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Manatū Ahu Matua

Aohanga Incorporation: Climate change mitigation and adaptation:

A social process framework for engagement and the development of a climate change resilience strategy

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Executive Summary

The Aohanga case study was a one-year Sustainable Land Management and Climate Change (SLMACC) Project funded by the Ministry of Primary Industries and the Ministry of Science and Innovation. The purpose of the project was to, in collaboration with Aohanga Incorporation, develop a science-based climate change resilience strategy for Aohanga's multiple owned Owahanga Farm Station and to develop a social process framework for engaging rural communities and land-owning Iwi Incorporations in climate change mitigation and adaptation. Following the 2009 United Nations Framework Convention on Climate Change Copenhagen conference, there has been an increased focus on the relationship between climate change and agriculture. Agriculture is recognised as: one of the causes of climate change; an important sector impacted by the affects of climate change; and a potential contributor to climate change solutions.

Because New Zealand is a country heavily dependent upon agriculture for economic and social prosperity, resilience to the impacts of climate change on agriculture is essential to our future prosperity. As a global citizen and a signatory to international climate treaties, New Zealand has a responsibility to reduce national greenhouse gas (GHG) emissions. In order to achieve New Zealand's international GHG emission targets and obligations, agriculture and forestry will need to adopt mitigation and adaptation practices.

A suite of agricultural mitigation and adaptation strategies and technologies have been developed, and government agencies are keen to see enhanced uptake by the New Zealand rural community. The efficacy of new management practices and technologies for climate change mitigation and resilience is dependent upon land owner adoption. Therefore, much of New Zealand agriculture's resilience and response to climate change is dependent upon individual or group decision-making regarding the adoption of new practices and technologies. By using a case study approach with a Maori Incorporation, this project sought to understand climate change resilience issues and potential mitigation and adaptation strategies, and develop a framework for enhancing climate change understanding and adoption of resilience strategies by rural land owners and land owning Iwi Incorporations.

Aohanga Incorporation is a Māori land-owning entity with approximately 1400 geographically dispersed shareholders. It has a seven member elected Committee of Management responsible for governance and a farm manager responsible for day-to-day farm management. Aohanga Incorporation's major asset is the Owahanga Station, a 7142 ha farm block, 77Kms southeast of Dannevirke on the Wairarapa coast, between the Owahanga River in the north and the Maitaikona river in the south. On the west the property is bordered by the Makatote and Waingongoro streams and on the east by 14 kms of sand country Pacific Ocean coastline. The core business of Owahanga station is sheep and beef with some forestry, a small quantity of olive trees and some apiaries.

The project involved a series of iterative workshops or hui with Aohanga and the science team in order to determine and explicate: the purpose, process and deliverables of the project; the research partner roles; Aohanga's initial questions and queries regarding climate change; the potential impacts of climate change at the national and regional level (i.e., Wairarapa) at 2040 and 2090; identification of potential mitigation and adaptation strategies for Owahanga Station; the opportunities presented by these strategies; the barriers to their implementation; Aohanga's questions regarding these strategies and the science team's responses; and the fit of the potential strategies with Aohanga's values and aspirations for Owahanga Station.

At a hui held on 9th Dec. 2011, James Renwick from NIWA presented an overview of projected climate change impacts at global and national levels and downscaled to the local Wairarapa region. Principal impacts this century were identified as: increasing weather variability, 2-3° Celsius temperature rise, increasing frequency and severity of extreme weather events (with erosion potential), less rainfall in winter and spring (drought risk), sea level rise 0.5 – 1m+, increasing ocean acidification and ocean temperature, biodiversity and biosecurity issues including species migration (e.g., weeds, pests, disease vectors). This climate change impact work was also presented as a project output report (Renwick and Sturman, 2012).

Other science presentations included: agro-forestry and climate change (Luke Barry, Scion), climate change and aquaculture opportunities (Mike Mandeno – Cawthron Institute), sustaining the pasture base for agriculture (Alec Mackay – AgResearch), GIS maps of the property (Andrew Manderson – AgResearch) and computer based models for analysing financial, environmental and social consequences of different land use options (Oscar de Montes – AgResearch). A brainstorm session identified 15 potential resilience strategies (and targets). This information, along with a summary of the discussion, is reported in a document produced for Aohanga Incorporation (Aohanga Climate Change Report: Presentations from a Hui Held on the 9th December 2011).

Aohanga Incorporation then worked with the identified potential strategies to ascertain the fit of each strategy with their values and aspirations for the Owahanga Station. They also developed a list of questions they had in regard to each strategy and, additionally, they identified four strategies of particular interest (and good fit with their values and aspirations) that they would like to have further analysed by environmental, financial and social impacts modelling. These four resilience strategies are: water harvesting, erosion control throughout property and along coastline, strengthening core business (i.e., sheep and beef enterprise), and building soil humus and carbon sequestration. Modelling of these strategies was addressed in a parallel core funded AgResearch project. Two of Aohanga's other strategic development strategies, carbon forestry and wind/biofuels energy generation, are also strategies for climate change mitigation.

A hui was held on the 16th July 2012 to present to Aohanga an outline of a climate change resilience strategy (Bruce Small – AgResearch) and a framework for analyzing the social return on investment of climate change resilience strategies and other potential diversification strategies and business enterprises (Oscar de Montes – AgResearch). Climate change resilience is both a sustainability issue and a strategic issue. Therefore, a key element of the climate change resilience strategy was embedding it in Aohanga's strategic development plan and ensuring consistency with Aohanga's values and aspiration for their land (which includes intergenerational sustainability).

Other elements of Aohanga's climate change resilience strategy include: awareness and acceptance of potential local climate change impacts, climate change sensitivity and vulnerability analyses (land and business enterprises), local knowledge, documentation and matauranga Māori regarding the history of the land and past extreme events, digital elevation modelling (LiDAR) of Owahanga Station for the purpose of high tide and flood modelling and identification of potential water storage sites and future infrastructure development (e.g., access roads and buildings), familiarity with and training in the use of a range of computer models for ongoing monitoring of climate change impacts and analyzing financial, environmental and social impacts of land uses and business enterprises (e.g., Farmax, Overseer, MyLand, whole farm models and water and carbon footprinting). This information

is documented in a climate change resilience strategy report produced for Aohanga (Owahanga Station Climate Change Resilience Strategy – AgResearch Client Report).

The project also produced a report for the Ministry of Primary Industries with a focus on a social process framework for community engagement for the development of a climate change resilience strategy (i.e., this report). The social process framework includes a range of potential elements sorted into three stages: Pre-engagement, engagement, and post-engagement elements. The social process framework elements may be selected for use dependent upon the particular circumstances of the community involved. Some elements of the framework are suitable for all land owners while, because of the nature of the research project and the case study, other elements are more suited to use for the engagement of Maori Incorporations or Trusts.

Barriers encountered to the research project and the development of a resilience strategy for Owahanga Station and consequent lessons for similar future research projects, or a climate change resilience rollout programme, are also discussed. One important lesson, which echoes previous findings from public and community engagement research, is the necessity to allow adequate timeframes for community organisations to discuss, consider and respond to the issues and engage with the scientific community in the development of policy and strategy.

OUTPUTS OF THE CURRENT PROJECT

Below are listed the outputs of the current project – both those that have already been delivered and those that are currently planned for the near future.

Delivered to MPI

1. Small, B. (2012). Aohanga Incorporation: Climate change mitigation and adaptation: A social process framework for engagement and the development of a climate change resilience strategy. MPI discussion paper.

Delivered to Aohanga

2. Small, B., Montes de Oca Munguia, O., Renwick, J., Mandeno, M., Barry, L., Mackay, A., Manderson, A., and White, T. (2012). Aohanga climate change resilience project: Presentations from hui 9th December 2011. AgResearch Client Report.
3. Renwick, J., & Sturman, J. (2012). Climate change information for Aohanga Incorporation case study. Wellington: NIWA.
4. Small,B., Montes de Oca Munuia, O., Lieffering, M., Newton, P., Li, F., Vibart, R. Barry, L. and Heubeck, S. (2012). Aohanga climate change project: Presentations from hui 16th July 2012. AgResearch Client Report N. RE500/2012/001.
5. Small, B. Aohanga climate change resilience strategy. AgResearch Client Report (To be delivered in September 2012).
6. Dahm, J. (2012). Coastal erosion control strategy for Owahanga Station. Client Report. (To be delivered in November).

Academic output

7. Montes de Oca Munguia, O. and Small, B. (2012). Facilitating a climate change resilience strategy on a large Māori owned station. (Paper submitted and accepted for presentation at the International Rural Network World Forum, Whyalla, Upper Spenser Gulf, September 24-28th 2012).

Introduction

This is the final report of the MAF/MSI funded Sustainable Land Management and Climate Change (SLMACC) project C10X1003 – Aohanga Case Study. During the SLMACC bidding process the research team identified an opportunity to build upon an existing relationship with Aohanga Incorporation (a Māori land-owning legal entity), developed through the FRST funded Iwi Futures project (MAUX0711).

STRUCTURE OF THE REPORT

This report has three sections plus three appendices. The Introduction consists of a statement of the aims of the project and the project background including a review of a range of literatures of generic relevance to the case study. The second section, entitled "Developing a climate resilience strategy with Aohanga Incorporation" describes the stages and development of the strategy as well as some results. The third section, entitled "Social process frameworks for engaging with rural communities and rural Māori communities in climate change resilience, mitigation and adaptation" draws together the relevant generic literature and reviews some existing engagement frameworks, both international and national, with experience from the current project to make recommendations about approaches to engagement and engagement frameworks. However, engagement is a crosscutting social process and factors influencing engagement are distributed and discussed across all sections of this report.

AIMS OF THE RESEARCH PROJECT

The overall aim of the project was to, in collaboration with Aohanga Incorporation, enhance Iwi Incorporation adoption of climate change interventions, consistent with their farm systems and values. Through the use of a case study approach, our intention was to identify crosscutting influences on land owner decision-making in order to facilitate science informed solutions to climate change. There were two main secondary aims and deliverables of the project:

1. A climate change resilience strategy for Aohanga Incorporation's Owahanga farm block; and
2. A social process framework, for engaging with Māori Incorporations responsible for the management of multiple owned lands, for the development and adoption of mitigation and adaptation strategies for resilience to the impacts of anthropocentric climate change. Some aspects of the social framework will be Māori specific while other aspects will have a more general application i.e, to other land owners and communities

To achieve the two above aims the work was guided by a set of eight steps or objectives:

1. The development of climate change impact scenarios for the Aohanga Incorporation with particular reference to their Owahanga Station;
2. Identification of Aohanga Incorporation's questions regarding climate change and the provision of science based responses/answers;
3. Identification of climate change mitigation and adaptation strategies or practices for Agro-forestry production;
4. The identification of barriers to the adoption of mitigation or adaptation strategies and Aohanga Incorporation's questions and queries regarding the potential strategies;
5. Identification of Aohanga incorporation's values and aspirations regarding their land and the evaluation and determination of the climate change resilience strategies and practices that best fit these values and aspirations;

6. The development of farm/forest scale economic cost benefit analysis of the interactions between climate change impacts and Aohanga Incorporations preferred mitigation and adaptation practices;
7. The identification of biological and social science knowledge gaps; and
8. The development of a mitigation/adaptation plan for resilience to climate change for the Owahanga Station.

BACKGROUND TO THE PROJECT

As background to the research project, we first state the research problem and discuss some very generic social context (psychological and sociological factors) affecting attitudes and responses to climate change and climate change impacts. These generic social factors underlie the development of a social framework for engaging land owners in climate change resilience actions. This is followed by a brief consideration of climate change issues pertinent to land owners and agricultural resilience. Then we take a more detailed look at the potential impacts of climate change on Māori and engagement of Māori agricultural communities and incorporations in climate change resilience research and behaviour and practice change. Finally, in the Introduction section of the report, as contextual background we provide reference information about Aohanga Incorporation and their Owahanga Station relevant to climate change.

The research problem and the generic social context

To achieve New Zealand's international green house gas emission targets and obligations agriculture and forestry will need to adopt mitigation and adaptation practices. Since the 2009 United Nations Framework Convention on Climate Change Copenhagen conference, there has been an increased focus on the effects of agriculture on climate change and the impacts of climate change on agriculture (2011). Thus, agriculture can be seen "as both a cause and a solution" to climate change (Almås, et al., 2011, p. 164).

Currently, the costs and benefits of mitigation and adaptation practices are unknown with respect to financial, social, cultural and environmental values. A suite of mitigation and adaptation strategies have been proposed or developed, however, uptake is considered slow (Green Growth Advisory Group, 2011). While new management practices and technological approaches are essential to climate change intervention and resilience, they remain only potentially useful if individuals and organisations do not adopt them. Therefore, solutions rest on individual or group decision-making regarding practice change and technological adoption.

In New Zealand, Māori Incorporations administer large and diverse agricultural enterprises. They have concerns and questions about climate change and intervention strategies and seek a science-based understanding of their impacts and potential resilience solutions to help inform their decision-making (Harmsworth, 2012). This project seeks to address this issue in a case study approach with Aohanga Incorporation.

However, from a long-term strategic perspective, other factors (not specifically addressed in this report) also need to be considered in conjunction with agriculture and climate change (Biermann, et al., 2012; Brown, 2008; Raven, 2002). Principal amongst these are: increasing demand for food caused by rising population and changing food tastes, such as increased consumption of meat (Brown, 2008; Cohen, 2003), peak oil or the inevitable depletion of planetary oil reserves upon which current food production is highly dependent (Pimentel, Pimentel, & Karpenstein-Machan, 1999; Youngquist, 1999), increasing water scarcity (Brown, 2008; Gleick, 2003; Vorosmarty, et al., 2004), and erosion and depletion of soil

(Fedoroff, et al., 2010; Lal, 2007; Pimentel & Sparks, 2000). The production of biofuels to mitigate oil depletion will provide competition for land currently used for food production.

Population growth (from the current 7 billion to approximately 9.2 billion by 2050) will increase demand for food, which in turn will place increased pressure for oil use for the production of food on diminishing available agricultural land. Increased oil use means increased climate change emissions. In turn climate change will exacerbate water scarcity, erosion and soil depletion and agricultural production capacity per land unit area (Brown, 2008; Fedoroff, et al., 2010). Thus, on a planetary scale we face an issue of self-reinforcing problems that require urgent action on an unprecedented scale (Biermann, et al., 2012; Brown, 2008; Fedoroff, et al., 2010; Lubchenco, 1998; Raven, 2002).

Synergising local/personal benefit and global altruistic benefit

The adoption of mitigation strategies, for the purpose of helping to achieve New Zealand's international obligations, such as the Kyoto Protocols, is one aspect of rural climate change action (with long-term global benefits). Another aspect, perhaps more directly pertinent to land owners, is adaptation and resilience to the economic, environmental, social and cultural impacts of climate change on their land, businesses and communities (i.e., local/ personal benefit). The former, mitigation aspect of climate change resilience, is related to participation in a global process to reduce atmospheric CO_2e (carbon dioxide equivalent greenhouse gas) to mitigate the effects of climate change. This is a form of global citizenship and action to reduce green house gas emissions and/or remove carbon from the atmosphere to ameliorate the projected negative consequences of anthropogenic global climate change. The sooner mitigation responses are adopted, the more useful and effective they will be. However, at present, mitigation action generally appears to have a more altruistic (being for the benefit of all), future orientation, and is subject to the effect known as "the tragedy of the commons".

This is an effect named and described by Hardin (1968) which essentially states that individual rational behaviour (the maximisation of individual short-term gain) can cause long-term harm to common pool resources (e.g., the environment) with eventual negative impacts on both other users of the resource and ultimately oneself. Scholars, such as Ostrom and colleagues (e.g., Dietz, Ostrom, & Stern, 2003; Gleick, et al., 2010; Ostrom, 1990, 2011), and Sabatier and colleagues (Leach, Pelkey, & Sabatier, 2002; Leach & Sabatier, 2005; Weible, Pattison, & Sabatier, 2010; Weible, et al., 2011) have argued that the tragedy of the commons is not an inevitable consequence of human nature. They proposed analysis frameworks to identify particular situations in which human collaboration can counter tragedy of the commons behaviour and effects. This includes identifying elements important to the success or otherwise of collaborative action. Nonetheless, the tragedy of the commons is a powerful effect and current international policy attempts at collaboratively addressing anthropogenic climate change and target CO_2e emissions are considered to be falling well short of the biophysical reality that confronts us (Anderson & Bows, 2008).

The latter aspect of climate change resilience for land-owners and land owning entities, that is, adaptation for resilience to the economic, environmental, social and cultural impact of climate change on their land, businesses and communities, generally has a less altruistic focus. Although in some cases, such as Māori Incorporations, it may also have a focus on the protection of future generations. However, its primary focus tends to be on the personal (or organisational) wellbeing of the land-owners with respect to their business, the state of their property, their social reality and their cultural values. Provided one accepts the premise of climate change (anthropogenic or otherwise), motivation to participate in behaviour or practice change for resilience to these impacts is much closer to home in personal impact and

benefit. However, because climate change impacts are largely located in the future, adoption of adaptation strategies are currently subject to time discounting (discussed below).

Mitigation acts to limit the rate and magnitude of atmospheric CO_2e concentrations, thus reducing climate change impacts. Whereas, adaptation is a response to cope with, or exploit for beneficial opportunity, the projected and actual impacts of climate change. Without mitigation, climate change impacts will be more severe and the adaptation required more extreme, disruptive, transformative, and potentially difficult and costly to implement (Kates, Travis, & Wilbanks, 2012). Therefore, both mitigation and adaptation are important to enhance climate change resilience. Resilience is defined by the IPCC (2012a, p. 5) as: "The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions."

In order to encourage individual (or organisational) behaviour and practice change for long-term global benefit, it is important that social frameworks for engaging land-owners in climate change resilience seek to synergistically integrate local and global reasons for taking action. That is, strategies for the mitigation of atmospheric CO_2e should also be demonstrated (where empirically possible) to be consistent with personal or local benefits associated with changed behaviour and practice. In particular, two goals which land-owning businesses may have may provide an entry point for creating this synergy: *local ambitions for sustainable development* (Halsnaes & Verhagen, 2007; Metz & Kok, 2008) and *disaster risk reduction from extreme events* (IPCC, 2012a). This may help to mitigate the negative impact of the tragedy of the commons effect. It may also provide a criterion for identifying the "low hanging fruit" of climate change resilience action.

However, a difference between behaviour for global benefit and local benefit is the temporal framework in which the action needs to take place. As discussed in the next section on climate change, it is imperative that mitigation action to avert or ameliorate global climate change impacts occurs almost immediately to enhance its future benefits (i.e., reduce projected impacts). However, the benefits of such actions will primarily occur for generations subsequent to current decision-makers. On the other hand, adaptation action for local benefit, in many cases, can be left for the future because the local impacts will occur in the future (perhaps even after current decision-makers are retired or dead), and people see little urgency to act in the present. Except, perhaps, as part of a long-term developmental strategy. However. for most businesses climate change is a much longer term process than usual strategic business planning timeframes.

Time discounting, decision-making under uncertainty, prospect theory and issue framing,

This problem is exacerbated by a psychological phenomenon known as time discounting, time preference or inter-temporal choice. While there are slight theoretical distinctions between these terms, for the current purposes it suffices to say that humans tend to place greater preference on rewards that are in close temporal proximity than on rewards that are more temporally distil (Frederick, Loewenstein, & O'Donoghue, 2002). Therefore, a second important psychological component of a general social framework for climate change resilience is appropriate framing of the *decision and choice issue* (Tversky & Kahneman, 1981) to minimise temporal discounting and emphasise the urgency of the required changes – particularly with respect to mitigation activities.

In a related inter-temporal choice effect, people tend to procrastinate or delay action to a future time to an increased extent when the immediate effort required is large rather than if it

is relatively small (Frederick, et al., 2002). Importantly, it has been shown that people are more able to hit a future target if they plan in incremental action and temporal steps. Thus, if they wish to make, for example, a 20% reduction in the next ten years, they are more likely to achieve this target is they break it into two (or more) relatively even steps e.g., a 10% reduction in the first five years, then another equivalent reduction in the following five years (Frederick, et al., 2002). This suggests another general psychological principle underlying social engagement frameworks, *the planned and staged introduction of the adoption of climate change resilience behaviours*. This might be considered part of framing of the *proposed solution choices* based upon a psychological understanding of human nature, goal setting behaviour and inter-temporal choice. However, incremental adaptation will be more successful if climate change impacts are moderate rather than large – again, suggesting the importance of early mitigation to successful latter adaptation.

Considerable research has been conducted into time discounting with a number of moderating and mediating effects being found (Frederick, et al., 2002). Although not discussed further in this report, this is potentially a fertile area of study for the extraction of general psychological principles for engagement frameworks for land owners and communities in climate change resilience action. For example, a number of studies have indicated a 'sign effect' – that gains are time discounted at a greater rate than losses (e.g., Thaler 1981, Loewenstein, 1987). Another moderator of time discounting relevant to climate change resilience is the 'magnitude effect' that small outcomes are discounted more than large outcomes (e.g., Thaler 1981, Loewenstein, 1987).

Given the degree of uncertainty that exists around the specific risk and the magnitude and timing of the impacts of climate change (discussed in the next section), the work of Tversky and Kahneman, in particular judgement under conditions of uncertainty (Tverski & Kahneman, 1974), and prospect theory (Kahneman & Tverski, 1984; Tversky & Kahneman, 1991) are also important theories to consider for a general framework of social engagement about climate change. Perhaps particularly important is prospect theory, which defines value as deviations from a reference point e.g., losses or gains relative to the status quo. Losses loom larger than gains – people are prepared to take a larger risk in order to avoid a loss than make a gain of equal value - and decision-makers are biased in favour of retaining the status quo.

This represents a barrier to action in the case of climate change mitigation and adaptation. Although some gains and efficiencies may be made, some losses are also inevitable and this tends to loom largest in people's perception. Anecdotally, New Zealand farmers' resistance to including agriculture into emissions trading schemes is an example of the pressure to maintain the status quo when a loss to their freedom to act or their income stream seems consequent (it might also be considered an example of the tragedy of the commons). Thus, whether climate change actions are framed as future losses or gains effects the decision to act and the amount of risk individuals and groups are willing to put up with to maintain the status quo. Again, this highlights the importance of issue and action response framing in climate change engagement with both the public and the rural sector.

