BEFORE THE MARLBOROUGH DISTRICT COUNCIL HEARINGS COMMITTEE

IN THE MATTER	**of the Resource Management Act 1991 Marlborough District Council Proposed Marlborough Environment Plan**
AND	
IN THE MATTER	**Climate Change**
AND	
IN THE MATTER	**of the submissions and Councils section 42 report**

STATEMENT OF EVIDENCE BY JUDITH HELEN LAWRENCE

ON BEHALF OF CLIMATE KARANGA MARLBOROUGH

1 FEBRUARY 2018

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SUMMARY

1. My name is Judy Lawrence. I am Senior Research Fellow at the NZ Climate Change Research Institute, Victoria University of Wellington. I have 40 years of experience in resource management and public policy at central and local government. I am Director of PS Consulting Ltd. I hold a PhD in Public Policy and MA in Physical Geography from Victoria University of Wellington.
2. I was co-author of the Ministry for the Environment revised Coastal Hazards and Climate Change Guidance 2017 and am Co-Chair of the Government's Climate Change Adaptation Technical Working Group.
3. I have been asked by Climate Karanga Marlborough to give this evidence in support of their submission on the Marlborough Environment Plan.

Background

4. Climate Change impacts will affect the Marlborough region in different locations in different ways over the life of the plan.
5. Impacts are emerging in different ways
    a. Slowly e.g. sea level rise, rising groundwater levels;
    b. Widening climate variability e.g. drought, increased pluvial flood frequency, increased coastal flood frequency;
    c. Extremes e.g. coastal storm surge, intense rainfall, wind and fire events;
    d. Surprises e.g. impacts of accelerated sea level rise;
    e. Combined impacts e.g. sea level rise, inundation and flooding, intense rainfall and landslip
    f. Cascading impacts e.g. combined impacts that flow from a sector into other sectors and socio-economic systems, such as provision of water services or health services for example.
6. Adaptation actions taken today will affect how, and at what cost, future adaptation can be implemented e.g. some actions can be adjusted in future while some cannot and will lock in activities in exposed locations
7. Each type of impact has different levels of uncertainty e.g. sea level rise is virtually certain to mid-century, but its rate and magnitude is uncertain beyond that because of uncertainty about the behaviour of the polar ice sheets and how quickly carbon emissions will be reduced
8. The Marlborough coastline is long and exposed to the effects of sea level rise, inundation and flooding events over the short and medium terms
9. Sea levels have already risen 0.16-0.20m over the past 100 years in New Zealand and will continue to rise and accelerate due to climate change.
10. Climate Change is already making coastal inundation worse from storm-tides and wave overtopping as storms and waves ride on the back of a higher sea level. Uncertainty is not a reason for delay in addressing risks from climate change

Section 6 (h) of the RMA and giving effect to the NZCPS in the MEP

11. The mandate for councils to address the effects of climate change and uncertainties surrounding it has been strengthened over the last few years. The NZCPS 2010 embodies a methods for addressing uncertainties (the precautionary principle applied over at least 100 years), the new matter of national importance in the RMA requires councils to recognise and provide for the management of significant risks from natural hazards, and give particular regard to the effects of climate change. The Ministry for the Environment 2008 and 2017 Coastal Hazards and Climate Change Guidance, embodies a risk-based approach with methods to assess hazard and sea level rise risk and to adapt to climate change over 100 years.
12. The significance of using risk-based approaches is that investment decisions taken today will have long lifetimes and thus be affected by the ongoing climate change impacts.
13. Stress testing is one way of addressing uncertainty, especially climate change impacts on subdivisions, Greenfield developments and major new infrastructure which can be using high end scenarios (e.g. H+) and across the range of scenarios using the adaptive pathways approach for changes in land use and redevelopment (intensification). These are precautionary approaches widely used elsewhere (e.g. in the UK, Europe and USA, and increasingly in equatorial delta regions), to avoid future hazard risk.

Implications for the MEP

14. It is my opinion that the MEP text as written (my evidence para 20) does not reflect the statutory requirements by framing climate change in too uncertain terms.
15. **I recommend** therefore that the sections set out in para 21 of my evidence be amended to better reflect current knowledge of climate change impacts as reflected in the statutes and the MfE 2017 Coastal Hazards and Climate Change Guidance.

Application of the 2008 and 2017 Coastal Hazard and Climate Change Guidance

16. The impacts of rising sea levels is set out in my evidence at paragraph 13 based on the 1017 revised MfE Guidance, released in December 2017. The revised Guidance provides specific guidance on hazard assessments and sea-level rise that enables uncertainties to be accommodated, community engagement processes, dynamic adaptive planning methodology and monitoring changes over time. The MEP uses the 2008 Guidance to inform the sea level rise provisions. This has two implications
    a. The 2008 Guidance has not been applied correctly in the S42 assessment recommended for changing the MEP

b. There is new Guidance now available 2017 and it is different from the 2008 Guidance as to SLR allowances for assessment and planning approach

17. The 2008 allowances have a base year of 0.5m relative to 1988-1999 average, plus an assessment of higher SLR of at least 0.8m relative to 1988-1999 average. And an additional allowance for long decision timeframes of 10mm per year beyond 2100.
18. The middle step is missing in the recommendation in the S 42 assessment.
19. The 2017 Guidance attaches different transitional allowances until adaptive pathways planning can be done using 4 sea level rise scenarios.
20. The allowances are different according to the type of activity as follows
    a. *Coastal Subdivision, greenfield developments and major new infrastructure – avoid the hazard risk by using SLR over more than 100 years and H+ scenario*
    b. *Changes in land use and redevelopment (intensification) — adapt to hazard by conducting a risk assessment using a range of scenarios and using the pathways approach*
    c. *Land use planning controls for existing coastal development and assets planning—use of single values at local/ district scale transitional until dynamic adaptive pathways planning is undertaken*
    d. *Non-habitable short-lived assets with a functional need to be at the coast, and either low-consequence or readily adaptable (including services) — 0.65 sea-level rise.*
21. If the 2008 guidance is applied correctly, the minimum allowance becomes 1m which is the same as the transitional allowance using the 2017 Guidance for activity C –existing coastal developments and asset planning until DAPP is undertaken.
22. However this is insufficient for new developments which is why the 2017 Guidance gives different allowances for new activities that will be at increased exposure.

