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The climate change matrix facing Māori society

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Determining the impacts of climate change on particular economies, industries and socio-cultural groups and activities is an extremely difficult task, yet one that must be undertaken in order to identify risks and priorities and to develop appropriate response and adaptation strategies. This paper attempts to make some sense of how the environmental, economic, social and cultural elements of Māori society are likely to be impacted by climate change this century; and further considers the diverse vulnerability, risks, coping capacity, and adaptation options available to Māori across key sectors, systems and groups. Understanding the matrix of linkages between these elements and factors is regarded as a key component in responding to "what needs to be done". It is highly likely that climate change will exacerbate many of the socio-economic difficulties and disparities already faced by Māori. The most vulnerable regions, communities, organisations and groups are those that are exposed to not only existing climatic variability and hazards, but those that have limited access to economic resources, low levels of technology, poor information and skills, remote and substandard infrastructure, unstable or weak institutions and governance structures, and inequitable empowerment and representation in local, regional and central government planning. While Māori are experienced in dealing with climate variability, in many cases new strategies will be needed to ensure the long-term sustainability of different sectors and regions in the context of climate change. Māori will do this in different ways, from defining their own aspirations, collaborating and driving new research and strategies, drawing on customary values and knowledge, and participating in discussion and active solutions at all levels from the *marae* (traditional meeting place and buildings) and *kura* (school) to regional and national business and political forums.

He uaua rawa atu te whakamārama i ngā pānga 'tūturu' o ngā rerekētanga o te āhuarangi ki ngā tūmomo ōhanga, ūmanga, rōpū ā-iwi me ā rātou mahi. Ēngari me tautuhi ka tika kia āta kitea ngā mōrearea me ngā whāinga tōmua ka raupapahia ai ngā whakautu me ngā takatūranga tika. Ko te whāinga o tēnei pepa he whakamārama ki te reo ngāwari te pānga o ngā rerekē tanga o te āhuarangi ki ngā take ā-taiao, ā-ōhanga, ā-pāpori, ā-tikanga o te ao Māori i tēnei rautau; tae atu ki te aro ki ngā tūmomo whakaraerae mai, ngā mōrearea, me te āhei ki te tū pakari tonu, otirā ngā kōwhiringa takatū e wātea ana ki ngā iwi Māori huri noa i ngā wāhanga, ngā pūnaha, me ngā tūmomo rōpū. He mea whakahirahira te mārama ki te papatau o ngā tūhonotanga o waenga o ēnei take hei whakautu i te pātai, 'Me pēwhea rā?' He pānga kino anō o ngā rerekētanga o te āhuarangi ki ngā toimahatanga kei runga i te ao Māori i tēnei wā. Ko ngā hapori, ngā rōpū tino kahakore, ko ērā e kohura ana ki te piki, te heke o te āhuarangi me ngā mōrearea o nāianei, heoti rā ko ērā me uaua kē te wātea mai o ngā rauemi ā-pūtea, o te hangarau rauangi, o te mōhiohio, o ngā pukenga tūturu, o ngā hanganga tōtika; he ngoikore anō pea nō ngā whakanōhanga me ngā mana whakahaere, kāore hoki i te whaimana ki roto o ngā rautakinga o ngā kāwanatanga o te takiwā, o te rohe, o te motu. He wheako anō a te Māori ki te taiao me ōna rerekētanga, heoi anō me whai huarahi rautakinga anō i ngā pānga ki ngā rerekētanga o te āhuarangi kia tika tonu ai te manaaki mauroa i ngā wāhi me ngā rohe. He momo huarahi nā te iwi Māori, mai i te tautuhi i ā rātou ake wawata; mai i te mahi ngātahi, me te kōkiri i ngā rautakinga me ngā rangahau hōu; he mea here ki ngā tikanga me ngā mātauranga o mua; he whai wāhi hoki ki te whakawhitiwhiti kōrero, me te kimi whakataunga ki ngā marae, ki ngā kura, me ngā hui ā-rohe, ā-pakihi, ā-tōrangapū o ngā takiwā, o te motu rā anō hoki.

1. Introduction and background

Evidence is accumulating that human-induced climate change is underway and that these changes are very likely due to an increase in greenhouse gas emissions (IPCC 2007). Yet, despite this evidence and the increasing scientific consensus there remains a list of associated and unanswered questions related to (i) how societies and the varied sectors and groups within them are likely to be impacted, and (ii) how specific places and populations might adapt to reduce vulnerability, build resilience and accommodate climate change risk? These questions are particularly important when considering the distinctive character of, and challenges already facing, Māori society. This paper builds upon work submitted for inclusion into the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) (Hennessy et al. 2007) and explores further some of the projected impacts and adaptation options of climate change facing key sectors, systems and groups across Māori society.

To begin, the paper sets a context and provides some relevant background information, including consideration of the key drivers of influence that complicate the climate change issue for Māori society. Based on this framework, we work through the nature of linkages between climate and Māori institutions, which is essential for understanding the vulnerability, impacts and adaptation options available to Māori society. It is important to recognise that our projections of vulnerability to projected climate changes are necessarily speculative based on current social and economic conditions.

