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Implications of Climate Change for New Zealand's Natural Hazards Risk Management

Introduction

The significant challenge posed for current and future generations by the impacts of climate change (IPCC, 2014) raises questions about whether 'better government' is required for adequate responses. Climate change exacerbates current natural hazard risk and creates impacts not experienced before. The Intergovernmental Panel on Climate Change (IPCC) concluded with '*very high confidence*' that impacts from recent climate extremes reveal significant exposure and vulnerability of human systems to 'current climate variability' (IPCC, 2014, p.6). This 'adaptation deficit' (IPCC, 2014; Parry et al., 2009) highlights the sensitivity of society and its underpreparedness to change. The concentration of development in low-lying coastal areas and on flood plains that will be increasingly exposed to climate change impacts, such as sea level rise and high-intensity rainfall events, compounds the problem. Such impacts will exacerbate the challenges faced by decision-makers when they are under pressure to restore normality as quickly as possible following extreme events. Such pressures fall on the emergency management system, flood risk management and the planning system. However, learning from these events is slow to be integrated into risk reduction planning.

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One reason for this is that people differ in their perception of risk, based on their different values and knowledge (Adger et al., 2009). This can create contested spaces: on the one hand, if decision-makers anticipate change before it happens they receive opprobrium; on the other, if they wait until the damage has occurred, councils are exposed to liability for damages, and lock-in to escalating risk can result. Such a 'no-win' situation can contribute to whether current natural hazard management practices will be sufficient for the rate and scale of the changes coming, and, if not, whether they can be adapted or will require new institutions to build adaptive capacity. This is essentially a question of 'better government' that has the levers for anticipating the change and thus reducing the risks.

The IPCC suggested strategies to manage the intersection of extreme climatic events and climate change adaptation, such as better integration of actions across portfolios to reduce the compounding effect of several hazards (IPCC, 2012), and that offer benefits in the near term as well as reduction in vulnerabilities in the longer term. But is the climate change risk being adequately characterised, and are the connections between emergency management, natural hazards planning and climate change adaptation working in practice? Will the recent focus globally[1] on 'resilience' provide a better framing of the challenges and enable adaptive responses to changing climate risk profiles?

Using insights from a New Zealand-based empirical study of the adequacy of institutional frameworks and practice for adapting to climate change (Lawrence, 2015), this article shows how climate change impacts and current natural hazard risk responses can increase the level of residual risk (the unavoidable risk), and thus challenge the capacity of the emergency management, flood risk reduction and planning systems to address those risks.

Context

The institutional framework for natural hazard management is set within a complex web of different statutory instruments that rely for their effectiveness on a high degree of co-ordination across all governance scales – of emergency management, preparedness, and risk reduction through structural protection and land use planning.

Two statutes govern and enable the funding of flood risk management in New Zealand: the Soil Conservation and Rivers Control Act 1941, administered by regional councils to prevent damage from floods and prevent and mitigate soil erosion; and the Land Drainage Act 1908, administered by regional and district councils to maintain watercourses and drains. The Resource Management Act 1991 (RMA) provides a statutory framework for natural hazards management to reduce risk through policies and measures in regional and district plans. This sits alongside the general powers conferred by the Local Government Act 2002 to carry out local public services through long-term plans, including any structural protection.

The emergency management system manages disaster risk at the national and local levels of government under the Civil Defence Emergency Management Act 2002. The National Civil Defence Emergency Management Strategy 2007 (soon to be renamed the National Disaster Resilience Strategy) sets out four types of risk-management activities – readiness, response, recovery and reduction – known as the 4Rs.[2] The Earthquake Commission Act 1993 provides insurance funding for residential property damage from natural disasters, administered by the Earthquake Commission and funded through a levy on private property insurance for underwriting damages up to $100,000 per event.[3]

Emergency management operating at district, regional and national levels has focused predominantly on emergency event response and recovery. This has resulted in less attention being given to reduction of risk and to readiness (Glavovic, 2014). Such allocation of attention emanates from the historical focus on catastrophic disasters, such as major earthquakes. Timeframes are different between emergency response and recovery activities, and natural hazard risk reduction through structural protection and land use planning: immediate emergency response and recovery occur within short-to-medium timeframes; protection and planning over longer timeframes. The institutional system demonstrates fragmentation, time inconsistency and a different focus of respective expertise, leading to a lack of co-ordination (ibid).

