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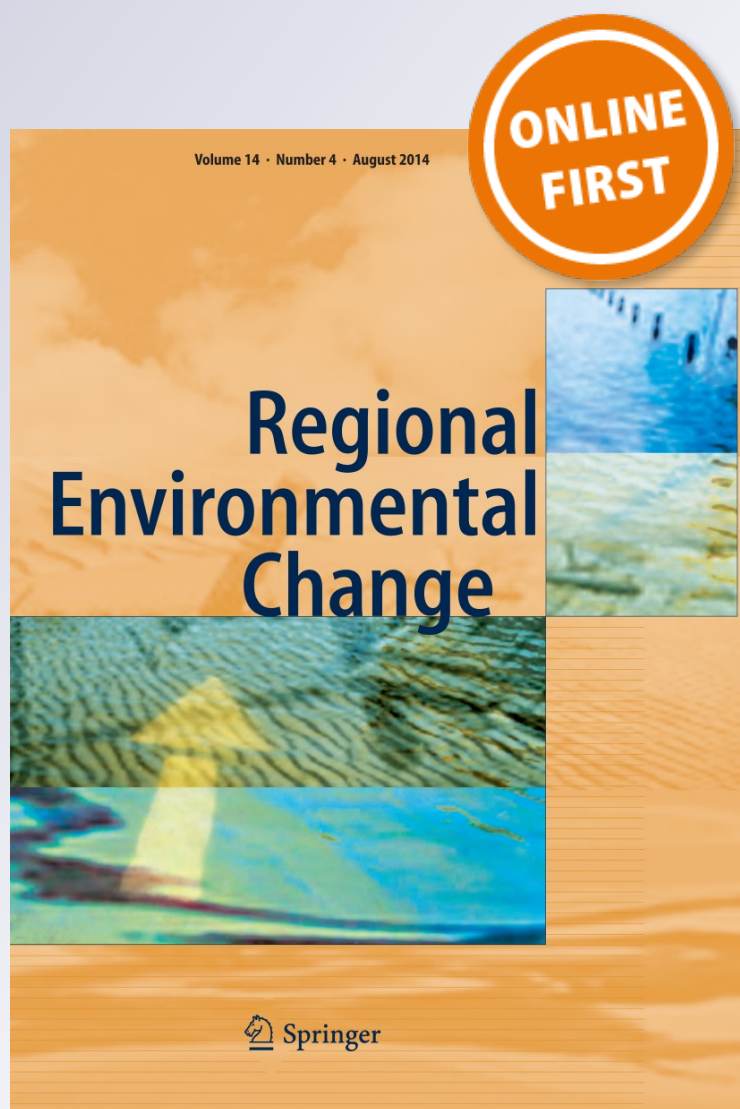
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Dealing with changing risks: a New Zealand perspective on climate change adaptation

Martin Manning · Judy Lawrence ·
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Abstract Future changes in New Zealand's climate are expected to be less than in many other countries, and New Zealand has well-established governance structures for dealing with environmental risks. While this might imply that adaptation would be straightforward, extensive public and private investments, as well as many traditional Māori assets and cultural values, are in areas increasingly at risk of flooding and sea level rise. In order to consider the country's adaptive capacity in more detail, we have used an empirical research approach, working with government practitioners at three levels and with Māori communities. Very different perceptions of risk, and structural inertia in planning processes have emerged as key issues for implementing adaptation responses. In particular, the use of static frameworks biases responses towards retrospective, rather than anticipatory analysis. Ongoing socioeconomic

changes in New Zealand also raise the risk of structural effects caused by climate change impacts becoming unevenly distributed across society. Our analysis indicates that a national and regional strategic approach, centred on a dynamic view of climate risk, is necessary for effective decisions at the local government and community level. In addition, effective adaptation requires better identification of barriers and opportunities for addressing changing risk, together with more effective and continuous social engagement.

Keywords Climate change · Adaptation · Barriers · Community response · Local government · Indigenous people

Introduction

Impacts caused by increased drought, flooding or storm damage will depend on their magnitude and extent relative to the ranges that systems have become adapted to in the past (Smit et al. 2001). Small changes can be very significant in places that have a mild climate such as New Zealand. The capacity to adapt to such changes then depends on the social, political and economic systems that form a basis for planning and risk management and the extent to which these can deal with changing circumstances (Adger et al. 2009; Turner et al. 2003).

New Zealand is a country with significant amounts of coastal infrastructure and assets vulnerable to sea level rise (SLR) (McGranahan et al. 2007), and where adaptation responses are influenced by perceptions of property values (Freeman and Cheyne 2008) as well as different cultural values (Milfont et al. 2006). This is manifested in differences between European and Māori forms of social

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structure (Ministry of Justice 2001), together with the potential for different levels of sensitivity to the effects, and capacities to respond. Consequently, significant issues can arise from an overall lack of adaptation strategies, or from responses that create inequity or perverse outcomes (Barnett and O'Neill 2010).

While climate change impacts and potential responses have been analysed for some specific sectors in New Zealand (Kenny et al. 2000; MacLeod and Moller 2006; Becken and Hay 2012), these have not been comprehensive and no national adaptation strategy has been developed. Two different contexts for adaptation are considered here to assess the current forms of response and provide insights into the country's adaptive capacity. First, the ways in which local government agencies are starting to address climate change impacts, and the statutory frameworks for doing so are examined. Second, potential responses to climate change in a semi-rural Māori community are considered by examining how such communities deal with present climate variability and extremes, along with a diversity of structural changes, such as ongoing redress for historical grievances related to breaches of the Treaty of Waitangi¹ (Durie 2005).