Implications for the MEP

23. The NZCP requires councils to take account of national guidance and the best available information on the likely effects of climate change on the region or district.
24. **I recommend** that the Council use Table 10 of the 2017 Guidance to set a planning allowance until the DAPP process can be applied using the 4 scenarios, in conjunction with Table 12 in the 2017 Guidance for activities A. This would mean taking the life of the MEP at approximately 2130 giving an allowance of 1.52m. This would amend the recommendation given in the S42 report for 19.2.2.

Other impacts of climate change

25. Sea level rise will also affect coastal structures, reclamations, ports and marinas especially sea level rise and consequent inundation, and coastal flood events.
26. Sea level rise will also result in rising groundwater levels especially in lowing areas such as the Lower Wairau and lagoons area.
27. Potential effects of high intensity rainfall events cannot be ruled out and the MEP will also need to monitor such effects and identify priority risks including the effectiveness of urban stormwater systems and associated safety and damages to people, roads, buildings, and water services.
28. Wind and fire risk are also present impacts that are likely to be exacerbated by climate change in the Marlborough region which will require attention in the MEP for risks to urban and rural land uses
29. The monitoring programme for environmental results and monitoring of effectiveness across the MEP does not include any monitoring of natural hazards or climate change impacts. This would be prudent to address in the MEP for the reasons given in para 33 of my evidence.

Implications for the MEP

30. The RMA including the NZCPS requires councils to address the effects of climate change and the significant risks from natural hazards. These impacts will change over time, accelerate and exacerbate existing hazard risks which highlights the importance of signalling this now and monitoring risk levels.
31. **I recommend** the MEP be amended to include the additional impacts raised in this section and that the monitoring of the environmental results and effectiveness of the MEP include natural hazards and climate change effects.

Conclusions

32. The Government's Climate Change Adaptation Technical Working Group which I co-chair, has published a Stocktake of adaptation action currently in New Zealand, the impacts likely and identified areas for attention. A second report is due in the next few months which identifies further detail as to the areas where action is required nationally to successful ongoing adaptation to the sort of Climate change effects I have addressed in my evidence. These cover information and its access, organisation needed to coordinate adaptation at different governance levels, and dynamic action required to address what is a changing risk over at least 100 years.
33. The 2017 Guidance sets out a 10 step decision process (paragraph 37 and Figure 1 of my evidence) for councils to use iteratively, in assessing hazard risks and sea level rise, engaging with their communities to understand what matters most to them, options identification and evaluation, development of adaptive plans and monitoring and reviewing the plans to gauge its effectiveness.
34. These two recent initiatives will assist the MDC in addressing climate change in the MEP.

MAIN SUBMISSION

Introduction

1. My name is **Judith Helen Lawrence**. I am Senior Research Fellow at the New Zealand Climate Change Research Institute (CCRI), Victoria University of Wellington and Director of PS Consulting Ltd. My qualifications and experience are in my c.v. (Appendix 2) and as follows:

2. I have a PhD in Public Policy from the School of Government and an MA in Physical Geography, both from Victoria University of Wellington. I am a member of the Resource Management Law Association, the NZ Association of Resource Managers, and a member and office holder of the Society for Decision Making Under Deep Uncertainty (an international network of professionals).

3. I have worked in the field of resource management, hazards management and climate change in New Zealand, Australia and internationally over the last 40 years, including for the Ministry of Works and Development, the Ministry for the Environment, the NZ Climate Change Office (Director), PS Consulting Limited (current) and the NZ CCRI at Victoria University of Wellington. My experience has spanned technical advice, management, and research and previous elected member of the Wellington Regional Council. My PhD completed in 2015, examined the adequacy of institutional frameworks and practice for climate change adaptation decision making, for which I received a Dean's Award. My past and current research has been on climate change impacts and implications for decision making, climate change impacts, and decision making tools for addressing changing climate risks and uncertainty.

4. I was a co-author of the Ministry for the Environment revised Coastal Hazards and Climate Change Guidance released last December. I am also currently Co-Chair of the Government's Climate Change Adaptation Technical Working Group reporting on a Stocktake of adaptation and impacts and reporting in March on adaptation options. I have advised central and local government agencies in NZ and Australia. I am currently undertaking research projects on cascading climate change impacts, decision triggers for adaptive decision tools, resilience governance and coastal adaptation. I have a familiarity with the Marlborough region, having lived in Blenheim for my first eighteen years and have visited frequently since. My experience and research informs this expert evidence.

Code of Conduct

5. I confirm that I have read the Code of Conduct for Expert witnesses contained in the Environment Court Practice Note and I agree to comply with it.

6. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on published literature.

