12 UNDERSTANDING CLIMATE CHANGE IMPACTS

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12.4 INTRODUCTION

It's a fact. The world's climate is changing. The atmospheric gases that sustain life is thickening thus, trapping more and more heat. The atmosphere contains the oxygen we need to breathe, protects us from ultraviolet radiation and the extreme cold of space, and plays an essential role in recycling energy, water and other essentials for life. Weather is a direct product of atmospheric processes, and influences our pattern of living (Ministry for the Environment 2007d, 2007e). Without this atmosphere, temperatures at the Earth's surface would be about 30°C colder.

The planet is getting hotter and it is directly attributable to human activities like driving cars, farming, burning coal, oil and gas reserves and removal of forests (IPCC 2007). As a result the human population are producing more greenhouse gases (GHG) (i.e. carbon dioxide, methane and nitrous oxide) than ever before in the last 650,000 years.

Figure 1. Greenhouse Gases (GHG) are:

- Carbon dioxide (CO_2)
- Water vapour
- Methane (CH_4)
- Nitrous oxide (NO_2)

Information surrounding what level of GHG emissions occurs in the Kaipara catchment and what effects will climate change have on ecosystems and local communities living around the Kaipara Harbour is nil. However, information from monitoring the physical environment (e.g. climate, rainfall, extreme weather events, water flow) is quite substantial. The present gap is that this information needs to be analysed and assessed to identify the most likely threats and/or benefits of climate change for the Kaipara.

Figure 2. Examples of Global Changes Observed

- The Gulf Stream, the warm current that keeps Western Europe habitable, has weakened by 30%.
- The West Antarctic ice sheet is breaking up at an unprecedented rate.
- The Arctic Sea ice is disappearing and glaciers are in retreat in most parts of the world.
- Alaska has the fastest change in climate.
- Number of extreme weather events of all kinds has increased 5 fold since the 1950's and there is evidence that this is linked to climate change (IPCC 2007). The intensity of hurricanes has increased since the mid 1970's and the first hurricane ever recorded in the South Atlantic hit the coast of Brazil in 2004.

12.5 NEW ZEALAND'S GREENHOUSE GAS EMISSIONS

In the 10 year period between 1995 and 2005 New Zealand's Greenhouse Gas (GHG) emissions increased by 25% (Ministry of Environment 2007e). Consistent with global trends, Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (NO_2) all have increased.

It is the global atmospheric concentration of GHG that determines the risk of climate change (Ministry for the Environment 2007d, 2007e). New Zealand's total GHG emissions were 77.2 Mt CO_2 in 2005, which is 0.3 percent of global emissions (25,733.3 Mt CO_2) (Ministry for Environment 2007d). Another estimate puts total global emissions in 2000 at 42 giga tonnes[1] (Gt) of CO_2e (Carbon Dioxide equivalent) (Stern 2006).

National information on GHG emissions is collected annually by the Ministry of Environment (MfE 2007e). The most recent information is from 2005.

New Zealand has an unusual GHG emission profile for a developed country, where methane and nitrous oxide from our agricultural sector account for close to 50% of our total emissions. While the remaining 43% is CO_2 from energy production and transport. In comparison, other developed countries have comparatively lower agricultural emissions but higher energy generation emissions (MfE 2007e).

Table 1 outlines New Zealand's gas emissions by sector: energy, agriculture, transport, industrial processes, removals (i.e. forest sinks or carbon sinks) and waste. In 2005, agriculture made up 49% of our total emissions, energy 42%, transport 18%, industrial processes 6% and waste 2% (Ministry for Environment 2007e).

Table 1. NZ Greenhouse Gas Emissions by Sector (Source: Ministry for the Environment, 2007e)

Sector	Mt* CO_2-e 2005	% of GHG emissions 2005	Change in period 1990-2005
Agriculture	37.4	49%	+15%
Energy	33.4	42%	+42%
Transport	14.2	18%	+62%
Industrial processes	4.3	6%	+32%
Waste	1.9	2%	-26%
Removals	-24.5	n/a	n/a

*1 megatonne (Mt) = 1,000,000 tonnes

New Zealand has an emissions profile with two parts: an "emissions path" in which emissions rise steadily by about 1% a year through to 2045, and a "forest sink trend" in

[1] Gt (giga tonne) = 10^6 (one thousand million)

which planted forests that are harvested through the mid- to late- 2020s to mid-2030s cause emissions spikes (Cabinet Policy Committee 2007).

Energy Sector Emissions

The energy sector rate of emissions growth was the highest of any sector in New Zealand between 1990 and 2005. Emissions increased 42% over the period. This sector includes emissions from fuel combustion, including combustion that produces heat in industrial processes, and fugitive emissions (those that escape from activities relating to fossil fuels).

Transport Sector Emissions

Transport emissions include those from domestic road, rail, air and sea transport. In 2005, transport contributed 18% of NZ's total emissions. Emissions were also 62% higher in 2005 than in 1990.

Road transport represented 89% of domestic transport emissions in 2005, which has been the largest growth in emissions between 1990 and 2005.

Agricultural Sector Emissions

The agricultural sector contributes 96% of New Zealand's total Nitrous Oxide (N_2O) emissions and 91% of total methane (CH_4) emissions. Emissions have increased by 15% from 1990 levels.

The number of individual dairy farms is decreasing but the size is increasing. In 1994, there were 16,843 dairy farms and in 2005 there were 12,810 dairy farms. According to the Ministry of Agriculture and Forestry (MAF), some 445,000 hectares of forestry land has the chance of being deforested for pastoral landuse, especially dairy farming. This is about 25% of New Zealand's pine plantations and over seven times the size of Lake Taupo.

The agricultural sector source of emissions includes:

- Cattle digestion fermentation
- Sheep digestion fermentation
- Agricultural soils
- Manure management
- Grassland and agricultural residues burning

When cattle and sheep digest food they produce methane – this is New Zealand's highest single emissions category, contributing 31% to total emissions in 2005. This fermentation process (Enteric fermentation) represents 64% of all emissions from agriculture.

Nitrous oxide emissions occur from agricultural soils. This occurs through the application of nitrogenous fertilisers, animal effluent deposited on agricultural soils, and the use of nitrogen-fixing crops. Emissions can be direct from the soil or indirect through run-off, leaching and atmospheric deposition.

Forestry and Landuse Sector Emissions

This sector produces GHG emissions through landuse, landuse change and forestry—that is, removals of GHG from the atmosphere by forest sinks as well as emissions from changes in landuse.

The category includes changes in six landuse types: forest land, cropland, grassland, wetlands, settlements and other land. Transfers of landuse from one type to another can result in either CO_2 emissions or removals. Emissions can also arise from burning forestry slash (branches and other woody debris from forest harvesting that are not removed from the site), decay of biomass and changes in soil carbon.

The forestry sector does not yet remove enough GHG emissions to reduce climate change. Removals of GHG from other changes in landuse were not significant.

While theoretically increased CO_2 presence in the atmosphere could increase plantation forest growth rates, a six year study on plantation forest ecosystems concluded that productivity increases will be small when nitrogen is limiting. Though carbon uptake increased, it could be lost by various increased turnover processes (Morel 2001).

12.6 CLIMATE CHANGE IMPACTS ON NEW ZEALAND

Although New Zealand will not be as severely affected as some other countries, we will still have to deal with increased severe weather events such as extreme floods and storms and in some areas more frequent droughts. Sea level rise will threaten our largely coastal settlements and infrastructure and new pests and diseases will become established.

Agriculture/Horticulture/Forestry

- These industries rely heavily on natural ecosystems, particularly soil ecosystems. Current research indicates that the warmer climate would bring both benefits and risks to the farming sector. Concentrated efforts on the management of soil moisture availability pasture species composition and pasture pests and fungal diseases will become more relevant in day-to-day pasture management. The overall impact of

climate change on pasture quality is difficult to quantify and will vary with region (MfE 2001, Morel 2001).

- A range of adaptation measures for the farming sector need to be investigated and targeted regionally, including drought-tolerant species and sub-tropical grasses.

- The type of, and suitable location for, key crops may also change. Higher temperatures could cause problems for crop production. For example, Northland kiwifruit require cold winters for fruit development. Kenny *et al*. (2000) used the CLIMPACTS computer model to model thresholds for three representative types of food, including kiwifruit. Since the majority is produced in one region, they are at a relatively high risk of being negatively impacted by climate change. But defining critical thresholds at which climate change will have negative effects requires incorporating social, economic, and environmental data, which the authors report will be a challenge for the future.

Tangata Whenua

- Coastal erosion and sea level rise can pose a particular problem to Māori, whose spiritual sites (urupa and wahi tapu) are often located close to sea level.

- Impact of climate change on fisheries production is highly uncertain at present therefore, proactive adaption is required to avoid losses of local fish and shellfish resources.