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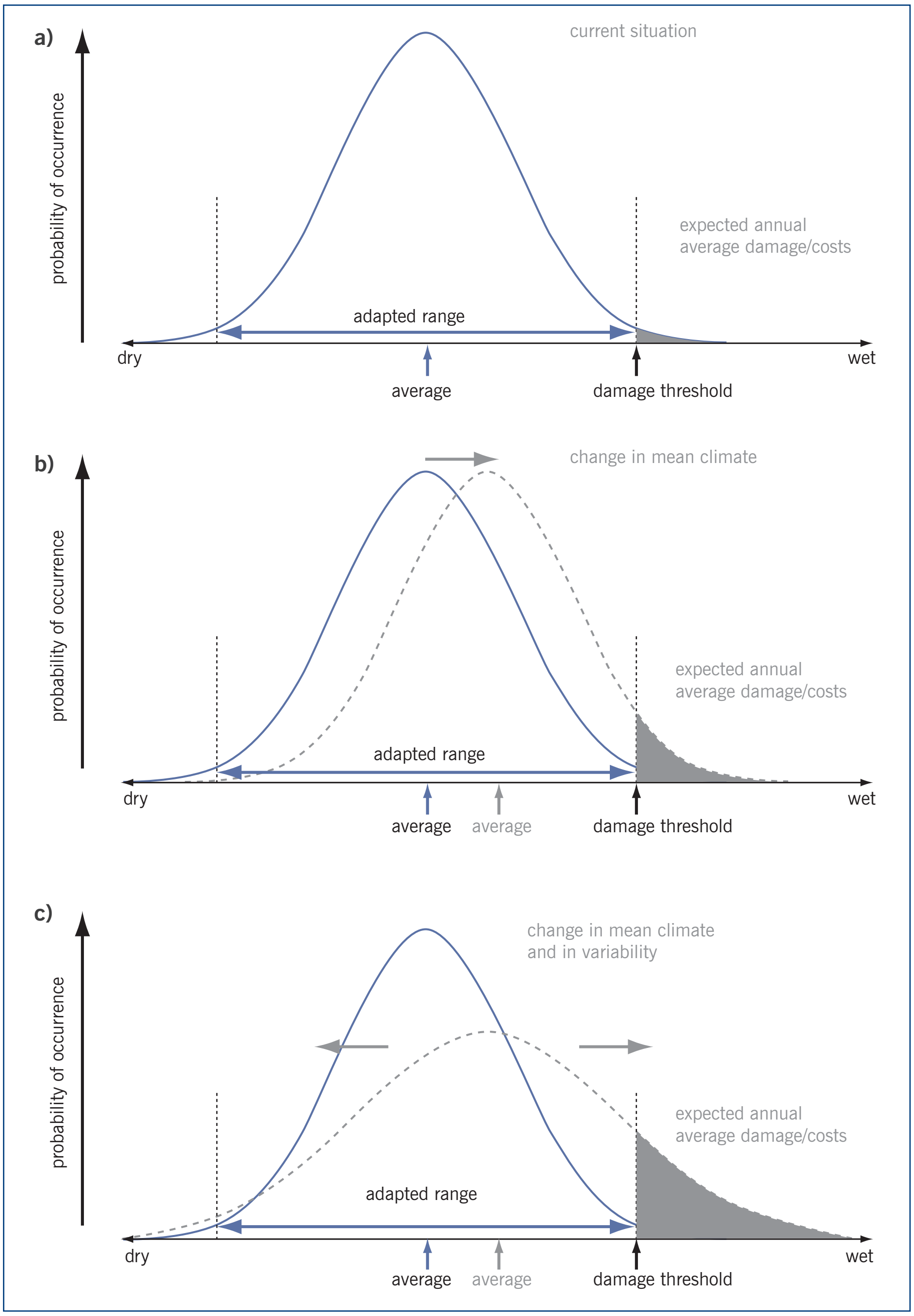
A recent shift in emphasis towards disaster risk reduction conveys sudden events; but not all climate change risks manifest as 'events'. The practice of using static measures such as stopbanks and fixed hazard zones to manage flood and coastal inundation sets up societal expectations of 'safety' within the bounds of those measures. Such practices can mask consideration of residual risk under current conditions, and residual risk as it increases relative to the static protection level as the climate changes. This can lead to path dependency if the measures cannot be adapted to the change over time and spatially. Thus, decision choices are constrained.