The above few examples of generic social factors affecting willingness to engage in climate change resilience planning and actions are psychological barriers or enablers (sometimes reverse sides of the same coin depending upon the framing). A report of the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change (2010) identified a fuller range and specific sequence of psychological barriers to climate change action. The barriers and the sequence they identified were:

1. **Ignorance -** lack of awareness of the problem or specific actions to help address it.
2. **Uncertainty** – (discussed in more detail below) is often used as a justification for inaction or to postpone action- note that this is contrary to the precautionary principle.
3. **Mistrust and reactance** – distrust of risk messages from science and government and negative reaction against policy advice.
4. **Denial** – either of climate change or humanity's role.
5. **Discounting** – (time discounting was one of the example psychological barriers discussed above), however, spatial discounting may also occur – such that if impacts are not projected to be so bad in the local environment the need for mitigation action (for global benefit) is reduced.
6. **Place attachment** – populations with greater historical geographic mobility may be less attached to particular places and less willing to act for their benefit.
7. **Habit** – habitual behaviours while extremely commonplace are extremely resistant to change. Where habitual behaviour is contrary to good climate change behaviour (e.g., driving cars, international travel, rampant consumerism) habit poses a considerable barrier.
8. **Perceived behavioural control** – if individuals believe their behaviour has little control over the problem outcome they are less likely to act.
9. **Perceived risks from behaviour change** – adopting new behaviour may carry a range of perceived and/or real risks – e.g., functional, physical, financial, social, psychological and time loss.
10. **Tokenism and the rebound effect** – lower cost behaviours are favoured over higher cost but more effective mitigation behaviours (tokenism). The rebound effect – i.e., new more efficient technology may lead to an increased use of the technology such that any savings are exceeded by the costs of the changed behaviour e.g., efficient heat pumps resulting in decreased cost may lead to an increase in home heating (for the same cost as previously) resulting in greater energy use rather than reduction.
11. **Social comparison, norms, conformity and perceived equity** – e.g., in resource dilemmas perceived inequality reduces cooperation. This effect is clearly demonstrated in the conflict between the first world and the third world over who and what actions should be taken regarding mitigating climate change. Peer norms are a strong control on social behaviour.
12. **Conflicting goals and aspirations** – common goals and aspiration, such as owning a big house, flash car, overseas vacations etc. – desirable things that exacerbate climate change causes can trump goals of mitigating climate change.
13. **Belief in solutions outside human control** – the irrational belief that "mother nature" or "God" will not allow disaster to occur.

Other important psychological fields of study and theory that may also contribute to the development of generic social processes for community engagement in climate change resilience include the literatures on risk analysis, risk perception and management, stress and coping behaviour, and disaster response and prevention. Given that climate change is an inter-generational (and intra-generational) justice and ethics issue, a focus on ethics and societies ethical and social norms is also highly relevant. This section has provided a very brief overview of a few of the generic psychological and sociological factors underlying social framework issues that are applicable to nearly all individuals or organisations with respect to the adoption of climate change resilience strategies and practices. Next, we briefly consider general issues of concern regarding climate change.

The climate change problem

Climate change is defined as changes over time in the averages and variability of surface temperature, precipitation, and wind as well as associated changes in Earth's atmosphere, oceans and natural water supplies, snow and ice, land surface, ecosystems, and living organisms (IPCC, 2007d).

Global warming and sea level rise: causes and impacts, certainty and uncertainty

Although significant portions of the public and the agricultural community question the validity of anthropogenic climate change (Evans, Storer, & Wardell-Johnson, 2011), the almost universal scientific consensus is that it is real (Oreskes, 2004). Indeed, statistical analysis indicates, with a high degree of confidence, that recent extreme high temperature anomalies such as the Moscow 2010 and Texas and Oklahoma 2011 are a consequence of global warming (Hansen, Sato, & Ruedy, 2012). There is also scientific consensus that, due to the extended lifetime of many greenhouses gases in the atmosphere, a degree of change is now inevitable, because of emissions that have already occurred (IPCC, 2007c). However, the exact magnitude and timing of climate change impacts is subject to considerable uncertainty involving feedback loops that are not yet well understood. These include CO_2 and methane release from warming tundra and permafrost (Davidson & Janssens, 2006; Oechel, et al., 1993), changing absorptive capacity of natural sinks as temperature rises (Anderson & Bows, 2008), and reduced albedo feedback caused by diminishing ice surface (Hansen, et al., 2008).

Another source of uncertainty lies in the fact that we cannot accurately predict what new technologies will be developed in the coming years and how new technologies will be able to address climate change issues. While it is almost certain that new and potentially useful technologies will be developed, it is not clear *how* useful they will be, nor is it clear that humanity will use any such technologies in an appropriate way, as history and the rebound effect show (Gotton, 2001; Jevons, 1865). Considerable uncertainty also stems from the fact that we do not know how humans will respond to the threat of climate change, although currently humanity appears to be taking little real action to address it. The imperative for humanity, the situation that requires global collaborative action to avoid, is expressed by Kolbert (2006, p. 189): "It may seem impossible to imagine that a technologically advanced society could choose, in essence, to destroy itself, but that is what we are now in the process of doing."

Most of the actions proposed by politicians and policy-makers are considered inadequate by the science community, if the aim is to avoid exceeding the politically accepted target of 2°C temperature rise threshold (Anderson & Bows, 2008; Hansen, et al., 2008; Rockström, et al., 2009). This suggests that while mitigation is necessary and appropriate it is unlikely to be adequate to forestall the major problems associated with climate change, and, in the long term, adaptation will necessarily end up being humanity's primary response to climate change. In the very long-term, managed retreat may be the primary adaptation to avert the impacts of sea level rise and global temperature rise. The system wide magnitude of the required change is highlighted by a recent warning from the science community:

> …human activities are moving several of the Earth's sub-systems outside the range of natural variability typical for the previous 500,000 years. Human societies must now change course and steer away from critical tipping points in the Earth system that might lead to rapid and irreversible change. This requires a fundamental reorientation and restructuring of national and international institutions towards more effective Earth system governance and planetary stewardship….As a general conclusion, our work indicated that incremental change…is no longer sufficient to bring about societal

> change at the level and with the speed needed to mitigate and adapt to Earth system transformation. Structural change in global governance is needed, both inside and outside the UN system and involving both public and private actors.
>
> (Biermann, et al., 2012, p. 1306)

Climate change is a consequence of pollution from oil and coal use, along with chemical pollution from industrial and agricultural production resulting in changing chemical composition of the atmosphere (Raven, 2002). The primary cause is the use of fossil fuels for energy. Globally, in 2004, sector contributions to GHG emissions were as follows. Energy supply generated 25.9%, industry 19.4%, forestry 17.4%, agriculture 13.5%, transport 13.1%, residential and commercial buildings 7.9%, and waste and waste water 2.8% of all GHGs (IPCC, 2007d). The major agricultural GHG are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). According to the IPCC "Global atmospheric concentrations of CO_2, CH_4 and N_2O have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years" (IPCC, 2007d, p. 5). Between 1990 and 2005 N_2O and CH_4 emissions increased by approximately 17%. In 2005, globally, agricultural emissions accounted for 60% of N_2O and 50% of CH_4 emissions (IPCC, 2007a).

The world is heavily dependent on fossil fuels for energy. At the turn of the millennium only 5% of energy came from other sources (Chow, Kopp, & Portney, 2003). Although some commentators hope for a technological revolution in energy generation and storage (e.g., fusion technology and superconductor technology), it seems highly likely that oil and gas will continue to be our main source of energy for the next 30-50 years. Currently, no other alternatives are viable or provide the advantages of the energy density of petroleum. The AR4 estimates that between 2025-2030 more than 80% of all energy use will still be derived from fossil fuels (IPCC, 2007e). Without energy we cannot grow the food we need to feed our burgeoning population (Youngquist, 1999), nor live the lifestyles that our technological infrastructure not only allows, but also locks us into.

The IPCC projections suggest that by 2100 planetary average temperature will increase by 1.1-2.9 degrees centigrade, on a low scenario, and by 2.4-6.4 degrees centigrade, on a high scenario. Hansen, Sato and Ruedy (2012, p. 1) note that in the past 30yrs there has been an "emergence of a category of summertime extremely hot outliers, more than three standard deviations warmer than the climatology of the 1951-1980 base period." The IPCC claims that the current anthropogenic causes will continue to increase global temperature and sea levels for at least a millennium due to the timescales required to remove greenhouse gasses from the atmosphere (IPCC, 2007c). Projected changes in temperature and sea level rise over the next millennium greatly exceed the 2100 projections. If all remaining fossil fuels are burnt (and this seems a possibility because as previously noted we have no practical energy alternatives available in this timeframe), temperature rise by the second half of the millennium, by some estimates, will be between 4-9 degrees Celsius and sea level rise between 3-8 metres (Hasselmann, et al., 2003).

More recent scientific studies indicate that the AR4 IPCC projections are very conservative (Meier, et al., 2007; Met Office Hadley Centre, 2009; Rockström, et al., 2009; Vermeer & Rahmstorf, 2009). Research summarising 400 scientific studies conducted since the AR4 IPCC report indicated that the actual situation is worse than the worse case IPCC scenario (United Nations Environment Programme, 2009). If current emissions continue unabated, a 4° Celsius average global temperature increase is likely between 2050 and 2100. A global temperature increase of this level would mean much greater warming in various regions (e.g., up to 15° C in the Arctic and up to 10° C in western and Southern Africa) along with major

worldwide changes in rainfall patterns. These conditions are expected to have extremely negative consequences for food security, water availability, and human health (Costello, et al., 2009; Met Office Hadley Centre, 2009).

Pre-industrial (i.e., 1750 AD) levels of atmospheric carbon dioxide were about 280ppm (parts per million). Present levels are around 387ppm. Hansen et al. (2008) calculated from paleoclimatic data that, in order to avoid ecological tipping points, safe levels of atmospheric carbon dioxide are between 300-350ppm (in contrast the IPCC is currently aiming to keep atmospheric carbon levels below 450ppm). Due to the long time lag between atmospheric carbon build-up and temperature and sea level rise, Hansen et al. recommended 350ppm as an upper limit.

According to Hansen et al. (2008), paleoclimate history suggests that, at 387ppm, equilibrium sea level rise will be at least several metres. If this is the case, then to reduce the most dramatic, irreversible climate change effects we need to decrease the current levels of atmospheric carbon, rather than merely slowing the rate of growth of carbon pollution back to 1990 levels, as is the current political ambition. In fact, the rate of carbon pollution has continued to accelerate since 1990 (Kharecha & Hansen, 2008).

Atmospheric concentration of CO_2 is dependent not only upon emission quantity, but also land use change (e.g., deforestation for new agricultural land) and carbon sink capacity of the biosphere. In order to stabilise the atmosphere at the AR4 (IPCC, 2007c) recommended 450ppm CO_2e, behaviour change to mitigate the global effects of emissions and land use change needs to begin more or less immediately with peak emissions by 2015 and drastic annual reductions thereafter of 4% CO_2e and 6.5% in energy and process emissions (Anderson & Bows, 2008). Given that emissions have continued to increase between 2000 and 2008 at approximately 2.4% per annum (Anderson & Bows, 2008), such a target will require concerted global action. If emission peak is delayed until 2020, and the less stringent Stern review stabilisation target of 550ppm is used (Stern, 2006), then post 2020 annual emission reductions of 6% in CO_2e and 9% in energy and process emissions will be required.

More detailed climate change predictions for New Zealand for the next 100 years, with specific reference to the Wairarapa coast, where Aohanga Incorporations Owahanga farm block is located, are contained in a separate document prepared for the current SLMACC project by Renwick and Sturman (2012). This data was presented to Aohanga in a hui held on 9th December 2011. A brief summary is presented in the second section of this report.

Sea level rise is a major consequence of climate change with important implications for global population distribution (i.e. climate refugees) and for coastal communities and rural land, such as the Owahanga farm block. On a very conservative basis, i.e., ignoring ice sheet melt, the IPCC projected that ocean levels will rise by 18-38cm, under a low scenario, and 26-59cm, on a high scenario, due to thermal expansion alone (IPCC, 2007c). However, in the 21st century by far the most important cause of sea level rise will be polar ice melt caused by rising average global temperatures (Meier, et al., 2007; Vermeer & Rahmstorf, 2009).

Sea level rise is now occurring at 3mm per year, 50% faster than the average for the 20th century. Ice melt at both polar regions is increasing rapidly (Pritchard, Arthern, Vaughan, & Edwards, 2009). During the past 13 years at least 25% of sea level rise is believed to have been caused by Greenland ice sheet melt. Since 1995 the Greenland ice sheet has been losing 265 cubic kilometres per year. Ice sheet melt rate is increasing. The 2007 melt extent was 20% greater than the average for the 1995-2006 period (Mernild, et al., 2009).

Some scientists speculate that ice melt could raise sea levels by up to 2 metres by 2100. The 2009 report, *Antarctic Climate Change and the Environment* by the Scientific Committee on Antarctic Research (SCAR), estimates sea level rise by 2100 to be around 1.4m (SCAR, 2009). Vermeer and Rahmstorf (2009), linking global sea level to global temperature, estimated sea level rise to be approximately 3 times the IPCC estimate, ranging from 75cm to 1.9m for the period 1990-2100. According to these authors ice melt will cause the bulk of sea level rise in the 21st century with thermal expansion declining from the current 30% contribution to 20% by the second half of the century. Hansen (2007) makes the most extreme sea level rise projection suggesting that it could be as much as 5m for the 1990-2090 period, however, Pfeffer, Harper and O'Neel (2008) claim that glaciological constraints would limit sea level rise in this period to a maximum of 2m.

The Antarctic ice mass is much larger than the Arctic, containing 30 million cubic km of ice. This is equivalent to an additional 70 metres of water in the world's oceans. Recent satellite studies indicate that Antarctic melting due to global warming is occurring much faster than previously thought (Pritchard, et al., 2009). The Antarctic's annual net loss of ice mass has increased from 112 billion metric tonnes in 1996 to 196 billion metric tonnes in 2006 (Rignot, et al., 2008). One fear is that global warming could lead to a tipping point at which the ice melt becomes irreversible (Rockström, et al., 2009). Recent estimates by the Pew Environmental Group suggest that the cost associated with ice melt and sea level rise could reach anywhere from US$2.4 to US$24 trillion by 2050 (Goodstein, Huntington, & Euskirchen, 2010). However, there is still considerable uncertainty as to the actual rate of change that will occur.

Global warming and ice melt are mutually reinforcing, as the surface area of the poles reduces, less heat is reflected back to space by the white ice (the albedo feedback effect referred to earlier) and more heat is absorbed by the dark oceans and earth (Karl & Trenberth, 2003). With similar consequences, as the arctic tundra unfreezes it releases large quantities of CO_2 and the powerful greenhouse gas, methane (Post, et al., 2009; Simpson, 2009, June). Boreal and Arctic permafrost store nearly twice as much carbon as is currently present in the atmosphere. How significant this carbon will be for global warming depends on the rate at which it is released as the tundra melts. Currently, this rate is highly uncertain (Schuur, et al., 2009).

Projected global and national consequences of climate change

Some of the projected consequences of global warming and sea level rise are shifting climatic patterns, increasingly erratic weather conditions, increasing frequency of extreme weather events - droughts, floods, hurricanes and storms (Hansen, et al., 2012). Crop and flora growing regions are predicted to shift, while the already catastrophic global biodiversity depletion (Leakey & Lewin, 1996; May, Lawton, & Stork, 1991; Wilson, 2002) will be compounded (IPCC, 2007b). Climate change will increase desertification, coral reef bleaching and death, and may even change ocean current patterns. It is predicted to cause the flooding of many major, population dense, coastal cities and low-lying islands. Global warming will exacerbate the depletion of important rivers as their glacial sources dissolve. It is estimated that more than 150 million human climate refugees will be fleeing from the rising tide by 2050 (IPCC, 2007c).

Figure 1 below, sourced from the Stern report, graphically illustrates the projected global impacts of climate change.

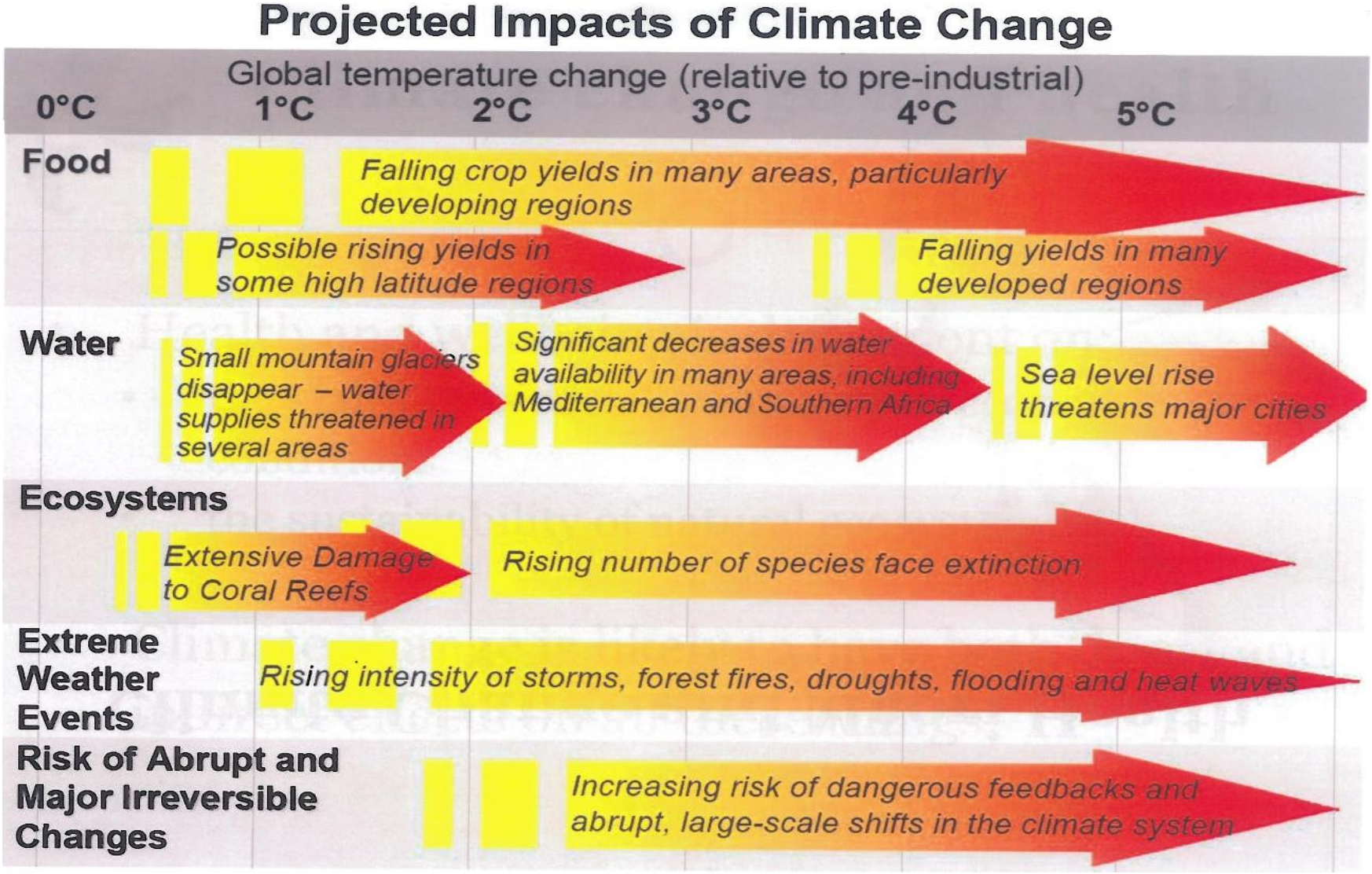

Figure 2. Projected impacts of climate change. Source: Stern Report 2006, WWW.sternreview.org.uk

Bell, Hume and Hicks (2001) cited in Rouse and Blackett (2011, p. 12) catalogued the potential effects of climate change/sea level rise on New Zealand coastal regions:

- "Changes to coastal storms, leading to changes in storm-surges and wave heights
- Increased frequency of coastal inundation from tides, waves, and coastal storm surges
- Increased erosion of coastal areas
- Salinisation of near-coast groundwater systems and lowland rivers and creeks
- Combined changes in river flooding and coastal inundation impacting on estuaries and coasts
- Increased challenges for drainage of coastal and estuary harbours
- Coastal squeeze of ecological habitats between advancing shorelines and human development."

Renwick and Sturman (2012), as part of the current SLMACC project, catalogued potential climate change impacts for New Zealand (projected impacts for the Wairarapa and the Owahanga Station are presented in the next section):

- Increase westerly wind circulation
- Precipitation to increase in western regions and decrease in eastern and northerly regions in winter and spring
- Precipitation may increase in the east in summer and autumn
- 2-3° C temperature increase by 2100 (70% of global temperature increase rate, due to buffering affect of surrounding oceans)
- Changes in extremes of climate i.e., reduced frost frequency, increased risk of heat waves, reduced soil moisture, increased risk of drought in the east and north (doubling during the 21st century), increasing risk of forest fires in the east and north, increased frequency of heavy rainfall events and increase risk of extreme wind events
- Sea level rise, increased frequency of extreme high tides and coastal inundation
- Ocean acidification, decreased oxygen content and reduced nutrient upwelling from changes in the stratification of the water column leading to a significantly altered marine ecosystem.

Climate change and agriculture

The consequences of global climate change will have profound effects on agriculture and food production. Temperature increases will reduce crop productivity. The optimal temperature for photosynthesis is between 20-25° Celsius. At 30° C the main food crops suffer a 20-30% decline in production. Climate models indicate that between 2050 and 2100 temperatures in the highly productive tropical and sub-tropical regions will regularly exceed 30° C. This will be occurring at the same time as fossil fuels and fresh water are depleting and as the planet's population hits 9 billion (Brown, 2008; Fedoroff, et al., 2010; The Royal Society, 2009).

Sea level rise will reduce the availability of highly productive agricultural coastal land and force coastal populations to migrate – thus potentially occupying land currently used for agriculture. Changing rainfall patterns will increase the risk of drought, making some currently productive land almost unusable for agriculture. Extreme weather events will pose threats and risks to agricultural businesses and create erosion and soil depletion in vulnerable environments (IPCC, 2012b).

However, while much of the news is bad for agriculture, in some areas, there may be some increased opportunities for New Zealand agriculture, given our relative proximity to the Antarctic pole (i.e, we are not in the tropical zone which will suffer the major impacts of temperature rise on crop production). Some land, perhaps even land that is currently

unproductive, may increase in agricultural productive capacity due to increased temperature, rainfall changes, and increased plant growth associated with higher levels of atmospheric CO_2 – an effect known as CO_2 fertilisation. In some parts of New Zealand, higher average temperatures may increase growth rates of pasture or lengthen harvest seasons and allow the cultivation of new agricultural and horticultural crops, perhaps even increasing the diversification potential of agriculture and horticulture (Stroombergen, et al., 2008).

Agricultural climate change resilience and sustainability

Climate change resilience is an issue of sustainability (Halsnaes & Verhagen, 2007; Metz & Kok, 2008) – an attempt to ensure that the resources available to current humans for their welfare and survival are also available to future generations. Therefore, the imperative to develop and adopt technologies and practices that provide resilience to the impacts of climate change and protect infrastructure and resources for the use and wellbeing of future generations is also an ethical issue of intergenerational equity. Hillel and Rosenzweig (2011, p. 4) succinctly stated the challenge of climate change to agriculture "The challenge is to develop and maintain agroecosystems that simultaneously adapt to and mitigate our changing climate." They identified two climate change relevant alternative modes of agroecosystem land use management: an exploitative mode and a sustainable mode. They define these as:

1. "An *exploitative mode*, in which the natural vegetation is eradicated, leading to denudation of the land, loss of biodiversity, decomposition and depletion of organic matter with consequent emissions of green house gases (CO_2, CH_4, N_2O). Leaching of nutrients, erosion by wind and water, deterioration of soil structure, wasteful use of energy and water, and gradual (often irreversible) loss of productivity.
2. A *sustainable mode*, in which the production of crops and livestock is able to adapt to changing climate conditions because it is designed to minimize soil and ecosystem degradation buy means of minimal tillage and precision application of nutrients, integrated pest management (including biological control methods), conservation of energy, improvement of soil stability and fertility by organic matter enrichment and carbon sequestration, efficient use of water, and the overall integration of production within a stable and healthy ecosystem." (Hillel & Rosenzweig, 2011, pp. 4-5).

