

# Coastal Adaptation to Climate Change

## *Pathways to Change*



November 2011



# **Coastal Adaptation to Climate Change: *Pathways to Change***

**A report prepared as part of the Coastal Adaptation to Climate Change Project**

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## Disclaimer

While every effort has been made to ensure that this guide is as clear and accurate as possible, NIWA will not be held responsible for any action arising out of its use.

## Acknowledgements

This report was prepared as a part of the FRST funded Coastal Adaptation to Climate Change project (C01X0802).

We appreciate the support of those who assisted in the peer review.

Ministry for the Environment: Warren Gray

Ministry for Civil Defence & Emergency Management: Ljubica Mamula-Seadon

Thames-Coromandel District Council: Peter Wishart

Waikato Regional Council: Peter Singleton

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## Abbreviations Used

AMSL	Annual Mean Sea Level
AR4	Assessment Round 4 (IPCC) (refer also Appendix 4)
ENSO	El Niño–Southern Oscillation (a 2–4 year climate cycle)
IPCC	Intergovernmental Panel on Climate Change
IPO	Interdecadal Pacific Oscillation (a 20–30 year cycle of variability in ENSO)
ISO	International Organisation for Standardisation
LiDAR	<u>L</u> ight <u>D</u> etection <u>A</u> nd <u>R</u> anging (laser scanning for high-resolution topography)
LGA	Local Government Act 2002
m	metre
MCA	Multi-Criteria Assessment
MfE	Ministry for the Environment
MSI	Ministry of Science and Innovation
MHWS	Mean High Water Spring
NZCPS	New Zealand Coastal Policy Statement
RMA	Resource Management Act 1991
SPRC	Source-Pathway-Receptor-Consequence (risk assessment framework)
UKCIP	UK Climate Impacts Programme
UNISDR	United Nations International Strategy of Disaster Reduction

## 1. Introduction

### 1.1 Genesis of pathways to change

The **Coastal Adaptation to Climate Change** project is a three year study which has been undertaken by NIWA and partners. The partners include Robin Britton, Eco Nomos Ltd (Jim Dahm), AgResearch (Paula Blackett), Thames-Coromandel District Council (Peter Wishart), Waikato Regional Council (Peter Singleton), Department of Education University of Waikato (Anne Hume) and the Whitianga and Manaia communities. It is a programme funded by the Ministry of Science and Innovation (MSI). The overall aim of this project is to create the necessary information and tools to enable adaptation by communities, in tandem with central and local government, to the impacts of climate change in the coastal environment. As well as providing a national perspective the project also focuses on how adaptation can be facilitated at regional and local levels to address specific local issues. Hume (2007) comments that the risk of coastal properties from coastal hazards continues to increase and there are substantive benefits in reducing this rising risk to infrastructure and properties through prudent and proactive adaptation.

The project has three key components:

- Building a national coastal vulnerability profile
- Engaging communities and institutional decision-makers
- Encouraging best practice planning.

A key outcome of this research is to enable more informed proactive communities and to assist local authorities to develop local adaptation plans that encompass community values. Our adaptation guidance *'Pathways to Change'* is a synthesis of findings from the overall programme.

### 1.2 Why focus on adaptation?

Adapting to climate change along with intensive development pressures on our coasts will be an ongoing challenge into the future. The potential impacts of climate change will lead to changes in our coastal environments. People within our coastal communities will need to become more aware of climate change effects and either accept the changes and live with them, or start adapting their communities so that they become more resilient to the potential impacts of climate change.

***"The future is not someplace we are going to, it is a place we are creating.  
The path to the future is not found, it is made."***

***Peter Elyard***

There are clearly benefits from increasing people's awareness of climate change impacts and acting now to adapt and provide for a more resilient community in the future.

To maximise the success and effectiveness of adaptation actions there needs to be a joint understanding between people within communities, local authorities and other key stakeholders. This will help all parties to work together to develop adaptation pathways which are based on a mutual understanding of the issues relating to climate change, coastal hazards and risk, and the needs of the different participants. Adaptation is a shared responsibility and partnerships are critical i.e., it is not something that any one council or particular agency, or community, or discipline can do alone. It will require a combined and integrated approach.

A risk management approach is fundamental to this adaptation journey. By taking a risk management approach, coupled with regular monitoring and reviews, the uncertainties associated with the magnitude and timing of climate change impacts can be more readily addressed. That is, there needs to be a balance between the risks of acting too early or too late, and between the potential benefits of actions and the likely magnitude of impacts. A failure to act will simply lead to our communities being more vulnerable in the future. To circumvent uncertainty in the magnitude and timing of climate change, rather than waiting for more surety, an adaptive management approach (in conjunction with regular monitoring and reviews) is a useful way to proceed. As such, implementing pre-planned actions or adaptation stages can be advanced or delayed well ahead of time depending on how changes in sea level and other coastal hazards are tracking – faster or slower than expected (see Box 6.6).

Taking a risk management approach will also enable people and communities to be aware of and help define, the level of acceptable risk for their property, or community, or coastal area. In other words, acceptable risk is the level of risk individuals and communities are prepared to live with, along with the amount they are prepared to pay for activities that would help them adapt to climate change effects over time. People within our coastal communities will need to understand and foresee the issues involved, in order for them to make informed decisions and to help build resilience into the way they act and the way their communities evolve into the future. The decisions we make today, particularly in relation to our land use activities, will affect our future vulnerability and resilience. Making informed decisions about risks that take into account our communities' values, will have clear benefits for the future management of our coastal areas.

This journey of change and adaptation in our coastal areas is likely to be diverse and councils and their communities will be faced with a range of different pathways and barriers through time. The success and effectiveness of adapting to climate change will involve understanding the need for adaptation, embedding it into everyday decision-making and jointly planning actions that will increase each community's resilience to the future impacts from climate change effects on our coasts. It will also involve being flexible to changing circumstances (e.g., new information, increased erosion/ inundation, more frequent closures of coastal roads etc). There is no instant answer – there is no denying that it will take time and effort to adapt. However delaying adaptation will only cost more in the future and expose communities to a greater level of risk to coastal hazards. While it will be difficult, it won't be impossible. We hope that this adaptation guidance will give you ideas and encouragement to start out on your *Pathways to Change*.

### 1.3 Scope of this report

This document provides local authorities and communities with useful and relevant guidance to assist them plan for and implement actions which will help to make our communities more robust to the potential impacts of climate change in our coastal areas.

*Pathways to Change* presents:

- A framework which describes the steps that need to be taken along the pathway to adaptation
- A discussion of key drivers and options available for undertaking each step on this journey
- Case study examples from New Zealand and overseas relevant to each of the steps
- Indicators for measuring and reviewing progress
- A range of reference material.

*Pathways to Change* is intended for use primarily by local authority councillors and staff, particularly those involved in coastal policy and implementation actions, such as resource planning and consents, engineering, building permits, designations for utilities and infrastructure, scientific monitoring and community action. It is also for use by other agencies involved in coastal work, community groups and individuals interested in ensuring their communities are as resilient as possible for the future.

We acknowledge that this guidance document will not provide solutions to every problem that local authorities and communities face. We intend that it provides a pathway to assist you in taking a journey, making changes over time that will make our coastal communities more resilient to the effects of climate change. We also recognise that there is a range of other complementary work that has or is being undertaken in relation to coastal climate change and adaptation and we have sought to provide linkages throughout this document to key documents and case studies.

***“The challenge is not to find the best policy today for the next 100 years, but to select a prudent strategy and to adjust it over time in the light of new information.”***

***(IPCC, 1996)***

### 1.4 Structure and how to use this adaptation guidance report

In developing *Pathways to Change* we aimed to make this guidance:

- Appropriate in a New Zealand policy and local government context
- Consistent with existing national guidance on climate change
- Apply a risk management framework to decision-making, and
- Useful for enabling local solutions to be found that are appropriate for the risks and resources of each council.

We have structured our document around four key steps along the Adaptation Pathway. You can delve into whichever step of the pathway is most appropriate and useful for where your council or community is up to on its journey towards coastal adaptation to climate change. These steps are likely to be iterative. By this we mean that while you may progress along the steps in our journey, sometimes the path may be blocked by a barrier and you may need to go back to a previous step and do more work before proceeding again. This iteration of steps also recognises that the changing pace in the on-set of climate change (faster or slower than anticipated) may require further evaluation.

As per the flow chart below:

**Chapter 1** provides an **introduction** to the guidance and some key themes underlying the document.

**Chapter 2** provides a **context**. It overviews the science that guides how we are dealing with adaptation to climate change in New Zealand. We also provide some key definitions to set the context for our *Pathways to Change* document, along with some background on adaptation planning.

**Chapter 3** describes the ***Pathways to Change*** framework. This a key starting point for any person using this document. The journey along the Adaptation Pathway may not be linear but may be repetitive over time depending on different ‘drivers’ that influence a council or community at any stage in time and on changes in the pace of climate change.

In **Chapters 4 to 7** we describe the **4 steps** along the Adaptation Pathway along with identifying the key characteristics of that step, some suggested approaches and tools that could be used and some case studies:

- Chapter 4: **Awareness and Acceptance** - of what coastal adaptation to climate change is about and accepting that we have to do something to prepare for the future
- Chapter 5: **Assessment** –involves gathering information and assessing the level of risk our communities face, both at an overview and site specific levels
- Chapter 6: **Planning a way forward** - sets out the commitment to plan a way forward for the future
- Chapter 7: **Implementation, Monitoring and Review** – is about implementing the adaptation plan and monitoring and reviewing it to ensure that the actions are effective, that we measure progress along the adaptation journey, and make iterative changes when and where needed.

In **Chapter 8** we finish off with a **wrap-up** of key messages.

A range of supporting reference material is provided in the **Appendices**. Throughout the document we use boxes to highlight case studies of work being carried out in New Zealand (and beyond) that contributes to adaptation to climate change. These examples illustrate the breadth of work that is already being undertaken, in the hope that this will encourage you to start along the *Pathways to Change*.

Chapter 1:  
Introduction

Chapter 2:  
Setting the Scene

Chapter 3:  
Adaptation Pathway

Chapter 4:  
Step 1 Awareness and Acceptance

Chapter 5:  
Step 2 Assessment

Chapter 6:  
Step 3 Planning a Way Forward

Chapter 7:  
Step 4 Implementation, Monitoring and Review

Chapter 8:  
Wrapping up

***The longest journey begins with the first step***

(ancient Chinese proverb)

*We wish you well on your adaptation journey*

## 2. Setting the Scene

### 2.1 Climate change, sea-level rise and coastal hazards

Before we outline our Adaptation Pathway, it is important to understand the context of climate change within New Zealand and the projected impacts of climate change at the coast, including sea-level rise.

The most up-to-date and comprehensive account of the effect of climate change and sea-level rise on coastal areas of New Zealand is provided in the Ministry for the Environment's national guidance manual *Coastal Hazards and Climate Change: A Guidance Manual for Local Government in New Zealand* (MfE, 2008a). This national guidance manual should be regarded as the fundamental basis for any adaptation journey. A number of Factsheets at the end of this national guidance document provide useful information about technical aspects of coastal processes, (e.g., on topics such as waves, tides, and coastal erosion).

This national guidance manual identifies that a high proportion of New Zealand's coastal edges have been settled by urban development. Some of this development has been located in areas currently vulnerable to coastal hazards (such as coastal erosion and inundation by storm-tides and wave overtopping, drainage problems, saltwater intrusion into landward areas and estuaries). Climate change effects, while gradual, will increasingly exacerbate these coastal hazards and begin to affect previously untouched areas. Locally managing the effects of such coastal hazards along with the progressive influence of climate change, through monitoring, reviewing and appropriate implementation actions, is fundamental to maintaining or developing sustainable and resilient communities. Planning decisions that incorporate adaptation to climate change are therefore essential.

This national guidance manual specifically:

- Provides a New Zealand context of the key effects of climate change on coastal hazards
- Provides a risk assessment framework for incorporating coastal hazards and climate change considerations into decision-making processes
- Promotes the development of long-term adaptive capacity for managing coastal hazard risk through adoption of adaptive management and no-regrets or low-regrets response options.

At its 2008 publication date, this guidance manual was based mainly on the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) which was released in 2007 (Bindoff et al., 2007; IPCC, 2007b). The guidance manual also encapsulated additional peer-reviewed scientific studies on sea-level rise that appeared after the 2006 cut-off point for publications to be considered in the AR4 report. These and more recent studies (Royal Society of New Zealand, 2010) indicate sea levels may rise higher than the upper levels presented by IPCC (notwithstanding that IPCC at the time of AR4 were not prepared to provide a best estimate or an upper bound, due to the limited understanding of the response of polar ice-sheets).

In terms of climate-change impacts, the MfE (2008a) guidance manual advocates planning for:

- A range of possible sea levels by the 2090s (2090-2099) using a risk assessment process that includes a consideration of adaptation costs, taking into account uncertainties in the timing and magnitude of future sea-level rise. An overview of the MfE (2008a) sea-level rise guidance is shown in Box 2.1 below with a commentary on its usage
- Climate change impacts on tides, storm surges, waves, swell and sediment supply; both the magnitude of the effect and changes to the frequency of occurrence
- The present mean high water spring (MHWS) level will be exceeded more frequently in the future and increasingly so (MfE, 2008a).

*Pathways to Change* builds on the information contained in the national coastal hazards guidance manual (MfE, 2008a and MfE, 2009). It does this by providing a wider framework for considering in more detail the tools and methods that can be used to enable adaptation to the likely impacts of climate change on our coastal margins, so that these can be built into local authority planning and decision-making. Our adaptation guidance *Pathways to Change* is intended to complement, and not in any way replace, this existing national guidance.

#### **BOX 2.1: Sea-level rise guidance within a risk-assessment framework**

The MfE (2008a) guidance manual *Coastal hazards and climate change* recommends for planning and decision timeframes out to the **2090's** (2090-2099):

1. a **base** value sea-level rise of **0.5 m relative to the 1980–1999 average** should be used, **along with**
2. **an assessment of potential consequences from a range of possible higher sea-level rises** (particularly where impacts are likely to have high consequence or where additional future adaptation options are limited). At the very least, all assessments should consider the consequences of a mean sea-level rise of **at least 0.8 m** relative to the 1980–1999 average. Guidance is provided in Table 2.2 (*of the guidance manual*) to assist this assessment.

*Note: Table 2.2 in the MfE (2008a) guidance manual covers a range of sea-level rise projections by 2100 with upper bounds from 0.8 m from IPCC (2007b) to 1.0–1.4 m (based on three empirical studies from 2007 and 2008 described in the Table 2.2), to which values from more recent studies outlined in a Royal Society of New Zealand Emerging Issues paper could also be considered within the risk-based assessment. (Royal Society of New Zealand, 2010).*

For longer planning and decision timeframes where, as a result of the particular decision, future adaptation options will be limited, an allowance for sea-level rise of **10 mm per year beyond 2100** is recommended (in addition to the above recommendation).

(MfE, 2008a)

### Commentary on the sea-level guidance:

The risk assessment should be based on a broad consideration of the potential consequences (direct impacts, loss of assets and amenity) from different sea-level rise magnitudes on a specific decision, objective or issue. The particular sea-level rise adopted in each case should be based on the acceptability of the potential consequences and likelihood of that sea-level rise (=risk) and the potential future adaptation costs that may be incurred, especially if sea-level rise is higher than anticipated.

Each risk assessment should also take into account the physical shore-type context (e.g., gravel, sandy or cliffed coasts) and the adjacent land-uses. In particular, upgrading existing development should be treated differently from new developments ('greenfields'), where risk avoidance and a precautionary approach are paramount (e.g., Policies 3(2) and 25(b) of the New Zealand Coastal Policy Statement (NZCPS), DoC 2010; see Appendix 1) along with the need to recognise the permanency of such developments and that sea levels will continue to rise for possibly several centuries. Therefore in undertaking a risk assessment and appraising future adaptation for greenfield developments, sea-level rises well over 0.8 m should be considered. The MfE guidance (MfE, 2008a), as it stands, recommends assessing a **range of sea levels**, starting any appraisal with a 0.5 m rise (by 2090s) and with the "at least 0.8 m" as a minimum higher sea-level rise to consider when assessing future consequences. Using this set of two benchmark values is therefore a minimum to consider, but assessments should not to be limited to those values.

Hence the risk assessment process, as recommended in the MfE guidance manual (MfE, 2008a), is an enduring approach, although it will need updating periodically in terms of planning timeframes. For example, the 2010 NZCPS requires assessments of hazards for "at least 100 years" (Policies 10(2)(a), 24, 25). So already the range of sea-level rises that should be considered needs to take into account the presently recommended extension of 10 mm per year beyond 2100 e.g., the equivalent benchmarks **by 2115** (nominally the next 100 years relative to the 1980–1999 average) would be for an assessment starting at a **base value of 0.7 m** (equivalent to 0.5 m rise by 2090s) and **considering a range of possible higher values including at least a 1.0 m rise** (was a 0.8 m rise by 2090s). Both these 2115 values have been rounded to the nearest 10 centimetres, taking into account the present guidance is for the 2090s decade with mid-point at 2095.

## 2.2 Useful definitions

There are a number of key concepts which we use in *Pathways to Change* and we have drawn on the following definitions from national guidance (MfE, 2008a), unless otherwise stated:

**Adaptation to climate change:** Undertaking actions to minimise threats or to maximise opportunities resulting from climate change and its effects

**Adaptive capacity or Resilience:** The ability of a social or ecological system to: adjust or respond to climate change (including both variability and extremes); moderate potential damages; take advantage of new opportunities arising from climate change; or cope with and absorb the consequence; and includes the capacity for self-organisation, and the

capacity to adapt to stress and change. (Note: these terms are often used inter-changeably) (adapted from MfE, 2008a and IPCC 2007a)

**Adaptive management:** A structured, iterative process of optimal decision-making in the face of uncertainty, with an aim of reducing uncertainty over time via system monitoring. In this way, decision-making simultaneously maximises one or more resource objectives and, either passively or actively, accrues information needed to improve future management (Source: Wikipedia)

**Climate change:** A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer)

**Hazard:** a source of potential harm to people or property.

Examples are coastal erosion or inundation. Note a hazard does not necessarily lead to harm or damage.

When thinking about hazards and adaptation, we also need to consider levels of risk and how much risk a community is prepared to tolerate in terms of its vulnerability.

**Risk:** effect of uncertainty on objectives (AS/NZ ISO 31000, 2009).

The chance of an 'event' being induced or significantly exacerbated by climate change, that event having an impact on something of value to the present and/or future community. Risk is measured in terms of **consequence** and **likelihood**. It also has an element of **choice** by humans regarding how much risk they will tolerate or accept (adapted from MfE, 2008a)

**Vulnerability:** predisposition to be adversely affected or unable to cope with events (adapted from World Health Organization, 2002)

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. (adapted from MfE, 2008a and IPCC, 2007a).

Risk (which includes consideration of magnitude, likelihood, consequence and vulnerability) is about the degree to which human communities and natural ecosystems are exposed and susceptible to adverse effects of climate change. There are many aspects of vulnerability, arising from various physical, social, cultural, economic, and environmental factors. Examples (from UNISDR, 2009) may include poor design or location of buildings, lack of public information and awareness, limited official recognition of risks, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. The definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure (UNISDR, 2009). However, in common use the word is often used more broadly to include the element's exposure.

As far as the relationship between vulnerability and adaptation is concerned, vulnerability is defined in terms of the capacity to adapt or adaptation is facilitated by reducing vulnerability (Kelly and Adger, 2000).

## 2.3 Decision-making in the face of uncertainty

Putting these key concepts together in the realm of natural hazards and significant long-term change can often mean we are making decisions within a context of uncertainty. There can be uncertainty around:

- When and how often (frequency) these effects could occur
- The magnitude of effects likely to occur in a given timeframe
- The future trajectory of natural climate variability (e.g., El Niño/La Niña) and extremes
- Downscaling global-average projections of climate change down to local or regional impacts
- The timeframe we need for considering any actions which will assist with adaptation, and
- Projecting the future changes in our communities (e.g., demographics, socio-economic make-up, energy use, environmental values, legislative changes).

The need to make decisions in the face of these uncertainties is also recognised in the NZCPS (DoC 2010), particularly through Policy 3 on the precautionary approach and through the timeframes for identifying hazard risk over a 100 year period in Policy 24 (Appendix 1).

One tool for addressing uncertainty is the development of climate-exposure scenarios or ‘what if’ questions to determine the impacts of climate that your problem or decision is most sensitive to. This approach can provide decision-makers with a range of future options to consider (e.g., Gluckman, 2010). Implementing adaptation may initially adopt one of these options, or an initial staging of the option. But within an adaptive management framework, it may be superseded by another option if future changes in the uncertainties or trends warrant it. Another key tool for dealing with uncertainty is the risk management approaches as set out in AS/NZ ISO 31000 (2009).

However while uncertainty is a barrier to decision-making as identified in Britton (2010) it is important that uncertainty is not used as the key reason for taking no actions or to postpone adaptation planning. Rather, to deal with the uncertainty of timing and magnitude of future projections in climate change, we recommend that **a credible mid-range** trajectory in sea-level rise is adopted (this is discussed further in section 6.4).

*“Good strategies .. are necessarily built on imperfect and incomplete information ... But consider the alternative .. there is a greater threat of ‘analysis paralysis’ looking for the last piece of information, leading to no decision being taken ..”*

*(Sterling, 2003)*

### **Box 2.2 Decision-making in the face of uncertainty in a climate change context**

The physical and natural science involved in trying to understand climate change issues (from understanding past climate changes to modelling predicted future climate scenarios) is extremely complex. The social science involved in understanding the potential risks to humans and the ranges of mitigation and adaptation options available are equally as complex, as are the politics involved in decision-making on a global scale. Working at this global scale, the working groups of the IPCC span these uncertainties, and as a result the IPCC has undertaken a very thorough process to understand these uncertainties. One of the outputs of this process was a guidance note for lead authors (IPCC, 2005), helping to typify uncertainties and giving advice on how to deal with uncertainty, including defining terminology to be used when discussing the likelihood of particular events. Hence the IPCC AR4 reports use terms such as 'virtually certain' (>99% probability), 'likely' (>66% probability) or 'very unlikely' (<10% probability) to enable consistency between very different subject matter. By doing this the IPCC has established a clear methodology for communicating the scientific uncertainty of specific statements, so that policy makers can understand the nature of the information they are using to set policy.

Regardless of any attempts to understand and measure the uncertainty around the projected effects of climate change, there will always be residual risk that requires management (Rouse and Norton 2010). Adaptive management, risk management, and precautionary approaches can all be used to assist with making decisions in the face of uncertainty.

In New Zealand, a risk management approach to managing climate change risks is promoted, and there is guidance as to how to undertake risk assessments for a number of potential climate changes issues (MfE, 2008b) and more specifically for coastal issues (MfE, 2008a; AS/NZ ISO 13000, 2009). A similar risk management approach is advocated in the UK (see UKCIP website <http://www.ukcip.org.uk/>; Willows and Connell, 2003). At a regional and local scale, councils seeking to manage coastal climate change effects using a risk management approach need to understand uncertainties about both the likelihood and consequences that make up the risk.

*Pathways to Change* has identified a number of key pointers to help councils in managing coastal climate change, and in particular those seeking to engage their local communities in discussion around climate change impacts and potential adaptation options. Some main points for assisting decision-making in the face of uncertainty include:

- Acknowledge any uncertainties in the information available – this is an important first step to managing it
- Avoid 'decision paralysis' – while you do need to acknowledge uncertainties, make sure that uncertainty discussions don't lead to inaction overall
- Give it some context - talk about current issues that are being experienced first, before casting thoughts to the future
- Make it personal – understand what is valued by the community, and show how that might be impacted

- Focus on ‘not if but when’ – uncertainty about the exact numbers of likelihood or consequences of a risk such as sea-level rise does not mean it won’t happen
- Scenarios are useful to express upper and lower bounds of possible effects so that people understand the likely ranges. But within that range, it will be most useful to define a ‘credible’ scenario as a basis for action. Importantly, don’t be alarmist - scaring people is unlikely to engage them
- Aim for robust rather than optimal adaptation (Wilby and Dessai, 2010) – choose low regrets options that will allow flexibility rather than the best possible options for an uncertain effect

### **BOX 2.3 Responses to uncertainty in the magnitude of sea-level rise within a planning timeframe**

Councils have shown differing responses when faced with information from scientists about the uncertainties in the magnitude of sea-level rise that will eventuate. This applies particularly to the prospect of increased polar ice-sheet discharges, which has if anything, increased the uncertainties for the range of sea levels expected within a given planning timeframe.

Some councils have responded by beginning to assess the risk for a range of possible higher sea-levels, irrespective of the planning timeframe, which has been extended up to assessing the impacts for a 2 m rise in the case of a Wellington City Council vulnerability study (Bell, 2011). Other councils appear to be waiting for more definitive values of sea-level rise, delivered either through a National Environment Standard or from the next IPCC 5<sup>th</sup> Assessment Report (Working Group I), which is not due until late 2013.

Despite ongoing uncertainties around the rate of rise of sea-level rise and the effect of climate change on coastal hazards, national and local government and communities should and can continue to make decisions that either implicitly or explicitly make assumptions about changes in climate within required planning timeframes. Other sections of this guidance discuss approaches, such as risk management, adaptive management, or applying the precautionary approach (Policy 3, NZCPS) which can circumvent some of the issues associated with future uncertainties in the magnitude and timing of sea-level rise.

## **2.4 Drivers for adaptation planning**

Adaptation to climate change can be seen as a series of actions taken over time that involve social, cultural, economic and technical elements. The actions aim to build increased resilience in coastal communities and in natural coastal ecosystems, so that communities and the environment have an increased ability to cope with and to adjust to the potential effects of climate change.

