Ministry for the Environment 2016

Coastal Hazards and Climate Change Guidance Manual

Review of Four Questions

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Executive Summary

[1] Four questions were reviewed:

- Is the Guidance Manual appropriate for its intended purpose – to assist local government to better understand and take into account climate change effects when carrying out their day-to-day operations?
- Is the recommended risk-based approach to coastal hazard management (including not prescribing an allowance for sea level rise) consistent with the requirements on local government for planning (especially the requirements of the NZCPS)?
- Is it appropriate to recommend using a high level scenario of sea level rise to stress test adaptive pathways, policies or major new development?
- Recognising that practice is developing rapidly and that MfE will assess the validity of the Guidance regularly, does the new material on community engagement and adaptive planning represent current good practice?

[2] The previous Ministry for the Environment manual for local government *Coastal Hazards and Climate Change* (2008) has been described as providing 'high level guidance' on the issues involved. This revised guidance, under the same title eight years later, reflects that standard in the four questions reviewed here.

[3] While providing up-to-date analysis of the national and international science on climate change and coastal hazards, it provides a fresh focus on local government's leadership and responsibilities in the face of a changing climate.

[4] Among those responsibilities is the necessity to manage the increasing risks from climate change and coastal hazards in a fresh and comprehensive way through providing adaptive management strategies and pathways to address the considerable problems envisaged.

[5] The strategies involve community engagement as a requirement for successful management of the complexities arising. The methods of how this is achieved are addressed with a detailed, step-by-step analysis that signals a significant shift away from earlier forms of community consultation.

[6] The document also addresses innovative perspectives on the science and adaptive management surrounding ongoing climate change and sea level rise in a very uncertain world. These and other risks are a significant part of the dialogue.

[7] How the risk management approach of current planning practices is absorbed into adaptive management processes in the document is a continuing theme throughout.

Summary

[8] The Guidance Manual provides extensive new material building on that contained in the Ministry for the Environment's 2008 Manual.

[9] The authors have gone to impressive lengths to establish a new risk management planning focus – one that is all-encompassing in the context of climate change, sea level rise and coastal hazard risk.

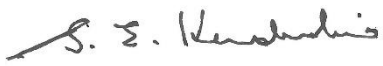
[10] The authors have addressed the various related provisions of the NZCPS with a comprehensive analysis that informs much of their material.

[11] Some chapters are over-written, particularly around sea level rise, and there is constant repetition of how the given issues relate to adaptive management processes. These could both be condensed.

[12] The level of detail in the body of the text, the comprehensive use of informing material in the Appendix, the creativity around addressing active management processes in the context of the RMA is commended.

Disclaimer

The undersigned has not seen the Department of Conservation's latest Information Guide (2016) to the NZCPS nor the previous one.



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Is the Guidance Manual appropriate for its intended purpose – to assist local government to better understand and take into account climate change effects when carrying out their day-to-day operations? [Question i]

Introduction

[13] The previous Guidance Manual for Climate Hazards and Climate Change (2008) ('the Manual') has been described as providing 'high level guidance' on how councils should approach their decision-making around coastal hazards and climate change, and sea level rise ('SLR') as well as several principles to assist in understanding what is involved.[1]

[14] The Guidance Manual (2016) for local authorities builds on that tradition in a greatly expanded form with extensive new information, analysis, data, graphics, maps, photographs, figures fact sheets, case and planning law, and appendices.

[15] It is a major revision of the 2008 edition and importantly includes the findings and projections of the latest 5th Assessment Reports produced by the latest Intergovernmental Panel on Climate Change ('IPCC AR5'), while also including the provisions and analysis of the New Zealand Coastal Policy Statement 2010 ('NZCPS), published since the MfE 2008 document was made available.

[16] It provides a step-by-step approach to assist local authorities to enable effective planning and adaptation of coastal communities, stakeholders, coastal assets and processes to avoid increasing coastal hazard risk arising from climate change with techniques that underpin the process.

[17] It differs from previous editions of current coastal hazard and climate change management practice in several respects:

- the central role that community engagement has in any future council decision-making process around climate change and coastal hazard risk;
- the treatment of uncertainty;
- the major challenges SLR poses for today's decision-makers;

[1] Parliamentary Commissioner for the Environment ('PCE') *Preparing New Zealand for rising seas: Certainty and uncertainty* (2015) para 7.2 p 61.

- an adaptive management approach to identifying and managing climate change, sea level rise ('SLR') and coastal hazard risks.

A Broad Overview: the Need to Better Understand Climate Change

What is climate change?

[18] Changes in the global climate are leading to warmer temperatures, rising sea levels and more extreme weather events. Where these natural events interact with coastal communities and property (including infrastructure) they can result in coastal hazards including coastal erosion and coastal inundation. A definition of climate change is relevant here:

> Climate change refers to a change in the state of the *climate* that can be identified (e.g. using statistical tests) by changes or trends in the mean and/or the variability of its properties, that persists for an extended period, typically decades to centuries. Climate change includes natural internal climate processes or external climate forcings such as variations in solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.

[19] Of relevance also is a definition of climate projection:

> A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission-concentration-radiative-forcing scenario used, which is in turn based on narrative with assumptions e.g. future socio-economic, technological developments or land use change that may or may not be realised. [2]

The certainty of climate change

[20] These definitions are rounded out with descriptions provided of the impacts of climate change:

- Increasing concentrations of carbon dioxide (now above 400 ppm) and other greenhouse gases are trapping heat and the climate ocean system has responded.

- Warming of the climate system is unequivocal.

- Observed changes indicate they are unprecedented over timescales of decades to millennia. The present level of greenhouse gas components and their effects,

[2] Guidance Manual, Glossary pp 25-26.

together with other anthropogenic drivers, have been skewed throughout the climate system and are *extremely unlikely* to have been the dominant cause of the warming since mid-20th century (IPCC).

- The oceans have warmed, the amounts of snow and ice diminished, and sea levels have risen with an attendant rise in global CO^2 emissions.[3]

- The primary climate driver for SLR is global and regional surface temperature increases in turn strongly influenced by greenhouse emissions.

- More realistic assessment of the relationships between warming and observed changes to natural systems such as ocean warming, glacier and ice sheet responses and sea level rise are now possible to undertake climate-related projections (IPCC, 2013; Church et al, 2013).

Day-to-day operations

[21] Local government has a leadership role with respect to climate change and its effects on regional and local communities. It is a role undertaken against the background of ensuring sustainable management of the natural and physical resources of regions and cities under s 5(1) of the Resource Management Act 1991 ('RMA') to meet the reasonably foreseeable needs of future generations (s 5(2). While contributing to building community resilience in terms of managing natural hazards in its coastal margins under the Local Government Act 2002 ('LGA').

[22] Everyday operations include:

- covering the statutory and non-statutory roles and responsibilities of local government in managing coastal hazard risk including the effects of climate change;

- providing information on aspects of climate change and sea level rise, and other coastal hazards;

- outlining approaches and good practice for coastal hazard exposure assessments;

[3] Guidance Manual p 96, Figure 5-9. IPCC AR5. Projections of global-average MSL rise (metres relative to the base MSL of 1986-2005). Source: IPCC (2013a: SPM).

- setting out key principles and approaches for engaging with communities and iwi/hapū around issues of coastal hazard and climate change risk;

- emphasising the importance of working collaboratively with stakeholders and affected communities, at various steps of the decision-making process;

- updating latest guidance on sea level rise projections to –

    - establish future exposure, vulnerability and risk

    - assist with developing policy and adaptation trigger levels and decision points to include in adaptive strategies and implementation plans and during asset design and management

- relying on a risk-based planning framework for incorporating changing coastal hazard exposure, sensitivity to climate change and adaptive capacity considerations into risk and vulnerability assessments, to underpin collaborative processes associated with assessing and evaluating response options;

- promoting the development of long term adaptive capacity for managing coastal hazard risk and uncertainties through adoption of a dynamic adaptive pathway that may change.[4]

[23] Of particular importance to local government's roles is the requirement in s 7(i) to have particular regard to the effects of climate change. It imposes a duty to be on inquiry of how to address the issues arising and adds a new complexity to local government's roles.[5]

[24] The Guidance Manual considers the issue in Box 4.1 Is climate change decision-making different from other kinds of decision-making?:

> Climate-related decisions have both similarities and differences with decisions concerning other long-term, high consequence issues. Commonalities include the usefulness of a broad risk framework and the need to consider uncertain projections of future biophysical and socio-economic conditions. However, climate change includes even longer time horizons and affects a broader range of human and earth systems relative to many other sources of risk. Climate change impact, adaptation, and vulnerability assessments offer a specific platform for exploring

[4] Guidance Manual p 13. Local Government New Zealand ('LGNZ') October 2014. Managing natural hazard risks in New Zealand towards more resilient communities: A think piece for local and central government and others with a role in managing natural hazards.
[5] Guidance Manual s 10(1) LGA, p 32.

long-term future scenarios in which climate change is considered along with other projected changes of relevance to long-term planning.

In many situations, climate change may lead to substantial and irreversible outcomes (e.g. sea level rise), which challenge conventional economic tools and environmental policy. In addition, the realisation that future climate may differ significantly from previous experience is still relatively new for many fields of practice (e.g. food production, natural resources management, natural hazards management, insurance, public health services, and urban planning).

Source: Adapted from FAQ 2.3, Frequently Asked Questions (IPCC WGII 2014).

[25] In an earlier assessment of climate change for the Canterbury coast one scientist notes that SLR gets the publicity but climate change will also affect other important coastal drivers such as waves, winds, river flows and storms that in turn could substantially alter sediment supply to the coast with the potential to cause further erosion in some areas.[6] The Guidance Manual, however, indicates that beyond 2100 the SLR will dominate over these 'secondary' climate change effects and hazard sources.[7]

[26] The Guidance Manual identifies a number of 'Guiding Principles' that apply to community engagement but apply equally here. These principles in the context of the changing risks associated with climate change and SLR identify:

- the need to be flexible and adaptable;
- the need to be inclusive and empathetic and ensure representatives' participation;
- the need to run a transparent process;
- the need to be cognisant of scientific input and knowledge;
- the need to secure committed responses and institutional support.[8]

Climate change in an uncertain environment

[27] The nature and reach of coastal hazard risk with the looming pressure of continuing SLR is influenced increasingly by climate change. Changes in storm surge and wind and wave climate, for example, increased storminess (frequency and intensity of

[6] Bell R 2001 Impacts of climate change on coastal margins in Canterbury. NIWA Client Report CHC01/69 prepared for Environment Canterbury, July 2001.
[7] Guidance Manual p 113.
[8] Guidance Manual pp 59-61.

storms), rising sea level (incorporating both absolute and local contributions), vertical land movement, and the El Niño/Southern Oscillation and the 20-30 year interdecadal Pacific Oscillation ('IPO') have additional impacts under varying time frames.

[28] Climate change will continue unless there is a drastic diminution in gas emissions, and sea level rise will continue rising for several centuries. Land-use planning and asset infrastructure decisions made today will have long lifetimes because of the permanency of development (infrastructure, buildings, subdivision), these issues become major factors to consider. They compound the challenges that local government already faces with risk impacts created by climate change (namely coastal erosion, inundation, flooding, rising groundwater and salination in coastal lowlands).