Let us consider some important realities facing Māori society at the beginning of the 21st century that affect the vulnerability[1] and adaptive capacity[2] of different *whānau/hapū/iwi* (family/sub-tribe/tribe) and Māori business to limit and/or exploit the social, economic and environmental impacts of climate variability and change. Māori constitute about 15% of the New Zealand population (about 600 000 at last census) (Statistics New Zealand 2007). Of this figure, some 80% of Māori dwell in urban environments, with about 20% of Māori living in rural environments. This mix of living arrangements is enriched, but also complicated, by virtue of iwi affiliations. It is also often underpinned by a distinct worldview and identity associated with whakapapa: that is, ancestral lineage and sacred connection to the natural environment. High levels of economic hardship also characterise Māori society with some 52% of Māori regarded as "economically deprived" (Statistics New Zealand 2007). Based largely on household incomes (and high unemployment) this figure reflects to a large degree the limited financial capacity of Māori families to respond to everyday issues. This also reflects an historical legacy of loss of land and resources (Durie 1998).

Māori economic, social and cultural systems are strongly tied to the natural environment – with almost 50% of the total Māori asset base invested in climate sensitive primary industries (forestry, fishing, agriculture and to a lesser extent tourism) (NZIER 2003). Related to this, about 60% of Māori businesses are export-dependent compared with some 30% for the national average (TPK 2002). This situation can create a different economic playing field for Māori that can result in different objectives and different outcomes (Packman et al. 2001).

Many of the land and ocean-based resources owned by Māori are also held in multiple or communal ownership. It is estimated that 80% of Māori land is governed in this way, creating a distinct set of governance rules and processes for Māori that are sometimes quite different from those faced by other groups in New Zealand society (TPK 2002). Under this system many individuals, often from the same *whānau, hapū* or *iwi*, share ownership in a single block of land or associated business activity such as sheep and beef farming. Depending on the size of the asset and/or scale of the activity, decision-making authority is typically vested with *kaumatua* (elders) and/or elected leaders that manage these assets, most notably through Ahuwhenua trusts and Māori incorporations, on behalf of Māori landowners and shareholders (Funk & Kerr 2007). While there are significant opportunities and strengths that come from these structures across a range of operational scales (TPK 2007a), they can also create a set of obstacles that encumber decision-making and affect the success of trusts and incorporations (Cottrell et al. 2004), particularly when commercial experience is limited and Māori are forced to balance responsibilities under the New Zealand legal and commercial system as well as their own *tikanga* (NZIER 2003).

Although it is not the intent of this paper to fully discuss the range of governance or company structures under which Māori assets are managed, Māori businesses like any other in New Zealand when operating under the Companies Act (1993) must comply with the obligations set out in that legislation. Perhaps the key points of difference or complications for Māori businesses relates to the additional compliance required under such legislation as the Treaty of Waitangi (Fisheries Claims) Settlement Act (1992), where specified governance structures and management activities are detailed in the enabling legislation, and Te Ture Whenua Māori Act/The Māori Land Act (1993), which requires that elected Trustees ultimately operate under a Trust Deed and are accountable not only to their beneficiaries but also to the Māori Land Court if they are in breech of their Deed.

A final distinction related to Māori land is the role of the Māori Land Court and associated statutory sales restrictions related to land tenure that can restrict and/or rule out options such as sale and relocation that are normal practice for mainstream groups (MfE 2001). Add to this that a disproportionate amount of Māori land is remote and marginal (about 95% is located in the North Island) and these factors, combined, contribute to the overall exposure, sensitivity and capacity of different Māori to adapt to social, economic and environmental challenges.

Like many groups in New Zealand society, vulnerability and the capacity to cope and adapt to climate change is likely to be driven not only by physical changes in the climate, but also by political, economic, social and cultural factors (Tompkins & Adger 2003, Adger et al. 2004, 2007). As we will see, some Māori (*whānau/hapū/iwi* and business enterprises) may sometimes be more vulnerable and/or differently affected than other groups in New Zealand society.

[1] Vulnerability to climate is typically defined and assessed as a function of the exposure of a particular system/group, the sensitivity of the system/group to change, and the capacity of the system/group to adapt to that change. Systems and groups that are exposed, sensitive and less able to adapt are considered highly vulnerable (IPCC 2007).

[2] Adaptive capacity is about the *potential* of different sectors, systems and groups to change and/or make adjustments in their processes (both natural and human), practices, and/or structures to reduce or offset the potential for damage associated with climate variability and change (i.e., reducing exposure and/or sensitivity) (Tompkins & Adger 2003).

> "The question Māori have to ask, and are starting to ask, is "How will climate change affect me, my whānau, and my community?"

2. Previous research

To date, limited research has been conducted on Māori issues related to climate change. The earliest formal work involved a stakeholders group convened in 2001 by the New Zealand Climate Change Office (NZCCO) to consider how Māori might be affected by the Government's decision to ratify the Kyoto Protocol (Packman et al. 2001). This included a brief consideration of how aspects of Māori society might be impacted by changes brought on by a warming climate. Shortly thereafter, this led the National Institute of Water and Atmospheric Research (NIWA) to hold the first and second Māori Climate Forums in 2003 and 2006 which brought together Māori stakeholders from across the country to discuss climate change concerns and research priorities for the future (King & Penny 2006). Research outcomes from these meetings included a crop-suitability mapping project for Ngati Porou Whanui Forests Ltd (Tait et al. 2008), a pilot study with elders from Te Whānau-a-Apanui and Ngāti Pare examining *Matauranga Taiao* (Māori environmental knowledge) of local weather and climate change (King & Skipper 2006), and the submission of an indigenous section to the IPCC's Fourth Assessment Report (AR4) on 'Impacts, Adaptation and Vulnerability' (Hennessy et al. 2007). During this same period, Landcare Research initiated a project to examine carbon farming opportunities (and barriers) for Māori land-owners on the east coast (Carswell et al. 2002, Harmsworth 2003, Funk & Kerr 2007). This work is ongoing – some of the findings of which will be returned to later in this paper. The NZCCO also convened a national meeting in 2004, which led to the formation of the "The Māori Issues Group" and an abridged report that summarised the potential economic, cultural, environmental and social impacts on Māori arising from climate change and related policies (Cottrell et al. 2004). One key conclusion was the need for future work to effectively communicate the risks and opportunities arising from climate change to Māori communities and Māori trusteeships. The most recent piece of work, facilitated by the Ministry for the Environment in 2007, involved 13 regional *hui* (meetings/forum) with Māori around the country to discuss climate change policy and related energy issues (MfE 2007). While many issues were raised, such as the need for Māori-specific analysis and information (including some dissent over the engagement process), there was widespread acknowledgment by those consulted that current and future projected climate change is an important and urgent issue for Māori (Te Aho 2007). Clearly, there has been some research conducted to date, but much more is needed, including an associated process of integrating research findings into meaningful and realistic actions, if we want to make constructive change.