The global efforts at integration under a 'resilience' rubric (Gunderson and Holling, 2002) have gained currency in New Zealand (National Infrastructure Unit, 2013). This framing could address climate change impacts, since the theory suggests that there are shifts over thresholds between stability domains –

Figure 1. Changes in extremes with changes in mean climate



Source: Andy Reisinger adapted from IPCC (2012) Figure SPM3

changes described by Walker et al. (2004) as the capacity to create a fundamentally new system when ecological, economic or social structures make the existing system untenable. For this to happen, the characteristics of climate change impacts across a range of scenarios, and their relationship to emission reduction trajectories, need to be better understood.

Climate change as an exacerbator of hazard risk

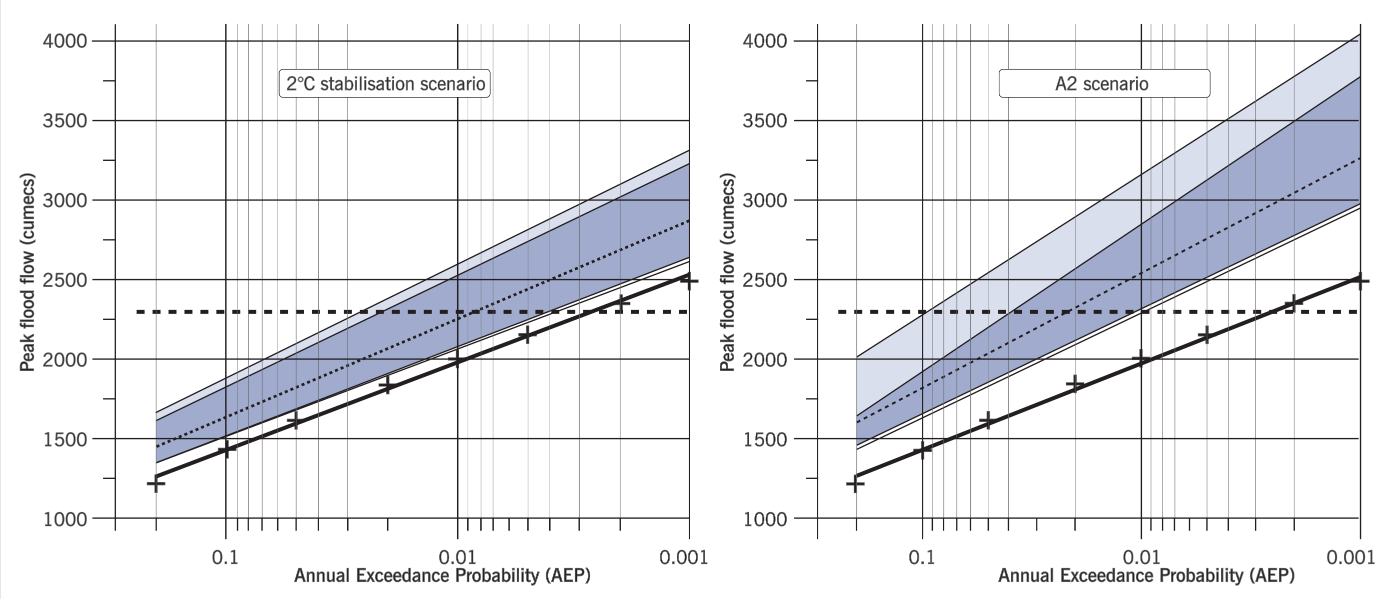
The IPCC concluded that continued higher amounts of warming are increasingly likely, since the pace and scale of actions to date to reduce emissions fall short of what is required to reduce the chance of dangerous climate consequences.[4] This means that more severe, frequent and ongoing impacts from climate change are highly probable.

Several characteristics of the changing climate will pose new risks (e.g. rising seas and groundwater), and will also combine to exacerbate existing risks (e.g. rainfall events and drought). The capacity of the emergency and flood risk management and planning systems to cope with extreme events when they occur will be stretched. In many cases it is the extremes that lead to the most noticeable and significant impacts on human activities. First, changes in mean conditions can increase damage costs at the extremes and lead to damage thresholds being exceeded. For example, Figure 1 shows how a shift in mean conditions from the current situation (diagram a) affects the frequency of the extreme conditions (diagram b), by increasing expected annual average damages; and how a shift in variance (diagram c) means more variable weather, which increases the damages from the extremes even further.

Second, Figure 1 also illustrates how changes will challenge the adaptive range of human activities by reaching a damage threshold (black arrow in diagram c), where the coping range for a particular type of extreme event is exceeded. Where the coping range is already exceeded from the current conditions shown in diagram a, and the changes shown in diagrams b and c occur, the coping capacity will be challenged (Burton, 2009; Parry et al., 2009). The gap between the current state of a system and a state that minimises adverse impacts from existing climate conditions and variability is called an adaptation deficit (IPCC, 2014).