- Māori are one of the largest landowners in Northland (95%) (MfE 2001) with most land being in lower land classes (or marginal land). Loss of productivity from invasive pest grasses and increased frequency of droughts and floods will add pressure to Māori landowners

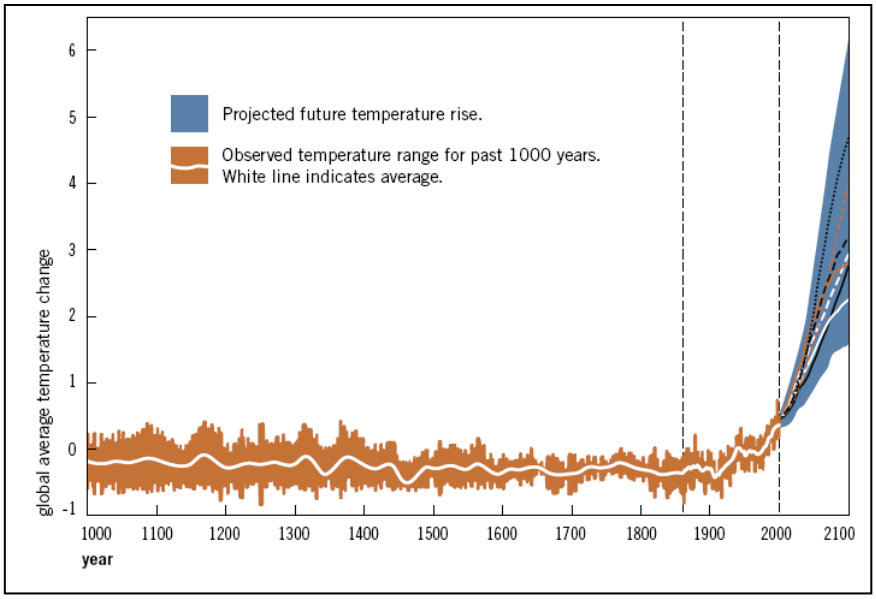
Temperature

- New Zealand's average surface temperature has increased by 0.2°C between 1920 and 2000 (Ministry for the Environment 2001, 2001). This increase is consistent with increases in global temperature. For the next two decades (to 2030) global increases in temperature of about 0.2°C each decade are projected for a range of expected levels of GHG emissions (IPCC 2007).

- These changes suggest that we no longer can rely on using historical climate data to predict our future climate patterns.

- Figure 1, from the IPCC (2007), shows average global temperature in the past, highlighting the speed with which it will change in the future. Change will occur more quickly in the next 100 years than in any past natural climate variations. The lines in the shaded area represent different GHG emissions scenarios (Ministry for Environment 2001d).

Figure 3. Average global temperature over time with future projections under varying scenarios (IPCC, 2001).



Rainfall

- Changes in New Zealand's annual rainfall are expected as a consequence of climate change. A warmer atmosphere will hold more moisture, and so increased rainfall amount and intensity are likely (IPCC 2007).

- An increase in the frequency of westerly winds is likely to result in more rainfall and flooding in the west, and less rainfall and more droughts in the east of the country (Ministry for the Environment 2004) (Figure 4). This will have implications for the Kaipara harbour as the predominant wind pattern is a southwesterly.

Extreme Weather Events

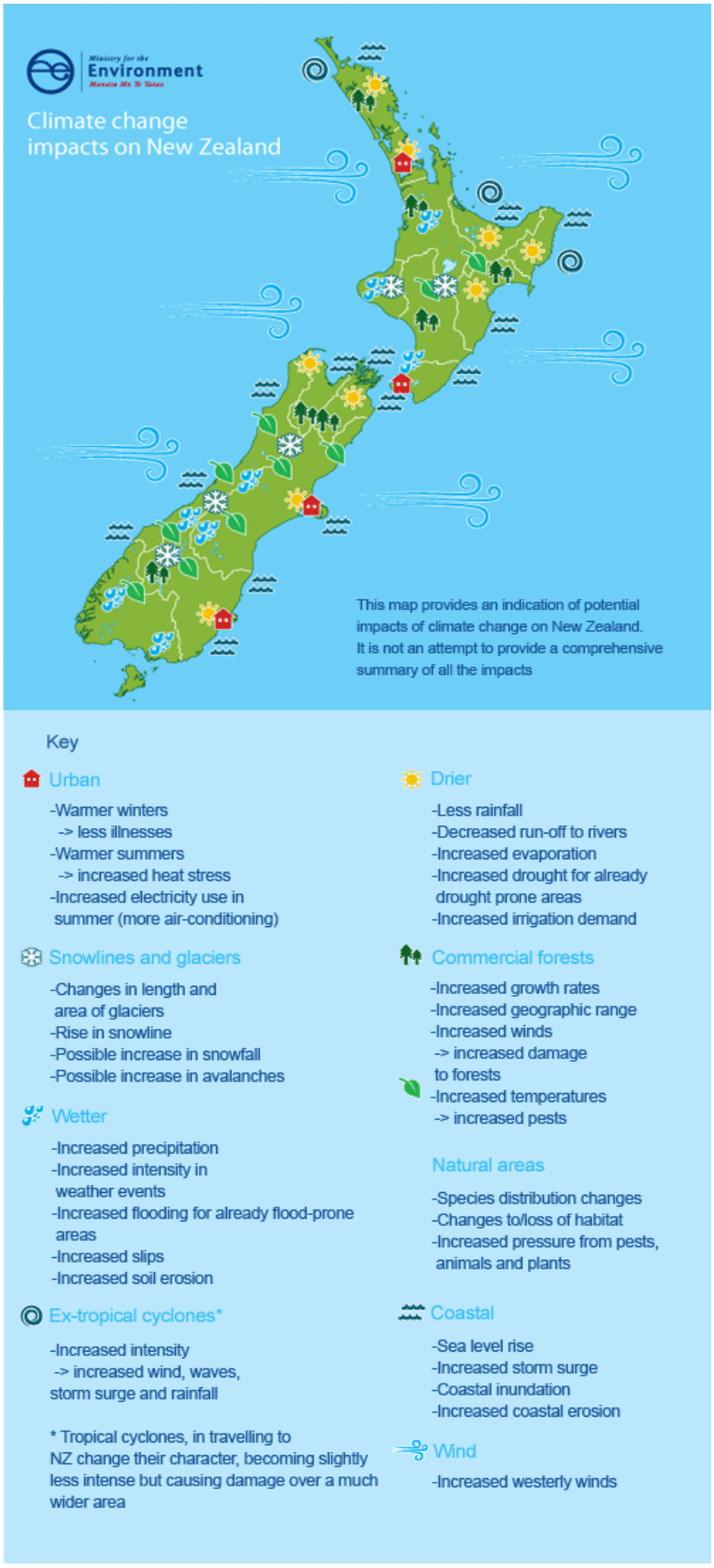
- Climate models predict that New Zealand will experience an increased intensity and frequency of extreme weather events, including droughts in already drought-prone areas, and larger and more frequent floods in regions already vulnerable to flooding.

Oceans

- Over the last 200 years, the ocean has been the only net sink for anthropogenic carbon dioxide, and the terrestrial biosphere has been a net source. Though the ocean will absorb about 90% of anthropogenic carbon dioxide emissions over the next several thousand years, it mixes so slowly that it currently only takes up about 30% of anthropogenic emissions(Sabine 2004).

- Ocean acidification is believed to have a major impact on marine ecosystems, with possible adverse effects on fisheries (Stern 2006).

Figure 4. Climate change impacts on New Zealand.



Ecosystems

Many potential patterns of change have been identified, though quantifiable and known trends are lacking. For instance:

- Fragmented native forests in Northland are vulnerable ecosystems to the effects of climate change (MfE 2001). However, in general climate change probably will compound the stresses on already vulnerable species and species living at the edge of their climatic limits rather than causing extinctions on its own.

- Warmer climate may also make native flora and fauna more vulnerable to invasive species.

- Similar concerns as for the native forest ecosystems apply to freshwater ecosystems. Changes may begin with vegetation types along waterways, instream flow dynamics and seasonal patterns, loss of wetlands, and; the quantity of run-off to streams and rivers. More specifically, warmer stream/river temperatures, which can affect mixing and eutrophication processes, decrease available habitat for native species and increase habitat and growth of invasive, exotic species.

- Mangrove, an essential ecosystem for estuarine water quality, fisheries, and many other aquatic processes, is one of the most vulnerable ecosystems. Mangroves are threatened by the temperature, carbon dioxide, precipitation, and sea level changes, as well as hurricanes and storms, associated with climate change (McLeod & Salm 2006).

- However, mangroves are tolerant plants and have adaptations that may help them survive sea level rise, their biggest threat. For instance, they can expand their range towards land and in New Zealand, southwards. Mangrove survival is dependent on location and habitat—mangroves with enough sediment or those that can move inland if sea levels rise can best survive predicted sea-level rise. Identifying such mangrove areas is important so that managers can protect them as buffers in the event of other stand losses (McLeod & Salm 2006).

- Other concerns are ecosystem goods and services provided by various ecosystems that humankind depend.

Health

- In the health arena, a warmer climate may allow increased mosquito establishment, increasing the potential for Ross River virus and dengue fever arrival and transmission.

- To an unknown extent, climate change could slow the recovery of the ozone layer, which regulates the amount of harmful ultra-violet light entering the Earths atmosphere thus, increasing skin cancer rates.