7. I am authorised to give this evidence on behalf of Climate Karanga Marlborough.

Scope of this evidence

8. My evidence complements that of Professor James Renwick by focusing on those provisions of the Proposed Marlborough Environment Plan (the MEP) that relate to the effects of climate change, or create flow-on effects to other sections of the MEP. My evidence includes:

- Background on the type of climate change impacts and their different characteristics; timeframe issues; uncertainty and changing risk profiles over time and the planning implications of these
- Section 6 (h) of the RMA regarding significant natural hazards as matters of national importance and giving effect to the NZ Coastal Policy Statement regarding climate change impacts such as sea level rise, inundation and coastal flooding and implications for the MEP
- Use of the 2008 and the 2017 Ministry for the Environment Guidance on Coastal Hazards and Climate Change with respect to sea-level rise
- Other potential climate effects across the region that are relevant to the MEP

Background

Climate change impacts

9. Climate change impacts can be differentiated according to how they emerge. For example;

a) Slowly emerging impacts e.g. sea level rise, rising groundwater levels;
b) Widening climate variability e.g. drought, increased pluvial flood frequency, increased coastal flood frequency;
c) Extremes e.g. coastal storm surge, intense rainfall, wind and fire events;
d) Surprises e.g. impacts of accelerated sea level rise;
e) Combined impacts e.g. sea level rise, inundation and flooding, intense rainfall and landslip
f) Cascading impacts e.*g*. combined impacts that flow from a sector into other sectors and socio-economic systems, such as provision of water services or health services for example.

10. Each type of impact will affect the Marlborough region to some extent and will require different types of responses. Action taken today will affect how, and at what cost, future adaptation can be implemented. Some adaptations have the potential to lock-in particular land and water uses and service levels, while others can be adjusted in the future. The former will create planning lock-in with a potential to increase the need for future adjustments, while the latter will enable the Council to change responses in the

future as the climate risk levels change (Lawrence, 2016). Examples are unsustainable water demand for a use that is reliant on fixed infrastructure and cannot move location easily, or a new dwelling or development located at the coast that will be inundated by rising seas.

11. In addition, each type of impact has different levels of uncertainty. For example, the levels of sea rise are virtually certain out to the mid-century, while beyond that, there are number of different plausible scenarios depending on the behaviour of the polar ice sheets effect on rates of change and magnitude of sea level rise and how quickly humans can reduce carbon emissions. Each scenario will have different scales of impact. While sea level rise is a slowly emerging impact (compared with a high intensity rainfall event, for example), it is the combined effect of rising seas and storms/ winds and tides experienced as 'events', that affect people and their activities over the short-term. Over the longer term beyond mid-century, sea level rise will become the more dominant driver of impacts at the coast (Le Cozannet et al., 2015).

12 The Marlborough region with its long coastline will be exposed to the effects of sea level rise, inundation and flooding events at the coast over the short and medium terms. I therefore draw to your attention for consideration further in the MEP the following;

> *"Sea level has already risen 0.16–0.2 m over the past 100 years in A-NZ and will continue to rise and accelerate due to climate change. Climate change is already exacerbating coastal inundation from storm-tides and wave overtopping, as storms and waves ride on the back of a higher sea level."* (Bell et al., 2015)[1]

13. The MfE Coastal Hazards Guidance (Guidance) (Ministry for the Environment, 2017) states that;

> *"the rise in sea level is of great relevance for long-term decisions made in coastal areas, for two main reasons.*
>
> *1. The long-term impacts on coastal populations, developments and environments are potentially large (eg, Hinkel et al, 2014; Nicholls et al, 2011b), because past coastal developments were built on the premise of a relatively 'stable' sea level.*
>
> *2 The sea level response to warming of the Earth's climate system makes it an integrated global indicator – 90 per cent of the energy added to the climate system ends up in the oceans (Rhein et al, 2013). Observed sea-level rise, however, needs to be interpreted in light of substantial lags (decades to millennia) in the ongoing response to warming of the oceans and melting of glaciers and ice sheets (Dangendorf et al, 2014; IPCC, 2013a).*

[1] I use italics throughout to denote quotations from referenced material

Rising sea level in past decades is already affecting human activities and infrastructure in coastal areas, with a higher base mean sea level contributing to increased vulnerability to storms and tsunami. Key impacts of rising sea level are:

- *gradual inundation of low-lying marsh and adjoining dry land on spring tides*
- *escalation in the frequency of nuisance and damaging coastal-inundation events*
- *exacerbated erosion of sand and gravel shorelines and unconsolidated cliffs (unless sediment supply increases)*
- *increased incursion of saltwater in lowland rivers and nearby groundwater aquifers, raising water tables in tidally influenced groundwater systems*

These impacts will have increasing implications for most development in coastal areas, along with environmental, societal and cultural effects. Local government road and 'three-waters' infrastructure will also be increasingly affected, such as wastewater treatment plants and potable water supplies, besides capacity issues with stormwater and overland drainage systems.

With a sea-level rise of around 0.2 metres since 1900, low-lying areas of New Zealand are seeing an increased incidence of coastal storm inundation (Parliamentary Commissioner for the Environment, 2014, 2015; Stephens, 2015).

Uncertainty issues

14. Analysing, characterising and dealing with uncertainty is fundamental to decision making about climate change adaptation (Jones et al., 2014). Four elements of the 2017 Guidance on Coastal Hazards and Climate Change support the development and implementation of strategies to deal with uncertainty over long time frames;

- different levels of uncertainty including statistical, scenario and deep uncertainty
- community engagement
- dynamic adaptive pathways planning (DAPP)
- a monitoring regime, with early signals and triggers (decision points)

15. Uncertainty is not a reason for delaying action on potential risk from climate change. The NZCPS, the 2008 and 2017 MfE Guidance all highlight uncertainty for consideration in two ways. The NZCPS embodies the "precautionary principle" which in a climate change context has been defined by Article 3.3 of the UN Framework Convention on Climate Change.