In general, many actions and practices designed to increase the sustainability of agriculture are also compatible with climate change resilience strategies. Hillel and Rosenzweig (2011) provide the following schematic to illustrate the two alternative modes of agroecosystem land management. The green spiral represents the sustainable mode and the red spiral the exploitative mode.

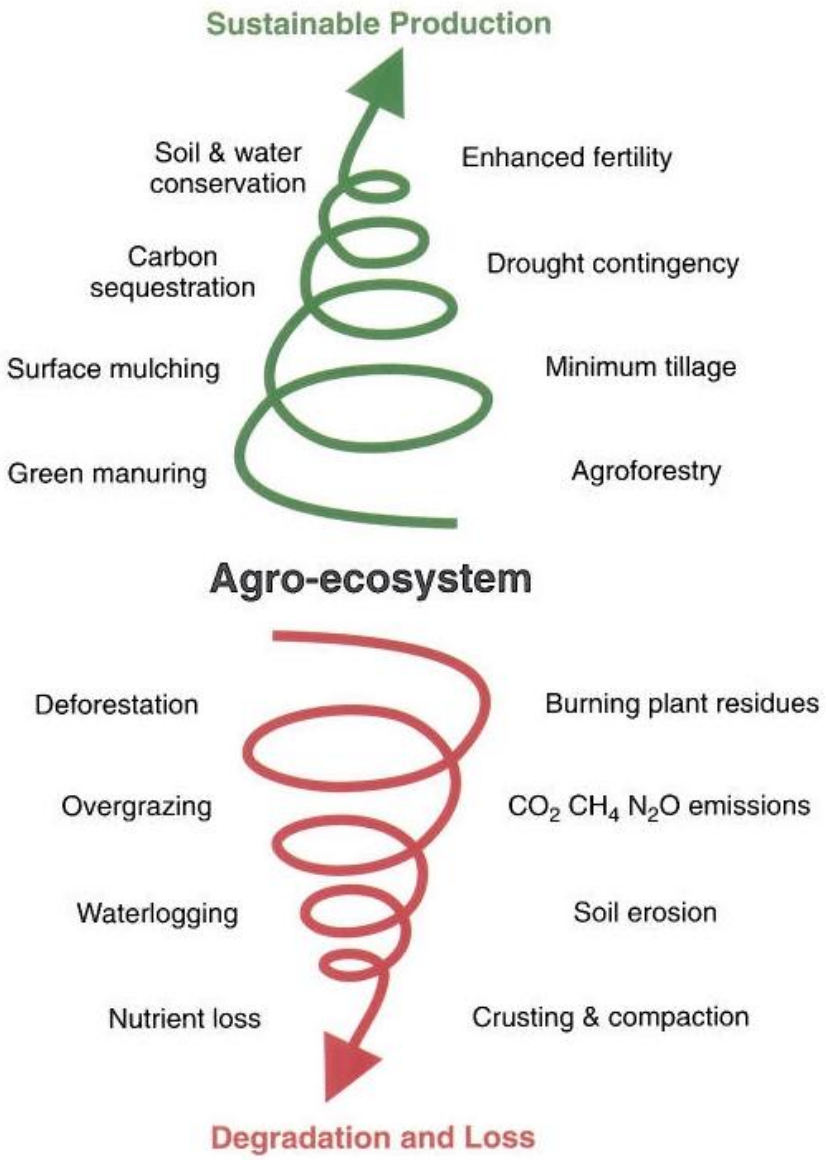

Figure 2. Schematic illustration of alternative modes of land and agroecosystem management in relation to climate change. Source: Hillel and Rosenzweig (2011).

The strategic wellbeing of the New Zealand economy is particularly vulnerable to climate change impacts because it is highly dependent upon agriculture (Wedderburn, Kingi, Paine, & Montes de Oca, 2010). Agriculture comprises 44% of New Zealand's merchandise exports totalling $43.1 billion in the year ending November 2010 (Statistics New Zealand, 2010). While the direction of global patterns of climate change are reasonably well understood, even if magnitude and timing are characterised by a degree of uncertainty, different geospatial locations will be differentially effected (Hillel & Rosenzweig, 2011).

Similarly, factors such as the scale, types of agricultural enterprise, and sensitivity and vulnerability of the local community will also affect climate change impacts on agriculture (Adger, 2006; Aydinalp & Cressner, 2008; Reilly & Schimmelpfenning, 1999). Hence, in order to engage local land-owners and communities in practical climate change resilience action, there is a need to localise climate change information to specific localities and to understand the local communities in order to identify the probable impacts and the most appropriate local responses. For the current SLMACC project, localisation of climate change impacts on weather conditions in the Wairarapa area where Aohanga Incorporation's

Owahanga Station is located, was prepared and presented to Aohanga Incorporation as a subcontract carried out by NIWA (Renwick & Sturman, 2012).

Agricultural mitigation and adaptation

A report of the International Assessment of Agricultural Knowledge, Science and technology for Development (IAAST) discusses the role of agriculture in addressing climate change:

> To address expected climate change challenges and impacts, a major role for agricultural knowledge, science and technology is to increase adaptive capacity and enhance resilience through purposeful biodiversity management. Options include irrigation management, water harvesting and conservation technologies, diversification of agriculture systems, the protection of agrobiodiversity and screening germplasm for tolerance to climate change. (IAASTD, n.d.)

The two main human responses to enhance resilience to climate change are mitigation and adaptation. The IPPC (2007, p. 996) defines mitigation as: "Technological change and substitution that reduce resource inputs and emission per unit output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks." They define adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." A range of agricultural mitigations have been identified by the IPPC. These include:

> …improved crop and grazing land management (e.g., improved agronomic practices, nutrient use, tillage, and residue management), restoration of organic soils that are drained for crop production and restoration of degraded lands. Lower but still significant mitigation is possible with improved water and rice management; set-aside, land use change (e.g., conversion of cropland to grassland and agro-forestry; as well as improved livestock and manure management. (IPCC, 2007a, p. 499)

Although agricultural mitigation options usually have a long-term focus on the reduction of GHGs and are designed to act as a break on the rate of climate change, there is sometimes a synergy with short-term local benefits. That is, they frequently represent the use of improved technologies, and improved practices that result in increased efficiencies and may result in reduced input costs, as well as their improved environmental footprint. However, over recent years there has been a recognition that countries and communities will need to adapt to buffer against the most serious long-term impacts of climate change (Parry, Palutikof, Hanson, & Lowe, 2008; Van Aalst, Cannon, & Burton, 2008).

Agricultural adaptation has been classified into two main types: autonomous and planned adaptation. Autonomous adaptation refers to short-term adjustments made as a reaction to changing climate patterns (e.g., changing precipitation patterns) by farmers such as crop changes or changes to harvest or planting dates. Autonomous adaptation may be implemented without the need for research or policy interventions. Planned adaptation are policy options or research based response strategies to facilitate specific adaptations or alter the adaptive capacity of an agricultural system. These may require major structural changes, be multi-sectoral in nature, and oriented to the long-term (Food and Agriculture Organisation of the United Nations, 2007).

Reilly and Schimmelpfennig (1999) identified the following major classes of agricultural adaptation:

- Seasonal changes and sowing dates;
- Different crop variety or species;
- Other inputs (e.g., fertiliser, grain drying, different field operations);
- New crop varieties;
- Tillage methods;
- New technologies.

Reilly and Schimmelpfenning (1999) also identified several broad categories of response to climate change for agriculture, some of which are directly relevant to land-owner resilience:

- Training and education;
- Identifying present vulnerabilities;
- Agricultural research;
- Genetic resources and intellectual property rights protection;
- Agricultural extension;
- Food security programmes;
- Marketing and distribution systems;
- Commodity and resource policy reform.

Reilly (1995) claimed that building capability to detect change and assess potential responses is essential to successful adaptation. With this in mind Reilly provides the following table (Table 1). It was developed from studies of past agricultural adaptations, necessitated by environmental challenges or changes such as adverse events, and provides an indication of lead in times to the adoption of various potential adaptations.

Table 1: Speed of adoption for major adaptation measures

Adaptation	Adjustment time (years)
Variety adoption	3-14
Dams and irrigation	50-100
Variety development	8-15
Tillage systems	10-12
New crop adoption (Soybeans)	15-20
Opening new lands	3-10
Irrigation equipment	20-25
Transportation systems	3-5
Fertiliser adoption	10

Source: Reilly (1995)

Adaptation can be managed over time as an ongoing journey. It is not a one-off event, it can be viewed as "a complex and iterative process involving many steps….to reduce the risk to people, property and infrastructure" (Rouse & Blackett, 2011, p. 14) from the effects of climate change. As climate change accelerates, adaptation can be adaptively managed.

The social nature of the climate change problem (and solutions)

Most of this sub-section on the climate change problem has focussed on biophysical aspects. However, in order to emphasise the social nature of the climate change problem (and solutions), we end this section with a quote from the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change (American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change, 2010, p. 13):

> Global climate change is fundamentally a biophysical phenomenon. However, the recent and accelerating warming of the earth's climate is largely attributable to human activity, and its impacts are mediated by psychological and social processes and can be limited primarily by human activity.

Climate Change and Māori

A paper for the RURALS SLMACC climate change project (a project linked to the present project) written by Harmsworth (2012, p. 1) opens with the following statement:

> Projected impacts of climate change on Māori are expected to be diverse and intense across a range of economic, social, cultural and political dimensions. Much of the previous research, literature, discourse, and conversations indicate that Māori society is highly sensitive and disproportionately vulnerable to climate variations, shocks, and changes and that many parts of Māori society will be adversely affected.

Harmsworth (2012, p. 4) identified a number of specific needs for Māori regarding building climate change resilience:

- "Better access to climate science and technical information in a form that supports Māori strategies, programmes and actions;
- Help build Māori research capability and capacity at the iwi/hapu level through appropriate resourcing, interaction-participation, and training/skills development in key areas;
- Develop Māori led research areas – Understanding resilience from a Māori perspective? How can Māori adapt to climate change? What are the key actions from a Māori perspective?
- Help support and build Māori adaptation and resilience strategies for climate change especially across land based sectors;
- Enable Māori to better participate in and benefit from the ETS;
- Improve understanding of climate change impacts on Māori land based sectors and help develop strategies to mitigate climate change shocks and implement opportunities;
- Help develop programmes/actions for adaptation and resilience in land based sectors;
- Help develop programmes/actions for energy self-sufficiency in land based sectors;
- Help develop programmes/actions for sustainable land management and increased productivity in land based sectors - "future proof land" from climate shocks (e.g. storm damage events); and
- Build Māori capacity/research capacity – knowledge networks/knowledge translation within communities to individuals."

Climate change impacts on Māori agriculture, forestry and fisheries

Below we summarise background issues that are relevant to climate change and Māori agriculture in general and the current Aohanga Incorporation case study.

Māori land occupies 1,515,071 ha - less than 6% of New Zealand's total land mass (Carswell, Harmsworth, Kirikiri, Turney, & Kerr, 2002; Harmsworth, Tahi, & Insley, 2010). However, large areas are classified as undeveloped or uneconomic – either mixed aged scrub or pasture and scrub. From the perspective of climate change resilience, this situation presents Māori with low capital business opportunities in terms of carbon farming and other businesses (e.g., oils, pharmaceuticals, apiaries) related to indigenous scrub such as mānuka and kānuka (Carswell, et al., 2002). Harmsworth et al. (2010) identified approximately 37% of total Māori land or 558,000 ha as being eligible for Kyoto forest with reversion to scrub and forest being

a potential for a further 15% or 230,442 ha. Insley (2010) claimed climate change generated business opportunities, such as carbon farming and renewable energy production, could potentially be worth $100's of millions for the Māori and New Zealand economies.

Fifty-two percent of the Māori economy is dependent upon agriculture, forestry and fishing. More than 60% of Māori owned land is vulnerable to erosion from climate change related extreme weather events, such as intense rainstorms, primarily because of its steep and hilly nature. On lower elevations, Māori owned coastal and lowland plains are susceptible to climate change induced sea level rise, flooding and sediment deposition (Harmsworth, 2012; King, Penny, & Severne, 2010). Drought is already a concern on Māori owned land on the northern and eastern areas of New Zealand and climate change is expected to exacerbate this situation with implications for the Owahanga farm block (Renwick & Sturman, 2012).

Fisheries, both culturally and economically important to Māori, are also vulnerable to various climate change impacts, such as, sea level rise, increasing ocean temperatures and ocean acidification (Harmsworth, 2012). Changes in the timing of seasonal activities of flora and fauna associated with climate change have already been documented and this process is expected to accelerate as climate change accelerates (Reilly & Schimmelpfenning, 1999; Walther, et al., 2002). These climate change induced effects will have an impact on fishing seasons and also agriculture and land management activities and practices. For example, seasonal production of forage species is expected to be modified by climate change; this may necessitate changes in farm systems management (Lieffering, Newton, Li, & Vibart, 2012; Reilly & Schimmelpfenning, 1999).

An expected impact of increased average terrestrial and oceanic temperatures is a change in the biodiversity of geospatial regions, thus changes in flora and fauna are expected on both land and sea. Related to this, species distribution will also change as climate changes. This is caused by species-specific physiological tolerances with respect to temperature and precipitation (Walther, et al., 2002). For Owahanga Station and other coastal Māori, this may affect the gathering of kaimoana (sea food) from traditional fishing areas, and also result in the introduction of new and/or invasive species. This creates potential biodiversity and biosecurity issues. These changes could result in lowered productivity of Māori coastal assets (Harmsworth, 2012).

In New Zealand, terrestrial temperature increases due to climate change are likely see the migration of flora and fauna in a southerly direction. The consequence of this for agro-forestry systems is likely to be changes to the areas in which indigenous and exotic tree species grow (Barry, 2011). Also of concern is the likely arrival of new pest and weed species which may contribute to lowered agricultural productivity and new parasites, disease vectors and pathogens, which may bring new risks to New Zealand's biodiversity, exacerbating existing pressures (McClone & Walker, 2011), and bring new risks to human health (Costello, et al., 2009).

Climate change and Māori health

Māori communities in rural areas may be particularly vulnerable to the arrival of new diseases associated with changing climate and disease vectors, such as, Ross River virus and dengue fever (Reeves, 2011). Māori are a population already challenged by housing, health and socio-economic inequalities, and such climate impacts could be disproportionately felt by them (Harmsworth, 2012). A report on the health impacts of climate change in the Lancet concluded: "Climate change is the biggest global health threat of the 21st century" (Costello, et al., 2009, p. 1728). Costello et al. also noted that the health impacts of climate change will be disproportionately felt by poorer socio-economic groups. Their comprehensive report

examines six links between climate change and health: changing patterns of disease and mortality, extreme events, food, water, shelter, and population. The report advises that in order to increase resilience to climate change impacts it is essential to reduce inequalities in socio-economic conditions, housing, access to resources, and access to services such as fresh water, sanitation and health.

In a Manu Ao seminar on climate change and Māori health, Jones (2010, Slide 14) identified vulnerabilities and resilience factors which will influence the effects of climate change on Māori. Vulnerabilities noted were:

- "socio-economic deprivation,
- heavy reliance on vulnerable resources,
- poor housing,
- living on marginal land,
- strong cultural connections to natural resources,
- existing health inequities, and
- poor access to health care."

Jones identifies Māori resilience factors to climate change as:

- "strong social networks,
- indigenous knowledge of natural ecosystems?, and
- experience dealing with adversity?" (note: question marks in source).

Jones noted that there are also opportunities arising from climate change mitigation that may have health co-benefits for population wellbeing. He identified some mitigation and related health co-benefits:

- low carbon transport systems (e.g., reduced traffic deaths, reduced urban air pollution, exercise related health benefits),
- reduced animal-based food diets (i.e., reduced incidence of cardiovascular disease, obesity and bowel cancer), and
- more efficient residential energy use (reduced impacts from extremes of heat and cold).

Jones observed that: "The challenge is to align climate change, health, indigenous rights and equity goals (Jones, 2010, Slide 20). He concluded that there is a need for social transformation and a need to engage with values, in particular "re-establishing indigenous values as the basis for human development" (Slide 37).

Climate change and Māori worldview and values

Of particular importance to Māori is their distinct worldview, te ao Māori, which gives them a special relationship to the environment. This worldview is holistic and integrative and

> …not primarily anthropocentric…. it does not separate humans from the rest of nature. Plants, trees, birds and humans were directly created by the god Tane, and thus are all related to each other. Fish and reptiles were created by Tangaroa, god of waters, and cultivated foods by Rongo, but since they and Tane are brothers it follows that all living things are kin" (Gunn, 2007, pp. 10-11).

Te ao Māori is manifest through cultural values such as whakapapa, mauri, mana, utu, taonga, tikanga, rangatiratanga and kaitiakitanga, (Harmsworth, 2012; King, et al., 2010). Whakapapa refers to genealogy linking Māori to each other, the land and to creation myths. Mauri refers to life force of the physical world, which comes from wairua – the spiritual source of all existence. Mauri departs from humans at death but is present in non-living things

and ecosystems (Morgan, 2004). Mana refers to prestige or respect, usually associated with an individual, hapu or iwi. Utu refers to reciprocity – from an environmental perspective, land and water sustain people and people must reciprocate this relationship. Taonga refers to treasures from the gods or ancestors, including natural resources and biodiversity, which must be preserved and made available for future generations. Tikanga refers to the beliefs, values, practices, customs and protocols that guide ethical behaviour. Rangatiratanga refers to having the mana or authority to govern and make decisions regarding the use and care of natural resources.

This right of rangatiratanga is guaranteed to Māori in Article II of the Treaty of Waitangi. Kaitiakitanga refers to stewardship or guardianship, by Tangata whenua or authority with the appropriate mana, of the mauri of the natural world and the duty to pass the natural world on to future generations in as good or better condition than the present state. Tikanga is part of the ethic and practice of kaitiakitanga. Kaitiakitanga has been legally defined in the Resource Management Act (1991) as: "The exercise of guardianship by the Tangata whenua of an area in accordance with tikanga Māori in relation to natural and physical resources; and includes the ethic of stewardship based on the nature of the resource itself." Changing environmental conditions may have direct and unpredictable impacts on this relationship and worldview.

Another relatively unique aspect of Māori values and culture is the multiple ownership of land. A number of different governance structures may be associated with multiple owned Māori land including authority vested in kaumatua or elected leaders through the auspices of Ahu Whenua trusts and Māori incorporations. According to Harmsworth et al. (2010), there are ~374,787 ha of Māori land governed by 159 Māori Incorporations and ~730,800 ha administered by 5700 Māori Trusts. Detailed information about Māori land, land use classes, potential uses, and governance structures is provided in Harmsworth et al. (2010).

While multiple ownership may be a considerable strength in some circumstances, it can also present difficulties for decision-making through the necessity of having to integrate tikanga with western commercial practice. A relatively unique feature of Māori land is that it is legally very difficult to alienate and, generally, Māori intend to keep their land in perpetuity. This provides Māori with a unique advantage with respect to engaging with the climate change issue; they can take a very long-term perspective – a perspective in which climate change has important implications for te ao Māori.

Māori research needs regarding climate change

Many of the above circumstances combine to increase the vulnerability of Māori to the social, environmental, cultural and economic impacts of climate change (King, et al., 2010). However, as previously noted, climate change will differentially impact different geospatial regions and there is likely to be differential impacts on Māori communities and assets in different locations in New Zealand. Thus, as King et al. (2010, p. 103) stated "each iwi, hapu, Māori business or community must assess and address climate change from their own perspective and exposure, but in order to do so effectively must collaborate with others to interpret the issues they face." This suggests an action research case study approach involving the research community with specific Māori communities that wish to explore climate change issues for their community, land or business. A case study approach to the issue was also the recommendation of a Landcare report for engaging Māori landowners in "carbon farming" using indigenous forest regeneration – one type of climate change mitigation/adaptation strategy (Carswell, et al., 2002).

The past decade has seen the publication of a number of research projects considering various aspects of impacts of climate change on Māori (King, et al., 2010). From their overview of the research previously conducted King et al. (2010, p. 103) noted some of the main findings as:

- "The need for future work to effectively communicate the risks and opportunities arising from climate change to Māori communities and Māori trusteeships";
- "the need for Māori-specific analyses and information (including some dissent over the engagement process)";
- "widespread acknowledgement by those consulted that current and future projected climate change is an important and urgent issue for Māori".

King et al. (2010, p. 103) assess the past research, "Clearly, there has been some research conducted to date, but much more is needed, including an associated process of integrating research findings into meaningful actions, if we want to make constructive change." They further conclude: "This means learning about climate change and its ramifications by sorting the rhetoric from the reality; it also means engaging in the right networks and processes and gaining access to the right information and skills." (p. 109).

Aohanga Incorporation

This section briefly outlines the specific context of Aohanga Incorporation and their Owahanga farm block. Aohanga Incorporation is a Māori owned incorporation established in 1970 for the purpose of administering the Owahanga farm block on behalf of its owners. There are approximately 1400 shareholder/owners most of whom reside outside the area due to poor local employment opportunities. Aohanga Incorporation has a seven member elected Committee of Management who govern the management of the property. A farm manager is responsible for day-to-day management operations.

The property is relatively remote, being located in the Wairarapa 77 kms southeast of Dannevirke, on the southeast coast of the North Island, between Owahanga River in the north and Mataikona River in the south. On the west it is bordered by the Makatote and Waingongoro streams and on the east by 14 kms of sand country Pacific Ocean coastline consisting of dunes, beaches, marine terraces and wave cut platforms. The total land area of the block is 7142 ha, as calculated from GIS mapping, rising from sea level to 457 metres a.s.l. at its highest point. Slopes are steep to very steep (>50% is classified as LUC 7 or 8) with few fertile flats (6% LUC 3). Low hill ranges parallel the coast. About 42% or 3000 ha is pasture with approximately 4000 ha in scrub (approximately 75% of which is mānuka/kānuka) and native forest of which 248 ha are mature indigenous forest. In 2009, 2449 ha of the scrub and native bush was covenanted under a kawenata for 25 years and is protected under Nga Whenua Rahui. About 500 ha are in gorse and broom while a further 80-100 ha are coastal sands and bare rock (Harmsworth, Sutherland, Heke, & Procter, 2010).

The block has a coastal climate with warm summers and mild winters and mean annual average temperatures between 10°C, at the property peak, and 14°C on the coastal flats. Summer temperature range is between 22°C and 25°C. In general, the block is characterised by low rainfall with mean annual averages of 1000 mm at the coast to 1400 mm at higher elevations. It is subject to moisture deficits and drought in the summer months from November to May, exacerbated on the eastern hills by strong prevailing westerly winds. Solar radiation ranges from a mean of 14 MJ/m^2/day at the coast to 13.7 MJ/m^2/day in the higher hills. Solar radiation is considered a limiting factor for cropping and horticulture (Harmsworth, Sutherland, et al., 2010). Figure 3 below shows the Station location at the bottom of the North Island.