Case studies are used to consider the nature and extent of potential barriers and enablers for response at both the community and local government level. Current risk management practices and policies are analysed in terms of their capacity to deal with change. Similarities and differences across these two areas provide a basis for considering integrated approaches to adaptation over a range of socioeconomic circumstances. This is used to identify the necessary characteristics of decision frameworks that enable development of greater resilience to changing risks.

The New Zealand context

Climate

Despite New Zealand having recent temperature trends significantly less than the global average, there is a growing recognition of increasing risk of floods, coastal erosion, storm damage, and drought. While attribution to anthropogenic climate change is clearest for average temperatures (Dean and Stott 2009), that can also be related to rainfall decreasing in the north and east of the country and increasing in the west (Salinger and Griffiths 2001) together with significant trends in extreme rainfall (Alexander

et al. 2006). This can also be linked to the occurrence of landslide events (Crozier 2005; Glade 2003), and, during 2011–2012, such events closed two major state highways for over a year.

It has been acknowledged by local governments (LGNZ 2011), as well as central government (MfE 2008a, b), that these changes should be seen as part of a longer-term trend and has led to a recent assessment of its implications for the future by the Prime Minister's Chief Science Advisor (Gluckman 2013). Recognition of vulnerability to climate is also seen in the New Zealand Treasury identifying El Niño Southern Oscillation (ENSO) variability as a significant cause of an economic recession in the late 1990s (Treasury 2008).

Climate model projections for New Zealand's future show it warming by less than the global average (Christensen et al. 2013; Reisinger et al. 2010), but by a similar fraction of the annual temperature range that systems have become adapted to, as is expected to occur in much of the Northern Hemisphere. While there is a significantly wider range of projections for changes in rainfall, there is evidence that the intensity of extremes can increase by up to 12 % per degree of warming (Carey-Smith et al. 2010) and this can be expected to cause major future impacts.

Sea level rise has been observed in New Zealand for over a century and has a rate consistent with reaching 1 m over the next 100 years (Bell and Hannah 2012). Coastal impacts related to this can be very significant because of the country's high proportion of urban population on coastal land <10 m above sea level (McGranahan et al. 2007), where groundwater levels can rise by a similar amount as sea level (Bjerklie et al. 2012) and exacerbate the extent and frequency of coastal river reach flooding. Specific studies of storm surges have found that their spatial extent for some urban areas is very sensitive to the amount of SLR (Lane et al. 2013). Figure 1 shows the regional similarity in vulnerabilities to river flooding and storm surge by comparing their spatial extent in the Hutt valley (Ballinger et al. 2011; Lane et al. 2013).

Socioeconomic factors

A number of characteristics in New Zealand's history shape its vulnerability to changes in climate. In the nineteenth century, a focus on agricultural production and export markets led to extensive land-use changes and the introduction of many exotic plant and animal species (Hawke 1985; MacLeod and Moller 2006). Significant ecosystem change has resulted, including new pasture and soil management practices together with extensive plantation forestry, and New Zealand's economy remains dependent on agricultural, seafood and forestry exports (Statistics New Zealand 2013). Tourism is another major

¹ The Waitangi Tribunal was established by the Treaty of Waitangi Act 1975 and is a permanent commission of inquiry charged with making recommendations on claims brought by Māori relating to actions or omissions of the Crown that breach the promises made in the Treaty of Waitangi 1840.

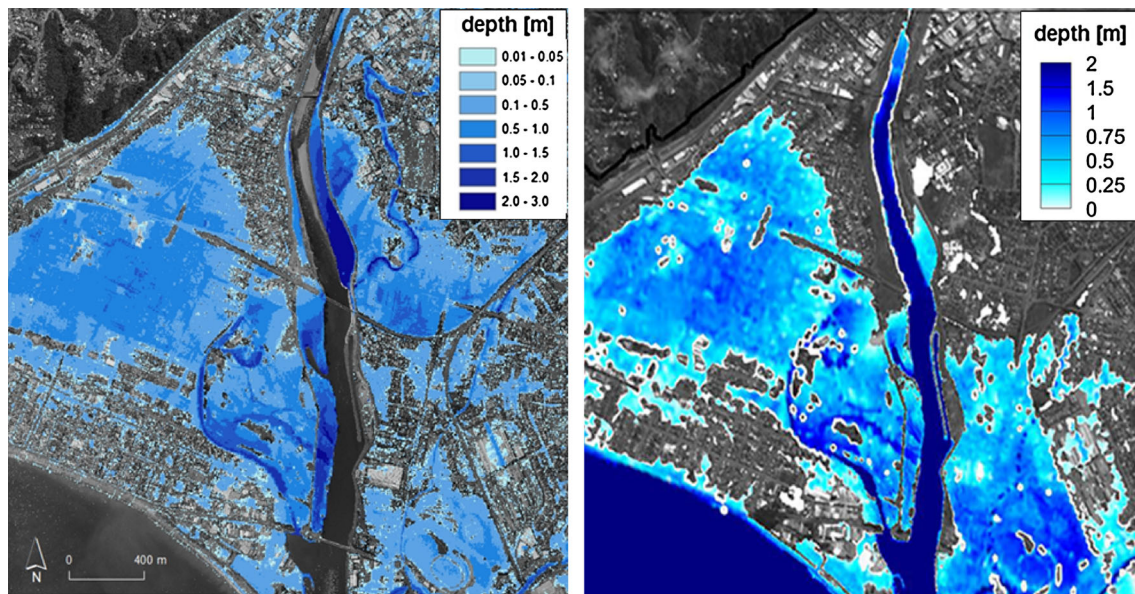


Fig. 1 Comparison of areas vulnerable to flooding and storm surge in the Hutt Valley, Wellington. The *left panel* shows areas that would be covered by a 2,800 cumecs river flood (Ballinger et al. 2011) and the