"The parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost effective so as to ensure global benefits at the lowest possible cost."[2]

16. The 2008 MfE Guidance takes a risk-based approach and embodies this through the recommended sea level rise allowances quoted in this evidence. The 2017 revised Guidance provides an approach (Dynamic Adaptive Pathways Planning (DAPP)) for managing uncertainty and changing risk profiles over 'at least 100 years'. This removes the 'difficult task' referred to in the MEP of using projections of impacts where their timing and magnitude is uncertain. Consequently, actions on adaptation can be taken in an anticipatory manner if a risk-based approach is used.

17. The significance of this approach is that many decisions taken today about investments in infrastructure (roads, bridges, ports, airports, marinas and residential, commercial and rural developments) will have long lifetimes. This means that consideration of climate risks need to be built into decisions being made today, and in a way that can retain flexibility for adjusting to change, ahead of climate change impacts becoming unmanageable. Designing and monitoring signals and triggers for such adjustments to be made, can be incorporated into the council monitoring programmes. It is my opinion that the MDC should be signalling in the MEP that waiting for certainty is not a prudent approach. Scientific certainty about all climate risks is unlikely before action will need to be taken. This is the principle behind the precautionary principle embodied in the NZCPS and in both the 2008 and 2017 national Guidance on coastal hazards and climate change impacts.

18. The 2017 revised MfE Coastal Hazards and Climate Change Guidance (2017 Guidance) (Ministry for the Environment, 2017) sets out an approach that enables hazard and sea level rise assessments to address uncertainty that can inform the development of adaptive plans for rising climate change risks. I have applied the approach in New Zealand for other climate change impacts, e.g. flood risk management in the Hutt River and for the Hawkes Bay Coastal Hazards Strategy 2120. What it took to catalyse adaptive planning and the lessons learned are set out in Lawrence and Haasnoot (2017). My international colleagues have applied the approach in the Netherlands (Haasnoot et al., 2013) and Bangladesh, in UK for the Thames River management (Ranger et al., 2013), in Florida for sea level rise and urban inundation (Obeysekera, 2017), in Australia for natural resource management (Bosomworth et al., 2017; Wise et al., 2014), and in England (Petr and Ray, 2017) for forestry management.

[2] Refer to http://unfccc.int/resource/docs/convkp/conveng.pdf

Section 6 (h) of the RMA and giving effect to the NZCPS in the MEP

19. Part 2 of the Resource Management Act (RMA) has since April 2017 a new matter of national importance that must be "recognised and provided for" i.e. "the management of significant risks from natural hazards". Along with section 7 (i) of the RMA, which requires "particular regard to the effects of climate", gives strong direction to Councils in the matters relating to climate change impacts. In addition, the New Zealand Coastal Policy Statement 2010 gives statutory direction for planning under the RMA for coastal hazards and climate change. Recently released (15 December 2017) revised central government guidance from the Department of Conservation gives specific assistance to Council in interpreting the implications of the NZCPS. This complements the revised national Guidance on Coastal Hazards and Climate Change 2017 (Ministry for the Environment, 2017).

20. These directions and Guidance elevate the importance of climate change for local government attention. It is my opinion that currently the MEP as written underplays the uncertainties and difficulties of addressing the effects of climate change. In particular the following statements

Introduction

"Uncertainty about the nature of these effects at international, national and local level makes this a difficult task. Most projections are also long term and certainly beyond the ten year life of the Marlborough Environment Plan (MEP)."

Issue 19A

"The predictions of climate change at a national level involve significant uncertainty and little work has been undertaken to apply these national predictions to Marlborough's climate. This makes the task of responding to the effects of climate change in Marlborough difficult. This situation is complicated further by the fact that New Zealand and Marlborough are subject to natural climate variations associated with La Nina/El Nino and the Interdecadal Pacific Oscillation. These natural variations will be superimposed on human-induced long term climate changes."

Objective 19.1

One of the difficulties is that there is inherent uncertainty regarding the likely local climate changes in Marlborough and therefore the exact nature of those adverse effects is unknown, making it particularly difficult to plan for climate change. Further research will assist in this regard.

21. The lifetime of the MEP is likely to be 10 years and will guide existing and new developments in areas that are, and will be affected by climate change impacts over that period and beyond. It is my opinion that to give due weight to avoiding and reducing risks from climate change in the Marlborough region that the following amendments are made to the MEP.

a. References to uncertainties and difficulties in addressing climate change effects be reworded across the MEP to better reflect the risks spelt out in this evidence
b. Climate change should be identified clearly in the Objectives, Policies and rules where they relate to subdivision, use and development activities including matters taken into account in decisions. These will affect the appropriateness of subdivision, use and development of activities in the coastal areas throughout the region and where they are to be avoided, could be signalled
c. Section 13 Use of Coastal Environment is a context setting section for the whole region. A cross reference to the Climate Change Chapter in the MEP would signal relevant impacts and risks the region faces from climate change
d. Issue 13D could have "and sea level rise and storm inundation" added after natural hazards in para 5 of 13D p. 13.13. Objective 13.5 makes no reference to coastal hazards and sea level rise but refers to tsunami risk in Policy 13.5.4, a risk that is less certain than sea level rise. Policy 13.5.7 relating to "where resource consent is required" for residential development and/or subdivision within the Coastal Living Zone needs specific reference to "the effects of any natural hazard [must] be avoided, remedied or mitigated" to adequately signal that these are matters relevant to consenting
e. Section 13.2.3 includes reference to matters of national importance in the RMA needing to be recognised and provided for on an ongoing basis. However this is part of a list of matter relevant to short consent durations in the coastal marine area only.