Figure 3. Owahanga Station location map (bottom of North Island)

Figure 4 below is a paddock rating map of the Owahanga Station showing paddock boundaries.

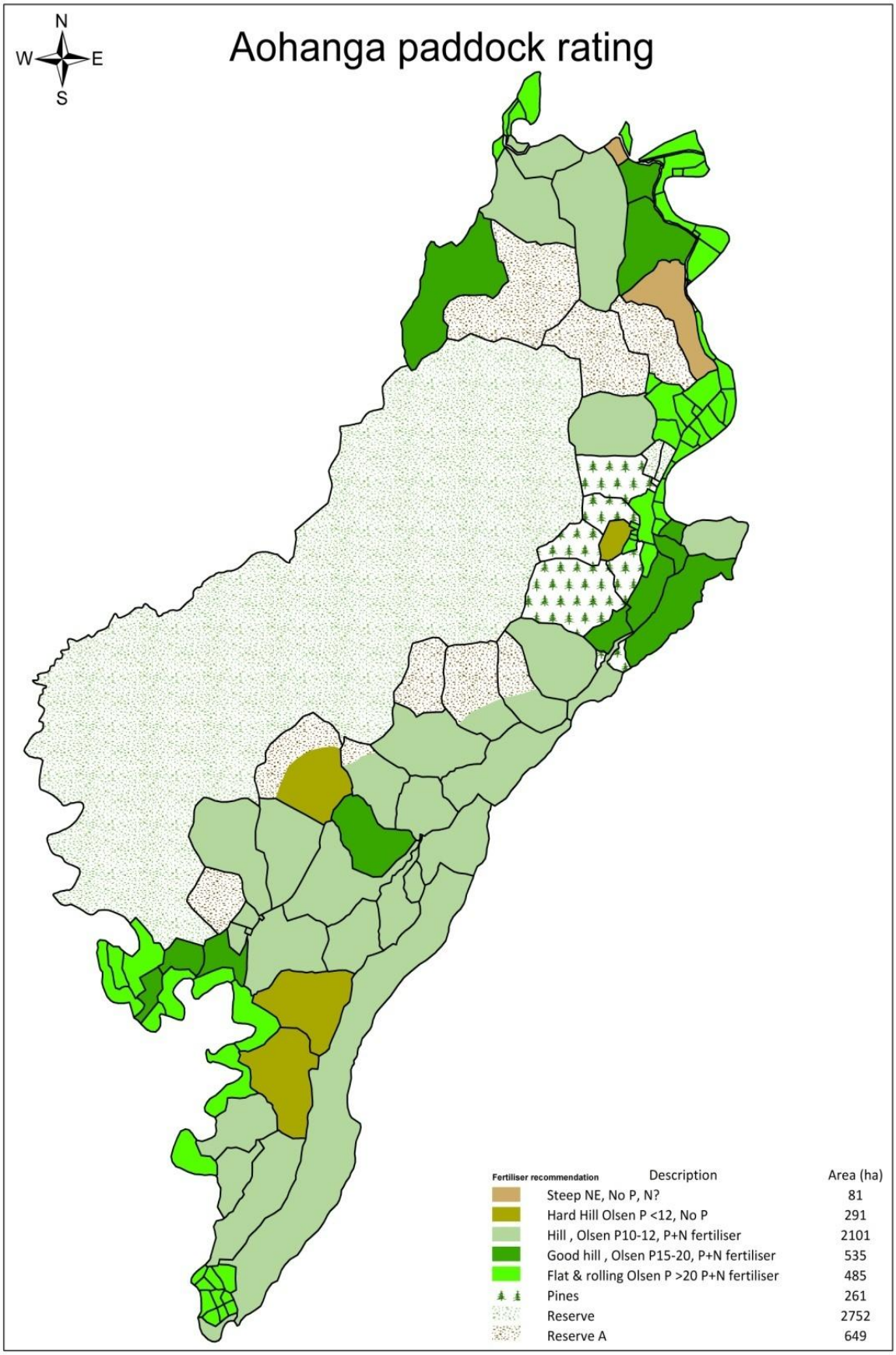

Figure 4. Paddock Rating Map of Owahanga Station

The core business of Aohanga Incorporation is sheep and beef farming, which occupies approximately half of the block (3325 ha of effective farming area) with around 38,500 livestock units. An estimated 146 ha are in plantation forestry (pines). There is also a small quantity of olive trees, and some apiaries. Average paddock sizes range between 30-50 ha, while some are as large as 100 ha. Currently, a development program is in operation to fence paddocks at around 30 ha. The land has been GIS mapped at 1:50,000 (using national and secondary land resource data) and 1:10,000 (using a Wellington Regional Council farm map). Land use classes and soil and rock types have been identified and mapped for the block. Potential land uses and options have also been identified for horticulture, cropping, intensive agriculture and forestry, along with productivity indices. Of particular relevance for climate change mitigation is the potential for carbon forestry – 3803 ha are classified as Kyoto eligible (Harmsworth, Sutherland, et al., 2010).

Extensive and detailed property information (the primary source of the above information) is available in a recent report, published by Landcare Research and written by Harmsworth, Sutherland, Heke and Procter (2010), for Aohanga Incorporation. This useful reference work is entitled: *Aohanga Inc. Technical Report: Resource Stocktake for Owahanga Land Block and Catchment*.

Developing a climate change resilience strategy with Aohanga Incorporation

This second section of this report chronicles the process and development of a climate change resilience strategy with Aohanga Incorporation. This section is ordered as per the research steps listed below, which roughly reflects the chronological order of the research process. This process and the outlined steps, initially developed in draft form in the research proposal, were further negotiated and agreed upon, with Aohanga Incorporation, in the first hui/workshop on the 9th of September.

1. Identification of Aohanga Incorporation's initial questions regarding climate change and the provision of science based responses/answers.
2. The development of climate change impact scenarios for the Aohanga Incorporation with particular reference to their Owahanga farm block.
3. Identification of climate change mitigation and adaptation strategies or practices for Agro-forestry production.
4. The identification of barriers to the adoption of mitigation or adaptation strategies and Aohanga Incorporation's questions and queries regarding the potential strategies.
5. Identification of Aohanga incorporation's values and aspirations regarding their land and the evaluation and determination of the climate change resilience strategies and practices that best fit these values and aspirations.
6. The development of farm/forest scale economic cost benefit analysis of the interactions between climate change impacts and Aohanga Incorporations preferred mitigation and adaptation practices.
7. The identification of biological and social science knowledge gaps.
8. The development of a mitigation/adaptation plan for resilience to climate change for the Owahanga farm block.

The current research project fits within the action research framework, that is, the research is expected to bring about change in the community participants' awareness and actions (Lewin, 1952; Stringer, 1996). Specifically, it is intended to increase: awareness of climate change and the need to take action to address it; knowledge regarding the potential impacts of climate change and the levels of certainty and uncertainty associated with the projected impacts, particularly with regard to the Owahanga Station; knowledge regarding potential mitigation and adaptation strategies; and adoption of climate change resilience strategies.

This research method included a bottom-up qualitative data gathering process to ascertain the needs and queries of Aohanga Incorporation in regard to climate change and mitigation and adaptation strategies and their assessment against Aohanga Incorporation's values and aspirations. A top down quantitative biophysical modelling process was used to assess the environmental and financial impacts of the chosen strategies. Thus, the research framework integrated biophysical and socio-economic approaches to climate change resilience analysis. An integrated biophysical and socio-economic bottom-up qualitative, top-down quantitative approach to the analysis of climate change mitigation and adaption strategies was recommended and applied in a recent case study of a New Zealand dairy farming system (Kalaugher, Bornman, Clark, & Beukes, In Press, Corrected Proof available on-line 11 May 2012 Corrected Proof available on-line 11 May 2012).

AOHANGA INCORPORATION'S QUESTIONS REGARDING CLIMATE CHANGE

At a meeting in late August 2011, key members of the research team (i.e., two science managers, a Māori innovation manager and a Māori business broker) developed a 'strawman'

work plan, based upon the research proposal, to use as a starting point for negotiation of the partnership and research process and expectations with Aohanga Incorporation. The researchers were aware that this was a less than ideal process, but felt the need to negotiate a compromise between the requirements of the science culture, its funding criteria, and Māori culture and tikanga.

A workshop was held on the 9th of September 2011 with key representatives from Aohanga Incorporation, (i.e., the Committee of Management Chairperson, accountant and the Owahanga farm manager), and representatives from AgResearch (i.e., science managers and a Māori business broker). Aohanga Incorporation's broad questions regarding climate change were canvassed at this meeting as were their expectations regarding the research project and their preferred methods of engagement and information presentation and exchange. The result of the workshop was the modification of the research team proposal and the joint development of a work plan for the project. The work plan was considered a working document to guide the project and the research partners' engagement. However, it was acknowledged by both parties that the work plan could be subject to revision during the research process, depending on circumstances, including the available project time and funding, This work plan is attached to the current document as Appendix 1.

From Aohanga Incorporation's perspective, at this early stage of the research process, their primary questions regarding climate change, and interest in the current SLMACC project, were:

- General information about climate change and potential impacts (global/national) 20, 50, 100 yrs. Low, medium, high scenarios;
- Climate change information specific to Owahanga Station over 20, 50, 100yr timeframes with low, medium, high scenarios. Impacts on temperature, rainfall, freshwater availability, soil, erosion, coastline, kai moana, vegetation, biodiversity, trees, bees, animals, pests;
- Adverse weather events – frequency, severity, potential impacts; and
- Mitigation and adaptation resilience strategies to climate change and to adverse impacts.

These initial questions were later further fleshed out:

- To understand the likely impacts of climate change on the Owahanga farm block.
- To obtain an indication of the science-based potential mitigation and adaptation strategies that might be practical and suitable
    - With regard to their current business enterprise mix,
    - With regard to their strategic business plan.
- To examine the identified mitigation and adaptation strategies against Aohanga Incorporation's values and aspirations for their land.
- On the basis of fit with values and aspirations, to select four mitigation/adaptation strategies for economic and environmental analysis, using a refined version of the Linear Programming Farm Optimisation Model initially developed in the Iwi Future project and being further developed in a concurrent core funded AgResearch project.
- The development of a climate change resilience strategy with implementation monitoring.

Aohanga Incorporation's preferred method of engagement was through hui and workshops. Their preferred methods of receiving science information were through presentations and other visual tools such as maps, graphs and diagrams. Aohanga Incorporation's principle values and aspiration regarding their land were identified at this point as strong sustainability for ownership in perpetuity for the benefit of current and future owners.

CLIMATE CHANGE IMPACT SCENARIOS

As noted in the above summary of previous research regarding climate change and Māori, there is a need:

- For "Better access to climate science and technical information in a form that supports Māori strategies, programmes and actions" Harmsworth (2012, p. 4).
- To "improve understanding of climate change impacts on Māori land based sectors" Harmsworth (2012, p. 4).
- "For future work to effectively communicate the risks and opportunities arising from climate change to Māori communities and Māori trusteeships" (King, et al., 2010, p. 103).
- For "each iwi, hapu, Māori business or community must assess and address climate change from their own perspective and exposure, but in order to do so effectively must collaborate with others to interpret the issues they face" (King, et al., 2010, p. 103).

Consistent with the above needs, climate change impact scenarios localised for Aohanga were developed by Renwick and Sturman (2012) as a sub-contract by NIWA to the current SLMACC project, and were presented by James Renwick at a hui held with Aohanga on the 9th December 2011. Renwick and Sturman also produced a report which was forwarded to Aohanga for their future reference. A hardcopy of the powerpoint presentation and a written summary of the subsequent discussions at the hui along with digital copies of the presentation and digital voice recording of the presentation and the subsequent discussion are contained in a report of the hui prepared for Aohanga Incorporation. Renwick and Sturman's main projections for national climate change impacts were listed in the previous section.

The extent of future climate change (i.e., speed and magnitude) is dependent upon levels of atmospheric GHG concentrations, which are depended upon future human action. Therefore, in order to aid climate change projections and to understand the possible variation associated with human activity the IPCC published a set of scenarios known as the "SRES" (Special Report on Emission Scenarios) (Nakicenovic N. et al., 2000). Renwick and Sturman (2012) used two of these scenarios, the A1B and the A2 scenarios, as the basis for their projections for the Aohanga case study. The A1B scenario is considered a 'middle-of-the-road' scenario, while the A2 scenario is a more fossil fuel intensive (business as usual) scenario.

For the first 50yrs the average projected temperature increase for the two scenarios are much the same, but after that point they start to diverge in the second half of the century with the A2 scenario having higher projected average temperatures than the A1B scenario. There is a substantial increase in the number of warm days projected by the end of the 21 century with average temperature being 2-3°C higher. For the current climate, there are around 15 warm days per year. This is projected to triple or quadruple for the Wairarapa, with around 30 to 50 extra warm days per year by 2100 (Renwick and Sturman, 2012). Table 2 shows the 50yr and 100 yr projected temperature changes for the A1B and A2 scenarios.

In the coastal parts of the Wairarapa, rainfall is projected to decrease overall, while annual mean rainfall is projected to increase over the Tararua ranges and in the far west of the Wairarapa. Although there is projected to be an overall decrease in the average annual rainfall (20% decrease by 2100), there is expected to be significant seasonal variability. No change, or small increases are projected for summer and autumn, with larger decreases in winter and spring. However, Renwick and Sturman (2012) noted that there is a considerable degree of uncertainty regarding the magnitude of change. For the Owahanga Station drought frequency is projected to at least double by 2100 (a drought is defined as a period of at least a month where soil moisture stays below the present-day ten-percentile). Table 3 shows the 50yr and 100yr projected precipitation changes for the A1B and A2 scenarios.

The other major impact of climate change for the Owahanga Station is sea level rise and ocean acidification. Renwick and Sturman (2012), while noting that there is considerable uncertainty around the magnitude and rate of sea level rise, suggest that between 0.5m and 1m is likely by 2100. However, as noted in the previous section some experts in this field suggest that up to 2m rise (over 1990 levels) may be possible by the end of the 21st century.

Table 2

50- and 100-year projected changes in seasonal and annual average mean temperature (in °C, from 1980-1999) for a point near the centre of Aohanga farm, averaged over 10 climate models. The ranges shown in square brackets are the lower and upper limits over the 10 GCMs analysed, across both A1B and A2 scenarios.

Period	Summer	Autumn	Winter	Spring	Annual
2030-2049 (50 y)	[0.3, 1.4]	[0.3, 1.7]	[0.3, 1.8]	[0.4, 1.4]	[0.4, 1.4]
A1B	1.0	1.1	1.3	1.0	1.1
A2	1.0	1.1	1.2	1.0	1.1
2080-2099 (100 y)	[1.7, 3.3]	[1.6, 3.5]	[1.9, 4.0]	[1.2, 3.3]	[1.6, 3.3]
A1B	2.3	2.4	2.8	2.3	2.4
A2	2.8	3.0	3.3	2.7	2.9

Source: Renwick and Sturman (2012).

Table 3

50- and 100-year projected changes in seasonal and annual average precipitation (in %), from 1980-1999, averaged over the area of Aohanga farm. Figures shown are the average change over 10 climate models for A1B and A2 scenarios. The ranges shown in square brackets are the lower and upper limits over the 10 GCMs analysed, across both A1B and A2 scenarios.

Period/location	Summer	Autumn	Winter	Spring	Annual
2030-2049 (50 y)	[-15, +23]	[-13, +24]	[-29, +4]	[-28, +2]	[-13, +8]
A1B	+2	+6	–13	–13	–5
A2	–1	–1	–12	–15	–7
2080-2099 (100 y)	[-27, +45]	[-22, +52]	[-41, +7]	[-36, +5]	[-27, +11]
A1B	+5	+4	–23	–19	–8
A2	0	+9	–25	–20	–9

Source: Renwick and Sturman (2012).

Below is a list of some projected consequences, for the Owahanga Station, associated with projected climate change impacts.

- An increase in the frequency and intensity of extreme weather events with strong westerly winds and heavy rainfall will increase the risk of erosion throughout the property and along the coastline.

- Current business enterprises will be at risk from increased temperatures, changing biodiversity – new pests and diseases, and high winds, drought and flooding events.
- Changing seasonality of crops and forage may necessitate changing on-farm management practices.
- Projected sea level rise and associated increases in the frequency of extreme high tides, combined with storm surge and a changing wave climate imply increasing risks of coastal inundation and other coastal hazards through this century and beyond for the Owahanga coastline.
- Continuing acidification of the oceans, and changes to oxygen content, nutrient supply and ocean currents, suggest that marine ecosystems may be significantly affected by climate change with consequences the collection of kai moana.

IDENTIFICATION OF POTENTIAL MITIGATION AND ADAPTATION STRATEGIES

Scientists from a range of different disciplinary fields were present at the hui on the 9th of December 2011. The disciplines represented included: climate science, farm systems, forestry, modelling, social science, agricultural economics, soil science and aquaculture. A Māori business broker and a senior Māori scientist were also present. Representatives of Aohanga were able to question the scientists directly regarding climate change and receive immediate responses. After Renwick's presentation of the likely climate change scenarios and their likely impacts at 2040 and 2100 with regard to Owahanga Station, further presentations were made by the science team regarding various potential business opportunities associated with mitigation and adaptation strategies. Discussion, questions and responses followed each presentation. As noted above, all this information was recorded as both a digital sound recording and as a report for Aohanga's future reference.

The presentations and discussions acted as a stimulus for a brainstorming session to identify further possible mitigation and adaptation strategies for the Owahanga Station. The identified strategies were entered into a table that contained columns for: opportunities associated with the strategy, barriers to the implementation of the strategy, any questions or queries that Aohanga Incorporation had for the science team regarding the identified strategies, and the degree to which the strategies were consistent with Aohanga Incorporation's values and aspirations. The identified high-level mitigation and adaptation strategies arising from the brainstorming session are listed below.

1. Resilence to temperature increase
2. Water harvesting
3. Erosion control throughout property
4. Erosion control along the coastline (in particular protection of access on the property via existing tracks)
5. Resilience/mitigation against acidification
6. Strengthen core business
7. Diversification
8. Joint partner investors
9. Integration of potential natural resources
10. Self-sufficient energy source
11. Identifying ways of building soil humus
12. Livestock policy change
13. Gorse and weed control (turning problem into resource e.g., biochar, native forestry nursery)
14. Protection against extreme events
15. More detailed investigation of natural resource base

Some barriers and opportunities were discussed and entered into the table at the hui, but much of the table was left blank with the understanding and expectation that the representatives of Aohanga Incorporation would discuss these issues in further detail and complete the table with other shareholders. Aohanga Incorporation were also to select up to four specific preferred strategies for further research by the science team and biophysical modelling and analysis for environmental and economic outcomes.

It was discussed and acknowledged that, because climate change mitigation and adaption is a long-term future oriented process and strategy, and the impacts of climate change will be experienced over time and progressively intensify, *it is important that any mitigation, adaptation and resilience strategies are integrated into strategic development planning for the Owahanga Station.* Thus, any development plans, or new or current farm enterprises, need to be evaluated for potential climate change impacts for the predicted life of the enterprise or development. In particular, developments or enterprises which last a long period of time (e.g., infrastructure, buildings, forestry), and/or which have a degree of inflexibility regarding their ability to be adapted or changed, need to be considered carefully in the light of predicted climate change impacts. Where possible a precautionary approach should be taken, and/or an adaptation strategy planned, commensurate with the predicted life of the enterprise or development and the certainties and uncertainties associated with the timing and magnitude of climate change impacts.

This latter point is particularly relevant to infrastructure such as roading, and the placement of farm buildings and plant, items that will last for many years. Due to the uncertainty around the timing of impacts, a precautionary approach combined with an ongoing monitoring approach and regular updating of the latest scientific information about the impacts and speed of climate change is recommended. To enhance resilience, such an approach should plan to enable adaptive management of adaptation and mitigation strategies and actions. As noted by the IPCC (1995, p. 45) "a prudent way to deal with climate change is through a portfolio of actions aimed at mitigation, adaptation and improvement of knowledge…. The challenge is not to find the best policy today for the next 100 years, but to select a prudent strategy and to adjust it over time in the light of new information."

IMPACTS, OPPORTUNITIES, BARRIERS, AND QUESTIONS

Once this information was completed and the selected strategies chosen, Aohanga Incorporation forwarded the information to the research team for environmental and economic modelling. Aohanga Incorporation added an extra column to the table – which they called climate change variables. The purpose of this column was to lists some of the specific climate change impacts relevant to Aohanga, as presented by James Renwick of NIWA, including:

- Temperature rises by 2-3 degrees this century;
- Less rainfall in winter/spring, little change in summer/autumn (drought risk);
- More intense heavy rainfall;
- Many changes in the ocean, sea level rise of 0.5 - 1m this century;
- Acidification, loss of oxygen, changes to upwelling/nutrients;
- Thereafter, general climate change scenarios

Resilience, mitigation, and adaptation strategies were associated with climate change impacts that they were designed to address. A range of opportunities and barriers to each of the potential resilience strategies was identified as well as questions regarding each strategy. Appendix 2 contains the collected data.

AOHANGA INCORPORATION'S VALUES AND THE FIT BETWEEN IDENTIFIED MITIGATION AND ADAPTATION STRATEGIES

After the hui on the 9th of December 2012, Aohanga took the information presented and the potential strategies generated back to their community for further evaluation and endorsement. A well as considering barriers to the strategies, opportunities arising from them, and questions regarding them, Aohanga Incorporation evaluated each of the 15 identified strategies against their values and aspirations for their land. The results of that evaluation are contained in Appendix 2. Additionally, a copy of Aohanga Incorporation's **draft Values Statement** is presented in Appendix 3. Note that this Values Statement is in draft form and that the statement has not yet been officially endorsed by the Board. It is expected that the values expressed may undergo some slight revisions, However, the values expressed have been part of Aohanga Incorporation's menu of values for some time (M. Mullins, personal communication, May 31, 2012).

According to Barnett and Campbell (2009) and O'Brien (2009), in order for adaptation planning to be effective, legitimate and equitable local community values must be acknowledged and aligned. Jones (2010, slide 37) suggested that, for Māori, part of the climate change solution "lies in establishing indigenous values as the basis for human development." We found climate change resilience activities fitted well with Aohanga's values and aspirations for their land, notably:

- "To protect and enhance the mana of Aohnaga for the benefit of its shareholders (Mission Statement, Aohanga Incorporation, 2012, p. 3)
- "As whānau hapū members we place a good deal of importance on cultural values" (Aohanga Incorporation, 2012, p. 3)
- " Mana Whenua, Mana Moana - this principle defines Māori to the environment occupied by right of ancestral claim" (Aohanga Incorporation, 2012b, p. 2) (Aohanga intend to own their land in perpetuity)
- "…to have a sustainable business that future generations will benefit from" (Aohanga Incorporation, 2012a)
- "We believe in the deep interdependence of the hapū and its associated values, which among others includes mutual respect, fairness, cooperation, gratitude, compassion, forgiveness, humility, courage, confidence, courtesy, integrity, loyalty and respectful use of all our resources. Therefore land development, which is tīkanga based, is an important aspect. Strong Sustainability means the preservation of integrity of all ecological systems.... A strong sustainable hapū lives and develops as an integral part of the surrounding ecosystem. Matauranga Māori is the basis of our learning and important to whānau, hapū growth. (Aohanga Incorporation, 2012b, p. 3).
- "Kiatiakitanga – this principle embraces the spiritual and cultural guardianship of Te Ao Marama, a responsibility derived from whakapapa" (Aohanga Incorporation, 2012b, p. 2) (the responsibility of stewardship of their land).