12.7 ADAPTATION MEASURES

12.7.1 GOVERNMENT POLICY TO CONTROL EMISSIONS

The government has taken steps to manage GHG emissions and therefore respond to global climate change. These steps include setting goals for GHG reductions, such as becoming carbon neutral in various sectors, increasing energy conservation and renewable sources, implementing programs to help consumers reduce their GHG emissions, including climate change in local government planning, and performing annual GHG emissions inventories. A major economic response has been the Emissions Trading Scheme, which will be discussed later.

New Zealand's aspiration is to be carbon neutral. To get there New Zealand is adopting the following targets:

- *"By 2020, we achieve a net increase in forest area of 250,000 hectares from 2007 levels*
- *By 2025, 90 percent of our electricity generation is from renewable sources*
- *By 2040, our per capita transport greenhouse gas emissions are reduced by half of those in 2007*
- *We will be one of the first countries in the world to widely deploy electric vehicles*
- *We remain a world leader in agricultural emissions reduction research, and in the early adoption and application of new technologies and processes that reduce agricultural greenhouse gas emissions."*(Ministry for the Environment 2007d)

Achieving these targets will allow New Zealand to be effectively:

- "*Carbon neutral in the electricity sector by 2025*
- *Carbon neutral in the stationary energy sector by 2030*
- *Carbon neutral in the transport sector by 2040*
- *Carbon neutral in the total energy sector by 2040"* (Ministry for the Environment 2007d).

About half of New Zealand's emissions come from farming (from methane and nitrous oxide) and half from the energy and transport sector (from burning fossil fuels). Our ability to reduce emissions varies from sector to sector. There are renewable alternatives to fossil fuels, so the energy sector could provide most of New Zealand's emission reductions.

12.7.1.1 NEW ZEALAND'S EMISSIONS TRADING SCHEME

Due to a need to incorporate climate into the national "economic transformation agenda," a New Zealand Emissions Trading Scheme (ETS) was proposed in August 2007 by the Labour-led government and was passed into law on 23 November 2009 by the National-led

government. It will include all sectors by 1 January, 2013. However, the agricultural sector will be last sector to enter (Cabinet Policy Committee 2007).

Before this time, no GHG emissions reduction scheme existed on an economic, market-driven scale, but policy existed in some sectors that were funded from the government or from compliance costs. Before the Bill was proposed, tourism, viticulture, and agriculture industries were already starting to respond to climate change. As biological industries (such as pastoral farming) are a large part of the economy but produce such a large percentage of GHGs, adapting this industry to deal with climate change will be a challenge (Cabinet Policy Committee 2007). This is because few technical solutions exist to reduce food production GHGs, especially methane production by ruminant animals (such as cows) (Ministry for the Environment 2007d).

Some features of the bill include:

- A cap and trade scheme, in accordance with the Kyoto accords
- Inclusion of all sectors of the economy (including agriculture, a first for domestic schemes) and all gases.
- Fuel and electricity cost changes felt by consumers
- Forestry is a priority because it has a significant influence on emissions both positively and negatively (Cabinet Policy Committee 2007).

In an Emission Trading Scheme, one emission unit must be surrendered for each tonne of GHG emissions for which the participant is responsible. This necessitates quantifying emissions from their activities. Also, participants can gain one emission unit for each tonne of emissions they remove with their activities, which they can sell for profit on the market. A participant is someone who performs activities that produce GHG emissions or that remove GHGs from the atmosphere.

Another part of the Bill amended the Electricity Act 1992, putting a 10-year restriction on:

> *"new baseload fossil-fuelled thermal electricity generation, except to the extent required to ensure the security of New Zealand's electricity supply."*

This promotes renewable electricity sources (Ministry for the Environment 2007c).

Currently, changes to the ETS are being deliberated through a Select Committee Review and discussions with Australia about their Carbon Pollution Reduction Scheme (Ministry for the Environment 2009).

Meaning of the ETS

There will be an economic cost to reducing emissions—the actual cost depends on a number of factors, such as, how easy it is for companies to move away from activities with high emissions; domestic policy; international actions; price of carbon on the World market and; pricing and availability of technology that reduces emissions. All models tested by Stroombergen *et al*. (2009) illustrated that the New Zealand economy will still grow, but there will be a cost nonetheless, particularly in the short term. However, Stroombergen *et* al.

(2009) recommends an ETS with certain elements, and to maintain introducing a carbon price.

Kerr (2007) found the proposed bill to be a potentially effective document in both an economic and environmental sense. The proposed ETS strength is its comprehensive nature, in which all emissions are included in one system, as opposed to the European Union system. However, weaknesses in the policy that need to be addressed are the policy's short- and long-term environmental contribution, leakage and allocation issues, transitioning to the scheme, and incorporating science into regulation.

While the Labour, Green, Progressive Party and ACT Party opposed the ETS Bill on 23 November 2009 they do see benefits to the ETS, but argue for bringing the farming sector into the ETS in 2009 with other sectors, such as forestry and energy, rather than subsidizing the change and allowing the industry to enter in 2013.

The non-government international conservation group Greenpeace (New Zealand) believes the ETS will have minimal effect, but it does represent progress and good intentions in dealing with climate change (Greenpeace New Zealand 2007a, 2007b). One of the many flaws in the scheme that Greenpeace New Zealand believes, is the treatment of the agricultural sector; the ETS is "*too generous to agriculture and other big polluters and won't result in the deep emission cuts needed to tackle climate change*." Greenpeace New Zealand wants agriculture to enter the scheme before 2013 and additional measures to be put in place promoting "*low input, less intensive agriculture around New Zealand*" to decrease GHG emissions (Greenpeace 2007a, 2007b).

A risk assessment and pathways required to lessen these risks was part of the proposed ETS Bill, and is provided in Appendix 7.

12.7.1.2 EFFECTS OF THE EMISSION TRADING SCHEME FOR MĀORI

General concerns for Māori include how the principles of the Treaty of Waitangi will affect the ETS, how small and medium sized businesses will be affected, and how additional costs stemming from the ETS will be met. These include land-based activities costs as well as everyday expenses like food and energy, especially in lower income households. Policy effects on Māori land are of concern, regarding the principle of rangātiratanga (NZCCP 2001).

The ETS has potential to affect Māori interests in energy costs, fishing, agriculture, pre-1990 and post-1989 forestry, geothermal energy, employment, and treaty settlement assets (particularly crown forestry land). A summary of specific details of the Bill and their effects is given in Table 2. For instance:

- Increased electricity (5-10%) and motor fuel (4-7%) prices will have a small impact since electricity is 3.6% and motor fuels is 4.7% of Māori household expenditures in 2004

- Increased electricity and motor fuel prices will have a larger effect on Māori than on non-Māori households since Māori households spend 7% more for electricity and 12% more for liquid fuels than non- Māori households
- Fishing will mainly be affected through increased liquid fuel costs
- As Māori have greater interests in the fishing sector than non- Māori, they will feel effects of increased liquid fuel and possibly electricity prices more. Combined with other economic factors, increased energy prices from the ETS might affect Māori fishing assets more than those of non-Māori (Insley & Meade 2007).

In the farming sector, Māori will likely be affected by emissions policies in the same way as non-Māori farmers, except in the case of multiple ownership where land-use change is less feasible. As Māori have a greater interest in farming exports than the national average, Māori might feel like the effects of international competition with countries without emission reduction targets more acutely.

As Māori forestry interests are significant, policy created for the forestry industry and carbon sinks will be important (NZCCP 2001). Concern has been expressed by Māori over ownership and ETS treatment of Crown Forest License lands (Mahuika 2007).

Table 2. Summary of Emission Trading Scheme points with effects on Māori. (Source: Insley & Meade 2007).

ETS Detail	Māori Impact
Criteria for targeting support to low- and middle-income households to mitigate impact of higher electricity prices	Low-income Māori households may have a greater case for increased support, particularly given lower home ownership rates and hence less ability to take advantage of home efficiency support measures.
Eligibility criteria for industrial production free NZU allocations	Māori fishing interests may prefer a lower annual emissions thresholds (than 50,000 tonnes/year) in order to qualify for free allocations to mitigate impacts of increased electricity prices on fish processing.
ETS non-compliance penalties	Possibility of increased land forfeiture risk.
Inclusion of indigenous forestry	Strong Māori interest in indigenous forestry, and pre-1990 bias, suggest will be an important issue for Māori. If relevant land has low conversion potential then proposed pro rata NZU allocations may give rise to windfall gains, based on historical deforestation rates. Conversely, if land has significant non-forestry potential, or if future

ETS Detail	Māori Impact
	deforestation should be permitted and become more economic, appropriateness of proposed allocation level is unclear.
Papakainga exemptions	Māori interested in developing papakainga housing on Māori-owned land will be interested in securing such exemptions.
Agriculture point of obligation	Possible governance issues for Māori, including the ability to affect the nature of subsequent devolution of emissions costs to famers by processors/companies or sector bodies. If devolutions are averaged rather than emissions-based, relatively low-intensity Māori farmers may face disproportionate costs. Opportunities to create Māori sector bodies?
Agriculture allocation level	Possible governance issues if free NZUs are allocated to processors/companies or sector bodies. Māori may benefit if allocations are averaged rather than emissions-based. But could be locked into lower-intensity farming if allocations are targeted according to emissions.