[29] Any adaptation to climate change therefore requires much wider consideration from local government than hazard risk management. It involves many components of the environment - including the natural environment, conservation values, the built environment as well as community values and aspirations. Effects on social, cultural and economic values, communities' coping capacity and ability to adapt, and the sensitivity of the natural and physical environment (expressed as vulnerability) will amplify the impacts of climate change in some coastal areas. All of these issues are implicit in the relevant provisions of RMA and NZCPS.

[30] As such, the Guidance Manual aims to provide updated information and good practice guidance within 'a risk based adaptive management framework to strengthen the integration of coastal hazards *and climate change considerations* relating to land use planning, resource management, building consents, asset and flood management, risk and emergency management' that form part of local authorities' day-to-day operations.

The need for better understanding

[31] Coastal communities anticipate the coastal margins will exist permanently and that any risk from coastal hazards and climate change will be able to be managed safely. SLR has been identified as the 'game changer' for that expectation and the resulting perception. Estimates of climate change in terms of sea level rise are available, and trends in the near term mid-century (50 years) are known with reasonable confidence, the implication of what may be seen as manageable and consistent

trends becomes less reliable in future (no less than 100 years). These trends occur across wide areas, depending on the SLR scenarios.[9]

[32] While climate change will not introduce new hazards, it will increasingly change the nature and extent of their impacts by altering and compounding these, particularly from SLR. Climate change will impact coastal and estuarine environments with weather-related drivers such as storm surges, waves, winds and the frequency and the occurrence and intensity of storms. Any changes in impacts from these will have implications for coastal erosion, coastal storm inundation and groundwater/drainage levels that are part of local authorities' day-to-day operations.[10]

[33] Detailed information is provided in the Guidance Manual on all these issues, together with coastal assessment examples and particular case studies of relevance.[11].

[34] Generic guidance of such issues includes:

- considering sensitivity to storms and extreme weather events in analyses or assessments when making infrastructure and planning considerations and determining coastal hazard exposure areas;
- considering tides, storm surges and El Nino – Southern Oscillation effects on MSL variability, winds and waves and their effects on infrastructure and planning decisions as well as determining coastal hazard exposure areas;
- using the best monitoring data and modelling techniques available to undertake locally relevant and context-specific coastal hazard assessments.

[35] Specific guidance is provided based on more recent IPCC AR5 case studies such as:

- undertaking sensitivity testing for coastal engineering projects and for defining coastal hazard exposure areas out to 2100, using:
- a range of possible future increases across New Zealand of 0-10% for *storm surge* out to 2100;

[9] Identified in IPCC AR5.
[10] Guidance Manual Chapter 5 p 113.
[11] Ibid Chapter 6. Appendices, Appendix B Case Law p 22 ff.

- a range of possible future increases across New Zealand of 0-10% for extreme *waves and swell* out to 2100;

- incorporating changes in 99-percentile *wind speeds* by 2100 for the relevant RCP scenario from MfE (2016) on climate-change projections, to assess *waves in limited-fetch situations,* such as semi-enclosed harbours, sounds/fjords and estuaries.[12]

[36] Local authorities are advised that climate change is already starting to impact on communities and will have irreversible impact on the coastal margins as SLR will continue to accelerate and do so for centuries, even if greenhouse gases are reduced. Up-to-date figures are presented indicating the nature of the risk facing communities and stakeholders. An example is given under the heading Coastal storm inundation:[13] 'For existing areas prone to coastal inundation, climate change means that coastal inundation during storms will become more frequent, relative to the present day, given the same specific ground level or barrier height (PCE, 2014; PCE, 2015; Stephens, 2015). Coasts with smaller tide ranges will be more frequently exposed (e.g. east coast on both the North and South Islands and Cook Strait/Wellington) than coasts with higher tide ranges (Stephens, 2015). The extent of the area at risk of inundation may increase relative to the present day, although this will depend on the specific site (Bell et al, 2015).'

[37] Meanwhile, present and future coastal risk exposure in low-lying areas were evaluated nationally in the recent Parliamentary Commissioner for the Environment ('PCE') reports (PCE, 2015; Bell et al, 2015). Overall, while only 0.6% of New Zealand's land area has an elevation within 3 m of the mean high-water mark (MHWS), these areas account for 6-7% of the replacement costs for all buildings NZS52B-2011 and NZS52S-2011) and 6.6% (281,900 residents; 2013 Census) of the total resident population (Bell et al, 2015).[14]

The necessity to adapt planning in coastal areas – adaptive management

[38] In the past 10 years there has been a distinct shift in the scientific literature away from forecasting the impacts of greenhouse gas emissions towards a focus on managing climate change risk and its consequences:

[12] Guidance Manual pp 115-116.
[13] Guidance Manual pp 124-126.
[14] Figure 1-1 Sources Bell et al (2015); PCE (2015). National Coastal Risk Exposure.

- on vulnerable coastal regional and local communities and assets;
- on natural values such as beaches, dunes, wetlands, salt marshes, estuaries, habitats and vegetation;
- on nationally important and permanent assets such as airports, roading infrastructure and ports;
- on the recognition that the major impacts of climate change require significant adaptive management will be coastal hazards and floods.[15]

[39] The more recent focus on managing the risks of climate change is significant because climate change-related risk arises from three distinct drivers, namely climate-related hazards, the exposure of natural and human systems to these hazards, and their sensitivities to those hazards, that is, their ability to cope with or adapt to change.[16]

[40] The point is made that recent global initiatives – started by the IPCC Special Report (IPCC, 2012), followed by the Paris Conference of Parties (COP21) climate agreement (UNFCCC, 2015) and the Sendai Framework (2015), have attempted to bridge the gap between present-day disaster risk management and climate change impacts – often treated separately. Planning and developing future resilience through adaptation will involve a transformation of communities' understanding of the unpredictability and range of possible climate-change futures. On the other hand, the public willingness to act to mitigate climate change through emission reductions is based on growing experience and understanding of the impact of disasters already likely to contribute to that change.

[41] Adaptation is now seen an integral part of climate change policy world-wide. The Sendai Framework for Disaster Risk Reduction is in place for a 15 year period 2015-2030 and is an organisation seeking to achieve global targets for risk management and reduction which include climate change effects.

[42] Internationally, managing disaster is now framed around risk reduction rather than the prevailing 'response and recovery' expectations.

[15] Reisinger et al (2014) Australasian Chapter 25 IPCC WGII.
[16] Reisinger and Lawrence (2016) Probabilities In An Uncertain World – beyond the oxymoron. Paper presented to the 2016 Legal Institute of the New Zealand Law Society, p 6.

The importance of uncertainties

[43] Dealing with uncertainty by local authorities is an important aspect of climate change because the interacting sources of the issue mean that some aspects of its impacts on coastal areas will not be known with any precision for the foreseeable future. They therefore necessitate ongoing engagement between decision-makers and communities where:

- parties to a decision do not know or cannot agree on the problem, its boundaries, the outcome sought and the relative importance of interests, and the probability of uncertain inputs to the problem (Lempert et al, 2003; Walker et al, 2013); or
- there is dynamic interaction between factors that cannot be considered independently (Haasnoot et al, 2013; Hallegatte et al, 2012); or
- many possible response options exist and different interests are at stake.[17]

[44] The Guidance Manual identifies that uncertainties typically play out through a number of risk transfer mechanisms including the transfer of risk from individuals and the wider community today, to future generations, and potentially to risk-transfer agencies such as the insurance sector and EQC, which may not be sufficiently underwritten for the scale and scope of future climate change consequences.

[45] Local government therefore has statutory and fiduciary duties towards its communities to reduce hazard risk mandated from the NZCPS, CDEMA and the LGA. And that when planning for the future under uncertain conditions, it is important to also consider the risk transfer, legal liabilities and the financing consequences of decisions.[18] While waiting for uncertainties to be resolved is usually not acceptable to those exposed to the risk (or for future generations).[19]

[17] Guidance Manual p 66.
[18] Guidance Manual pp 73-74.
[19] Ibid p 72 Box 4.2 How uncertainty affects adaptation and mitigation.

[46] Adaptive planning encourages transparency and considerations of the full spectrum of uncertainty and how to factor those into more adaptive planning that retains flexibility over time, whatever impacts evolve.

Adaptation to climate change and adaptive pathways

[47] The Guidance Manual at the outset provides a succinct summary of what local authorities can expect from the ongoing challenges of climate change and how to address them.

[48] The adaptive pathway concept it introduces is intrinsically an exercise in planning and risk management, engaging with stakeholders and communities in order to resolve the consequences for a range of possible coastal futures. If it has not already done so, it is now becoming part of the day-to-day operations of local authorities.

[49] The Guidance Manual sets out the structure of what follows in an iterative 10 step Decision Cycle graphic simulation embedded throughout the document. It comprises a framework around the elements to secure and implement long term strategic planning and decision-making on climate change issues. It provides an immediate visual and continued focus on what is to be achieved by local authorities as best practice.[20]

[50] Then follows an exhaustive list of what is required to be addressed in the context of regional and local responsibilities. Each step is identified with what other chapters cover and a description of the key tasks for decision-makers.

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[20] Guidance Manual Chapter 2 pp 42-43. The 10 step Decision Cycle is grouped around five issues which are then identified or answered in chapters that follow, viz:

A. What is happening? (includes setting the context and preparation through to undertaking sea level rise and hazard assessments based on scenarios)
Chapters 1 to 6
B. What matters most? (centred around values and objectives: people and asset service delivery and undertaking risk and vulnerability assessments)
Chapters 7 to 8
C. What can we do about it? (identifying and evaluating options)
Chapter 9
D. How can we implement the strategy? (secure and implement an adaptive planning strategy)
Chapter 10
E. How is it working? (monitoring and regular reviews and possible adjustments)
Community engagement is embedded or tied into a number of the steps and drivers of change, for additional iterations of the process include new climate information, re-appraising triggers or decision points and social, cultural and economic change.

Conclusion

[51] The Guidance Manual is appropriate for its intended purpose. It comprehensively provides local authorities with the information to better understand the nature of climate change and the challenges it presents.

Is the recommended risk-based approach to coastal hazard management (including not prescribing an allowance for sea level rise) consistent with the requirements on local government for planning (especially the requirements of the NZCPS)? [Question ii]

Are the implications of a risk-based approach to coastal hazard management consistent with requirements for local government planning?

[52] Much of New Zealand's urban 'peri' urban development is situated in coastal areas, harbours, creeks and lowland rivers. There is a perception in communities that land along the coastal margins will persist permanently and that living there they will be safe from natural coastal hazards[21] (apart from rare tsunami or storm events). But recently that perception has begun to change with the growing realisation among coastal communities of the potential impacts of climate change and the directives given in legislation to address them.

[53] The directive for managing natural hazards is given to local authorities under s 5(1) RMA – the promotion of sustainable management of New Zealand's natural and physical resources; and s 5(2) managing these resources in a way that (inter alia) sustains them to meet the reasonable foreseeable needs of future generations. The requirements under the RMA also require particular regard to be given to climate change by local authorities under s 7(i), and various coastal natural hazard effects ('impacts' in scientific terms) under s 3(a)-(f) are identified to be managed or avoided. The identification of 'risk' arising from climate change and coastal issues arises directly under NZCPS Objective 5, and Policy 25(a) where it is defined in the Glossary.[22] It is mentioned generically in Policy 24(1) as 'Hazard risks' in everyday (undefined) language.