right panel areas that would be covered by a storm surge after a SLR of 1 m (Lane et al. 2013)

part of the country's economy that is clearly sensitive to both climate effects and international mitigation measures (Becken and Hay 2012). Some vulnerabilities therefore stem from New Zealand being an island nation with an economy dependent on the environment and with risks that can be exacerbated by a changing climate.

The economic, social and cultural systems of Māori are also strongly tied to the natural environment, with almost 50 % of the total Māori asset base being invested in climate-sensitive primary industries (NZIER 2003). Māori constitute approximately 15 % of the total New Zealand population of 4.5 million people and are largely (~84 %) urban (Statistics New Zealand 2007). Higher population growth rates and youthfulness when compared to the nonMāori population characterise demographic patterns. Traditional kinship ties are also widely maintained, and the *whānau* (extended family) as well as *marae* (traditional buildings and surrounding areas) remain an integral part of Māori life. However, significant socioeconomic disparities exist between Māori and nonMāori, particularly in health, education, employment and housing outcomes (Durie 2005); and these contextual conditions have already been identified as factors that increase the sensitivity of Māori society to climate change impacts and risks (King et al. 2010).

Governance systems

Having regard to the effects of climate change in New Zealand is a statutory requirement undertaken primarily by

local government under a highly devolved system set out in the Resource Management Act (RMA) (New Zealand Government 2012). This is supported by the New Zealand Coastal Policy Statement (DOC 2010a) and a number of guidance documents for coastal management (including SLR) and for flood risk management. All levels of government operate under this common national framework, which is precautionary. It promotes a risk-based approach and is linked to a number of other statutes covering: flood control, flood warning and land drainage, storm water management, water management, land-use controls and the avoidance or mitigation of natural hazards, climate change effects and the management of assets including infrastructure, water and emergency management. The Local Government Act provides the governance umbrella with a mandatory consultative framework for decision-making and Long-Term Plans (LTPs) over a 10-year timeframe, which the government now proposes to extend to 30 years for infrastructure planning.

Consideration of climate change effects by local government is at two levels: (1) regional councils set planning frameworks through Regional Policy Statements and Plans (including coastal plans and regional rules); and (2) territorial local authorities (TLAs), comprising city and district councils within the regional boundaries, implement land use, building and subdivision controls, and provide infrastructure and services. Some authorities (unitary authorities) combine regional and territorial functions. There is provision for appeal of council RMA decisions to the Environment Court, which is also increasingly adopting a

precautionary approach for the effects of climate change (Kenderdine 2010).

The current New Zealand Ministry for the Environment guidance document on coastal hazards (MfE 2008a) suggests planning levels for SLR at 0.5 m generally, and at 0.8 m where the impacts could have major consequences. It also sets out the basis for considering a 100-year or longer-timeframe by recommending that allowance be made for a rise of 10 mm per year after 2100 for long-lived assets. This guidance that goes beyond a static approach for coastal planning recognising a continually changing sea level, has been followed in Australia (Gibbs et al. 2011). However, local government has difficulty applying such changing parameters within current planning practices because they are driven by expectations of certainty in the legal system and the community (Lawrence et al. 2013b).

For Māori society, many of the land- and ocean-based resources owned by *iwi/hapū/whānau* (tribal kin group/sub-tribal kin group/extended family) are held in multiple or communal ownership, governed principally through Māori-specific authorities and structures that operate across a range of scales (Funk and Kerr 2007). While significant strengths and opportunities come from these 'indigenous' structures (Te Puni Kōkiri 2007), they can also encumber decision-making (Cottrell et al. 2004), particularly when expertise is limited and Māori are forced to balance responsibilities under the New Zealand legal and commercial system with their own *tikanga* (customary practice, rules, values) (NZIER 2003). Many of these structures have recently identified, through *iwi/hapū* and *marae* plans, the need to know more about the implications and risks of a changing climate for *iwi/hapū* and *whānau* as well as the need to strengthen institutional capacities to assess, plan and respond to the diverse challenges ahead. Much work, however, remains to be done in translating this growing awareness into existing issues of *iwi/hapū* planning and development.

Current approaches to climate risk management

Our research was undertaken in two distinct contexts. The first analysed local government systems and decision-making practices for addressing changing climate risk with specific consideration of flooding and SLR. A household survey was undertaken in the Hutt valley, yielding a sample of residents (190) who had been affected (55) and not affected (135) by major flooding events, to examine the impact of experience of floods on approaches to risk and responsibility for managing it (Lawrence et al. 2014). This was extended by interviews of sixteen local government practitioners across their functional areas to analyse the factors influencing adaptive decisions (Lawrence et al.

2013b). The effects of SLR and adaptation options were analysed for two coastal areas in Auckland based on 21 interviews with local government practitioners (Hart 2011). Complementary workshops involving 76 participants from seven regional and territorial scales of local government were also analysed (Lawrence and Manning 2012).