12.7.1.3 EMISSION TRADING SCHEME 2009 – CLIMATE CHANGE RESPONSE (MODERATED EMISSIONS TRADING) AMENDMENT BILL

The moderated ETS Amendment Bill has replaced the one passed by the previous Labour-led government just before the 2008 election and was put on hold by the newly elected National-led government.

On 23 November 2009, the newly drafted, and some consider, watered down version of the ETS, was passed by a narrow majority after negotiations were held with the Māori Party. The Amendment Bill was supported by National, Māori Party and United Future.

From the 1 July 2010, there will be a price on carbon and an incentive for afforestation.

The main points of agreement between the Māori Party and National were (Hon Dr Nick Smith 2009):

- $24 million will be invested in home insulation scheme, targeted exclusively at low income families. This will bring an additional 8,000 houses into the scheme.

- A Treaty of Waitangi clause will be added to the Bill. The clause will include consultation and set out "ongoing decisions" process.
- Advisers from the Iwi Leadership Group will have input "at the highest level" on international negotiations.
- A review of schemes to encourage tree planting on poor quality land particularly the Permanent Forest Sink Initiative, which encourages indigenous tree planting by issuing Assigned Amount Units for carbon sequestration. A review of this scheme will be initiated in early 2010.
- Address solutions to resolve issues raised by Ngāi Tahu over the likely impact of the ETS on iwi treaty settlement and pre-1990 forest land. An Agreement in Principle has been reached on a contract for a comparable area of Crown land, which will avoid litigation.
- Further work will be undertaken to develop afforestation projects on Crown land through partnerships.
- The Government has agreed to consult with the Māori Party on other climate change measures that will contribute to New Zealand moving to a lower carbon economy.
- National Policy Statement on Biodiversity is an important issue for Māori and the Crown has agreed to begin progressing consultation with Māori by March 2010.

Features of the Amendment Bill

The key new features of the Climate Change Response (Moderated Emissions Trading) Amendment Bill 2009 (Office of the Minister for Climate Change Issues & Cabinet Legislation Committee 2009) are:

- New entry dates for transport, energy and industrial sectors from 1 July 2009, to 1 July 2010 and for agriculture sector from 1 January 2013 to 1 January 2015.
- Transitional phase extending to 1 January 2013 with a 50% obligation and $25 fixed price option for the transport, energy and industrial sectors
- Incentives for afforestation created by a domestic and international market for carbon credits
- Enhanced transitional support for fishing industry
- Production-based industry average approach to allocations of credits for trade
- Phase-out of industry support aligned with trading partners and Governments 50% 2050 reduction target in GHG emissions.

12.7.2 SUPPORT LOW-CARBON TECHNOLOGY CREATION, USE & EDUCATION

The 2007 New Zealand Energy Efficiency and Conservation Strategy (EECA 2007) addresses support for the development of low-carbon technologies, education and breaking down barriers to use such technologies. Specifically, greater efficiency and sustainability is the goal for air travel, businesses, farms, horticulture, products, central government leadership, local government leadership, travel management, schools, lighting, tourism, industry and commercial buildings, freights, homes, electricity systems, and vehicles. To help achieve energy efficiency, bio-ethanol from dairy, biodiesel from tallow, forestry, geothermal power, small scale renewable, marine energy, small scale distributed generation, biofuels, regional travel demand strategies, and other renewable energy sources will be important.

Certain government initiatives already address climate change. For example, the EnergyWise® Homes package will provide financial incentives to help people make their homes more energy-efficient. The Energy Intensive Business program promotes energy-efficient business by providing grants. The Electricity Commission campaign has helped sell millions of energy-efficient light bulbs. There are also a number of resources available on the Internet to help the public make informed, efficiency-conscious decisions regarding, for instance, their homes and transportation (Ministry for the Environment 2007d).

Other Responses

1. The RMA (Energy and Climate Change) Amendment Act 2004 introduced the requirement for any authority exercising powers or functions under the RMA to have particular regard to "*the effects of climate change*". Local governments must therefore incorporate long-term climate change patterns into community planning, according to the existing principles of sustainability, and planning for adaptation to alleviate the risks associated with climate change. Infrastructure planning should also incorporate climate change considerations (Ministry for the Environment 2007a).

   The amendment to the RMA requires a fundamental paradigm shift in the approach taken to hazard management (Figure5). With climate change hazard management will increase which will place considerable pressure on local authorities to achieve long-term sustainable management of land and coast resources and their respective communities.

Figure 5. The paradigm changes seen in future hazard management and adapting to climate change impacts.

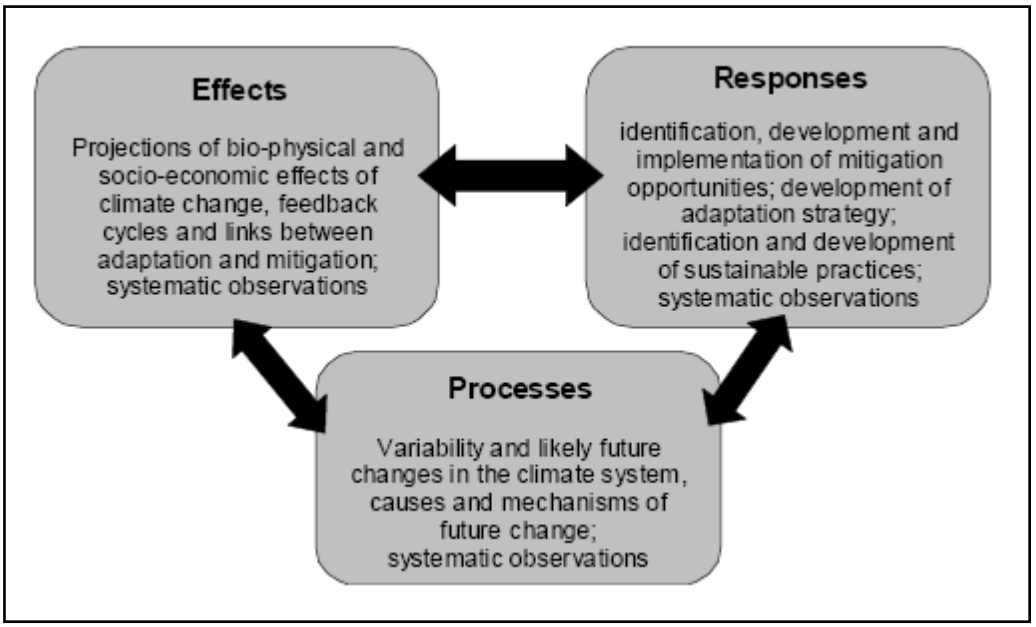
2. According to the United Nations Framework Convention on Climate Change (UNFCCC), which New Zealand has signed, an annual GHG inventory must be completed (Ministry for the Environment 2007e). Inventories from 1990-2005 are available at: http://www.mfe.govt.nz/publications/climate/nir-jul07/index.html.

3. The *Sustainable Biofuel Bill of 2009* (Fitzsimons 2009) would ensure that biofuels supplied or sold in New Zealand are sustainable, as some biofuel production is not environmentally sound.

4. The National Science Strategy Committee for Climate Change (NSSCCC) (Morel 2001) recommends research organised into three broad categories to effectively

address climate change, as summarised in Figure 6. Information on "Processes" should flow to information on "Effects" and on to "Responses".

Figure 6. Research area recommendations by the National Science Strategy Committee for Climate Change.



5. Some research has already been done in these areas, such as physical climate system studies, GHG exchange between the atmosphere, ocean, and biosphere, GHG emissions, regional climate change, past climates, plantation forest ecosystems, natural ecosystems, renewable energy sources and technologies, and consumer transportation choices (Morel 2001).

6. The Pastoral Greenhouse Gas Research Consortium, funded by industry and government sources, is heading research on ways to reduce methane and nitrous oxide emissions from agriculture. These strategies include lowering nitrous oxide emissions by better management of soil, stock, fertiliser, and nitrification inhibitors (Ministry for the Environment 2007d).

7. Seasonal and updated current climate information is available via the Internet from NIWA's National Climate Centre (http://www.niwa.co.nz/our-science/climate). This can aid the decision-making process of farmers and others performing activities affected by climate (Morel 2001).

Economics and Climate Change Research and Reports

Changes in the international market and other nations' economies may affect New Zealand's economy to an unknown extent. New Zealand has put policies in place as an economic approach to dealing with climate change.

For instance, compared to the surrounding Pacific Island nations, New Zealand is in a better position to deal with climate change. These nations may be impacted heavily by sea level rise and natural disasters associated with climate change. New Zealand might be called upon for disaster relief or economic aid to these countries if climate change slows their economic growth (Ministry for the Environment 2007b). Also, the possibility of increased agricultural activity in certain northern-hemisphere regions might affect New Zealand agricultural prices (Morel 2001).

The Kyoto Protocol addressed the need to respond to climate change on an international scale (see below).

International initiatives on climate change

Kyoto Protocol

The Kyoto Protocol was agreed in 1997 and came into force in 2005. The protocol sets targets for the greenhouse gas emissions of developed countries for the period 2008 to 2012 (the first commitment period). For that period it aims to reduce the total greenhouse gas emissions of developed countries to 5% below the level they were in 1990.

Different countries have different targets to achieve. New Zealand's target is to reduce its greenhouse gas emissions to the level they were in 1990, or take responsibility for excess emissions.