The potential effects of climate change on our coasts can also include beach and cliff erosion, beach accretion, storm-tide inundation and effects on king (perigean-spring) tides. In addition there are threats to ground water or potable lowland-river supplies from salinisation, and coastal squeeze of

buildings and important ecosystems. These effects are already recognised as being coastal hazards but climate change will exacerbate them (MfE, 2008a).

The main driver for managing coastal hazard risks in New Zealand is legislation, including in particular the Resource Management Act, 1991. An outline of relevant legislation is provided in Appendix 1. These legislative drivers set out requirements for identifying risks and planning to address those risks. To support this planning, scientific information as discussed above is required. In addition there is an awareness amongst councils that new and ongoing protection of our coastal edges may not be sustainable (economically or environmentally) in the future as the rate of climate change increases (Britton, 2010).

Hazards planning can involve both proactive and reactive approaches. These are contrasting approaches that are both commonly used by local authorities in New Zealand (Adger et al., 2007; MfE, 2008a; Britton, 2010).

Proactive planning involves putting policies, strategies and/or actions in place in advance, to avoid or reduce the potential risks from coastal hazards. It is about involving communities and making strategic decisions for the future. For example, it could mean controlling the location and density of landward coastal subdivision so that natural beach processes (waves, sediment movement and resulting shoreline cut and fill) are not impeded. Or it could involve design requirements for redevelopment such as location away from the coastal edge or increased minimum floor levels for buildings, or flexible types of building foundations, or more strategic location for infrastructure. On the other hand, reactive planning looks at options that address the effects of a hazard event once it has occurred, and often requires a rapid response to the hazard event, as well as to public and political pressures. This generally results in the consideration of a narrower range of alternatives, with an emphasis on protecting property or infrastructure at immediate risk. Such responses restrict coastal processes by 'holding the (shore) line' with structures such as seawalls, rock protection or beach nourishment.

Undertaking proactive planning now provides time for the avoidance of new or future risks, for the consideration of alternative management options, for financial commitments and for implementation, in advance of any potential disaster. If we delay planning and taking actions now to help our communities to adapt, we will be facing a future of ongoing costs associated with (reactive) responding to damage from coastal hazards, to people, property, infrastructure, the local economy and to our coastal amenities and environments. These costs will likely escalate as our coasts become more and more urbanised, with increasing service levels expected from our communities for supporting infrastructure and protecting increasing land and capital values. Likewise there will be an increasing tension between sustaining natural coastal processes (and natural character) and people's expectations based on their property rights. For example, while coastal-edge home owners may be able to afford the cost of shoreline protection works, such works will inevitably result in a loss of public beach values (such as amenity values, high tide beach, access at high tide in front of seawalls and natural character) that are enjoyed by the wider community. Local authorities will also need to assess whether they can sustain escalating costs of ongoing maintenance and upgrades to existing structures and increasing new demands for hard protection works or soft-engineering approaches such as beach sediment replenishment.

## 2.5 Where are we at with coastal adaptation to climate change?

In developing *Pathways to Change* we have drawn on the information gathered from a report on *Local Government Planning Practice and Limitations to Adaptation* prepared as one component of the overall Coastal Adaptation to Climate Change project (Britton, 2010).

The aim of this background report was to provide an overview, from a council staff perspective, of the approaches local authorities in New Zealand are currently taking to coastal climate change adaptation. This work helped us to develop the Adaptation Pathway by providing insights into the range of barriers being faced by Local Authorities and identification of areas where help was needed.

Staff from 24 local authorities, including regional, district and unitary councils were involved in this research. Questions were asked in respect of their current approaches to managing adaptation to climate change, impediments to them responding to adaptation to climate change, how they saw future directions for their council and work programmes, and what additional resources could be of assistance to them.

The report found that in general, local authorities' work programmes did not address adaptation to climate change as a specific work programme; however all councils surveyed were involved in work areas directly linked to the management of coastal natural hazards, including for example: planning, research and investigations, education and community involvement, liaison and engineering works. There was agreement that climate change would be included into the 2<sup>nd</sup> generation RMA plans (due to the RMA Amendment, 2004). However, when asked whether the current approaches being undertaken were sufficient to adequately adapt to climate change, 75% responded in the negative.

Many barriers or limitations to action were identified by council staff. Those that were most commonly identified included a lack of political understanding and 'buy-in' and issues around resourcing work (especially prioritising work and funding). All local authorities identified the following as limitations or barriers: political attitudes and awareness, community awareness and understanding, national guidance, risk information, and decision-making processes and timeframes. In addition district councils commented specifically on availability of funding (particularly for infrastructure) and staff resources, as well as on staff skill sets; while regional councils commented specifically on land use planning, the propensity for inaction and legal barriers.

One local authority commented that to overcome the inertia on adaptation to climate change would require a public-wide culture change or 'sea change', through more informed public debate. It was considered that a co-ordinated approach to achieving such a change would be required involving for example, central government, councils, communities, banks, insurance agencies. When asked about changes that would be required to assist them in the adaptation journey, common themes that were mentioned included: stronger national policy guidance, more robust data and locally specific information, increased community and political awareness, and additional guidance material.

We have therefore sought through this *Pathways to Change* document to address some of these requirements, by providing a simple adaptation framework of steps, reinforcing a range of readily available information that can be drawn on and building on the policy directives provided for by the NZCPS (DoC 2010). In short, while it appeared at the time of the survey (2009), that many councils were at or near the beginning of their adaptation journey, we have found during the development of *Pathways to Change* that there are many examples of actions that different councils are already taking towards adaptation planning.

In developing this guidance we have included data from the 2009 survey (Britton, 2010) in each of the steps, along with information links and case studies from different examples.

### 3. What is an Adaptation Pathway?

Adaptation involves managing changing levels of risk, including minimising or reducing risk where possible, and managing any residual risk. It also involves a process for achieving change over time to enable people and communities to adjust to changing conditions and to minimise or reduce the risk to themselves and to property from the effects of natural coastal hazards, which have been exacerbated by climate change (Smit and Wandel, 2006). In essence, adaptation is a social process because it concerns the ways in which human activity and systems will respond to change (Duerden, 2004). It is also a complex and iterative process involving various steps (Klein et al., 1999).

It is in this context that adaptation can be seen as a **journey** which involves many steps along the way. It also involves iterative steps over time and so is an ongoing and sometimes meandering journey. The end destination of the journey is a place where coastal communities are resilient, i.e., they have the capacity to adapt to climate change impacts.

The Adaptation Pathway outlined in *Pathways to Change* is shown in Figure 3.1 and Table 3.1. It is a framework for considering adaptation and the key steps along the pathway.

Figure 3.1: *Pathways to Change* – 4 steps on the adaptation journey towards a resilient community



**Table 3.1: The 4 Step Adaptation Pathway**

<p><b>Step 1</b></p>	<p><b>Awareness and Acceptance</b></p>	<p>This step is about informing people within your council and your communities of the potential effects of climate change. It is also about accepting there's a problem and that further work is needed.</p> <ul style="list-style-type: none"> <li>• <i>Why do we need to be doing anything about coastal adaptation to climate change?</i></li> <li>• <i>How much of a priority is it?</i></li> <li>• <i>What are the levels of political and community awareness, and how could we enhance this awareness?</i></li> <li>• <i>How are other councils addressing coastal adaptation to climate change?</i></li> <li>• <i>Do we have general acceptance that we have a problem to address?</i></li> </ul>
<p><b>Step 2</b></p>	<p><b>Assessment</b></p>	<p>This step is about gathering knowledge to be better informed on the scale and scope of potential effects of climate change</p> <ul style="list-style-type: none"> <li>• <i>What information do we need to assess how climate change might affect our local coastal communities?</i></li> <li>• <i>What issues do we face?</i></li> <li>• <i>Where are our most vulnerable locations?</i></li> <li>• <i>What is the level of risk we are facing?</i></li> </ul>
<p><b>Step 3</b></p>	<p><b>Planning a way forward</b></p>	<p>This step is about planning what needs to happen to achieve adaptation to climate change</p> <ul style="list-style-type: none"> <li>• <i>What is going to be our strategic and long-term approach to adaptation?</i></li> <li>• <i>What are the steps required to move us in this strategic direction over time and thereby build community resilience?</i></li> <li>• <i>How do we get buy-in from key stakeholders and communities?</i></li> </ul>
<p><b>Step 4</b></p>	<p><b>Implementation, Monitoring and Review</b></p>	<p>This step is about undertaking the actions that have been set out in the adaptation plan developed in Step 3. It includes monitoring change over time of the environment, of information, of implementation progress and so on. The monitoring results then feed into regular reviews of the adaptation plan, in order to incrementally build community resilience to the increasing risks being faced.</p> <ul style="list-style-type: none"> <li>• <i>Is our plan for a strategic way forward being implemented effectively?</i></li> <li>• <i>Are our communities becoming more resilient to climate change?</i></li> <li>• <i>What do we need to monitor, and what are the triggers for reviewing our adaptation plan?</i></li> </ul>

While each step has a number of characteristics which can be used to define it, to some extent the steps occur along a continuum or pathway. However, formulating this pathway with distinct steps provides a framework for considering how adaptation to climate change in coastal areas can be addressed over time, and adaptation achieved through incremental steps along the Pathway.

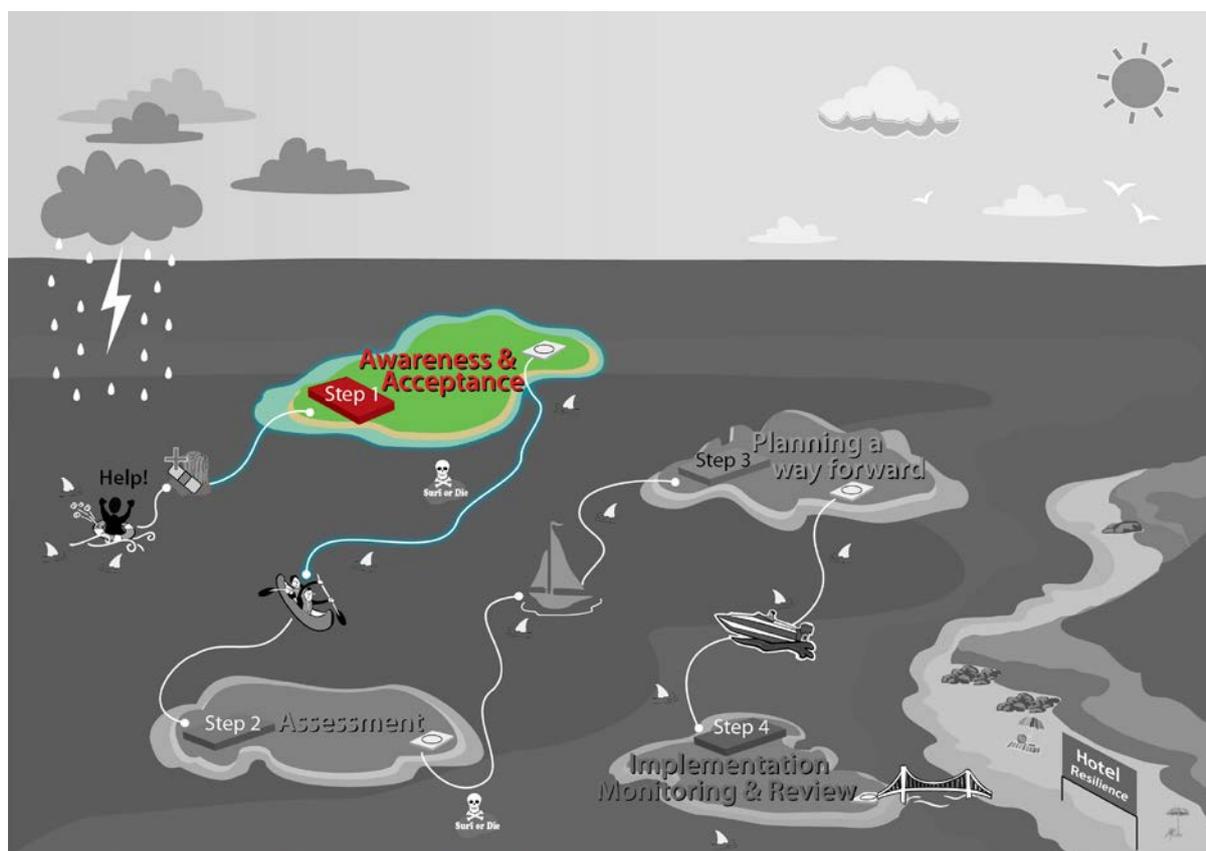
We discuss each of these steps in more detail in the following chapters (chapters 4-7) and within each step we describe:

- The key drivers for the step and some of the barriers you may encounter
- Tasks that should be undertaken at this particular step, and some tools for undertaking those tasks
- The key outputs that will result from these tasks, and
- Case studies to help explain the tasks in the step.

## 4. Step 1: Awareness and Acceptance

### 4.1 How do I know if I'm at Step 1?

Awareness of **how much and by when** climate change could impact your local coastal communities is the first step on any adaptation journey. The first step could be triggered through a storm event causing coastal erosion or flooding, or through an Environment Court challenge to a plan or consent, or through a groundswell of general public opinion, or awareness through media and discussions, or through the council's need to undertake long-term planning for coastal infrastructure. Awareness is the foundation of change, and the elements that build this awareness will underpin the following steps of the adaptation journey.



If you are at this step on the pathway, key questions that you and your council and community might be asking include:

- *Why do we need to be doing anything about coastal adaptation to climate change?*
- *How much of a priority is it?*
- *What are the levels of political and community awareness, and how could we enhance this awareness?*
- *How are other councils addressing coastal adaptation to climate change?*
- *Do we have general acceptance that we have a problem to address?*

If you are at Step 1, there will be a range in the levels of political and community will – but if your council is not really ‘doing’ much you are probably here ... at the start of the journey! Key tasks at Step 1 include informing people both within council and within your communities of the potential effects of climate change. It’s also about taking them on a journey of dialogue or korero where they can discover for themselves how climate change might impact on the amenities or assets they value in their communities. Only then will they realise (and accept) the need for adaptation. Engaging communities and raising their awareness can be a long and slow process, especially when the impacts of climate change may not affect them directly, but will affect their grandchildren and beyond.

## 4.2 Key drivers and barriers

At the first step on the Adaptation Pathway, a key driver that will encourage councils to think about climate change is the legislative requirements. The legislative drivers are expanded further in Appendix 1 and in the national guidance developed by MfE (Chapter 4 and Appendix 1 in MfE, 2008a; Section 4.3 of MfE, 2008b).

Local authorities have both social and legal obligations to take climate change effects into account in their community planning and to ensure existing and future generations are adequately prepared for future climate conditions. This is central to building adaptive capacity (i.e., resilience) within coastal communities.

Legal challenges for not meeting these obligations can be significant. For example, this could include Environment Court appeals on resource management plans or resource consents. In addition longer term costs and liability are also relevant drivers for local government actions (e.g., dealing with past decisions made about land use, where properties may be threatened in the present or future). While councils can be financially liable for decisions that are shown to have been made in the face of information that should have led to a different decision, climate change related issues are less likely to result in direct liability unless areas become uninhabitable as a result. However, community costs in enhancing or retrofitting infrastructure can be considerable (e.g., realigning roads, relocating sewage, water supply, stormwater structures). Questions of equity in relation to wider community interests also arise (e.g., protection of private property can result in loss of beach amenity for the wider community; funding hard protection structures now for the protection of future generations). (For further information refer to the MfE resources identified in Box 4.2 and Appendix 3).

Within your council and within your communities, the level of understanding of, and attitudes towards, climate change can also be significant drivers or barriers. While fellow staff, politicians, and local and national lobby groups may be allies in gaining traction in increasing awareness about climate change and adaptation, they may also be reluctant to get involved and support you. In addition, in working with your council and communities it will be important to manage their expectations of adaptation planning in order to keep the workload achievable and manageable.

Likewise, existing hazard issues may be a critical driver as they provide a focus on issues or locations that need to be managed, and if the hazard problems are sensitive to climate change, it is likely the problem will be exacerbated in the future.

The level of awareness and acceptance of climate change and the need to adapt will influence a council's work programmes and budgeting priorities.

#### **Box 4.1 Local Authorities' Views:**

The following extracts are from the *Report on Local Government Planning Practice and Limitations to Adaptation* (Britton, 2010)

"It was also noted that more communities were likely to be confronted by adaptation decisions in the future. In this respect, it was frequently commented that increasing community awareness of climate change impacts and an understanding of 'acceptable risk' would be critical in helping to modify people's expectations about future subdivision, use and development in the coastal environment."

"Political attitudes influenced to what extent adaptation to climate change was addressed in a council. Where there was a lack of belief in climate change, or where there was a variable level of understanding and knowledge, there was generally a reluctance to commit resources to or set priorities for this area of work, particularly as it was perceived that there was no national directive to do so (noted at the time the research interviews were undertaken)."

"The level of knowledge and understanding within communities is varied and not well developed, making it difficult for affected individuals or communities to engage in a discussion of the issues in a way that would enable them to take responsibility for determining the preferred actions for the future of their settlements."

"Generally there is a low level of understanding of 'natural processes' and an expectation that councils will 'protect' private property rights and public reserve land (i.e., 'hold the line' against coastal erosion). Most communities were seen to be extremely resistant to ideas of retreat, relocation or judicious development on coastal margins, particularly when there is no obvious or imminent hazard threat."

### **4.3 Tasks for Step 1**

As Step 1 on the Adaptation Pathway is all about Awareness and Acceptance, the key task that is required is putting together an argument to act. This includes raising awareness of both your organisation and your communities about the potential effects of climate change on your coast, and about ways of adapting to those potential effects. Typically the information you need to cover includes:

- Potential climate change and associated impacts within various timeframes (e.g., IPCC, 2007b; MfE, 2008a; MfE, 2008b)
- The physical setting and topography for your communities (e.g., Is it a cliff, gravel, or sand coast? Does it have coastal defences? Is it low lying?)
- The local coastal habitat and ecosystems and how they might be affected

- Those areas in the district/region that have historical problems that will be exacerbated sooner than other areas
- The local coastal dynamics (i.e., how and when might coastal inundation or erosion impact at local sites relative to any historical records)
- How and if your council's RMA and LGA plans currently deal with climate change adaptation
- Council responsibilities and liabilities (particularly for communication of information to politicians and council staff, and to local property owners)
- Identification of key community values and infrastructure and how and when they might be impacted.

#### 4.4 Tools to help you at Step 1

Raising the awareness of your colleagues, council and communities about climate change at the coasts and getting their acceptance of the need to adapt to it is no small task. This step is about beginning to open dialogue and to bring information to people's attention for them to consider and to start thinking more about climate change and potential impacts. This might include addressing arguments from climate change 'sceptics', and providing information that can be built on. But it must be acknowledged that you will never get all people to agree on climate change and accept the need to manage potential impacts.

There are two parts to raising awareness and seeking acceptance for further action: getting agreement from your council (politicians and staff) that adaptation to climate change rates highly enough to be addressed; and getting other individuals and the community to discuss the issues and to realise that adaptation problems will need to be addressed. You will need to take different approaches for these two groups.

Politicians, individuals and communities need to be well informed about the potential impacts and risks from climate change before they can make informed decisions about or accept that they need to take actions to adapt. Therefore it is critical that councils have political and senior management awareness, acceptance and support for adaptation actions, since without this it will be difficult to commence dialogue with other individuals or communities. However we iterate that acceptance does not mean that all people involved need to be in agreement on climate change issues, rather it is important that the key council decision-makers accept that taking no action is not a sustainable option for the future. It is also important to note that taking climate change into account is already a fundamental part of the council's normal business (e.g., taking account of sea-level rise when planning new/ upgraded infrastructure).

Raising council awareness will include providing specific information on climate change science, sea-level rise and the projected impacts of climate change at the coast, as well as on legislative responsibilities and liabilities. The resources under References and in Appendix 3 can provide the basis for the preparation of material for discussions.

Mapping the projected impacts from initial scoping impact studies can also be an effective tool for raising awareness (see also Step 2).

## Box 4.2 What climate change information do we need to tell people about?

Guidance on the most recent information on climate change for New Zealand is summarised in a series of Ministry for Environment guidance documents, including in particular:



MfE, 2008a. *Coastal Hazards and Climate Change. A Guidance Manual for Local Government in New Zealand*. This guidance is a comprehensive technical report which is updated after each IPCC assessment.

<http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/>



MfE, 2008b. *Climate Change Effects and Impact Assessment: A Guidance Manual for Local Government in New Zealand*. This guidance is a comprehensive technical report based on the Fourth Assessment Report of the IPCC.

<http://www.mfe.govt.nz/publications/climate/climate-change-effect-impacts-assessments-may08/index.html>



MfE, 2008c. *Preparing for Climate Change: A Guide for Local Government in New Zealand*. (Red book). This is a summary of the MfE (2008b) guidance.

<http://www.mfe.govt.nz/publications/climate/preparing-for-climate-change-guide-for-local-govt/>



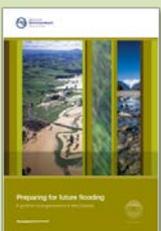
MfE, 2009. *Preparing for Coastal Change: A Guide for Local Government in New Zealand*. (Blue book). This is a summary of the MfE (2008a) guidance, with easy to read fact sheets.

<http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/index.html>



MfE, 2010a. *Tools for estimating the effects of climate change on flood flow: A guidance manual for local government in New Zealand*. This guidance is a comprehensive technical report.

<http://www.mfe.govt.nz/publications/climate/climate-change-effects-on-flood-flow/index.html>



MfE, 2010b. *Preparing for future flooding: A guide for local government in New Zealand*. (Green book). This is a summary of the MfE (2010a) guidance.

<http://www.mfe.govt.nz/publications/climate/preparing-for-future-flooding-guide-for-local-govt/index.html>

To assist you with deciding on the level and scope of information required for any **council dialogue** that you are intending to undertake it would be useful to consider:

- What does the council already do to manage climate change?
- What are the gaps in the current approaches? (You could use the checklists provided in MfE guidance documents *Climate change adaptation and second generation RMA plans*, and *Climate change and long-term council community planning* to assess your plans – refer Appendix 3 for web links)
- What information is required to counteract the climate change sceptics?
- What are council's potential liabilities if they take no action?
- What legacy does council want to leave for future generations?
- What information do politicians/ staff need in order to accept that adaptation to climate change is important and move them to Step 2 of the Pathway?
- Is there a clearly identified person(s) who will be a champion for climate change?
- What actions are other councils taking on the issue?

Clearly how each council might choose to implement this dialogue and to increase awareness and acceptance would depend on the individual staff and the nature of the council concerned.

To assist you with deciding on the level and scope of information required for any **individual or community dialogue** that you are intending to undertake it would be useful to consider:

- Who are the influential stakeholders within a community?
- What is the climate change message you want to convey?
- What groups are aligned with this message?
- What are the potential barriers to engagement and which groups might have contradictory agendas to yours?
- Do you need to gather some baseline information on what are the general attitudes, opinions and concerns of the community about climate change?
- Do you know what are the amenities and assets of particular value to the community?
- Have you considered how to approach climate scepticism and do you have appropriate information available?
- What information does the individual or communities need in order to move them towards Step 2 of the Pathway?

Again as mentioned above, how you might choose to implement this dialogue and to increase levels of awareness and acceptance would depend on the size of the community you are dealing with and whether there is traction to be gained by linking to other council work programmes. But awareness and acceptance of the need to look into coastal adaptation to climate change is a significant turning point which leads to the next steps of *Pathways to Change*.

Additional resources to assist you at this step are in Appendices 2 and 3.

### Box 4.3 Engaging with the community over the potential impacts of climate change

As part of the Coastal Adaptation to Climate Change project, the project team carried out a case study to test a methodology for engaging with communities around climate change adaptation, something that is recommended by the IPCC and the benefits of which are discussed in section 1.2 above. The project team wanted to approach the community to: provide information on the potential projected impacts of climate change; explore how climate change might affect the things which were of value to the community; and discuss potential future adaptation alternatives. The research team decided that a participatory method was best because of the well documented advantages of participatory approaches in engaging with the community over complex issues, where multiple values are at stake, and there are many possible outcomes and solutions (Rouse et al., 2011; Rouse and Blackett, 2011).

The **advantages** of participatory methods include:

- Consensus and support for the agreed outcomes will lead into action on the part of individuals
  - Can increase the efficiency of activities by involving local resources and skills
  - Help to secure the sustainability of the activities as locals assume ownership
- The process will result in a more informed and aware community (from both a scientific perspective and a greater understanding and empathy for others)
  - Participation helps to build local capacities and develop the abilities of local people to manage and to negotiate activities
  - Participation can lead to better targeting of benefits via the identification of key stakeholders who will be most affected by the activities
- The process will result in integration of locally relevant social, economic, cultural and scientific concerns into the agreed solution
  - Can also increase the effectiveness of such activities by ensuring that, with people's involvement, they are based upon local knowledge and understanding of problems and will therefore be more relevant to local needs
- The community will be better connected and have a greater understanding of and empathy with its members.

However, participatory approaches also have **challenges** which need to be managed:

- Scientific information is needed to ensure ecologically or scientifically effective outcomes BUT climate change is an extremely complex, and there is a perceived lack of scientific consensus about the likely impacts of climate change
- There are tensions between local level solutions and national or global interests. In particular, people find it hard to see their personal impact on the problem due to:
  - the inter-generational nature of the impacts
  - global consequences and impact of any individual actions or sacrifices
- Achieving consensus can be hard!
  - interpersonal animosity constrains communication
  - fear of conflict inhibits discussion and debate

- To achieve successful engagement with the community you need to get the right people to the table, avoiding pitfalls such as:
  - Not including the right stakeholders
  - Failure to include the decision makers
- Ensuring that decisions are representative of all participants.