The second carried out place-based research with a *hapū*-based community (Ngāti Huirapa) from Arowhenua Pā (Temuka, South Island) to consider Māori perspectives in the context of current experience and projected scenarios for river flooding and SLR (King et al. 2012). This examined the current climate conditions and risks that the community contend with, as well as modelled scenarios for future river flooding and sea level rise. Semi-directive group-based, paired and individual interviews with a total of 42 informants were used during 2010 and 2011 to gather information on potential social responses.

Findings on flood risk management

Our case studies suggest that New Zealand government (local and central) decision-making frameworks and professional operating practice remain largely oriented to the use of hard structural flood control using static single numbers to reflect climate risk (Milly et al. 2008; Merz et al. 2010; Lawrence et al. 2011). This poses significant challenges for decisions concerning assets with a long life and a lead time for change (Hallegatte et al. 2012; Hallegatte 2009). By giving minimal consideration to the dynamics of changing climate, decision-makers and communities can get the impression that existing responses can continue to be adjusted indefinitely, e.g. raising levee height or floor levels and that this will be a sufficient and sustainable response.

The survey of Hutt valley households showed that this practice has raised the expectations of communities that they will be protected by the responsible agencies (Quade and Lawrence 2011) and has resulted in a 'serial engineering' mindset, which has increased path dependency in the urban settlements and the infrastructure on which they depend in the Hutt valley. Furthermore, the results from the household survey showed that there is a weak understanding of the current flood risk, and of how climate change increases the frequency of the design flood of 2,300 cumecs (cubic metres per second), which has a current annual exceedance probability of 0.23 % (1:440 year event) in the management plan for the Hutt river (Wellington Regional Council 2001). Under a low emissions scenario, by the end of this century, this would increase to about 1 % (1:100 year event) and under a high emissions trajectory to over 2 % (1:50 year event) (Lawrence et al. 2013a). Others have noted the weak planning response to such dynamic risk under the RMA affecting

existing settlements (Glavovic et al. 2010). Damage cost modelling indicates that for floods above 2,300 cumecs, flood damages increase sharply and have significant financial impacts on the Hutt valley community (Lawrence et al. 2011).

Guidance from central government on how to address increased flood frequency and intensity does account for some dynamic risk (MfE 2010). However, practitioners told us that they find it difficult to apply these in a dynamic way due to the constraints inherent in the decision-making process arising from the desire for 'certainty' in evidence-based legal processes under the RMA, and the related political demands for certainty and simplicity to satisfy community expectations.

The household survey showed that damaging floods can have a disproportionate impact on particular societal groups. There was evidence that implementation of flood 'protection' occurred sooner in higher socioeconomic areas, compared with lower socioeconomic areas, due to the higher benefit-cost ratios in the former due to higher land values. Past experience of flooding affected householders behaviour and willingness to consider a wider range of 'protection' measures that included a preference for land-use planning controls in areas at risk. The low understanding of flood risk was demonstrated as reinforcing maladaptive household responses, especially when those people with the means and experience to cope with flooding move away and are replaced by new arrivals.

Findings on coastal management

Our research on coastal management practice in Auckland showed that local governments have not yet developed more than rudimentary response options for dealing with SLR. The preferred response is hard protection such as sea walls to protect property, with the value of property at risk being a likely factor in future local government responses (Hart 2011).

It is also evident that local governments have widely varying levels of concern about SLR (Lawrence et al. 2011; Lawrence and Manning 2012), similar to that seen in other countries (Tol et al. 2008). Attempts to implement spatially sensitive setback lines based on risk, together with signals in some areas that retreat could be inevitable, have led to opposition and revision (Carley et al. 2014). Concerns have also been expressed about individual property values, and a desire for greater public involvement in how risks can be managed over time.

So far there has been little recognition that significant parts of New Zealand's building and infrastructure stock on low-lying coastal land are likely to require some form of protection or managed retreat over similar periods of time. This means that continuing development in coastal areas,

together with a dearth of anticipatory planning, may lead to major financial constraints for future responses. Also what become temporary responses, such as further development on low-lying land and a growing reliance on hard protection measures, could lead to maladaptation and entrenchment of risk. This would constrain adaptive capacity, especially in lower socioeconomic areas.

While the New Zealand Coastal Policy Statement (DOC 2010a) sets a legal framework for considering appropriate planning responses for SLR over timeframes of more than 100 years, there are different views on how far inland this coastal policy should apply. For example, in 2012, the Environmental Protection Agency approved construction of a motorway on low-lying coastal land even though experts from both sides had agreed that the effects of a rising groundwater table across low-lying coastal land had not been considered in the planning process (Williams et al. 2012). Thus, while future adaptation measures are feasible, coastal development requires greater consideration of the short- and long-term components of asset management strategies in order to balance current and future expectations of communities.

Māori community perspectives

Responses from community members from Arowhenua Pā to questions about current climate conditions and risks were dominated by references to past flooding and the impacts on *whānau* and community activities. Historical changes in river courses, flows and *mahinga-kai* (food species and gathering areas) were all identified, as well as recognition of the amplification of flood risks due to human modification of the environment. The importance of local planning in setting regulations and managing natural resources and associated climate hazards and risks was also identified.