Addition of climate change consideration listed above would result in a much more robust set of planning provisions for Marlborough that can avoid the situation which has emerged elsewhere in New Zealand (e.g. the Coromandel) where new and extensions to existing uses in areas of coastal hazard risk have not required a resource consent and substantial development has occurred, thus increasing the exposure to sea level rise and coastal inundation and flooding.

Use of the 2008 and 2017 Ministry for the Environment Coastal Hazards and Climate Change Guidance for sea level rise values

22. The MEP bases its provisions on sea level rise allowances in the 2008 Ministry for the Environment Coastal Hazards and Climate Change Guidance for local government. This has two implications

c. The 2008 Guidance has not been applied correctly in the S42 assessment recommended for changing the sea level rise allowances in the MEP
d. Revised Guidance was released in December 2017 which is different from the 2008 Guidance as to SLR allowances for assessment and planning approach.

23. The calculation of the sea level rise planning allowances recommended in the Council Section 42 assessment of submissions, are based on only one part of the 2008 Guidance.

24. The 2008 Guidance contains a recommended approach for calculating a sea level rise for planning and decision timeframes out to 2090s (2090-2099) as follows;

> *1) a base value of 0.5m relative to the 1980-1999 average* ***along with***
>
> *2) an assessment of potential consequences from a range of possible higher sea-level rise values.* It goes on to recommend that *at the very least, all assessments should consider the consequences of a mean sea –level rise of at least 0.8m relative to the 1980-1999 average.*
>
> *3) For longer planning and decision timeframes beyond the end of the century,* it *recommends an additional allowance for sea level rise of 10mm per year beyond 2100.*

25. The section 42 report has based its extrapolation to the 100 year timeframe (as required by the NZCPS) on the first step and then adds the 10 mm per year for the 100 year planning period. The second step preceded by *"along with"* has been missed in the section 42 report calculation. If one recalculates the sea level rise allowances including the second part of the guidance, the allowance becomes 1metre as the minimum level for planning and decision purposes, rather than the 0.67m figure recommended in the section 42 report.

26. The 2017 Guidance which was released after the MEP submissions had closed and after the section 42 report was completed. The recalculated sea level rise allowance using the **full** 2008 recommended sea level rise guidance for allowances, is the same minimum level as recommended in the 2017 Guidance for transitional allowances of 1 metre, *but only for existing coastal developments and asset planning* (my emphasis). The 2017 Guidance notes that *use of single values at local/district scale are transitional until dynamic adaptive pathways planning is undertaken.*

27. This means that if Council are to rely only on the 1metre calculated sea level rise allowance based on the 2008 Guidance for the full duration of the MEP, this will convey a false sense of 'safety' to development. New buildings and subdivisions in coastal areas will last at least 100 years, as noted in the section 42 report. This means that there could be an increase, rather than a reduction in exposure of people and assets to future natural hazards and climate-related risk and is inconsistent with the NZCPS Policy 25 (c) and would increase expectations of protection using hard structures also inconsistent with the NZCPS Policy 27 (2) (a). Breaking this cycle of expectation by taking a precautionary approach and anticipating the inevitable adverse events on communities using adaptive planning approaches, is an intrinsic part of the 2017 Guidance which is based on international best practice (California Coastal Commission., 2015; City and County of San Francisco Sea Level Rise Committee., 2015; Haasnoot et al., 2013; Tobin, 1995).

28. The 2017 Guidance links transitional sea-level rise values to the scale or type of development. This gives councils the ability to actually avoid increasing exposure to coastal hazards- a requirement of the NZCPS. The 2017 Guidance sets out transitional sea-level rise allowances for the period while in transition toward Councils undertaking adaptive pathways planning. Adaptive pathways planning (See Appendix 1) uses the New Zealand-wide sea-level rise scenarios to stress test the adaptation options for their sensitivity to a range of futures and thus addresses the uncertainty inherent in sea level rise values beyond mid-century. The transitional provisions in the Guidance are derived from a risk-based approach in relation to the scale or type of development as follows;

A. *Coastal Subdivision, greenfield developments and major new infrastructure – avoid the hazard risk by using SLR over more than 100 years and H+ scenario*
B. *Changes in land use and redevelopment (intensification) — adapt to hazard by conducting a risk assessment using a range of scenarios and using the pathways approach*
C. *Land use planning controls for existing coastal development and assets planning—use of single values at local/ district scale transitional until dynamic adaptive pathways planning is undertaken*
D. *Non-habitable short-lived assets with a functional need to be at the coast, and either low-consequence or readily adaptable (including services) — 0.65 sea-level rise.*

29. Considering how these difference between the 2008 and 2017 Guidance can be addressed I note that the NZCPS has a clause in Policy 24 (1) (h) Identification of coastal hazards, that when having regard to the effects of climate change, national guidance and best available information on the likely effects of climate change on the region or district, must be taken account of. This clause in my opinion could enable the council to update the sea level rise allowances for all types of development and thus be consistent with the 2017 Guidance.

30. It is my opinion that these two matters (the calculation under the 2008 Guidance, and the 2017 guidance being different for subdivision, greenfield development and changes (intensification) of land use) should be changed to provide a robust reflection of the statutes, including the NZCPS, to avoid further exposure to coastal hazards that will create liabilities and cost impacts on the council and communities.

I recommend that the Council use Table 10 of the 2017 Guidance to set a planning allowance until the DAPP process can be applied using the 4 scenarios, in conjunction with Table 12 in the 2017 Guidance for activities A. For the life of the MEP at approximately 2130, gives a minimum allowance of 1.52 metres. This would amend the recommendation given in the section 42 report for 19.2.2.

Other impacts of climate change and implications for the MEP

31. Coastal structures, reclamations, ports and marinas will also be affected by sea level rise, therefore the Objectives, Policies, and Rules relating to sea level rise will need to apply to them.