3. The climate change matrix

There is a diversity of influences that complicate the climate change issue for Māori and make it difficult to specify the "implications" with any certainty. In Figure 1 we present a modified conceptual model (Bradshaw & Smit 1997) to illustrate the main factors and processes that drive climate change impacts, vulnerability and coping capacity that lead to response and further change. In this context, and with respect to sustainability generally, these linkages are seldom conceptually elucidated and important relationships between human and physical systems are often poorly identified, defined and understood (Rayner et al. 1994). Therefore, a necessary starting point is to arrange the main factors and processes in a way that broadly reflects the biophysical, economic, social and cultural realities of Māori society. This makes it possible to see the context within which different sectors, systems and groups experience change, and thereby respond, on a range of spatial scales. The model begins from the premise that no Māori individual, group, community or business enterprise exists in isolation.

A key feature of impacts and vulnerability is that environmental changes brought on by climate change are likely to be unevenly distributed, both spatially and temporally. That is, regional changes in climate across New Zealand will vary depending on geographic location and inter-annual to decadal scale variations in climate (e.g., La Niña or an El Niño). Hence, Māori at the household, business, *hapū* or tribal level will be affected differently by the biophysical impacts of climate change. This in itself presents a challenge to Māori. That is, each *iwi*, *hapū*, 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 understand and interpret the issues they face. The question Māori have to ask, and are starting to ask, is "How will climate change affect me, my *whānau*, and my community?"

While the environmental effects on their own are diverse and complex, this is further compounded when applied to a diverse group such as Māori. While this may seem obvious, it is too easy to fall into the trap of considering Māori society as being homogeneous as is so often done in our media. Obviously this is not so. Today, Māori cannot adapt, relocate, or change resource use activities as easily as they may have been able to do in the past, because most now live in permanent communities and have to negotiate greatly circumscribed social and economic situations. Most Māori live in planned settlements with elaborate infrastructures, and their resource activities are determined to a large extent by regulatory and legal regimes, land use and land ownership regulations, quotas and local and global markets. Further, across Māori society different groups have different skills, different knowledge and serve different roles, they are situated in different places and within different environmental contexts and have access to different resources and capital. Consequently, the responses of different Māori to these external influences are likely to be quite variable given differing perceptions and sensitivities, both of which are a function of the particular attributes and social capital of individuals, *whānau, hapū, iwi* and business institutions.

It is also important to acknowledge that Māori are affected by the decisions, policies and actions of others here and overseas (TPK 2002). That is, the livelihoods of Māori are subject both to the historical