Third, the frequency and intensity of heavy rainfall events will increase as a result of climate change. We do not know how frequent or how intense they will be, or exactly when these conditions will occur. But we do know that these uncertainties are unlikely to be resolved (if at all) before decisions are made about the location of development and infrastructure that will be affected within the lifetime of those developments. Figure 2 is illustrative of how increased flood frequency in the Hutt River catchment in New Zealand is affected by two different emissions scenarios for a range of different climate models (Lawrence et al., 2013). For a design flood flow of 2,300 cubic metres per second (the black horizontal dashed lines in both graphs), the current annual exceedance probability of 0.23% (one-in-440-year event) would increase to about 1% (one-in-100-year event) by the end of the century under a low-emissions trajectory (left-hand graph), and to just over 2% (one-in-50-year

Figure 2: Changes in exceedance probabilities under different emission scenarios.



Source: Lawrence et al., 2013

Note: The black crosses and solid line show estimated exceedance probabilities for a range of design flood volumes. The dotted line shows the flood volumes for alternative emissions scenarios in 2090 (left: 2°C stabilisation; right: A2 SRES emissions) for a range of climate models. The light grey band shows the full model range, whereas the dark grey band shows the 10–90 percentile model range. The black dashed line shows the volume of the current design flood of 2,300 m3/s, with an estimated current AEP of 0.23%.

event) under a high-emissions trajectory (right-hand graph).

A fourth characteristic of changing climate impacts is different from the natural hazards that emergency management and planning measures have had to address to date. Permanent and ongoing incremental increases in coastal inundation from sea level rise or the interaction of sea level rise with groundwater levels (Manning et al., 2015) pose further hazard risks that do not occur as a disaster 'event'.

These impacts will also increase the residual damages that occur when current design 'protection' levels are exceeded, through increased frequency and intensity or rising seas. These have profound implications for the ability of emergency management, natural hazard management and planning measures to respond and to assist recovery, because the scale of residual damage will be increasing spatially as well as in severity. In addition, sea levels will be rising concurrently around the country. The impacts will affect the ability of sea walls and levees to contain inundation; flash flooding will render inadequate storm water systems designed for lesser magnitude of rainfall events and result in more widespread surface flooding; and ongoing sea level rise and storm tide (high tide plus storm surge) inundation will threaten coastal areas.

Such changes in climate impacts will challenge assumptions about the location and numbers of exposed and vulnerable people who require egress from damaged areas, and the logistics of response operations. Greater frequency of climate events will also affect the ability of communities to recover between events, further exacerbating current risk and the ability to respond and recover. Furthermore, human exposure to natural hazard risk shows no sign of reducing; existing land uses tend to become permanent, thus creating a compounding effect. While attempts to address the legacy effect of path dependency have been discussed and contested – e.g. planned retreat from such locations – in many places (Glavovic and Smith, 2014; McDonald, 2010; Reisinger et al., 2015; Rosenzweig et al., 2011), the effect of climate changes on the capacity for emergency management, natural hazard risk management and planning for increased residual risk is less often discussed. Despite calls for more integrated planning and the potential for risk reduction through the RMA (Glavovic, Saunders and Becker, 2010), planning, engineering and emergency management approaches have been slow to converge (Lee, 2010), due, in part, to the dominance of a disaster event management discourse (Glavovic and Smith, 2014). However, as a consequence of the 2010–11 Canterbury earthquakes (a large shock) two discourses have emerged that have the potential to modify the disaster event discourse. 'Resilience' is beginning to frame infrastructure and city planning, and 'risk reduction' has emerged in the Local Government New Zealand initiative to set up a 'risk agency'. These broader framings could encompass climate change impacts if the discourse embraces an understanding of changing climate risk profiles.

This raises an issue of the *capacity* of institutions to address variations in climate that are outside the range of societal experience (Dovers and Hezri, 2010), making adjustments difficult or challenging institutions' and society's ability to cope at a fundamental level. These challenges will be on top of existing adaptation deficits where current infrastructure, for example, is outside its coping range already (Office of the Auditor-General, 2014). A further compounding factor is that current Earthquake Commission policy settings that replace assets in the same location without adapting to the changing risk, will increase exposure, creating further legacies that will challenge emergency and natural hazards management and climate change adaptation.

