorities with their communities that will be initiating adaptation action.

## Organised

The research community fulfils a role in society of independent scholarship and public commentary on societal issues and has an ongoing role with respect to climate change adaptation. Academia through its teaching programmes also builds the skills and knowledge in the next generation of researchers and practitioners. With respect to research, universities compete for programme funding just like consultants and crown research institutes do. Increasingly though they are part of teams or lead research across these research providers. They also act as independent facilitators and knowledge brokers working with practitioners to develop policy and practice solutions, able to introduce new processes and tools through access to international networks of problem solvers and scholarship. Multi-disciplinary projects will enable such new information and networks to leverage adaptation action.

The IPCC serves as a weak coordination mechanism that synthesises the peer reviewed knowledge globally on about a 7 year cycle. There is however a general lack of coordination that results from there being no national adaptation strategy to guide the research undertaken in New Zealand. While the National Science Challenges have given attention to some aspects of climate change, there is no cross-challenge climate change theme that can integrate the key Science Challenges. This would help to focus attention on the gaps in adaptation research.

## Dynamic action

The greater focus from researchers on the ‘how’ has resulted in a number of tools being developed that enable uncertainty and changing risk profiles to be addressed. These include:

- **Urban Impacts Toolbox** – a resource to help planners, engineers, asset managers, and hazard analysts in New Zealand urban councils understand and evaluate the potential impacts of climate change in their city
- **Dynamic Adaptive Pathways Planning** – an exploratory model-based planning tool that helps design adaptive and robust strategies using different future scenarios to stress test adaptation options
- **simulation games** – to help experience decision-making under uncertainty over the long term. The Sustainable Delta Game adapted for New Zealand conditions, simulates decision-making in a river catchment or coastal setting and helps participants to learn about preparing an adaptive plan.

## CASE STUDY 7: A CONVERSATION WITH YOUTH REPRESENTATIVES ABOUT CLIMATE CHANGE ADAPTATION

The Ministry for the Environment convened a meeting with youth representatives from social NGOs in Wellington to discuss their views on climate change adaptation.

A number of issues were discussed ranging from legacy issues to opportunities and enablers they see for climate change adaptation. Some of their key concerns for New Zealand's future include:

- the legacy issues they will inherit when they are decision-makers
- understanding the risks and vulnerabilities for communities (ensuring adequate future proofing for flooding, erosion, impacts on freshwater)
- future food security – increased agricultural pressures within already stressed environmental limits
- loss of biodiversity and conservation values (ability to access and enjoy the wilderness)
- the need to tell an empowering narrative for climate change – the need for the framing of climate change to be accompanied with what action can be taken and what achievable goals look like (eg, concern over youth suffering pre-traumatic stress as a result of fear for the future state)
- increased public health problems (eg, asthma, *E. coli* in water and food sources).

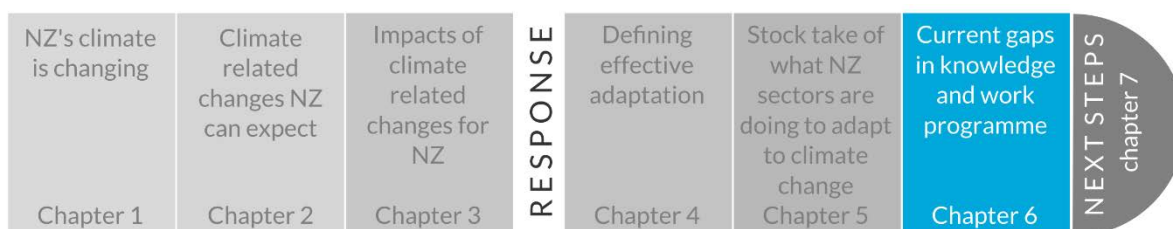
The youth representatives expressed their concerns over the action and inaction consecutive governments have taken/not taken with regard to climate change. They recognise the Paris Agreement as an achievement, but question how effective we will be at implementing it and preventing further greenhouse gas emissions. They recognise that short-term decision-making will negatively affect them and future generations, but are concerned they do not have the influence needed to advocate for government to ensure policies and action are adequate and take a long-term vision.

Compounding the issue surrounding youth and their perception of climate change adaptation, Māori youth feel like they are in an especially vulnerable position. Having already experienced land and resource losses, they believe that climate change will increase their vulnerability. Land that is returned in settlements may be unproductive in the future and there is uncertainty around how their rural communities will adapt to these changes.

Youth are taking their own action, organising themselves around issues and lobbying for the change their generation see as necessary.

They want a voice at the table on policy decisions, to be included in co-design solutions and want easier access to research and information. Above all, they want to know what they can do and task us with ensuring the narrative around climate change adaptation is empowering and inspires future generations with hope.

# 6 Current gaps in knowledge and work programmes and overall summary of the New Zealand stocktake



This section summarises key findings from the stocktake and identifies gaps in New Zealand’s current approach to climate change adaptation.

Overall we found that New Zealand is in the early stages of planning for climate change and that many positive initial steps have been taken in some areas and sectors – it is in the informed phase, with some areas having advanced to the organised phase. However, there are considerable gaps in our current approach that act as a barrier to adaptation. New Zealand’s current approach to adaptation is described in the following sections, grouped according to each of the three characteristics of effective adaptation.

## 6.1 Informed phase

New Zealand has developed a significant amount of information about what is happening to our climate and the impacts of a changing climate. However, this is not currently all in forms that can support adaptive decision-making. This means information is either not accessible to decision-makers, decision-makers do not have the capacity or capability to make decisions, or they are not able to prioritise adaptation action based on current information.