Climate change resilience is an issue of sustainability (Halsnaes & Verhagen, 2007; Metz & Kok, 2008) – an attempt to ensure that the resources available to current humans for their welfare and survival are also available to future generations. Therefore, the imperative to develop and adopt technologies and practices that provide resilience to the impacts of climate change and protect infrastructure and resources for the use and wellbeing of future generations is also a moral issue of intergenerational equity, as demonstrated by the values of Aohanga Incorporation.

AOHANGA INCORPORATIONS PREFERRED STRATEGIES FOR FURTHER MODELLING ANALYSIS

From their analysis of the information and potential resilience strategies, Aohanga Incorporation selected four strategies by for further initial analysis and consideration. These strategies were:

1. Strategy 2: Water harvesting
2. Strategy 3/4: Erosion control throughout property and along the coastline
3. Strategy 6: Strengthen core business
4. Strategy 11/13: Building soil hummus and gorse/weed control.

The high-level strategies 3 and 4 and 11 and 13 were considered similar enough by Aohanga Incorporation to group together as single strategies for the purpose of analysis. Additionally, Aohanga Incorporation, requested that the project map:

- Indigenous and exotic forest land registered in the ETS to date per the shape files provided (overlaid on the updated paddock map)
- Culturally significant sites on and around the station per the maps and information provided as part of the Iwi Futures project.

An extensive range of digitised maps was developed by Andrew Manderson, of AgResearch, and provided to Aohanga in digital form. As some of these maps contain culturally sensitive information, they are not reproduced in the current document.

BIOLOGICAL SCIENCE KNOWLEDGE GAPS

We have already identified and discussed the fact that there is considerable uncertainty associated with the magnitude and timing of climate change effects. Areas of uncertainty include:

- Temperature rise – magnitude and rate;
- Biological feedback loops affecting both release and sequestration of carbon, albedo effects, many features of the carbon cycle are still not understood;
- Ice melt and sea level rise – magnitude and rate;
- Frequency and severity of extreme weather events;
- Biological tipping points;
- Changing geospatial patterns of species and biodiversity;
- Ocean acidity and impacts on marine food chains – magnitude and rate;
- Interactions between elevated CO_2 temperature, moisture deficit, and nutrient availability;
- Interaction amongst crops, pests, water supply and factors affecting livestock;
- Interactions with other factors, such as population growth, fossil fuel depletion, biofuel production;
- Bio-technology developments.

Uncertainty is also associated with the development and adoption of new technologies designed to mitigate climate change (e.g., carbon sequestration technologies, atmospheric carbon scrubbing, carbon neutral energy generation technologies, geo-engineering technologies designed to mitigate climate change, and green technologies and practices to replace current carbon polluting technologies). These scientific uncertainties at the global level and the uncertainty around new technologies for mitigation are important to specific cases, such as Aohanga's climate change resilience planning, because they will impact on the level of adaptation that is required in the future,

Digital elevation modelling

With regard to sea level rise for coastal land, such as the Owahanga block, accurate digital elevation modelling represents an important gap in local biophysical knowledge. Digital elevation modelling (DEM) of the land is very useful for understanding the probable impacts of sea level rise and tidal surges caused by extreme weather events and hence for the planning and adoption of either mitigation or adaptation strategies and actions. Accurate DEMs may be used to do 'bathtub' modelling and to estimate the effect on the high tide mark and consequences for land erosion (i.e., map inundation hazard exposure). Likewise, there are also sophisticated computer applications available for modelling the implications of river flooding, which combined with sea level rise, could have very real implications for Owahanga, given that their most productive land is primarily alongside the two rivers. However, the only digital elevation data currently available for the Owahanga block is 20m contours and associated 15m resolution DEMs (which are derived from the 20m contours). Unfortunately, these are far too coarse for use with sea level rise/flooding models.

LiDAR (Light Detection and Ranging) is an airborne-based, remote sensing, laser scanning technology that can produce very accurate DEMs suitable for a range of activities that could be very useful for climate change resilience planning for Owahanga. These include: flood modelling, corridor mapping, road and engineering design, power line mapping, and natural resource assessment. While Aohanga could invest in having a LiDAR DEM developed for their block, it is an expensive exercise. Fortunately, the data may soon be available courtesy of the Greater Wellington Regional Council (GWRC). Contact with Nick Page, from GWRC, indicated that, although GWRC do not currently have a LiDAR map of the Wairarapa coast, they are preparing a tender for full regional imagery and LiDAR coverage, with a view to acquiring copyright free data in 2013. LiDAR maps have proven to be a powerful tool for communicating future risk exposure to sea level rise, for teaching and for resilience planning (Rouse & Blackett, 2011). We recommend that, as part of their climate change resilience strategy, Aohanga follow this up and obtain the LiDAR maps for sea level rise and river flood mapping.

COMPONENTS OF A CLIMATE CHANGE RESILIENCE STRATEGY FOR OWAHANGA STATION

Through a process of iterative engagement between Aohanga Incorporation and the science team the following components of a climate change resilience strategy for the Owahanga Station were identified.

Awareness and acceptance of climate change

The first component of the resilience strategy is awareness and acceptance of climate change by Aohanga Incorporation and it shareholders. There are a number of factors which Aohanga and its shareholders need to be aware of and accept. These include:

- The nature and likely impacts of climate change at a global level
- The nature and likely impacts of climate change at a local level relevant to the Owahanga Station
- The relationship between climate change resilience and sustainable land management
- The relationship between climate change resilience and strategic development planning i.e., the need to evaluate business development and diversification opportunities through the lens of climate change projections
- The relationship between climate change resilience and *disaster risk reduction* i.e., climate change resilience strategies should be consistent with or strengthen Owahanga Station's resilience to extreme weather events and, therefore, contribute to disaster risk reduction

- The uncertainties associated with climate change and climate change knowledge
- The need to have a flexible, adaptive management approach to climate change resilience and resilience planning

Assessment of sensitivity, exposure and vulnerability to climate change impacts

The second component of a resilience strategy for the Owahanga Station is assessment of the current situation with regard to climate change and likely impacts. Assessment is necessary in order to identify where risks lie and to plan an appropriate resilience strategy. When undertaking assessment and developing a resilience strategy, it is necessary to consider the timeframe/lifecycle of the resource, or the business enterprise being assessed with respect to the projected timeframes for climate change impacts. Thus, resources or business enterprises with long-term horizons, particularly infrastructure, such as roads, buildings, and mechanical plant need to be managed or planned with a precautionary approach regarding climate change, due to rate and magnitude uncertainties. Important factors of this component include:

- Documenting local knowledge, matauranga Māori, stories and history of the station to help understand likely future events, e.g.,
    - Extreme weather events and the damage caused to property
    - Extreme weather event impacts on business enterprises
    - Erosion events – locations and impacts
    - Extreme high tide and storm surge events and impacts
    - Flooding events and areas impacted.
- Climate change sensitivity and vulnerability analyses of:
    - The community i.e., Aohanga Incorporation and shareholders
    - The Station property
    - Current business and agricultural enterprises
    - Strategic property development/plans/diversification options.
- Climate change impacts for Aohanga to consider in sensitivity and vulnerability analyses
    - Average temperature rise – but with increased variability
    - Reduced rainfall – but with increased variability
    - Increasing frequency and severity of extreme weather events
    - Changing seasonality of pasture and crops
    - Farm animal species tolerance to climate change and impacts
    - Terrestrial biosecurity (invasive species) and species biodiversity impacts/risks
    - Sea level rise and coastal erosion
    - Storm surges and high tide impacts from extreme weather events
    - Ocean warming and acidification
    - Ocean biosecurity (invasive species) and species biodiversity.

In order to do the above analyses a number of different tools are necessary or useful

- Accurate topographical contour maps of the Owahanga Station i.e., LiDAR Digital elevation modelling. This may be used in conjunction with various computer models to:
    - Project sea level rise impacts for future points in time
    - Consider likely impacts of high tide events, river flooding and storm surges
    - Identify potential erosion sites
    - Identify potential water storage sites.
    - Identify at risk infrastructure and plan for future infrastructure development
- Whole farm models such as Farmax, Overseer, Myland, Optimisation models and Social Return on Investment models can help provide:
    - Farm level assessment of social, economic and environmental impacts of climate change

    - Farm level assessment of social, economic and environmental sustainability impacts of resilience strategies, diversification options and strategic development plans.
- Carbon footprinting, water footprinting, energy footprinting, and lifecycle analysis can help provide:
    - Assessment of environmental impacts of current enterprises and practices
    - Assessment of environmental impacts of resilience strategies, diversification options and strategic development plans.

In addition, the above sets of tools will also be of value for measuring, monitoring and reviewing environmental and economic progress and sustainability over time, for evaluating the rate and magnitude of climate change impacts and for evaluating and adaptively managing climate change mitigation and adaptation responses.

Development and embedding a resilience action plan in Aohanga's strategic development plan

Identification of potential risks and hazards through exposure and vulnerability assessment provides the background information necessary for the development of a climate change resilience action plan. As previously noted climate change resilience is both a strategic development issue and sustainability issue. Therefore, the most logical place for a climate change resilience plan is to be embedded in Aohanga's Incorporations recently developed (May 2012) draft strategic development plan; GrowthPLUS™ Strategy. The opening sentence of the GrowthPLUS™ Strategy states Aohanga Incorporation's "…goal is to have a sustainable business that future generations will benefit from." Thus, sustainability is at the heart of Aohanga's strategic plan. Having a climate change resilience strategy is consistent with, and will help to realise, the goal of sustainability.

However, as discussed above, it is not necessary, or even advisable, given the degree of uncertainty regarding the rate and magnitude of climate change, that a strategy be fully developed or fleshed out with actions plans for the next hundred years. Rather the climate change resilience strategy should be thought of as the outline of a journey in which the destination (sustainability in the face of climate change) may be reached by a variety of paths, while traversing a range of obstacles. At present, some of the obstacles and the paths around them remain unchartered. Therefore, it is important to head off in the right direction, but it is also important to maintain flexibility in the route to resilience and sustainability.

Aohanga's GrowthPLUS™ Strategy has four key pillars:

1. Production: Improve on farm production through improving soil fertility, paddock size, weeding, and genetics of stock,
2. People: Build our people by providing staff development, mentors, a relationship with a Training Institute,
3. Governance: Enhanced governance by implementing contract management strategies, clear delegation of roles, seasonal budgets, foundation documents, and
4. Diversification: Diversification by considering, is this a distraction to our farming operations, does it meet our criteria?

Climate change resilience planning is an issue that cuts across, and may be embedded in, all four key pillars of Aohanga's strategic plan. Thus, in pillar 1 (production) soil fertility may be enhanced by building soil carbon stocks – this is an opportunity for carbon sequestration in soil – a mitigation action. Another example from pillar 1 is improving the genetics of stock, one criterion for improved stock genetics could be increased heat and drought tolerance – an adaptation strategy. Management practices, such as nutrient management plans, forage selection and management, planting and harvest dates, animal slaughter dates etc. may be

evaluated with respect to climate change impacts on on-farm production. For pillar 2 (people) staff development provides an opportunity for development of awareness and acceptance through training about climate change and its likely impacts. Training may also be required in the use of tools and models that help measure and monitor sustainability of the business and property and the rate and magnitude of climate change. This type of staff training may benefit from mentoring and the development of relationships with the research organisations that develop the models and tools.

Regarding pillar 3 (governance), the strategic goals of sustainability and climate change resilience are governance decisions which provides the opportunity of embedding them in the organisations foundation documents (e.g., the organisational strategic plan). Within this strategic pillar, climate change resilience and management may benefit from delegating a specific individual or organisational position the role of 'climate change resilience champion'. This person, as part of their staff development and education, could be given the role of understanding and keeping up-to-date with the latest developments in the field of climate change science and technologies and practices to mitigate and adapt to it. Finally, the 4th pillar (diversification) provides the opportunity of embedding climate change resilience as a criteria by which potential diversification options are evaluated. The GrowthPLUS^{TM} Strategy lists eight decision-making criteria for evaluating potential diversification options. We recommend the addition of a climate change criterion that considers the diversification option's vulnerability/resilience to climate change impacts, any adaptation pathway/strategies, and also, carbon and water footprints of the diversification options.

Organisational strategic plans are living documents that provide direction but which require regular monitoring, updating and adapting in the light of new circumstances or opportunities, new information and new technologies and practices. Given the previously discussed uncertainties associated with climate change, resilience strategies and actions will also need regular monitoring, updating and adapting. Embedding climate change resilience planning in all aspects of the strategic plan should ensure that monitoring and updating climate change resilience occurs concurrently with updating the strategic plan.

During the course of this project Aohanga have already identified a range of issues and potential mitigation and adaptation strategies as listed in Table 2 above. Further, they have identified a small number of these that are highly compatible with their values and aspirations for the property, and that they are interested in investigating further in the near future. These provide the basis, and set the general direction, for their resilience action plan. Once the sustainable potential of these mitigation and adaptation actions are modelled and assessed, and particular actions settled on, they can be moved into operational plans with timeframes and identification of individuals responsible for implementation and monitoring.

Implementing, monitoring, evaluation and adaptive management

The final stage of a climate change resilience strategy for Aohanga Incorporation and the Owahanga Station is implementation of mitigation and adaptation actions and the development and implementation of a plan to monitor the impacts of climate change and the resilience action plan for the purpose of evaluation and adaptive management of the action plan. This will require familiarity with and use of some of the tools mentioned in the second step of the strategy (assessment of vulnerability). An awareness of changing knowledge, technologies and practices in agriculture and in the climate change field will be essential for the adaptive management of Aohanga's climate change resilience strategy.

Social process frameworks for engaging with rural communities and rural Māori communities in climate change resilience, mitigation and adaptation

BACKGROUND

A theme flowing through, and cutting across, the previous sections of this report has been about the social process of engagement with communities, and in particular rural Māori communities, for the purpose of mitigation, adaptation and resilience to climate change. Some of the discussion related to this cross cutting social issue has been of a generic nature; psychological and sociological factors relevant to all communities attempting to engage in climate change resilience planning. Such discussion occurred in the section entitled: "The research problem and the generic social context". Issues of impact uncertainty, differential geospatial impacts, the need for localised climate change information, and the relationship between sustainability and climate change resilience, were discussed in the sections entitled: "The climate change problem"; "Climate change and agriculture" and "The social nature of the climate change problem (and solutions)". These issues are relevant to almost all rural communities of humans with respect to community engagement in climate change resilience.

Other crosscutting factors related to the social issue of engagement have been oriented more specifically to Māori and to land-owning Māori Incorporations, such as in the sections: "Climate change and Māori", and "Climate change and Māori worldviews and values". The research strategy and procedures, negotiated with Aohanga Incorporation, and itemised at the beginning of the section: "Developing a climate change strategy with Aohanga Incorporation" represent an aspect of a climate change engagement framework specifically oriented to the needs and requirements of Aohanga Incorporation and their Owahanga station. However, much of the process described is relevant to any Māori land owning organisation or agricultural land owning entity. Similarly, the combination of bottom-up qualitative research methods and top down quantitative modelling methods discussed in the same section are relevant to most agricultural enterprises or entities.

This section of the report first considers some potential research issues, for the current project, regarding engagement with Māori in climate change resilience. These issues stem right from the earliest stage of the project; the request for proposal, and the pre-proposal engagement with Aohanga (including the previous work conducted in the Iwi Futures project). Next is a brief account of the relationship between the current project and the Iwi Futures project – particularly with regard to the engagement process. These two sub-sections provide a background for the current projects engagement with Aohanga.

Next we provide an overview of some generic principles of community engagement, followed by a brief review of some international examples of community engagement for climate change resilience. This is followed by some climate change engagement framework case studies from the New Zealand literature – including with Māori. Then, distilling the engagement literature and the generic psychological and sociological discussions in this report, a generic framework for social engagement is presented. Next, is a brief discussion of factors and synergies that helped Aohanga engage in the development of a climate resilience strategy. Finally, the section ends with a discussion of some difficulties encountered in the current project and the lessons learned regarding rural community engagement in climate change resilience, with a particular focus on Māori communities.

Potential research issues

Some potential research issues and risks were identified in the original research proposal. Proposal application timeframes restricted meaningful pre-proposal engagement and collaboration with Aohanga Incorporation. When working within a participatory action research framework, and in a partnership relationship with community and/or Māori groups, it is best practice to interactively and jointly design the research objectives, methods and deliverables.

This is particularly the case when working with Māori communities, especially when the process is being managed by Pakeha scientists who have little understanding of Māori tikanga, kawa and values (Harmsworth, 2002/2012; Wilcox, et al., 2008). Wilcox et al.'s paper is concerned with engagement over controversial technologies in particular, but many of the element are generically applicable to any engagement between research providers and tanga whenua, "furthermore, parts of the process could be used for non-controversial research that is of interest to Māori" (p. 225). Perhaps the essence of both papers is the importance placed on establishing the relationship between Māori and the research providers. Indeed, Harmsworth (2002/2012, Section 2.1) stated: "The most apparent ingredient is to build a meaningful relationship from the start."

Both Harmsworth (2002/2012) and Wilcox et al. (2008) recommend that, ***before writing*** (Harmsworth) or ***before submitting*** (Wilcox et al.) a research proposal, an extended three phase process of engagement should occur in order to develop a culturally appropriate research partnership. Harmsworth's three phases are 1) initiating the relationship, 2) building the relationship, and 3) maintaining the relationship. Wilcox et al.'s three phases are 1) toolkits to enhance understanding before the two parties engage in dialogue, 2) dialogue about the proposal, 3) response to proposal dialogue. These authors considered it essential that the research agreement and process be designed and built on a developed relationship.

The extended relationship development is considered necessary in order to develop trust and understanding between the two groups, to demonstrate commitment to the relationship, and to seeing the research project through to completion. As stated above, the key element in a successful research partnership between Western science providers and Māori appears to be relationship development – all further progress depends upon the successful establishment of an ***ongoing*** trusting relationship. Both Harmsworth and Wilcox et al. stress the necessity for the relationship to be ongoing.

Within the timeframes for writing up the SLMACC proposal only the most cursory of engagement between the research proposers and Aohanga Inc was possible. This engagement was primarily between the Māori scientist who led the Iwi Futures project and the Chairperson of the Aohanga Committee of Management. This minimal pre-proposal engagement potentially foreshadows an engagement problem for both the research proposers and the Māori research partner. However, it was hoped that the involvement of researchers who had previously worked with Aohanga Incorporation in the Iwi Futures project, as well as the involvement of Māori business brokers, would help smooth and enable the engagement process, despite the lack of full engagement at the proposal writing stage.

However, the science manager of the project and main proposal writer (a Pakeha social scientist) was new to Aohanga Incorporation, and with no previous experience in working with Māori communities. Thus, these initial conditions, which may be interpreted as not fully complying with best practice and good faith principles of engagement with Māori, as specified by Harmsworth (2002/2012) and Wilcox et al. (2008), highlight an important

misalignment or clash between the expectations and process of two cultures: the science culture and its funding process, and Māori community processes, kawa and culture.

In practice, the boundaries and general intention of the research are contractually obligated by the proposal (and the proposal is necessarily shaped by the original research request for proposals). In order to acknowledge this contractual barrier to developing and conducting a truly participatory partner based research design and process, and to attempt to mitigate this barrier to good faith engagement, the proposal stated that negotiation with Aohanga Incorporation would shape the research process and results, in terms of the questions, issues and potential climate change mitigations and adaptations chosen to analyse.

Additionally, to enhance the participative nature of the research, it was proposed to use a process of iterative engagement, in which future components of the research could be determined throughout the life of the project. There were some potential risks for the research group of using such a process. First, it was unclear how the research would develop and what research topics/issues would arise for investigation. Following from that uncertainty, it was likewise unclear what research capabilities and capacities would be required to address the issues that arose, and whether those capabilities would be present in the research team. Next, if the appropriate capabilities were not in the current research team, it was uncertain as to whether appropriate expertise could be found and drawn upon in a timely manner, and whether the project funding would be adequate and available for redirection.

These issues were discussed with representatives of Aohanga Incorporation's Committee of Management at the first workshop held on the 9th of September, 2011. It was acknowledged by both research partners that, under such a research and engagement framework, finances and timeframes would be a limiting factor to both engagement and deliverables. The other potential risks were that the science-based information required or requested by Aohanga Incorporation would not be able to be answered by the researchers due to gaps in current science knowledge or lack of adequate technical models.

Iwi Futures project

The current project was designed to stand on the shoulders of the FRST funded Iwi Futures project (MAUX0711) in three main ways. First, the Iwi Futures Project was considered to offer an entry point for engagement with the case study community, Aohanga Incorporation. Some of the team members in the current SLMACC project were also in the Iwi Futures project, in particular, a senior scientist employed as a Māori science leader, a Māori business broker, and a senior scientist skilled in modelling. Engaging with Māori communities in research is known to be complex and time consuming and fraught with cultural expectations and often misalignments between the research partners, of which the research community is sometimes not cognizant (Harmsworth, 2002/2012; Wilcox, et al., 2008). Therefore, the expectation and hope was that, by including researchers and Māori business brokers who had an already established relationship with Aohanga Incorporation, the process of engagement would proceed in an acceptable fashion, to both Aohanga and the research providers, despite the acknowledged lack of appropriate engagement and participation during the proposal writing phase.

Secondly, one of the outputs of the Iwi Futures project was a linear programming, agro-forestry land use optimisation model. This model, although only in early development at the time of the SLMACC bid, was seen to have the potential (after some additional development work) to model alternative climate resilience activities, practices and business enterprises, involving agro-forestry production for environmental and financial impacts. Therefore, it was anticipated that the model could be used as a decision aid tool in the development of a climate

change resilience strategy. Thus, the current SLMACC project was run in parallel with an AgResearch core funded programme to further develop the optimisation model for these kinds of analyses and to make the programme more user-friendly for potential users.

Thirdly, at the time of writing the current SLMACC proposal, it was also expected that another planned output from the Iwi Futures project would be available for use in this SLMACC project. This was a report on the values and aspirations of Aohanga Incorporation for their Owahanga farm block. Unfortunately, although the research was conducted, the report has not yet been completed and hence was not available to us. Thus, it became necessary to seek this information from within the current SLMACC project. To this end, we sought the assistance of Mavis Mullins, the Chairperson of the Aohanga Committee of Management, who kindly provided us with Aohanga's corporate Statement of Values.

ENGAGEMENT FRAMEWORKS

Below, we first present seven core principles for community engagement. These are generic principles for community engagement regarding any issue. Next, we review a few international examples of engagement processes specifically for climate change resilience. Then we review some New Zealand case studies of engagement in climate change resilience research including some Māori case studies.