Emergency and planning responses

How do the emergency management, natural hazard management and planning practices currently operate and how might they be entrenching natural hazard risk?

Emergency management

Emergency management practice is largely reactive; it focuses on readiness, response, and recovery from disaster events. Warning systems and preparedness by homeowners are anticipatory, but only for those things that individual property owners can influence (Lawrence, Quade and Becker, 2014). The focus is on events rather than incremental increases in hazard risk, such as coastal inundation from sea level rise, or the interaction of sea level rise with groundwater levels. Reactive practice emanates from the statutory framework and disciplinary practices within which the different advisors and decision-makers operate. Some operate within the same institutional frameworks by being located within the same organisation (e.g. regional councils); others are distant and separated by and within their institutional and organisational arrangements (emergency management).

For example, while there are some signs of emergency management starting to integrate across governance scales in the Wellington region (the Wellington Regional Emergency Management Office integrates its activities across nine local government councils, lifeline utilities, welfare agencies, emergency services and response teams), this integration has not extended to system integration across functions, such as structural protection and land use planning, nor to managing climate change impacts. Also, Wellington City Council has become one of the 100 Resilient Cities, but without a mandate to integrate its activities across the whole region on which resilience depends. Meanwhile, the Greater Wellington Regional Council is preparing a natural hazards management strategy, but has a constrained mandate for implementation which relies upon separate units of local government. Consequently, integrated practice is unlikely to eventuate without integrated governance.

Nevertheless, it has taken the Canterbury earthquakes in 2010 and 2011 to raise awareness among decision-makers and practitioners nationally of the scale of disruption that can occur if such widespread hazard risk is inadequately anticipated. What emerged in Canterbury under special legislation from national government was a special-purpose recovery agency – CERA (the Canterbury Earthquake Recovery Authority) – with a sunset clause, followed by the location of recovery and rebuild functions within the Department of the Prime Minister and Cabinet. Whether this will enable a more anticipatory form of risk reduction to emerge is unclear, since attempts by the Christchurch City Council to address climate change and natural hazard risk in its new district plan have been challenged.

In New Zealand, as elsewhere in the world (Carlman, 2005), new institutional design that follows disasters tends to focus on the particular type of disaster that has just occurred (despite the publication in 2007 of a National Hazardscape Report).[5] For example, after the Indonesian tsunami in 2004 the government focused on tsunami risk and warning (Glavovic, Jones and Johnston, 2008); after the Canterbury earthquakes, earthquake-related natural hazards were the focus of institutional reform (an amendment to the Local Government Act (section 101B) providing for infrastructure planning over 30 years to manage risks relating to natural hazards; a proposal to elevate consideration of natural hazards to 'matters of national importance' in part 2 of the RMA; and the preparation of a national policy statement on natural hazards). The current review of the National Civil Defence Emergency Management Strategy has signalled a move to managing risk rather than managing disasters, but 'disasters' still appears in the strategy title, and there is no direct link thus far being made in the RMA amendments between natural hazards and the existing statutory provision 'to consider the effects of climate change'. Such a link would make integrated planning for disaster and climate change risk easier for councils to address.

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Flood risk management and planning for changing climate risk

Reduction of risk is addressed by flood risk managers, planners and asset managers under the Soil Conservation and Rivers Control Act, the Local Drainage Act, the Local Government Act and the RMA. However, integration of these activities has proven difficult due to the fragmented nature of the statutes, and their governance being in separate units of local government and at different levels of government.

Structural protection under the Soil Conservation and Rivers Control Act exhibits time- and space-bound characteristics that constrain consideration of changing climate risk profiles. For example, flood schemes have finite design capacity, which entrenches asset growth and potential super-design failures (breach and overtopping) that have higher residual damages than if there was no failure. The impact of structural protection has been widely recognised for decades in New Zealand (Ericksen, 1986) and elsewhere (Burby, 2006; Burby and French, 1981), but change has been slow. It is only recently that new approaches have begun to be applied in New Zealand that enable changing climate risk to be factored into flood scheme reviews in an anticipatory way using adaptive pathways planning (Lawrence and Haasnoot, under

Greater Wellington Regional Council, 2015 review). The current wide exposure to risk and entrenched settlement patterns, creating a legacy effect due to path dependency of past decisions, are compounded by a poor perception by communities of the changing climate risk profile (Lawrence, Quade and Becker, 2014) and embedded expectations of ongoing 'protection'.