32. Sea level rise will affect groundwater levels in low lying areas near and some distance inland in many parts of the world (McGranahan et al., 2007) and in some locations across New Zealand. The extent will depend on local geology and hydrology. The low-lying lower Wairau area, and around the Wairau lagoons are likely areas exposed to such effects. I am aware that the council sewage ponds are located in this area. I draw this issue to the attention of Council, because rising groundwater levels may affect the long-term functionality of the sewage ponds if they have not already taken such effects into account.

33. It is noted that the monitoring of anticipated environmental results and monitoring effectiveness across the MEP does not include natural hazards or climate change impacts like sea level rise. The NZCPS requires planning for 'at least 100 years' in the coastal areas. To give effect to the NZCPS, section 6(h) and 7(i) of the RMA, it would be appropriate therefore to add monitoring of the provisions for natural hazards and climate change effects within the 10 year period of the Plan and beyond. A greater number of residential, commercial and marine activities exposed to climate change effects and compounded by natural hazards would increase the liability of the council and costs of adjustment as sea level rise, inundation and coastal flooding increases.

34. Climate change impacts will affect the appropriateness of methods for addressing flood risk. There are uncertainties around how and whether increased high intensity rainfall will affect future flood flow in rivers and surface flooding. However the IPCC Fifth Assessment Report Australasia Chapter 25 (Reisinger et al., 2014) indicated that any region in New Zealand can expect an increase in high intensity rainfall events even if average rainfall is declining. Areas affected may fall outside currently identified Floodway Zones with impacts for stormwater management for the Council. The MEP largely deals with stormwater impacts in the context of health issues from contamination from sewage and other contaminants. Issues such as debris and sedimentation in the stormwater system during high intensity rainfall or during intense dry periods have not been addressed as a climate change impact in the MEP. Such impacts are addressed in White et al. (2017). Provision in the MEP for monitoring the capacity of the stormwater system over time, its maintenance and potential surface flow on effects to dwellings and other land uses, would be prudent as a response to climate change effects.

35. The Rural Environment may also experience both warmer temperatures, increase in wind speeds and fire risk, and more intense rainfall events. These could increase land

instability, sedimentation, bridge and culvert maintenance and design, and rural access, irrigation infrastructure and demand on water resources across the region.

Conclusions

36. The impacts of climate change are widespread across all sectors either directly or through cascading effects. Climate change is ongoing and will not be linear in its progress through time and we can expect surprises. For councils to exercise their responsibilities in this area they require staff expertise and systems and processes to be able to undertake hazard and sea level rise assessments (and interpret them if done by external resources), undertake risk and vulnerability assessments to understand the interests and values at stake and the allocation of costs across generations for an issue that will be ongoing for some time punctuated by surprises. The Government Climate Change Adaptation Technical Working Group which I co-chair, is shortly to complete its second report, advising on options for adaptation for New Zealand. This will provide further support to councils such as yours.

37. When undertaking the Coastal Hazards and Climate Change Guidance revisions for the Ministry for the Environment, as co-authors we were conscious that the issue was a particularly difficult one for councils to address. Accordingly we designed a 10 step decision process that makes the necessary steps for developing climate change adaptation strategies very clear. We based the Guidance on the steps in Figure 1 which are grouped around 5 questions that frame each stage in the process. At the heart of the process is the community who at Step 3 can identify what matters most to them, and a collaborative process with the community that can elicit options and adaptive pathways for addressing the priorities in the region. This provides a way of making adaptation to climate change more manageable, address the uncertainties and gaining a degree of community consensus for actions starting now and continuing over time. I am currently engaged in such a process in the Hawkes Bay with three councils and community panels which will provide a good model for application in other areas of New Zealand. Marlborough could be next.

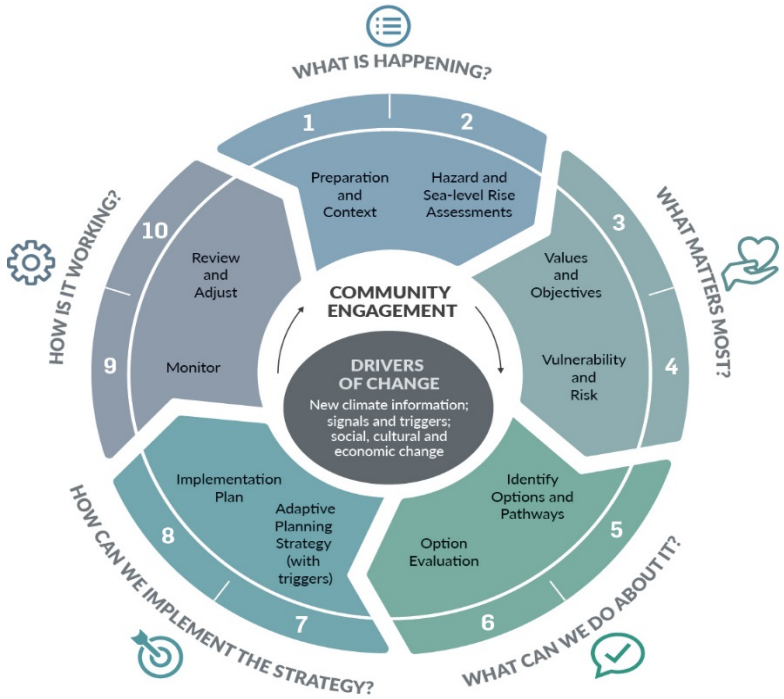

Figure 1 The 10-step iterative decision cycle in the revised 2017 NZ coastal guidance, grouped around five questions that frame each stage in the process (Source: (Ministry for the Environment, 2017). Adapted by the Ministry for the Environment from (UN-Habitat, 2014).