Seven core principles for public engagement

In 2009, as a response to the Obama Governments January 21st memorandum on transparency and open government, a collaborative project was led by the National Coalition for Dialogue & Deliberation (NCDD), the International Association for Public Participation (IAP2) and the Co-Intelligence Institute, to develop a set of core principles for public engagement. These are generic principles relevant to all public engagement exercises independent of the issue under discussion. The seven principles are (Public Engagement Principles Working Group, 2009, pp. 5-18):

1. **Careful planning and preparation**
   Through adequate and inclusive planning, ensure that the design, organization, and convening of the process serve both a clearly defined purpose and the needs of the participants.
   In high quality engagement:
   Participation begins when stakeholders, conveners and process experts engage together, with adequate support, in the planning and organizing process. Together they get clear on their unique context, purpose and task, which then inform their process design as well as their venue selection, set-up and choice of participants. They create hospitable, accessible, functional environments and schedules that serve the participants' logistical, intellectual, biological, aesthetic, identity, and cultural needs. In general, they promote conditions that support all the qualities on this list.
2. **Inclusion and demographic diversity**
   Equitably incorporate diverse people, voices, ideas, and information to lay the groundwork for quality outcomes and democratic legitimacy.
   In high quality engagement:
   Conveners and participants reflect the range of stakeholder or demographic diversity within the community or on the issue at hand. Where representatives are used, the nature, source, and any constraints on their representative authority are clearly identified and shared with participants. Alternatively, participants are randomly selected to represent a microcosm of the public. Participants have the opportunity to grapple with data and ideas that fairly represent different perspectives on the issue. Participants have equal status in discussions, and feel they are respected and their views are welcomed, heard, and responded to. Special effort is made to enable normally marginalized, silent, or

dissenting voices to meaningfully engage — and fundamental differences are clarified and honoured. Where necessary, anonymity is provided to enable important contributions.

3. **Collaboration and shared purpose**
   Support and encourage participants, government and community institutions, and others to work together to advance the common good.
   In high quality engagement:
   Organizers involve public officials, "ordinary" people, community leaders, and other interested and/or affected parties as equal participants in ongoing discussions where differences are explored rather than ignored, and a shared sense of a desired future can emerge. Organizers pay attention to the quality of communication, designing a process that enables trust to be built among participants through dialogue, permits deliberation of options, and provides adequate time for solutions to emerge and evolve. People with different backgrounds and ideologies work together on every aspect of the program — from planning and recruiting, to gathering and presenting information, all the way through to sharing outcomes and implementing agreed-upon action steps. In government-sponsored programs, there is good coordination among various agencies doing work relevant to the issue at hand.
4. **Openness and learning**
   Help all involved listen to each other, explore new ideas unconstrained by predetermined outcomes, learn and apply information in ways that generate new options, and rigorously evaluate public engagement activities for effectiveness.
   In high quality engagement:
   Skilled, impartial facilitators and simple guidelines encourage everyone involved to share their views, listen, and be curious in order to learn things about themselves, each other, and the issues before them. Shared intention and powerful questions guide participants' exploration of adequate, fair, and useful information — and of their own disagreements — in an open and respectful atmosphere. This exploratory atmosphere enables them to delve more deeply into complexities and nuances and thereby generate new understandings, possibilities, and/or decisions that were not clear when their conversation began. There is an appropriate balance between consulting (a) facts and expertise and (b) participants' experience, values, vision, intuition, and concerns. Participants and leaders take away new skills and approaches to resolving conflicts, solving problems, and making decisions. Careful review, evaluation, and a spirit of exploration and innovation improve subsequent engagement work and develop institutional and community capacity.
5. **Transparency and trust**
   Be clear and open about the process, and provide a public record of the organizers, sponsors, outcomes, and range of views and ideas expressed.
   In high quality engagement:
   Relevant information, activities, decisions, and issues that arise are shared with participants and the public in a timely way, respecting individuals' privacy where necessary. Process consultants and facilitators are helpful and realistic in describing their place in the field of public engagement and what to expect from their work. People experience planners, facilitators, and participants with official roles as straightforward, concerned, and answerable. Members of the public can easily access information, get involved, stay engaged, and contribute to the ongoing evolution of outcomes or actions the process generates.
6. **Impact and action**
   Ensure each participatory effort has real potential to make a difference, and that participants are aware of that potential.
   In high quality engagement:
   People believe — and can see evidence — that their engagement was meaningful, influencing government decisions, empowering them to act effectively individually and/or

together, or otherwise impacting the world around them. Communications (of media, government, business and/or nonprofits involved) ensure the appropriate publics know the engagement is happening and talk about it with each other. Convening organizations or agencies maximize the quality and use of the input provided, and report back to participants and the public about how data from the program influenced their decisions or actions. The effort is productively linked to other efforts on the issue(s) addressed. Because diverse stakeholders understand, are moved by, and act on the findings and recommendations of the program, problems get solved, visions are pursued, and communities become more vibrant, healthy, and successful — despite ongoing differences.

7. **Sustained engagement and participatory culture**
   Promote a culture of participation with programs and institutions that support ongoing quality public engagement.
   In high quality engagement:
   Each new engagement effort is linked intentionally to existing efforts and institutions — government, schools, civic and social organizations, etc. — so quality engagement and democratic participation increasingly become standard practice. Participants and others involved in the process not only develop a sense of ownership and buy-in, but gain knowledge and skills in democratic methods of involving people, making decisions and solving problems. Relationships are built over time and ongoing spaces are created in communities and online, where people from all backgrounds can bring their ideas and concerns about public affairs to the table and engage in lively discussions that have the potential to impact their shared world.

The purpose of the Core Principles is to help "effectively build mutual understanding, meaningfully affect policy development, and /or inspire collaborative action amongst citizens and institutions. The seven interdependent principles serve both as ideals to pursue and as criteria for judging quality" (Public Engagement Principles Working Group, 2009, p. 4). While these principles are designed primarily for community engagement for the development of public policy, they nonetheless have a degree of applicability for the current case study as underlying principles of engagement.

Food and Agricultural Organisation of the United Nations engagement framework elements for adaptation to climate change

The Food and Agricultural Organisation of the United Nations (FAO) proposed a framework for adaptation to climate change in agriculture, forestry and fisheries. While it is not strictly speaking a framework for social engagement, its elements are relevant within a social engagement framework. The FAO climate change framework is presented below:

- *"Legal and institutional* elements – decision making, institutional mechanisms, legislation, implementing human right norms, tenure and ownership, regulatory tools, legal principles, governance and coordination arrangements, resource allocation, networking civil society.
- *Policy and planning* elements – risk assessment and monitoring, analysis, strategy formulation, sector measures.
- *Livelihood* elements – food security, hunger, poverty, non-discriminatory access.
- *Cropping, livestock, forestry, fisheries and integrated farming system* elements – food crops, cash crops, growing season, crop suitability, livestock fodder and grazing management, non-timber forest products, agroforestry, aquaculture, integrated crop-livestock, silvo-pastoral, water management, land use planning, soil fertility, soil organisms.
- *Ecosystem* elements – species composition, biodiversity, resilience, ecosystem goods and services.

- *Linking climate change adaptation* processes and technologies for promoting carbon sequestration, substitution of fossil fuels, promoting use of bioenergy."

(Food and Agriculture Organisation of the United Nations, 2007, pp. 6-7)

The United Kingdom Climate Impacts Programme

The United Kingdom Climate Impacts Programme (UKCIP) is an agency set up to help with adaptation to climate change. They have developed and made available a range of tools for this purpose. In one of their publications (West & Gawith, 2005), they document lessons learned regarding stakeholder engagement. Several barriers were identified:

- Uncertainty about climate change extent and magnitude;
- The complexity of climate change and adaptation;
- The timeframes of climate change (long) as opposed to planning timeframes; and
- Resource constraints.

Measures identified as enhancing success of the programme included:

- Engaging with stakeholders about current issues and risks first before casting to future changes;
- Enquire and engage on issues that are relevant to stakeholders' concerns (climate change may not be one);
- Work with existing networks;
- Helping stakeholders understand that it is in their interest to adapt; and
- Be aware that engagement takes time and effort.

Australian Climate Adaptation Flagship Programme (CSIRO)

The Climate Adaptation Flagship Programme of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian national science agency, produced a report with best practice guidelines for engaging stakeholders in climate adaptation. Three principles were highlighted (Cited in Rouse & Blackett, 2011, p. 45):

1. Engagement literature can offer some consistent guidelines;
2. Climate change and adaptation are topics that make engagement hard;
3. Mechanisms to overcome these barriers do exist.

Plus, a set of recommended 'mechanisms' were given:

- Prior to engagement – set goals and plan, contextualise the issue, define the stakeholders, manage expectations;
- Engagement process – use group discussion, use varied presentation formats, allow mutual influence, foster trust, respect and ownership;
- Climate change issues – address gaps in knowledge, acknowledge uncertainty
- Address scepticism, address emotional reactions
- Engagement follow-up and evaluation – maintain contact and feedback, plan evaluations from the outset, evaluate both process and outcomes, acknowledge other impacts.

New Zealand community engagement example: Rouse and Blackett (2011)

In an inspiring piece of local work, developed from their experience with three case studies conducted with the Whitianga, Mercury Bay and Manaia communities, Rouse and Blackett (2011) developed a suggested good practice approach for engaging communities in climate change and coastal sea level rise adaptation. Their conceptual approach was founded on a participatory ideology of "developing a partnership between the community and council and other participants, building trust and enabling the sharing of knowledge" (2011, p. 61). They developed a schematic model based on four factors they believed to be keys to their

successful case studies. They called their model the "Engaging communities: Making it work" approach. Their model is reproduced below as Figure 5

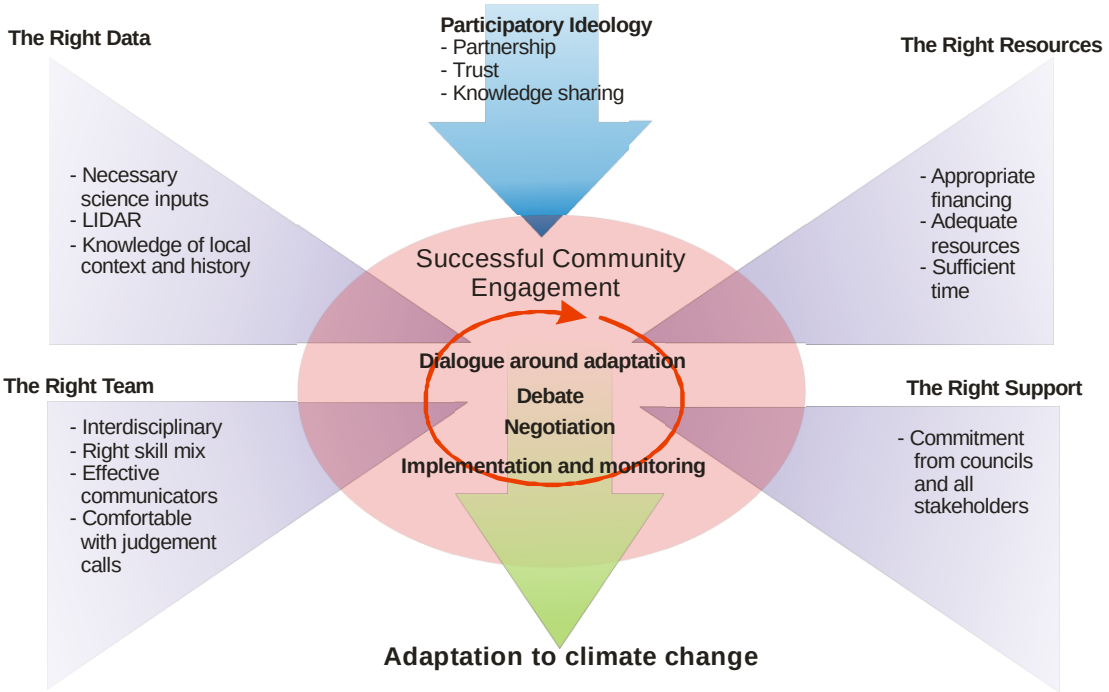

Figure 5. Engaging communities: Making it work. Source: Rouse and Blackett (2011)

The four success elements defined by Rouse and Blackett (2011) were:

- *The right team* – interdisciplinary team able to provide the necessary physical, ecological, and social science skills and with an ability to communicate complex ideas in a manner suitable for lay audiences;
- *The right data* – appropriate and credible science data with the backing of scientific consensus and knowledge of the community;
- *The right support* – support and commitment from appropriate authorities with the 'right' local contacts;
- *The right resources* – adequate technical resources, adequate funding and appropriate timeframes are all necessary elements for successful public engagement.

New Zealand dairy farmer engagement example: Kalaugher et al.(In Press)

Another insightful recent piece of New Zealand work by Kalaugher, Borman Clark and Beukes (In Press, Corrected Proof available on-line 11 May 2012) developed an integrated biophysical and socio-economic framework for analysis of climate change adaptation strategies in a New Zealand dairy farm system. They proposed a Mixed Methods Framework with seven stages. Although this model is primarily designed for analysing climate change adaptation strategies for a dairy farming system, its stages and elements overlap with a more generic social process for engaging rural communities in climate change resilience. Similar to the current project, their Mixed Method framework involved the use of bottom-up qualitative methodology combined with a top-down quantitative methodology. The framework includes iterative engagement phases between a research team and the farmer or landowner. The seven phases proposed by Kalaugher et al are:

1. Scope (researcher)
2. Scope (farmer)
3. Scenario generation (researcher)
4. Pool ideas (with farmer)
5. Analyse options (researcher)

6. Validate results (with farmer)
7. Evaluate adaptation strategies (with farmer)

They illustrate their model with the following diagram (Figure 6)

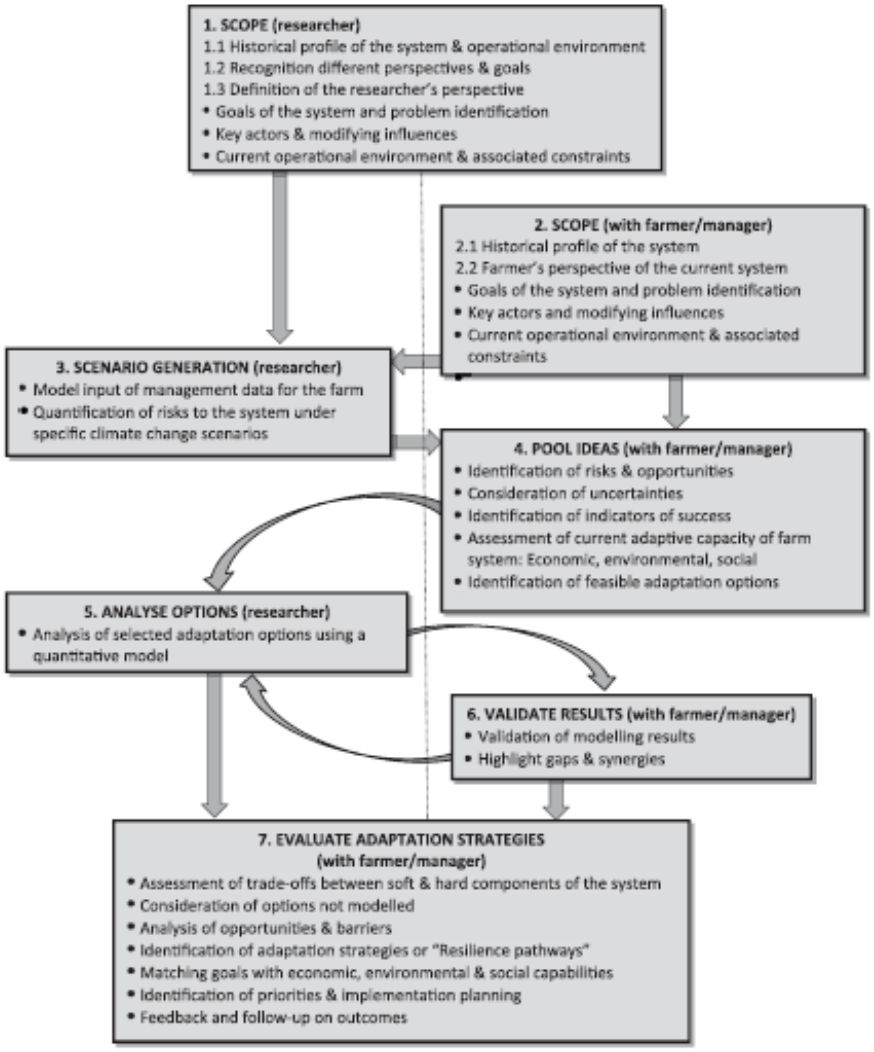

Figure 6. Mixed Method Framework for analysing adaptation strategies in a New Zealand dairy system. Source: Kalaugher et al. (In Press, p. 6)

Māori specific engagement framework examples

Some excellent projects have specifically examined the engagement of Māori in various climate change mitigation and adaptation strategies. Carswell et al.(2002) proposed a framework for engagement of Māori landowners in carbon farming using indigenous forest regeneration. Their framework was developed in consultation with two Māori groups, Nga Whenua Rahui and representatives from Ng~ti Porou. While it is not focussed on overall mitigation and adaptation strategies, carbon farming is a mitigation and adaptation strategy that holds particular interest to Māori because of its potential in the Māori economy. Their framework consisted of seven steps:

1. Identify one or two key Māori landowners willing to participate;
2. Quantify economic benefits;
3. Ascertain quantity and location of land eligible as Kyoto forest;
4. Refine knowledge about CO_2 implications of different land management options;
5. Explore advantages/disadvantage of protection in perpetuity relative to temporary storage;
6. Design or adopt vehicles for implementation of CO_2 sequestration kawenata;
7. Design appropriate contract mechanisms.

Carswell et al.(2002) provide a diagrammatic representation of their framework (Figure 7).

In an online discussion paper, Harmsworth (2002/2012) provided extensive and detailed information and criteria for a collaborative research model for working with iwi. His paper was primarily concerned with relationship establishment prior to writing the research proposal. He considered the establishment and building of the relationship to be the key ingredient to working with Māori. He listed a number of criteria that he believed should be considered when establishing a relationship.

- "identify immediately the right iwi organisation with whom to work. In some geographic areas this may involve talking to a wide range of iwi members, groups, and Mäori organisations before narrowing down work with one group. It may involve talking to several iwi rather than just one. It is important at this point to have some understanding of whakapapa, Mäori values, and to enter discussions with an open mind. For a scientist or researcher it is important to realise that this stage is at the bottom of learning curve;
- identify key people to work with in the iwi or Mäori organisation. Many of these may be working at the 'coal-face' rather than at the top of the organisation;
- be aware of cultural or political protocols, and have some understanding of inter-iwi and intra-iwi politics and relationships;
- have some understanding of, or identify, Mäori issues, either within a geographic area or nationally;
- take a personal interest, much wider than the research interest, in the iwi, Mäori organisation, or the iwi personnel being approached;
- set up and maintain regular contact and dialogue so the relationship may progress;
- maintain the relationship by regular networking and communication, personal visits, and regular contact (e.g., E-mail, phone, letter);
- identify a common area of interest, e.g., an issue(s), or interesting research on which to focus;
- be willing to help iwi or individual iwi members, even before setting up collaborative projects, to access and disseminate information of particular interest, networking with other researchers, or other iwi, helping with iwi proposals for funding, etc.;
- demonstrate some long-term commitment to wanting to work with the iwi."

(Harmsworth, updated 2012: http://www.landcareresearch.co.nz/science/living/indegenous-knowledge-and-valies/collaborating/successful-ingredients)

Harmsworth (2002/2012) also provides a framework for developing a collaborative research proposal. He states that the framework should consider the following:

- "the kaupapa, which can take the form of a set of guidelines, a guiding philosophy, a terms of reference, outcomes and vision for the proposed project;
- the size/magnitude of the project;
- the proposed time-frame;
- important protocols, tikanga, cultural sensitivities that should be followed when developing the research proposal;
- the key issues the proposal will address;
- the people, groups, communities, and stakeholders who are the target end-users or beneficiaries of the research, and the relevance or significance of the research to them;
- the people, groups, and stakeholders to be involved in the actual research (e.g., the collaborators);
- specific research questions the iwi and collaborators want answered;
- specific research questions other groups or stakeholders may want answered;

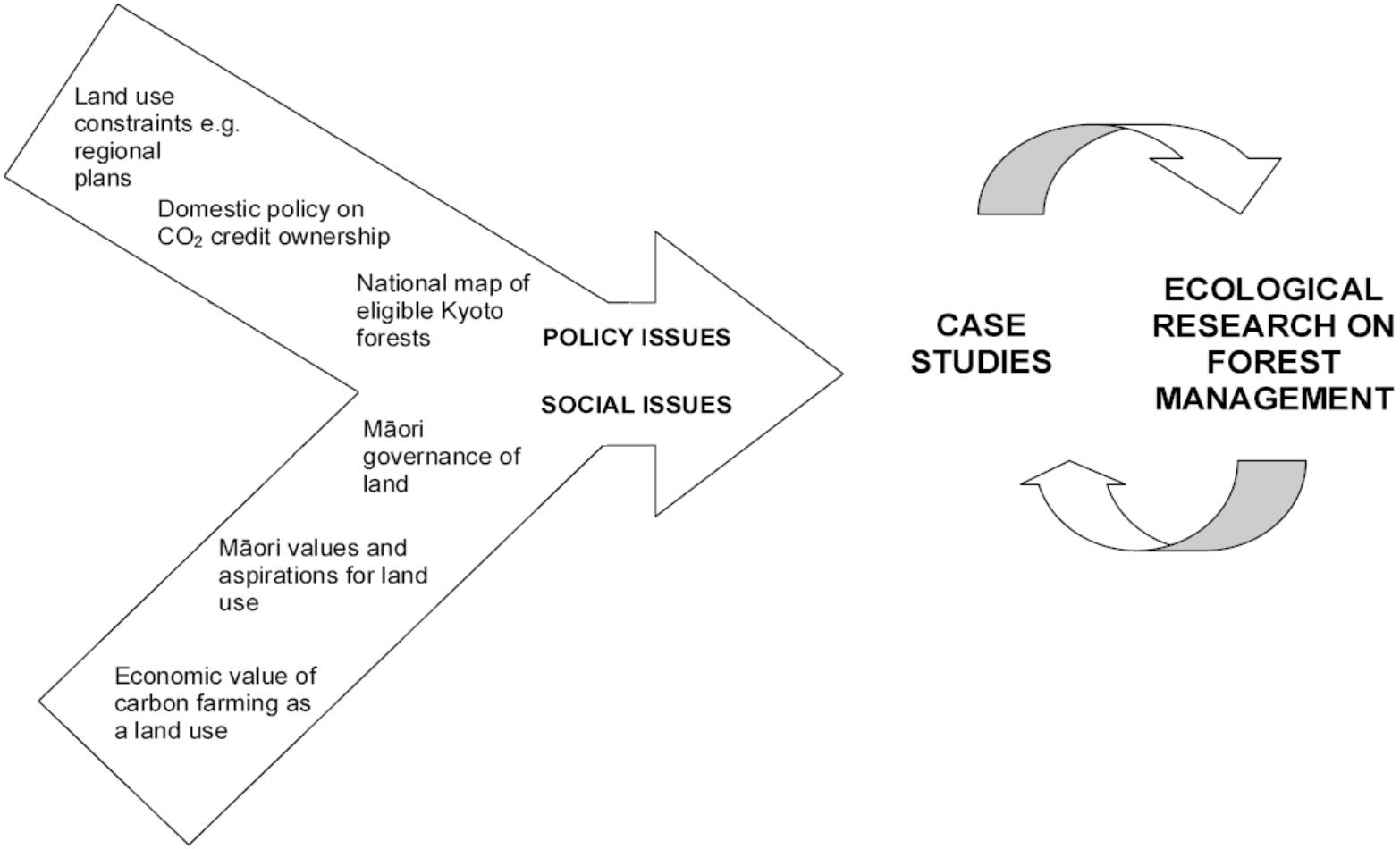

Figure 7. A framework for engagement of Māori landowners in 'carbon farming' using indigenous forest regeneration. (Source: Carswell et al. 2002)

- whether the research questions will in fact contribute to the outcomes and accurately address and provide answers in line with the issues;
- an effective communication strategy during the writing of the proposal;
- an effective communication strategy and key contacts to maintain collaborative links."