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was established by governments in 1988 to improve understanding of and response to climate change. The role of the IPCC is to assess scientific, technical, and socio-economic information relevant to:

- The risk of human-induced climate change
- Global vulnerability to climate change
- Negative and positive consequences of climate change
- Options for adapting to climate change.

The IPCC also assesses options for how to limit greenhouse gas emissions and how to otherwise mitigate climate change. The IPCC assesses and develops methods and practices for the development of national greenhouse gas inventories and disseminates information about inventory methods and practices. These methodologies have been agreed by the UN Framework Convention on Climate Change (UNFCC) for use in compiling national inventories.

It is crucial that the United Nations negotiates a climate change agreement for the post-Kyoto period after 2012. New Zealand agreed to stablise atmospheric GHGs at 450ppm CO_2-e and to reduce its emissions by 2050 to 50 percent of 1990 levels (Ministry for the Environment 2009).

On a global scale, the Stern Review (Stern 2006) advocates policy responses in three areas: (1) carbon pricing, (2) support of low-carbon technology creation and use, and (3) taking down barriers to energy efficiency and educating about individual-based responses. It

supports emissions trading and favors linking emission schemes internationally or regionally with trade partners (Stern 2006).

In an economic sense, failure to respond to climate change immediately will hurt the economy more than responding later (Stern 2006). How the world responds in the next 10-20 years greatly affects the second half of the century and beyond. According to economic models, if the world does not respond, climate change will cost the global GDP five percent a year in the short- and long-term. Taking into account greater risks and effects of climate change, it could cost 20 percent or more. However, responding now by decreasing GHGs would only cost about one percent of the global GDP per year. Dealing with this international problem necessitates an international response with long-term vision (Stern 2006).

12.8 POTENTIAL CONSEQUENCES FOR THE WORLD OF KAIPARA

National and regional climate data shows that New Zealand has warmed over and above natural variability. Few clear predictions of the direct and indirect effects of climate change on the Kaipara environment can be made at this stage. However, pro-active adaptation mechanisms are available.

Current knowledge and model predictions suggest the following changes:

- Increase in the intensity and frequency of westerly winds (Ministry for the Environment 2008).
- Increase in the frequency of heavy rainfall events
- A rise in sea-level
- Lower average annual rainfall (Figure 7) making it much drier and causing decreased run-off to rivers and streams.
- Winters and summers will become warmer (Ministry of Environment 2004, Northland Regional Council 2007c; Auckland Regional Council 2010). From four global climate models, annual mean temperatures for Northland and Auckland is predicted to change between 1.0° to 2.8°C (MfE 2001).
- Large storm surges
- Lower soil moisture
- Increased frequency of droughts in Northland region of the Kaipara catchment.

It is believed that most of the social, cultural and economic effects will be felt through impacts to freshwater ecosystems – rivers, streams, lakes, and wetlands.

Agriculture

Agriculture is the predominant landuse in the Kaipara catchment. Dairy farming activity is concentrated on the rich low-lying alluvial valleys that surround the Wairoa River, Kaihu

River and up into the Wairua River (Figure 8). The increased frequency of westerly winds with subsequent flooding will cause impacts such as landslides, increased soil erosion, increased flooding; and increased pressure on public and private flood insurance schemes in the Kaipara.

Rising sea levels will increase the risk of saltwater intrusion into Kaipara aquifers, such as those located in Ruawai, Parakai and Maungakaramea; and tidal stretches of rivers, such as the Wairoa River and Kaipara-Kumeu River. This is concerning considering the large percentage of dairy farms located in these areas.

Groundwater and tidal records exist (Figure 9). Groundwater aquifers are monitored at Ruawai, Whangarei, and Parakai regularly. Tidal records exist at Dargaville, Pouto and more recently at Helensville (established to assist with development of Kaipara-Kumeu River Catchment Plan).

The change in rainfall trends and temperature is likely to result in decreased recharge of groundwater aquifers and thus increased saltwater intrusion. The Northland Regional Council (NRC) have identified Ruawai and Maungakaramea groundwater aquifers as 'at risk' under the Regional Water and Soil Plan (NRC 2007c). Most of the groundwater taken from the Ruawai aquifer is for the Ruawai township, stock and domestic requirements for the rural area. The groundwater taken from the Maungakaramea aquifer is for horticultural irrigation, stock drinking, and public water supply.

Drier conditions will also impact on freshwater supply that is not necessarily collected from groundwater but from rivers, streams and lakes for agricultural purposes. Drought risk already experienced in the Kaipara catchment is expected to increase (EcoClimate 2008). Calculations from various possible climate change scenarios, the number of drought events is expected to increase at least twice as often as current in Northland (EcoClimate 2008). Other scenarios, known as 'medium-high'[2] scenario, suggest that the frequency of severe drought in much of Northland could increase even more. They are projected to at least double by the 2080s. It is also projected that droughts will expand into spring and autumn months.

Forestry

Exotic forestry (predominantly *Pinus radiate*) is another important landuse in the Kaipara catchment and climate change is believed to have both positive and negative effects on forestry production. The forestry sector is a unique situation in climate change, as forests (particularly new forests) are 'sinks'[3] for carbon and can help reduce GHG emissions but, also emit GHG when harvested.

[2] Scenario based on global models rather than local New Zealand models that incorporate local and regional topography (EcoClimate 2008).

[3] Sinks – any process, activity or mechanism which removes a GHG from the atmosphere. Forests and other vegetation may be considered sinks because they remove CO_2 through photosynthesis (MfE 2007e).

For commercial forests, simply put, it is predicted that growth rates will increase and due to the increase in winds forest damage will also increase.

It is believed that with the risks involved with effects of climate change management will require change particularly in production management. Attention will be required to manage the risks rising from the increased scarcity of water (radiata pine requires at a minimum 1500mm of annual rainfall for optimal growth), more droughts and more westerly winds which may increase fire risk to forest stands, and; increased pest and fungal disease problems.

The positive benefits are the increase in growth rates as temperatures and CO_2 increase. Studies carried out on pine seedlings confirm increases of up to 20% under double CO_2 concentrations (MfE 2001). However, older trees showed very little response to the double concentrations under growth chambers.

Ecosystems

Of particular concern for Kaipara ecosystems (ie. estuarine, coastal-marine, wetlands, dune-sandfield, forest, shrubland, freshwater) is:

- Change in geographical range of some species coping with positive or negative benefits. For example, mangroves in the Kaipara Harbour may expand their geographical range due to increasing sea-level and warmer temperatures; or they may contract in their distribution as freshwater supply to the mangrove forest reduces as rainfall decreases. Other species may seek out refuge areas as sea-level rises and the frequency of westerly winds increases. Wetland areas may benefit as sea-level rises and expand in their geographical range but they may also contract as freshwater run-off declines.

- Increased stress to an already declining biodiversity due to other non-climate change impacts (e.g. habitat fragmentation, exotic species, coastal development, sedimentation).

- Sea-level rise and the effects to low-lying areas around the Kaipara Harbour as the rate of erosion along coasts increase. Local residents already notice the retreating coastline and higher tide levels. The sanddune ecosystems will be vulnerable to climate change effects which may lead to dune blow-outs and flooding of low-lying areas behind the dunes. Areas along the Kaipara peninsulas may continue to accrete, but more slowly (e.g. South Head). The rate will be dependent on sediment supply.

- Rising sea-levels will increase the risk of storm surges.

- Estuarine and coastal productivity due to changes in sea surface temperature, river run-off, ocean circulation and wave generation and offshore/estuarine climate patterns would affect productivity within the coastal and estuarine of the Kaipara Harbour which has dependency with the open-coast environmental processes (e.g. upwelling, currents circulation).

- Estuaries and wetlands are already under stress in the Kaipara due to a variety of economic and social activities. Because of their function (e.g. shoreline stablisation, nursery habitats, sinks for land-derived contaminants and nutrients, pathway for nutrients to deeper waters) they will be vulnerable to climate change effects.
- Seagrass communities in the Kaipara Harbour. Sea-level rise, increased acidification of seawater which will effect productivity will cause seagrass to redistribute into possible refuge areas or expand in their distribution.
- Warmer climate may make Kaipara flora and fauna more susceptible to invasion by introduced species such as, trees, shrubs, climbers and grasses.
- The reduction in freshwater due to decrease in the average annual rainfall will impact across all ecosystems: fragmented native forests, rivers and streams run-off, wetlands, lakes; are probably the most vulnerable to climate change.
- Resilience and adjustment to climate change for old growth forests in the Kaipara catchment will be severely hampered by fragmented and unconnected seed sources through forest clearance, invasion of exotic species from adjacent landuse and development. Also, they may also face the stress of increased fire risk due to increase in westerly winds and frequency of drought events.

Ngāti Whatua ki Kaipara (Hapū)

The effects of climate change on Kaipara hapū will be significant due to their lower socio-economic condition and heavy reliance on subsistence living around the Kaipara natural resources (e.g. shellfish, flounder, mullet, freshwater). Climate change will impact on mauri of Kaipara.