[54] Local authorities have a leadership role in addressing planning issues to manage the problems arising as government has devolved to them the legal mandate to sustainably manage such issues into their own regions and districts primarily under

[21] 'Natural Hazard' is defined as meaning any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment: s 2 RMA.

[22] NZCPS Glossary p 27. This definition was amended from the earlier definition provided in the draft NZCPS that went to the Minister: see Glossary in the Working Papers. It was essentially the often expressed view of the Board as Risk – Likelihood x Consequences: see Proposed New Zealand Coastal Policy Statement 2008, Board of Inquiry Report and Recommendation Volume 1, July 2009.

the provisions of LGA, RMA, Civil Defence Emergency Management Act 2002 ('CDEMA'), the Building Act 2004 ('BA') and Building Regulations 1992.[23]

[55] The Guidance Manual addresses local authorities' roles and functions under these statutes comprehensively, providing in the Appendices a planning framework for managing natural hazards as well as identifying the key subsidiary plans, statements and strategies to implement the legal imperatives the statutes provide.[24]

What are the requirements on local government planning?

[56] A risk-based approach underpins the current approach to coastal hazard planning and decision-making – focusing on consequences and dealing with likelihood, depending on the hazard being assessed (for example, cases on storm-tide, storminess, coastal hazard lines, wave action)[25].

[57] The more recent key responsibilities of local government in relation to natural hazards are set out in the 'think piece' from LGNZ (October 2014) which addresses the regional and territorial councils roles and responsibilities in relation to the coastal environment.[26] The avoidance or mitigation of natural hazards is one of the core services to which councils must have particular regard when addressing their functions and performing their roles. [27]

[58] Leadership in the local context addresses local government's responsibilities in real time including emphasis on legacy issues (where coastal residential communities and infrastructure have been built in coastal areas). There is thus a need to identify that vulnerability of communities and assets has what the Guidance Manual calls 'a time dimension' – local vulnerable communities will be the first to experience risks from inundation, water ponding, regularly share damaged protection structures, erosion, damage to local roads and underground services.

[59] The impact of climate change in some areas will be significant. Coastal erosion and inundation, storm surge, loss of or change to infrastructure and assets (already occurring in some parts) together with greater costs associated with asset repairs and maintenance are one significant part of the problem. The implications for

[23] See Appendices, Appendix A pp 6-21 for other relevant statutes and case law.
[24] Appendices, Appendix A p 6.
[25] See Appendices, Appendix B Case Law.
[26] Guidance Manual pp 22-23.
[27] Section 10(2)(c) LGA.

biodiversity and natural systems from temperature rise and extreme weather events are another. The implications for coastal communities, their social, cultural and economic values, their coping capacity together with the overall sensitivity of the natural and physical environment (expressed as vulnerability) will further amplify the impacts from climate change in some coastal areas.

[60] Local authorities are expected to address the fact that risk management and planning must be undertaken in the context of recognising that there is both a changing risk exposure from coastal storm and erosion events, but also a deep (high level of) uncertainty regarding future issues of ongoing carbon emissions, sea level rise and the possible onset of polar ice sheet instabilities into next century.

[61] Internationally, managing disaster risk is now framed intentionally around *risk reduction* (that is, a risk-based approach), rather than the prevailing 'response and recovery' approach after each hazard event, as is seen currently in New Zealand. The United Nations Framework Convention on Climate Change (UNFCC) and the 2015 COP21 Paris Agreement, along with the IPCC Special Report (IPCC, 2012) take a wider view of how climate change interacts with current hazard risk that occurs outside so-called disaster events. As a result, there is now a distinct shift in scientific literature from forecasting impacts of climate change, towards a focus on managing its risks, and that requires planning for them.

[62] The Guidance Manual advises that climate change risk assessments in various forms have now become common place in adaptation planning globally, including at district, regional and national scales (for example, UK Climate Risk Assessment Report (2012); Parliamentary Commissioner for the Environment ('PCE') (2015);[28] Tonkin & Taylor (2016); Australian Department of Climate Change and Energy Efficiency (2011)).

Difficulties with current planning practices around risk management under RMA

[63] Difficulty with current practices for risk management in the context of conventional planning for local authorities require the acknowledgement that under the RMA:

[28] Parliamentary Commissioner for the Environment (2015). *Preparing New Zealand for Rising Seas: Certainty and Uncertainty*. The Commissioner provides two examples where adaptive management planning techniques have been applied (see Figure 1-2 Brisbane Airport situated on low-lying coastal land) and Figure 1-3 the Thames Barrier protects London from tidal and river floods) pp 12-13.

- There are limitations as to the future predictions science can currently make in the face of climate change as global emissions impact from ocean warming.

- Policies and plans and management choices defined early in the process make it practically difficult to change course when new information or problems are identified; consequently they can 'close off' provisions to manage events sustainably.

- Environmental assessments for resource consent decisions required early in the process as to whether to proceed with projects or not – called 'front loading' – can be seen as a critical weakness in managing coastal hazard risk and a real difficulty for local authorities;

- Competing time frames can be an issue in managing coastal hazards. RMA plans are valid for 10-20 years while resource consents are available for up to 35 years. With plans that do not recognise uncertainties, there is a risk of continuing to compound adverse impacts that have arisen earlier. LGA now requires that local authorities prepare infrastructure strategies for at least a period of 30 consecutive financial years, and includes resilience considerations in that preparation. Coastal hazard areas are expected under NZCPS to be assessed over at least 100 years.[29]

- Section 5(2) RMA requires sustainable management to account for the needs of future generations into 'the foreseeable future'. This means authorities must take into account the interests of future communities and the direct and indirect costs arising in defining and managing coastal hazard risk and climate change over that period.

- The need to replace, modify, protect or remove buildings and infrastructure in vulnerable coastal areas makes such issues a major (different) responsibility for local authorities.

- Generic planning rules also require specific hazard zones so selection of the appropriate likelihood of effects and lengthier time frames might be required.

- Science and planning can collide with property rights and emergency events; the first can throw up financial liability concerns for councils while with the

[29] NZCPS Policy 24(1) p 23.

latter there is little time to engage with wider communities into considering long term implications.

- Waiting for uncertainties to be resolved before making decisions or making them at all in the face of uncertain conditions, is not viable or acceptable to those most exposed to risk, nor for future generations – implicit under s 5(2)(a) RMA.

- The interrelationship between BA and the RMA creates a number of tensions that are difficult to resolve – and require resolving if integrated management of risk is to be successful.[30]

- Some of the relevant legislation creates conflicts of interest between local authorities themselves.

Is the risk-based approach to coastal hazard management consistent with the requirements of the NZCPS?

[64] The NZCPS is a national (mandatory) policy statement provided for in the RMA 1991. The Guidance Manual identifies the NZCPS as providing the 'dominant guidance for coastal management in New Zealand'. As such, it interacts with issues extant through its various provisions with local authorities' planning roles in managing coastal hazards.

[65] The requirements of the NZCPS statutory policy framework on climate change and coastal hazard risk extends through into all planning and decision-making under the RMA, to form a basis within which adaptation to climate change and coastal hazard risk in the coastal environment can begin to be advanced by communities and their local governments. A direction is given as from 'the time of gazettal of the statement' that the RMA's requirements of the NZCPS relate to.

[66] In terms of specific policies in the NZCPS that local authorities are required to address, Policy 24(1)(a)-(h) **Identification of coastal hazards** requires a technical identification of coastal hazard risk through a scientific coastal adviser. It is Step 2 in the 10 step Decision Cycle graph embedded in the Guidance Manual. It identifies the need for a hazards and a SLR assessment for areas of high risk over at least 100

[30] See Appendices, Appendix A Box 4.3.

years, taking into account this national guidance and the best available information on the likely effects of climate change on the region or district.

[67] Policy 25 **Subdivision, use and development in areas of coastal hazard risk** sets out the framework for policy development and decisions by local authorities when areas affected by coastal hazards have been identified in terms of Policy 24(1). Policy 25 contains (inter alia) strong directives:

- to avoid changes in land use or reclamation that would increase adverse effects from increased risk of coastal hazards;
- to avoid increasing the risk from coastal hazards in social environment and/or economic terms;
- to encourage infrastructure to be located away from hazard risk where practicable;
- to encourage changes in land use that would reduce risk of adverse effects from coastal hazards including measures to build resilience …
- to discourage land protection structures and promote alternatives.

[68] Where existing development and assets are involved, Policy 27 **Strategies for protecting significant existing development from coastal hazard risk** outlines strategies for developing options to reduce coastal hazard risks, including 'identifying and planning for transition mechanisms and time frames for moving to more sustainable approaches'. For existing (legacy) development, consequences can be established through risk and vulnerability assessments, but where likelihood (for example, time frames to reach risk triggers or thresholds) is a component, the dynamic adaptive pathways planning approach of adaptive management identifies the conditions under which policies and measures fail to reach the objectives of the adaptive plan. Policy 27 also identifies the key issues around land protection structures and how to address them in the context of a changing risk environment.

[69] Policy 7 (1)(b) **Strategic planning** requires local authorities to identify areas where forms of subdivision, use and development are inappropriate or may be inappropriate. As climate change impacts on coastal ecosystems, human systems as well as coastal physical processes, Policy 7(2), relating to significant threats and risks, also has climate change dimension.

[70] Objective 5 **Pursuing coastal hazard risks taking account of climate change** requires that in the case of new development (for example, greenfields) there is a statutory imperative to *ensure* such development is located away from areas prone to coastal hazard risk including the effects of climate change.

[71] Policy 3 **Precautionary approach** is identified as requiring a precautionary approach towards activities where their effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse. Coastal resources potentially vulnerable to the effects of climate change are particularly emphasised as requiring a precautionary approach so that:

- avoidable social and economic loss and harm does not occur;
- natural adjustments of the natural environment can occur; and
- natural character, public access, amenity and other coastal values meet the needs of future generations.

[72] A risk-based perspective in managing climate change effects may justify a proactive and precautionary response to potential climate change effects even if those effects are of low probability but would have a high potential impact (s 3(f) RMA) such as the effects of infrequent but devastating storms in eroding locations. It is *not* to be applied to technical assessments under Policy 24(1).

[73] **Objectives 1, 2, 4** and **5** and **Policies 13, 14, 15, 18, 19** and **26** are also referred to as relevant to the decision in terms of natural character and natural coastal defences.

Policies 24, 25, 27

[74] There are two issues arising out of Policies 24, 25 and 27. They revolve around the word 'likely' in Policy 24(1)(a)-(h) and Policy 27(1), and the word 'risk' as defined in Policy 25(a). Policy 24 is set out here in full:

> **Policy 24 Identification of coastal hazards**
>
> (1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:
>
> (a) physical drivers and processes that cause coastal change including sea level rise;

(b) short-term and long-term natural dynamic fluctuations of erosion and accretion;

(c) geomorphological character;

(d) the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;

(e) cumulative effects of sea level rise, storm surge and wave height under storm conditions;

(f) influences that humans had or are having on the coast;

(g) the extent and permanence of built development; and

(h) the effects of climate change on:

(i) matters (a) to (g) above;

(ii) storm frequency, intensity and surges; and

(iii) coastal sediment dynamics;

taking into account national guidance and the best available information on the *likely* effects of climate change on the region or district. [My emphasis]

The term 'likely'

[75] When addressing the generic hazard risks under Policy 24(1), climate change requires assessments of its effects on *all* matters identified in Policy 24(1)(a)-(g) above, as well as its more specific effects on storm frequency, intensity and surges, and coastal sediment dynamics *taking into account national guidance and best available information on the 'likely' effects of climate change on the region or district* [my emphasis].