There are some information gaps which could hamper adaptation action, including:

- an understanding of social vulnerability and how to assess it
- the potential costs to the economy, as well as social costs, over the medium and long term if no action is taken to adapt now
- the potential biosecurity threats to the various sectors of our economy
- how pluvial flooding responds to changes in climate
- how our natural systems may respond to greater climate variability and increased intensity in climate events
- nationally-consistent standards for assessing local climate change risks and opportunities

- making existing information readily available to sectors in forms that are relevant to their decision-making.

The lack of a nationwide assessment of climate risks means that it is difficult for New Zealand to develop a planned approach for climate change adaptation because priorities for action cannot yet be articulated. This would be the first step towards an aligned approach across all sectors to help stimulate action in a systematic way.

## 6.2 Organised phase

New Zealand's focus on adaptation to date has mainly been on improving its information base about climate risks and opportunities. There has been less of a focus on organising ourselves, in a coordinated manner, to translate this information for decision making on adaptation. At this stage New Zealand does not have a coordinated plan for how to adapt to climate change.

A key barrier is that climate change adaptation is not currently integrated into many central government agency objectives. In the absence of coordinated leadership on climate change adaptation, other sectors operate within regulatory frameworks and policies which are not well aligned or fit for purpose for adaptation. This makes it difficult for government and sectors to proactively organise themselves and take action.

Other organisational gaps include:

- no strategy, plan or common goal for how New Zealand can adapt to climate change
- unclear roles, responsibilities and liabilities (which makes investment in resources to deliver adaptation action challenging)
- inconsistencies in timeframes and in some instances competing objectives across legislation and policies related to climate change adaptation, resilience and disaster risk reduction
- limited enabling tools to help facilitate adaptation, including the use of national direction tools
- lack of alignment in how climate change adaptation and resilience objectives are incorporated into legislation and policy.

## 6.3 Dynamic action phase

We have seen a few examples of proactive adaptation action where there is high exposure and potentially large costs involved (eg, investment in flood risk and coastal hazard management and some transport projects). However, overall there is limited evidence of proactive action that reduces medium- and long-term changing and increasing risk profiles. In most cases, actions have been reactive and part of a sector's natural hazard management response after extreme events occur, rather than being proactive and undertaking preventative measures which take a long-term view and consider the wider impacts.

Key gaps include:

- resource scarcity, including insufficient expertise and funding, was identified as a barrier to action by all sectors
- limited monitoring and evaluation of existing climate change adaptation measures hampering our ability to adjust our approach in response to changing risks, issues, opportunities and circumstances that emerge.

## 6.4 Overall summary

Table 6.1 provides a summary of each sector's current approach to climate change adaptation associated with the characteristics for effective adaptation.

Based on these findings, we can conclude that while some specific actions are being taken to adapt to climate change, the current decision-making framework does not support or incentivise effective adaptation at the scale we consider necessary for maintaining and/or improving the well-being of New Zealand's current and future communities in the face of a changing climate.

It is important that action that is being taken now is maintained and built upon. This includes work in the informed phase and specifically investment in research, for example through the Deep South and Resilience Science Challenges and other climate change-relevant programmes to understand the ongoing changes in climate that New Zealand can expect, the implications of these for our main hazards and social, economic and natural systems, tools to assess climate and social vulnerability and analytical tools to support decision-making processes. Some New Zealand communities facing significant current and ongoing impacts are more informed than others about the further changes they can expect.

**Table 6.1: Overview of what New Zealand is currently doing to adapt to climate change assessed against the characteristics and attributes of effective adaptation system identified in Chapter 4**

	ATTRIBUTES	PUBLIC SECTOR		PUBLIC AND PRIVATE SECTOR			PRIVATE SECTOR		CIVIL SOCIETY
		Central Government	Local Government (excluding infrastructure)	Infrastructure providers	Finance and insurance	Health providers	Primary sector	Other business	
INFORMED	They understand what's happening								
	They understand the implications of the climate-related changes and what this means for them								
ORGANISED	They know what's expected of them								
	They have common goals								
	They have a planned approach								
	They have the tools they need								
DYNAMIC ACTION	They are taking anticipatory action								
	They are being flexible								
	They are reducing risks by adapting								
ASSESSMENT:	Maintain There is evidence that all descriptors of the attribute are in place	More Work Required There is evidence that most descriptors of the attribute are in place	Significant work required There is evidence that some descriptors of the attribute are in place	Not present There is no evidence that any descriptor of the attribute is in place					



## 7 Next steps

NZ's climate is changing	Climate related changes NZ can expect	Impacts of climate related changes for NZ	RESPONSE	Defining effective adaptation	Stock take of what NZ sectors are doing to adapt to climate change	Current gaps in knowledge and work programme	NEXT STEPS chapter 7
Chapter 1	Chapter 2	Chapter 3		Chapter 4	Chapter 5	Chapter 6	

This stocktake report provides an overview of New Zealand's current progress towards developing an effective approach to adaptation.

The Group acknowledge that it has been challenging to summarise and reflect the broad range of perspectives, actions and initiatives currently being undertaken across New Zealand to adapt to climate change.

The information provided in this report represents the best information available to the Group and our expert judgement. The gaps in knowledge and work programmes signify those present as of 31 May 2017.

The next step is to use this stocktake report as a basis for our second report on options for how New Zealand can address the challenges identified and build resilience to the effects of climate change while growing our economy sustainably.

Our final report will be submitted to the Minister for Climate Change by March 2018.