Kaipara hapū are one of the largest landowners in the Kaipara catchment. A small proportion of Māori-owned land is in commercial enterprise compared to most of Māori-owned land concentrated in areas with less productive land types (e.g. marginal land), which may be more prone to erosion, saltwater intrusion, invasion from weeds and pests.

There will be positive benefits arising from climate change particularly Māori-owned land in forestry. With the increase in CO_2 and warmer temperatures, growth rates for exotic forestry will increase particularly for new forests rather than older mature forests. See discussion above regarding forestry and agriculture changes due to climate change.

Coastal areas around the Kaipara Harbour form traditional and spiritual land-seascapes for Kaipara hapū. The increase in coastal erosion will cause significant impact as these areas that very important for mahinga kai, practice of kaitiakitanga, manaakitanga, wairuatanga, decrease.

Kaipara hapū are likely to be vulnerable to health impacts of climate change. Many Māori whanau may become prone to new diseases (e.g. dengue fever, Ross River fever) that are normally found in warmer, tropical climates (MfE 2001).

Figure 7. Average annual rainfall pattern for the Kaipara catchment.

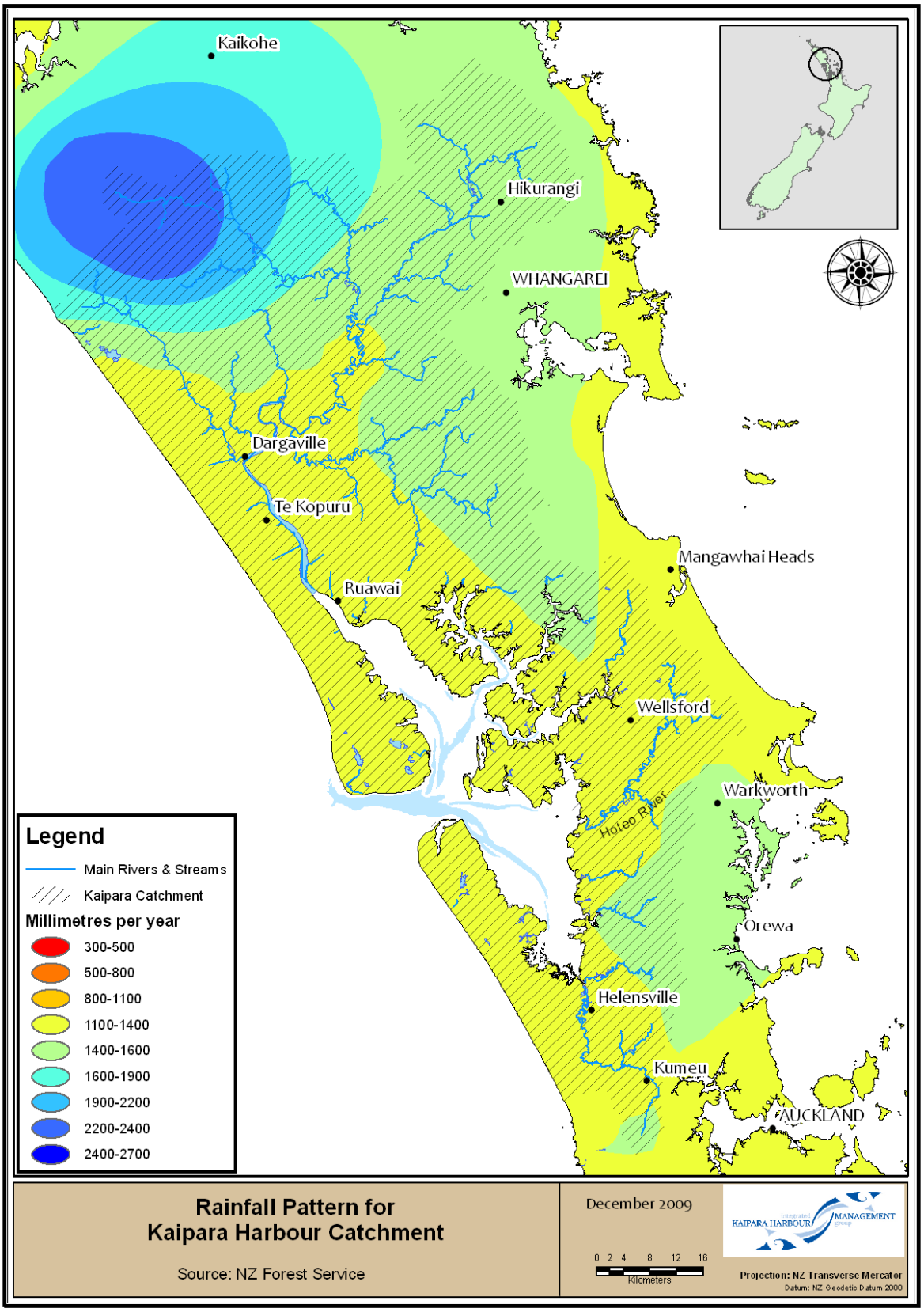


Figure 8. Landuse (Dairy Farming) in the Kaipara Catchment.

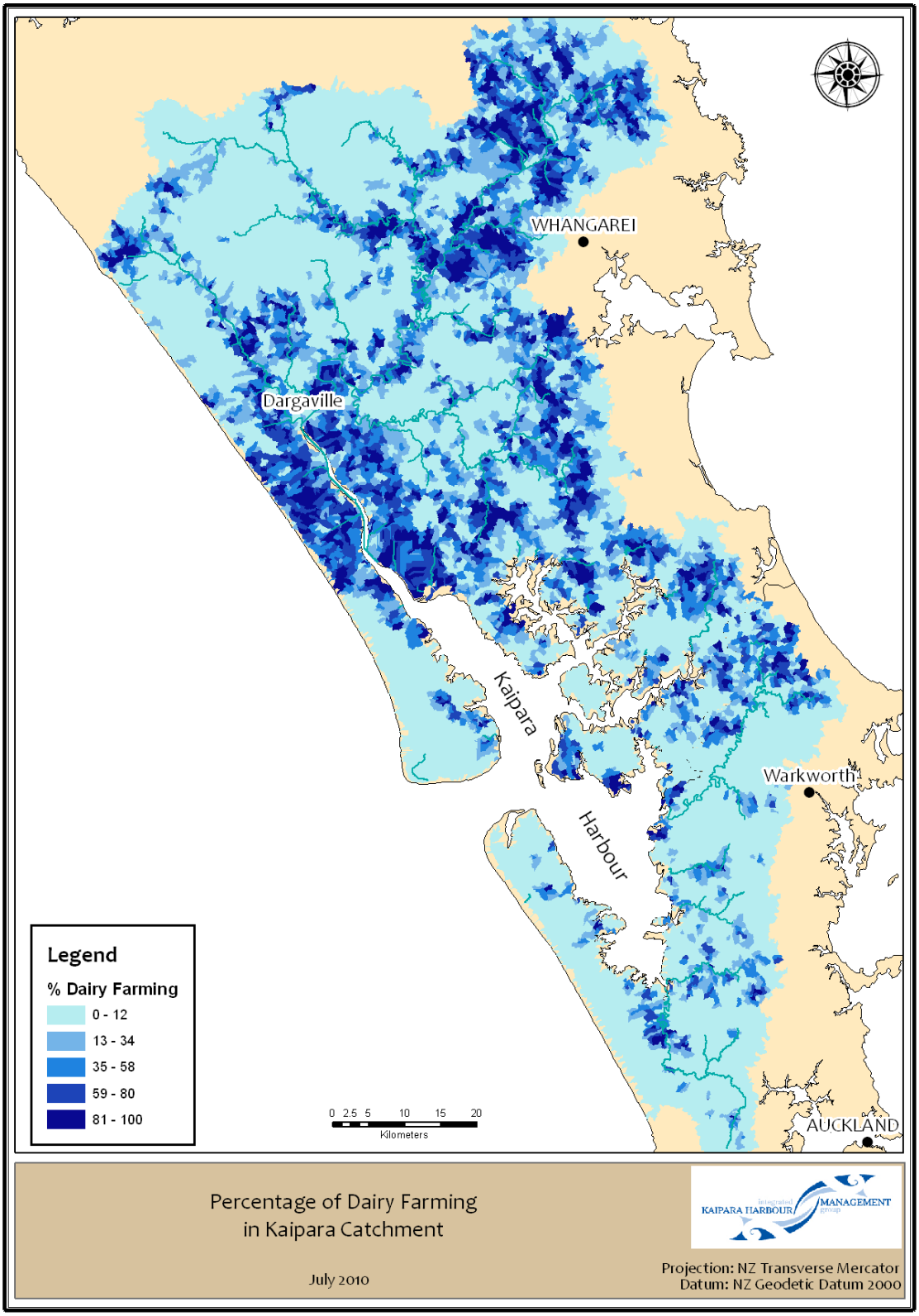
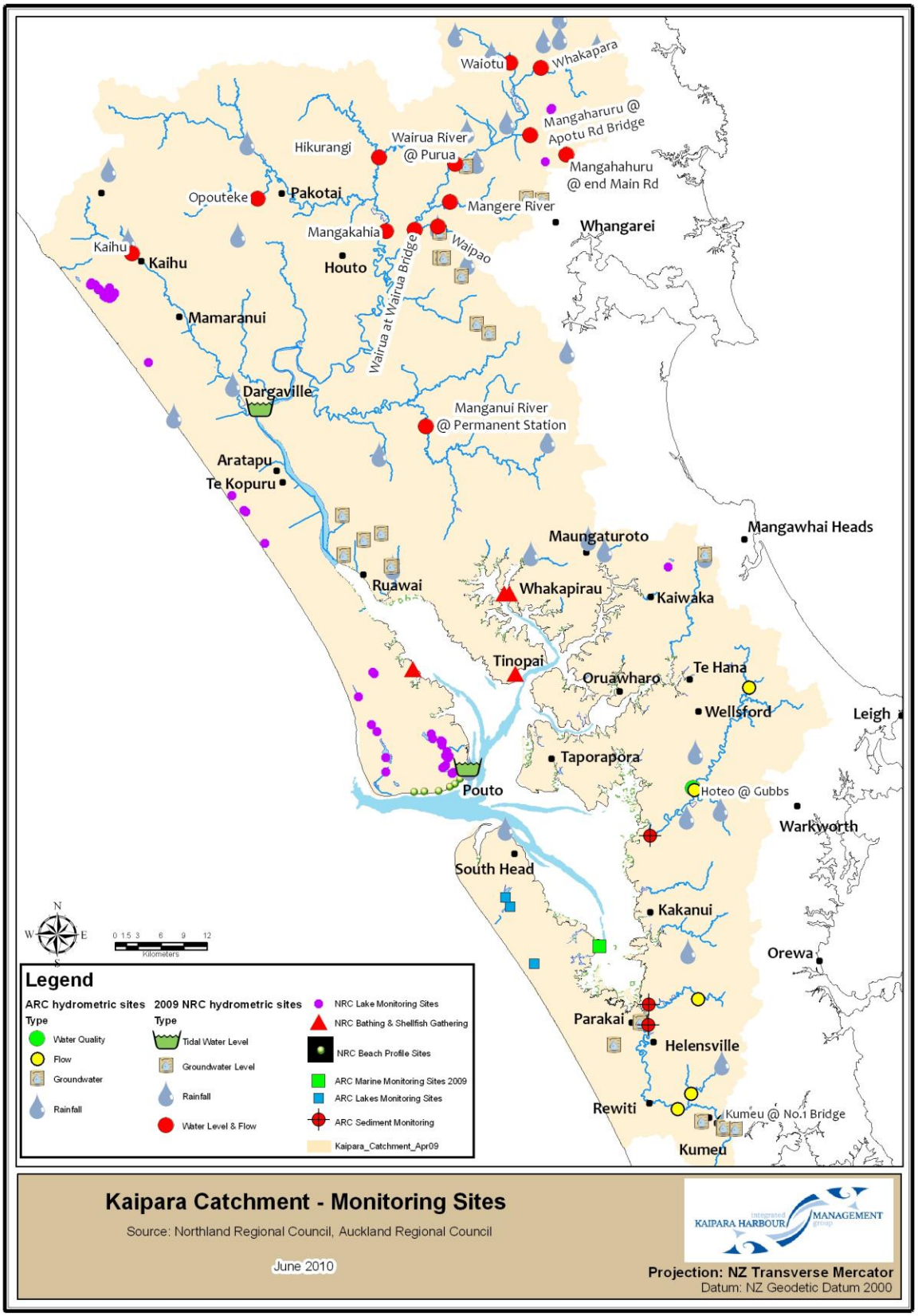