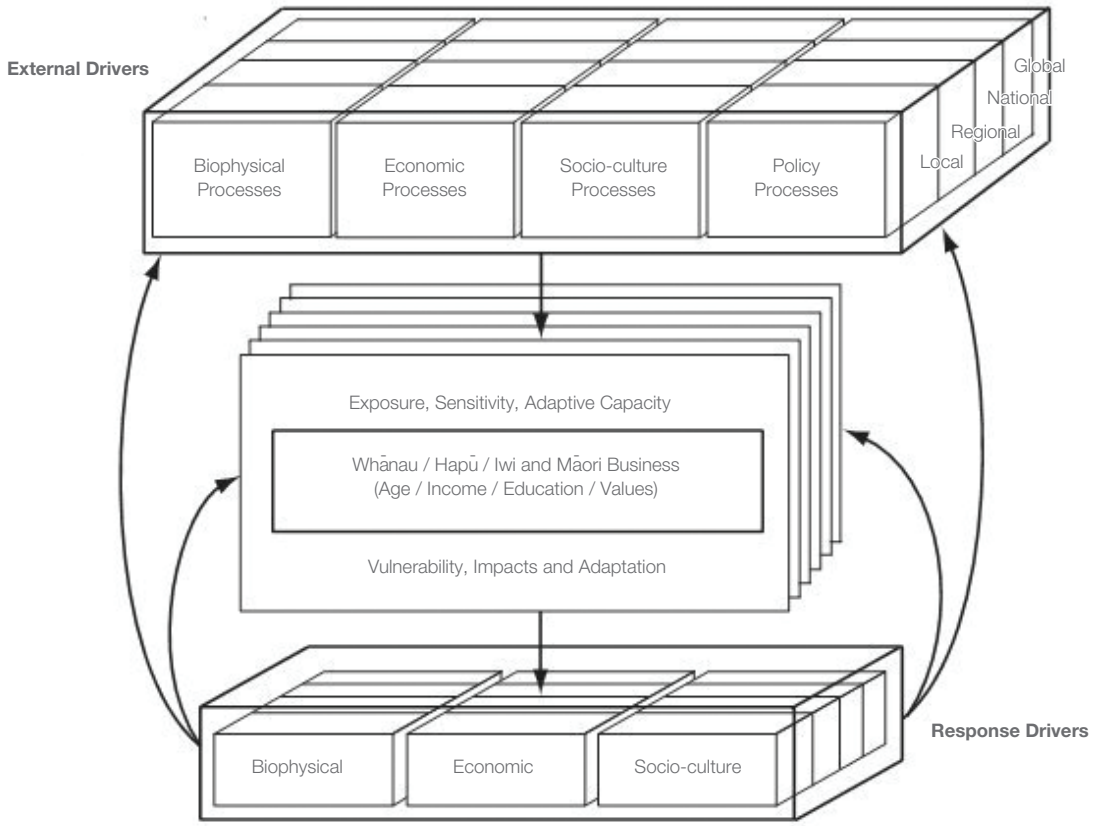

Figure 1. The climate change matrix facing Māori society.
Modified from: Bradshaw & Smit (1997).

development and the contemporary influences of markets and to the implementation of government policy and resource management regimes. For example, the New Zealand Government's decision to ratify the Kyoto protocol and associated proposal to introduce an Emissions Trading Scheme to reduce greenhouse gas emissions raises issues of equity for both pre-1990 Māori held forestry assets and past as well as future Treaty of Waitangi land settlements (Te Aho 2007). Such arrangements might unfairly disadvantage Māori who cannot leverage off land forested in perpetuity as well as restrict the ability to use settlement lands for anything else other than forestry (MfE 2007). As has been the case in the past, there is no doubt that Māori will continue to be affected by the processes, policies and decisions of governments, businesses, and markets here and overseas with regard to climate change and other matters.

Given this matrix-like setting, we have to take the effects of multiple variables into account and work through the linkages in some detail to begin to form a clearer view of what the problems, options and opportunities are for Māori. Change one variable, force or response and the outcomes are also likely to change.

4. Sectors, systems, and groups

In the following section we review key sectors, systems, and groups across Māori society that are, in some way or another, already sensitive to climate variability and thereby future climate change. For each sector, system and group we consider the present context, projected impacts, coping capacity and adaptation options. Importantly, the sectors, systems and groups are not discrete units, nor static, but rather are influenced by driving forces that are integrated, produce feedbacks, and depend on context and scale.

4.1 Agriculture sector

The livelihoods of Māori are strongly linked to land use with many Māori agricultural investments already exposed and vulnerable to climate variability (Packman et al. 2001). This century, there is a high probability that Māori farmers in northern and eastern areas of the country will be highly challenged by a warmer and drier climate as temperature and evaporation rates increase causing more frequent drought (Mullan et al. 2001, 2005, 2008). Warming temperatures bring a number of challenges to pastoral based investments, with a potential reduction in pasture quality through earlier maturation, evolution of the

[3] This Counsel is similarly conveyed by Shea et al. (2001) who maintain that distinguishing between climate variability and change has no practical meaning from the standpoint of those who are doing the adapting. The best option these authors argue is to implement strategies that help deal with present climate variability and this experience can be used to reduce vulnerability and enhance resilience to future climate related adverse impacts.

pasture base toward less palatable herbage, intensification of carbon and nutrient cycles, changes to pest and disease occurrence and increases in heat stress days for the animal. An associated reduction in frost frequency is also likely to adversely impact some horticultural operations as many temperate fruits need winter chilling to ensure normal bud-burst and fruit set (Atkins & Morgan 1990). Amidst these projected changes, Māori may find also new opportunities connected with warming temperatures, such as faster growth of pasture and longer seasons for harvesting, expansion of current agricultural ranges to new areas and diversification of horticulture practice (Stroombergen et al. 2008). Any beneficial effects of climate change in the short term, however, are expected to diminish if greenhouse gas emissions are not reduced or at least capped. Further, with the expected intensification of the hydrological cycle, any changes in the magnitude or frequency of extreme weather events and climate related hazards such as storms and floods are expected to place additional stress on this sector. These challenges will almost certainly affect production rates, yields and GDP from agriculture (Clark et al. 2006). Even areas that may not be directly impacted by the physical constraints of changes in climate may nonetheless be affected by the impacts of climate change on agricultural production, markets and policies in other regions or countries (Kingwell 2006).

In terms of coping capacity, some Māori may be well placed to respond to climate change, having access to modern infrastructure and storage systems, agri-business and research services, a range of marketing networks and more resilient farm land. Underpinning adaptation are factors like Māori innovation and creativity, traditional and contemporary knowledge, learning and networks, right and access to both physical and natural capital and the financial capacity to make change. Some have already shown considerable capacity to adapt to climate variability by introducing new land management systems, changing stocking rates and feeding regimes, and selecting new technologies to increase efficiency of water use. These types of examples signal the kinds of adaptive response that can be made to respond to future changes in climate (Kenny 2001)[3]. Notwithstanding these adaptations, there will be other Māori farmers who do not have access to a similar quality or quantity of resources and skills, and this group appears vulnerable and restricted in their capacities to adapt to the changing conditions (Clark et al. 2006). Furthermore, farms that can no longer rely on coping strategies in the face of low rainfall, high temperatures, high evaporation rates and associated drought may inevitably be forced away from activity in this sector (Kingwell 2006). Assessing the capability of specific groups within this sector to adapt is a critical element in identifying the industry's risk from a changing climate. Future adaptation options might include staggered planting times to reduce crop production risk and re-design of existing farm infrastructure to manage low irrigation water availabilities (Howden et al. 2003). Further, breeding new cultivars that are suited to changing conditions in the different arable cropping regions in New Zealand may be required. However, the success of such crops will be strongly dependent on future market requirements and conditions. Adaptations need to be appropriate to local circumstances, financially viable, environmentally sustainable, and consider potential changes under greenhouse gas mitigation policies. Future adaptation research must be informed by thorough and ongoing analysis of the vulnerability, sensitivity and exposure of the Māori agricultural sector to climate change, recognising all the inter-linkages and dependencies between people and the physical environment.