# Glossary

<b>Adaptation</b>	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2014c, annex II).
<b>Adaptive capacity</b>	The resources available for adaptation to climate change and variability or other related stresses, as well as the ability of a system to use these resources effectively in pursuit of adaptation (Brooks and Adger, 2004).
<b>Adaptive management</b>	A structured process that addresses a changing state that is dynamic and cannot be predicted over the long term, and where the change is irreversible in human timeframes so there is no reversion to an earlier state. It is flexible decision-making that can be adjusted in the future as conditions change, thus reducing risk by avoiding lock-in of decisions that are costly to change later.
<b>Climate-related changes</b>	Changes to the climate and other environmental variables resulting from increased concentrations of greenhouse gases in the atmosphere. These include changes to climate variables, such as temperature and rainfall, changes to the oceans (warming, acidification and sea-level rise), and associated changes to natural hazards.
<b>Co-benefits</b>	Co-benefits are the added benefits of climate change adaptation, above and beyond the direct benefits of improved resilience to future climate change. For example, coastal and land use planning and flood protection work can reduce present economic losses and social and cultural impacts from floods and coastal erosion; building more resilience to drought into our agricultural and horticultural activities has immediate financial benefits for rural communities and the economy overall; reducing pests and diseases will help our ecosystems now and set them up to better cope with future changes.
<b>Exposure</b>	The presence of people, livelihoods, ecosystems, environmental functions, services and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected by natural hazards and climate change (adapted from IPCC, 2014c, annex II).
<b>Impacts</b>	Effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate change or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system (IPCC, 2014c, annex II).

<b>Mitigation</b>	Human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2014c, annex II) and limit further climate change.
<b>Resilience</b>	There are many definitions of resilience, most of which cover concepts such as the ability of a system to withstand and/or cope with disruption, disturbance or hazardous events. Some also cover the concept of adaptability and flexibility, as well as, early discovery and rapid recovery from failure. Some distinguish between bouncing ‘back’ and bouncing ‘forward’ from an event. The IPCC (2014c annex II) defines resilience as the capacity of social, cultural, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.
<b>Risk</b>	Effect of uncertainty on objectives (AS/NZS ISO 31000:2009, Risk management standard). Risk is often expressed in terms of a combination of consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.
<b>Vulnerability</b>	The predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including: sensitivity or susceptibility to harm or damage, and lack of capacity to cope and adapt (adapted from IPCC, 2014, annex II).

# Appendix 1: Terms of Reference

## Climate Change Adaptation Technical Working Group

In July 2016 Cabinet agreed to the establishment of a Climate Change Adaptation Technical Working Group (the Group) to provide advice to the Government on adapting to the impacts of climate change.

Under the Paris Agreement, New Zealand is required to plan for and take action on adapting to the impacts of climate change.

1. The Group will provide to the Minister for Climate Change Issues:
  - (i) An **interim report by May 2017**. This interim report should include a summary of the expected impacts of climate change on New Zealand over the medium and long term and a stocktake of existing work on adaptation, by both central and local government. The stock take should identify any gaps in knowledge and work programmes.
  - (ii) A **draft final report by November 2017**. The report should identify options for how New Zealand can build resilience to the effects of climate change while growing our economy sustainably. The report should identify the benefits and limitations of New Zealand having an integrated economy-wide approach to adaptation. Any recommendations should not be policy-prescriptive,<sup>83</sup> should build on the findings of the interim report and provide a range of options.
  - (iii) A **final report by March 2018**, with final recommendations. The recommendations are not to be policy-prescriptive and should provide a range of options for consideration.

### *Mode of work*

2. The members of the Group are to also provide advice to technical questions from officials and Ministers throughout the process on an as needed basis.
3. Opportunities will be explored for community interaction to inform the work of the Group where appropriate.
4. The Group will be supported by a small secretariat based at the Ministry for the Environment.
5. The Group will draw upon a range of people from Government agencies and the private sector to inform specific elements of the work being undertaken.
6. The Group will not revisit New Zealand's climate change targets, look at options to mitigate climate change, get involved with international negotiations, investigate options which would replace or discontinue the New Zealand Emissions Trading Scheme, write policy, or develop regulations or legislation.

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<sup>83</sup> The purpose of the Group is not to draft legislative tools, but to provide advice and options for consideration by the Government.

### *Membership of the Climate Change Adaptation Technical Working Group*

7. The members of the Group are appointed for a fixed period (November 2016 to March 2018) and the membership is listed in the Annex. However following the interim report, the membership of the Group could rotate depending on the issues identified.
8. The Group will be co-chaired by Penny Nelson, Deputy Secretary Sector Strategy, Ministry for the Environment and Dr Judy Lawrence, Victoria University Wellington.
9. The members of the Climate Change Adaptation Technical Working Group will be subject to confidentiality arrangements<sup>84</sup>.
10. Members of the Climate Change Adaptation Technical Working Group will receive fees as appropriate and reimbursement for travel.

### *Meetings and reporting*

11. The Climate Change Adaptation Technical Working Group will interact regularly (including meetings and using electronic means), with the frequency of meetings being not more than approximately every six weeks.
12. It is anticipated that the reports will be made publically available.

## **Annex 1: Membership of the Climate Change Adaptation Technical Working Group**

- Dr Judy Lawrence, Senior Research Fellow, Climate Change Research Institute, Victoria University of Wellington (co-chair)
- Penny Nelson, Deputy Secretary Sector Strategy, Ministry for the Environment (co-chair)
- Frances Sullivan, Principal Policy Advisor, Local Government New Zealand
- Kirk Hope, Chief Executive, BusinessNZ
- James Hughes, Associate Director – Climate and Resilience, AECOM\*
- Bryce Davies, Senior Manager Government and Stakeholder Relations, IAG
- Bruce Wills, Horticulture NZ Board, Motu Trustee and previous President of Federated Farmers
- Dr Sam Dean, Chief Scientist for the Climate and Atmosphere Centre, NIWA
- Whaimutu Dewes, Lead Advisor to the Climate Change Iwi Leaders Group
- Dr Gavin Palmer, Director Engineering, Hazards and Science, Otago Regional Council

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<sup>84</sup> These arrangements are not intended to prevent the Group from engaging and consulting with stakeholders.  
\* James Hughes is now the Climate and Resilience Specialist at Tonkin + Taylor.