(Harmsworth updated webpage 2012 http://www.landcareresearch.co.nz/science/living/indegenous-knowledge-and-valies/collaborating/research-proposal)

Harmsworth (2002/2012) also provides a diagram to illustrate the key steps in developing collaborative research with Māori (Figure 8)

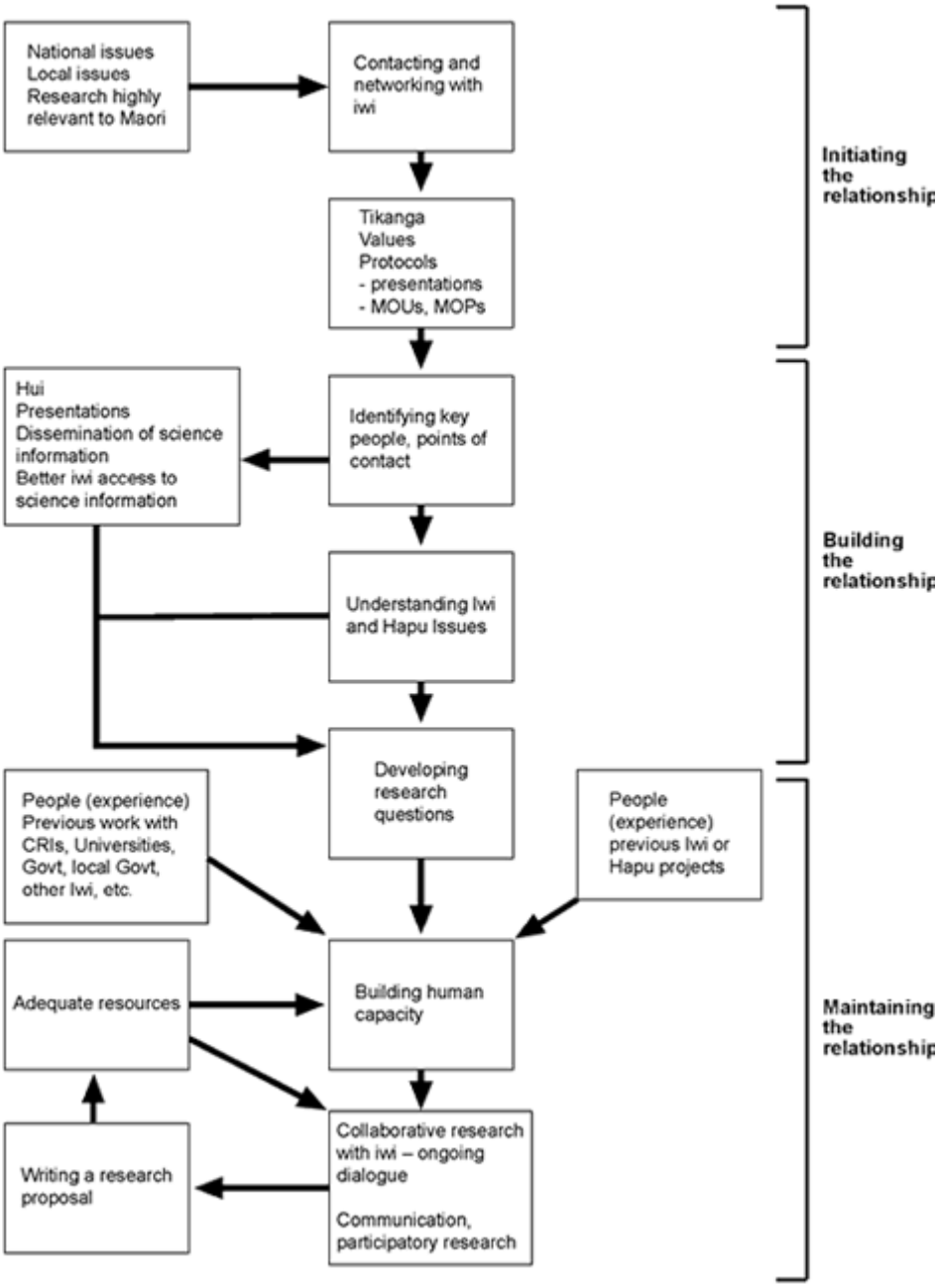

Figure 8. The key steps to developing collaborative research with (source: Harmsworth, 2002, Website update 2012: http://www.landcareresearch.co.nz/science/living/indegenous-knowledge-and-valies/collaborating/successful-ingredients)

Wilcox et al.(2008), noting that how to engage with Māori in research was not well understood by scientists, saw a need to develop a process to facilitate safe and comfortable dialogue for all parties. They called the process they developed for working with Māori, Te Arotūruki. It is a values-based process for cross-cultural dialogue between scientists and Māori suitable for the purpose of writing research proposals (i.e, like Harmsworths', 2002/2012, framework above, it is a pre-proposal engagement framework). Other unique features of the framework include: equitable power status and mutual respect, the use of Māori advisor/facilitators to assist the process, rangatiratanga - it is not prescriptive regarding how Māori entities evaluate proposals, and it provides web-based toolkits for both researchers and Māori entities. They provide a diagram to illustrate the process (Figure 9)

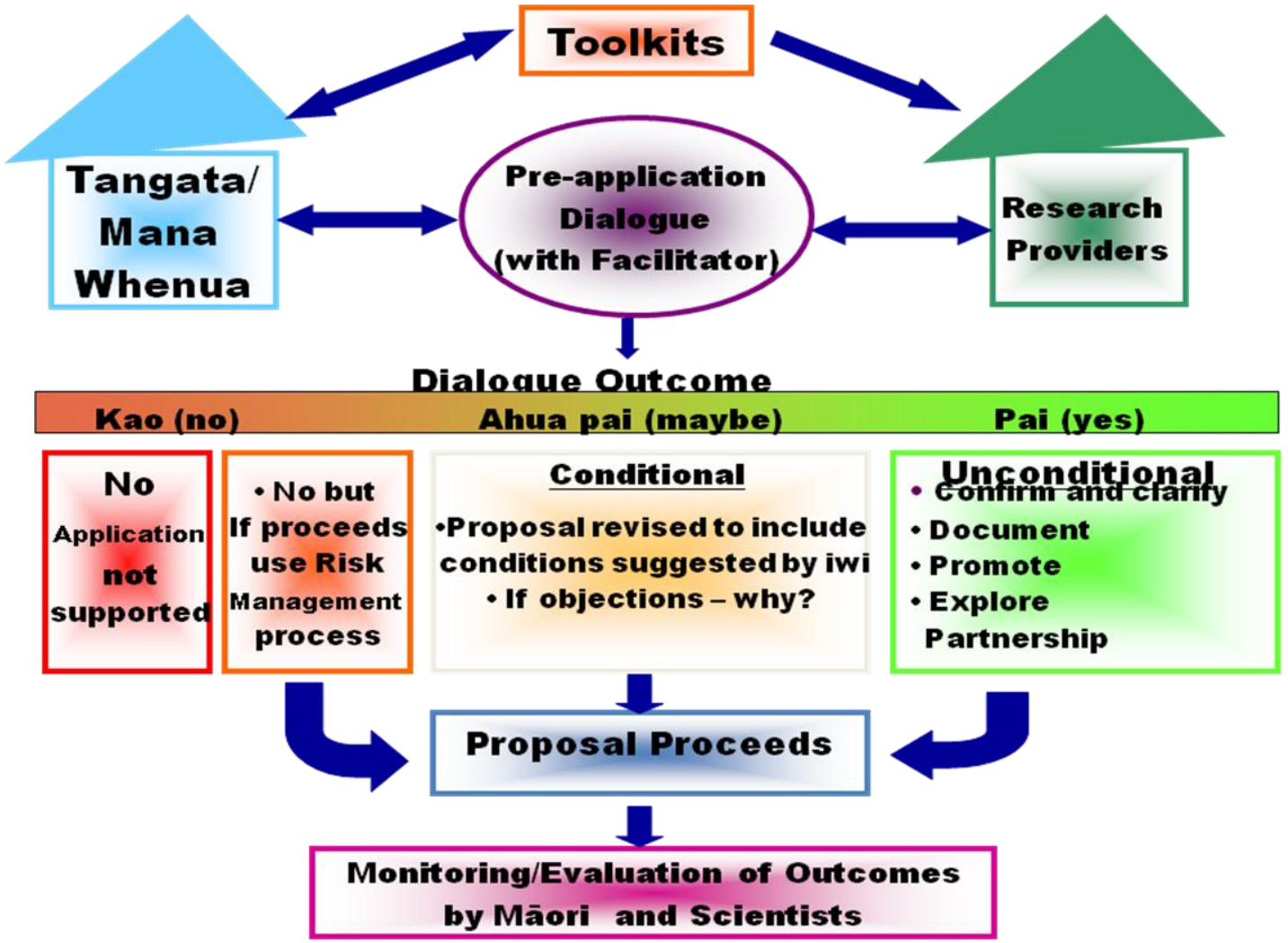

Figure 9. The Te Aroturuki Framework process for cross-cultural dialogue. (Source: Wilcox, et al., 2008)

SOME ELEMENTS AND 'GENERAL SEQUENCE' OF A GENERIC SOCIAL ENGAGEMENT FRAMEWORK FOR CLIMATE CHANGE RESILIENCE

Below, we outline some elements and an approximate 'general sequence' of a generic social engagement framework for climate change resilience (note: there may be a degree of variation in the exact sequence and some elements will occur concurrently).

Pre –engagement and higher-level elements that "set the scene" for engagement

- Social norms are important mechanisms of changing and maintaining human behaviour. Therefore, meaningful and decisive leadership and action is required from the Government. The Government needs to demonstrate their acceptance of the scientific evidence and their commitment through legislation, policies and practices to mitigate climate change, including analysing their growth strategies and economic policies to ensure that they are compliant with reducing New Zealand's carbon footprint. This includes Government action to comply with Kyoto and other environmental commitments. Through such action, strong signals would be sent to the public creating new social norms and priming the public and businesses for behavioural change including the adoption of climate change mitigation and adaptation behaviours. Currently, despite successive New Zealand Government's acknowledgment of the global importance of the climate change issue, meaningful action remains to be taken. Until the Government responds to the issue with the urgency and importance that it warrants, the social norms of the New Zealand business sector and the public will likely remain ambivalent to climate change and difficult to engage in resilience planning.
- Increased flexibility in Government funded research and climate change engagement programmes in order to enable participative public engagement. This includes recognition of, and allowance for, the energy, commitment and time burden placed upon the community and its representatives for participative engagement. It is essential to ensure that appropriate resources and timeframes are provided in order to enable participative public engagement.
- Familiarity with psychological theories such as: judgment under conditions of uncertainty and prospect theory; the sequence of psychological barriers to climate change adaptation; risk assessment; risk perception; risk management; stress and coping behaviour; disaster response and prevention; participative engagement processes; deliberative processes; facilitation; arbitration, dialogue; debate and negotiation.
- For engagement with Māori communities – familiarity is required with Māoritanga and te ao Māori, and a range of Māori cultural concepts, protocols and values including: te ao turoa, mātauranga, whakapapa, iwi, hapū, whanau, mauri, ritenga, tikanga, kawa, ahi kaa, tapu, aroha, mana, te awe, taonga, kaitiakitanga, wahi tāpu, tribal rohe, mahinga kai and general historical colonisation issues, including Te Tiriti O Waitangi and tino rangatiratanga.

Engagement elements

- The process of initiating, building and maintaining a relationship.
- Identifying, understanding and respecting the partner's culture, cultural values and aspirations.
- Identifying and understanding and respecting the partner's different knowledge sets.
- Recognising the need for flexibility and adaptive management practices to facilitate relationship building, trust, and public engagement.
- Recognition of the moral nature of the responsibility to respond to climate change, including intra and inter-generational justice and equity issues.

- Becoming familiar with relevant biophysical, historical, and sociological and spiritual events and circumstances connected to the land and the people that act as the background for engagement.
- Identifying the "value objects" or the things of value in the local environment/land, community, economy, culture and stakeholders' quality of life that the community wishes to preserve and maintain for themselves and future generations (or attain where deprivation and inequity currently exist).
- The right data – community knowledge (e.g., as gathered in the above elements) and the appropriate scientific data and information about climate change, mitigation, adaptation, including from a global scale, but with primary emphasis on localised data, impacts, and strategies.
- Make explicit certainties and uncertainties.
- Identifying the stage of the sequence of the psychological barriers to climate change adaptation which community members are at, and recognising the implications for psychological framing of issues and solutions.
- Where possible, synergistically integrate global benefits of mitigation and adaptation strategies (e.g., reduced green house gas emissions and slowing climate change impacts) and local benefits (e.g., increased efficiency, reduced inputs, lower environmental footprint), that is, looking for win-win strategies.
- Accessing the right support, building relationships and gaining commitment to the project;
- Forming and committing to a research/programme partnership;
- Determining partnerships roles and spelling out mutual expectations;
- The right team - identifying the appropriate people, with the right interdisciplinary skills, appropriate authority and communication ability for particular roles and responsibilities;
- Access to the right resources- time, personnel, information, methodology and tools;
- Understanding and respecting the partners' different abilities to provide resources, personnel and time;
- Developing agreed methods and modes of information exchange;
- Localisation of climate change issues and impacts;
- Learning from each other;
- Build capacity to detect climate change impacts and assess potential responses;
- Jointly developing a research proposal or plan of action to understand and address climate change resilience;
- Integrated use of bottom-up qualitative research methods and top-down quantitative research modelling tools;
- Use of appropriate and accepted social and biophysical tools, such as carbon footprinting, water footprinting, life cycle analysis, whole farm models, social return on investment models, climate change models, etc;
- Identification of sensitivities, thresholds and vulnerabilities with respect to climate change, socioeconomic circumstances, cultural and spiritual traditions, current agricultural business enterprises and business development plans;
- Integration of climate change resilience strategy with strategic and operational business plans;
- Plan for staged introduction of the adoption of climate change resilience strategies (.i.e, setting of goals to progressively reach targets over time);
- Production of a mitigation and adaptation implementation plan;
- Monitoring and review of plan and implementation; and
- Ensure commitments are honoured and deliverables achieved;

Post engagement elements

- Ongoing contact and relationship maintenance, monitoring to detect local changes, review and adaptive management of mitigation and adaptation plans.
- Ongoing monitoring of the latest scientific finding regarding climate change and new practices and technologies to help mitigate and adapt to climate change.

The above social engagement framework provides a menu of social engagement process elements to be aware of before, during and after the main engagement events. While many of these elements will have some applicability to any public engagement, much depends upon the community with whom engagement is occurring. Some elements will not be relevant in some circumstances, while in some situations some element will require an increased emphasis. Similarly, although the framework elements are laid out in a "general sequence" this is only meant to be a rough guide, and depending on the situation, a difference sequence of elements may be appropriate. Clearly, some of the elements are not steps which are completed before moving on to the next step but rather are activities, processes, attitudes and values which may occur concurrently, or should be maintained throughout the entire engagement process.

FACTORS THAT FACILITATED AOHANGA'S ENGAGEMENT IN CLIMATE CHANGE RESILIENCE PLANNING

Two key related factors provided an entry point and helped facilitate Aohnaga's engagement in climate change resilience planning. The first factor is Aohanga's traditional cultural values. By looking for synergies between the aims and purpose of climate change resilience planning and Aohanga's traditional values, it was possible to demonstrate the relevance and importance of climate change resilience planning for Aohanga. Their traditional values of kiatiakitanga, rangatiratanga and tikanga, their desire to own the land in perpetuity, and their aspiration to leave the land in good condition to provide for future generations endows them with an ethic of strong sustainability - which is identified in their values statement. Climate change resilient is an important component of sustainability. Therefore, the importance that Aohanga places on the sustainable development of their land enhanced their willingness to engage in resilience planning.

The second factor, related to and inclusive of their values, is the fact that Aohanga were in the process of developing a strategic plan for the Incorporation. The strategic plan is a longer-term plan that looks at development options from within the framework of their values. It describes their aspirations for the land as well as a range of potential diversification options for the future. As climate change is a long-term phenomenon, it is appropriate for a climate change resilience strategy to be embedded within the strategic plan. In the current project, it was possible to embed elements of the climate change resilience strategy in all four pillars of the Aohanga strategic plan. Because it is necessary to regularly revisit and revise strategic plans in the light of continually evolving circumstances, embedding the climate change resilience strategy in the strategic plan also provides a mechanism for future monitoring and evaluation.

CONCLUSION: DIFFICULTIES, BARRIERS AND LESSONS FROM THE CURRENT PROJECT

Cultural misalignment

The current project was not without its difficulties and barriers to progress and completion. There were a range of reasons for these difficulties and a number of lessons regarding engagement with communities, and in particular, Māori communities, are apparent. At the

root of the barriers to successful engagement in the current project was the clash between two different institutional cultures with different values and aims. The two cultures and the formal and informal institutional rules, which compose their institutional frameworks, are the Māori community and the science research community. These two communities have significantly different value structures and expectations from their relationship. The institutional rules of these two cultures differ on a number of levels making research engagement with Māori challenging under criteria important to, but differentially applied, by both cultures.

At the very heart of this cultural misalignment lie the concepts of relationship and trust and how they are approached differently by the two cultures. Strongly related to the different approaches to relationships and trust is each cultures different relationship with time. These themes of relationship, trust, and time are woven throughout this document. What follows is an analysis of these constructs in the current project through the eyes of the author, the project manager. However, the author is a middle-aged, Pakeha, male scientist and necessarily reflects a demographic and researcher bias, which the reader must take into account when evaluating this analysis and conclusions.

Māori land-owning communities wish to be kaitiaki of their land for **all time.** Pakeha research institutes generally have **short-term** vision, goals, and objectives – often vacillating around three year political terms. This short-termism is further reflected in the research funding process and single year accounting frameworks. Māori are focussed on **taking time to do things right**. Pakeha research institutions and their funding bodies, on the other hand, have a central focus on **getting the right things done on time,** within a socially constructed accounting cycle.

This difference in worldviews can lead to a misalignment of aims, process and outcomes regarding engagement for research projects. For Māori, it is initially about taking time to **establish a relationship** and **developing relational trust** for the purpose of working together as partners, preferably on an on-going basis, to achieve project goals. For researchers and their funders, it is about getting the process underway in order to achieve **time-bounded milestones and objectives** under a framework of **contractual trust**. Researchers expect that working together on a project will develop a relationship and perhaps relational trust. Nonetheless, generally for the researcher, and the research funder, contractual trust remains the dominant form of trust in a research partnership. While Māori expect an ongoing relationship past the completion of the current project, researchers and funders expect the relationship to, more or less, terminate at completion of the project.

In the current project these differences in the understanding of time, trust and relationship gave rise to difficulties and barriers to engagement at all of the three above identified stages of engagement activity; pre, during and post. Although what follows is primarily based on a description of the issues faced in the current project, nonetheless it describes a general systemic process that social researchers attempting to engage in participative research with community and/or Māori organisations often face. This purpose of this analysis is not to criticise any individual or organisation. Rather, the purpose is to elucidate systemic problems in the research engagement, problems which are also likely to be present in any climate change resilience rollout programme, so that lessons may be learnt and practices improved.

Pre engagement – proposal development

At the pre-engagement stage the funder releases a request for proposals (RFP). This may have a short timeframe attached to it, perhaps slightly over 2 months. It has various conditions or "signals" attached to it, to encourage certain kinds of behaviour on the part of researchers, such as, pan-organisational, multi-disciplinary teams, with co-funding and/or partnering with

end-users required (i.e., the involving of end-users in the development of the proposal), as well as the research theme(s). Upon receiving the RFP a researcher decides to bid for the project (or is selected by a science manager to do so – this may incorporate a week or so of delay).

Thus, begins the process of developing a pan-organisation, cross-disciplinary team with the right skill and knowledge sets to address the RFP themes. A time consuming and complex task, especially if the research participants are unfamiliar with each other, the necessary terminology from each others' disciplines, or variations in the use of terminology across disciplines. Once established this research team must then agree upon and develop a research proposal, that addresses the RFP theme, and draft the proposal, often while being located in disparate regions of the country. In order to do this, much of their communication must be via telecommunication tools such as email, telephone or video-conference. Valuable and useful communication tools, but nonetheless, deficient in comparison to face-to-face communication – especially for relationship and trust building, and especially under the just noted condition of linguistic uncertainty associated with multidisciplinary research. Certainly, these tools are deficient for the building phase of a relationship with a Māori research partner.

If they are not already familiar with the recent literature in the proposal area then the researchers make an attempt at this while drafting the proposal. Because, as noted above, for Western research institutions (and their funders) timeliness is an essential cultural construct, placing the bid in on time is necessary for it to be considered. Given the burgeoning research literature, generally, good familiarity with the literature is not possible in the timeframe allowed for the RFP –especially on a multi-disciplinary project where complexity of integration also adds to the burden of at least a basic familiarity with a range of different disciplines. The proposal is, therefore, time constrained on literature familiarity and likely to encompass a degree of ignorance regarding previous literature and research in the field of the RFP theme. If, at the proposal writing phase, the proposal writers had the familiarity with the literature that is gained during the project, the proposal may look quite different.

The proposal also usually undergoes several iterations and rewrites as it passes back and forth between the various researchers involved in writing. One individual usually gets the responsibility of massaging the various parts or drafts into a coherent proposal. The near final version is likely to be delivered just-in-time for the in-house research organisational review before being sent off a week later, again, just-in-time, to the research funder. Several months may pass before the research proposers are notified by funders as to whether or not they were successful.

Given the above process, the proposal is also likely to be based on limited interaction between the research end-user and/or partner, depending on the research partner's ability to engage in rapid, iterative discussions regarding the quickly evolving research proposal content. Such a process is really only feasible with a Māori partner if there is a strong history of previous interaction, a strong existing relationship, relational trust and an individual in the partner organisation with the necessary competence and time availability to participate in the writing process.

For the current project, the problems and issues related to these factors were discussed in the sections above entitled "Iwi Future project" and "Potential research issues". Māori researchers' views of pre-proposal engagement were discussed in the section entitled "Māori specific engagement frameworks". Of particular note, is the gulf between the actual process of developing a proposal, as described above, and an appropriate process as described by Māori researchers. For the current project, this gulf was a function of cultural misalignment,

reflecting both limitations in the funding procedure and the researchers/proposal writers' lack of prior familiarity with the excellent existing New Zealand literature on the subject of research engagement with Māori.