Figure 9. Location of environmental and climate monitoring sites in the Kaipara.



12.9 CURRENT & PROPOSED CLIMATE SOLUTIONS

12.9.1 SOME CLIMATE SOLUTIONS THAT THE NEW ZEALAND GOVERNMENT IS PROMOTING

- Sustainable land management and urban development: Land management refers to agriculture and forestry, which are the biggest landuses in New Zealand. In 2007, the government had established the *Permanent Forest Sink Initiative*, the *East Coast Forestry Project*, and was establishing the *Afforestation Grant Scheme*. Technological and management research is ongoing. The government is also looking at ways to affect transport, energy, industry, and household emissions (Ministry for Environment 2007d).

- Energy, transport and land management strategies – the list includes the New Zealand Energy Strategy, The New Zealand Energy Efficiency and Conservation Strategy, The Marine Energy Fund, New Energy Investment, The Forest Industries Development Agenda, Mandatory Minimum Energy Performance Standards, National Policy Statement, New Zealand Transport Strategy, Fuelsaver website, Biofuels Investment and Research, Choke the Smoke Campaign, Travel Behaviour Programs, The Walking School Bus Program, Mandatory Vehicle Fuel-Efficiency Labelling, Negotiated Greenhouse Gas Agreements with industry, Household Sustainability Campaign (EnergyWise® Homes Package and Smarter Homes campaign), Communities for Climate Protection

- Emission Trading Scheme (ETS): as described above, is an initiative to address the global climate change issue. The Government announced that an emissions reduction target range of 10-20% below 1990 levels by 2020 to signal New Zealand's commitment at the UN Climate Change Conference in Copenhagen in December 2009[4].

12.9.2 OTHER SOLUTIONS THAT ORGANISATIONS AND COMMUNITY GROUPS ARE PROMOTING

- A New Zealand government initiative delivered by the ICLEI-Oceania, the Communities for Climate Protection®- New Zealand (CCP-NZ) program began in 2004 and ended in 2009 (International Council for Local Environmental Initiatives - Australia/New Zealand 2006, 2009). These local community programs in collaboration with local councils represented 83% of the population during this period and sought to complete emission reduction projects and raise awareness of climate change. It is believed the program reported emission reductions of more than 400, 000 tonnes of GHG (International Council for Local Environmental Initiatives - Australia/New Zealand 2009).

[4] www.climatechange.govt.nz

- By 2009, there were 34 participant councils including Auckland City Council, Auckland Regional Council, Far North District Council, Kaipara District Council, and Rodney District Council. Council resources to undertake such local climate change initiatives varies between Councils.

- One of the key outputs of this program was the **New Zealand Supplement to the International Local Government GHG Emissions Analysis Protocol** (International Council for Local Environmental Initiatives - Australia/New Zealand 2008). This guideline was developed to assist local government to quantify GHG emissions from their internal operations and from their communities within their territorial boundary. This protocol describes how the principles outlined in the international protocol are to be implemented in New Zealand. The Auckland Regional Council completed a corporate and community emissions inventory in 2006 and 2001, respectively so a baseline was established to allow emission reductions to be measured. This was also carried out by Kaipara District Council and Rodney District Council at the same time. Of note was the Rodney Districts implementation of a climate change awareness program "Climate Change, Global Problem, Local Solution". In terms of their corporate actions, the Council commenced investigations and energy audits of their facilities and street-lighting (International Council for Local Environmental Initiatives - Australia/New Zealand 2009).

- To move towards sustainable business approach in the climate change environment, climate change audit by such companies as *Carbon Zero* http://www.carbonzero.co.nz/ – particularly address issues of reducing cost to business (medium to large) in areas of waste, energy efficiency and innovation/technology. (e.g. winery in south island). Is a certification initiative created through Landcare Research using over a decade of research on climate change, greenhouse gas measurement and carbon monitoring. Testimonial from Satinder Bindra, Director or Communications, United Nations Environment Program:

"The carboNZero program is an important example of how a nationally driven greenhouse gas emissions management and certification scheme can advance the global transition to low carbon economies and societies by encouraging companies big and small, organizations and even individuals to do something about their carbon footprint. It is also an inspiring example of how climate neutrality can be successfully branded and communicated to both domestic and international audiences. UNEP's Climate Neutral Network has greatly benefited from the pioneering and enriching experiences of Landcare Research's carboNZero programme and its many clients who have joined the CN Net initiative. They are a living and breathing testimony that "de-carbonizing" our communities, companies, cities and ultimately countries is both a viable and far-sighted strategy."

- Transition towns: www.transitiontowns.org.nz

- In "Turn Down the Heat: The Green Party's Proposals to Address Climate Change in New Zealand," the Green Party proposed a set of goals and policies relating to GHG emissions reductions. These strategies included the forestry, farming, air transport, and energy sectors (Fitzsimons 2006). It also addresses its climate change agenda in "Climate Change: Kicking the Carbon Habit" (Fitzsimons 2007).

- Climate change is one of Greenpeace New Zealand's campaigns. It promotes governmental action, phasing out fossil fuels, and renewable energy. It also calls for a GHG emissions reduction target of 30 percent by 2020 and 80-90 percent by 2050 from 1990 levels (Greenpeace New Zealand 2007a).

Transition Towns Aōtearoa

www.transitiontowns.org.nz

An international initiative to build self-reliant, empowered, self-sustaining communities working together to respond to environmental, economic and social challenges arising from climate change, resource depletion and an economy based on growth.

TT works at the local level to increase the ability of communities to withstand crisis and change. TT adopts four main assumptions:

1. That life with dramatically lower energy consumption is inevitable, and that it's better to plan for it than to be taken by surprise.
2. That our settlements and communities presently lack the resilience to enable them to weather the severe energy shocks that will accompany peak oil.
3. That we have to act collectively, and we have to act now.
4. That by unleashing the collective genius of those around us to creatively and proactively design our energy descent, we can build ways of living that are more connected, more enriching and that recognise the biological limits of our planet.