4.2 Fisheries sector

Māori own about 40% of the national fisheries quota and have substantial shares in several large fishing companies. This includes significant investment in fishing fleets, processing and marketing (NZIER 2003, TPK 2002, Hennessy et al. 2007). While there is little consolidated knowledge of the potential direct and indirect impacts of climate change on this sector, climate-induced changes in regional ocean temperature, currents, winds, nutrient supply, ocean chemistry and increasing acidification (as well as extreme weather conditions) are expected to alter regional fisheries productivity and operations, fishing incomes and ocean-based investment (Preston et al. 1997, Hobday et al. 2008). Other possible impacts include changes in the productivity of warm and cold water marine species that supply important commercial and customary (i.e., non-commercial) fisheries such as *kina* (sea-egg), *koura* (crayfish), *paua* (abalone), *kanae* (mullet) and *tāmure* (snapper). Climate variability has been shown to have significant influences on New Zealand fish stock availability (Renwick et al. 1998, Beentjes & Renwick 2001, Dunn et al. 2009). Such information is increasingly important for connecting the threats to the impacts on the environment as well as the socio-political realities facing Māori ownership, management and utilisation of commercial and non-commercial fisheries in New Zealand. Add in climate change mitigation policies, such as increased fuel costs and taxes related to food miles, and again we have an increasingly complex array of factors around which Māori will have to make investment decisions (NZBCSD 2009). The coping capacity of the sector will depend on the flexibility of the industry to modify their practices and investments, and to take advantage of new opportunities. Very little information, however, is available on this matter at present (MfE 2001).

In terms of adaptation options, the ecology of marine environments are likely to benefit from the introduction of new marine protected areas, reserves and parks, managed resource protected zones, and other types of marine management areas (COS 2009). However, Māori have widely expressed that maintaining ecosystem health and sustainability should not preclude economic development in this sector (King & Penny 2006). Anecdotal evidence suggests that many *whānau/hapū/iwi* are concerned with such options as they deny Māori access to commercial and non-commercial fishing grounds through the Deed of Settlement and the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, irrespective of Māori values[4]. Māori are likely to find new opportunities connected with land-based, inshore and offshore aquaculture developments (TPK 2007b). The aquaculture industry has already demonstrated considerable adaptation potential via selective breeding, regulating of the environment, flexibility of aqua-feed formulations and new species opportunities[5]. Notwithstanding these advancements, there is a need for fisheries and aquaculture management policies to better integrate the effects of climate variability and climate change in establishing harvest levels and developing future strategies. The southward shift of tropical species as a result of changing ocean temperatures may also present new opportunities for some wild fisheries (Hobday et al. 2008). Lack of information at present, however, is regarded as a significant adaptation barrier. Better understanding of the impacts of climate change on reproductive success, species invasions and changes in habitat and productivity due to physical changes in the environment (e.g., storms and inshore sedimentation) is required to assist with decision-making and planning in a sector where there are very significant existing risks to the sustainability of fisheries in New Zealand (Hurst et al. 2009, COS 2009).

[4] Many Māori continue to advocate a sustainable utilisation approach to marine management, based on a responsible environmental ethic and adaptive management.

[5] However, for coastal and offshore aquaculture, stronger and more frequent storm conditions could result in increased physical damage to infrastructure such as ports and vessels, and stock losses, which are all costly to operations (Preston et al. 1997).

4.3 Forestry sector

Māori have substantial production forests and are becoming actively involved in integrated processing of exotic and indigenous wood products (NZIER 2003). This evolving ability to add value and generate business opportunities may be impacted as climate changes are expected to affect production rates, wood quality, pest presence and fire-risk and to some extent, determine the scale and species-mix in future plantations (MAF 2001, Pearce et al. 2005). As projected west-east coast rainfall gradients become more pronounced, growth rates of economically important plantation forests (mainly *Pinus radiata*) are expected to increase in the south and west of the country, while tree growth reductions are more likely for the east of the North Island (Hennessy et al. 2007). Given the location of most Māori forestry land at present, this is likely to disproportionately affect Māori investment on the east coast. Some Māori investments in forestry may be well placed to respond to climate change, having access to modern infrastructure, research and development, and financial markets. However, by contrast there will be others that do not have access to a similar quality or quantity of resources – particularly some remote groups and businesses who stand to suffer disproportionately from more expensive fuel and higher roading costs (Cottrell et al. 2004). Regions most at risk in the coming years will be those that are currently at the edge of climate tolerance, those already stressed by economic and social and biophysical conditions, and those where long-term investments have been made that restrict adaptation options (e.g., slow growing plantation species).