[76] This is the first problem inherent in risk management under the NZCPS. In terms of the formal IPCC likelihood statements and their statistical interpretation in IPCC AR5 documents,[31] the term 'likely' pertains to 66-100% probability. But probability cannot be formally quantified around:

- how 'high' may be a coastal hazard area with differing hazard heights;
- trends and projections of future changes in associated coastal/ocean drivers such as wind, waves and wind surges are not clear and consistent;

[31] See Reisinger and Lawrence Note 16 citing Mastrandrea et al (2010) who formally assigned the term 'likely' to ordinary expressions of 'likelihood', writing them in italics so it is intended to be read in a formal way p 11.

- trends are likely to exhibit local and regional variations;
- trends in wave heights, storm surge and winds projected for New Zealand are relatively not as clear and consistent as for SLR;
- the current trends are relatively modest and inconsistent.[32]

[77] Policy 27(1) provides for strategies for protecting significant existing development 'likely' to be affected by coastal hazards requires comment too. Societal changes will concurrently alter the *consequences* of those climate changes in both exposure and sensitivity'. Changes in climate are mostly outside New Zealand's control, but changes in sensitivity and exposure are not, for the core focus of the RMA is on avoiding, remedying and mitigating negative effects.[33]

Sea level rise in Policy 24

[78] The *likelihood* component of conventional risk assessments and management is particularly difficult to quantify for coastal areas, and in the context of ongoing sea level rise identified in Policy 24(1)(a)(e), with widening uncertainty bounds in time. Current scientific and socio-economic studies cannot calculate with accuracy the probability of any particular sea level occurring in any given time frame.

[79] In respect of sea level rise, *likelihood* is more informatively couched in terms of bracketed time windows (using scenarios as seen in the IPCC AR5[34]) when sea level emerges above a specific local threshold (RCP2.6-RCP8.5) related to the trigger event identifying more frequent harm and disruption.

[80] Therefore, when assessing the risk associated with SLR in risk assessments, the most important component to focus on is the assessment and evaluation of *consequences* as exemplified in guidelines by the City and County of San Francisco City 2015 and the California Coastal Commission 2015.[35]

[81] Two experts in climate change have recently identified that if climate scientists are fairly confident that their dates and models are sufficient to allow a *quantitative* assessment of coastal hazard risk and climate change information and how they

[32] Guidance Manual pp 113-115.
[33] Reisinger and Lawrence (2016).
[34] Church et al (2013). Climate Change 2013: the Physical Science Basis Contribution of Working Group 1 to Fifth Assessment Report of Intergovernmental Panel on Climate Change, Cambridge University Press. Cited IPCC Chapter 13 Sea Level Change pp 1180-1181.
[35] California Coastal Commission (2015 Sea level rise policy.

will behave in the real world, then *expert* opinions will be an *absolutely necessary* component (sometimes hidden and non-transparent) of any assessment of '*likelihood'.* That is why the assessment of the technical matters under Policy 24(1)(a)-(h) should remain with the experts (albeit set within the scene identified by the local authorities, communities, stakeholders and iwi in Step 1 of the 10 step Decision Cycle).[36]

[82] For coastal hazard events that are more certain, a probability can be determined as currently used in risk assessments (for example, 1% annual exceedance probability ('AEP')), along with allowances for any sensitivity of those hazards to climate change, but *before combining with sea level rise.*

Definition of risk

[83] One of the other problems arising under Policy 25 is implicit in the definition of 'risk' which is identified under that policy. The International Standard Risk Management – Principles and Guidelines (AS/NZS, ISO31000:2009),[37] is defined in the Glossary as expressed in terms of a consideration of the consequences of an event including changes in circumstances and associated likelihood of occurrences.[38] It is said to provide a consistent, globally-accepted framework for undertaking risk assessments and the subsequent management of identified risks derived from any type of human or natural hazard exposure in identifying 'risk' is often expressed in terms of a continuation of the consequences of an event (including a change in circumstances) and the likelihood of occurrences.

[84] But this 'high-level' definition of risk is the 'effect of uncertainty on objectives'. 'Effect' here is defined as a deviation from the expected (negative or positive) and alludes to a range of 'objectives' such as financial, health and safety, resilience and environmental goals that can be applied at different scales, and through different processes, such as strategic, regional, organisational, or project levels. So this definition of risk encompasses understanding and addressing the effects of considerable *uncertainty* on future objectives *and* values for coastal areas.

[85] In practice, risk is assessed 'risk = likelihood x consequence' by combining the probability of an impact occurring (or *likelihood*) with the *consequence* of the

[36] Note 16 Reisinger and Lawrence (2016) p 11.
[37] NZCPS Glossary p 27.
[38] See NZCPS AS/NZS ISO31000:2009 *Risk management – principles and guidelines* November 2009 Glossary p 28.

impacts - with consequences here relating to the vulnerability of the exposure to communities and people. For the focus of managing the risks requires recognition that climate-related risks arise from the confluence of three distinct drivers of risk – climate-related hazards, the exposure of humans to those hazards, and their sensitivity or vulnerability.[39]

The new paradigm: adaptive management in planning for coastal hazard risk

[86] Adaptive management frameworks can be used to assess the risk consequence implications for a range of future sea level rise and climate change circumstances (scenarios), identifying the circumstances and time frames in which unacceptable levels of risk may be reached, and expressing those circumstances as decision points where and when a new pathway is needed. Through long-term monitoring, including the sea level rise and frequency of hazard events that transpire, the likely time frame for switching to the next adaptation measure can be reappraised and updated.[40]

[87] The process supports also the retention of the planning provisions of the statute regarding plans, objectives, policies, rules and other methods such as spatial/growth planning and regional strategies (such as those to do with natural hazards). It introduces special-purpose area plans, single purpose and place-based issues. (For natural hazard planning these can be undertaken through LGA, RMA or CDEM – with risk reduction - mandates).

[88] Local government's role includes an overview around the expectations and responsibilities that local government managers and staff are required to have in the context of adapting to climate change and adaptive pathways in a planning context.[41] Adaptive management planning for coastal risk provides for informed planning exercises now carried out within the LGA framework to assist framing the statutory RMA process. Box 1.1 **Skills, descriptions, knowledge sets to consider in an adaptation team** identifies key considerations to ask in this process. A set of preparatory tasks at the formative stage of setting the context and preparation for coastal adaptation projects follows.

[39] Note 16 Reisinger and Lawrence (2016) p 7.
[40] Guidance Manual, p 21.
[41] Guidance Manual p 23. Modified from the Irish Authority Local Adaptation Strategy Development Guideline: Gray 2016.

[89] In practical terms, the Guidance Manual Chapter 10 Figure 10.5 **Relationships for coastal hazard management under the RMA Policy and Plans**, provides the detail of the hierarchical suite of empowering tools for risk management beginning with RMA and NZCPS, Regional Policy Statement ('RPS'), Regional Coastal Plan ('RCP') and regional and district plans. Alongside the descriptions, details of the powers and functions of the relevant activities, their relationships and outcomes are also identified.

[90] Then follows an overview of how this type of risk planning may be addressed within an adaptive planning context. Beginning with regional plans (the most appropriate level for hazard identification and high-level risk screening) the discussion follows through the risk identification and management process by the local authorities to the involvement of communities, iwi and stakeholders, the allocation of hazard management responsibilities of the communities and stakeholders aligning with all the requirements of the 10 step Decision Cycle. It is effectively a blueprint for aligning the current legal processes for risk management within the decision cycle in what are effectively adaptive management strategies.

[91] Adaptive pathways have long time frames which transcend normal local government and RMA cycles. However, the pathways may be embedded in policy at regional or district level and/or in regional and district plans and passed on into future plans through review processes if still relevant. Already the RMA and NZCPS require that local authorities take a long-term view in planning, so the concept is not new or unusual.

[92] Figure 1-1 **10 Step Decision Cycle** provides a simple illustration of the long-term integrated planning and decision-making framework within which local government and communities can operate in relation to managing coastal hazard risk and climate change adaptation. As can be seen from the 10 step Decision Cycle graphic, the process is essentially cyclic, with opportunities for iterative revision processes over time. New information, the findings of monitoring, or social, economic or cultural change may initiate review and changes in management over time.

[93] This adaptive management approach to coastal change is thus possible within current legislation and practice.

[94] Figure A-1 of Appendix 1 is most helpful in illustrating the interconnection between statutes, national policy and regional policy statements, together with district plans

and various information memoranda. It is a visual checklist for how council practitioners proceed through what could be considered a maze of information.[42]

[95] The Guidance Manual also identifies where the magnitude and rate of SLR is uncertain, concepts of decision-making along adaptive pathways are now being used internationally to plan for adaptation with various scenarios used as markers in time.

[96] Minimum transitional SLR values are provided for use in planning processes for three broad categories of development based on RCP2.6, RCP4.5 and RCP8.5. Figure 5-14 identifies minimal transitional New Zealand-wide SLR values for use where a single value is required at a local/district scale while in transition towards adaptive planning using the New Zealand-wide SLR scenarios. The figure illustrates the minimum transitional values for Categories B and C (two values generally tied to the next 100 years). [43]

[97] In the 2008 MfE guidance, a risk-based appraisal for a particular application was recommended, selecting an appropriate single 1 m SLR value (above a minimum) to the 2090s, rather than carrying forward a range of scenarios into hazard and risk assessments and evaluating adaptation options. NZCPS Policy 24(1) requires the identification of areas 'potentially affected' by coastal hazards, and climate change (also in Policy 25), giving priority to areas at 'high risk of being affected'. Policy 27 focuses on existing effects or impacts (Department of Conservation, 2016) rather than selecting the 'most likely' sea level rise scenario, then applying that to hazard and risk assessments.

[98] The Guidance Manual recommends categories of activities for which a specific minimum transitional SLR value should apply, to provide more clarity. While a timeframe of 2120 is applied to the minimum SLR values for Categories B and C (Figure 5-14),[44] it does not necessarily mean that implementation of the plans/policies, adaptation plan or infrastructure retrofit projects using that SLR value has to be undertaken completely now; implementation can be staged or occur through a pathways approach. Again, this highlights the requirement to move

[42] Figure A-1 Appendix 1 p 6 is followed by the relevant statutes and national policy statements.
[43] To accommodate the over 100 year time frame identified for hazard assessments in NZCPS Policy 24(1).
[44] Minimum transitional SLR values: **Category B:** Land-use planning controls for *existing* coastal development and asset planning. Use of single values at local/district scale transitional until dynamic adaptive pathway planning is undertaken. **Category C:** Non-habitable short-lived assets with a functional need to be at the coast, and either low-consequences or readily adaptable (including services).

beyond transitional SLR values and to undertake dynamic adaptive pathways planning that incorporates scenarios that span a range of futures.