Land use planning measures have been included in most flood risk management plans under the Soil Conservation and Rivers Control Act for major rivers in New Zealand (Wellington Regional Council, 2001), recognising the limitations of structural protection measures: that they often do not address the residual risk, can give a false sense of security for further development, and have increased the potential exposure of people and assets at risk. Complementary planning recommendations by regional councils need to be translated into regional rules for them to be given effect by territorial local government. Most regional councils have been reluctant to use the statutory provision to constrain existing land uses, and planning measures for changing hazard risk consequently have not been routinely included in district plans. Where territorial local authorities have attempted to do so they have borne the brunt of community reaction at a local level, leaving other councils reluctant to progress natural hazard risk reduction for which they are mandated.

The tools of planning have also entrenched risk, due to their static space- and time-bound nature. For example, hazard lines on maps and floor level restrictions will eventually prove inadequate in the face of ongoing sea level rise. Where such approaches are contested, the courts become the default decision-makers, because they have to interpret the meaning of risk-based approaches to decision-making based on different interpretations by expert witnesses appearing before them. One recent example illustrates the legacy that the emergency management and planning system will inherit. Here the Environment Court interpreted the requirement in the New Zealand Coastal Policy Statement to consider climate change enhanced hazard risk over 'at least 100 years'. For a new subdivision in a remote coastal area the court in *Mahanga E Tu Inc v Hawkes Bay Regional Council and Wairoa District Council*[6] addressed the risk by placing the responsibility for future risk management back on the consent holder to move dwellings when a prescribed distance from the encroaching sea was reached. This was despite the proposed development being in a regulated coastal hazard zone that was so designated as a precautionary measure to discourage development. Underlying this decision was the notion of voluntary assumption of risk, reference to which has become a growing trend in Environment Court practice, as shown in *Hemi v Waikato District Council*:

> We agree that there is an element of 'voluntary assumption of risk' by people who choose to live near the coast in situations such as this, and the Court's concern must be whether such risk is acceptable on all of the facts presented to it, rather than whether such risk is able to be avoided absolutely.[7]

Three practice concepts are used as risk heuristics in the court's decision-making: the voluntary assumption of risk; 'acceptable' levels of risk; and whether the risk can be mitigated. The implications of such concepts applied in practice are significant for the emergency management system, natural hazard risk management and planning practice. The 'voluntary assumption of risk' has potential to mislead as sea levels rise and flood frequency and intensity increase. Those who assume the risk today will not be those who experience the risk in the future. An increasingly burdened emergency management system may not have the capacity to support those bearing the risk in the future. This is quite apart from the possibility that conditions of consent could become unenforceable in the future, thus creating a moral hazard for future generations.

The notion of 'acceptability' of risk begs the question, to whom will the risk be acceptable: current or future generations? Making judgements about future acceptability and tolerability is at best speculative; at worst it transfers the risk to those managing emergencies and to funding agencies at a later point in time. The notion that risk can be mitigated in most cases sets up expectations that there will be ongoing protection (Burby et al., 2001). When decision-makers focus only on mitigation of harms, this can lead to structural protection measures that create further legacy effects by creating a false perception of 'safety' (Burby, 2006). By so doing, residual risk is ignored. Such court-derived mitigation measures and conditions do not appear to consider that many properties can be affected concurrently, rendering building removal impractical, especially if alternative sites have not been identified. Mitigation here means reduction of harm, not elimination of harm, although those relying on mitigation often perceive mitigation as risk elimination.

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Decision-making institutions have tended to entrench societies' need for certainty over time, which is not surprising, as they are expressly designed to confer certainty for societal functioning (Ruhl, 2012). As a result, institutions exhibit time and space constraints in their design and practice (e.g. levees, sea walls, hazard lines) and decision-makers do not have reason to consider the future consequences of decisions today and

Box 1: Institutional framework and practice adequacy criteria

1) Understanding and representing the changing climate risk characteristics that alter the residual risk to be managed:
   - uncertainty treatment
   - lifetime of decisions
   - framing of climate change risk
   - consistency and accessibility of climate risk information.
2) Designing governance and regulatory institutions and practice tools that 'fit' the scale and interplay necessary to manage the changing characteristics of climate risk:
   - precautionary decision-making
   - risk consideration over long timeframes
   - experimentation and learning
   - codification of changing risk and complementary measures
   - monitoring and transition to new institutions.
3) Developing organisations and emergency response, recovery and readiness practices that have the capability and capacity to respond to changing climate risk in emergency situations without entrenching risk exposure and vulnerability that make future responses more challenging:
   - organisational learning across disciplines and scales
   - capability to lead and anticipate complex and changing risk across scales and functions
   - community engagement to reflect values.