Carbon trading could be an adaptation option to achieve both monetary returns and reforestation on marginal and erosion-prone hill country (Funk & Kerr 2007). Recent government commitments under the Kyoto Protocol to reduce carbon emissions to 1990 levels have created carbon trading opportunities for Māori land managers and owners who are willing to plant their land in native and exotic forests to act as carbon sinks. Māori may be interested in exploiting some of the opportunities presented by this market mechanism – including the attraction of external investment and improvement in existing land management practice through reforestation, erosion and flood control, and biodiversity protection. Notwithstanding these potential benefits, there are also some concerns that range from the setting of 1990 as an arbitrary date for carbon credit eligibility and the impact this will have on those who already hold their lands in forests (Te Aho 2007) to the carbon market promotion of quick-to-grow monoculture plantations and the subsequent downstream effects on water availability and use (Reeson 2009). According to participatory work coordinated by Landcare Research there are potentially some 200 000 hectares of Māori land eligible for carbon trading (Harmsworth 2003). However, the lack of clarity surrounding the certification of projects and uncertainty over the monetary returns in a new market environment has affected the uptake of carbon markets as a tool for sustainable development (Funk & Kerr 2007). Further, any measures to reduce deforestation will inevitably affect the flexibility of landowners to realise and implement new land use opportunities (Te Aho 2007). This has important implications for many Māori landowners who may wish to explore new land use options and/or intensify existing agricultural production regimes, as well as others who are concerned about inter-generational equity. Anecdotal feedback suggests that a number of Māori land owners will wait and see how the initiatives of others develop before committing *whānau/hapū* and *iwi* owned lands to carbon forests.

4.4 Settlements and infrastructure systems

Although most Māori live in urban environments, they also occupy remote and rural areas, where some vital infrastructure and settlements are vulnerable to extreme weather events (Harmsworth & Raynor 2005). Projected changes in weather extremes this century are expected to increase the risk of damage to life-line services such as roads, buildings, flood-plain protection and urban storm-water systems, particularly as the design criteria for heavy rainfall and floods are exceeded more frequently (Hennessy et al. 2007). Impacts such as these pose risks for local economies and may jeopardise future investment opportunities, leading to loss of jobs and income for local people (Chapman et al. 2006). Important contextual factors that influence the exposure and sensitivity of Māori settlements and infrastructure to climatic hazards include low investment in rural infrastructure (e.g., clean water resources, housing, roading), the marginal nature of some Māori land-blocks and the building of settlements and infrastructure close to waterways, floodplains and coastal areas (King et al. 2008). Add to this that many Māori landowners often have lower economic power and restricted access to finance and these factors contribute to an overall reduced capacity to cope. This situation will be worse in areas where communities have negligible or no insurance cover (ICNZ 2005, Allen Consulting Group 2005). Better information on insurance standards and clauses that may limit effective cover for Māori would assist Māori households and *hapū/iwi* infrastructural investments to make informed decisions about present and future needs.

Adaptation options include setting construction and development away from floodplains and flood zones, improving water supply, drainage and wastewater systems, and future-proofing new infrastructural developments such as the introduction of minimum floor levels for building. Adaptations such as these will contribute to making community infrastructure more resilient to current and future climatic hazards (O'Connell & Hargreaves 2004). Further, designing and building new housing or infrastructure to cope with a changing climate is likely to be more cost effective than retrofitting later (Chapman et al. 2006). Incorporating climate change issues into *iwi* management plans and meaningful participation for Māori in the development of local and regional planning, such as hazard management, are needed to prepare and reduce the exposure of Māori businesses, institutions and the community to climate variability and change. In urban areas more work is urgently required to better understand the exposure, sensitivity and resilience of Māori groups to climate change. As most Māori now live in cities and towns, those in private and state-owned residential, commercial and industrial dwellings will need to accommodate these risks to ensure basic standards of wellbeing, health, safety and quality of life are not jeopardised. In state housing there may be increased demand for maintenance and upgrades, restricted access to suitable development land and a need to include climate change considerations in the design, standards and materials used in new housing.
At present precise strategies and actions to reduce the vulnerability of Māori groups to climate change are being stalled by inadequate Māori representation and ineffective participation in local, regional and central government planning and decision-making and research (King & Penny 2006). Other key barriers relate to a lack of clarity from Government in terms of climate change policy and response, ongoing financial inequalities and people with the right expertise who can walk successfully between worlds (Harmsworth 1995, Matunga 2006, King et al. 2008).

> “Incorporating climate change issues into iwi management plans and meaningful participation for Māori in the development of local and regional planning, such as hazard management, are needed to prepare and reduce the exposure of Māori businesses, institutions and the community to climate variability and change.”

4.5 Water resource systems

Water availability, allocation and quality are already challenges for some *whānau/hapū/iwi* and Māori businesses, particularly in eastern and northern areas of the country where droughts currently place pressure on water supply for communities and agricultural end-users (Woods & Howard-Williams 2004). This century, the number of Māori living under water stress is likely to increase substantially, as increased water demand is heightened during hot, dry summers (Hennessy et al. 2007). Higher temperatures and lower rainfall are expected to reduce soil moisture, groundwater supplies and river flows for some areas, further aggravating water availability and water quality problems (Mullan et al. 2005, 2008). Meanwhile, the effects of changing hydrological regimes on water supplies are likely to seriously affect those places and populations where reticulated supply systems are poorly developed (or non-existent), and where there are inadequate resources to import water or pay for private treatment facilities (Woodward et al. 2001). Within these groupings are a handful of highly vulnerable communities and land-based businesses that should be targeted for water supply planning and adaptation research. The outcomes from such work are likely to have immediate public health implications as well as longer term climate-change adaptation benefits (Woodward et al. 2001). Further analysis is required to better understand how water resource systems are likely to be affected geographically (i.e., changes in water demand, low stream flows, lake storage, and groundwater recharge) including the downstream effects of these changes on irrigation, hydro-power, waste-water and fire management.