Any method needs to be designed to address these challenges as much as possible. The final method selected by the Coastal Adaptation to Climate Change team used a participatory GIS method, which is discussed further in Boxes 6.2 and 6.6.

#### **Box 4.4 Raising awareness in the school community**

Students and teachers from Mercury Bay Area School at Whitianga successfully collaborated with the Coastal Adaptation to Climate Change project team in identifying and finding solutions to local problems associated with coastal adaptation to climate change. The resulting cross-curricular study in a Year 10 class “has made the students appreciate that they can have an impact on the environment and the things they value” (Jan, teacher).

School pupils are likely to experience the effects of climate-induced changes to their coast in their lifetimes and perhaps have responsibility for making decisions in the future about how the Whitianga coastal community might respond and adapt to climate change.

The Head of Science and four teachers developed a programme wherein teachers and students would have the opportunity to learn about the risk of coastal flooding, erosion and habitat change associated with sea-level rise and climate extremes and to develop solutions to issues faced by their community. In developing the programme the teachers were supported with knowledge and resources on climate change, along with guidance on pedagogical enquiry based learning approach, by coastal scientists and a University of Waikato science educator on the Coastal Adaptation to Climate Change project team. This opportunity to trial a pedagogical approach was closely aligned with the goals of the recently implemented New Zealand Curriculum (i.e., teaching and learning programmes which promote young New Zealanders emerging from schooling as confident, connected, actively involved and lifelong learners).

The overall learning goal of the programme was to raise student awareness and understanding of the need for adapting to climate change on the coast. The teaching and learning programme was taught to a mixed ability Year 10 class for a 7-week period, averaging 14 hours per week spread over Science, Mathematics, English and Social Studies timetabled classes (approximately 100 hours in total). It culminated in a display of the students’ findings at the school’s annual ‘Enviro-showcase’ which was open to the community. The positive experience of teachers at Mercury Bay Area School and the empowerment the students experienced in this collaborative, cross-curricular approach prompted them to make their unit available to other New Zealand schools via their school website. The unit is called *Coastal Adaptation to Climate Change* and can be found on the school website at <http://www.mbas.ac.nz/>.

Paul (teacher) reflected on the learning experience for students as follows:

“What I would like to see from now on is that when our young people walk along the beach they see the world through different eyes ... what we have attempted to do with the learning tasks that we have provided is to take them step by step on a journey in which they have come to an understanding of the complex process involved if communities are to actively adapt to change. I think that our students have developed an understanding and are more likely to have the confidence to enter the coastal adaptation debate.”

Terry (scientist, Coastal Adaptation to Climate Change project team) reflected on the collaboration as follows:

“It was a very rewarding experience for the project team to observe the way the teachers met the challenge of distilling complex scientific concepts of coastal processes and climate change into information the pupils could understand and relate to. Cross-curricular learning is a very logical learning methodology for students who one day will need to address environmental issues which are best addressed through an interdisciplinary approach.”

#### **Box 4.5 Council Commitment to Climate Change Adaptation**

Two examples of Long Term Plans and Annual Plans that address climate change and adaptation are:

##### **Greater Wellington Regional Council:**

- A significant weighting is given to planning for climate change and adaptation. The council states that it is taking a lead in this area and will work collaboratively with the District Councils.
- Climate change considerations are built into management of resources (e.g., land and water) as well as into hazards management
- Community well-being and economic affordability are themes that underpin the short-term responses of the council, while nevertheless recognising adaptation to climate change as a longer-term issue.

<http://www.gw.govt.nz/10-year-plan-2009-19-incorporating-the-annual-plan-2009-1/>

##### **Thames Coromandel District Council**

- Recognises the need to embed climate change into work programmes and decision-making, with the intent of ensuring that communities are resilient, particularly including their ability to adapt to hazards arising from climate change
- Sets out an overview of IPCC projections and acknowledges the challenges this raises for council's work programme
- Expects planning for climate change to become a normal part of council's work i.e., embedded into decision-making

<http://www.tcdc.govt.nz/Council/Policies-Plans-Reports-and--Strategies/Ten-Year-Plan-Long-Term-Plan---LTP/Ten-Year-Plan-Long-term-Council-Community-Plan/>

Refer to **Appendix 2** for further examples

#### **Box 4.6 Case Study: Gisborne District Council**

Gisborne District Council has prepared two background reports on the effects of climate change and sea-level rise on their coastal communities (Savage, 2006; Savage, 2009).

Key points from the 2006 report: *Chapter 2: Changes to the Coastline*, include:

- Sea-level rise is a reality. It has already been quantified locally
- There are likely to be more coastal floods, and storm surges will reach further inland
- We will lose land, and some sandy beaches may be threatened
- People will still want to live on, and develop the coast, but it will become increasingly risky
- Treatment options will depend on what is practical, affordable and possible at a given location
- Some coastal structures are currently only 1-2 metres above sea-level
- Some dwellings and infrastructure will ultimately have to be shifted
- River mouths may be inundated, and rivers could alter their course close to the mouth
- The coast and beaches are valued by the residents of Gisborne, and people will be concerned about sea-level effects
- Rising sea-level will not significantly alter the impact of tsunamis.

<http://www.gdc.govt.nz/climate-change-reports/>

Refer to **Appendix 2** for other examples.

#### **4.5 Are you ready to move on to Step 2?**

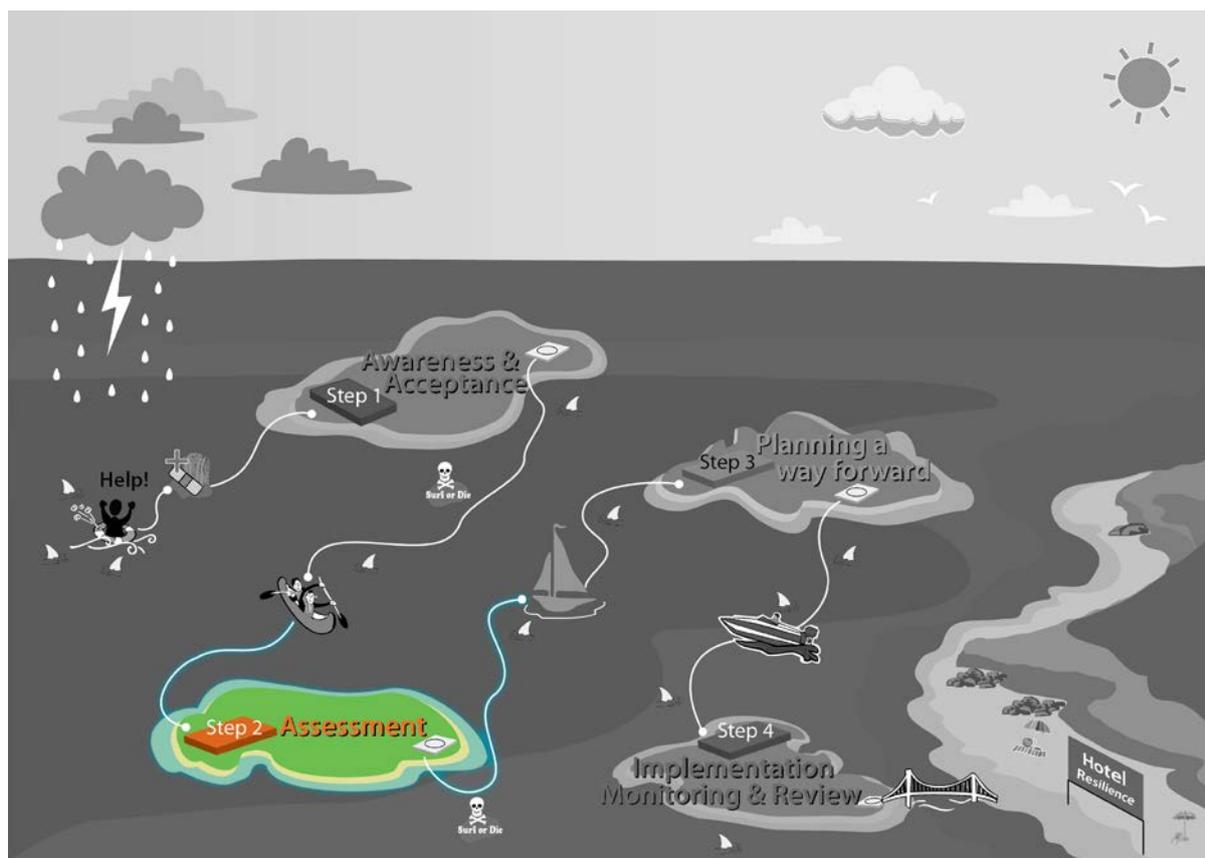
As a council you will know you are ready to move on to Step 2 when:

- You have a good grasp on general information on how climate change might affect your community – both threats and opportunities
- You have prepared some background papers on climate change and adaptation for council and to help community dialogue
- You have identified where climate change is already embedded into council work programmes
- Your politicians are aware of the key issues and they have accepted that the council does need to do something about adapting to climate change
- The council has agreed to fund and undertake further exploratory work
- You have identified a list of key stakeholders and communities you want to dialogue with
- You have identified a political and staff champion(s) for climate change adaptation
- You have assessed the level of awareness and acceptance that key decision-makers have and consider it's a good time to move on to Step 2.

## 5. Step 2: Assessment

### 5.1 How do I know if I'm at Step 2?

The second step of the Adaptation Pathway is about gathering information so as to be better informed on the scope, scale and timeframes of the potential effects of climate change that we may need to adapt to and making an assessment of the risk that is being faced. This step builds on the awareness and acceptance raised in Step 1.



If you are at this step on the pathway, key questions that you and your council and community might be asking include:

- *What information do we need to assess how climate change might affect our local coastal communities?*
- *What issues do we face?*
- *Where are our most vulnerable locations?*
- *What is the level of risk we are facing?*

If you are at Step 2, you (with your colleagues, communities and council) have accepted the need to address the potential impacts of climate change to ensure your communities are resilient, but you lack specific information on how they may be impacted and by when. Your focus at Step 2 is on

identifying the changes your communities may have to adapt to, and assessing the associated risks including community vulnerability.

The commitment to, and timeframes for, obtaining this information are directly related to the priority your council assigns to addressing risk assessment and coastal adaptation within their overall work programmes.

## 5.2 Key drivers and barriers

The legislative drivers mentioned in Step 1 are also relevant here (refer Appendix 1).

Other key drivers may be:

- Increased levels of awareness and acceptance of climate change by staff, politicians and/or community stakeholders
- Groundswell of opinion in vulnerable communities to see long-term planning
- Political commitment to funding information gathering work - reflected in budgeted work programmes
- Local issues and 'hot spots' which bring attention to coastal hazards that will be exacerbated by climate change
- Acceptance of need to ensure future resilience of your coastal communities, including maintaining social and business continuity and infrastructure services.

Possible barriers you may still encounter at this step include:

- Ongoing scepticism about the need to plan or adapt to future climate change (e.g., do you need further Step 1 work?)
- Lack of local community awareness of potential changes and specific associated risks (to be expected at this step – since you do not yet have the detailed information on risk including community vulnerability)
- Insufficient or limited funding for the required work programme (perhaps indicating the need for further Step 1 work to increase prioritisation of this work?)
- Managing community expectations to ensure that they are realistic compared to the funding available (i.e., this is about managing budgets realistically over time and avoiding 'non-delivery' of any adaptation actions)
- Changes in local circumstances (e.g., new politicians who may not be so aware of the issues; other priorities; changes in economy; hazard event in another locality, etc).

### **Box 5.1 Local Authorities' Views:**

The following extracts are from the *Report on Local Government Planning Practice and Limitations to Adaptation* (Britton, 2010)

“The inevitable tension between protecting property and protecting beach areas was recognised (and it was acknowledged that protecting one was in general, at the expense of the other). It was also noted that seldom are people’s lives at risk from coastal erosion hazards. A common thread arising from the responses to the questionnaire was the need to understand natural systems (such as waves, sediment, currents) and the preference to allow the systems ‘room to adjust’, before engineered solutions were implemented.”

“The lack of information on the level of risks most likely to be experienced in localised areas (and the certainty of this information) was considered to be a major limitation (i.e., there is a need to translate the theory into probable effects on the ground). The lack of clarity around the magnitude of impacts for a given area makes it difficult to balance risks versus costs and benefits.”

“It was noted that communities and decision-makers did not appreciate that 100% accurate or complete data will never be attainable. In this respect it was considered that the precautionary approach needed to be more strongly supported.”

## **5.3 Tasks for Step 2**

Risk assessment is fundamental to the second step of the Adaptation Pathway. The purpose of the risk assessment process is to aid subsequent decision-making, particularly if impacts are couched in terms of dollars of affected assets/infrastructure, number of affected people/properties and potential loss of amenity values and ecosystem services. As an initial stage, undertaking a district or region-wide scoping exercise can assist in prioritising climate change risks and comparing them with other risks, resource availability and cost issues (including works) that the local authority faces.

As part of this risk management process, and once the scoping exercise has identified priority sites, more detailed coastal hazard assessments need to be undertaken. In general, approaches for quantitative assessment of physical coastal change are reasonably well defined and guidance on choice of appropriate approaches and models are provided in a range of documents (e.g., Auckland Regional Council, 2000; MfE, 2008a; MfE, 2008b). It is fundamental that a wide range of stakeholders are involved in this assessment and in particular that it includes a focus on existing natural hazards management strategies and how these will be exacerbated by climate change.

Regardless, of the approaches used, there will be inherent uncertainties or assumptions that need to be made and judgment will need to be applied. These uncertainties and those relating to projections of future climate need to be taken into account and clearly communicated (refer to the discussion on decision-making in the face of uncertainty in sections 2.3 and 6.4). It is also clear that making decisions and moving along the Adaptation Pathway can still occur in the face of uncertainty.

### Box 5.2 Mapping inundation hazard exposure to support risk and vulnerability assessments:

Spatial mapping of coastal hazard exposure (for different sea-level rises), overlain on aerial photographs or GIS layers representing the built environment, has proved to be a powerful teaching and planning tool to communicate future risk exposure to communities and decision-makers (Rouse et al., 2011; Reisinger et al., in prep 2012; NOAA Digital Coast Viewer: <http://www.csc.noaa.gov/digitalcoast/tools/slrvier/index.html>).

An example map\* of coastal inundation exposure, used with the Whitianga community by a multi-agency research team lead by NIWA, is shown to the right. It 'paints the picture' of the mean high-water spring (MHWS) tide for the present day and in 2050 (yellow) and the 2090s (red) based on sea-level rise scenarios of 0.35 m and 0.8 m respectively. The key to resolving these areas potentially exposed is the use of high-definition laser topography often called LiDAR, which in this case was flown by Waikato Regional Council. Council politicians, staff and members of the community can readily identify how long-term climate change may affect property or businesses in the future.



Maps of areas exposed to coastal inundation from extreme storm-tide levels for present-day and compounded by future sea-level rise, were also used in risk scoping studies for Nelson City (Stephens and Bell, 2009), working with Nelson City Council planners and GIS analysts. An extreme 0.5% AEP (200-year return period) storm-tide event was mapped over the city with a range of sea-level rise scenarios. These provided a clear picture of the vulnerable low-lying areas of the city but interestingly showed that only small adjacent areas would be impacted at higher sea-level rises due to the run-out slopes of surrounding hills. Again LiDAR data was crucial in resolving the intersection of storm-tide levels + sea-level rise with an accurate topography of the land surface.

\* This map was produced by NIWA for the sole purpose of informing discussion at a public Open Day and Workshop. This context/purpose should be considered when interpreting the map. Use of this map for any other purpose is not permitted without permission of NIWA

## 5.4 Tools to help you at Step 2

Detailed guidance on risk assessment is provided in Chapter 5 of MfE (2008a) (and in Chapter 6 MfE, 2008b). A useful framework for assessing coastal hazard risk is outlined in the MfE (2008a) guidance

manual – it is called the source—pathway—receptor—consequences (or SPRC) approach. It provides a convenient way to consider the key drivers of coastal hazards and the ways that they impact on different elements of human and built environments within particular coastal margins. A schematic of how combinations can conceptually form is shown in Figure 5.1 below:

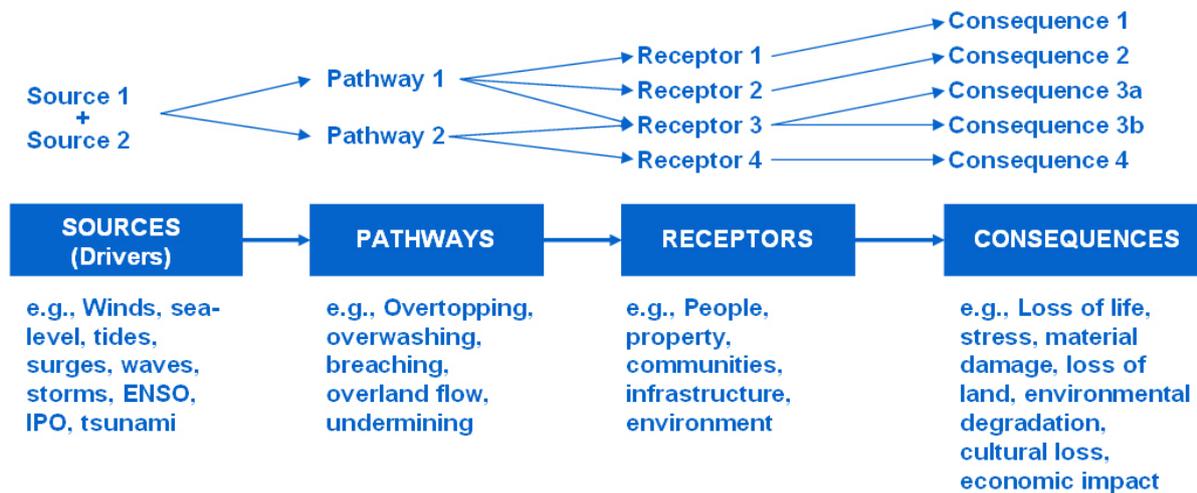


Figure 5.1 The Source-Pathway-Receptor-Consequence (SPRC) framework for assessing coastal hazard risk (Source: MfE 2008a).

The key elements of the risk assessment framework include:

- Define the problem and establish the context (i.e., ‘set the scene’)—see Section 5.3.1 of the MfE (2008a) guidance manual. This will assist with selecting the level of risk assessment required. The physical coastal setting will determine to some extent the future vulnerability (e.g., sand vs gravel coast, cliffed coasts, low-lying harbour margins, sand spits). Also the land-use context will be a critical factor in any risk assessment when it comes to managing risk—existing development will be mainly about risk mitigation, risk transfer and tolerating some residual risk, while risk avoidance should be to the forefront for any greenfields development
- Identify the coastal hazards (e.g., coastal erosion or inundation) and climate-change drivers relevant to the site. The SPRC framework (shown in Figure 5.1) is a convenient way to consider the key drivers of coastal hazards and how they reach (via a pathway) and impact on a range of human and environmental values within a specific coastal locality
- Assess the likelihood (frequency of occurrence) and magnitude of the hazards occurring over specific planning timeframes<sup>1</sup> including the effects of climate change
- Assess the scale of potential consequences on the receptors over that timeframe e.g., the community, its infrastructure, and the environment (e.g., ecosystem services such as beach amenity, kaimoana, estuarine wetlands or biodiversity). Potential consequences can include casualties, number of properties affected; physical disruption to people; tangible and intangible

<sup>1</sup> With climate change introducing increasing trends or acceleration of effects e.g., sea-level rise, it becomes imperative that all impact or risk assessments are tagged to a specific planning timeframe e.g., for the next 100 years by 2115 for example, relative to an appropriate baseline.

loss and damage to property, community and lifeline infrastructure, the environmental and cultural assets; and direct and indirect impacts on the local and regional economy e.g., loss of tourism for a beach community

- Evaluate the hazard risk for different planning timeframes (particularly 100 years as required in the NZCPS 2010), combining the scale of the consequences with the likelihood of occurrence e.g., for a particular timeframe, the consequences may be significant but with a very low likelihood, so such combinations could be evaluated as being a low or moderate risk (see section 5.3.5 of the MfE (2008a) guidance manual)
- Determine how residual risk will be managed either through transferring the risk to another party (e.g., insurance), sharing the potential residual losses between the community and local/national government or acceptance by the community that such residual losses will be tolerated and borne by the community.

This framework can be used for either a qualitative assessment of risk or for a more detailed quantitative assessment – depending on the situation being considered and how much information you have - particularly spatial information on assets, demographics and topography (e.g., LiDAR). As the level of detail required from the risk assessment increases, input from suitably qualified and experienced specialists will generally be required.

Another key tool for risk assessment is the Risk Management Standard ISO: 31000 (2009). In this context, risk assessments should be cognisant of the wider all-hazards approach that is set out in the councils' Civil Defence and Emergency Management Group Plans. Coastal adaptation actions may well be able to be leveraged off existing civil defence strategies and other risk management approaches.

Risk assessments should be undertaken in close consultation with key stakeholders and politicians, reflecting the importance of communication, as set out in Step 1 of this journey. In addition, the importance of local community information should not be overlooked.

Additional resources to assist you at this step are in Appendices 2 and 3.

### **Box 5.3 Mapping national coastal sensitivity to climate change**

In a general sense, vulnerability is the susceptibility to physical or emotional injury or attack. This concept has been used when looking at hazards and disaster management, in which case vulnerability is the extent to which a community can be affected by the impact of a hazard. Vulnerability assessments in the context of hazards and disaster management means assessing the threats from potential hazards to the population and to the infrastructure developed in that particular location. Vulnerability assessments in the context of climate change involve assessing the threats arising from climate change, both in an average sense and from changing extremes.

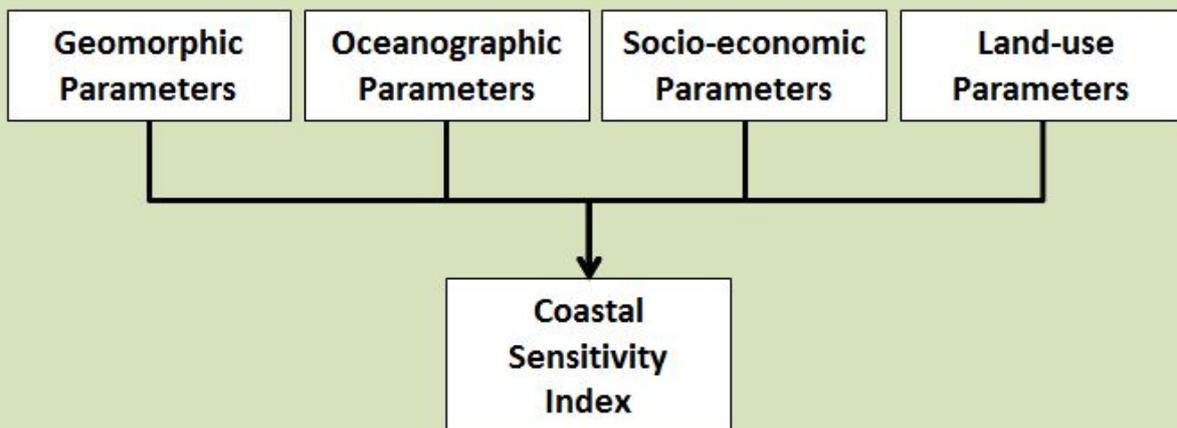
The realm of climate change related vulnerability assessments has evolved rapidly over the last 20 years or so, and many organisations (e.g. United Nations Framework Convention on Climate Change (UNFCCC) 2008) offer guidance on how to carry out these assessments. Kay & Travers (2008)

provide a useful overview of a number of Coastal Vulnerability and Adaptation Assessment tools and methodologies.

We currently have a poor national picture of the relative sensitivity of New Zealand's coastline to coastal hazards and the potential impacts of climate change. The only previous approach that has attempted to rank sections of the coast susceptible to coastal hazards in a standardised way was the Coastal Sensitivity Index (CSI) developed by Gibb et al. (1992). This was a relative index based on eight variables (elevation + storm wave run-up + gradient + tsunami + lithology + landform + horizontal trend + short-term fluctuation), which were ranked for sections of the coast based on their susceptibility to coastal hazards on a scale of 1 to 5 (corresponding to very low, low, medium, high and very high sensitivity to coastal hazards).

An initial New Zealand coastal classification system has previously been developed and is available online at <http://wrenz.niwa.co.nz/webmodel/coastal>. The existing coastal classification is based on morphology (sediments, geomorphic character, hinterland characteristics, morphology controls) mapped at a scale of 1:50,000 around the coast.

Several aspects of the above CSI and coastal classification are important physical parameters that will contribute towards a revised New Zealand Coastal Sensitivity Index. Work being carried out by the Coastal Adaptation to Climate Change project team will expand and improve on this work to deliver a consistent national-regional level assessment of coastal sensitivity. In particular it is being expanded to include oceanographic, land-use and socio-economic parameters to create a basic mapping of coastal sensitivity for all open-coast soft shoreline regions of New Zealand. A comparison is also being made of a more comprehensive set of parameters collated for the Northland, Auckland and Waikato coasts to assess the potential benefits of different levels of detail.



#### **Box 5.4 Other Climate Change assessment tools – the Impacts of Climate Change on Urban Infrastructure & the Built Environment project**

The *Impacts of Climate Change on Urban Infrastructure & the Built Environment Toolbox* is a resource to help planners, engineers, asset managers, and hazard analysts in New Zealand urban councils understand and evaluate the potential impacts of climate change in their city.