# Appendix 2: Societal sectors and sub-sectors

		Examples
PUBLIC SECTOR	Central government	Departments and ministries Regulators
	Local government	Regional councils Unitary authorities Local councils
	Infrastructure	Electricity generation and transmission Water, wastewater and stormwater Communications Roads Ports and airports
	Finance	Banking and non-bank deposit takers Life, health and general insurance Investments and funds management
	Health	Hospitals Primary care providers
	Primary	Agriculture Horticulture Forestry Fishing and aquaculture Mining
	Transport (addressed within the Infrastructure section)	Road Rail Shipping Air
	Tourism	Accommodation; food and hospitality; arts and recreation
	Other business	Retail; wholesale trade; manufacturing; construction; education; professional services
	PRIVATE SECTOR	PARTNERS

# Appendix 3: Stakeholders we engaged with

## Central government agencies:

1	Ministry of Health NZ
2	Ministry of Social Development
3	Health Quality & Safety Commission
4	Ministry of Education
5	Ministry of Civil Defence and Emergency Management (DPMC)
6	Department of the Prime Minister and Cabinet
7	Ministry of Business, Innovation and Employment (MBIE)
8	Land Information New Zealand (LINZ)
9	Local Government New Zealand (LGNZ)
10	Ministry of Transport
11	Te Puni Kōkori
12	Ministry for Primary Industries (MPI)
13	Department of Conservation (DOC)
14	Department of Internal Affairs (DIA)
15	New Zealand Treasury
16	Ministry for the Environment (MfE)
17	Commerce Commission
18	Energy Efficiency Conservation Agency (EECA)
19	Environmental Protection Authority (EPA)
20	NZ Defence Force (NZDF)
21	Ministry for Culture and Heritage
22	Maritime NZ
23	Ministry for Pacific Peoples
24	Ministry for Women
25	Reserve Bank of New Zealand
26	Office of the Children's Commissioner
27	Health Research Council of New Zealand
28	Health Promotion Agency (HPA)
29	Social Policy Evaluation and Research Unit (SUPERU)
30	Fire Emergency New Zealand/New Zealand Fire Service
31	Ministry of Defence

32	Productivity Commission of New Zealand
33	New Zealand Tourism Board
34	Statistics New Zealand
35	Heritage New Zealand

*Local government:*

1	Auckland Council
2	Bay of Plenty Regional Council
3	Buller District Council
4	Canterbury Regional Council/Environment Canterbury
5	Dunedin City Council
6	Far North District Council
7	Gisborne District Council
8	Gore District Council
9	Greater Wellington Regional Council
10	Grey District Council
11	Hamilton City Council (not the template, but provided information)
12	Hastings District Council
13	Hauraki District Council
14	Horowhenua District Council
15	Hurunui District Council
16	Hutt City Council
17	Kaipara District Council
18	Manawatu District Council
19	Marlborough District Council
20	Masterton District Council
21	Matamata—Piako District Council
22	Napier City Council
23	Nelson City Council
24	New Plymouth District Council
25	Northland Regional Council
26	Opotiki District Council
27	Otago Regional Council
28	Palmerston North City Council
29	Porirua City Council
30	Rangitikei District Council
31	Ruapehu District Council
32	Selwyn District Council
33	South Taranaki District Council
34	South Waikato District Council



35	South Wairarapa District Council
36	Stratford District Council
37	Taranaki Regional Council
38	Tasman District Council
39	Taupo District Council
40	Thames—Coromandel District Council
41	Waikato District Council
42	Waikato Regional Council
43	Waipa District Council
44	Wairoa District Council
45	West Coast Regional Council
46	Western Bay of Plenty District Council
47	Westland District Council
48	Whanganui District Council

### *Infrastructure and transport:*

In addition to relevant central and local government stakeholders who manage infrastructure, we also engaged with:

1	NZ Transport Agency
2	Kiwirail
3	Trustpower
4	Wellington Water
5	Watercare
6	Meridian Energy

### *Primary industries:*

1	Horticulture NZ
2	Fonterra
3	Fertilizer Association
4	DairyNZ
5	Beef and Lamb NZ
6	Peter Weir (Ernslaw One)
7	Peter Clark (PF Olsen Ltd)

### *District health boards:*

1	Waitemata District Health Board
2	Counties Manukau District Health Board

# Appendix 4: Adaptation research and information

One of the most important roles central government has taken on adaptation has been on funding research and providing information to help build an understanding of the impacts and implications of climate change across New Zealand. This research and information includes:

- **The Deep South Challenge** (2015–2019) – a current four-year programme with a mission ‘to enable New Zealanders to adapt, manage risk and thrive in a changing climate.’ It has three research programmes: Processes and Observations, Earth System Modelling and Prediction, and Impacts and Implications; as well as two cross-cutting programmes: Engagement and Vision Mātauranga. The Impacts and Implications programme is the current provider of most adaptation-relevant research in New Zealand  
<http://www.deepsouthchallenge.co.nz/along-with-the-Resilience-Science-Challenge>  
<https://resiliencechallenge.nz/>
- **National Science Challenges** – a number of current Challenges that are relevant to adaptation including Resilience to Nature’s Challenges (which includes a ‘Living at the Edge’ work programme focused on communities that are highly vulnerable to natural hazards; and a Resilience Governance programme); New Zealand’s Biological Heritage; Our Land and Water; Sustainable Seas; and Building Better Homes, Towns and Cities  
<http://www.mbie.govt.nz/info-services/science-innovation/national-science-challenges>
- **The Sustainable Land Management and Climate Change (SLMACC) programme** – launched in 2007 and ongoing, aims to help the agriculture and forestry sectors address the challenges arising from climate change. Much of the output of the programme has been compiled into a web-based adaptation resource  
<http://www.climatecloud.co.nz>
- **The Coastal Acidification: Rate, Impact and Management Project** (2016–2019) – will provide new knowledge on coastal acidification to enhance the protection and management of coastal ecosystems <https://www.niwa.co.nz/coasts-and-oceans/research-projects/carim-coastal-acidification-rate-impacts-management>
- **The Climate Change Impacts and Implications (CCII) programme** (2012–2016) – focused on the significance of considering climate change impact in decision-making and on enhancing capacity and increasing coordination to support this  
<http://ccii.org.nz/>
- **The Conservation and Environment Science Roadmap** (2017) – identifies the development of adaptation scenarios that test and demonstrate the sensitivity of New Zealand’s environment, economy and society to climate-related impacts as a priority research area within the first five years  
<http://www.mfe.govt.nz/sites/default/files/media/About/cesr-at-a-glance.pdf>

- **Climate Change Projections for New Zealand (2016)** – provides updated projections of atmospheric changes in New Zealand as a result of climate change  
<http://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/nz-climate-change-projections-final.pdf>
- **Environmental Health Indicators on Climate Change (2014)** – monitors New Zealand’s health through a set of environmental health indicators related to climate change  
<http://www.ehinz.ac.nz/indicators/climate-change/>
- **Preparing the Tourism Sector for Climate Change Project (2009–2012)** – provides information on the impacts of climate change on the sector, and identifies adaptation strategies to increase the ability of tourism decision-makers to cope with future changes  
<http://researcharchive.lincoln.ac.nz/handle/10182/4376?show=full>
- **Impacts of Climate Change on Urban Infrastructure and the Built Environment: Toolbox Handbook (2012)** – provides information to help local councils understand and evaluate the potential impacts of climate change in their cities  
[https://www.niwa.co.nz/sites/niwa.co.nz/files/cc\\_and\\_urban\\_impacts\\_toolbox\\_handbook.pdf](https://www.niwa.co.nz/sites/niwa.co.nz/files/cc_and_urban_impacts_toolbox_handbook.pdf)
- **The Coastal Adaptation to Climate Change Research Project (2011)** – includes a national coastal sensitivity profile  
<https://www.niwa.co.nz/climate/research-projects/coastal-adaptation-to-climate-change>
- **Adaptation to climate variability and change (launched in 2009)** – this and the previous NIWA programme aimed to increase New Zealand’s scientific understanding of the climate system, our ability to predict the climate, and decision-making tools to help New Zealand adapt to climate variability and change  
<https://www.niwa.co.nz/climate/research-projects/adaptation-to-climate-variability-and-change>
- **The Community Vulnerability Resilience and Adaptation to Climate Change programme (2008–2011)** – focused on developing a consistent framework for considering potential vulnerability to climate change in New Zealand, and how to build social and structural resilience. It focused on Māori community responses to climate change, local government management of the climate risks and the effects of climate change on human health.  
<http://www.victoria.ac.nz/sgees/research-centres/ccri/research/community-vulnerability,-resilience-and-adaptation-to-climate-change,-2008-2013>

# Appendix 5: Central government frameworks and tools on adaptation

Central government provides some frameworks and tools on adaptation as listed below:

- Climate Change Effects and Impacts Assessment (2008)  
<http://www.mfe.govt.nz/publications/climate-change/climate-change-effects-and-impacts-assessment-guidance-manual-local-6>
- Coastal Hazards and Climate Change Guidance (2017)  
<http://www.mfe.govt.nz/publications/climate-change/coastal-hazards-and-climate-change-guidance-local-government>
- Tools for Estimating the Effects of Climate Change on Flood Flow (2010)  
<http://www.mfe.govt.nz/publications/climate-change/tools-estimating-effects-climate-change-flood-flow-guidance-manual-lo-10>
- New Zealand Coastal Policy Statement Guidance Note (2010) (updated pending publication)  
<http://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>
- New Zealand's Framework for Adapting to Climate Change (2014)  
<http://www.mfe.govt.nz/publications/climate-change/new-zealands-framework-adapting-climate-change>
- Adaptation Framework for the Conservation of Terrestrial Native Biodiversity in New Zealand (2014)  
<http://www.doc.govt.nz/Documents/science-and-technical/sap257.pdf>
- National Civil Defence Emergency Management Plan (2015)  
<http://www.civildefence.govt.nz/cdem-sector/cdem-framework/national-civil-defence-emergency-management-plan/>
- The Thirty Year New Zealand Infrastructure Plan (2015)  
<http://www.infrastructure.govt.nz/plan/2015/nip-aug15.pdf>
- Biosecurity 2025 Direction Statement (2016)  
<https://www.mpi.govt.nz/protection-and-response/biosecurity/biosecurity-2025/>

## Appendix 6: What are other countries doing?

The international policy environment for climate change adaptation includes the assessment reports of the IPCC, guidance and decisions developed and adopted under the UN Framework Convention on Climate Change (UNFCCC) and most recently the Paris Agreement where Parties agreed an adaptation goal of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change.

Each Party to the Paris Agreement is to engage in adaptation planning processes and the implementation of actions. It is against this backdrop that as part of the stocktake we have looked at how a number of developed countries have advanced their approaches to climate change adaptation, bearing in mind that how each country adapts to the impacts of climate change is dependent on each country's national circumstances, including the physical environment, societal context and government structures.

As summarised in the table below, the approaches taken vary across jurisdictions.