Above, we have focussed on difficulties with the development of the research proposal. This reflects the fact that the current project was conducted as research. There is always likely to be an element of research in climate change resilience planning for a particular community or group – because different groups will have different resources and different sensitivities and vulnerabilities to the impacts of climate change, as well as the fact that impacts vary across geospatial regions. However, as more such projects are conducted and climate change resilience planning becomes more main stream, with a correspondingly increased database of standardised information, well developed geospatial analogues available, and a more clearly defined programme structure, such projects will become less research oriented and take the form of a managed programme rollout.

When this happens some of the above issues may evaporate, nonetheless some will remain. Climate change resilience will still require multi-disciplinary teams and individuals in them will need to become familiar with each others' disciplines. However, specialist teams developed for this purpose (or who repeat the process with multiple groups or communities) may develop working trust and the required knowledge of each others' disciplines. The process of engagement between multi-disciplinary science teams and communities will still require the development of trust and an appropriate pre-resilience strategy programme engagement to determine the expectations of both parties and specification of the programme deliverables. Pre-programme engagement with Māori communities will still bring extra challenges in terms of developing relational trust and the requirement of appropriate levels of cultural sensitivity and knowledge amongst the programme team.

Engagement – project process

Once the current research project had began, the difficulty was in maintaining engagement. Even with the best of will, iterative participative engagement with researchers may be difficult for community partners to maintain. In the case of Māori partners, such as Aohanga, such difficulties may arise for a range of legitimate reasons. The individuals within the Māori Trust may be geographically dispersed and need to travel considerable distances to a meeting place. They may have jobs and other responsibilities and their work for the Trust may be in addition to these responsibilities. The members of the Trust may also have a range of responsibilities to the Trust, other than the research project (or a climate change resilience programme), which will also be a competing demand on their limited time availability. Often, in order to have attained the necessary mana and authority to represent their shareholders the Committee of Management members may be elderly and may have associated health problems. Such factors affect both the ability of members of multiple owned Māori lands to plan availability for engagement and their ability to participate in planned engagement. Time availability for engagement in iterative processes may also pose equally legitimate problems for members of non-Māori communities.

While researchers operating from within the science culture will place considerable importance on achieving milestones according to a project timeline, the community research partner may face a range of other issues that are significantly more important or urgent to them, and which, therefore, take precedence to the research (or programme rollout). This is particularly so in the case of climate change, which to the layperson may appear a distance concern, subject to the previously discussed psychological phenomenon of time discounting, and hence be easily out-competed by more immediately urgent concerns. Under such circumstances, changes to planned engagement (or ability to attend) may occur at short

notice. While frustrating for researchers or programme providers, nonetheless, understandable on the part of the community partner, and with legitimate reasons. When a participative community research project relies on iterative interactions for the production of knowledge and forward movement to the next project step, a delay at any one point pushes all project steps back to future dates. This was a problem issue during the current project.

Project delays may make little appreciable difference to a Māori research partner, as they may be prepared to take the time necessary to complete the project. However, it has significant implications for the researchers or programme providers, who may have time-bound milestones and project deadlines upon which their funding to do the research or implement a programme is based. This issue posed a significant problem in the current research project, with planned engagement meetings being postponed and a lack of clarity around when the postponed meeting would then be able to take place. Similarly, Aohanga was, on occasion, unable to deliver planned inputs from iterative engagement steps within the planned timeframes. We hasten to add, that when such inputs were received, it was clear that considerable effort and thought had been put into their production. We also note that during engagement events Aohanga were concerned to ensure the research team was able to meet its commitments to the research funder.

For the current project, engagement difficulties were exacerbated by inflexibility regarding extending timeframes for engagement and project completion. Although no extra funds were required, government reporting and accounting timeframes took precedence over the community's ability to participate in the engagement process. This caused stress for the researchers who were keenly aware of the agreement they had reached with Aohanga and were concerned about being unable to meet the commitments and deliverables they had promised. Although sure they could honour their commitments to Aohanga within the project budget, about two thirds of the way through the project, for reasons given above, it was clear to the researchers that it would be very difficult to do so within the contract timeframe.

Generally, in compliance with accounting procedures, project money disappears at the end of the contract, whether it has been used or not, and whether the project objectives have been achieved or not. Funding cessation puts a halt to any continued engagement and honouring of commitments beyond the contract deadline. Given Māori cultural understanding of relationships and time, the researchers were aware of, and concerned about, the damage to any ongoing relationship with Aohanga that such failure may cause. Likewise, they were aware of the potential ripple effects that such failure might have for engagement with other Māori communities with the researchers, and perhaps with the research community in general.

Towards the end of the project timeframe, the researchers' employing organisation agreed to carry funds forward to allow continued engagement and fulfilment of research commitments to Aohanga. Thus, the final planned hui was eventually held on the 16th of July 2012 (16 days after the project completion date and into the new financial year). A report from this hui was forwarded to Aohanga on the 13th August. Currently, the final project commitment to Aohanga, a climate change resilience plan (an elaboration on the section above entitled, "Components of a climate change resilience strategy for Owahanga Station") is planned for delivery in September 2012. In addition, we are also investigating the possibility of delivering a coastal erosion control strategy for the Owahanga Station sometime in October or November – as engagement and financial opportunities allow.

Without the flexibility and co-operation of the researchers' employing organisation, these commitments and further good faith engagement activities could not have been achieved. These issues point to the importance of allowing adequate time for community research

partners to engage and participate. This may be done either by having appropriate timeframes arranged from the beginning, or by having a flexible approach to project /programme timeframes. An adaptive management approach with respect to timeframes is recommended as part of the engagement strategy for communities in climate change resilience planning.

Post-project engagement

With current management and accounting practices, when project funds cease, researchers are very constricted in their ability to maintain ongoing contact and relationships with communities. As previously noted, this can be an area of cultural misalignment between the research community and Māori communities. In the current case, as well as continuing to deliver outputs desired by Aohanga as part of the project, in a timeframe manageable to them, we are attempting to continue the relationship by bidding into a Sustainable Farming Fund round to build on the research that we have already delivered to Aohanga. The project that we are hoping to gain funds for would allow us to work with Aohanga and NZIER to develop a Social Return On Investment framework as a tool for evaluating potential diversification options (one of the climate change resilience strategies) for the Owahanga Station.

Lessons learned from the project regarding engaging communities in climate resilience planning

1. There needs to be a good alignment between project/programme funding and the needs of the community research partner, otherwise the research partner may be unable to fully participate due to lack of time availability in the face of more immediate and urgent contingencies. This problem is particularly likely to affect climate change projects due to the long-term nature of climate change impacts and time discounting. With Māori and indigenous communities, climate change resilience strategies must also be aligned with traditional values. Perhaps the best way to achieve alignment is to have full participation of the research partner in the proposal development.
2. Research that requires the engagement and participation of community or Māori groups as research partners needs to allow adequate lead-in time for the full involvement of the community in the proposal development phase. When working with Māori, culturally sensitive advice on appropriate timeframes and expectations may be found in the excellent work of New Zealand researchers such as Harmsworth (2002/2012, 2012), King et al. (2010), and Wilcox et al. (2008). Research /programme funders in control of this process need to be aware and take account of this issue. Similarly, researchers /programme managers need to ensure that timeframes are suitable for community engagement when bidding for contracts.
3. When engaging and working with communities, especially Māori communities (where multiple ownership of land and consensual governance procedures may be important factors), there is a need to allow appropriate research timeframes that align with the communities' capacity to engage and respond. Both researchers /programme managers and research/ programme funders need to ensure adequate timeframes are allowed for such work. Furthermore, if, and when, time slippage does occur with regard to planned timeframes, there needs to be flexibility on the part of all relevant players to extend the timeframes to suit the community research partner. Otherwise, the project may fail to achieve the potential that the funding would otherwise allow, and relationships and trust, which are hard to win but easy to lose, may be harmed. True community engagement can only occur when the community has access to the necessary resources (including time) to fully participate in the process.
4. When working with Māori and other indigenous cultures researchers need to work within a values and ethics framework that is acceptable to the indigenous community. This may mean that researchers /programme managers/teams need to become familiar with indigenous worldviews, values, customs and protocols. By looking for alignments between climate change resilience (both mitigations and adaptations) and a community's

worldviews, values, aspirations and goals, win/win synergies may be found or created, that facilitate engagement with climate change resilience planning.

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Appendix 1 - Joint workplan

Aohanga Workshop 9 Sept. 2011 10am-2pm

Present
Aohanga: Mavis Mullins, Anita Broughton, Scott Somerville
AgResearch: Oscar de Oca Munguia, Hoani Ponga, Bruce Small

Purpose
Introductions
Clarification and agreement about project plan
Clarification about hui and engagement
Clarification about dates and timeline
Clarification about attendees
Clarification about Aohanga's information needs regarding climate change
Clarification about Aohanga's preferred information formats
Clarification about project outputs

Outcome of workshop

Research questions and proposed outputs

	Research questions	Hypotheses	Outputs
Climate Change	What are the impacts of climate change and how do we facilitate science based solutions?		Written reports Climate change resilience strategy Monitoring plan
Aohanga Futures	To apply and further develop the Iwi Futures decision support framework for Aohanga		Tools –access to and/or obtain Training/evaluate options for identified users Proposal to AgR for strategic multi-party research

Agreement to hold 3 hui as per proposed project plan
- Subject to revision by partners agreement

Timeline for hui

Approx dates	Aohanga planned meetings	Climate Change meetings	Attendees
9 sept.	First planning meeting		Mavis, Anita, Scott, Hoani, Oscar, Bruce
18-19 Nov.	AGM At Aohanga	Meet Aohanga shareholders Tanira to present overview of Iwi Futures project Bruce to present big picture overview of climate change project. Oscar to present optimisation tool [Presentations no longer required – No available time at meeting – advised by Mavis]	100-120 Aohanga shareholders Oscar, Bruce, Hoani, Tanira?
Dec 7-9 (1 day to be confirmed)	First Hui -At Grassland Palmerston North Facilitators: Mavis, Irene Purpose: Explore climate change impacts, mitigation and adaptation strategies, identify Aohanga's preferred strategies for economic and environmental modelling. Actors: Aohanga presents overview of aspirations, values for land. Oscar presents optimisation tool. Climate scientists present climate change data and potential mitigation strategies. Group brainstorms potential barriers /opportunities to/for mitigation strategies. Identification of Aohanga's preferred strategies for modelling and reporting back at second hui.		Aohanga committee 5 -6 scientists (climate, soil, water, energy) Approx 15-18 people all up
Feb 2012	Aohanga committee meeting		Aohanga committee
March	Second hui Plan to be developed in conjunction with Aohanga		Approx 15-18 people all up. 10-13 Aohanga 5 -6 scientists
May	Aohanga committee meeting		Aohanga committee
May	Third hui – to be planned in conjunction with Aohanga		To be decided
30 June 2012	Project finish – Output to be complete – Report to MSI/MAF - may have 1-2 months grace		

Aohanga's information needs about climate change

- General info about climate change and potential impacts (global/national) 20, 50, 100 yrs. Low, medium, high scenarios
- Climate change info specific to Aohanga farm 20, 50, 100yr. Low, medium, high scenarios. Impacts on temperature, rainfall, freshwater availability, soil, erosion, coastline, kai moana, vegetation, biodiversity, trees, bees, animals, pests
- Adverse weather events – frequency, severity, potential impacts
- Mitigation, adaptation resilience strategies to climate change and to adverse impacts

Aohanga's preferred information format

- Hui/workshop
- Maps
- Graphs
- Presentations
- Report
- Visual data preferred

Outstanding Iwi Futures work

Liz's organisational value work (Bruce to see Liz)
Anne-Marie's cultural work
Maps etc. (Oscar to check

Actions

Actions	**Who**
Presentation - Aohanga Overview	Mavis, Anita
Presentation - tools	Oscar
Presentation - Climate change project overview	Bruce
Suggestions for soil expert	Scott
Confirm dates/venue	Hoani
Invite to AGM	Aohanga

Appendix 2. Aohanga's climate change mitigation/adaptation brainstorm results

Aohanga Climate Change Mitigation/Adaptation Brainstorm Session Results

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
1	Temperature rises by 2–3 degrees this century	**Resilience to temperature increase**	Look at alternative tree species for shade Using AgResearch mapping tools to identify possible areas where planting would be most appropriate	The investment that would be required to set it up The ongoing investment that might be required	What types of alternative tree species could we consider? Where would be the most appropriate place/s to plant such trees? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity costs if we do not do this?	Good

Notes:

* Specific climate change variables A – E were provided by James Renwick from NIWA

** Key for fit with Aohanga values - very poor, poor, neutral, good, very good

Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
2	. Less rainfall in winter/spring, little change in summer/ autumn (drought risk)	**Water harvesting**	Mitigate the impacts of a drought Using AgResearch mapping tools to identify possible areas for water harvesting	The investment that would be required to set it up The ongoing investment that might be required	What would be the desirable level of water storage for Aohanga? Would there be a single storage facility or multiple storages? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity costs if we do not do this?	Very good

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
3	More intense heavy rainfall	**Erosion control throughout property**	Water harvesting the excess rainfall (see above) Planting of trees to secure the land Might be able to apply for AGS (Afforestation Grant Scheme) Ability to add planting into ETS (Emissions Trading Scheme) Using AgResearch mapping tools to identify areas which might be prone to erosion	The investment that would be required to set it up The ongoing investment that might be required	What is the likelihood of intense rainfall impacting/eroding property? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity cost if we do not do this?	Good

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
4	Many changes in the ocean, sea level rise of 0.5 – 1 metre this century	**Erosion control along the coastline (in particular protection of access on the property via existing tracks)**	Planting of trees to secure the land Might be able to apply for AGS Ability to add planting into ETS Building of retaining walls Using AgResearch mapping tools to identify areas which might be prone to erosion Using AgResearch mapping tools to Identify alternative access/tracks Securing existing tracks	• The investment that would be required to set it up • The ongoing investment that might be required	What is the likelihood of sea level rises impacting existing tracks? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity cost if we do not do this?	Very good
5	Acidification, loss of oxygen, changes to upwelling/ nutrients	**Resilience/ mitigation against Ocean acidification**				

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
6	General	**Strengthen core business**	Investment in farming infrastructure Development of a 3 – 5 year farm infrastructure plan AND/OR a staged strategy over a longer time period of 20- 50+ years Aim to meet/exceed target ongoing profit from farming of $100k pa Using AgResearch mapping tools to identify potential farm infrastructure requirements Farm infrastructure examples may include fencing, fertiliser, pole planting, shade, weed control, alternative pasture species, animal genetics, staff education, tracks, water, diesel/petrol, cropping.	The investment that would be required to set it up The ongoing investment that might be required	What are the potential farm infrastructure requirements? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity cost if we do not do this?	Very good

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
7	General	**Diversification**	Eco-tourism i.e. hunting, Aquaculture (could take pressure off land base) Paua/ rock lobster finishing Production timber Wind farm opportunity Manuka honey Developing markets Off farm investment	Isolation Capital Capability Resource consents Licences and quota requirements	If we were to look at developing at least one of these diversification options, given Aohanga climate/resources what would be the most feasible opportunity to pursue? Why? For Aquaculture, what would be the species suitability and upfront/ongoing investment?	Very good
8	General	**Joint partner investors**	Networks and partnerships with neighbouring blocks in different climatic	Different agendas/ purposes/values Ensuring that the arrangement is a win/win	What types of climatic differences would be a good complement to Aohanga property?	Good

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
9	General	**Integration of potential natural resources**	Freshwater Sea Pastoral system (e.g. animal effluent feeding fish)	The investment that would be required to set it up The ongoing investment that might be required	What are the potential opportunities available? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity cost if we do not do this?	Good

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
10	General	**Self-sufficient energy source**	Ability to be self-sufficient Biogas Wind farm Tidal power	The investment that would be required to set it up The ongoing investment that might be required	How much energy would we need to generate to be self-sufficient? What would be the most feasible way of Aohanga generating its own energy? What would be the likely upfront investment? What would be the likely ongoing costs? What would be the likely opportunity cost if we do not do this?	Good
11	General	**Identifying ways of building soil humus**				Very good
12	General	**Livestock policy change**				

Notes:

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Appendix 2 Continued. Aohanga Climate Change Mitigation/Adaptation Brainstorm Session

#	Climate Change variable/s *	Climate Change mitigation land use strategies	What are the opportunities?	What are the barriers?	Questions regarding this strategy	Fit with Aohanga's Values**
13	General	**Gorse and weed control (turning problem into resource)**	Gorse for biochar Gorse as nursery cover for other crops	Cost/benefit analysis of any approach taken	What would be involved if we were to pursue any of these opportunities?	Very good
14	General	**Protection against extreme events**	Using AgResearch expertise and mapping tools to identify possible extreme events which Aohanga could consider mitigating against	The investment that would be required to set it up The ongoing investment that might be required	What would be the key extreme events for Aohanga to consider mitigating against? How would we best mitigate against them?	Very good
15	General	**More detailed investigation of natural resource base**	Using AgResearch expertise and mapping tools to identify possible extreme events which Aohanga could consider mitigating against	Outside the scope of this project/ AgResearch inhouse expertise The investment required to undertake a detailed investigation	What other organisations/ agencies would we need to involve to get a good understanding of our resource base?	Good

Notes:

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Appendix 3. Aohanga Incorporations Draft Values Statement

Aohanga Incorporation

30 May 2012

Our Values Statements (DRAFT- yet to be endorsed)

1. Aohanga Incorporation Oath of Office

To the people of Aohanga,
within my role as a Committee of Management Member, I pledge

To uphold and protect the Mana of Aohanga
To be a person of faith and principles
To sustain the spirit of the land in my heart
To be generous in my feelings and deeds
To be a friend and companion to each other
To bear myself loyally and upright at all times
To shun hatred, rancor and selfishness
To forgive and forget the harm others may have caused me, and I them

And to look upon the children of Aohanga as my own, and the aged as my own parents

Through God I ask that he grant me also to know that it is not the beginning but the continuing of the same, until it is thoroughly finished, which yieldeth the greatest accomplishment.

2. Code of Practice for Members of the Board

There is a draft Code of Practice which serves to provide guidance to the Board to assist them in carrying out their duties and responsibilities in accordance with the highest professional standards.

Values

Noted values that guide the BEHAVIOUR AND PERFORMANCE of Board members and the Board are:

- Practicing self determination
- Recognising mana whenua, mana moana, mana tangata
- Honesty and integrity
- To be a good employer
- Best practice animal husbandry
- Pursuing business excellence
- Iwi and community development and support
- Kaitiakitanga - see Māori Guiding Principles for detail

Māori Guiding Principles

These are also noted in the draft Code of Practice. Aohanga acknowledges these Values as being sourced from Atihau Whanganui Incorporation. While the Incorporation is a business, it

is a business with a Māori kaupapa and as such has additional guiding principles that should be taken into account when interpreting and applying its policies and procedures.

The principles are as follows:

Principle	Description	Tikanga
Kotahitanga	*This is the principle of unity of purpose and direction.*	*To promote whanaungatanga based on knowledge of shared heritage and an understanding and celebration of cultural distinctiveness.*
Manaakitanga	*Behaviour that acknowledges the mana of others expressed through aroha, hospitality and mutual respect.*	*To promote a fair and just society*
Rangatiratanga	*The expression of the attributes of rangatira including humility, leadership by example, generosity, altruism, diplomacy and knowledge of benefit to the people.*	*To promote whānau and uri, self determination through the establishment of good governance, effective policies, self worth and importance.*
Wairuatanga	*This is about the belief that there is a spiritual existence alongside the physical. It is expressd through the intimate connection of the people to their maunga, awa, whenua, moana, marae, tupuna and atua.*	*To encourage, maintain and promote spiritual identity and connection with our environment.*
Whanaungatanga	*This principle underpins the social organisation of whanau, uri and iwi and includes rights and reciprocal obligations consistent with being part of a collective. It is the principle which binds individuals to the wide group and affirms the value of the collective.*	*To promote whanaungatanga as the model for good collective arrangements between different whanau and uri.*
Mana Whenua *Mana Moana*	*This principle defines Maori to the environment occupied by right of ancestral claim. It defines turangawaewae and ukaipo, the places where you belong, where you count, where you are important, where you can contribute.*	*To develop kaitiaki whenua, kaitiaki moana who will take advice and guidance from whanau and uri and to develop mana whenua, mana moana as the basis for land management policies.*
Kaitiakianga	*This principle embraces the spiritual and cultural guardianship of Te Ao Marama, a responsibility derived from whakapapa.*	*To create a clean, safe and healthy environment by promoting the protection and restoration of our natural environment.*
Mana tupuna	*This defines who Maori are as people. It is the bridge that links us to our ancestors.*	*To promote whakapapa as an analysis and synthesis tool. Furthermore, to support endeavours by whanau and uri to establish their iwi connections, find their place in the world and become positive contributors to the wider community.*
Te Reo	*This principle is about the expression of one's self in a world that is diverse as it is divided.*	*Identification of who we are as an indigenous people in this world to encourage and support the use of this unique language of the context of our business.*

3. Mission Statement

"To protect and enhance the mana of Aohanga for the benefit of its shareholders"

… is the mission statement that all decisions of the Incorporation are measured against, but as noted, there are values equally important that provide the weave towards achievement.

4. Iwi Futures Aohanga Inc. *Technical Report, June 2010*

Below are two comments quoted from this report:

"As whānau hapū members we place a good deal of importance on cultural values, and imperatives can often be challenged in order to separate the perceived linkages between economic success, sustainable practices and hapū/cultural development. All have quite different measures of success, but none necessarily mutually exclusive of the other."

Mavis Mullins, Chair, Aohanga Committee, 2010, pers comm.
Landcare Research Aohanga Inc. Technical Report

"We believe in the deep interdependence of the hapū and its associated values, which among others includes mutual respect, fairness, cooperation, gratitude, compassion, forgiveness, humility, courage, confidence, courtesy, integrity, loyalty and respectful use of all our resources. Therefore land development, which is tīkanga based, is an important aspect. Strong Sustainability means the preservation of integrity of all ecological systems. This journey of new awareness is intended to illuminate and validate all initiatives toward sustainability. A strong sustainable hapū lives and develops as an integral part of the surrounding ecosystem. Matauranga Māori is the basis of our learning and important to whānau, hapū growth. Kaitiakitangi is the practice of responsibility and not a right as some people believe it to be."

Aohanga Inc, 2009
Landcare Research Aohanga Inc. Technical Report

5. Decision Making Framework

A proposed decision making framework for Aohanga Incorporation was *He Tapuwae*.

A lot of the decision making criteria come from a legacy statement which was drafted on behalf of the Committee of Management for further development:

"Dear mokopuna of Aohanga this is what I leave to you:

- **Land** and **Water** that is natural, nurtured and pristine - so that you may know what it is to feed from the land and drink from a spring
- **Sea** that is brimming with life and is bountiful in the gifts of the sea – so that you may know what it is to be a seafood gatherer and not a seafood hunter
- A **Culture** that resonates with tikanga of old, taonga from the present and opportunities for the future –so that you know who you are, where you come from and why you are special
- **People** that are secure, informed, skilled and known for their knowledge on a global scale – so that you may travel the world with confidence in your knowledge
- An **Economic** base that provides for all of the above – so that you may forever return to Aohanga to replenish your body, your mind and your soul when needed.

This is the legacy I leave; this is what you can hold me to account for..."