Transition Towns near the Kaipara:

- Kaiwaka

12.10 GAPS IN UNDERSTANDING THE IMPACTS OF CLIMATE CHANGE

Climate change is real.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) delivered its fourth assessment and stated that New Zealand's climate is "virtually certain" (greater than 99% probability) to be warmer with noticeable changes in extreme events.

Major climate change impacts include:

- Sea level rise
- Heat waves and fire are virtually certain to increase in intensity and frequency;
- Floods, landslides, droughts and storms are likely to become more frequent and intense.
- East Northland and Auckland is likely to have lower than average soil moistures causing an increase in demand for freshwater.
- Increased storm surges
- Increase in frequency of high intensity, short duration rainstorms.

Natural ecosystems, particularly freshwater, are identified as being most vulnerable to these changes and their ability to adapt to climate changes is uncertain. The rate at which climate change will occur is well in excess of the evolutionary adaption rate for many species and communities.

Climate change is not just an environmental issue but also a socio-economic and cultural issue. Climate change policy, planning and management are focused not just on the environment but also on people's homes, business, workplace and playgrounds.

Very little regional and landscape scale for planning, management and research to include climate change impacts. The DoC Conservation Management Strategies for Northland and Auckland currently do not look at adapting for climate change. There is also no climate change policy direction for fisheries management.

Large amounts of raw data climate, hazard and environmental data exists for Kaipara Harbour and catchments to begin a response to climate change. Large gap exists here in that data needs to analyses and assessed to identify most likely threats and/or benefits of climate change to Kaipara ecosystems.

The impact of such an ETS in the day-to-day lives of Kaipara communities is unknown but may become an integral part of daily living just like Goods & Services Tax (GST) when it was introduced in the 1980's.

The capacity for the World of Kaipara is adapt to climate change impacts and respond to the risks, uncertainties, challenges and opportunities will be dependent on several features. The amount and speed of climate change, degree of knowledge and education, level of

commitment towards reducing GHG emissions and supporting development of low-carbon technologies, resilience and adaptation of natural ecosystems.

12.10.1 TOP PRIORITY GAPS & OPPORTUNITIES

- **Analysis of raw climate, hazard and environmental data to develop vulnerability assessments and adaptation[5] strategies.** This data currently exists and is held by NIWA and local authorities. A gap exists in the compiling and analysis of this data to build evidence of climate change patterns. Temperature changes at Dargaville, Woodhill Forest, Riverhead Forest, Hoteo catchment, Waipoua Forest Visitor Centre has been published by NIWA and should be reviewed. Any significant trends should be noted. At these same sites, precipitation levels have been recorded. Data should be analysed and any significant events varying from diurnal and seasonal patterns should be noted.

  Flooding and coastal inundation events are recorded at Dargaville and Helensville tidal gauges and by district councils, respectively. These records need to be compiled and analysed to identify any significant events and patterns.

  Sea level change within the Harbour is also available from tidal gauges, particularly Pouto, Helensville and Dargaville.

  Analyse of this data can assist with identifying vulnerable communities around the Harbour and develop community adaption strategies through education and other initiatives.

  Particular attention should be given to the following opportunities when developing local adaptation strategies:

  - Monitoring will have a role in adapting to climate change. The establishment of long-term monitoring programs to ensure pro-active management and response. Particular attention should be given to improve long-term datasets for estuarine and marine ecosystems, especially understanding correlations are variability between oceanography and biological assemblages.
  - Development of adaptation strategies for our most vulnerable ecosystems: freshwater and estuarine-wetlands.
  - Coastal hazard planning to understand a community's coastal hazards, vulnerabilities (e.g. "Vulnerable Zones" in Flood and Erosion policy),

[5] Adaptation to climate change – *undertaking actions to minimise threats or to maximise opportunities resulting from climate change and its effects. Various types of adaptation can be distinguished:* anticipatory – *adaptation that takes place before impacts of climate change are observed;* autonomous – *adaptation that does not constitute a conscious response to climate stimuli but is triggered by other factors such as ecological change in natural systems or market changes in human systems;* planned – *adaptation that is the results of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to or maintain a required state.* (Ministry for the Environment 2008a)

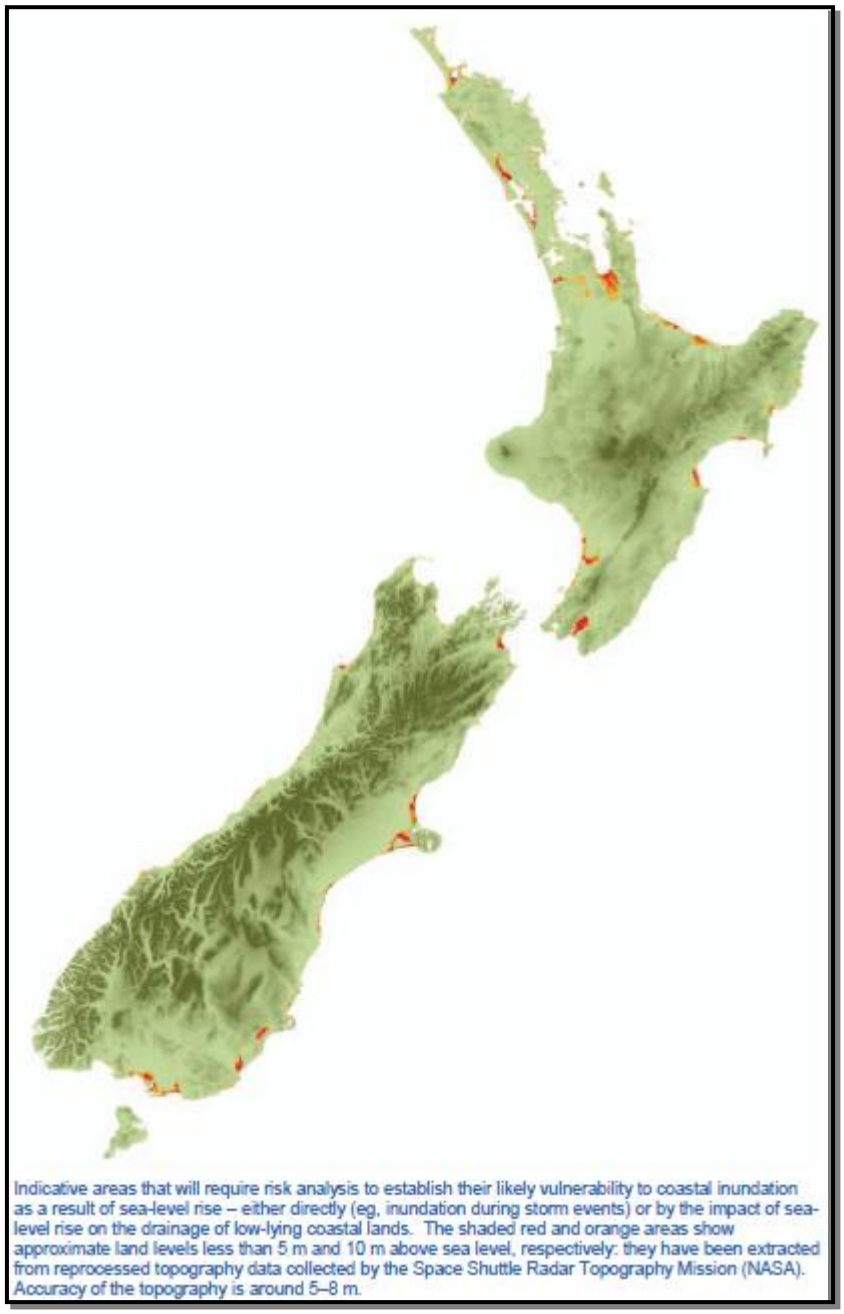
increased areas of erosion, sustainable landuse, saltwater intrusion and biosecurity risks. Ministry of Environment (2008a) coastal hazard guidance manual identifies coastal areas within the Kaipara Harbour needing risk analysis to establish likely vulnerability to coastal inundation as a result of sea-level rise (Figure 10).

- Work in partnership with Kaipara hapū and communities.
- Policy development that commits to planting trees along riparian edges, coastlines, foredunes and corridors between fragmented terrestrial ecosystems. Brisbane City Council recently (July 2010) committed to planting 2 million trees by 2012 to help make Brisbane the most sustainable city in Australia[6]. The 2 Million Trees Project will carry out largescale bushland restoration, greening infrastructure sites, and street tree plantings in order to reduce CO_2, reduce energy use and emissions and trap other GHG emissions, reduce stormwater run-off and, provide habitat for animals, birds and insects. Private property revegetation assistance is provided for private landowners to re-establish native bush through a Partnerships Program.

The New Zealand government supports and encourages organisations and communities in vulnerable sectors and regions to engage in early planning (MfE 2007a). The immediate focus for adaptation is on water, coastal issues, biodiversity, biosecurity, primary industry, infrastructure and utilities.

[6] http://www.brisbane.qld.gov.au/BCC:BASE::pc=PC_2645

Figure 10. Indicative areas that will require risk analysis to establish likely vulnerability to coastal inundation. (Source: MfE 2008a).



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