Source: Lawrence, 2015

how they might address future change that at present appears uncertain. Such practice can also reduce consideration of residual risk under current conditions, and residual risk as it increases relative to the static protection level as the climate changes. If the measures cannot be adapted to the change over time or spatially, this will constrain decisions or choices in the future.

A 'new' normal under a changing climate?

Climate change impacts will challenge the emergency management and natural hazards management and planning systems' capacity to respond because of scale, spatial and frequency changes. How these systems can adapt to the changing climate risk is yet to emerge in the form of new practice approaches. While resilience framing holds promise, it is largely untested.

One of the enablers of integrated practice is to address the inherent fragmentation across different statutory frameworks that have their own entrenched disciplinary processes and tools for management of hazard risk. Better integration of climate change adaptation, natural hazards planning and emergency management has been suggested by Smith and Glavovic (2014) through: alignment of terminology; better linking of spatial and temporal scales of decision-making; linking top-down and bottom-up policies and practices; aligning risk frameworks, their practice and communication; mainstreaming financing strategies across development, risk reduction and adaptation; and coordination across governance frameworks and networks.

Scholars of institutional theory (Ostrom, 1990, 2009, 2010; Young, 2002) discuss nested institutional forms that govern the behaviours of the players according to their distinct roles and the dependencies between them. However, in New Zealand such a nested form has not adequately motivated anticipatory planning for considering climate change impacts. Institutional dependencies, combined with a high level of devolution and fragmentation of responsibilities, act as barriers, rather than fostering the interconnectedness envisaged by Ostrom and Young. Current governance and institutional rules typically result in incremental adaptation that addresses current climate variability; they will be stretched by climate changes that fall outside the range of climate experienced to date, while an adaptation deficit already challenges those responsible for major assets.

Research that informed this article (Lawrence, 2015) derived a three-part typology and criteria for identifying the adequacy of current institutional frameworks and practice for climate change adaptation decision-making. It addresses interrelated barriers to implementation. For example, fragmented practice has its source in fragmented statutes, the disciplinary traditions of the practitioners who frame climate risk differently, and practitioners who are unable to implement climate change adaptations because of the social, cultural and political contexts within which decisions are made. The barriers compound and broadly relate to the concepts of 'fit', 'interplay' and 'scale' (Young, 2002). The typology could be applied to address implementation barriers that impede integration of climate change adaptation with emergency and natural hazard risk management. The three-part typology and criteria are shown in Box 1.

Climate change adaptation discourse highlights the local level as the appropriate locus of action (Adger et al., 2005; Agrawal, Kononen and Perrin, 2009; Wilson, 2006). However, most countries exhibit tiered governance and fragmented institutional mandates and measures that require integration and actions at all levels (Glavovic and Smith, 2014). Nalau, Preston and Maloney (2015) suggest that the 'adaptation is local' mantra does not hold true because of the multi-level nature of climate risk governance (Cash, Adger and Berkes, 2006), and that scale will determine the most appropriate level at which to implement adaptation. In other words, some actions are better supported at national level (national guidance); others at local levels (spatial