[99] The example of Mapua/Ruby Bay (Box 2.3) provides a case study of current good practice, retaining options for future decision-making in terms of an area which has been identified as being or high risk adversely affected by coastal processes, including the effects of climate change. (Mention is made in Question iv below of other New Zealand examples.)

[100] Details of the adaptive iterative planning strategy (as an example) are also developed using the DAPP approach and may be incorporated into a district or regional plan through an appendix or schedule where it can provide context and guidance for planners and be reviewed at the time of plan review.[45]

[101] In the context of adaptive management, the Guidance Manual provides a careful analysis and brings full circle risk management planning issues identified throughout the document. It provides many of the answers to some of the problems experienced with day-to-day planning detailed above.

[102] Further, to counter many of these objections to current risk planning under the RMA, the Guidance Manual provides Table 10-1 Types of plan and planning processes available to local government in managing coastal hazard risks. It is a thoughtful and welcome addition of 10 pages that assists in avoiding some of the difficulties in the way of authorities advancing coastal hazard risk adaptation and management in what is stated above about the RMA.

[103] The dynamic adaptive pathway planning approach identified in this document interactively embeds the 'likelihood' or emergence aspect, where the time to reach pre-agreed decision or trigger points can be adjusted through regular monitoring and reviews as climate change effects unfold. This is seen an appropriate way of addressing future coastal vulnerability and risk management in an adaptive manner, which will enable uncertainties to be worked around, rather than adapting now for a pre-determined future by selecting a 'best' or 'likely' estimate.

[104] Adaptive pathways planning is risk-based and addresses the 'effects of climate change'. Its implementation requires flexible planning measures such as the ability to change plans and consent conditions in ways that signal future change (prohibited activities and subdivisions, and temporary development or land use

[45] See Question iv.

consents); or redundancy of infrastructure (stormwater design currently embodies such concepts) where over trigger flow capacities overland flow is used for egress of water), for example. Measures used currently by councils, such as floor heights and relocatable buildings, rely upon a fixed level however, and activities designed in this way will be locked in as change occurs, unless there is land to which the houses can be readily relocated.[46]

Conclusion

[105] The Guidance Manual identifies a risk-based approach to coastal management through the provisions of the RMA and related statutes. Through its analysis of the adaptive management strategies that approach can be utilised. A process has begun which effectively embeds the RMA and other planning statutes in the evolving principles of adaptive management. It is a significant direction to take.

[46] Note 16 Reisinger and Lawrence (2016) pp 18-19.

Is it appropriate to recommend using a high level scenario of sea level rise to stress test adaptive pathways, policies or major new development? [Question iii]

What is the issue?

[106] IPCC AR5 bases projections of global temperature rise and SLR on simulations of various global climate-ocean modelling groups use the four RCPs (RCP2.6, RCP4.5, RCP6.0, RCP8.5) as the input radiative forcing transients representing different pathways of human development.

[107] IPCC AR5 predicted up to a metre of SLR by 2100 for the upper end of the 'likely' range of the representative concentration pathways ('RCPs') RCP8.5. This did not include any significant contribution from Antarctica. Recent journal publications indicate however, that instabilities and the onset of the Antarctic ice sheets particularly West Antarctica, are more vulnerable to a warming climate than was envisaged when developing the IPCC AR5 RCPs.[47]

[108] There is thus ongoing debate whether SLR will still be within the 'likely' range (two-thirds probability)[48] of the IPCC AR5 projections. More recent studies on Antarctica indicate a wider upper spread in SLR projections from ice sheets than the IPCC AR5 range with SLR reaching *above* 1 metre beyond 2100 for higher emission scenarios.

[109] Overall, considerable (deep) uncertainty remains in the timing and extent of the critical contribution to SLR from polar ice sheets and the resulting degree of instability in the region. But what is becoming clearer from these studies is the emergence of a more skewed tail distribution (toward the upper range of possibilities) of the application of single SLR projections beyond 2100. This is primarily driven by the ice sheet contributions where the complex processes and feedback mechanisms that cause sea level rise are not completely understood. Also, thresholds or instabilities that could result in irreversible or runaway reductions in ice sheet values for the different RCPs lead to deep uncertainty at the upper end projections.[49]

[110] Inclusion of uncertainties in climate and sea level projections have taken the scientific community outside of the zone of what can be predicted using process-

[47] Guidance Manual p 111. Figure 5.15 illustrates a schematic demonstrating a generalised observational SLR probability distribution and a generic hazard and consequence curve as a function of SLR. The risk within a planning time frame (multiplying likelihood and consequence) peaks at a higher SLR than 'most likely' SLR.
[48] See Appendices.
[49] Kopp et al (2014); Slangen et al (2016b).

based and semi-empirical models. The adaptive pathways planning approach and stress testing of plans and major new infrastructure is designed to work around the deep uncertainty emerging.[50]

[111] In responding to questions whether or not the IPCC WS1 took a moderate line on the RCP8.5 scenario,[51] Church et al pointed out that AR5 provided 0.52-0.98 m by 2100. In the calibrated 'uncertainty language' attributed to RCPs this likelihood means that there is roughly a one-third probability that SLR by 2100 may be outside the 'likely' range. That is, AR5 did not exclude the possibility of higher or lower sea levels. But if they were substantially higher, then the 'likely' range would only occur in the 21st century if sections of the Antarctic ice sheet below sea level were to collapse. That team considered even so (with medium confidence) that the additional contribution would only exceed tenths of a metre SLR during the 21st century. (DeConto and Pollard (2016) determined projections at the upper end and even beyond the several tenths of a metre (decimetres) IPCC AR5.[52])

[112] Previously, regional and unitary plans have adopted values of 0.7 m and at least 1.0 m SLR rise extended out by 20 years to 2115 by applying a 10 mm rate as outlined in *Pathways to Change.*[53] But now taking a larger view to satisfy the minimum NZCRS 2010 time frame, of over 100 years to 2120, and using more recent research with potentially significant polar ice sheet contributions in the frame, scientists have begun a re-focus toward adaptation and on developing and testing plans and evaluating projects on the basis of a number of scenarios to cover the widening range of plausible SLR in the future. Given the widening range of possible coastal futures, the Guidance Manual provides more flexibility in developing adaptation plans rather than reliance on a single SLR value or scenario. This is in line with international practice now in the US and UK.[54]

[113] As stated, identified in Question ii above, part of the problem also lies in the fact that 'risk' is often identified as Risk = Likelihood – Consequence. This means that 'likely' projections as identified in the RCP2.6 to RCP8.5 scenarios can no longer be a qualifying agent. Normally a quantified expression of uncertainty such as 'likely' is only possible if scientists are fairly confident that their data and models actually reflect the real world. This is not the case past 2100. Up until then, the IPCC

[50] Appendices, Appendix D Emergence of polar ice sheet instabilities D.6 p 59.
[51] Church et al. *Science* Vol 342 20 December 2013, p 1445.
[52] Church et al (2016).
[53] The IPCC considers New Zealand regional SLR may project up to 10% more than the global SLR.
[54] Guidance Manual p 101.

concluded that in a high carbon world global mean sea level would likely rise by 0.53 to 0.97 m by 2100. [55]

[114] The inability to reliably assign an overall 'likelihood' distribution for global SLR in a given planning time (irrespective of the RCPs) is recognised in international guidance with San Francisco SLR Guidance recommending focusing on the consequences of each SLR scenario being assessed *before* prioritising adaptation plans or asset design. (In any case, SLRs of up to around 1.0 m are virtually certain over a planning time frame out to the next 100-130 years – with just a matter of when that takes place for a specific SLR.)

Why a new approach?

[115] With the main constraint as the inability to attribute specific likelihoods to each set of RCPs if that occurs, the issue becomes *how* implementation of emission mitigation policies, land use and planning, socio-economic factors and technologies will evolve over at least 100 years as specified inn NZCPS Policy 24(1), as well as the characterisation of physical processes and feedback in models.

[116] As is pointed out, the goal of working with climate change scenarios is not to predict or forecast the future but to better understand how the future might unfold under a consistent set of assumptions and associated uncertainties in order to reach decisions that are robust under a wide range of possibilities. [56]

[117] However, the state of the climate in a future period depends not only on the pathway of human development (for example, described by an RCP and supporting shared socio-economic pathways (SSPs)) but also the response of the climate system (and its various components) to the forcing from that pathway and natural climate variability (global and regional).

[118] Therefore, use of individual RCPs as input to climate-ocean-ice models does not mean projections should converge towards a single sea level or temperature projection trajectory for that RCP. If emissions are higher than RCP2.6 the shift of individual sea level projections would lead to more skewed tail distribution that is primarily driven by ice shelf calculations.[57]

[55] Guidance Manual p 179. Guidelines produced by City and County of San Francisco.
[56] Reisinger and Lawrence (2016) p 8.
[57] Guidance Manual p 101. Kopp et al (2014); Slangen et al (2016b).

[119] Rather, projections should encompass a range of possible outcomes for each RCP, with variability arising from use of different types of models and processes including initial start-up conditions, a range of possible response mechanisms and 'a' logs, that is, deep ocean glacier and ice sheet response to ongoing warming as well as climate variability.

[120] Percentiles are used to quantify the distribution of the various projections for each RCP scenario (as in the IPCC AR5 projections to 2100) with the *median* (50-percentile) plotted as the main curve with a range defined between specified lower and upper percentile bands.

[121] Percentile distributions, including the median, for projections of SLR for *each RCP scenario* are available, arising from the many combinations of various contributors to SLR, climate variability and inter-model variations for the given RCP. So while a 'likelihood' is not able to be assigned to particular SLR values, the percentile ranges, within each RCP scenario *set*, are useful inputs to adaptation planning and vulnerability or risk assessments, to test policy, planning, or engineering design options including their sensitivity to sea level rise and associated coastal hazards.[58]

What is a high level scenario? Recent SLR projections: Kopp et al (2014)

[122] Pushing projections out to the longer time frame requires developing and testing plans and testing proposals on the basis of a *range* of scenarios to cover the widening range of possible sea level futures.

[123] Using the Probabilistic (Monte Carlo) simulation technique (as opposed to the process-based model of the IPCC AR5) to sample many thousands of times probability distributions for each contributing component to SLR,[59] Kopp et al (2014) produced projections for three RCPs, namely RCP8.5, RCP4.5 and RCP2.6, out to 2200.[60] This approach enabled different percentile ranges (rather than just the 'likely' range used by IPCC AR5) to quantify the spread of possible SLR with each RCP set. The projection out to 2100 using this method indicated a 'likely' range SLR will be 0.62-1.0 m by 2100 - similar to that of IPCC AR5, thus demonstrating a greater level of agreement between the parties. From this, Kopp et al (2016) then

[58] Guidance Manual p 100.
[59] Guidance Manual: see extended definition of that technique and definition of the process based model used in IPCC AR5 p 94.
[60] Excluding RCP6.0 as there is little difference between that and RCP4.6 (as shown in Figure 5-10 in the Guidance Manual).

assessed projections out to 2150 (a 135 year time frame) which were adopted for stress testing plans, policies and greenfield situations characterised as RCP8.5 H^{++}.