Country	Approach/approaches to climate change adaptation at a national level
Australia	<p><b>National Climate Resilience and Adaptation Strategy</b></p> <p>Sets out how Australia is managing the risks of a variable and changing climate; identifies a set of principles to guide effective adaptation practice and resilience building; outlines the Australian Government's vision for a climate-resilient future. Planning and action at the national and sub-national levels. Australia's investments in research provide a strong foundation for the strategy.</p>
Canada	<p><b>Federal Adaptation Policy Framework 2011</b></p> <p>Enables the government to take account of climate risks when making decisions.</p> <p><b>Vancouver Declaration on Clean Growth and Climate Change (March 2016)</b></p> <p>Canada's first ministers agreed to develop a pan-Canadian Framework to achieve Canada's commitments in the Paris Agreement. This involved setting up a working group on preparing for and responding to the impacts of climate change. The Working Group on Adaptation and Climate Resilience released its final report in December 2016 which provides conclusions and options.</p>
Germany	<p><b>German Adaptation Strategy 2009</b> together with</p> <p><b>Adaptation Action Plan of the German Strategy for Adaptation to Climate Change 2011</b></p> <p>Aims to reduce the vulnerability of the natural, social and economic systems, and to maintain and improve their capacity to adapt to the impacts of climate change. Federal government leads the process through each sector of government, and each sector is responsible for implementing the relevant portion of the plan. The plan promotes an integrated approach that considers the interactions between sectoral and regional activities, and seeks to anchor consideration of the possible climate change impacts in all relevant sectoral policies.</p>

Country	Approach/approaches to climate change adaptation at a national level
United Kingdom	<p><b>Climate Change Act 2008</b></p> <p>Sets a legally binding long-term framework including a five-yearly UK-wide climate change risk assessment; and a National Adaptation Programme which sets out the Government’s objectives, proposals and policies for responding to the identified risks (every five years) and also sets out how businesses and society are adapting.</p>
United States	<p><b>President’s Climate Action Plan 2013</b></p> <p>Includes a focus on preparing the United States for the impacts of climate change, followed by an <b>Executive Order</b></p> <p>This contains more detail on implementation and formalised the creation of an interagency <b>Council on Climate Preparedness and Resilience</b> (replacing an earlier 2009 Task Force). Federal agencies must facilitate communities’ efforts to strengthen resilience to extreme weather and prepare for other impacts of climate change, including impacts to their own assets and operations (eg, the USEPA Climate Change Adaptation Plan 2014). The objectives of the Council are to develop, recommend and coordinate interagency efforts; support regional, State, local and tribal action; facilitate the integration of climate science in policies and planning of government agencies and the private sector.</p>

Regardless of the type of approach taken, they have a number of common themes and these are presented in the box below.

- Having a strong scientific evidence base, providing robust information and raising awareness.
- The importance of coordination, collaboration, cooperation and partnerships between central government and other levels of government, and across sectors and society. Shared responsibilities are important while acknowledging the importance of national leadership.
- Identification of priority sectors, including assisting and prioritising vulnerable people and regions.
- The need to anticipate the risks, be proactive and comprehensive.
- Factoring and integrating climate risk into decision-making.
- Taking a long-term view and building resilience.
- The importance of monitoring and evaluating progress towards building resilience with feedback into review of a strategy or plan.
- Looking for and taking advantage of opportunities for adaptation.

Barriers to adaptation were also identified by the countries we looked at, and relate to:

- market failures
- governance/institutional arrangements
- policy/regulatory settings
- cultural/behavioural aspects
- costs of and resources needed for action

- uncertainty in or lack of information
- moral hazard.

In the material examined for this section the importance of public engagement was highlighted by all countries.

The United Nations Framework Convention on Climate Change (UNFCCC) provides guidance for development of national adaptation plans<sup>85</sup> focused on incorporating integrated planning, country-specific solutions, and providing continuity. While this guidance is directed at developing countries it has relevance for all countries, regardless of their level of development. Using this guidance as a reference, NIWA has undertaken a desktop review<sup>86</sup> of the national adaptation plans of nine developed countries looking at possible options for the structure and various elements of a New Zealand national adaptation plan.

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<sup>85</sup> Summarised in [http://unfccc.int/files/adaptation/application/pdf/nap\\_poster.pdf](http://unfccc.int/files/adaptation/application/pdf/nap_poster.pdf)

<sup>86</sup> Developing a national climate change adaptation plan (NAP) for New Zealand. Scoping Report. March 2017. <https://www.niwa.co.nz/climate/research-projects/developing-a-national-climate-change-adaptation-plan-for-new-zealand>

# Appendix 7: Climate change published reports

## Published research papers on adaptation in New Zealand

There are two key documents available which describes and reviews recent literature on climate change adaptation in New Zealand. These are:

- McKim, L, 2016, *A systematic review of recent research: Implications for policy and management, and tools to support adaptation decision making in New Zealand*. Prepared for the New Zealand Climate Change Research Institute, Victoria University of Wellington as part of the Climate Change Impacts and Implications (CCII) for New Zealand to 2100 research programme. MBIE contract CO1X1225. 59pp  
<http://ccii.org.nz/wp-content/uploads/2017/01/RA4-Review-of-recent-research.pdf>
- Reisinger, A & Kitching R, 2014, *IPCC Climate Change: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Australasia (Chapter 25)*  
[https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap25\\_FINAL.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap25_FINAL.pdf)

The following lists other relevant documents that have merged since 2016 and were not captured in the above documents.