Table 1: Enablers and entry points

Entry points	Central government	Regional government	Territorial local authorities	Courts
Understanding and representing uncertainty and dynamic change characteristics of climate change	Amend national guidance to make uncertainties and dynamic change more prominent and add tools that can manage uncertainty and changing risk. Reflect uncertainty and dynamic change in standard scenarios. Undertake regular updates under the environmental reporting legislation climate domain.	Use dynamic adaptive pathways planning to address uncertainty and dynamic change. Make climate change information available early in planning processes and regularly update to reflect changes. Stress-test a range of response options using scenarios. Review and adjust using decision triggers to shift between pathways.	Implement dynamic adaptive pathways for spatial planning. Use regional climate risk information and make it publicly available early in planning processes. Stress-test a range of response options using scenarios. Review and adjust using decision triggers to shift between pathways.	Reflect the New Zealand Coastal Policy Statement policies in decisions.
Governance and regulation	Exercise partnership with local government in climate change adaptation. Support governance integration between regional and local scales. Promulgate a national policy statement for climate change. Make explicit links between the RMA, Local Government Act, Building Act and Soil Conservation and Rivers Control Act for consideration of climate change risks. Add climate change to the Earthquake Commission Act provisions for monitoring and updating Crown contingent risk. Make climate change risk monitoring a part of the environmental reporting legislation climate domain.	Partner with territorial local authorities for managing climate risk. Promulgate regional rules for climate hazard risk; avoid future climate risk in decisions for new developments; adopt transitional adaptive measures for existing uses. Undertake regional climate hazard risk assessments and integrate with other hazard risk planning. Highlight decision timeframes and lead times for decision implementation.	Align local spatial planning with regional climate risk. Link with regional councils to develop regional hazard assessments and spatial plans that address uncertainties and dynamic change. Implement regional rules that avoid future climate risk in decisions for new developments and adopt transitional adaptive measures for existing uses. Highlight decision timeframes and lead-times for decision implementation.	Consider the practical implications of 'voluntary assumption of risk' and 'acceptability of risk' for future generations. Practise avoidance of future climate risk in decisions for new developments and adopt transitional adaptive measures for existing uses that highlight decision timeframes and lead times for decision implementation.
Organisations and actors	Institutionalise adaptive management in the institutional framework.	Share practice models between governance scales and functional areas that address uncertainty and dynamic change and that address intergenerational equity of outcome. Engage with communities early and continuously using a range of interactive and visual tools. Develop new practice norms through education and action research. Use boundary organisations to facilitate practice change, mindful of cognitive behaviours of the actors.	Share practice models between governance scales and functional areas that address uncertainty and dynamic change and that address intergenerational equity of outcome. Engage with communities early and continuously using a range of interactive and visual tools. Use boundary organisations to facilitate practice change, mindful of cognitive behaviours of the actors.	Use informal educative opportunities for understanding changing climate risk and options for addressing it.

planning affecting values). The typology and criteria presented here address the locus of action by highlighting, first, the character of the climate change problem, and then asking whether governance scale, institutions, organisations and their actors 'fit' the problem. This typology can inform the design of new approaches where the system is challenged by uncertainty and changing climate risk. Institutional enablers and entry points for addressing the shortcomings of the current natural hazards and climate change decision-making system are shown in Table 1.

Successes[8] in New Zealand integrating natural hazard risk and climate change effects management have exhibited the following characteristics: comprehensive assessment of hazard risk; a strategic approach that has continued over decades, integrated with development strategies; high levels of staff continuity; highly integrated function operations within unitary[9] governance arrangements; ongoing community engagement at critical stages; political leadership; and consistency of approach. Immediate enhancements to the integration of natural hazard risk and climate change effects could include: reflection of 'risk' instead of 'disasters' in the title of the new Civil Defence Emergency Management strategy; linking of 'climate change effects' to natural hazards in the RMA amendments to 'matters of national importance'; integration of the operational requirements of the RMA, Soil Conservation and Rivers Control Act, Local Drainage Act, Building Act 2004 and Local Government Act; changing the Building Code standard of 2% annual exceedance probability for flood risk in light of changing climate risk; and funding institutions for adjustments to climate change impacts.

Conclusion

Advancing better government implies that governance, institutional frameworks and practices can enable the big issues facing our society to be addressed. Climate change raises questions about whether our institutions and practices are adequate for responding in the interests of current and future generations. This article has raised issues about whether emergency management, natural hazard management and planning practice can adapt to changing climate risk profiles without failing. The changing risk profiles need attention in an integrated manner so that decisions can be made that are robust over a range of possible future scenarios. Single policy responses have the habit of boomeranging and cascading across other domains when tested in real-life settings, and could prove highly costly over time. Changes will be required to the current governance and institutional arrangements to enable implementation of robust and flexible strategies and plans as risk profiles change. The opportunities for institutional strengthening suggested in this article could complement current efforts to improve risk management of natural hazards by building a more integrated risk reduction system and improving our ability to respond to the compounding effects of climate change.

1 See www.100resilientcities.org/.
2 http://www.civildefence.govt.nz/cdem-sector/national-disaster-resilience-strategy-development/.
3 This level is currently being reviewed.
4 IPCC, 2013; Rocha et al., 2015.
5 http://www.civildefence.govt.nz/resources/national-hazardscape-report/.
6 *Mahanga E Tu Inc v The Hawkes Bay Regional Council and the Wairoa District Council*, [2014] NZEnvC 83, 10 December 2014.
7 *Hemi v Waikato District Council*, [2010] NZEnvC A688, 24 June 2010.
8 Success in this context means that policies have been implemented in district plans with few challenges and are currently operative.
9 Unitary governance is where regional and territorial local government functions are governed by the one unit of local government.

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