Consideration of modelled future river flooding and SLR scenarios was dominated by concerns about the endangerment of elderly *whānau* living alone; potentially higher insurance premiums which would place additional burdens on *whānau/hapū* finances; the impact of extreme events on degraded infrastructure such as sewerage systems with associated risks that such impacts pose for local ecologies and *whānau* health; and the eventual loss of *whānau/hapū* land and *wāhi-tapu* (sacred and historical places) through erosion and semi-permanent to permanent inundation of coastal areas. The identification of these potential impacts and risks were strongly shaped by a concern for *whānau* living on, or around, Arowhenua Pā as well as longer-term considerations of the world being left for future generations.

Notwithstanding these insights, most community members recognised that strong social-cultural networks based

on *whakapapa* (ancestral and kinship linkages between people and place) helped *whānau* and the *hapū* to respond and recover from adverse climate impacts and stresses. Many of those interviewed also regarded Māori-specific institutions and governance structures such as the Marae, the Arowhenua Mātaitai Roopū, that conducts cultural and environmental assessments of the waterways across the Arowhenua area, and the Te Rūnanga Papatipu o Arowhenua as invaluable for bringing people together to ‘get things done’. Such institutions and governance arrangements were also recognised as highly important for the *hapū* in terms of formal representation at local and regional government levels.

Some interviewees also spoke of the accumulated knowledge that they held of high-risk areas and traditional safety zones—including awareness of environmental signs that indicate when extreme events are imminent and most likely to occur. And, almost simultaneously, the new skill sets held by the younger generation and the positive contributions these young people were making (and would make) to the community were identified.

However, our work also indicated that rapid transformations in the character and structure of the community at Arowhenua Pā—in the space of one to two generations—has made it harder to meet the increasingly complex array of challenges facing this *hapū*-based community. Commonly, interviewees identified the tensions and challenges surrounding greatly altered living arrangements, loss of Māori-owned land holdings, a growing reliance on modern services and markets, and increasing individualism. Drastic alteration of the physical environment and increased competition for resources have also affected the way community members can engage with traditional lands, waters and other resources. Together, these conditions are all recognised as having created new tensions that increase the sensitivity of the community to climatic risks and inversely undermine certain aspects of adaptive capacity.

Discussion: the need for new response strategies

Approaches to adaptation

Our case studies show that resilience-informed responses to changing circumstances are beginning to emerge (Lawrence and Manning 2012; Lawrence et al. 2013b; King et al. 2012) and that the time is right for developing new strategies for their implementation. But this also raises the issue of planning in the context of uncertainty and changing risks.

While scientific methods have been developed by the IPCC to cover a range of possible climate futures (Moss et al. 2010; Nakicenovic and Swart 2000), it is not clear to

what extent such analyses can be an effective basis for decision-making (Dessai et al. 2009). A focus on specific futures can lead to forms of “anchoring” and a limited capacity to handle surprises (Lempert et al. 2002), whereas approaches that use a range of futures can reduce vulnerability without reliance on predictions (Füssel 2007; Lawrence et al. 2013a). For example, it has been noted that resilience to earthquakes has tended to increase despite the absence of detailed predictions (Sarewitz and Pielke 1999).

However, while New Zealand has developed a major response strategy for severe earthquakes through establishment of the New Zealand Earthquake Commission (EQC) and development of a government managed fund, extending private sector insurance, this came only after earthquakes had caused major damages. This approach continues to evolve, and while the EQC covered 40 % of the claims for the 2010–2011 Canterbury earthquakes, a subsequent review led to seventy further recommendations covering improved design, decision-making and response (Canterbury Earthquakes Royal Commission 2012a).

If adaptation to climate change was approached in a similar retrospective way, the damage costs would be higher than necessary and the response options more limited. Such delayed adaptation responses could also result in a write-down of the value of long-lived assets, and potentially contentious debates about the distribution of costs.

Barriers

Our case studies have shown a number of barriers that can combine to produce structural inertia in decision-making on climate risk in the New Zealand context (Table 1), many of which are also found in other jurisdictions (Adger et al. 2009; Stafford Smith et al. 2011; Biesbroek et al. 2013; Moser and Ekstrom 2012).

Inertia is manifested in a continuing increase in population in low-lying coastal areas prone to flooding, storm surges and SLR with its implications for rising groundwater levels. These intersect with continuing development of infrastructure serving those populations. Further still, underpinning cognitive factors (Weber 2010) and entrenched professional practice (Lawrence et al. 2013b) appear to drive the way climate change is framed and perceived. For example, response practice on flood risk has been developed based on historical analyses and measurable data that is part of a ‘protection’ paradigm stemming back to governance and institutional arrangements, which are not well integrated with planning practice (Glavovic et al. 2010). While future projections may be considered, often just one mid-range scenario is chosen as plausible for design protection. This approach is unlikely to adequately cover significant changes, such as an ongoing increase in the magnitude and frequency of flood events. In addition,

Table 1 Barriers and enablers for adaptation to climate change in the New Zealand context