The Toolbox is designed with an overall 5-step evaluation framework represented by the 'trays' in the Toolbox. Within each tray are downloadable reports (or 'tools'), each with a specific purpose.

The 5 trays start with an information gathering phase, followed by a hazard assessment. The next stage is a risk analysis, which considers what the hazard may impact. Stage four involves considering options (and their costs and benefits) to reduce the risk, and stage five is the integration of information into the planning and decision-making process.

Each tool has been written so that it can be read and understood on its own, with references to other tools included within. The tools demonstrate, using worked examples, methods and approaches that can be used to perform an assessment of climate change impacts. Readers are encouraged to contact the authors of the tools to discuss using specific software or other proprietary material.

The information in this Toolbox is consistent with the Australian and New Zealand Standard for Risk Management, AS/NZS 4360:2004, which is widely used in the public and private sectors to guide strategic, operational and other forms of risk management.

Funding for the Toolbox was provided by the Ministry for Science and Innovation (formerly the Foundation for Research, Science and Technology), contract C01X0805. The Toolbox was produced by researchers in NIWA, MWH New Zealand Ltd, GNS Science and BRANZ.

The following councils supported the development of the Toolbox: West Coast Regional Council, Buller District Council, Wellington City Council, Greater Wellington Regional Council, Auckland Council, Christchurch City Council, and Environment Canterbury Regional Council.

The *Urban Impacts Toolbox* is available (from October 2011) via the NIWA website [www.niwa.co.nz/climate](http://www.niwa.co.nz/climate).

### **Box 5.5 Case Study: Progress with Coastal Hazard Assessment in New Zealand**

Coastal hazard assessments incorporating the potential impacts of climate change have now been undertaken for many areas of New Zealand's coast.

Region and/or district wide assessments of coastal hazards have been completed in many areas – including for example Hawkes Bay and Canterbury regions, Thames Coromandel, Kapiti, Opotiki, and Whakatane districts, and Tauranga City Council. In addition, inundation hazards have been determined for parts of Auckland and Christchurch cities and the coastal districts of Wellington region. A wide range of site specific assessments have also been completed for various North and South Island coastal communities.

#### **Examples of Coastal Hazard Assessments**

- *Hawke's Bay Regional Coastal Hazard Assessment 2004*  
<http://www.hbrc.govt.nz/Coast/CoastalHazards/tabid/143/Default.aspx#report>
- *Thames Coromandel District*

<http://www.tcdc.govt.nz/Consultation/CoastalHazards/>

- *Whakatane District*

[http://www.whakatane.govt.nz/PageFiles/295/OtherInformation/Variation6\\_WDCCoastalHazardAnalysis02.pdf](http://www.whakatane.govt.nz/PageFiles/295/OtherInformation/Variation6_WDCCoastalHazardAnalysis02.pdf)

Refer to **Appendix 2** for further examples.

## 5.5 Are you ready to move on to Step 3?

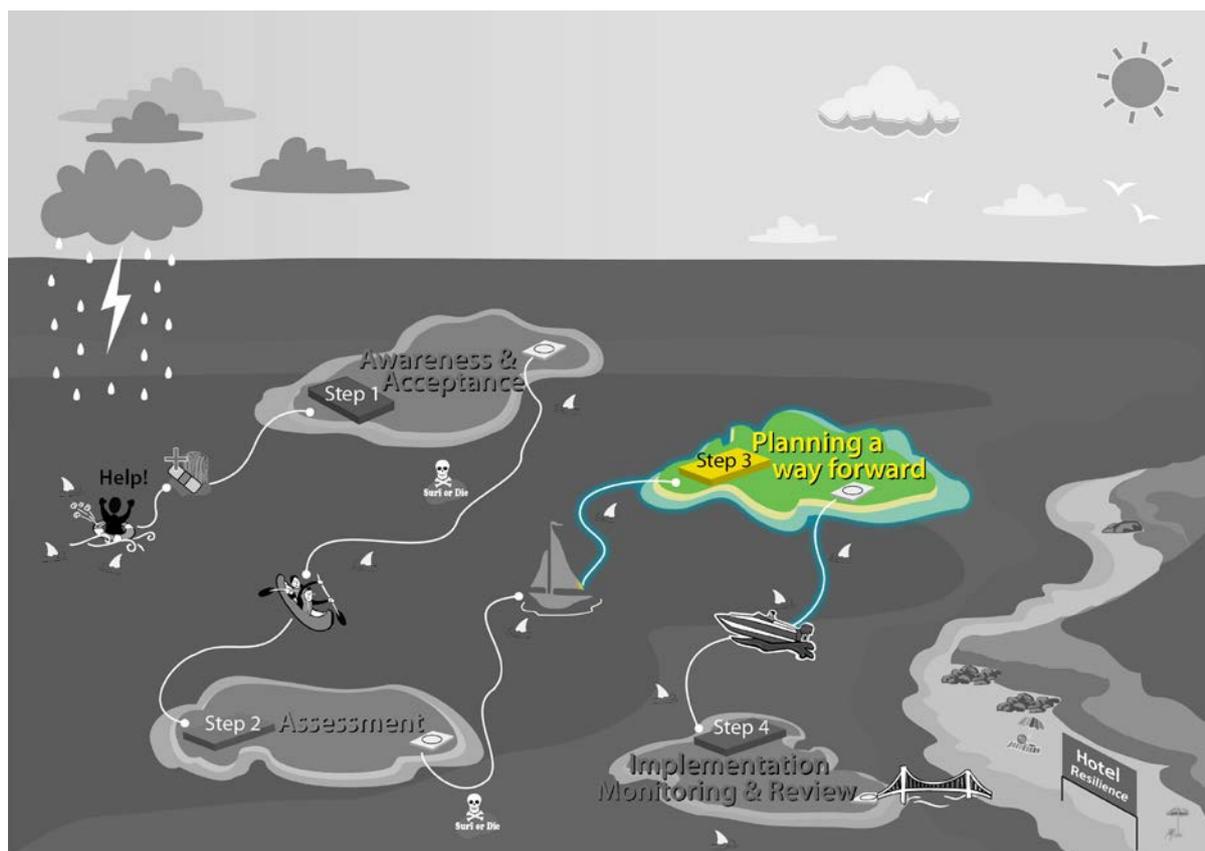
As a council you will know you are ready to move on to Step 3 when:

- You have carried out a regional scoping exercise to identify areas most vulnerable to coastal hazards and potential impacts of climate change
- You have prioritised those areas requiring a full or partial risk assessment process
- You have developed a programme for carrying out hazard and risk assessments
- You have carried out a risk assessment for high priority areas, to determine the significance of the risk (starting with a risk scoping exercise first)
- You have identified what further information is required (as a result of your scoping exercise) so that you, your council and communities can be fully informed of the hazards and associated risks
- You have political acceptance of the priorities for climate change adaptation and your politicians recognise the need to plan strategically for a way forward.

## 6. Step 3: Planning a way forward

### 6.1 How do I know if I'm at Step 3?

The third step of the Adaptation Pathway is about planning what needs to happen to best adapt to climate change. This step builds on the awareness of climate change, the acceptance for the need to start taking actions and the prioritised assessment of potential impacts on your local coastal communities arising from your work in Steps 1 and 2.



If you are at this step on the pathway, key questions that you and your council and community might be asking include:

- *What is going to be our strategic and long-term approach to adaptation?*
- *What are the steps required to move us in this strategic direction over time and thereby build community resilience?*
- *How do we get buy-in from key stakeholders and communities?*

If you are at Step 3, you accept the need to address the potential impacts of climate change and have reasonable information about these impacts on your coastal communities. Your focus is on considering adaptation options and working with key stakeholders and communities to make decisions on the best way forward in both the short and longer term.

*“Very few people would deny that, in today’s fast-moving fast-changing business world, strategy, with its long-range perspective, is critical. By analogy, if the guidance system on an airplane or ocean liner is not programmed to reach its destination, then it cannot keep the plane or ship on course in rough or stormy weather. For any company today, strategy provides, or should provide, that overall trip plan against which management can true up in difficult times.”*

**(Gurowitz, 2007)**

## 6.2 Key drivers and barriers

The significant drivers of this step are:

- The legislative requirements as discussed in Step 1 (Refer Appendix 1)
- Awareness and acceptance of the potential issues and challenges arising from Step 2
- The potential costs of failing to address climate change impacts
- Awareness and acceptance of the need for actions to build community resilience
- Acknowledgement of existing legacy and liability issues arising from past decisions made about land use in coastal areas
- The political and community support for change enhanced through Steps 1 and 2, including a commitment to funding adaptation planning
- Local issues and ‘hot spots’ that reinforce the need for adaptation planning
- Natural hazards such as storms/ tsunamis exacerbated by climate change impacts.

Possible barriers and challenges you may encounter at Step 3 include:

- An unwillingness to consider some adaptation options because they conflict with existing attitudes and expectations (e.g., commitments to hard engineering; assumed property rights) and an unwillingness to consider alternative management options which communities and stakeholders are less familiar with (e.g., soft engineering or managed realignment options)
- Dealing with people with short-term interests (and hence ‘solutions’) with little commitment to a longer-term approach that recognises environmental, social, cultural and economic concerns
- Dealing with people with economic interests or other vested interests in assets (e.g., infrastructure and/or private assets in areas potentially at risk) that may be in conflict with the vision for your council with regard to adaptation.
- Funding sources and issues (e.g., who pays?, public/private benefits)
- Managing community expectations with the ability of the Local Authority to realistically resource (\$ and staff) the adaptation plan
- Barriers discussed in Steps 1 and 2 may also continue.

### **Box 6.1 Local Authorities' Views:**

The following extracts are from the *Report on Local Government Planning Practice and Limitations to Adaptation* (Britton, 2010)

“Another common theme arising from the questionnaire responses was that the sustainable management of coastal resources needed to address environmental, social, economic and cultural concerns. This is reflective of the wider focus of the LGA to meet community outcomes, and the need for local authorities to draw on provisions from other legislation, in order to effectively address adaptation to climate change.”

“Fifteen local authorities acknowledged climate change as being embedded into their LTCCP<sup>2</sup>s through a range of work programmes. One local authority made the comment that they expected their LTCCP would be used more proactively in the future to outline their council’s stance on climate change.”

“Availability of funding also influences the option that might be chosen for adaptation actions. Funding for adaptation measures also raises the issue of inter-generational equity. One example provided was that the current ratepayers were still paying for the replacement of now obsolete infrastructure, while at the same time they might be expected to pay for new infrastructure to adapt to future climate change. This is a significant burden on current ratepayers (and particularly so for councils with a small rating base).”

## **6.3 Tasks for Step 3**

The key task at Step 3 is preparing an adaptation plan. The assessment of community vulnerability over the next 100 years (Chapter 2) leads on to developing a way forward or strategy that will build the capacity of the community to adapt over time.

Planning a way forward would include:

- Developing a vision(s) of what your coastal community(ies) want to be like in the future that incorporates community values and environmental and amenity values
- Identifying and assessing feasible and sustainable adaptation options
- Gathering stakeholder and community information, through consultation and participation
- Assessing the Civil Defence and Emergency Management Group Plan and other community resilience strategies in order to align or leverage work areas and resources where possible
- Setting out preferred management actions, with timeframes and identifying who is responsible for implementing each action, along with indicative costs.

The advantage of having an adaptation plan which can be implemented in stages, is that it sets out the overall context and strategic directions for managing coastal areas at a district-wide or region-wide level, including drawing together the community aspirations for the area. It also provides

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<sup>2</sup> Note: since the time of this report an amendment to the Local Government Act has changed the terminology from LTCCP (Long Term Council Community Plan to Long Term Plan (LTP)).

guidance on how local issues or areas will be addressed, including guidance on resource consent applications.

Your adaptation plan should include a series of prioritised actions that will be implemented over time to help build community resilience. Undertaking this planning helps avoid ad-hoc decision-making that may exacerbate the level of risk for communities in the future (e.g., when there are site specific pressures or resource consents applications seeking a short-term solution). Rather, responses to specific problems are addressed within the context of defining a strategic way forward.

It is also important to see the 'way forward' as a living document. Adaptation planning is not just about the document that is prepared; it is about the process of change and embedding adaptation into all areas of decision-making and council and community actions (sometimes called 'mainstreaming'). As such, the adaptation plan will need to be continually reviewed (see Step 4, chapter 7) until such time as adaptation activities are mainstreamed across all work areas.

## 6.4 Tools to help you at Step 3

### Developing a Vision

The vision needs to clearly state what the community would look like in the future if it was 'well' adapted and resilient to the potential impacts of climate change. Key stakeholders and the community in general need to be involved in developing this vision to ensure that it identifies those community and environmental values that are important to all who use or enjoy the area. Getting this buy-in is particularly important if these values are fundamental to defining the area (e.g., a regionally important beach).

#### **Box 6.2 Case study: What do Whitianga residents value about their local community and how will these be affected by the projected impacts of climate change?**

The first step on the way to developing a community vision is understanding what it is about the community that residents currently value, and how these values will likely be affected by climate change. A case study in Whitianga, a coastal township on the Coromandel peninsula (Rouse et al., 2011; Blackett et al., 2010), used large maps to illustrate the projected impacts of climate change to the community in terms of coastal inundation, coastal erosion and estuarine habitat change. People who attended an Open Day were encouraged to use flags to mark on these maps 'objects' of value which might be impacted by those changes. The values were varied but included:

- Community recreation assets e.g., boat ramps, local parks, picnic areas, beaches
- Recreation activities e.g., surfing, swimming, walking along the beach, fishing, water sports
- Local aesthetics and ecology e.g., the natural character of the beach and estuary
- Community assets, infrastructure and events e.g., wharf, boat mooring, local roads
- Local business and private property e.g., homes and businesses

It can be assumed that any vision for the future would seek to retain these valued elements of the community.

### Identifying and assessing management actions

The adaptation plan defining your way forward should include various actions that may be required to achieve the desired vision. As shown in Table 6.1, the actions are likely to be wide-ranging including environmental information and monitoring, relevant policy development and plan changes, ongoing community participation and engagement requirements, and on-the-ground actions or options. Appendix 1 also outlines the legislative framework that would set the context for the different actions.

#### Box 6.3 Case Study: Iwi Management Plan

##### Ngai Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008

This Southland plan was developed collaboratively and has a broad environmental scope, focusing on more than just the RMA. The importance of the link between climate change and coastal resources is highlighted. The plan identifies the need for cultural issues and policies to be considered when making resource management decisions and identifies importance of working with agencies to implement the plan.

<http://www.es.govt.nz/plans/other/iwi-management-plan.aspx>

#### Box 6.4 Some council examples

##### Hawkes Bay Regional Council:

*The Regional Coastal Environment Plan* defines the extent to the coastal environment and controls some land use activities in this area. The Guidelines for decision-making are very directive and comprehensive about adaptation and avoidance of subdivision or use on inappropriate areas. Rules support a consent approach to land use activities in hazard zones or protection structures.

<http://www.hbrc.govt.nz/ReadAboutIt/PlansandStrategies/ProposedRegionalCoastalEnvironmentPlan/tabid/895/Default.aspx>

##### Greater Wellington Regional Council:

*Wellington Regional Climate Change Response: Discussion Document, June 2009:* This discussion document was prepared as a collaborative piece of work involving all the councils within the Wellington region. It will lead to the development of an action plan. Adaptation to climate change and in particular in coastal areas is recognised. A key action is to undertake a vulnerability study for the whole region.

<http://www.gw.govt.nz/wellington-regional-climate-change-response/>

##### Christchurch City Council

*Climate Smart Strategy 2010 – 2025:* This strategy sets a vision of a climate smart Christchurch resilient to the impacts of climate change (including coastal erosion). It promotes a wide range of actions for resilient communities for the future. Strong emphasis is placed on education and understanding of the issues.

<http://www.ccc.govt.nz/thecouncil/policiesreportsstrategies/strategies/healthyenvironmentstrategies/climate-smart/index.aspx>

#### **Gisborne District Council**

*Urban Coastal Strategy 2005 - 2025:* The strategy guides the development of residential, business and open space areas along the coastline. It sets clear directions and identifies action plans to be carried out by council over the next 4-5 years to assist in achieving those directions. The strategy identifies areas vulnerable to natural hazards, and identifies this as a constraint to future development options being considered in the document.

<http://www.gdc.govt.nz/urban-coastal-strategy/>

#### **Hastings District Council**

*Hastings Coastal Environment Strategy 2000:* This strategy provides a framework for all aspects of planning and management for the coastal environment in the Hastings District over the next 20 years. It sets out an integrated response to the competing demands between protection and development and identifies actions for specified areas at risk. It has been used to underpin the District Plan and other council actions in coastal areas.

<http://www.hastingsdc.govt.nz/coastal-strategy>

#### **New Plymouth District Council**

*The Coastal Strategy 2006:* This strategy sets a guiding image or picture of what the community wants the coastal environment to look like in 20 years time. The strategy brings together knowledge from local communities of their landscape and their visions for its future. It prioritises 100 key actions that the council will implement over the next 20 years. This is complemented by the iwi coastal strategy document: *Mana Whenua Mana Moana* position paper 2006 for Taranaki.

<http://www.newplymouthnz.com/CouncilDocuments/PlansAndStrategies/CoastalStrategy.htm>

The above plans/ strategies are indicative of a range of work that is being undertaken in councils in response to climate change. Much of this work is recent and/or in progress. As key trends, there is a focus on coastal communities, and on the need for adaptation for the future. Defining a way forward may also be embedded into other documents, rather than existing as a stand-alone document.

**Appendix 2** provides further examples of RMA and LGA plans and strategies from various Local Authorities.

**Table 6.1: Possible actions that could be included into an adaptation plan and/or into the various policy and management documents that Local Authorities prepare.**

<b>Action</b>	<b>Examples (not a comprehensive list)</b>
Environmental information and monitoring	<ul style="list-style-type: none"> <li>• Addressing gaps in science knowledge about local coastal areas (e.g., beach profiles, mapping shoreline trends over time)</li> <li>• Contributing to ongoing monitoring of sea-level and vertical land movement through a network of gauges</li> <li>• Doing hazard and risk assessments – as in Step 2</li> <li>• Updating assumptions on potential climate change impacts as a result of further IPCC assessment reports and NZ climate research projects</li> <li>• Undertaking ‘state of the environment’ monitoring programmes for the coast, along with monitoring the effects of implementation actions that are undertaken</li> <li>• Folding the information gathered back into ongoing reviews of the strategic adaptation plan</li> </ul>
Policy approaches	<ul style="list-style-type: none"> <li>• LGA long term plan and annual plans               <ul style="list-style-type: none"> <li>○ Actions, timeframes and budgets specified and prioritised</li> <li>○ Actions built into specific work programmes for staff</li> <li>○ Different rating levels based on servicing of protection works or moving at risk infrastructure</li> </ul> </li> <li>• RMA policy               <ul style="list-style-type: none"> <li>○ Development setbacks from the coastal edge</li> <li>○ Land use controls in identified hazard areas; including density, location on site, rebuilding after an event etc</li> <li>○ Controls on undeveloped land to protect options for the future migration of estuarine vegetation</li> <li>○ Controls on type and location of ‘protection structures’</li> </ul> </li> <li>• Building Act controls               <ul style="list-style-type: none"> <li>○ Location and type of building in relation to defined hazard areas</li> <li>○ Restrictions on floor levels, foundation type (e.g., poured slabs are inflexible compare to piles) and building materials</li> <li>○ Caveats on land titles e.g., controlling time for removal/location of buildings/council liabilities</li> </ul> </li> <li>• Infrastructure/ Asset planning               <ul style="list-style-type: none"> <li>○ Future-proofing existing infrastructure/assets at the time of maintenance or up-grades by e.g., increasing the pipe diameter for stormwater; ground improvements during road upgrades to support future increase in road heights (where re-routing is not an option for the future)</li> <li>○ Location and relocation of infrastructure and critical services away from high risk areas (e.g., water supply, stormwater and sewerage networks; essential services such as hospitals, ambulance, fire, police, schools; infrastructure realignment, such as roads, power, telecommunications cables)</li> <li>○ Increasing the resilience of infrastructure and services that need to remain within hazard risk areas (e.g., inundation proofing including elevating critical</li> </ul> </li> </ul>

	<p>control elements; protection structures)</p> <ul style="list-style-type: none"> <li>○ Promotion of alternative designs or practical options to deal with impacts on the coastal edge</li> <li>● Civil Defence and Emergency Management <ul style="list-style-type: none"> <li>○ Assessing the all hazards approach in the Group Plan, and identifying opportunities to work collaboratively with other actions or initiatives</li> <li>○ Ensuring community objectives for civil defence and adaptation planning are aligned</li> </ul> </li> <li>● Reserve Management <ul style="list-style-type: none"> <li>○ Policy on how erosion of reserves will be managed</li> <li>○ Providing for ecosystem restoration and inland migration in response to sea-level rise (e.g., dunes; estuarine wetlands; cliffs)</li> <li>○ Providing for public access to and along the coast (and taking into account management of access ways or boat ramps, as they can be pathways for coastal inundation)</li> </ul> </li> </ul>
Stakeholder engagement and participation	<ul style="list-style-type: none"> <li>● Working with communities and tangata whenua to enable change and build resilience (e.g., identification of community values and aspirations; ongoing provision of information on climate change, hazards, costs and implications of different management options; discussing expectations of retreat over time)</li> <li>● Ensuring communities are aware of the changing level of risk and identifying the level of risk they are prepared to 'live with' and what adaptation options they are prepared to fund, taking into account that climate change will exacerbate existing natural hazards</li> <li>● Activities that increase the level of community participation and responsibility (e.g., Beach care dune restoration programmes; public access and walking tracks)</li> <li>● Working with other management agencies on coastal adaptation and risk transfer (e.g., central government; other councils; EQC, the insurance industry, engineers, utility and transport operators). For example, insurance can be an obstacle to climate change adaptation if insurance subsidies provide a disincentive for property owners to reduce their risk. However, when seen as part of a broader risk-management framework, insurance can play a beneficial role in risk communication and incentivising adaptation (Hall, 2011).</li> </ul>
On-the-ground actions to manage 'coastal squeeze'	<ul style="list-style-type: none"> <li>● Managed retreat and/or managed realignment options</li> <li>● Protection, restoration or enhancement of natural protective coastal ecosystems (e.g., coastal dunes; estuarine wetlands)</li> <li>● Beach nourishment or other 'soft engineering' options</li> <li>● 'Hard engineering' options (e.g., sea walls, groynes), (noting NZCPS Policy 27(2)(a) calls for a focus on reducing the need for hard protection structures)</li> <li>● Do nothing (i.e., live and cope with the changing coast). However this requires an understanding that affected property owners (and future owners) agree not to undertake ad-hoc protection works after damaging events.</li> </ul>
Identification of the 'Unknowns'	<ul style="list-style-type: none"> <li>● Identify and assess what you don't know or what might trip you up (i.e., so this can be transparent and can be monitored over time; or so you can focusing on getting information to fill the gaps)</li> <li>● Risk of liability (e.g., councils can be liable for decisions taken, if those decisions do not take into account information that was available at the time)</li> </ul>

- |  |  |
|--|--|
|  | <ul style="list-style-type: none"><li>• Possible future changes in insurability for coastal properties and public/private infrastructure (driven by the re-insurance sector or continuing coastal losses).</li></ul> |
|--|--|

When identifying and assessing management options there are two possible approaches that can be taken (Kwadijk et al., 2010):

- a) the classical top-down approach which starts with selecting what is seen as an appropriate climate-change scenario to adapt to (see IPCC guidance document Nicholls et al., 2011), before deciding on staging, over time, appropriate adaptation responses to the projected impacts from that scenario; or
- b) an adaptation tipping-point or scenario-neutral analysis. The analysis simply considers how much climate change existing communities or infrastructure can cope with in terms of impacts, leaving aside the timing of when it might happen. Similarly, additional adaptation stages are pegged to specific magnitudes of future sea-level rise or coastal erosion. Issues of timing the implementation of adaptation measures are addressed independently (Nicholls, 2011), through an adaptive management approach coupled with regular monitoring and reviews (See example in Box 6.6).

Whichever of these two possible approaches is taken, the task of identifying and assessing management actions will involve an evaluation of the environmental, social, economic and cultural costs and benefits of each of the different options in order to identify and prioritise the preferred actions. It should include a consideration of costs and benefits over time (at least 100 years), relative to the costs and benefits of the 'do nothing' (and live with the coast) option. The financial implications and appropriate discount rates must be transparent in any cost-benefit assessment. This would ensure that adequate resourcing of actions is made available to implement the actions and that limited resources are used effectively. The cost-benefit assessment should therefore include the time required to engage with communities to implement the adaptation actions effectively.

Relevant on-the-ground management options will need to be specified in sufficient detail to enable appropriate assessment and evaluation. The level of detail required will vary depending on the scope of the study (e.g., preliminary assessment vs detailed design) and on the scale and potential risk of the area being addressed (e.g., regional vs district vs site specific). The evaluation of on-the-ground options can involve a wide range of considerations. Summary of the various strengths and weaknesses in a matrix form can assist with the comparison of the options and identification of the relevant trade-offs involved with each (e.g., Beca et al., 2006).

In most coastal situations, long-term adaptation plans should consider a combination of management options for various stages within the planning horizon, including for example protecting significant existing development in the short-term but identifying and planning for transition mechanisms and timeframes to move to more long-term and sustainable approaches (refer NZCPS Policy 27).