## Impacts and implications

- Ausseil AGE, Bodmin K, Daigneault A, Teixeira E, Keller ED, Baisden T, Kirschbaum MUF, Timar L, Dunningham A, Zammit C, Stephens S, Bell R, Cameron M, Blackett P, Harmsworth G, Frame B, Reisinger A, Tait A, Rutledge D, 2017, *Climate Change Impacts and Implications for New Zealand to 2100: Synthesis report RA2 lowland case study. Synthesis Report LC2714. Climate Change Impacts and Implications for New Zealand to 2100*.  
<http://ccii.org.nz/wp-content/uploads/2017/03/RA2-Lowland-Case-Study-Synthesis-report.pdf>

Provides a case study analysis on key pressures, critical time steps and potential responses for alpine and the lowland environment.

- Barron MC; Pech RP; Christie JE; Tait A; Byrom A & Elliot G, 2016, *Climate change impacts and implications: an integrated assessment in the alpine case study. Synthesis Report: RA2 Alpine Case Study. The beech forests of New Zealand. Climate Change Impacts and Implications for New Zealand to 2100*. MBIE contract CO1X1225.  
<http://ccii.org.nz/wp-content/uploads/2017/03/RA2-Alpine-Case-Study-Synthesis-Report.pdf>

Provides a case study analysis on key pressures, critical time steps and potential responses for alpine and high elevation native forest ecosystems.



- Law, C.S; Rickard, G.J; Mikaloff-Fletcher, S.E; Pinkerton, M.H; Gorman, R; Behrens, E; Chiswell, S.M; Bostock, H.C; Anderson, O & Currie, K, 2016, *The New Zealand EEZ and South West Pacific. Synthesis Report RA2, Marine Case Study. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100*  
<http://ccii.org.nz/wp-content/uploads/2016/12/RA2-Marine-Case-Study-Synthesis-report.pdf>

Provides a case study analysis on key pressures, critical time steps and potential responses for alpine and the marine environment.

- McBride G; Reeve G; Pritchard M; Lundquist C; Daigneault A; Bell R; Blackett P; Swales A; Wadhwa S; Tait A & Zammit C, 2016, *The Firth of Thames and Lower Waihou River. Synthesis Report RA2, Coastal Case Study. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100.*  
<http://ccii.org.nz/wp-content/uploads/2017/02/RA2-Coastal-Case-Study-Synthesis-report.pdf>

Provides a case study analysis on key pressures, critical time steps and potential responses for alpine and the coastal and estuary environment.

- Tait, A; Sood, A; Mullan, B; Stuart S; Bodeker, G; Kremser S & Lewis, J, 2016, *Updated Climate Change Projections for New Zealand for Use in Impact Studies. Synthesis Report RA1. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100.* MBIE contract C01X1225.  
<http://ccii.org.nz/wp-content/uploads/2016/10/RA1-Synthesis-report.pdf>

Updates and improves regional-scale projections of climate trends and variability across New Zealand out to 2100 based on the latest global projections. It describes the process of updating and improving regional-scale climate projections for New Zealand and describes how users can access the new data. Work done on generating a large ensemble of temperature projections for New Zealand is also presented, as are web-based tools for exploring visualisations of the data.

## Decision-making and governance

- Flood, S & Lawrence, J, 2016, *Framing conversations around risk and uncertainty. Climate Change Impacts and Implications (CCII) for New Zealand to 2100.*  
<http://ccii.org.nz/wp-content/uploads/2017/01/RA4-Framing-conversations-around-risk-and-uncertainty.pdf>

Explores how to effectively deal with climate change-related risk and uncertainty as well as highlight the importance of considering a range of future scenarios when making decisions that are affected by climate change.

- Frame, B & Reisinger, A, 2016, *Exploring Options for New Zealand under Different Global Climates. Synthesis Report RA5. Climate Changes, Impacts and Implications (CCII) for New Zealand to 2100.* MBIE contract C01X1225.  
<http://ccii.org.nz/wp-content/uploads/2017/02/RA5-Synthesis-report.pdf>

We describe a framework for establishing globally linked national-scale socio-economic scenarios for New Zealand (NZ). These were developed to enable a better understanding of potential

societal changes and how those changes may interact with changing climatic conditions, to inform climate change vulnerability and adaptation research and decisions.

- Lawrence, J; Blackett, P; Cradock-Henry, N; Flood, S; Greenaway, A; & Dunningham, A, 2016, *Synthesis Report RA4: Enhancing capacity and increasing coordination to support decision making. Climate Change Impacts and Implications (CCII) for New Zealand to 2100*. MBIE contract C01X1225.

<http://ccii.org.nz/wp-content/uploads/2017/01/RA4-Synthesis-report.pdf>

Presents evidence about the impacts and implications of climate change that have decision relevance for a range of stakeholders. The evidence supports the development of new practices for addressing and planning for climate change impacts and implications in New Zealand.

- Palmer, G.W.R, 2015, New Zealand's defective law on climate change, *New Zealand Journal of Public and International Law*, v. 13 n.1:p115-136.  
<http://search.informit.org/documentSummary;dn=683629212907831;res=IELNZC;subject=Archaeology>

Describes international efforts to combat climate change in the last twenty-five years with the view that progress has been limited. Asks how much worse will it need to get before effective change will be implemented? Examines the state of NZ law on climate change and the approach NZ is taking to international negotiations.

## Insurance

- Storey B; Noy, I; Townsend, W; Kerr, S; Salmon, R; Middleton, D; Filippova, O and James, V, 2016, *Insurance, Housing and Climate Adaptation: Current Knowledge and Future Research*, Motu Note #27, funded by the Deep South Science Challenge.

<https://motu.nz/assets/Documents/our-work/environment-and-resources/climate-change-impacts/Insurance-Housing-and-Climate-Adaptation4.pdf>

Discusses how insurance will adapt to a changing climate. New Zealand's current insurance institutions are surveyed; these are sufficiently unusual to limit the applicability of the international literature. Issues with the provision of climate-sensitive insurance – particularly with its pricing – are discussed, as are relationships between insurance markets and financial markets. Possible policy responses are suggested. The note concludes by proposing high-priority questions for future research.