Barriers	Enablers
<i>Information</i>	
Limited data quality and complex form	Consistent methodologies; decision-relevant local information; centralised information collection; frequent updates reflecting changing risk
<i>Capability</i>	
Little climate change expertise and capacity	Mechanisms to share experience and information; capacity building
<i>Funding</i>	
Limited funding for risk assessments, risk reduction; legacy from adaptation deficit	National risk assessment for identifying critical risks; regional pool funding for response options; contingency mechanisms for retreat; and capacity building
<i>Community perceptions and expectations</i>	
Denial of changing risks; opposition to transparent hazard information; expectation of protection using structural measures	Commitment to community engagement to build trust and understanding; changing risk communicated
<i>Roles and responsibilities</i>	
Inflexible plans and rules; case-by-case decisions; lack of consistency and statutory misalignment across affected resources; inequitable political representation of Māori	Regional all-hazards approach; integration of consenting within councils; integrated regional strategic and local specific planning
<i>Relationships—social/cultural/political networks</i>	
Weak relationships between councils; complex relationships between ahi-ka and nonresident whanau; structural change in Maori social groups; loss of connection with the natural world	Processes to build social networks based on community values, traditional values and ethics; new cultural, social and political networks
<i>Institutions, governance and policy</i>	
Lack of national risk assessment methodologies; structural barriers to changing risks in legislation; wide range of views on human–environment relationships	National policies on all natural hazards including changing climate risk; greater alignment of statutes affecting climate change response; strong Maori led institutions and governance

climate risk is often perceived as a lower priority and distant threat (Spence et al. 2011) and it is only when the threat is brought forward in time, or made real by recent experience, that decision-makers focus on the range of complementary measures that could combine to address future changing risk (Lawrence et al. 2013a).

Also, underpinning the barriers is a common perception that climate change remains highly contested, despite it being subject to very detailed assessments (Hegerl et al. 2007) and with a very high level of agreement in the science community (Anderegg et al. 2010). Perceptions of contestation within the constraints of the decision context (largely static in time and legally bound) make climate change adaptation a difficult issue to get on the agenda in a way that can be discussed strategically by decision-makers across a range of planning and institutional scales.

The devolution of climate change adaptation to local government under the RMA has resulted in each council addressing climate change effects separately and facing court challenges individually in an ad hoc and inefficient way. This is compounded in the regulatory legal environment through emphasis on single numbers and averages as expressions of climate risk and their translation into ‘fixed’ structural protection and static hazard lines in plans. For example, while the NZCPS recommends the precautionary principle to deal with uncertainty in coastal planning, that is not always followed in New Zealand courts as a basis for refusing consent for coastal development (DOC 2010b). This approach has had the effect of entrenching risk exposure and reducing flexibility for managing change over time; it has thus become a legacy effect making adaptation more difficult (Lawrence et al. 2013a).

When councils deliberate on private and public interests, pressure for new economic and land development is often very evident. Decision-makers tend to be averse to limiting private property owner expectations or being perceived to adversely affect property values when risk information is uncertain. In addition, different planning timeframes for local government functions mean that dynamic risks are dealt with differently by the different functional areas across council organisations (e.g. for asset and property management, resource management, political management) (Lawrence and Manning 2012). The consequence in New Zealand is an historic legacy where private risk is transferred to the public as a direct result of inadequate planning and regulation of risk, and private interests pressuring decision-makers. These effects have been demonstrated in the building industry around leaky buildings (Mumford 2011), the Canterbury earthquakes series (Canterbury Earthquakes Royal Commission 2012b), the Pike River mine disaster (Royal Commission on the Pike River Coal Mine Tragedy 2012) and in several coastal locations where local councils have continued to ‘protect’ private property in the face of coastal inundation (Lawrence et al. 2013b).

At the same time, many citizens expect that councils will protect them from harm. This drives decisions to adopt tangible and visible protection structures, which may have limited lifetimes and effectiveness. Decisions can also be

distorted by the short election cycle placing pressures on decision-makers to address community expectations within short time periods. There can be a mismatch between what is politically and socially acceptable, on the one hand, and what is indicated by the science and councillors' statutory responsibilities for harm minimisation, on the other. There is thus a legacy of development, including long-lived infrastructure, exposed to increasing climate risks that will create ongoing costs and liabilities for councils. This pattern is country wide and not confined to New Zealand (Lawrence et al. 2013b; McDonald 2010, McDonald 2013; Stafford Smith et al. 2011; Reisinger et al. 2013).

Contextual conditions play an important role in the way climate risk is considered by different communities. For example, considerations of vulnerability, resilience and adaptation to climate change for Māori communities such as found at Arowhenua Pā are inseparable from issues linked to sustainability and *whānau/hapū/iwi* development (King et al. 2012). That is, even without ongoing climate variability and extremes, the community at Arowhenua Pā would be affected by social–economic and political processes that influence their capacity to cope in the short term and adapt in the longer term. This point is important for leaders and decision-makers across a range of scales and institutions, particularly given that community members commonly indicated how much lower a priority climate change is when compared with other everyday pressures confronting individual *whānau* and the community as a collective.

Connected to these challenges, there is a shortage of 'community' members who have the time (and relevant expertise) to represent and take responsibility (as well as provide leadership) for community-related affairs—such as legislative demands that require local authorities, council boards and committees to 'consult' and 'engage' with Māori (but not necessarily pay for such services) on resource management issues (King et al. 2012). Notwithstanding this challenge, many studies assert the value of greater participatory involvement in local and regional planning—particularly by permitting different groups to articulate their views and concerns, which can contribute to solutions to problems (Berkes et al. 2003). Collaborative governance processes have become increasingly common (Land and Water Forum 2012) and are proposed as an option for resolving large complex issues such as water management (MfE 2013).