GIS optimisation frameworks have been published that use a simplified cost-benefit analysis of hard protection and beach nourishment relative to a retreat response, that can help inform at what sea-

level rise and when along the planning horizon the latter becomes the only sustainable option (e.g., Neumann et al., 2010; 2011). Another means of making sea-level rise adaptation decisions involves subjecting options to a multi-criteria assessment (MCA), where different adaptation options are scored (weighted) against various criteria e.g., risk reduction, scope for mal-adaptation, ease of implementation, cost, co-benefits, CO<sub>2</sub> emissions, etc (Nicholls, 2011). Where possible, evaluation of environmental and amenity services should also be accounted for in these types of assessments. However, such assessments are no substitute for prudent decision making.

#### **Box 6.5 Case Study: Cooks Beach Coastal Erosion Management Strategy**

<http://www.waikatoregion.govt.nz/publications/Technical-Reports/Cooks-Beach-Coastal-Erosion-Management-Strategy-Part-I/>

Coastal erosion is a significant hazard risk at Cooks Beach, with projected sea-level rise over the next 100 years estimated to cause another 15-20 metres of erosion. This strategy involved a detailed investigation to identify preferred management options. The options were qualitatively assessed against various environmental, social and economic impact categories (multi-criteria analysis). Each option was also quantitatively assessed using cost-benefit analysis techniques to measure the overall well-being (or welfare) impacts and macro-economic techniques to measure impacts on the size of the local economy. The preferred coastal erosion management options most likely to achieve the strategy vision over a 50 year-time period were identified using an evaluation matrix and the results of the economic analysis.

#### **Box 6.6 Case Study: Adaptive Management Approach, Thames Estuary, UK**

Thames Estuary 2100 is an (English) Environment Agency-led flood risk management project set up to protect London and the tidal reaches of the Thames. The project called for an adaptive plan able to protect up to a 1.9 metre rise in sea level predicted in the UK's 'High++' scenario as well changes in the frequency and severity of North Sea storm surges and water drainage from the Thames and its tributaries.

The plan has developed different flood management options for different reaches of the Thames. The plan includes adaptation to different future climate scenarios on short (2010-2034), transition period (2035-2049) and long (2050 and beyond) timescales. The final time horizon (from 2050) will see the end of the century option, planned, designed and constructed taking the flood risk management in the Thames estuary into the 22nd century (all dates based on current UK climate change guidance).

These scenarios have been evaluated to find the most effective and cost beneficial solution. From this process, thresholds have been determined specifying when decisions need to be made to adequately prepare in time for future sea level and climate changes. The plan also provides detailed recommendations should the most extreme projections be realised.

Specifically, for upgrading the Thames Storm-Surge Barrier, adaptation planning has been structured around uncertainty using a tipping-point or scenario-neutral analysis (Nicholls, 2011), based on how

much sea-level rise can be absorbed before each stage needs to be in place. Then an adaptive decision-pathway approach has been adopted, where the timing for the various stages is initially based on a credible trajectory for sea-level rise, which in the Thames situation is benchmarked to a 0.9 m rise by 2100 (T. Reeder, Environment Agency, pers. com.). With such large infrastructure projects, where lead times are critical, this needs to be underpinned by a robust monitoring and review process. If sea-level rise accelerates beyond that trajectory, then plans will be brought forward and vice versa if sea-level rise is less than anticipated.

This adaptive management approach, where the system response and the climate-scenario/timeframe analysis were addressed independently, has shown that London can adapt to sea-level rise up to at least 5 m – a rise far larger than expected during the next 100 years. However, the space to implement all the proposed stages is being safeguarded for future generations (Nicholls, 2011).

**Sources:**

<http://www.environment-agency.gov.uk/research/library/consultations/106100.aspx>

[http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Resilient\\_Cities\\_2011/Presentations/E/E5\\_and\\_F5\\_Reeder.pdf](http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Resilient_Cities_2011/Presentations/E/E5_and_F5_Reeder.pdf)

<http://www.mca4climate.info/report-and-guidance/Articlesthemes/adaptation/coastal-zone-management/>

### **Stakeholder information, consultation and participation**

This is central to the entire process of developing and implementing an adaptation plan as a wide range of stakeholders and interests are invariably involved. Stakeholder involvement in adaptation planning is also an iterative and an ongoing rather than a one-off process, as over time the character and demographics of communities change, council decision-makers change and the coastal environment will invariably change. It is important to manage community expectations to ensure that the actions included in an adaptation plan are realistically achievable.

The level of consultation and participation will vary according to the issues being addressed and the level of knowledge about climate change impacts that people have. In some cases, the process will largely focus on consultation where agencies formally seek out the views and opinions of individuals and community groups on specific issues. In other situations (e.g., detailed site-specific strategies) a more participatory approach will be required where relevant stakeholders and communities are actively involved in deciding on the most appropriate adaptation options (e.g., Dahm et al., 2005).

Effective community involvement in developing a strategic way forward is more likely to lead to effective implementation (Sterling, 2003).

Refer back to Step 1 and the resources available in Appendices 2 and 3 to assist you with undertaking this task.

### **Box 6.7 Whitianga case study: First steps along the pathway to negotiating community adaptation to climate change**

Box 6.2 above explained how large maps were used at an Open Day to understand value objects which the Whitianga community would wish to see retained under future climate change. These maps were then used at a subsequent Workshop with members of the Whitianga community as a base for general dialogue and debate around how the community could adapt in the future to meet the challenges likely to be imposed by climate change. By focusing conversations around the maps and the identified community values, discussions remained grounded in reality, pragmatic alternatives were considered, and the trade-offs between various potential adaptation options were clearly (and visually) illustrated. Our Whitianga case study did not seek final solutions to these issues, but provided very useful grounding along the pathway to adaptation (Rouse et al., 2011).

However, according to Forester and Theckethil (2009) dialogue and debate are the early stages of generating a consensus around alternative strategies. Further debate and negotiation are the next crucial stages within which to engage all the relevant stakeholders in a forum where (all) participants work with the local management authorities to generate consensual responses to the projected impacts of climate change. This is where the tough decisions will need to be made.

### **Box 6.8 Case Study: Cooks Beach Coastal Erosion Management Strategy: Stakeholder engagement**

The strategy for managing coastal erosion at Cooks Beach (see Box 6.5) has involved a high level of stakeholder engagement and illustrates the time required to resolve complex coastal adaptation issues. The adaptation strategy at this site includes replacement of existing adhoc sea walls with an engineered revetment located further landward within private properties. The strategy is contrary to traditional management approaches, which usually place sea walls on or seaward of property boundaries, regardless of impacts on other coastal values.

The stakeholder engagement process has so far (mid-2011) extended over 5 years and included:

- Setting up the consultation process – including discussions of assessment reports with Council and the local Community Board, and agreement on a process for consultation with the affected landowners.
- Preparation of a detailed presentation outlining the various issues, management options and the strategy proposed by the earlier report (Box 6.5). The presentation included graphics of Cooks Beach properties to illustrate the key concepts.
- Letter to all property owners advising them of the proposed consultation.
- Meetings with each of the property owners (usually in their own homes) with a short presentation and lengthy discussion of issues (each meeting typically was 1-2 hours)

- Two subsequent meetings with property owners to discuss issues and concerns with Council on a collective basis. Owners were advised by letter prior to each meeting and the meetings were held on holiday weekends to facilitate landowner attendance (Cooks Beach is largely an absentee owner community). A summary outlining the key issues and outcomes arising was forwarded to each owner after the meetings.
- Formation of a Working Party with property owner representatives to discuss and negotiate (without prejudice) details of an appropriate long-term solution.
- Several meetings of the Working Party have been held since June 2007. Minutes were prepared and circulated to Working Party members following each meeting and confirmed at the following meeting.
- Preparation of a handout summarising a broad proposal negotiated by the Working Party. Property owner representatives discussed the handout with affected landowners (with 16 of the 26 owners supporting and 2 opposed).
- Further meetings of the Working Party culminated in late 2010 in a detailed Working Party report outlining the proposed strategy and implementation. This was circulated to all owners over the 2010-11 summer with a feedback form.
- Feedback was obtained from all owners over the following months – with all but 4 of the 26 owners supporting the proposal.
- A response to the outstanding issues was prepared by the Working Party and circulated to all owners in mid-2011.
- A small group comprising of 2 landowners and a local Community Board member is currently working with the owners who remain opposed in an attempt to resolve their issues.
- Draft legal agreements and other material have been prepared and discussed with the Working Party. It is anticipated that design and consenting work will be undertaken in 2012 along with consultation with the wider community.

### **Box 6.9 Case Study: Coastal Management and Monitoring in the Netherlands**

The Dutch have a coastline extending over 350 km and are very dependent on a system of dikes, natural dunes and storm surge barriers to protect people and infrastructure from inundation. The floodable area protected by sea defences includes 60% of the country, 80% of the GDP, and 60% of the population – with large cities like Amsterdam and Rotterdam below mean sea-level. A serious national disaster was experienced in 1953 when sea barriers were breached. As such, a primary function of coastal management is to protect the low-lying hinterland from flooding.

Detailed risk assessments using a range of climate change scenarios indicate that projected climate change will significantly increase pressure on the coast and coastal defences. Accordingly, a long term strategy has been developed to keep The Netherlands safe and dry. The strategy involves the

adoption of three separate sea-level rise scenarios for different aspects of management – 20 cm per century for decisions with a short design life (e.g., beach nourishments); 60 cm per century for significant infrastructure like dikes and storm surge barriers; and 85 cm per century for allocation of coastal space.

At present, the strategy involves dikes, natural dunes and other flood defences as well as the addition of large quantities of sand to maintain the coastline. In some places, it has also been recognised that some areas will have to be ‘surrendered’ to the sea – including areas in the province of Zeeland.

(Taal et al., 2010; Boer and Dijkhuis, 2005)

### Planning your way forward

This step involves pulling all your information together and setting out the preferred actions, timeframes and timelines for actions (indicative of priorities over time) and people/agencies responsible for implementing them, into a comprehensive framework. This framework sets out the short and long-term approaches that your council will take to manage the potential impacts of climate change. It is also essential that a clear review process is stated (refer chapter 7, Step 4).

To circumvent the uncertainty in timing and magnitudes of future projections in climate change, the adopted time line for implementation of actions should be set in relation to a **credible mid-range** trajectory in sea-level rise and associated changes in coastal hazards. If sea-level rise is slower than the adopted trajectory and coastal hazards have not changed significantly, then the implementation of the next stage of the adaptation plan can be delayed, but if changes are faster than anticipated, the next set of actions along the timeline will need to be brought forward. This highlights the importance of tracking sea-level rise regionally in relation to the adopted sea-level rise trajectory, so that the adaptation plan can be adjusted when new information or changing circumstances arise.

When developing the adaptation plan which defines your way forward, council decision-makers will need to carefully consider questions of social and economic equity both within existing communities and between current and future generations (e.g., protection of private property can result in loss of beach amenity for the wider community; funding hard protection structures now for the protection of future generations). For further information refer to the MfE resources identified in Appendix 3. Decision makers will also need to provide a balance between allowing for ‘reactive’ (i.e., reacting to problems as they arise) while maintaining ‘proactive’ strategic approaches (i.e., building capacity to adapt to potential change).

Effective adaptation will require local authorities to allocate resources and actions through their LGA long term and annual plans.

Additional resources to assist you at this step are in Appendices 2 and 3.

## 6.5 Are you ready to move on to Step 4?

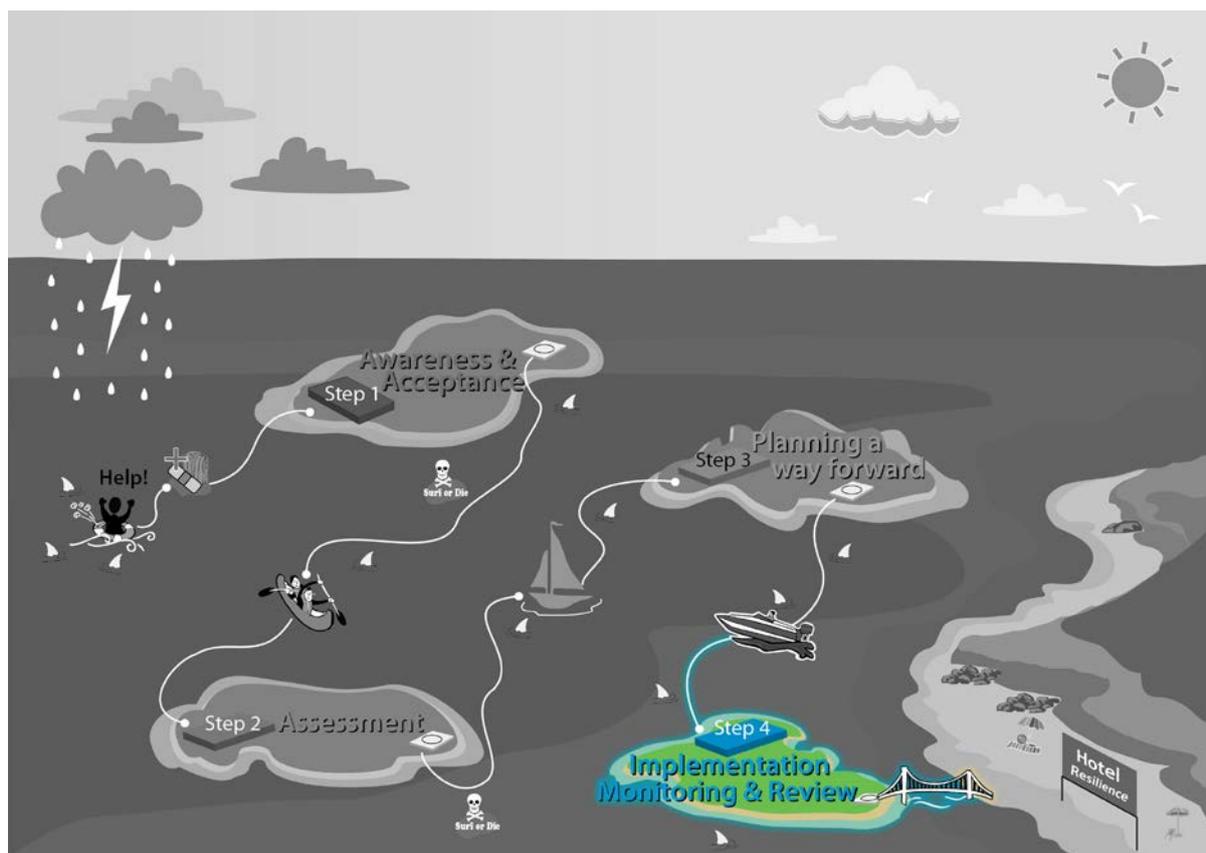
As a council you will know you are ready to move on to Step 4 when:

- You are clear about your communities' vision(s) for adaptation to coastal climate change
- You have identified the preferred set of adaptation actions, and timeframe and timeline targets
- You have a commitment from your council for resourcing the implementation of the strategic way forward (staff/time/finances)
- You have political and community support of the actions within the adaptation plan defining the way forward and are clear about those things you cannot do anything about.

## 7. Step 4: Implementation, Monitoring and Review

### 7.1 How do I know if I'm at Step 4?

The fourth step along the *Pathways to Change* is about implementing actions identified in the adaptation plan that was developed in Step 3. It is also about monitoring the actions being implemented and the changes that are being achieved, along with reporting on these and feeding this information back into a review of the adaptation plan and to your communities.



If you are at this step on the pathway, key questions that you and your council and community might be asking include:

- *Is our plan for a strategic way forward being implemented effectively?*
- *Are our communities becoming more resilient to climate change?*
- *What do we need to monitor and what are the triggers for reviewing our adaptation plan?*

If you are at Step 4, you have already developed an adaptation plan which sets out a strategic way forward and have identified the key actions required. Your focus is now on implementation, monitoring and review of the adaptation plan. You want to ensure the plan is being implemented, is effective and that it is kept up-to-date.

You also need to know what the triggers should be for bringing forward some of the actions or delaying them (e.g., if sea level rise is slower or faster than the adopted trajectory, or other coastal impacts such as rates of erosion have changed, then the timelines allocated for the different actions in your adaptation plan may also need to change).

## 7.2 Key drivers and barriers

The significant drivers at this step are:

- All drivers from previous steps
- Political and community pressure for implementing the adaptation plan
- Funding and resources committed to implementing the adaptation plan
- Statutory functions and responsibilities
- New hazard events at a local level.

Possible barriers and challenges you may encounter at this step may include:

- An unwillingness to proceed with actions because of the long-term nature of change (and which is longer than the political term of a council), or the lack of ‘hot spot’ issues leading to decreased perception of risk
- An unwillingness to alter ‘existing use’ property rights
- An unwillingness to commit resources to implementing the adaptation plan
- Lack of leadership to drive the implementation process
- Barriers discussed in Steps 1, 2 and 3 may also continue.

### **Box 7.1 Local Authorities’ views:**

The following extract is from the *Report on Local Government Planning Practice and Limitations to Adaptation* (Britton, 2010)

“Allied to the comments above ... on the reluctance to make ‘hard’ decisions, there is a propensity for councils, communities and individuals towards inaction based on: a hope that extreme events won’t occur (even though they are predicted to do so); more immediate issues pressing (it’s not a priority); the cyclic nature of past coastal erosion (resulting in the hope that the problem will go away); the slow rate of sea-level rise (compared with natural variations); and the cost of changing buildings or infrastructure.”

## 7.3 Tasks for Step 4

Key tasks for Step 4 are to make sure that the adaptation plan developed at Step 3 is implemented effectively, and that a monitoring and review process is set up to ensure the plan remains relevant.

It is also important to ensure that the progress being made with implementation along with the results of the monitoring undertaken is well-communicated to council, key stakeholders and communities. This sharing of information assists in keeping people well-informed and up-to-date

with changes that are occurring in their communities, along with assisting people to be actively involved in any review of the adaptation plan.

### **Box 7.2 Case Study: Bay of Plenty Regional Council**

The goal of this project was to develop monitoring tools to measure the coastal hazard risk on the landward side of the coastal environment and to gather information to measure the effectiveness of the Regional Coastal Environment Plan objective of ‘No increase in the total physical risk from coastal hazards.’

A set of proposed indicators was developed and trialled through a pilot to test if they were workable. As a result of this pilot test there was some reworking and refinement of the proposed indicators into a simplified core set of seven coastal hazard risk indicators (CHRI):

**CHRI-1** Have coastal hazard zones been identified and included on district planning maps?

**CHRI-2** Are there district rules to support those hazard zones and are these aimed at not increasing physical risk of coastal hazards? (this may include no-subdivision rules and building setbacks)

**CHRI-3** Are there administrative or district plan policies to ensure that any building within the coastal hazard zones is subject to controls to mitigate risk such as relocatability and relocation management plans?

**CHRI-4** Average building setback for the most seaward residential dwellings on residential lots in coastal hazard zones from the year 2000 toe of fore-dune survey line datum.

**CHRI-5** Number of residential dwellings in the coastal hazard zones at the date of the most recent aerial photography.

**CHRI-6** Number of residential lots in coastal hazard zones from the DCDB at a date close to the most recent aerial photography.

**CHRI-7** Percentage of new residential dwellings within coastal hazard zones subject to resource consent with building relocation conditions.

(Gordon et al., 2005; Gordon, 2006)

<http://www.boprc.govt.nz/media/33571/Report-200605-CoastalHazardRiskIndicators1.pdf>

<http://www.boprc.govt.nz/media/33574/Report-200605-CoastalHazardRiskIndicators2.pdf>

## **7.4 Tools to help you at Step 4**

### **Effective Implementation**

Sustained implementation of an adaptation plan over a long period of time poses a particular challenge due to a wide range of factors – including, for example, political and staff changes, failure to keep the plan relevant, dwindling commitment to a monitoring and review process and the ‘tyranny of the urgent’. For instance, a 1999 study found that nearly 70% of strategic plans and strategies are never successfully implemented (Sterling, 2003).

A checklist to ensure successful implementation could include:

- **Keeping the adaptation plan relevant to changing circumstances.** As noted in Step 3, it is inevitable that any adaptation plan will be founded on imperfect and incomplete information and there is an ongoing need to adapt to changing circumstances and information.
- **Maintaining senior management and political support.** This is critical to:
  - Effective integration of the adaptation plan into all of council's work areas so that people actively consider the plan as they make day-to-day decisions and plan for future works and services. A real challenge in plan implementation is that from time-to-time people can lose focus as the daily work pressures take over (Sterling, 2003).
  - Adequate funding in council's annual and long term planning processes.
- **Leadership.** This would ensure:
  - Buy-in to and understanding of the adaptation plan among those who need to implement it
  - Core competencies required for implementation exist in the organisation
  - Ongoing focus on implementation priorities and timelines.
- **Effective ongoing communication of the adaptation plan** and its underlying rationale. This is particularly relevant when engaging the wider community and stakeholders (including new property and business owners) on an ongoing basis over time. It also assists in ensuring that there is continued pressure from outside the council to keep implementing the adaptation plan. Likewise it is important to report on and celebrate success with the stakeholders and sponsors. This ensures the continuation of the plan by giving people information on 'successes' and for them to claim a stake in that success.

#### **An effective monitoring and review framework**

Monitoring and review is critical to effective and ongoing implementation of any adaptation plan. As commonly stated - *if you can't measure it, you can't manage it.*

This monitoring and review process ensures the plan is both effectively implemented (e.g., actions being achieved within timelines and budgets) **and** achieving the desired outcomes. This process ensures the plan remains relevant and effective over time (e.g., that it adjusts to changing hazards and circumstances; addresses political and community drivers or barriers; builds on lessons learned; identifies what is working and what is not).

A monitoring and review framework involves two key components:

- a clear outline of what it is you are monitoring and why; and
- quality measures (e.g., indicators) to assess the performance of the adaptation plan.

A framework for monitoring the progress of an adaptation plan usually includes the following:

- Determine what should be monitored and why
- Define relevant indicators or other measures and data collection requirements (e.g., who does the monitoring; how; frequency; archiving data; etc)

- Analyse, interpret and report the results to council decisions-makers, key stakeholders and to the wider community
- Review and adjust the actions in the adaptation plan as required, but in particular the timelines and timeframes for the actions (including monitoring).

Indicators measure changes or trends over time and can be quantitative or qualitative. They provide the basis for before-and-after analyses to gauge the effectiveness of the adaptation plan. A list of potential indicators is provided in Table 7.1. It is not intended that all these indicators would be monitored. Rather it is about choosing the most appropriate ones for your council or community, depending on what step of the Pathway you are on and what your community vision is for the future.

Both the selection of indicators for monitoring and the frequency of monitoring can evolve over time as the adaptation plan is implemented. However, the indicators chosen for the monitoring should be robust as monitoring will need to be carried out with a long-term view in mind.

The relevant communities and stakeholders likely to be affected by the adaptation activities should be involved in the monitoring and evaluation process. This not only assists in ‘democratising’ the process but also enhances community learning and their capacity to adapt. The results of these feedback mechanisms can then be used to improve adaption practices and to contribute to council’s and communities’ learning.

Additional resources to assist you at this step are in Appendices 2 and 3.

**Table 7.1 Potential Indicators - A: Indicators Generic to all Steps.**

<b>Policies and Plans</b>	<ul style="list-style-type: none"> <li>• Have you set tasks and allocated funding to coastal adaptation to climate change in your Long Term Plan, annual plan and annual work programmes? (Yes/No/ number of tasks/ \$ allocated)</li> <li>• Have you included coastal adaptation policies/rules in RPS, regional and district plans? (Yes/ No/number of references/ presence of indicators for measuring policy effectiveness)</li> <li>• Does council have coastal setbacks and development controls in their RMA plans to identify and manage the potential effects of climate change? ( Yes/ No/ type/ effectiveness measures)</li> <li>• Have you considered risk reduction through coastal adaptation and included this into your CDEM Group plans? (Yes/no/how integration is achieved with other plans)</li> <li>• Does council have policy on adaptation of coastal reserves and other coastal public land to provide for the potential effects of climate change? (Yes/no/how integration is achieved with other plans/ effectiveness measures)</li> <li>• Does council have policy on adaptation of coastal infrastructure and assets to provide for the potential effects of climate change? (Yes/no/type of asset management approach/ effectiveness measures)</li> <li>• Is coastal adaptation to climate change embedded into council’s asset planning and delivery? (Yes/no/how/ effectiveness measures)</li> </ul>
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<b>Hazard Risk Indicators</b>	<ul style="list-style-type: none"> <li>• Number of sites within the district/ region with existing coastal hazard issues</li> <li>• Number of sites within the district/ region with potential coastal hazard issues with projected climate change</li> <li>• Number of dwellings/ lots within identified coastal hazard zones</li> <li>• Number of coastal communities where the potential impacts of climate change on coastal hazards has been identified</li> <li>• Monitor at for example 5-yearly intervals the trend in regional sea-level rise in relation to the trajectory of sea-level rise adopted for the adaptation plan (is it rising faster or slower than anticipated) (see Box 7.3)</li> <li>• Number of coastal inundation events regionally or local hotspots (causing disruption and/or damage) on a rolling 10-year average. (Note: the first signs of sea-level rise will manifest as an increasing frequency of coastal inundation events)</li> </ul>
<b>Community Participation</b>	<ul style="list-style-type: none"> <li>• Number of coastal communities with whom council is working on coastal adaptation</li> <li>• Are community attitudes and awareness relevant to climate change and coastal adaptation being monitored? (Yes/No/ how/ how often)</li> <li>• Number coast care/ estuary care groups involved in adaptation issues</li> </ul>
<b>Community Resilience</b>	<ul style="list-style-type: none"> <li>• Change in the number of dwellings in defined coastal hazard risk areas</li> <li>• Number of properties and dwellings in areas at risk from sea-level rise</li> <li>• Change in the quantity (length and number) of infrastructure located in areas deemed to be at high risk from sea-level rise</li> <li>• Change in the level of awareness of community members</li> <li>• Range of actions being undertaken to adapt to climate change impacts</li> </ul>

**Table 7.1 Potential Indicators - B: Indicators Specific to Different Steps.**

Many of these indicators can be used to establish a baseline against which the progress of your council and communities can be measured as you progress along the Adaptation Pathway.