[124] New Zealand has now developed four scenarios to cover a range of possible futures, created by the uncertainties around SLR and the Antarctic ice sheets:

- a low to net-zero emission median scenario (RCP2.6);
- an intermediate-low scenario based on the RCP4.5 median projections;
- a high-emissions scenario based on the RCP8.5 median projections;
- a slightly higher H^{+} scenario based on the RCP8.5 (83rd percentile) projections based on Kopp et al (2014).

[125] All scenarios include a small SLR offset from the global mean SLR for the regional seas around New Zealand.[61]

[126] Using the base set of global SLR projections, it is proposed that two sets of SLR projections for RCP 2.6, RCP4.5, and RCP8.5 median trajectory projections and RCP8.5 (83rd percentile) scenario[62] extended to 2120 to align within the amended planning time frame of over 100 years. An additional upper (83rd percentile) RCP8.5 H^{+} projection is added based on the RCP8.5 (83rd percentile) projection from Kopp et al to the suite of scenarios to reflect a world where surprises of a higher rate of SLR occur (for example, a faster polar ice sheet melt may be expressed beyond 2100). This scenario is at the upper end of the likely range (that is, 83rd percentile) of a suite of RCP8.5 projections. Such a scenario would be to stress test adaptive pathways and the timing of decision trigger points, as well as plans, policies and greenfield situations.

[127] The Guidance Manual identifies that:

- NZCPS (Objective 5, Policy 25) treats greenfield development (redevelopment, land intensification or change in land use) differently from existing

[61] Guidance Manual p 107.

[62] The IPCC provided an 'uncertainty' range for each RCP scenario that covered the middle 66% 'likely' range from the 17th to 83rd percentile, that is, there was a 33% chance SLR could be outside the 'likely' range as set out above. There is no guidance available from the peer reviewed literature on the ***overall*** likelihood distribution for SLR within a given time frame viability to attribute specific likelihoods to each set of RCPs while in the near term (by 2050) the projected global mean SLR for all the projected SLR ranges from IPCC is relatively tight 0.2-0.4 m.

development, with an emphasis on locating such development away from areas prone to coastal hazard risks (including climate change) and avoid increasing the risk. Therefore, given the anticipated long life of new development or intensification under Category A projects,[63] combined with sea level continuing to rise for several centuries, it is recommended that such developments are tested against a SLR of 1.9 m.

- This value is derived from the RCP8.5 H+ scenario, which indicates that this SLR could be reached by 2150 (Figure 5-13), or later for lower SLR scenarios. It is also just above the long-term commitment to 1.6-1.7 m SLR already embedded by emissions that have occurred to date. The 1.9 m SLR should also be applied to assessing the effects of any proposed intensification of existing developed areas at the coast. As shown in Table 5-4, a 1.9 m SLR could occur next century (from 2150 onwards), depending on the global emission trajectory and polar ice sheet response. It also covers the higher uncertainties posed by the polar sheet responses and limited understanding of the new linear processes, particularly in the lower half of the century.

- While it is difficult to apply land use planning processes for existing development to avoid or mitigate tsunami effects (NZCPS Policy 25(f)) there is the opportunity to incorporate planning elements when assessing climate change effects for new development in greenfields or intensification in coastal areas, which may reduce some of the future consequences from moderate-large tsunami events. Therefore, use of a SLR of 1.9 m for Category A developments at the coast can implicitly reduce future tsunami risk.

- Note: For above-ground new infrastructure at the coast, this does not imply that it be built now to the final level (incorporating a 1.9 m SLR), but can often be staged progressively towards that target SLR, provided foundations, ground treatment or other critical design features have been adequately enhanced to cope with future stages or retrofitting. Alternatively, dynamic adaptive pathways planning should be undertaken (Chapters 9-10), setting out triggers for switching to the next pathway or stage.

[63] Category A projects relate to coastal greenfield developments and change in land use, major new infrastructure (that is have potential to be staged to this level. See Figure 5-8 Minimum transitional NZ-wide SLR for use in planning instruments where a single value is required at a local/district scale while in transition toward adaptive planning using the NZ-wide SLR scenario.

[128] Use of a small number of scenarios such as those above is advised in the international practice for SLR guidance for planning and infrastructure design in the USA, UK and the Netherlands to avoid estimates of SLR impacts as being invalidated as new sea level projections become available.

[129] The Guidance Manual also identifies bracketed time frames to reach a specific increment of sea level rise, from the earliest to the latest time across the RCP2.6, RCP4.5, RCP8.5 and H+ scenarios are provided to assist with the timing of decision points in the dynamic adaptive pathway planning process, where particular SLR triggers or associated thresholds for frequency of inundation events have been established based on vulnerability and risk assessments.

[130] In this context it is important to distinguish also between global mean sea level projections and relative SLR for New Zealand (that is, taking account of the small increase from the 2-4 year interdecal Pacific Oscillations rather than using a single yearly and El Nino/Southern Oscillation projections[64] while also factoring the SLR component for vertical land movements or otherwise (for example, the recent Kaikoura earthquake).

Stress testing

[131] 'Stress testing' is to check performance over a full range of plausible future SLR and coastal hazard scenarios rather than reliance on a single SLR value or scenario.[65] The Guidance Manual advises stress testing policy options, land use plans for new development *and* major new infrastructure projects (emphasis)[66].

[132] RCP8.5 H^+ is primarily for the purposes of stress testing adaptation plans where tolerance is low and/or future adaptation options are limited and for setting a SLR for greenfield development, or as seen above, where the foreseeable risk is to be avoided (NZCPS Objective 5 and NZCPS Policy 25(a)-(b)). This latter approach is used in the UK, where an extreme H^{++} scenario was included for stress testing

[64] The El Niño Southern Oscillation can raise or lower the level of the sea around New Zealand by as much as 12 cm. The interdecadal Pacific Oscillation can raise or lower the level of the sea by as much as 5 cm (NIWA, 2015b, p 31).
[65] Guidance Manual p 104: see note 75.
[66] 'Low' here says that while the best we can say that at this stage is that tropical cyclones will become more intense but possibly reduce in number, we don't feel that this evidence is very robust as there are very few long term data sets and known shortcomings in models. In other words, new findings may well change this observation. P 93.

adaptation plans and major coastal infrastructure (Lowe et al, 2009; Nicholls et al, 2011).

[133] The Guidance Manual identifies that it is important to note the possibly considerable lead time that will be required to meet the plan for the upper range value of 1.9 m the year achieved for the RCP8.5 H^{+}.

[134] Importantly, it is stated that hazard assessments, risk/vulnerability assessments and comprehensive adaptation plans (Chapters 6, 8 and 9) will need to use these SLR scenarios in assessments, determining decision points for particularly to stress test adaptive pathways, policies or new development.

[135] Such higher-end scenarios are used in the USA (US Army Corps, 2014; National Research Council, 2012; US Department of Transportation, 2014) and UK (Lowe et al, 2009) to provide checks on planning for long-lived or critical infrastructure (e.g. Thames River barge in London) or where the risk tolerance is low or the future options for adaptation are quite limited. It also informs the decisions around avoiding risk for new developments or coastal areas where intensification of existing development is inadvisable.

[136] For all these reasons I consider that adaptive pathways, policies *and* major new developments require stress testing in the manner described.

Adaptive management

[137] In terms of coastal planning adaptive management, the use of RCPs:

- is not the singular most probable condition approach;
- allows for the purposes of stress testing adaptation plans where risk tolerance is low and/or future options are limited;
- is a selection of multi scenario alternatives integrating coastal hazards and SLR uncertainty into decision-making;
- allows an examination of extreme events for project alternatives using adaptive pathway planning to meet objectives;
- allows use of a small number of scenarios in line to trigger scenarios with best international practice for planning and infrastructure design both in the United States, the UK and the Netherlands;

- indicates no one particular or most likely climate future can be determined because of the different types of uncertainty (global emissions and polar ice sheets);

- indicates that there can be no presumption that SLR will follow any one of the scenarios;

- allows risk analysis/vulnerability assessments to determine how different scenarios will affect risk, levels of service, maintenance and viability of the community to be made before making decisions within the adaptive management framework;

- a range of pathways which can be valuated to meet objectives which can be implemented at a number of trigger points;

- allows for setting a SLR for greenfield developments where foreseeable future is avoided.

[138] Adaptive pathways planning approaches applied at local scales, which may be significantly exposed to a low SLR trigger, will invariably take time to develop for communities. Therefore transitional minimum sea level rise values are also provided for general guidance, covering three broad categories of activity:

- greenfields developments (and intensification);

- existing exposed development; and

- low-risk non-inhabitable works/activities, particularly those with a functional need to be near the coast.

[139] Use of these single values should be transitional, with the adaptive pathways planning approach providing a more adaptive framework at local and regional/district scales that can accommodate surprises either way.[67]

Conclusion

[140] The question provided is whether an upper end scenario should be used to stress test adaptive pathways, policies or major new development.

[67] Guidance Manual p 3.

[141] The Guidance Manual does not provide the alternative 'or' for major development – it provides the conjunctive 'and'.

[142] Major developments such as coastal infrastructure, greenfield developments, major infrastructure redevelopments such as aerodromes at sea level such as Wellington and Auckland, and ports at Auckland, Tauranga and Dunedin should, on all the evidence presented here, be stress tested.

[143] Meanwhile, adaptive planning strategy and implementation provides some of the answers that can be identified for the criteria to engage in such an approach:

- Is the reasonable foreseeable future of over 100 years in issue?
- Can policies be embedded in the statutory planning framework that provide sufficient certainty over time with a long-term planning approach to –

  - enable alternative pathways to be developed

  - trigger and decision points signalled when a new pathway is required.

[144] Table 10.2 of the Guidance Manual provides specific planning methods and techniques to make it possible.

Conclusion

[145] The conclusion here is that not only should major new developments be stress tested but also adaptive pathways and policies which would be an integral part of the adaptive management process.

Recognising that practice is developing rapidly and that MfE will assess the validity of the Guidance regularly, does the new material on community engagement and adaptive planning represent current good practice? [Question iv]

Community engagement: does the new material represent current good practice?[68]

What is community or stakeholder?

[146] Step 1 in the 10 step Decision Cycle begins by asking: what is community and who are the stakeholders? Working on the principle that more is less, 'who' includes the local community consisting of those who live in the coastal location while the stakeholders may have an interest in both the local and the wider area (stakeholders are identified in categories such as beachfront holders, business and infrastructure providers).

[147] Iwi/hapū and whanau who either live on the coast or elsewhere and have partnership interests in the Treaty are given special mention, as are local interested parties from government, or in some cases, NGOs who represent future generations (they will inherit the current decisions on coastal management or adaptation). Identification of these groups may have to occur at both a national and local level.[69]

[148] A series of extensive questions is provided to underpin the different methods to identify stakeholders and the spatial boundaries of the participants for this process.[70]

[149] This is subsequently expanded with issues that relate to the current social context of affected areas.[71] To understand what is meant by 'social context', questions are provided which underpin the different methods to understand the current social environment such as:

- What are the historical experiences of coastal hazard and climate change impacts?