Dr Judy Lawrence

1 February 2018

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Appendix 1 Dynamic Adaptive Pathways Planning approach

The Dynamic Adaptive Pathways Planning (DAPP) approach (Haasnoot et al., 2013)[3] is an exploratory model-based planning tool that helps design strategies that are adaptive and robust over different scenarios of the future. It has been developed as an analytical and assessment approach for making decisions under conditions of uncertainty. Effective decisions must be made under conditions of unavoidable uncertainty (Dessai et al, 2009).

In the context of rising sea levels, where conflicting values prevail for coastal areas, the consequences of decisions can be profound, and may be impossible to reverse. This will result in activities that are locked-in to the place and space, thereby reducing the ability of decision-makers to adapt to future conditions. Costly adjustments that have distributional consequences on different groups within society may result.

The DAPP therefore focuses on keeping multiple pathway options open into the future – these help alleviate irreversible decisions and reduce the risk of being wrong when making decisions in the present. It does this by making transparent future actions that can be taken, should actions today prove insufficient to meet objectives.

The DAPP approach can also be used to facilitate iterative decision-making involving both decision-makers and stakeholders. The DAPP approach has been used increasingly for implementing climate-resilient pathways for water management in situations of uncertainty; its application to a problem of compounding coastal hazard risk resulting from sea-level rise is particularly helpful for decision makers.

Within the DAPP, a plan is conceptualized as a series of actions over time (pathways). The essence of the approach is the proactive planning for flexible adaptation over time, in response to how the future actually unfolds. The DAPP approach starts from the premise that policies/decisions have a design life and might fail as the operating conditions change (Kwadijk et al., 2010).

Questions used in the DAPP process

A set of questions below are used to prompt consideration of: the changing risk over a long timeframe, and different strategies that would meet long- and short-term adaptation objectives under different coastal climate-change scenarios and their risk profiles:

What are the first impacts we will face 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 we able to change path easily and with minimum disruption and cost?

The options and alternative pathways and decision points (trigger points) can be drawn using iterative processes by technical advisors, decision-makers and with communities, as input to

[3] Based on two complementary approaches for designing adaptive plans: "Adaptive Policymaking" and "Adaptation Pathways", which Haasnoot et al (2013) originally called "dynamic adaptive policy pathways". Here, the term Dynamic Adaptive Pathways Planning is used.

the adaptation decision-making process. An example is shown in figure 1. For details of on the application of the approach see below, and the case study (box 1).

Once actions or options fail, additional or other actions are needed to achieve objectives, and a series of pathways emerge; at predetermined trigger points the course can change while still enabling the objectives to be achieved. By exploring different pathways, and considering whether actions will lock in those actions and not enable adjustments in the future, thereby creating path-dependency, an adaptive plan can be designed that includes short-term actions and long-term options.

The plan is monitored for signals that indicate when the next step of a pathway should be implemented or whether reassessment of the plan is needed. The signals can be those defined by thresholds in the physical processes, and socially defined triggers that reflect the tolerability of the adverse consequences by the community affected by the sea-level rise or coastal hazard.

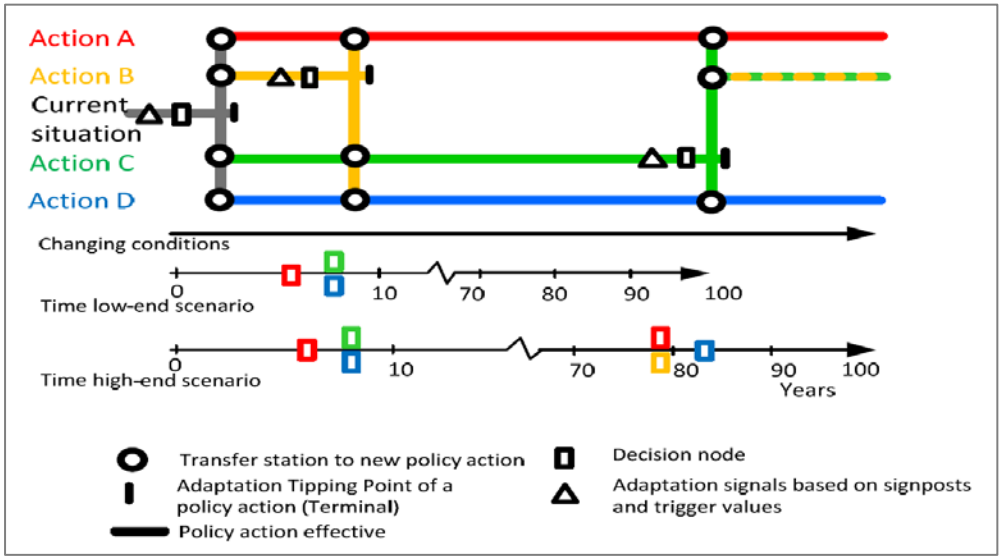

Figure 1: Example of a pathways map

Source: (Haasnoot et al., 2013; Hermans et al., 2017)

The resulting pathways can be tested for robustness with respect to a number of assumptions and parameters, for example: different climate change scenarios (using sea-level rise scenarios or hazard assessments); the discount rate; earlier or later decision review dates, and variations in the costs of the adaptation options and in expected losses. Robustness tests can be done on a number of complementary options; for example, structural options may become unaffordable and may need to be supported by planning and regulatory options, targeted rates and insurance.

When applied to flood adaptation planning in the Hutt River catchment (see box 1), 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^+) sea-level rise scenario (section 5.7), thereby better reflecting the upper-end uncertainty.