A more fundamental social–cultural tension identified through this work relates to greatly altered relationships between people, and people and their environment (King et al. 2012). Land-use change and engineering of the physical environment, new resource management regimes and rules, increasing competition for environmental resources, and degradation of local ecology and habitats

were all seen to have undermined such relationships. Such changes have affected the way the 'community' can engage with traditional lands, waters and resources. It is not surprising that a chorus of Māori voices at the second Māori Climate Forum in 2006 indicated that climate adaptation should focus on *kaitiakitanga*—that is, individuals, families, and communities being involved in the sustainable management (including monitoring, protection and use) of environmental resources and habitats (King and Penny 2006).

More broadly, the climate system, and the sociopolitical system within which responses are embedded, is highly complex. The language of global climate change science is jargon-filled and opaque, when presented as scenarios, probability estimates or return periods, and its potential impacts become abstracted. We found in each of our case studies (Lawrence et al. 2011; Lawrence and Manning 2012; Hart 2011; King et al. 2012) that the language of climate science represents a major obstacle to communicating with communities, decision-makers and some professional groups, such as planners. A growing body of research highlights the importance of increasing an awareness and understanding of the nature of climate risk by communities through ongoing constructive engagements in which the 'processes of delivery' are as important as promoting strategic planning and identifying options (Moser and Ekstrom 2010; Norris et al. 2008; Butler and Pidgeon 2011).

Opportunities for change

Our case studies have shown a number of enablers or entry points that could provide opportunities for change (Table 1).

Within the local government context, participants highlighted the need for a more integrated approach across hazard risk management nationally to achieve more consistent results. They also identified a need for wider discussion of who pays for precautionary responses to climate change effects. The provision of readily accessible climate change impacts and vulnerability information was regarded as a role that central government could play to assist councils in their devolved functions.

Participants' responses identified opportunities for better communication of risk by use of formats that vividly characterise change (e.g. visualisation, animation and maps that relate to people's experiences in the real world). They saw that this would enable responses to be developed that are robust over a range of futures and help develop consistency across the country. It could even help avoid costly reactive debate in many communities.

The value of audience-specific communicators and facilitators capable of reaching specific audiences was also

identified in both research contexts. For example, hapū members frequently commented on the value of Māori communicators because of the trust engendered in hearing from 'one of their own'. The age of communicators was also recognised as important—particularly given the credibility engendered and respect afforded to elders in the Māori world. Continuous engagement with diverse communities of interest will be necessary however as information changes.

There was strong evidence that bringing the human–environment consequences of climate change to life with strong examples and stories that are consistent with the best available scientific evidence, can be effective in raising awareness and support for adaptation responses (Ford et al. 2010; King et al. 2012). This would likely increase the receptiveness of different community actors to the diversity of policy responses required to address the interrelated nature of climate change. However, messages that warn of the risks of climate change need to be matched with discussion of solutions and options to avoid disempowerment (Milfont 2010).

It is evident that the constraints and strengths identified at the Māori community level represent opportunities for strategic planning that can address the adaptation needs of the community now and into the future. Such entry points are however deeply connected with existing social–economic–political and environmental conditions; and therein the capacity of the community to deal with future climate change risks, such as river flooding and loss of coastal lands due to SLR, rests upon responding to existing 'everyday' issues. At the same time, many hapū members preferred to emphasise the importance of partnerships, resourcefulness, and learning from experience which all help to 'deal with' changing risks and adverse conditions over time (King et al. 2012).

The requirement that local governments maintain long-term plans, establishes a basis for developing adaptation strategies, and a few are starting to consider changing climate risks (Lawrence et al. 2013b). However, there is currently a predominant focus on immediate issues, together with limited resources for long-term planning and a lack of national strategies for considering intergenerational changes in risks. Our analysis has shown little evidence for ongoing evaluation of the vulnerability of long-term assets to climate change, or adaptive approaches to risk management.

In short, recognition of the irreversible and ongoing nature of climate change over medium to long time scales, and the embedding of this in planning/investment and risk management processes in New Zealand is so far minimal. Whether the barriers are real limits to future adaptation or simply constraints, that limit future options or raise their costs, cannot be determined at this stage (Adger et al.

2009). However, a number of them could be overcome by greater integration across levels of government, by placing more effort into the provision of information and its framing specifically for decision-makers' needs within the current regulatory environment. Such an approach would also entail the development of a more responsive framework, outside current institutional arrangements, using strategic spatial planning approaches that address dynamic climate changes in a way that is more responsive to social and cultural values.

A transition from coping to greater resilience

The effectiveness of incremental adaptation becomes more time limited as the rate of SLR increases and extreme rainfall events become more serious (Kwadijk et al. 2010). A transformational adaptation approach requires a lead time during which analysis of the options, together with community engagement and development of investment strategies reach fruition using adaptation pathways approaches that are sensitive to change (Haasnoot et al. 2013). Moving from retrospective to anticipatory responses to climate risk therefore requires time-sensitive mechanisms for managing changing risk. For example, consideration of the *lifetime* of the adaptation decision relative to *the rate of change* is likely to result in more resilient options (Kwadijk et al. 2010; Stafford Smith et al. 2011; Reeder and Ranger 2011).

Consideration of options over a wide range of scenarios, including the consequences of more extreme events (Lawrence et al. 2013a), and the upper end of a range for future SLR (Pfeffer et al. 2008), can provide a better basis for decisions. Others have also noted the value of adaptation approaches that are more decision-maker friendly, such as moving from classical top down 'what if' scenario approaches, to 'how much can current systems cope with'—an adaptation tipping point approach used in the Netherlands (Kwadijk et al. 2010). Different activities will have different response priorities for their timing and the values at stake.