[68] The question begs the question what is good practice? Ramsay et al (2012) appear to address the issue in 'Defining coastal zones for setback: a guide for good practice', 1.1 Purpose of the guide.
[69] Chapter 3 Figure 3-1.
[70] Table 3-1.
[71] Table 3-2.

- What are the existing levels of conflict, debate or argument around coastal climate change adaptation?

- What existing pressures does the community face?

Why engage?

[150] It is recognised that adaptation to ongoing climate change and SLR require the widest participation from all sectors of the community. Magnitude is uncertain, particularly later in the century, depending on the trajectory or otherwise of greenhouse gas emissions. Hazard risk profiles will exhibit a wider range of possible future impacts than they do now.

[151] Around such issues, disagreement of values and world view that exist may not result in a consensus, associated adaptation options will not be distributed evenly, trade-offs are likely to occur, and some groups will be disproportionately affected.

[152] Without the adaptive management systems some decisions may be irreversible and create 'lock in', cutting off future adaptive capacity requiring more costly responses.

[153] Other benefits of engagement around adaptive management will result in more

- natural definitions of problems;

- a wider range of planning and decision-making;

- alternatives can be explored;

- certainty of policy outcome is likely to reduce implementation failure;

- better and more robust decision-making is likely more suited to the dynamics of SLR;

- engaging stakeholders early is likely to improve efficiency at the same time and reduce litigation costs.

How should participation proceed?

[154] A method of how participation proceeds is provided – different at various stages in the process and designed to suit the local context and the stage and scale of the

decision process positioned at the local level.[72] This provides a spectrum of the types of facilitation available, moving from the whole of those affected, to an especially affected subgroup, or providing a bottom-up selection of those to select a subgroup, or for a top-down selection where the local authority invites those with appropriate skill sets to participate. The process will be particularly important for Maori. Facilitators may play an important part in the overall process.

[155] These methods have both advantages and disadvantages needing to be explored. Adopting a generally accepted terminology will assist expectations and practice. Once the structure of who is involved has been decided, the mandate of each participant should be determined – to represent a group or individual. Do they have the right to make decisions on behalf of the group?

Where to position the engagement

[156] The spectrum of engagement may occur at the whole engagement level or more specifically, how to undertake a particular process or event. The IAP[2] spectrum of public participation[73] incorporating public and public participation goals identifies the need for critical questions around whether 'informing', 'involving', 'collaborating' or 'empowering' should occur.

[157] This system provides clear descriptions of what type of public engagement could entail and how decisions are made. Responses to what is the nature of the decision, what is the purpose of the engagement, how heterogenous are the community, and what are the values of the community, iwi/hapū and stakeholders, will have implications for the scale of the involvement.

[158] This requires –

- objective information to inform understanding;
- consultation to obtain public feedback and analysis alternatives;
- involvement through working with the public;
- collaboration with the public resulting in consideration of alternatives;

[72] Guidance Manual Table 3-3.
[73] Figure 3-3 IAP[2] refers to the International Institute of Public Participation, an international organisation frequently used to identify such issues. Guidance Manual Glossary p 250.

- empowerment placing the final decision-making in the hands of the public.

What is the nature of the decision?

[159] The type of decision made is key to the whole process of engagement. If decisions are being made with respect to new subdivisions, redevelopment such as intensification, or greenfield development, then the consultation process is articulated as 'good practice' associated with the application of the various provisions of the RMA and LGA. There should be hazard and risk/vulnerability assessments and other approaches identified. If the decision is how to influence behaviour, or hazards policy development, then a modification of the individual statutory processes can be constructed.[74]

[160] The LGA meanwhile provides much wider consultation provisions that are available in the RMA. In practice, it is suggested that the process sits between 'consult' and 'involve' on the IAP^2 system.

What is the goal or purpose of the engagement?

[161] If engagement can serve several purposes ranging from providing impartial information (such as the Waikato Regional Council's coastal inundation tool), increasing public awareness, or knowledge of a particular issue, then informing the public is appropriate. If the problem is simple, the science is accepted, the level of trust will be high.

[162] Key questions are provided to consider when exploring what type of engagement process could be undertaken: is there agreement on the science; what is the complexity of the problem; what are the levels of trust around the governance arrangements to protect or manage interests or implement change?[75]

[163] The more complex and contested the decisions, the greater level of recommended community or public mention. Where impacts are high around coastal hazard impacts and SLR, even more inclusive approaches are required, for example, careful location of new infrastructure. Where levels of behavioural change are regional or

[74] With regard to the RMA, recent amendments have restricted consultation issues and this issue may have to be revisited: Minister for the Environment 2016.
[75] Guidance Manual Table 3-4.

local, more participatory engagement is needed, with the Muriwai Beach study as a useful example.[76]

[164] Other examples of engagement approaches are also identified in Appendix 1 to the Appendices and worthy of exploration as methods to assist in identifying issues and how to approach them, including lessons learnt from engagement.[77]

Guiding principles for engagement

[165] Guiding principles for inclusive engagement are extensively provided throughout Chapter 2, incorporating some of those for negotiation and mediation, the need to create a safe place for discussion, taking the necessary time to explore issues, to listen and understand different perspectives, to engage regularly and to respond to the community in a timely manner. Other examples are:

- to be flexible and adaptable, as adaptive approaches are necessary to explore the complexity of the changing risks associated with coastal hazard and SLR;
- to be inclusive, empathetic and ensure representative participation;
- for the purposes of climate science, initiate adaptive conversations early, be cognisant of scientific knowledge, be transparent, and secure committed resources and institutional support.

[166] Figure 3-4 Key questions to consider when exploring what type of engagement process could be undertaken – purpose, knowledge and complexity provides a useful flow chart illustrating the key questions and what type of engagement to make.

Designing an engagement strategy in practice[78]

[167] This identifies that the 10 step Decision Cycle process will require a sequence of events and activities that could be undertaken using a collaborative team underpinned by guiding principles (identified throughout the chapter and applied

[76] Appendices, Appendix 1 Example of engagement approaches, *Coping with coastal erosion at Muriwai Beach*, p 79.
[77] Ibid pp 75-79.
[78] Table 3-5.

by the multidisciplinary team).[79] Box 3.3 sets out helpful resources and events to achieve outcomes.

Representation of an engagement through the steps in the Guidance[80]

[168] A series of steps is identified in the engagement process to identify with engagement practices with the various stages in the 10 step Decision Cycle.

Navigating further engagement issues

[169] Chapter 7 **Establishing values and objectives**; Chapter 8 **Vulnerability and risk monitoring**; Chapter 9 **Adapting to coastal risks arising from climate change impacts, adaptive planning and strategy**; Chapter 11 **Reviewing and monitoring** – all provide more detail on where community engagement is important.

Good practice?

[170] The methods adopted are a mixture of extended identification of the issues through

- step-by-step analysis, and identification of sets of guiding principles;
- use of tables, figures, graphs and boxes to highlight or condense issues;
- references throughout to national and international practice;
- 'story-telling' (engagement approaches) in the appendices to provide relevant scenarios.

[171] The methodologies used and their adequacy incorporate many features of good practice, providing new innovative methods to underscore the seriousness of the issues - climate change, coastal hazard risks and sea level rise.

Conclusion

[172] The extensive material identified in the community engagement chapter is important because:

[79] Figure 3-6. This is one of the few figures that could be redesigned to be simpler.
[80] Table 3-6.

- of the central involvement that communities now have in the planning for climate change, coastal hazards and sea level rise;

- it signals a significant shift to the all-inclusive status for communities, iwi and stakeholders at all levels to address their current and future concerns around the issues;

- it reinforces democratic processes in that decisions on these issues can no longer be just 'top down' but identify the need and secure opinions, rights and decisions from communities, iwi and stakeholders that might be otherwise overlooked;

- it provides for *implementation* of the need for community engagement at a national scale, something that has been signaled but not necessarily advanced adequately in other environmental forums.

Adaptive planning: does the new material represent current good practice?

[173] In reality, this question incorporates not just Chapter 10 provisions but also Chapter 9.

What is adaptation?

[174] A definition of adaptation identifies:

> Adaptation is considered a response strategy to anticipate and cope with impacts that cannot be (or are not) avoided under different scenarios of climate change.[81]
>
> Adaptation is the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.[82]

[175] At the local level the coast is one of the areas where climate change effects are likely to be particularly experienced. While local government's responsibilities relating to coastal hazards will continue on the 'business as usual' basis, others under RMA and CDEMA will be undertaken in a changing environment. The local implications of the complex interrelationship of weather events, coastal geomorphology and coastal processes will vary in place and time, but into the more

[81] IPCC WGII AR5 2014 (Denton, 2014, p 1104). Climate Change 2014: Impacts and Vulnerability.
[82] IPCC (2014) p 118.

distant future there is little certainty around all the potential consequences of climate change.

[176] Current decisions need to be routinely examined as to:

- whether they will 'lock in' new or increasingly unaffordable investment at exposed locations;
- whether at some stage they will increase hazard risk (in situ or elsewhere along the coast and have environmental impacts;
- how they will affect wider community values and vulnerabilities;
- the risk of acting or not acting if there is uncertain or insufficient information about the provision being considered (s 32(2)(c) RMA) and the costs and benefits of the decisions being considered;
- how they can be made flexible using adaptive measures, to enable feasible and affordable course correction over time.[83]

[177] Exacerbation of existing coastal hazards by ongoing climate change and SLR will create newer wider scale risks than ever before encountered in coastal areas. This has implications for planning today and well into the future, especially for those activities or assets that have been damaged or threatened in coastal areas affected by climate change impacts. Further, not all coastal locations will be able to be protected by hard or soft engineering approaches in the long term due to physical, spatial scale and affordability constraints.

[178] Adaptation to climate change addresses a changing state that is dynamic, a changing state, escalating risk and cannot be predicted over the long term, and where change is inevitable in human time frames there is no reversion to the original state.

[179] The phenomenon requires adaptation of existing development and design and location of major new infrastructure. Adverse effects can arise from both the hazards themselves and the communities' responses. The NZCPS flags the need to

[83] Guidance Manual p 188.

identify and plan for transition mechanisms and time frames for more sustainable approaches.[84]

What are we adapting to and why?

[180] The problems involved are spelt out around the issue of adaptation as a guiding practice:

> Frequency of coastal storm inundation will continue to increase. For example, flood events that currently occur rarely (e.g. 1% AEP level) will become an annual occurrence with only a modest SLR of 0.3-0.45 m. This SLR range is certain to occur by the mid-period of this century, e.g. sea level is rising, and foreseeable (PCE, 2015). However, uncertainty in the rate of change in sea level will increase through the rest of this century and beyond, and increasingly from polar ice sheet instabilities.
>
> For near-term decisions that intensify development in already exposed areas, and decisions on assets that have long lifetimes, the ability to make adjustments over time will need to be built in now. New (greenfield) developments in areas exposed to coastal hazards exacerbated by SLR should be avoided (NZCPS).
>
> Near-term sea level rise will affect underground services and surface drainage networks and their performance, well before higher SLR projections are reached.[85]

[181] Different types of relevant coastal adaptation options are identified as anticipatory or reactive, private, autonomous, spontaneous, planned or maladaptive. Adaptation options include protection, accommodation, retreat and avoidance strategies.