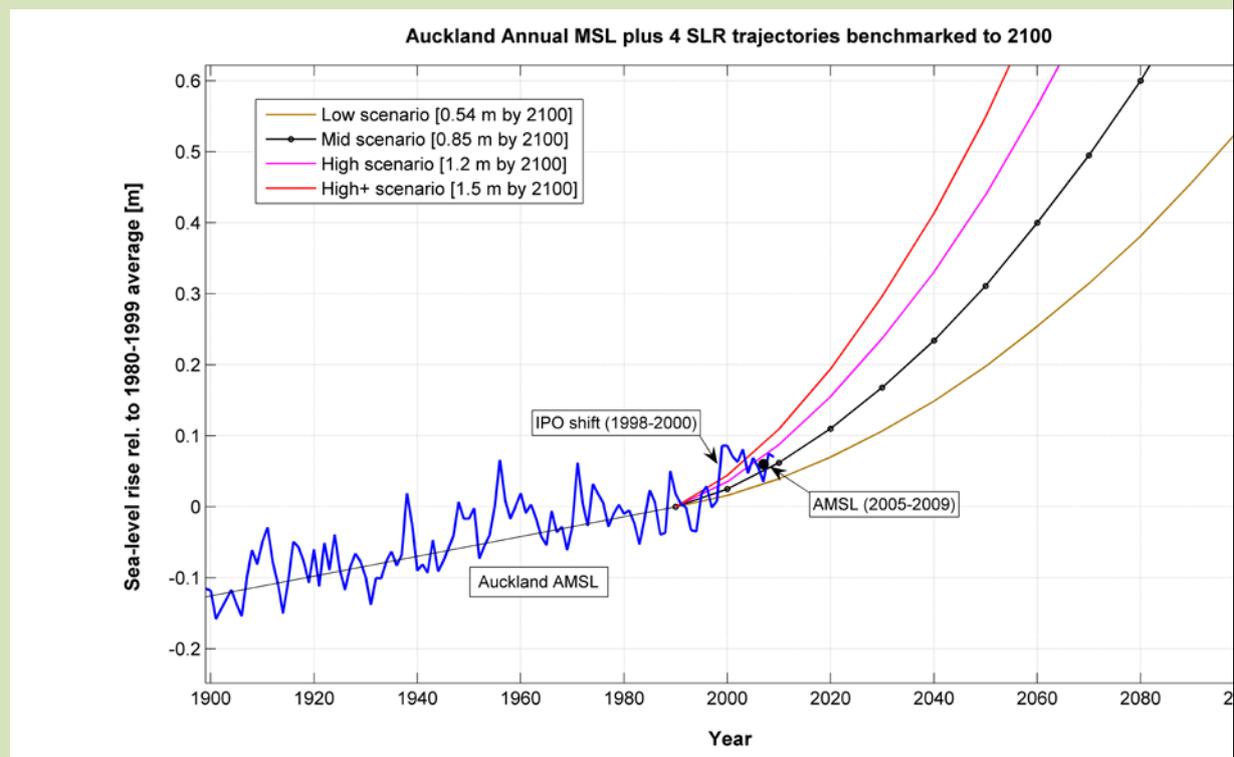
<b>Step 1: Awareness and Acceptance</b>	<ul style="list-style-type: none"> <li>• Have you developed a strategy for dialoguing with your communities about coastal adaptation to climate change? (Yes/ No/ what/how often)</li> <li>• Have you measured the level of political and community awareness in relation to coastal change issues (Yes/ no/ survey results/ trends over time)</li> <li>• What is the level of resources allocated to raising awareness of adaptation to coastal change in your council's budgets and work programmes? (\$ allocated/ trends over time)</li> <li>• Number of activities undertaken to raise political and community awareness of climate change and coastal adaptation (e.g., No. of public reports; press releases; meetings/ trends over time)</li> <li>• Number of people or communities with whom council is actively involved in</li> </ul>
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	raising awareness of coastal change and adaptation
<b>Step 2: Assessment</b>	<ul style="list-style-type: none"> <li>• Monitoring of coastal change (e.g., beach profiles, sea-level) (what is being measured? where? how often?/ trends over time)</li> <li>• Has information been produced on the analysis of the monitoring undertaken and been distributed to the council and communities? (yes/no/how often/how effective in delivering a message?)</li> <li>• What is the level of resources allocated to coastal hazard assessment in budgets and work programmes (\$ allocated/ trends over time)</li> <li>• Number of coastal communities for which risk assessment has been undertaken (increasing /decreasing on a 10-year average)</li> <li>• Number of people or communities with whom council is actively involved in assessing coastal risk.</li> </ul>
<b>Step 3: Planning a way forward</b>	<ul style="list-style-type: none"> <li>• Has a strategic adaptation plan been developed for the district/ region or for individual sites? (Yes/no/scope)</li> <li>• What is the level of resources allocated to developing your adaptation plan for adaptation to climate change in budgets and work programmes (\$ allocated/ trends over time)</li> <li>• Number of coastal communities engaged in development of adaptation plan or related strategies (either site specific or district/ region wide strategies)</li> </ul>
<b>Step 4: Implementation, Monitoring and Review</b>	<ul style="list-style-type: none"> <li>• What is the level of resources allocated to implementing the adaptation plan in budgets and work programmes? (\$ allocated/ equal to/ greater than/ less than planned for/ trends over time)</li> <li>• Has a monitoring and review framework been developed? (yes/no/is it integrated with other monitoring requirements of council?)</li> <li>• Effective implementation of the adaptation plan <ul style="list-style-type: none"> <li>○ Number actions implemented (e.g., in full/ partial, timelines met, within budget)</li> <li>○ Number actions amended (e.g., reviewed as a result of monitoring/ new circumstances)</li> </ul> </li> <li>• Monitoring the desired outcomes <ul style="list-style-type: none"> <li>○ Change over time: number dwellings/ lots/ critical service buildings at risk</li> <li>○ Change over time: capital value within hazard zones</li> <li>○ Change over time: infrastructure at risk from coastal hazards</li> <li>○ Change over time: community awareness and participation in adaptation actions</li> </ul> </li> </ul>

### Box 7.3 Regular monitoring and reviews for adaptive management: tracking sea-level rise

A key component in the implementation of any coastal adaptation plan is monitoring sea-level rise (and also storm-tide occurrence and coastal erosion) to ascertain locally how these drivers are changing with time and whether they are diverging from the credible best-estimate trajectory used to estimate the timing of different adaptation stages.

The figure below shows an example of a monitoring/review plot for Auckland that combines the ongoing trend in annual mean sea level with a range of possible future sea-level rise trajectories. Updating such plots at 5-yearly intervals will be very useful to inform whether changes to the timing of actions in your coastal adaptation plan are required.



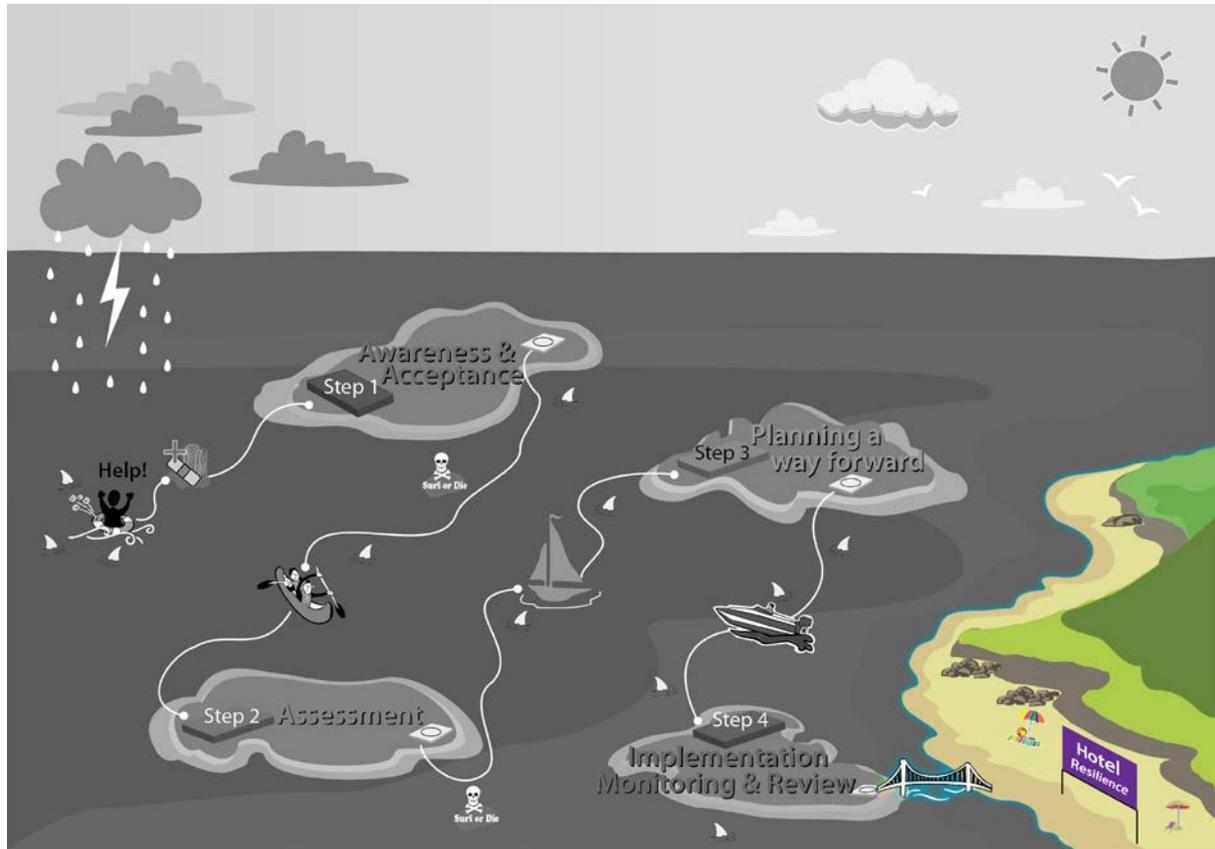
The plot above compares past annual mean sea level (AMSL) at Auckland with four possible sea-level rise scenarios relative to 1990 sea level (averaged over 1980–99). Example sea-level rise trajectories for comparison are benchmarked to 0.54, 0.85, 1.2, and 1.5 m by 2100. The lower two trajectories are equivalent to rises of 0.5 and 0.8 m by the 2090s (which form the basis of the guidance by MfE, 2008a). The black line is the trend of annual mean sea level (blue) from 1899 to 1990. The larger black dot marks progress of the average sea level for the recently-reviewed period 2005–2009, centred on 2007, which indicates sea-level is **currently** tracking along the dotted mid-scenario towards 0.85 m by 2100.

The step jump in annual sea level from 1998 to 2000 is annotated. This occurs when the 20–30 year Interdecadal Pacific Oscillation (IPO) changes to its negative phase. The key point illustrated here is that in reviewing the progress in sea-level trends, decadal variability in sea level needs to be taken into account in assessing how sea level is tracking locally. Reviews of the local monitoring also need to go hand-in-hand with a longer perspective that regularly updates sea-level rise projections from recent research literature, guidance material and regular IPCC assessment reports.

(Auckland AMSL derived from sea-level data supplied by Ports of Auckland Ltd.)

## 7.5 Have you completed your journey or are you ready to move on?

### The finish line: a resilient community



As a council you will know you have completed Step 4 when:

- You have an ongoing resourcing commitment from council (\$, time, people)
- You have a set of indicators to monitor the implementation and effectiveness of the adaptation plan
- You are regularly preparing progress reports on the implementation of actions and changes in the environment and/or your communities
- You are regularly reviewing the timeframes and timelines within your adaptation plan, and updating the actions as required
- You are reporting on success
- But in undertaking these review actions, you may also realise that there are some iterations of Steps 1, 2, 3 or 4 that you need to revisit.

## 8. Wrap up

In *Pathways to Change* we have set out a framework for you to consider, when undertaking your adaptation journey. The four key steps we have outlined are:

- Step 1: Awareness and Acceptance
- Step 2: Assessment
- Step 3: Planning a way forward
- Step 4: Implementation, Monitoring and Review.

*Pathways to Change: from troubled waters to a resilient community.*



These steps will build on existing work that you are already undertaking. You may start at Step 1 or jump to another step in the process. Your progress will be iterative as you respond to changing circumstances, particularly with respect to political changes, community awareness and changing environmental pressures. Therefore 'adaptation' is not an outcome in itself, rather it is about taking iterative steps that will enable change to occur in communities; change which will affect social, cultural, economic and environmental outcomes, and which will enable communities to become more resilient to the potential future impacts of climate change in coastal areas. In other words there is a lot of value in the process itself for both council and the community.

Through the development of the 4 steps in *Pathways to Change*, we identified the following key ideas, which we think apply to the overall journey no matter what step on the pathway you are on.

These include:

- The decisions we make today, particularly in relation to our land use activities, will affect our future vulnerability and resilience. This includes decisions about land use, infrastructure location and design, reserves management, property investment, etc.
- Uncertainty should not be an excuse for delay. A failure to act will simply lead to our communities being more vulnerable in the future. An adaptive management approach can circumvent uncertainty, where pre-determined actions can be advanced or delayed well ahead of time.
- There is no instant answer - it will take time and effort to adapt. For example, it will take time for some decisions to take effect or make a difference, often decades. It will also take time to build the skills and knowledge and build and maintain the community awareness required. However delaying adaptation will cost more in the future and expose communities to a greater level of risk to coastal hazards. Beginning now comes with the financial gain of expenditure spread over a longer time period.
- Adaptation is a shared responsibility and partnerships are critical. Adaptation is not something that any council or any particular agency or any community or any one discipline can do alone. It will require a combined and integrated approach.

***“The challenge is not to find the best policy today for the next 100 years, but to select a prudent strategy and to adjust it over time in the light of new information.”***

***(IPCC, 1996)***

Evaluating the effectiveness and efficiency of actions set out in your adaptation plan and monitoring change over time are essential to knowing whether you are on the right pathway to the vision set for your community, both in the short term and in the long term. This information gathering on the effectiveness of implementing your adaptation plan is also required to feed back into a review of that plan to ensure the actions remain valid and appropriate for the issues being faced now and for those anticipated for future generations. The economic efficiency of actions spread over time is also a key consideration when assessing and reviewing adaptation decisions and actions. Reducing the physical and economic risks of natural hazards is cost-effective for both our current and future generations.

## **Box 8.2 Good Luck on Your Adaptation Journey**

### ***Remember:***

- You are no doubt already doing things now that will lead to adaptation over time
- You can learn from other councils and communities
- Gathering actions into an adaptation plan to guide your way forward is achievable and can be reviewed and built on over time
- Committing to this adaptation journey now will leave a legacy of a more resilient community in the future

***The longest journey begins with the first step***

(ancient Chinese proverb)

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## Appendices

- Appendix 1      Overview of Legislation
- Appendix 2      Examples of Local Authority Plans
- Appendix 3      Annotated Bibliography

## Appendix 1 Overview of Legislation

The legislative context for managing adaptation to climate change in the coastal environment involves four key Acts, which are briefly outlined in this section. (Further information is also available in MfE, 2008a.)

### Resource Management Act, 1991 (RMA)

The RMA establishes the legislative framework for the sustainable management of resources, including the coastal environment. The 'effects of climate change' is identified in s7(i) as one of the 'other matters' that 'particular regard' must be given to, when managing activities and development (which was inserted in the 2004 amendment to the RMA).

Section 7 of the RMA also requires that "particular regard" be given to the ethic of stewardship and kaitiakitanga. The Ministry for the Environment notes: "The principle underpins sound planning decision-making in the interests of the community to avoid or minimise loss of value or quality over time. Its relevance to climate change relates particularly to asset management, land and water care, biosecurity, and biodiversity."<sup>3</sup>

The RMA sets out functions and responsibilities for central government and local authorities. Management functions for the coastal environment are shared between the Minister of Conservation, regional councils and territorial authorities (refer in particular to sections 28, 30, 3131A).

National, regional and district policy statements and plans set the policy framework for managing the effects of activities. The New Zealand Coastal Policy Statement (NZCPS) 2010 sets the national strategic policy direction for managing the coastal environment, including policy directives for coastal natural hazards and the management of coastal edge development (form and location). In addition, there is the Hauraki Gulf Marine Park Act 2000 which has the effect of a national policy statement and emphasises a more co-ordinated approach to the management of the land-sea interface.

Within the NZCPS 2010 adaptive management approaches include the precautionary approach as set out in Policy 3. Councils are also explicitly required to consider the effects of climate change in regard to management of public open space, coastal hazards, integration, reclamations and declamation, public open space and coastal hazards (refer in particular to NZCPS objectives 4 and 5 and policies 3, 4, 10, 18 and 24). The RMA requires that councils 'give effect to' these national directions (refer to sections 62(3), 67(3), 75(3) RMA). The New Zealand Standard (NZS4404:2010) for Land Development and Subdivision Infrastructure also requires climate change to be considered in risk assessments so that levels of service can be maintained through design lifetimes.

Within each region, the regional policy statement also has a role in defining the respective functions of regions and territorial authorities in managing the adverse effects of natural hazards. This separation of functions between regions and territorial authorities, along with the jurisdictional

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<sup>3</sup> See MfE site: <http://www.MfE.govt.nz/publications/climate/adapt-climate-change-second-generation-rma-2008-09/climate-change-adaptation-2nd-generation-rma.html>

boundary of MHWS is commonly acknowledged as adding complexity to the integrated management of the coastal water-land interface.

In terms of land use within areas that are likely to be affected by coastal hazards, a key management barrier is the 'existing use rights' of land owners. Recent work suggests that regional councils, through their Regional Policy Statement and Regional Plan(s), may override existing land use 'rights' for activities in the coastal environment, by including rules to control activities for hazard purposes (Berry, 2010). This is a significant planning option for councils to consider in order to achieve integrated management and adaptation of the coastal areas.

### **Local Government Act, 2002 (LGA)**

This Act sets out the framework for local government and has a strong focus on local democracy and the sustainable well-being of communities. The LGA, through its powers of general competence, gives local authorities a strong mandate to undertake activities related to adaptation to climate change.

The LGA emphasises the four well-beings for a community (cultural, social, economic and environmental) and requires councils to identify community outcomes, and actions to achieve these outcomes through a 10 year work programme (i.e., through each council's long-term plan).

Local government is also responsible for a range of functions that may be affected by climate change and have both social and legal obligations to take climate change effects into account in their community planning. Planning needs to embrace expected long-term shifts and changes in climate extremes and patterns to ensure existing and future generations are adequately prepared for future climate conditions.<sup>4</sup>

### **Building Act, 2004 (BA)**

This Act focuses on ensuring the safety and integrity of structures through controls on construction and use. In respect to natural hazards, s71 of the BA requires a building consent to be refused if works are proposed on land subjected to natural hazards, and adequate provision cannot be made to protect the land and buildings from natural hazards. Section 72 of the BA allows for a waiver if the building work does not exacerbate the natural hazard and if it is considered reasonable to grant the consent.

The BA process is complemented by the RMA process and in some instances a land use consent under the RMA is required along with a building consent under the BA. Where both consents are issued, the consent which has the more stringent controls prevails.

### **Civil Defence and Emergency Management Act, 2002 (CDEMA)**

This Act promotes the sustainable management of natural hazards and sets out a framework for emergency management. It focuses on a risk-management approach to natural hazards and emphasises reduction, readiness, response and recovery. Regional and territorial authorities are required to form a joint CDEM Group, which is responsible for preparing a CDEM plan. Such plans

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<sup>4</sup> ibid

cover the hazards and risks to be managed and the actions necessary to do so. We note that the RMA and BA provide complementary roles to the CDEMA, and are fundamental to achieving a 'reduction' of risk through land use and building controls.

### **New Zealand Coastal Policy Statement 2010**

In regard to the RMA, the NZCPS provides objectives and policies that direct management of the coastal environment. The NZCPS emphasizes the protection and/or enhancement of a wide range of coastal values including natural character, natural features and processes, public access, and cultural heritage as well as providing guidance for managing natural hazards.

In relation to managing natural hazards, Policy 27 from the NZCPS provides detailed national guidance for strategies protecting significant existing development from coastal risk (see Box A1.1).

Other NZCPS policy relevant to natural hazards includes:

- i. Adopting a precautionary approach in regard to the effects of climate change so that avoidable loss and harm to coastal communities does not occur and natural coastal adjustments are provided for (Policy 3)
- ii. Providing for integrated management and working collaboratively with other agencies within the coastal environment and across administrative boundaries (Policy 4)
- iii. Managing subdivision, use and development to avoid increasing the risk of harm and adverse effects from coastal hazards, to encourage reduction in the adverse effects and to encourage the location of infrastructure away from areas of hazard risk (Policy 25)
- iv. Discouraging hard protection structures and promoting the use of alternatives including natural defenses (Policy 25e and 26).

#### **Box A1.1 Extract from the NZCPS 2010**

Policy 27: Strategies for protecting significant existing development from coastal hazard risk

1. In areas of significant existing development likely to be affected by coastal hazards, the range of options for reducing coastal hazard risk that should be assessed includes:
  - a. promoting and identifying long-term sustainable risk reduction approaches including the relocation or removal of existing development or structures at risk;
  - b. identifying the consequences of potential strategic options relative to the option of 'do-nothing';
  - c. recognising that hard protection structures may be the only practical means to protect existing infrastructure of national or regional importance, to sustain the potential of built physical resources to meet the reasonably foreseeable needs of future generations;
  - d. recognising and considering the environmental and social costs of permitting hard protection structures to protect private property; and
  - e. identifying and planning for transition mechanisms and timeframes for moving to more sustainable approaches.
2. In evaluating options under (1):
  - a. focus on approaches to risk management that reduce the need for hard protection structures and similar engineering interventions;
  - b. take into account the nature of the coastal hazard risk and how it might change

- over at least a 100-year timeframe, including the expected effects of climate change; and
  - c. evaluate the likely costs and benefits of any proposed coastal hazard risk reduction options.
3. Where hard protection structures are considered to be necessary, ensure that the form and location of any structures are designed to minimise adverse effects on the coastal environment.
  4. Hard protection structures, where considered necessary to protect private assets, should not be located on public land if there is no significant public or environmental benefit in doing

Together these NZCPS policies provide a strong guide for managing land use activities in regional policy statements, and regional, coastal and district plans. While land use planning is only one of several adaptation actions it is clearly a critical mechanism for delivering a resilient framework for future land use decisions. It is also critical that integrated planning addresses the jurisdictional issues between local authorities to ensure that planning above and below MHWS is consistent.

**Summing up**

There is a range of inter-linking legislation which contributes to the management of the coastal environment. In addition the NZCPS is critical national policy.

We note that the RMA on its own is not sufficient to address the issues associated with adaptation to climate change. Thus a co-ordinated response to adaptation to climate change by both public and private parties, using a variety of methods and tools under a range of legislation, will be required.

## Appendix 2 Examples of Local Authority Plans

The following examples of plans and associated documents were identified from the work undertaken as a part of the report *Coastal Adaptation to Climate Change: Report on Local Government Planning Practice and Limitations to Adaptation* (Britton, 2010). They represent an overview of examples at the point in time when the questionnaires for the above report were completed.