## Iwi/Māori

- Bargh, M; Sarsha-Leigh, D; Te One; A; 2014, Fostering sustainable tribal economies in a time of climate change, *New Zealand Geographer*, v.70 n.2: p. 103–115.

<http://onlinelibrary.wiley.com/wol1/doi/10.1111/nzg.12042/full>

Reviews Environmental Management Plans to assess how Māori tribal organisations are proposing to move towards more sustainable tribal economies in a time of climate change. Presents a case study in the Bay of Plenty area focusing on Ngāti Kea/Ngāti Tuara. Suggests that

many tribal organisations are seeking to respond to climate change and transition to becoming producers of their own food and energy needs, and are often articulating these responses in relation to specific local resources and contexts.

## Health

- Metcalfe, S, 2015, Fast, fair climate action crucial for health and equity, *New Zealand Medical Journal*, v.128 n.1425: p.14–23.  
<http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2015/vol-128-no-1425-20-november-2015/6741>

Examines the threat to global health presented by climate change, and what health equity means for setting countries' greenhouse gas (GHG) emission targets, including New Zealand's share of the global effort.

- Macmillan A; Jones R & Bennett H, 2014, New Zealand health professional organisations' joint call for action on climate change and health. *New Zealand Medical Journal* (Online), v.127 n.1403: p.5–8.  
<https://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2014/vol-127-no-1403/6309>

Backgrounds the world context which prompted a joint 'Call for action on climate change and health' for New Zealand issued by 10 NZ health organisations to highlight human-caused climate change as an increasingly serious and urgent threat to health and health equity. Indicates the organisations involved. Summarises the points emphasised in the call for action.

## Immigration

- Tennent, D, 2015, The adverse effects of climate change, *New Zealand Law Journal*, Feb 2015; p. 23–26.  
[http://primo-direct-apac.hosted.exlibrisgroup.com/primo\\_library/](http://primo-direct-apac.hosted.exlibrisgroup.com/primo_library/)

Outlines the impact of climate change on such countries as Kiribati and Tuvalu, particularly the pressure of overcrowding. Queries the protection afforded people affected by climate change under current immigration legislation, if they are unable to obtain residence. Refers to the NZ Immigration and Protection Tribunal decisions in 'AF (Kiribati)' [2014] NZIPT 800413 and 'AD (Tuvalu)' [2014] NZIPT 501370–371, examining people's ability to claim refugee or protective person status, or to appeal deportation. Sets out the two main issues that require addressing in this matter.

- Cameron, M, 2013, The demographic implications of climate change for Aotearoa New Zealand: a review. *New Zealand Population Review*, v.39:p. 121–142.  
<http://researchcommons.waikato.ac.nz/handle/10289/7979>

Reviews international literature on the demographic impacts of climate change, with a particular focus on how this might affect New Zealand. Suggests expected changes will feature internal migration.

## Tourism

- Hall M; Baird T; James M & Ram Y, 2015, Climate change and cultural heritage: conservation and heritage tourism in the Anthropocene. *Journal of Heritage Tourism*.  
<http://dx.doi.org/10.1080/1743873X.2015.1082573>

Reviews some of the actual and potential effects of climate change on cultural heritage and its management with special reference to heritage tourism to help identify knowledge gaps and issues in relation to different types of heritage, management strategies and policy-making, as well as enabling an understanding of the potential significance of climate change impacts in a regional, national and international setting. It is also relevant to understanding the broader pressures of environmental and global change on the management of heritage tourism sites, and cultural heritage in particular, in the Anthropocene.

## Natural hazards

- Glavovic, B.C., 2014, The 2004 Manawatu Floods, New Zealand: Integrating Flood Risk Reduction and Climate Change Adaptation. *Adapting to Climate Change*, pp. 231–238. Springer Netherlands.  
[http://link.springer.com/chapter/10.1007/978-94-017-8631-7\\_10](http://link.springer.com/chapter/10.1007/978-94-017-8631-7_10)

Describes the lessons learned from the 2004 floods in the Manawatu region and how these could be used for building resilience and adaptive capacity in the face of climate change. It recommends priority actions for mainstreaming climate change adaptation.

## Oceans and coastal hazards

- Molinos G.J, Halpern B.S., Schoeman D.S., Brown C.J., Kiessling W., Moore P.J., Pandolfi J.M., Poloczanska E.S., Richardson A.J. and Burrows M.T. (2015). Climate velocity and the future global redistribution of marine biodiversity, *Nature Climate Change*, doi: 10.1038/nclimate2769.
- Munday P., Cheal A.J., Dixon D.L., Rummer J.L., and Fabricius K.E. (2014). Behavioural impairment in reef fishes caused by ocean acidification at CO<sub>2</sub> seeps, *Nature Climate Change* 4, 487–492 (2014) doi: 10.1038/nclimate2195.
- Renwick J.A., Hurst R.J., and Kidson J.W. (1998). Climatic influences on the recruitment of southern gemfish (*Rexea solandri*, *Gempylidae*) in New Zealand waters. *International Journal of Climatology* 18: 1655–1667; Beentjes M.P. & Renwick J.A. (2001). The relationship between red cod, *Pseudophycis bachus*, recruitment and environmental variables in New Zealand. *Environmental Biology of Fishes* 61: 315–328.; Dunn M., Hurst R., Renwick J., Francis C., Devine J., and McKenzie A. (2009). Fish abundance and climate trends in New Zealand. *New Zealand Aquatic Environment and Biodiversity*. Report No. 31. NIWA, Wellington.