What is adaptive capacity

[182] Adaptive capacity has been defined as:

> The resources available for adaptation to climate change and variability or other related stresses, as well as the ability of a system to use these resources effectively in the pursuit of adaptation.[86]

[183] Various decision tools to develop flexible, adaptive and can-be-adjusted decisions can be used for the 10 step Decision Cycle assessments Steps 2 and 4, evaluation Step 6, adaptive strategy planning Step 7, and implementation Step 8.

[184] The extent of any 'adaptation deficit' arising from the legacy of previous decisions, cumulative and compounding impacts over time will need identification. The

[84] NZCPS Policies 25 and 27.
[85] Guiding Practice p 187.
[86] Guidance Manual p 25. Glossary p 25. Brooks and Adger (2004) p 168. Guidance Manual p 25.

vulnerability of the community at risk will influence the capacity to adapt. It will become a critical factor for community wellbeing (people unable to move from homes for financial/insurance reasons) as the sea rises. It will eventually affect the viability of some coastal communities and the effective performance or level of service from infrastructure such as roading, water availability, suitable coastal greenfields).

[185] Adaptive capacity also aids decision-makers to reduce risk exposure, sensitivity and vulnerability; and to take opportunities such as redesigning the spatial configuration of coastal development. It includes the ability or potential of governance institutions and organisations to avoid/reduce risk. It provides the ability to make adjustments in behaviour, resources, integration between council coastal functions, and require integration with long term plans and management plans.

[186] Adaptation can ameliorate some of the impacts if they are anticipated, especially those with long lifetimes. Examples are provided of incremental planning adjustments that are the result of the aftermath of natural disasters that have already occurred in New Zealand, the experience of which is built on. Adaptation building examples from recent New Zealand practice usefully provides two adaptation planning examples with explanations as to their value for this discussion.[87]

Foundations for decision-making

[187] These identify (inter alia) the need for:

- better science – but while this and competent technical information is necessary, it is not sufficient, and decisions require appropriate decision support processes and tools (robust evidence, high agreement);

- a framework for iterative risk management for most climate change decision-making; this is most suitable in situations characterised by large uncertainties, long time frames, the potential for learning from these, and the influence of both climate as well as other socio-economic and biophysical changes (robust evidence);

[87] Guidance Manual p 191. Also Box 9.1. Auckland Unitary Plan (District Plan coastal hazard provisions) and Waimakariri District Council Infrastructure Strategy.

- identification of scenarios (role playing) as a key tool for addressing uncertainty that allows for the explanation of various options allowing identification of problems and exploration of solutions (robust evidence, high agreement);

- recognition of local and indigenous knowledge and diverse stakeholders' interests and expectations, as fundamental to building trust within decision-making processes (robust evidence, high agreement);

- transformational adaptation if incremental adaptation proves difficult (medium evidence, high agreement);[88]

- the existence of a set of available methods and tools and processes to support effective climate impact adaptation and vulnerability (CIAV) decisions in a wide range of contexts (medium evidence, medium agreement).

Adaptation decision-making

[188] This encompasses the context in which decisions are made (Step 5 of the 10 step Decision Cycle)), the identification of options and pathways (Step 5) and evaluation (Step 6) identifying the process as complex and wide. Five principles are identified:

- building a shared understanding of processes, hazards and community resilience;

- deciding council and community objectives (ensuring they have a long-term focus);

- exploring the future and how communities are affected;

- implementing the strategy and practice over time;

- monitoring the strategy using triggers and decision points for adjusting between pathways.[89]

[189] The importance of ignoring uncertainties about the future as stated in Question I is especially relevant for climate change adaptation decisions – all uncertainties

[88] Guidance Manual p 193. Box 9.2 Foundations for decision-making. Excerpt from Executive Summary Chapter 2IPCC WGII AR5 Jones et al (2014).
[89] Guidance Manual Figure 9-1. Steps 5-6 in the 10 step Decision Cycle grouped around what can be done about it.

cannot be eliminated, but ignoring uncertainties may limit opportunities in the future and could result in missed opportunities and lead to unsustainable plans.

Identification of options and pathways

[190] Guidance is provided on adaptation options (Step 5 in the 10 step Decision Cycle process), how to identify them and how to develop pathways to achieve them.

[191] At its broadest level the consideration for any area identified at risk should include maintaining the status quo, preparing to retreat, invest in protection of the area for longer, combinations/intermediate options based on the above.

[192] Examples of different levels of coastal hazards and resilience plans set out emerging solutions to support the various potentially affected communities and grow capacity for them to survive and adapt.[90]

The adaptive pathways approach

[193] This is based on the five-point questions on which the Guidance Manual is based.[91] These questions asked:

- What are the first impacts that will be faced as a result of climate change?
- Under what conditions will current strategies become ineffective in meeting objectives?
- When will alternative strategies be needed given that implementation has a lead time?
- What alternative decision pathways can be taken to achieve the same objectives?
- How robust are the options over a range of future climate scenarios?
- Are those involved able to change path easily and with minimum disruption and cost?

[90] Those identified include the Auckland Unitary Plan, Regional Policy Statement (Auckland Regional Council's Decision Version, 19 August 2016), the Clifton to Tangoio Coastal Hazards Strategy (2120) which has a combined technical and council advisory committee, and Wellington City Resilience Plan.
[91] Box 9.3 Examples of different levels of coastal hazards and resilience plans.

[194] The basic premise is made that decisions are made within dynamic systems and that policies/decisions have a design life as, for example, sea level rises or severe erosion occurs – they reach a locally defined trigger or decision point. Policy decisions have a design life and will eventually fail as the operating conditions fail. Once actions fail, other actions are needed to achieve objectives and an alternative pathway emerges. By exploring different pathways using scenarios, an adaptive plan can be designed that includes a mix of short term actions and long term plans. Figure 9-2 provides an adaptation trigger point analysis for identifying such measures.[92]

Foundations for decision-making: dynamic adaptive pathways planning

[195] This approach has evolved into the Dynamic Adaptive Pathways Planning ('DAPP') Dutch approach (Haasnoot et al) which has received strong recognition and endorsement in New Zealand (Lawrence and Haasnoot under review), the United Kingdom (Ranger et al, 2011) and Australia (Barnett et al, 2014). Adaptive pathways approaches are highlighted also in IPCC AR5 (Denton, 2014) as an iterative process that enables management and adaptation to climate change impacts that cannot be avoided.[93]

[196] DAPP conceptualises a series of actions over time (pathways) to achieve a set of pre-defined objectives under uncertain and changing conditions. It can track both policy implementation and any changing conditions, and different pathways can result in achieving the same objectives. Its approach is built upon the notion that decisions are made over time in dynamic interaction with the system itself and cannot be considered independently or predetermined. Figure 9-4 Example of an Adaptation Pathways map (similar to a metro map) presents alternative routes for getting to the same point.[94]

[197] Guiding practice further identifies that DAPP planning has particular utility for making decisions in the coastal context where there are dynamic characteristics leading to ever-changing risk profiles, and there is uncertainty around rates and magnitude of changes, especially over the long term.

[92] Guidance Manual p 199. Kwadijk et al (2010).
[93] Guidance Manual p 200. Box 9.4 Climate resilient pathways: adaptation, mitigation and sustainable development.
[94] Guidance Manual p 203. Figure 9-4 Example of an adaptation pathways map. (Graphics: Marjolijn Haasnoot, Deltares and TU Delft, the Netherlands).

[198] The method focuses on making transparent the path dependency between actions and whether options will result in lock-in of existing risk or create future exposure to hazard risk, while keeping multiple pathway options open for the future. This helps to reduce the risk of irreversible decisions.[95]

[199] Importantly, DAPP does not prescribe a single solution that is embedded up-front. Future options are left for future decisions, provided that they lead to the achievement of the stated objective. This means there is some certainty for the community about what the future possible pathways entails. Transparent trade-offs can be made where there are competing options, and different values in communities which can be made explicit. Thus, informed debate can take place on options with an awareness of how these may affect future decision-making.

[200] Table 9-1 provides a range of decision support tools, their applicability, their usefulness, limitations and potential uses.

[201] A recent example from Wellington using the adaptive management concept for evaluating and deciding options for the Hutt River Centre upgrade is provided in Box 9.5 Application of Dynamic Adaptation Pathways Planning: Greater Wellington Regional Council.[96] When applied to flood adaptation planning in the Hutt River catchment, New Zealand (see Box 9.5), it was noted that the annual exceedance probabilities (AEPs) and related river flows were based on Poisson distributions, which assume a known mean and variance, even though the historic record is too short to establish these reliably. A form of conjugate or extreme value distribution may better reflect the uncertainty around the mean and variance. This is one reason why, for sea-level rise assessments as set out in this Guidance, it is important to test for robustness and earlier onset using the upper-end (H^+) SLR scenario, thereby better reflecting the upper-end uncertainty.[97] The reference to using the upper-end H^+ sea level rise scenario has resonance back to the earlier Question (iii) on what it could be used for.

Adaptive planning and implementation

[202] Chapter 10 Adaptive planning strategy and implementation provides detailed guidance on developing this strategy, developing trigger points and how to

[95] Kwadijk et al (2016).
[96] Guidance Manual p 203.
[97] Greater Wellington Regional Council (2015).

implement them through New Zealand's current planning frameworks such as the RMA.

[203] For local authorities it will provide an end point as to where adaptive management practice can be applied to the relevant environmental statutes, and vice versa. It more than adequately resolves many of the queries this review process raised in the preceding chapters.

[204] The steps provided in 10.2.1 Planning frameworks demonstrate good practice while 10.2.2 Choices of methods and techniques is a very competent and welcome resolution of many queries raised. It exemplifies good practice.

Monitoring

[205] The Guidance Manual considers that as climate change effects increasingly impact on coastal areas and communities, there will be a need to bolster and re-target monitoring systems. It makes the point that in the past monitoring functions in the coastal environment have largely been carried out by the Minister of Conservation on national trends while councils are involved in monitoring physical changes and the effectiveness of policies and plans.

[206] It is considered now that in the context of climate change and adaptive management, there should now be a significant shift to communities, iwi/hapū and stakeholders and special interest (schools, business) in monitoring practices. Such involvement would assist in trigger points for change with examples given as witness to

- king tides, storm tide marks, regular inundation etc;
- the natural environment (dune restoration);
- community vulnerability and risk;
- adaptive frameworks for future decisions;
- the effectiveness of policies and plans;
- tying monitoring to trigger and decision points;
- remaining adaptation pathways.

Conclusion

[207] This overall review does not do justice to the detailed provisions on adapting to planning for changing risks arising from climate change, sea level rise and coastal hazards. Its overall comprehensiveness, its case studies, references to the international literature and extensive graphics leave no doubt that it represents current good practice.

[208] Because it has been charting new technology and innovative planning processes in New Zealand, a strength is the examination of the DAPP process already in use internationally providing a very useful example here of what can be achieved not only for SLR issues but for the current practices of managing coastal hazards and climate change risk.

[209] There is one criticism. Details of what planning tools such as the Regional Policy Statement ('RPS') should use and when; or what specific NZCPS objectives and policies should apply on certain issues and when, together with examples of different levels of coastal hazards and resilience plans identified in Chapter 9, more correctly come within Chapter 10. There is a confusion of process with implementation.