<b>Plan Type</b>	<b>Local Authority</b>	<b>Commentary</b>
<b>Local Government Act: Long Term Plans</b>	Greater Wellington Regional Council	<ul style="list-style-type: none"> <li>• 2009 – 19 LTP – has specific references to resilience and adapting well to climate impacts</li> <li>• Regional resilience planning identified as a short term target in the 2010/11 annual plan</li> <li>• Climate change considerations have been built into the management of resources (e.g., land and water) as well as into hazards management</li> <li>• Community well-being and economic affordability were underlying themes that would underpin the short-term responses of the council, while nevertheless recognising adaptation to climate change as a longer-term issue.</li> <li>• <a href="http://www.gw.govt.nz/10-year-plan-2009-19-incorporating-the-annual-plan-2009-1/">http://www.gw.govt.nz/10-year-plan-2009-19-incorporating-the-annual-plan-2009-1/</a></li> </ul>
	Bay of Plenty Regional Council	<ul style="list-style-type: none"> <li>• Adaptation to climate change is embedded into a range of work streams, with a focus on enhancing community resilience.</li> <li>• Includes a comprehensive position statement on climate change (which emphasises adaptation)</li> <li>• <a href="http://www.boprc.govt.nz/knowledge-centre/plans/ten-year-plan.aspx">http://www.boprc.govt.nz/knowledge-centre/plans/ten-year-plan.aspx</a></li> </ul>
	Gisborne District Council	<ul style="list-style-type: none"> <li>• Climate change and adaptation embedded into activities rather than being identified as a separate area</li> <li>• Undertook an update of climate change predications and implications for the future</li> <li>• The <i>Urban Coastal Strategy 2005</i> (refer below) was referred to specifically, along with the intention to control land use planning rather than relying on coastal protection works (reflecting a strong integration across MHWS).</li> <li>• <a href="http://www.gdc.govt.nz/ten-year-plan-2009-2019/">http://www.gdc.govt.nz/ten-year-plan-2009-2019/</a></li> </ul>

	Tasman DC	<ul style="list-style-type: none"> <li>• Climate change and adaptation embedded into activities with a particular focus coastal areas and on making communities resilient</li> <li>• There is a strong focus on information gathering.</li> <li>• <a href="http://www.tasman.govt.nz/policy/plans/ten-year-plans/ten-year-plan-2009-2019/">http://www.tasman.govt.nz/policy/plans/ten-year-plans/ten-year-plan-2009-2019/</a></li> </ul>
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<b>Resource Management Act Plans<sup>5</sup></b>	Hawkes Bay Regional Council	<ul style="list-style-type: none"> <li>• <i>Hawke's Bay Regional Resource Management Plan</i> (incorporating the Regional Policy Statement)(operative 2006) and <i>Hawke's Bay Regional Coastal Environment Plan Proposed</i> (amended by Council decisions 2008, outstanding appeals)</li> <li>• Within the RPS, Natural hazards management focus is on non-regulatory methods and seeking an integrated approach with Territorial Authorities through liaison. In terms of responsibilities both levels of councils are responsible for managing natural hazards.</li> <li>• The Regional Coastal Environment Plan defines the extent to the coastal environment - and controls some land use activities in this area.</li> <li>• The Guidelines for decision-making are very directive and comprehensive about adaptation and avoidance of subdivision or use on inappropriate areas.</li> <li>• Rules support a consent approach to land use activities in hazard zones and for protection structures.</li> <li>• <a href="http://www.hbrc.govt.nz/ReadAboutIt/PlansandStrategies/RegionalResourceManagementPlan/tabid/270/Default.aspx">http://www.hbrc.govt.nz/ReadAboutIt/PlansandStrategies/RegionalResourceManagementPlan/tabid/270/Default.aspx</a></li> <li>• <a href="http://www.hbrc.govt.nz/ReadAboutIt/PlansandStrategies/ProposedRegionalCoastalEnvironmentPlan/tabid/895/Default.aspx">http://www.hbrc.govt.nz/ReadAboutIt/PlansandStrategies/ProposedRegionalCoastalEnvironmentPlan/tabid/895/Default.aspx</a></li> </ul>
	Gisborne District Council	<ul style="list-style-type: none"> <li>• <i>Coastal Environment Plan</i> (proposed) and the <i>Combined Regional Land and District Plan (operative 2006)</i>. These plans effectively work together to control land-sea issues.</li> <li>• Natural Hazards chapter in the Coastal Environment Plan deals with coastal hazards and climate change.</li> <li>• The data for erosion and landslip have been pulled together into four Coastal Hazard Zones according to the degree of risk at</li> </ul>

<sup>5</sup> Refer also to an overview of Council RMA plan provisions in Jacobson, M., 2004 and Berry, S., 2010.

		<p>each location. The Zones are:</p> <ul style="list-style-type: none"> <li>• Extreme: hazards likely to manifest at any time</li> <li>• High: likely to manifest by 2050</li> <li>• Medium: likely to manifest 2050-2100</li> <li>• Safety: safety buffer.</li> </ul> <ul style="list-style-type: none"> <li>• ASCH (Area Sensitive to Coastal Hazard) maps are included into the Coastal and District Plans along with policy stating that for any developments in this area, a coastal hazard assessment may be required as part of an application for resource consent. Subsequent detailed hazard assessments have been undertaken for specific areas.</li> <li>• These Coastal Hazard Zones form overlays in the District and Coastal Plans and have policies and rules attached to them. The rules range from prohibiting subdivision and new buildings (in the Extreme Risk Zone) to making coastal protection works and building discretionary.</li> <li>• <a href="http://www.gdc.govt.nz/coastal-environment-plan/">http://www.gdc.govt.nz/coastal-environment-plan/</a></li> <li>• <a href="http://www.gdc.govt.nz/district-plan/">http://www.gdc.govt.nz/district-plan/</a></li> </ul>
	Taranaki Regional Council	<ul style="list-style-type: none"> <li>• <i>The Regional Policy Statement</i> (operative 2009) recognises the issue of climate change and in particular sea-level rise and variable extreme weather patterns. A clear statement is made (In accordance with section 62(1)(i)(i) of the RMA) that the control of the use of land to avoid or mitigate natural hazards is the responsibility of the Territorial Authorities.</li> <li>• Note: the functions for hard protection works that cross the landward boundary of the CMA were transferred to New Plymouth District Council in 2005, resulting in a 'one-stop shop' within the New Plymouth district for coastal hazard hard protection structures. This avoided the duplication of functions regardless of which side of mean high water springs the structures were located.</li> <li>• <a href="http://www.trc.govt.nz/regional-policy-statement/">http://www.trc.govt.nz/regional-policy-statement/</a></li> </ul>
	Invercargill City Council	<ul style="list-style-type: none"> <li>• The <i>Invercargill City District Plan 2005</i> (operative) addresses the management of coastal land use through the context of natural hazards management.</li> <li>• <i>Hazard maps</i>: identify areas below 3.0 m above mean sea level. These areas are broken down into two risk areas, depending on the existing level of protection and they are described as areas at risk from sea-level rise/ storm surge.</li> <li>• The rules range from permitted to discretionary depending on compliance with standards (such as floor levels).</li> <li>• <a href="http://www.icc.govt.nz/PublicDocuments/DistrictPlan.aspx">http://www.icc.govt.nz/PublicDocuments/DistrictPlan.aspx</a></li> </ul>

<b>Non-statutory plans or strategies</b>	Greater Wellington Regional Council and Wellington Territorial Authorities	<ul style="list-style-type: none"> <li>• <i>Wellington Regional Climate Change Response: Discussion Document: June 2009</i>: This discussion document was prepared as a collaborative piece of work involving all the Councils within the Wellington region. The Discussion document will lead to the development of an action plan. Adaptation to climate change and in particular in coastal areas is recognised. A key action is to undertake a vulnerability study for the whole region. Initiatives are also outlined for addressing sea-level rise.</li> <li>• <a href="http://www.gw.govt.nz/wellington-regional-climate-change-response/">http://www.gw.govt.nz/wellington-regional-climate-change-response/</a></li> </ul>
	Christchurch City Council	<ul style="list-style-type: none"> <li>• <i>Climate Smart Strategy 2010 – 2025</i>: This strategy sets a vision of a climate smart Christchurch resilient to the impacts of climate change (including coastal erosion). Current actions identified (in respect of coastal adaptation to climate change) include: changes to the City Plan to control development in areas vulnerable to flooding; restoration of dunes and salt marsh areas; construction and management of seawalls.</li> <li>• <a href="http://www.ccc.govt.nz/thecouncil/policiesreportsstrategies/strategies/healthyenvironmentstrategies/climatesmart/index.aspx">http://www.ccc.govt.nz/thecouncil/policiesreportsstrategies/strategies/healthyenvironmentstrategies/climatesmart/index.aspx</a></li> </ul>
	Gisborne District Council	<ul style="list-style-type: none"> <li>• <i>Urban Coastal Strategy 2005 - 2025</i>: The focus of this strategy is on urban planning, while taking into account natural hazard constraints. It complements the District Plan provisions. The strategy identifies areas vulnerable to natural hazards, and identifies this as a constraint to future development options being considered in the document.</li> <li>• <a href="http://www.gdc.govt.nz/urban-coastal-strategy/">http://www.gdc.govt.nz/urban-coastal-strategy/</a></li> </ul>
	Hastings District Council	<ul style="list-style-type: none"> <li>• <i>Hastings Coastal Environment Strategy 2000</i>: This strategy provides a framework for all aspects of planning and management for the coastal environment in the Hastings District over the next 20 years. This strategy provides for an integrated response to the competing demands between protection and development. It identifies actions for specified areas at risk. It has been used to underpin the District Plan and other council actions in coastal areas</li> <li>• <a href="http://www.hastingsdc.govt.nz/coastal-strategy">http://www.hastingsdc.govt.nz/coastal-strategy</a></li> </ul>
	New Plymouth District Council	<ul style="list-style-type: none"> <li>• <i>The Coastal Strategy 2006</i>: This strategy sets a guiding image or picture of what the community wants the coastal environment to look like in 20 years time. The strategy prioritises 100 key actions that the council will implement over the next 20 years. The <i>Mana Whenua Mana Moana</i> Paper was prepared by the Mana Whenua Reference Group for input into the New Plymouth Coastal Strategy. It highlights the importance of the coastal environment from the mana whenua perspective, by describing its history and values through stories. The paper also sets a direction for the future use and protection of the coast as desired by mana whenua</li> </ul>

		<ul style="list-style-type: none"><li>• <a href="http://www.newplymouthnz.com/CouncilDocuments/PlansAndStrategies/CoastalStrategy.htm">http://www.newplymouthnz.com/CouncilDocuments/PlansAndStrategies/CoastalStrategy.htm</a></li></ul>
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## Appendix 3      Annotated Bibliography

This Appendix sets out a range of resource material that you may find useful in guiding you through the various steps of the *Pathway to Change*. It is a selection of resources that we felt could be useful to your journey. In addition we have included some examples of other adaptation journeys.

### General resources useful for all Steps

Key resources are the **Ministry for the Environment documents** referred to in Box 4.2 in Step 1.

In addition to those documents in Box 4.2, the Ministry also provides guidance on:

- *Climate change adaptation and second generation RMA plans* (<http://www.mfe.govt.nz/publications/climate/adapt-climate-change-second-generation-rma-2008-09/index.html> )
- *Making good decisions – climate change effects* (<http://www.mfe.govt.nz/publications/climate/making-good-decisions-climate-change-effects-dec07/index.html> )
- *Climate change and long-term council community planning* (<http://www.mfe.govt.nz/publications/climate/climate-change-long-term-planning/index.html> )

Berry, S., 2010. *Planning Controls and Property Rights – Striking the Balance*. Prepared for the Resource Management Law Association Property Rights Roadshow 2010. Auckland.

The threat of sea-level rise as a result of global warming and the seemingly significant increase in the prevalence of extraordinary weather events produces a set of conundrums around the tension between restricting development in hazard prone areas and allowing land owners to develop their land in the manner they wish. This paper discusses planning control in the context of the Resource Management Act 1991. This includes examples of contemporary planning controls for managing coastal hazards.

Dean, C., 1999. *Against the Tide: The Battle for America's Beaches*. Columbia University Press. New York.

This book focuses on the theme that in the long term, extensive development cannot co-exist with an eroding beach and that people's attitudes will have to change. In spite of severe erosion rates and storm events, more and more development pressures are occurring on the coastal edge (particular the Atlantic coast). "Erosion is not a threat to the beach. If sea level is rising, the beach will simply retreat. Where there are no buildings, no human investment, no exploitation of the beach, this retreat occurs almost in silence, and no-one calculates it as an economic loss. But when people stake a claim on the coast, citizens and public officials must decide which is more important: preserving the beach or preserving the buildings behind the beach." p237. This scenario is expected to worsen in the face of climate change.

Gluckman, J.D.N., and C.A. Boyle, 2003. *Impacts of Climate Change in New Zealand and the Required Response: An Engineering Focus on Coastal Margins, Human Settlements, Infrastructure and Water Resources*. Institute of Professional Engineers New Zealand. Wellington  
<http://www.ipenz.org.nz/IPENZ/Forms/pdfs/TreNz3.pdf>

Engineers have a significant role to play in responding to the impacts of climate change in New Zealand. Engineers must take a proactive approach towards planning and managing the expected impacts of climate change. If the impacts of climate change are to be managed effectively, an integrated and precautionary approach is required. In the coastal environment, engineers must implement a range of complementary planned retreat, adaptation and protection measures.

Greenaway, A., and F.Carswell, 2009. *Climate change policy and practice in regional New Zealand: How are actors negotiating science and policy?* In *New Zealand Geographer* (2009) 65, 107 – 117. The New Zealand Geographical Society.

This article examines climate change responses in two regions: Marlborough and Waikato. Informants expressed a desire for more transparent government policy; that planning for climate change makes good business sense for farmers and other businesses; that technology is sought to increase productivity and decrease environmental impact; and research networks build capacity for local action, linking sectors and organisations.

Hunter, P., Burkitt, Z., and B. Trangmar, 2010. *Local Government adapting to Climate Change: Managing Infrastructure, Protecting Resources, and Supporting Communities*. In: Nottage, R.A.C., Wratt, D.S., Borman, J.F., and K. Jones (eds) , 2010. *Climate Change Adaptation in New Zealand: Future Scenarios and Some Sectoral Perspectives*. New Zealand Climate Change Centre, Wellington.

This paper "discusses a range of issues relating to local government, the effects of climate change on the communities they support and the infrastructure they manage." Case studies are provided and include references to risks from coastal flooding (sea-level rise and storm surge). A series of challenges for Local Government are identified along with the need for political and community buy-in to adaptation measures.

Jacobson, M., 2004. *A Review of the Effectiveness of the NZCPS in Promoting Sustainable Coastal Hazard Management in New Zealand*. Department of Conservation. Wellington.

As part of the independent review of the NZCPS undertaken in 2003, this review was commissioned to focus on the particular role of the NZCPS in promoting sustainable management of natural hazards in the coastal environment. The review undertook a range of case studies and made recommendations on policy changes to be considered as a part of the review process.

King, D.N., Penny, G., and C. Severne, 2010. *The Climate Change Matrix Facing Maori Society*. In: Nottage, R.A.C., Wratt, D.S., Borman, J.F., and K. Jones (eds), 2010. *Climate Change Adaptation in New Zealand: Future Scenarios and Some Sectoral Perspectives*. New Zealand Climate Change Centre, Wellington.

This paper “attempts to make some sense of how the environmental, economic, social and cultural elements of Maori society are likely to be impacted by climate change this century; and further considers the diverse vulnerability, risks, coping capacity, and adaptation options available to Maori across key sectors, systems and groups.” The paper recognises the vulnerability of coastal communities to sea-level rise and storm events and identifies barriers to adaptation for Maori.

Klein, R.J., Nicholls, R.J. and N. Mimura. 1999: *Coastal Adaptation to Climate Change: Can the IPCC Technical Guidelines be Applied?* Migration and Adaptation Strategies for Global Change Volume 4 (3-4): 239-252.

This paper evaluates *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations* (Carter et al., 1994) for the coastal environment, and also discusses the *UNEP Handbook on Methods for Climate Change Impact Assessments and Adaptation Strategies* (Feenstra et al., 1998) and its chapter on coasts (Klein and Nicholls, 1998). Klein et al., conclude that those early guidances were based on implementation of options, not on broader issues. The technical guidance is lacking in a number of areas – interaction between climate change and other pressures, public perception and awareness, spatial and temporal planning, mechanisms for involving public, non-technical (e.g., economic) areas, and tools to evaluate performance. Klein et al. propose 4 steps:

- Information collection and awareness raising
- Planning and design
- Implementation, and
- Monitoring and evaluation.

Wilson, E. and Piper, J., 2010. *Spatial planning and climate change*. The natural and built environment series, Routledge, London, 445p.

This book discusses the relationship between our changing climate and spatial planning and suggests ways of addressing the challenges by taking a longer-sighted approach to our preparation for the future. An overview of climate change and its impacts is provided along with an outline of the role of spatial planning in relation to climate change and a review of policy and legislation at international, EU and UK levels. Some case studies are

provided along with an outline of ways to help new and existing urban developments to reduce energy use and to adapt to climate change, through strengthening the relationships between urban and rural areas to avoid water shortage, floods or loss of biodiversity.

**Intergovernmental Panel on Climate Change (IPCC):** <http://www.ipcc.ch/>

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters.

The IPCC work is shared mainly among three Working Groups:

- Working Group I (WG I): assesses the physical scientific aspects of the climate system and climate change
- Working Group II (WG II): assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it
- Working Group III (WG III): assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere.

One of the main activities of IPCC is to produce the regular climate change Assessment Reports that are produced on an approximate 6-yearly cycle. Each of three Working Groups produces a set of assessment reports, comprising a comprehensive Technical Report, a Technical Summary and a Summary for Policymakers. All these reports are then condensed into a Synthesis Report. Publication dates for the previous assessment reports are:

1<sup>st</sup> Assessment Report (FAR): 1990

2<sup>nd</sup> Assessment Report (SAR): 1995

3<sup>rd</sup> Assessment Report (TAR): 2001

4<sup>th</sup> Assessment Report (AR4): 2007

with all reports available from: [http://www.ipcc.ch/publications\\_and\\_data/publications\\_and\\_data\\_reports.shtml](http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml)

The 5<sup>th</sup> Assessment Report (AR5) is due to be published in 2013/14.

**IPCC assessment and guidance reports cited in this guidance:**

- IPCC, 1996. *Climate Change 1995: Economic and social dimensions of climate change*. Contribution of the Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge.
- IPCC, 2007a. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976 pp.
- IPCC, 2007b. *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.
- Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, 2007. *Assessment of adaptation practices, options, constraints and capacity*. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, p. 717-743.
- Bindoff, N.L., J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan, 2007. *Observations: Oceanic climate change and sea level*. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p. 385–432.
- Nicholls, R.J., Hanson, S.E., Lowe, J.A., Warrick, R.A., Lu, X., Long, A.J. and T.R. Carter, 2011. *Constructing sea-level scenarios for impact and adaptation assessment of coastal areas: A guidance document*. Supporting Material, Intergovernmental Panel on Climate Change Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA), 47 p. [http://www.ipcc-data.org/docs/Sea\\_Level\\_Scenario\\_Guidance\\_Oct2011.pdf](http://www.ipcc-data.org/docs/Sea_Level_Scenario_Guidance_Oct2011.pdf)

### General Resource websites

<b>Country</b>	<b>Link</b>	<b>Description</b>
NZ	<a href="http://www.niwa.co.nz/ourscience/coasts/research-projects/all/coastal-adaption-to-climate-change">www.niwa.co.nz/ourscience/coasts/research-projects/all/coastal-adaption-to-climate-change</a>	<p>Coastal Adaptation to Climate Change project website: NIWA and its partners received a 3-year grant from the Ministry of Science and Innovation to create the necessary information and tools to enable adaptation - by central and local government and communities - to the impacts of climate-induced change on the coastal environment. The project includes three main work-streams:</p> <ul style="list-style-type: none"> <li>• Building a national coastal vulnerability profile</li> <li>• Engaging and informing communities</li> <li>• Encouraging best practice planning</li> </ul>
NZ	<a href="http://www.niwa.co.nz/our-science/climate/research-projects/all/climate-change-and-urban-impacts">http://www.niwa.co.nz/our-science/climate/research-projects/all/climate-change-and-urban-impacts</a>	<p>This site overviews a project on <i>Impacts of Climate Change on Urban Infrastructure &amp; the Built Environment Toolbox</i>. The project involves developing a science-based risk assessment approach for Central and Local Government to identify opportunities for reducing the impacts of climate change on the urban environment (See Box 5.4).</p> <p>Outputs from this project will be available from October 2011 via <a href="http://www.niwa.co.nz/climate">www.niwa.co.nz/climate</a></p>
NZ	<a href="http://www.nzclimatechange.org/research/climate-change-adaptation-publication">http://www.nzclimatechange.org/research/climate-change-adaptation-publication</a>	A range of resources on adaptation to climate change.
NZ	<a href="http://www.naturalhazards.net.nz">www.naturalhazards.net.nz</a> :	The Natural Hazards Centre was established in 2002 by NIWA and GNS Science, New Zealand's leading hazard Crown Research Institutes. Its role is to provide New Zealanders with a single point of contact for the latest natural hazard research, resources, and scientific expertise.
NZ	<a href="http://www.climatechange.govt.nz">http://www.climatechange.govt.nz</a>	This website contains information about climate change - its impacts and implications, and New Zealand's overall approach.
NZ	<a href="http://www.lgnz.co.nz/projects/EnvironmentalSustainability/ClimateChange/">http://www.lgnz.co.nz/projects/EnvironmentalSustainability/ClimateChange/</a>	<b>Local Government New Zealand</b> held a series of workshops on adapting to climate change. In this section you will find the workshop outcomes report, presentations from the workshops, council case

		studies on adaptation, and resource information on adaptation.
NZ	<a href="http://www.mfe.govt.nz/issues/climate/resources/adaptation/index.html">http://www.mfe.govt.nz/issues/climate/resources/adaptation/index.html</a>	This site has a wide range of climate change and adaptation papers. (refer also to <a href="http://www.mfe.govt.nz/publications/climate/">http://www.mfe.govt.nz/publications/climate/</a> for other publications).
NZ	<a href="http://www.qualityplanning.org.nz/index.php">http://www.qualityplanning.org.nz/index.php</a>	The purpose of the Quality Planning website is to promote best practice by sharing knowledge about all aspects of practice under the Resource Management Act (RMA). This site has a range of different papers relating to climate change and adaptation.
Australia	<a href="http://www.planning.nsw.gov.au/PlansforAction/Coastalprotection/CoastalDesignGuidelines/tabid/174/language/en-AU/Default.aspx">http://www.planning.nsw.gov.au/PlansforAction/Coastalprotection/CoastalDesignGuidelines/tabid/174/language/en-AU/Default.aspx</a>	Coastal Council of New South Wales, 2003. <i>Coastal Design Guidelines for NSW</i> . Coastal Council of New South Wales. Sydney.  These guidelines will ensure that future developments and redevelopments are sensitive to the unique natural and urban settings of coastal places in NSW. They provide a world-standard approach for how urban design can be best used in a coastal context. All local councils in the coastal zone when preparing a draft local environmental plan, are required to include provisions that give effect to and are consistent with the <i>Coastal Design Guidelines</i> , unless the inconsistency is justified by an environmental study or strategy.
Australia	<a href="http://www.geog.utas.edu.au/CCAP/">http://www.geog.utas.edu.au/CCAP/</a>	Curriculum materials for climate change adaptation planning were developed and trialled over 2008 and 2009 by the School of Geography and Environmental Studies with the aid of a grant from the Department of Climate Change and Energy Efficiency under its Climate Change Adaptation Skills for Professionals Small Grants Program. The School of Geography and Environmental Studies undertook to (i) build understanding and skills for climate change adaptation planning; and (ii) contribute to mainstreaming climate change adaptation into existing postgraduate education and training for planners and managers of built and natural environments. The materials comprise a core module and four content modules.
UK	<a href="http://royalsociety.org/search.aspx?query=climate%20change">http://royalsociety.org/search.aspx?query=climate%20change</a>	The Royal Society is a fellowship of the world's most eminent scientists. The site has a range of resources relating to climate change, including 'facts and fiction'.
UK	<a href="http://www.ukcip.org.uk/">http://www.ukcip.org.uk/</a>	The UK Climate Impacts Programme (UKCIP) helps organisations to adapt to inevitable

		climate change. The site has a wealth of resources to help understand what the future climate might bring, what impact it could have and provides methodologies to help prepare. It also has a range of adaptation case studies from across the UK.
USA	<a href="http://www.climatechange.ca.gov/adaptation/index.html">http://www.climatechange.ca.gov/adaptation/index.html</a>	California Natural Resources Agency, 2009. <i>2009 California Climate Adaptation Strategy. A report to the Governor of the State of California in response to Executive Order S-13-2008.</i>  This report outlines the best known science on climate change impacts in the state to assess vulnerability and outlines possible solutions that can be implemented within and across the state agencies to promote resiliency.
USA	<a href="http://www.icleiusa.org/programs/climate">http://www.icleiusa.org/programs/climate</a>	This site has some free <b>resources</b> to guide local government in the USA in <b>adaptation</b> to climate change. ICLEI (International Council for Local Environmental Initiatives) was established in 1990 to focus on climate protection and sustainable development.
USA	<a href="http://www.floods.org/NoAdverseImpact/CNAI_Handbook/CNAI_Handbook.pdf">http://www.floods.org/NoAdverseImpact/CNAI_Handbook/CNAI_Handbook.pdf</a>	NOAA and ASFPM, 2007. <i>No Adverse Impact in the Coastal Zone: Handbook. USA</i> (The Coastal Services Center, National Oceanic and Atmospheric Administration and the Association of State Floodplain Managers sponsored this handbook.)  The information in this publication demonstrates the application of mitigation strategies for the management of natural hazards occurring along the nation's coasts.
USA	<a href="http://collaborate.csc.noaa.gov/climateadaptation/default.aspx">http://collaborate.csc.noaa.gov/climateadaptation/default.aspx</a>	The Coastal Climate Adaptation Website is a community of practice. State and local officials use this site to see what their colleagues are doing in terms of adaptation. The site also includes basic climate change information and training materials useful for outreach efforts. (Large number of resource documents)
USA	<a href="http://www.epa.gov/climatechange/effects/coastal/index.html">http://www.epa.gov/climatechange/effects/coastal/index.html</a>	The US Environmental Protection Agency website provides information on climate change for communities, individuals, businesses, states, localities and governments. Includes a section on: Responses to sea-level rise along the coast.
Europe	<a href="http://ec.europa.eu/environment/iczm/ourcoast.htm">http://ec.europa.eu/environment/iczm/ourcoast.htm</a>	A European Union web site on integrated coastal zone management. It has a wide range of case study examples relating to climate change and to adaptation.

Uruguay	<a href="http://www.adaptationlearning.net/project/implementing-pilot-climate-change-adaptation-measures-coastal-areas-uruguay">http://www.adaptationlearning.net/project/implementing-pilot-climate-change-adaptation-measures-coastal-areas-uruguay</a>	<i>Implementing Pilot Climate Change Adaptation Measures in Coastal Areas of Uruguay.</i> Project Components: Level 1) Information Gathering, Identification and Monitoring. Level 2) Identify barriers to adaptation in coastal areas, design policy interventions and design pilot adaptation measures and capacity development packages. Level 3) Incorporate Adaptation Policy into existing National Sustainable Development Policy. Contribute to a National Adaptation Strategy for Coastal Areas in Uruguay, with an Action Plan designed to promote adaptation measures for critical exposed systems.
UNESCO	<a href="http://ioc3.unesco.org/icam/index.php?option=com_content&amp;task=view&amp;id=13&amp;Itemid=28">http://ioc3.unesco.org/icam/index.php?option=com_content&amp;task=view&amp;id=13&amp;Itemid=28</a>	The objectives of the <i>Adaptation to Climate Change in Coastal Zones (ACCC) project</i> are to perform adaptation actions in pilot sites particularly vulnerable to natural climate changes and to anthropogenic degradation in the short, medium and long term (erosion, mangrove destruction...). These actions could serve as an example for future regional and global application. Another major objective of the project is to formulate national and regional strategies of adaptation aiming at managing the impact of changes to the shoreline.