Adaptation options include the enhancement of existing water protection measures such as greater water use efficiency and conservation, planning for alternative water sources and artificial groundwater recharge (Kundzewicz et al. 2007). However, in many instances, adaptation to new conditions will require additional financial resources and technological capacity that many *whānau/hapū/iwi*, Māori communities and businesses do not currently possess (King et al. 2008). It should be noted that adaptation measures such as water resource protection, development and management are also likely to raise important social and cultural issues for Māori (Waitangi Tribunal 1983). It is imperative these issues be understood and acknowledged so that responses to the potential impacts of climate change on water planning and public health are aligned with the values of the people they are intended to help. This process would be greatly assisted by greater Māori involvement in local, regional and national water resource planning and management; and is acknowledged in the Government’s new strategic direction for water management in New Zealand (i.e., New Start for Fresh Water). Further work is needed in this vital system to provide critical information that will assist *whānau/hapū/iwi* and Māori businesses to make informed decisions about future needs, allocation, and adaptation measures for commercial and non-commercial water resource uses. At the same time, in spite of the uncertainties, in many areas and sectors there is sufficient information and knowledge available on water resource strategies and plans to implement adaptation activities now (Chapman et al. 2006).

4.6 Natural ecosystems

Many terrestrial and freshwater ecosystems are under substantial pressure from increasing populations, land-use change and pests (Fischlin et al. 2007). The well-being of these natural systems is of paramount importance to *whānau/hapū/iwi* and Māori business – particularly given the fundamental role of the natural environment in Māori values and the continuing rural and urban utilisation of public land, waterways and coastal resources for hunting, fishing, recreation and the collection of cultural resources (Penny et al. 2007a, 2007b). This century, the production and ecology of important flora and fauna will likely be challenged by new plant and animal pests, as well as the spread of pathogens and diseases as warmer weather favours conditions for increased competition (McGlone 2001, McGlone et al. 2010). Some vulnerable species may face habitat loss and even extinction. While natural ecosystems have some capacity to adapt naturally, increasing human populations, habitat loss and projected rates of climate change are likely to limit species migration and in some cases exceed rates of evolutionary adaptation and thereby seriously limit coping capacity (Hennessy et al. 2007). Impacts such as these are expected to adversely affect economic, social and cultural values across Māori society (King & Penny 2006). At the same time, Māori ethics, expressed through *tikanga* (Māori custom, codes, and conventions), recognise that cultural order comes from the natural environment and hence people have a responsibility to care for these systems. Lack of respect, honour and protection of this natural order compromises the well-being of these systems on which all people depend (Te Huirangi Waikerepuru, 2009: pers. comm.). A chorus of Māori voices has indicated that adaptation should focus on *kaitiakitanga* (environmental stewardship) – with families, and communities being involved in habitat protection and enhancement (King & Penny 2006, MfE 2007). Adaptation options might involve innovative collaborative management structures with local and regional authorities, Māori imposed standards on resource allocation and use, and cultural state of the environment reporting (Harmsworth 1995). However, growing populations, unsustainable modern living arrangements, fragmented local knowledge and the changing social structure of communities who have no connection to place, all present barriers to a more steward-like approach.

4.7 Coastal communities

Many Māori communities are situated along coastal margins, and these areas are highly vulnerable to sea level rise and other climatic events such as storms and high tides. They are also highly valued by Māori for recreation, for hunting and fishing to supplement household food supplies, as sources of identity and places of learning connecting the

living with the past (Hennessy et al. 2007, Penny et al. 2007a, 2007b). We are currently seeing many of these areas and values compromised by environmental changes (including coastal erosion, floods, catchment runoff, landslides, mangrove establishment and pest species incursions), increased pressure on resources and widespread coastal development – in both urban and rural areas (Goff et al. 2003, Penny et al. 2007a, 2007b, COS 2009). This century, climate change induced sea level rise in tandem with more intense storms (MfE 2008) is likely to cause widespread and more frequent coastal inundation, erosion of coastal infrastructure such as roads, homes and life-line services, and loss of inter-tidal food gathering areas and sacred places such as *urupa* (cemetery) and *marae* close to the coast (Bell et al. 2001). While there is considerable uncertainty about the projected upper range estimates of sea level rise at present (MfE 2008, Mullan et al. 2008), many Māori communities are likely to be disproportionately affected by these changes because of their socio-economic characteristics and the physical location of valued infrastructure and places on exposed, erosion-prone coastal lands make them vulnerable (MfE 2001, Packman et al. 2001). Analysis of the comparative risks for Māori coastal communities is important for understanding the sensitivities and exposure of this group and for identifying priorities for adaptation planning and implementation.

Adaptation options such as coastal protection (seawalls, rock revetments, beach re-nourishment and artificial reefs) may be short to medium-term solutions in some areas, while in other areas major long-life infrastructures (such as roads and causeways) will likely need climate change factors incorporated into future design, planning and construction (Turbott & Stewart 2006). Dune management and development of set-back zones can also reduce the effects of climate change through restoring and maintaining a protective natural dune buffer between coastal development and the sea (Dahm et al. 2005). However, for especially low-lying areas on receding coastlines, gradual to permanent sea inundation, degradation of dunes, sediment infilling, erosion and flooding is expected (Turbott & Stewart 2006, MfE 2008). Under these circumstances managed retreat may be the only sustainable solution (Bell et al. 2001). At this early point in time, the main barriers to adaptation by Māori include access to quality technical knowledge on which to make decisions, lack of participation in local planning arrangements, lack of capital for infrastructure and design, and poor infrastructure and services in some remote and isolated settlements. Another barrier may include the high spiritual value placed on coastal land and resources which can restrict, and may even rule out, conventional adaptation options being proposed by mainstream groups such as managed retreat and relocation (MfE 2001, 2008). Notwithstanding this reality for some Māori, pragmatic and timely decision-making are not foreign to *whānau/hapū/iw*i. That is, Māori will coordinate, plan, collaborate and make important decisions very quickly for the common good when required (TPK 2007a, King et al. 2008). Partnerships based on enduring relationships are regarded as vital to achieving the best outcomes for Māori and wider society in this space.