Appendix 2 Curriculum Vitae

Dr Judy Lawrence

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Academic qualifications

2015 PhD in Public Policy, School of Government, Victoria University of Wellington. *The adequacy of institutional frameworks and practice for climate change adaptation decision making.*
1976 MA Geography (Geomorphology), Victoria University of Wellington, New Zealand
1973 BA Hons, Geography, Victoria University, Wellington NZ
1981 COP Planning Law, Law, Victoria University of Wellington, New Zealand
1979 Soil Conservation Certificate

Professional positions held

2009-present Senior Research Fellow, NZ Climate Change Research Institute, Victoria University of Wellington, New Zealand
Current- Co-Chair, New Zealand Climate Change Adaptation Technical Working Group
2008 Chair, Governance Advisory Committee, National Energy Research Institute
2003-2005 Director NZ Climate Change Office, Ministry for the Environment, New Zealand
1995-2002 CEO Ministry of Women's Affairs, New Zealand
1994-2002 Convener, NZ National Science Strategy Committee on Climate Change
2000-2001 Consultant, Sustainable Development Project, OECD. Paris, France
1993-1995 Environment Strategy Manager, NZ Dairy Research Institute, New Zealand
1987-1993 Senior Manager, Ministry for the Environment, New Zealand
1974-1987 Water and Soil Planner and Deputy Manager Water and Soil Division, Ministry of Works and Development NZ

Present research/professional speciality

Expertise in climate change adaptation; institutional frameworks and practice; dynamic adaptive pathways planning; development of serious games for managing uncertainty. A research boundary agent between physical sciences (drivers of change & consequent impacts) and decision makers.

Distinctions and memberships (e.g. honours, prizes, scholarships, governance roles etc)

2015 Deans Award, Doctoral Achievement, Victoria University of Wellington
Current Membership Chair Society for Decision-making under Deep Uncertainty
Current- Member Resource Management Law Association
Current Member NZ Association of Resource Management
2008-11 Board member of the NZ Ecolabelling Trust
2008 Chair National Energy Research Institute Governance Advisory Committee
2002 Member Reference and Review Groups, Foundation of Research Science and Technology
1999 Fellow Stanford Graduate School of Business, & Harvard Kennedy School of Public Policy
1996 NZ Government Senior Sabbatical Fellow Stanford University Graduate School of Business

Number of publications	Journal articles	Books, chapters, books edited	Reports	Conference proceedings
	10 (+1 in press)	3 (+1 in press)	30+	11 since 2009

Publications

Peer-reviewed journal articles, book chapters and conference proceedings

Lawrence, J, Bell, R, Blackett, P, Stephens, S, Allan, S. (2017) National Guidance for Adapting to Coastal Hazards and Sea-level Rise: Anticipating when and how to change pathway. *Environmental Science & Policy [online]*

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Reisinger, A., Nottage, R., & **Lawrence, J**. (2011). *The challenge of limiting warming to two degrees.* New Zealand Climate Change Centre Climate Brief No.1.

Lawrence, J & Allan, S (2009). *A Strategic Framework and Practical Options for Integrating Flood Risk management-to reduce existing flood risk and the effects of climate change.* Report prepared for Ministry for the Environment, February 2009.

Lawrence, J & Hamilton D. (2007) *Flood Risk Review: Funding roles and responsibilities*. Report prepared for Ministry for the Environment, June 2007

Regular presentations at New Zealand, Australian and global climate change adaptation conferences, and workshops of the Society for Decision Making under Deep Uncertainty since 2014 at RAND Santa Monica; Deltares, the Netherlands, World Bank , Washington; and Oxford University, UK on adaptation and dynamic adaptive policy pathways planning and practice and decision tools, and institutional design for adaptation implementation.

Recent research work

1) *Research title:* *Deep South Science Challenge:* Cascading climate change impacts and implications for New Zealand 2016-2018; **Tools for s**upporting decision making in a changing climate 2017-2019
Principle outcome: Understanding the scope and scale of climate change impacts across New Zealand; Signals and triggers and scenarios for implementation of adaptive plans.
Principal end-user and contact: Central and local government agencies and the private sector
2) *Research title:* *Resilience Natures Challenges: Governance; The Living Edge objectives.* (MBIE National Science Challenge. July 2015-2019).
Principal outcome: Developing governance theory and practice for climate change adaptation
Principal end-user and contact: Local government and utilities.
3) Research title: *Climate Change Impacts and Implications: Enhancing capacity and increasing coordination to support decision-making* (MBIE October 2012-September 2016).
Principal outcomes: Critical decision factors for climate change risk decision-making.
Principal end users and contact: Decision-makers across private and public sectors.
4) Research title: *Applying and elaborating the dynamic adaptive policy pathways approach for decision making under uncertainty.* (CCRI funded to December 2015).
Research outcomes: Use of DAPP for decision making & NZ Rivers and Coast Games available.
Principal end users: Greater Wellington Regional Council, Wellington City Council, Tasman District Council and Ministry for the Environment.
5) Research Title: The Adequacy of *Institutional frameworks and practice for climate change adaptation decision making.* PhD 2015, School of Government, Victoria University of Wellington.
6) Research title: *Community Vulnerability, Resilience and Adaptation to Climate Change.*
Principal outcomes: Case studies and decision-specific framework for community vulnerability and for increasing resilience to climate change. Published work available.
Principle end users and contact: Other researchers and local government and iwi.
7) Research title: *Developing adaptive risk management for our changing climate* (Envirolink contract MBIE 2011-2012).
Principle outcomes: New framing of climate change risk, key factors in local government planning to integrate short and long-term risk planning. Report published.
Principle end users and contact: Local government and researchers.