New Zealand has opportunities to use existing institutions to provide a national framework and impetus for prioritisation of risk, consequence and vulnerability through national policy approaches such as the RMA. Also, the continuous cycle of strategic planning by local governments provides an opportunity for ongoing analysis and evaluation of response options. However, a national and region-wide identification of vulnerable hotspots, with clear and dynamic approaches to climate risk management, is also necessary in any framework for decisions at the district council level.

Local governments are able to signal their risk management priorities in terms of critical assets and infrastructure to communities, and it is noteworthy that government is currently considering stronger statutory powers for local government to consider long-term resilience of infrastructure assets to natural disaster risk. Re-configured roles and responsibilities across levels of government could also remove overlaps and gaps in functions such as land-use planning, hazards management and flood risk management and achieve greater integration within and between levels of government.

The lead time required for decisions will also become an important factor for decision-makers to distinguish near-term and longer-term priorities. The distributional consequences of a range of responses are affected by community values and will require community conversations prior to decisions by the responsible authorities. For example, poorer or better-off communities have different property values at stake from coastal or riverine flooding and communities attach value to different and unique cultural features. Consideration of the potential for inter-generational transitions in social mobility and perception also emerged from our research as an important factor related to distributional effects in the community.

How these factors can be implemented spatially over extended timeframes, has yet to evolve and would make a fertile space for further research to avoid continuation of practices that would further entrench exposure to risk. Table 2 shows the shifts that will be needed from coping with immediate threats and extreme events using current emergency management responses; to current adaptive management approaches which may in the long-term result in maladaptation to the type of climate changes likely; and enablers for a transition to a different way of addressing climate risk from the current largely static responses. Thinking about the changing climate in this way could unpack the elements that enable a more flexible and responsive system while supporting a range of response options and pathways for their implementation, and developing measures for their codification over different timeframes.

Table 2 Transition to new approaches

Coping	Adaptation	Transformation
Static protection measures	Community and government engagement	Dynamic risk management
Assumption of insurance or government cover for risk	Development of response options	Integrated planning and protection systems
Retrospective responses	Removal of barriers	Anticipatory responses

Conclusion

Adapting to climate change requires methods for dealing with continually changing risks in the foreseeable future. Furthermore, the impacts will be sensitive to the magnitude of change relative to the past ranges of experience to which environmental and social systems have become adapted. Consequently, projected climate change can be very significant for Aotearoa/New Zealand, because of its relatively mild climate.

Many of the barriers to adaptation within New Zealand, identified here, are manifested in a predominantly static characterisation of risks in the current legislative and policy frameworks that were intended to address risk management. Decision-making practices have become implicitly dependent on certainty and have difficulty when confronted with continuing increases in risk. This is exacerbated by community expectations of protection in a stable environment that has become a basis for the exercise of individual and collective 'rights', which are now embedded within the values of New Zealanders.

Experience in addressing earthquake disasters in New Zealand has shown that responses are often retrospective after major hazard events, whereas effective adaptation to climate change, and particularly to SLR, requires new forms of anticipatory planning. A growing number of local government practitioners now recognise the need to plan for continuing change, and Māori world views, that emphasise stewardship across generations, have the potential to inform frameworks for considering long-term issues.

The barriers to response and the enablers for addressing changing risk in New Zealand identified here are consistent with those found in other countries, such as Canada (Burch 2010), Australia (Measham et al. 2011; Productivity Commission 2012), the UK (Ranger et al. 2013), Scandinavia (Juhola et al. 2012; Storbjörk 2007) and the USA (Moser and Ekstrom 2012). There is, however, greater integration of methodologies that anticipate changing risk in the Netherlands where the Delta Commission has adopted the dynamic pathways approach (Haasnoot et al. 2013). Also, New York City's establishment of a flexible adaptation pathways approach in its climate action strategy has shown that this can lead to a transformative response after an extreme event, such as Hurricane Sandy (Rosenzweig and Solecki 2014). This shows the need to include early identification of future thresholds beyond which communities cannot cope or where costs will become unmanageable, in order to avoid more costly retrospective responses.

The key issues identified in this paper are also supported by studies in other jurisdictions enabling the New Zealand findings to have a wider relevance. For example, that

climate change adaptation is considered by communities and decision-makers as a low priority relative to other more immediate issues; that opportunities can be developed with indigenous communities by building on their relationship with land and water; the need to move from retrospective to anticipatory responses; the importance of considering the lifetime for an adaptation decision with respect to the rate of climate changes; that lead time is an important factor for decision-makers to distinguish between near-term and long-term priorities.

Effective responses to future climate change will require a greater level of community engagement on a continuous basis in order to achieve some collective understanding of possible response options. For an issue such as coastal retreat, decisions may take several decades to achieve and be an ongoing process. However, experience suggests that, without such engagement, responses will continue to be seen as autocratic or disruptive to current private interests. Consequently, strategic decision-making to address the effects of SLR, and climate extremes will become more effective with a higher level of continuous engagement between the affected communities and their local governments, supported by the national level of government.

In the past, New Zealand has made some significant changes to its economy, planning processes and social structures in response to major issues such as financial crises, social inequity and natural hazards other than climate change. The social contract between citizens and governments now needs to be extended to cover the potential for major disruptions from ongoing climate changes.

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