4.8 Health and well-being

The health and well-being of Māori people is dependent on the stability of social and cultural arrangements and, more fundamentally, on the sustainability and condition of natural resource systems (see: Natural ecosystems) (Durie 2001, Woodward et al. 2001, Penny et al. 2005). Climate change is likely to have both direct and indirect effects on these arrangements and systems, and thereby impact the health and well-being of Māori. The direct effects of climate change on Māori health include those that emerge from changes in temperature, rainfall, solar radiation, and other climate variables. For example, higher temperatures can result in heat stress (even mortality), hotter summers could lead to higher rates of skin cancer, and higher rainfalls can lead to floods posing direct risks to life and property, depending on standards of housing and the resilience of populations to cope (Hennessy et al. 2007). Indirect effects typically relate to secondary impacts on physical, social and economic conditions which influence human health. For example, changes in ecology and the introduction of new subtropical diseases normally found in warmer climates – such as dengue fever – pose an increased risk to already sensitive and exposed groups (Hennessy et al. 2007). Further, adverse mental health and psychological issues can result from climate change effects, such as ongoing drought and the associated impact on local economies (Howden-Chapman et al. 2010) and valued flora and fauna (Penny et al. 2005). It is important to recognise that many factors influence human health, and hence it can be difficult to distinguish the effects of climate change from other social and environmental conditions (Woodward et al. 2001). The direct and indirect effects of climate change on Māori health in urban areas and cities are much more integrated and even less clear at present.

Again, the coping capacity of different Māori to plan and respond to climate-related impacts on health is likely to be challenged by low levels of economic development, restricted access to funds for projects, substandard housing, equitable access to technical information, physical isolation and the provision of affordable health care services (Woodward et al. 2001)[6]. The impact of climate change on Māori health therefore depends not only on the extent and rate of climate change but also on secondary effects such as climate change mitigation policies and how well individuals and society can cope and adapt to these. Improved housing and insulation – as well as affordable access to domestic energy and heath care – are vital and existing needs for Māori (Waldegrave et al. 2006). The resolution of these issues would go a long way in improving the health and well-being of Māori now and in the future. In many situations, adaptation to new conditions will require additional and ongoing financial resources and support, as well as the transfer and uptake of technological capacity. Insurance for a range of covers is another area that has been identified as an important component of future action on adaptation (Allen Consulting Group 2005). It is important to acknowledge that the nature and character of Māori social and cultural relationships and networks can strengthen the resilience and adaptive capacity of communities and groups. That is, some Māori groups may be better able to respond to the pressures presented by climate variability and change because of strong partnerships, diversity, and the belief that life on earth is more about people. Building resilience through strong social networks is becoming increasingly important in natural hazards management and research (Adger et al. 2007). Further research is required to help understand how socio-economic and cultural factors determine climate-related health risk (Woodward et al. 2001). This information is a prerequisite first step in helping to develop effective community responses and public health intervention strategies.

[6] According to Tompkins & Adger (2003), the challenge is to promote adaptive capacity in the context of competing sustainable development objectives.

5. Concluding remarks

A matrix of climate change influences faces Māori society – and these drivers of change are expected to result in differential impacts across different sectors, systems and groups. It is likely that climate change will exacerbate many of the difficulties and disparities already faced by Māori. As outlined throughout this paper, these issues include access to economic and technological opportunities, governance challenges, lack of participation and representation in local, regional and central government planning, population movement, the extent to which government support and services are forthcoming, social cohesion, and lengthy Treaty settlement processes, among others. What is certain is that climate change and climate-related policies will rearrange things, economic signals will change, priorities will change, technology will change and relationships will change. While Māori are experienced in dealing with climate variability, in many cases new strategies will be needed to ensure the long-term sustainability of sectors and regions in the context of climate change. This means learning about climate change and its ramifications by sorting the rhetoric from reality; it also means engaging in the right networks and processes and gaining access to the right information and skills. Māori will do this, not only by defining their own aspirations but by participating in this discussion at all levels from the *marae* and *kura* to regional and national business, science and political forums.

There is an urgent need to better understand the vulnerability and adaptive capacity of *whānau/hapū/iwi* and Māori businesses in both rural and urban areas. Prioritisation for research (and development and demonstration assistance) depends on understanding the inter-linkages and dependencies between these variables (across local, regional and global scales) as well as identifying vulnerable systems or regions where failure is likely to carry the most significant consequences. This will assist with the identification of priorities for future adaptation as well as the likely limits to adaptation. Work also needs to be carried out to understand what makes some stakeholders more resilient than others. Learning from the mistakes and successes of different sectors, systems and groups is not only common sense but crucial in designing scale-appropriate adaptation options for different regions and communities. Many Māori have already recognised the need to (i) reduce their vulnerability to these increasing risks through adaptation, and (ii) strengthen their human and institutional capacities to assess, plan, and respond to these challenges. Considerable advantage is likely to be gained by those who consider and plan early for the future impacts of climate change – particularly given that many decisions today will have consequences well into the future.

“This means learning about climate change and its ramifications by sorting the rhetoric from reality; it also means engaging in the right networks and processes and gaining access to the right information and skills.”

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