### Examples of Other Adaptation Journeys

UK	<a href="http://www.ukcip.org.uk/wizard/">http://www.ukcip.org.uk/wizard/</a>	The UK Climate Impacts Programme (UKCIP) helps organisations to adapt to inevitable climate change. The site has a range of resources which are designed to help you to understand what the future climate might bring, what impact it could have and provide methodologies to help you to prepare. It also includes adaptation case studies. The 'wizard' is a 5 stage tool. At each stage there is a list of questions/ tasks that help users establish vulnerability and choose options and develop a strategy.
UK	<a href="http://archive.defra.gov.uk/environment/climate/action/documents/adapt-localcouncilguide.pdf">http://archive.defra.gov.uk/environment/climate/action/documents/adapt-localcouncilguide.pdf</a>	Defra 2010. <i>Adapting to climate change: A guide for local councils.</i> London.  This guide aims to provide local councils and community groups, wanting to take action to adapt to climate change, with information on some of the future risks and opportunities. It provides guidance and some practical examples of action that can make a real difference, including a number of case studies. The guidance does 3 things: - Gives 2 types of actions -getting started and delivering actions

		<ul style="list-style-type: none"> <li>- Provides a list of tools</li> <li>- Gives case studies</li> </ul>
UK	<a href="http://www.climatechangenorthwest.co.uk/assets/files/documents/jan_09/cli_12327_18910_NI_188_Guidance_notes_Dec_08.pdf">http://www.climatechangenorthwest.co.uk/assets/files/documents/jan_09/cli_12327_18910_NI_188_Guidance_notes_Dec_08.pdf</a>	<p>LRAP, 2008. <i>Adapting to Climate Change: Guidance notes for NI188</i> (The Local and Regional Partnership Board)</p> <p>The guidance covers 5 levels: getting started; public commitment and impacts assessment; comprehensive risk assessment; comprehensive action plan; implementation, monitoring and continuous review.</p>
USAID	<a href="http://pdf.usaid.gov/pdf_docs/PNADO614.pdf">http://pdf.usaid.gov/pdf_docs/PNADO614.pdf</a>	<p>USAID 2009. <i>Adapting to coastal climate change: a guidebook for development planners</i>. United states agency for international development (Usaid), prepared by the coastal Resources center–University of Rhode island (cRc–URi) and international Resources group (iRg).</p> <p>This guidance proposes a 5 step approach for assessing vulnerability to climate change and climate variability, developing and implementing adaptation options, and integrating options into programs, development plans, and projects at the national and local levels.</p>
UNEP	<a href="http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5503txt.php">http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5503txt.php</a>	<p><i>UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies</i></p> <p>The UNEP methodology establishes a generic framework for thinking about and responding to the problems of sea level rise and climate change. The user goes through the following seven guiding steps: Define the problem; Select the method; Test the method; Select scenarios; Assess the biogeophysical and socioeconomic impacts; Assess the autonomous adjustments; Evaluate adaptation strategies. At each step, methods are suggested but the choice is left up to the user.</p>
USA	<a href="http://www.springerlink.com/content/p0472270pk1t438k/">http://www.springerlink.com/content/p0472270pk1t438k/</a>	<p>Smith, J.B., Vogel, J.M. and J. E. Cromwell III, 2009. <i>An architecture for government action on adaptation to climate change. An editorial comment</i>. In: Climatic Change Volume 95, Numbers 1-2, 53-61, DOI: 10.1007/s10584-009-9623-1</p>

		<p>An architecture of government adaptation programs is presented. Components include leadership, institutional organization, stakeholder involvement, climate change information, appropriate use of decision analysis techniques, explicit consideration of barriers to adaptation, funding for adaptation, technology development and diffusion, and adaptation research. This architecture is a useful heuristic for identifying, evaluating, and reevaluating the needs of decision makers as they improve management of climate-sensitive resources in a changing environment.</p>
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## Resources useful for Step 1

Blackett, P. and T. Hume, 2007. *Community Involvement in Coastal Hazard Mitigation: Some Insights into Process and Pitfalls*. Paper submitted for the 2007 New Zealand Planning Institute ‘Politics of Planning’ Conference, 28-30 March.

Resource management authorities are challenged with managing both the numerous hazards associated with the coastal environment and the people that live work and play in these places. A task which has become more difficult as the coastline is increasingly populated and land values raise, primarily because of the greater risk and vulnerability of homes and infra-structure to natural process. This paper examines the role that community groups can play in mitigating coastal hazards, the key factors that lead to groups achieving their goals and the influence that groups have on mitigation policy.

Dahm, J., Jenks, G., and D. Bergin, 2005. *Community –based Dune Management for the Mitigation of Coastal Hazards and Climate Change Effects: A Guide for Local Authorities*.

This report (on CD) brings together lessons from existing and successful dune care/ restoration programmes in New Zealand. It details the benefits of this approach as an adaptive approach to help mitigate the effects of sea-level rise, and as an educative process for raising community awareness. It sets out best practice models and provides case studies. It includes a comprehensive list of references.

### Step 1 website resources

NZ	<a href="http://www.iap2.org.au/states/cid/6">http://www.iap2.org.au/states/cid/6</a>	<p>The International Association for Public Participation (IAP2) Australasia is for people who implement or participate in public decision making processes. The three <b>Key Priority Areas for IAP2 Australasia are: Practice Development</b> (advancing the practice of community engagement), <b>Member Support</b></p>
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		(meeting the current and future needs of its members) and <b>Leadership</b> (To provide leadership for the sector and to distil – or ‘make sense of’ – the practice of community engagement, leading the innovation and integration and embedding of public participation practice into the DNA of governments, public and private sector organisations and community-based groups).
NZ	<a href="http://pnz.sagepub.com/content/60/1/47.full.pdf">http://pnz.sagepub.com/content/60/1/47.full.pdf</a>	Hayward, B., 2008. <i>Nowhere Far From the Sea’: Political Challenges of Coastal Adaptation to Climate Change in New Zealand</i> . In: Political Science, Vol 60. No. 1, June 2008, pp 47-59. Sage, Wellington.  This article argues that community opposition to managed retreat cannot be dismissed as ill informed nimbyism. With reference to the case study of Waihi, the author argues that community resistance is an indicator of the complexity of the political challenges that underpin climate change problems.
UNEP	<a href="http://www.futerra.co.uk/downloads/">http://www.futerra.co.uk/downloads/</a>	<i>Communicating Sustainability : How to produce effective public campaigns</i> . Developed by Lucy Shea, Futerra, in co-operation with Solange Montillaud-Joyel, UNEP. United Nations Environment Programme, 2005  “This guide is about communication. Inspiring examples and visions from all regions can encourage national and local authorities to plan, develop and implement attractive and effective campaigns that make sustainable lifestyles fashionable and ‘cool’ ”.  See also: <a href="http://scholar.google.co.nz/scholar?q=futerra+communicating+climate+change&amp;hl=en&amp;as_sdt=0&amp;as_vis=1&amp;oi=scholart">http://scholar.google.co.nz/scholar?q=futerra+communicating+climate+change&amp;hl=en&amp;as_sdt=0&amp;as_vis=1&amp;oi=scholart</a>  This link shows a number of other documents related to communicating climate change and sustainability.
UK	<a href="http://www.espace-project.org/part1/publications/reading/WS_CCClimateCommunications%20Strategy.pdf">http://www.espace-project.org/part1/publications/reading/WS_CCClimateCommunications%20Strategy.pdf</a>	Department for Communities and Local Government, (undated). <i>Climate Change Communication Strategy: A West Sussex Case Study</i> .  This is an ESPACE (European Spatial Planning: Adapting to Climate Events) project.  “The purpose of this document is to develop a more systematic and effective approach to communicating climate change in West Sussex. The document draws on the experiences and lessons learned through climate change awareness raising projects in West Sussex”.

Australia	<a href="http://www.garnautreview.org.au/update-2011/commissioned-work/australians-view-of-climate-change.pdf">http://www.garnautreview.org.au/update-2011/commissioned-work/australians-view-of-climate-change.pdf</a>	<p>Leviston, Z., Leitch, A., Greenhill, M., Leonard, R., and I. Walker, 2011. <i>Australians' views of climate change</i>. CSIRO Report. Canberra</p> <p>This document “reviews recent studies examining Australians’ views of climate change, their beliefs about the role of human activities in producing climate change, and their support for various policy responses to climate change.” This study identifies a clear need for further research into the best ways to communicate information about climate change, its anthropogenic drivers, and potential policy responses.</p>
Australia	<a href="http://www.csiro.au/resources/CAF-working-papers.html">http://www.csiro.au/resources/CAF-working-papers.html</a>	<p>Gardner J, Dowd A-M, Mason C, Ashworth P. 2009. <i>A framework for stakeholder engagement on climate adaptation</i>. CSIRO Climate Adaptation Flagship Working paper No. 3.</p> <p>This site has a series of technical papers from the CSIRO Climate Adaptation Flagship. In particular refer to the above paper, which outlines best practice methods for engaging with stakeholders on the issue of climate adaptation.</p>
USA	<a href="http://www.pewclimate.org/communicating">http://www.pewclimate.org/communicating</a>	<p>This site has guidelines on communicating climate change. The <b>Pew Center on Global Climate Change</b> was established in 1998 as an independent organisation, to provide credible information, and innovative solutions on global climate change.</p>
USA	<a href="http://www.icleiusa.org/action-center/engaging-your-community/American%20Climate%20Attitudes_The%20Social%20Capital%20Project_May%202011.pdf">http://www.icleiusa.org/action-center/engaging-your-community/American%20Climate%20Attitudes_The%20Social%20Capital%20Project_May%202011.pdf</a>	<p>Pike, C. and M. Herr, 2011. <i>American Climate Attitudes: An Analysis of Public Opinion Trends and Recommendations for Advancing Public Engagement on Global Warming</i>. USA.</p> <p>This document provides a comprehensive analysis of public opinion trends and recommendations for advancing public engagement on climate change.</p>

## Resources useful for Step 2

**MfE, 2008a.** (see references and Box 4.2).

Auckland Regional Council, 2000. *Coastal Hazard Strategy: Coastal Erosion Management Manual*. Auckland Regional Council Technical Publication 130. Auckland.

This document informs users of the region's coast about the hazards of coastal erosion, and the environmental effects of implementing a particular response. It provides detail on how to avoid coastal hazards (the Coastal Hazard Strategy), and how to mitigate coastal hazards where they exist (the Coastal Erosion Management Manual).

Environmental Management Services Ltd, 2009. *Te Awanga – Haumoana Coastal Erosion: Review and Recommendations*. Prepared for the Hawke's Bay Regional Council and Hastings District Council. HBRC plan No. 4118

This report the current situation, current state of knowledge, options and recommendations for moving forward on the issue of coastal erosion and storm inundation. This is to assist the councils and the community in making a decision on the way forward, having regard to the risks and costs associated with the alternative options.

NZS/AS ISO 31000, 2009. *Risk Management Principles and Guidelines*: [http://www.iso.org/iso/catalogue\\_detail?csnumber=43170](http://www.iso.org/iso/catalogue_detail?csnumber=43170)

The purpose of these standards is to provide principles and generic guidelines on risk management. The 'family' of risk management standards - is not developed for a particular industry group, management system or subject matter field in mind, rather it provides best practice structure and guidance to all operations concerned with risk management. The ISO 31000 'family' is expected to include:

- ISO 31000:2009:Principles and Guidelines on Implementation
- ISO/IEC 31010:2009: Risk Management - Risk Assessment Techniques
- ISO Guide 73:2009: Risk Management - Vocabulary

Saunders, W. and B. Glavovich, 2009. *Opportunities for natural hazard risk reduction: perspectives from the State, Market and Civil Society*. In: Community resilience: research, planning and civil defence emergency management. Tephra Vol 22, July 2009.

This paper offers an interesting view on hazard risk reduction and give case studies at consent, RMA planning and community participation scales.

## Step 2 website resources

Australia	<a href="http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-coastal.aspx">http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-coastal.aspx</a> .	<p>Department of Climate Change and Energy Efficiency, 2011. <i>Climate Change Risks to Coastal Buildings and Infrastructure</i>. Commonwealth of Australia.</p> <p>This report presents additional data on the national assessment of climate change risks. It highlights the exposure of buildings and infrastructure. Greater than \$226 billion in coastal assets are potentially exposed to inundation and erosion hazards at a sea-level rise of 1.1 metres (high end scenario for 2100) combined with a very high tide or for some states, a 100-year average recurrence interval storm-tide.</p>
Australia	<a href="http://www.mandurah.wa.gov.au/HBItem79614.PDF">http://www.mandurah.wa.gov.au/HBItem79614.PDF</a>	<p>CZM Pty Ltd, 2009. <i>Coastal Zone Climate Change Risk Assessment and Adaptation Plan: Summary Document</i>. Australia</p> <p>City of Mandurah: This document sets out a Strategic Adaptation Plan as well as Site Specific Adaptation Plans.</p> <p>It outlines adaptation options to treat the strategic risks and provides information on the risks that each adaptation option contributes to treating, as each option can treat multiple risks and each risk may be treated by multiple adaptation options.</p>
USA	<a href="http://www.epa.gov/climatereadyestuaries/vulnerability.html">http://www.epa.gov/climatereadyestuaries/vulnerability.html</a>	<p>A US site with a wide range of tools and publications related to coastal vulnerability assessment and adaptation. Includes links to a variety of US vulnerability assessments for coastal areas.</p>
UNEP, Denmark	<a href="http://tech-action.org/Guidebooks/TNAhandbook_CoastalErosionFlooding.pdf">http://tech-action.org/Guidebooks/TNAhandbook_CoastalErosionFlooding.pdf</a>	<p>Xianli Zhu, (ed), 2010. <i>Technologies for Climate Change Adaptation – Coastal Erosion and Flooding</i>. UNEP Risø Centre on Energy, Climate and Sustainable Development; Risø DTU National Laboratory for Sustainable Energy, Denmark</p> <p>This publication aims to support good adaptation planning. It covers thirteen major adaptation technologies that reduce impacts of coastal erosion and flooding due to climate change. For each, the technology is described, advantages and disadvantages assessed, costs and benefits estimated, institutional or organisational requirements outlined, and detailed examples provided that illustrate how the technology can be applied.</p>

## Resources useful for Step 3

**MfE, 2008a** (see references and Box 4.2)

Freeman, C., and C. Cheyne, 2008. *Coasts for Sale: Gentrification in New Zealand* in *Planning Theory and Practice*, Vol 9, No 1, 33-56, March 2008.

The 'sea change' phenomenon, or the movement of people from metropolitan to non-metropolitan parts of the country (and especially to coastal areas) is well-documented in Australia, but it is now becoming increasingly apparent in New Zealand also. Since 2000 there has been an unprecedented and extremely rapid expansion in the property market, with prices booming for settlements in scenic locations, especially along the coast. This paper reports on a study of six coastal settlements in New Zealand, all of which have experienced this property boom. The paper explores the contradictions associated with the gentrification process. It argues that the future of these communities needs to be wrested back from the dictates of property market by implementing community-based planning, supported by local government.

Glavovic, B.C., Saunders, W.S.A. and J.S. Becker, 2010. *Land-use planning for natural hazards in New Zealand: the setting, barriers, 'burning issues' and priority actions*. In: *Natural Hazards*, Springer Netherlands.

Land-use planners have a critical role to play in building vibrant, sustainable and hazard resilient communities in New Zealand. This article explores the questions: What role does land-use planning play in managing hazard risks in New Zealand; and what needs to be done to reduce hazard risks and build community resilience? The article starts by describing the milieu within which natural hazards planning takes place. It goes on to outline the stakeholders and institutional and legal setting for natural hazards planning in New Zealand, including barriers to realising the potential of natural hazards planning. This synthesis reveals a number of 'burning issues', including the need to: (a) Improve understanding about the nature of hazards; (b) Prioritise risk avoidance (reduction) measures; (c) Provide national guidance for communities exposed to repeat events and address the relocation issue and (d) Mainstream climate change adaptation.

Reisinger, A., Lawrence, J., Hart, G., and R. Chapman, 2012. *From coping to resilience: the role of managed retreat in highly developed coastal regions*. In: *Climate Change and the Coast: Building Resilient Communities*, Glavovic, B., Kay, R., Michael Kelly, M., and A. Travers, (eds.), CRC Press.

Discusses managed retreat as an additional tool to promote the resilience of highly developed coastal regions and to increase the flexibility of local response options. Provides an overview of policies to support managed retreat, that links with different socio-economic contexts, community preferences and timescales for implementation. The authors explore the potential implications of these alternative approaches for two case study sites in Auckland and Manukau and highlight the technical and institutional elements that would support the implementation of managed retreat in practice. They conclude that given the uncertainties about sea-level rise as well as the long timeframes to implement managed retreat, further active development of policy tools and the information base required for managed retreat would contribute to the resilience of coastal

communities. These frameworks can help inform at what sea-level rise and when along the planning horizon the latter becomes the only sustainable option.

Nuemann, J., Hudgens, D., Herter, J., and J. Martinich, 2011. *The economics of adaptation along developed coastlines*. WIREs Climate Change, Vol. 2, p. 89–98 (Wiley).

Neumann, J.E., Hudgens, D.E., Herter, J., and J. Martinich, 2010. *Assessing sea-level rise impacts: A GIS-based framework and application to coastal New Jersey*. Coastal Management, Vol. 38(4), 433–455.

Demonstrates GIS optimisation frameworks that use a simplified cost-benefit analysis of hard protection and beach nourishment relative to a retreat response. These frameworks can help inform at what sea-level rise and when along the planning horizon the latter becomes the only sustainable option.

### Step 3 website resources

Australia	<a href="http://www.iclei.org/fileadmin/user_upload/documents/ANZ/CCP/CCP-AU/Projects/AI/AdaptationToolkit/ToolkitCCPAdaptation_Final.pdf">http://www.iclei.org/fileadmin/user_upload/documents/ANZ/CCP/CCP-AU/Projects/AI/AdaptationToolkit/ToolkitCCPAdaptation_Final.pdf</a>	<p>ICLEI Oceania, 2008. <i>Cities for Climate Protection Australia: Local Government Climate Change Adaptation Toolkit</i>. ICLEI Oceania and Department of Climate Change, Australia.</p> <p>This document aims to help build capacity in climate change adaptation The result of the first year's work on adaptation planning and resilience building is this Adaptation Toolkit, which has been piloted with five local councils from around Australia.</p>
Canada	<a href="http://www.iclei.org/fileadmin/user_upload/documents/Canada/Changing_Climate/ICLE076 - NRCan_Guide.pdf">http://www.iclei.org/fileadmin/user_upload/documents/Canada/Changing_Climate/ICLE076 - NRCan_Guide.pdf</a>	<p>ICLEI (undated). <i>Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation</i>, ICLEI, Canada</p> <p>With support from Natural Resources Canada, ICLEI developed this resource to provide guidance for municipal governments looking to create and integrate local climate change adaptation plans. This guide and workbook is a compendium of resources that provides a five-milestone framework to assist local governments with the creation of an adaptation plan to address the relevant climate change impacts in their community</p>
Europe	<a href="http://www.peer.eu/fileadmin/user_upload/publications/PEER_Report1.pdf">http://www.peer.eu/fileadmin/user_upload/publications/PEER_Report1.pdf</a>	<p>Swart,R., Biesbroek, R., Binnerup, S., Carter, T.R., Cowan, C., Henrichs, T., Loquen, S., Mela, H., Morecroft, M., Reese, M. and D. Rey, 2009. <i>Europe Adapts to Climate Change: Comparing National</i></p>

		<p><i>Adaptation Strategies</i>, Partnership For European Environmental Research, (PEER), Peer Report No 1., Helsinki</p> <p>This report outlines a number of national and regional climate adaptation strategies that have been developed in Europe in recent years.</p>
UK	<p><a href="http://archive.defra.gov.uk/environment/flooding/documents/policy/strategy/strategy-response1.pdf">http://archive.defra.gov.uk/environment/flooding/documents/policy/strategy/strategy-response1.pdf</a></p>	<p>Department for Environment, Food and Rural Affairs, 2005. <i>Making Space for Water: Taking Forward a New Government Strategy for flood and coastal erosion risk management in England</i>. Department for Environment, Food and Rural Affairs (DEFRA)</p> <p>This document presents a <i>comprehensive, integrated and forward-thinking strategy for managing future flood and coastal erosion risks in England. This document contains an exciting programme of work across several different aspects of flood and coastal erosion risk management, including how we assess risk, how we approach urban drainage issues, how we manage coastal flooding and erosion, and how we raise awareness and provide support for those at risk.</i></p>
Netherlands	<p><a href="http://www.deltacommissie.com/doc/delta-report_full.pdf">http://www.deltacommissie.com/doc/delta-report_full.pdf</a></p>	<p>Deltacommissie, 2008. <i>Working together with water: A living land builds for its future</i>. Netherlands</p> <p>The Sustainable Coastal Development Committee, was given the mandate to formulate a vision on the long-term protection of the Dutch coast and its hinterland. If we are to be well prepared for the expected consequences of climate change, we shall have to strengthen our flood defences and change the way our country is managed, both physically and administratively.</p>
Australia	<p><a href="http://www.climatechange.vic.gov.au/_data/assets/pdf_file/0017/73250/Planningforcoastalclimatechangev1.pdf">http://www.climatechange.vic.gov.au/_data/assets/pdf_file/0017/73250/Planningforcoastalclimatechangev1.pdf</a></p>	<p>Norman, B., 2009. <i>Planning for coastal climate change: An insight into international and national approaches</i>. Victorian Government Department of Planning and Community Development and Department of Sustainability and Environment, Melbourne.</p> <p>The purpose of this report is to provide an insight into existing international and national approaches which have been, or are being developed to respond to coastal climate change impacts. This report provides an overview of a variety of case studies across a range of jurisdictions focused on long-term management of the coastal impacts from climate change.</p>
Australia	<p><a href="http://www.dpcd.vic.gov.au/planning/plan sandpolicies/coastal-planning-in-victoria">http://www.dpcd.vic.gov.au/planning/plan sandpolicies/coastal-planning-in-victoria</a></p>	<p>This site has a range of information and planning resources.</p>

USA	<a href="http://www.epa.gov/climate/readyestuaries/vulnerability.html">http://www.epa.gov/climate/readyestuaries/vulnerability.html</a> <a href="http://collaborate.csc.noaa.gov/climateadaptation/default.aspx">http://collaborate.csc.noaa.gov/climateadaptation/default.aspx</a>	<p>These 2 sites have a wide range of tools and publications related to coastal vulnerability assessment and adaptation strategies, including links to a wide variety of US case studies.</p>
USA	<a href="http://www.cakex.org/sites/default/files/EcoAdapt_Marine%20and%20Coastal%20Synthesis%20Report_January%202011_Final.pdf">http://www.cakex.org/sites/default/files/EcoAdapt_Marine%20and%20Coastal%20Synthesis%20Report_January%202011_Final.pdf</a>	<p>Gregg, R.M., Hansen, L.J., Feifel, K.M., Hitt, J.L., Kershner, J.M., Score, A., and J.R. Hoffman, 2011. <i>The State of Marine and Coastal Adaptation in North America: A Synthesis of Emerging Ideas</i>. Prepared for: The Gordon and Betty Moore Foundation by EcoAdapt, USA.</p> <p>The intent of this report is to provide a brief overview of key climate change impacts on the natural and built environments in marine and coastal North America and a review of adaptation options available to and in use by marine and coastal managers. This report presents the results of EcoAdapt's efforts to survey, inventory, and assess adaptation projects from different regions, jurisdictions, and scales throughout North America's marine and coastal environments. The report provides a summary of commonly used adaptation approaches and examples from our inventory of projects.</p>
USA	<a href="http://www.rff.org/rff/documents/RFF-Rpt-Adaptation-KlingSanchirico.pdf">http://www.rff.org/rff/documents/RFF-Rpt-Adaptation-KlingSanchirico.pdf</a>	<p>Kling, D., and J.N. Sanchirico, 2009. <i>An Adaptation Portfolio for the United States Coastal and Marine Environment</i>. Resources for the Future (RFF).</p> <p>The goal of this paper is to discuss a portfolio of adaptation policies, which we define as the actions taken to enhance the resilience of human and natural systems to the effects of climate change and variability for marine and coastal environments within the US and its territories. While much of the paper deals with coastal eco systems and fisheries, it does also examine social adaptation and coastal communities in the context of a US legislative and planning model.</p>
UNEP	<a href="http://www.mca4climate.info/">http://www.mca4climate.info/</a>	<p>This site includes an outline of Multi-criteria analysis for climate change: Developing guidance that provides a practical framework for planning pro-development climate policies.</p> <p>In the Adaptation Theme, is a report on Improving Coastal Zone Management:</p> <p>Nicholls, R.J., 2011. <i>Adaptation Theme Report: Improving Coastal Zone Management</i>. MCA4climate: A practical framework for planning pro-development climate policies. Contribution to the MCA4climate Initiative, United Nations Environment Programme (UNEP). 23 pp.</p>

## Resources useful for Step 4

### Step 4 website resources

NZ	<a href="http://www.boprc.govt.nz/media/33532/Report-100203-Env0907CoastalHazardRiskIndicatorsReview2007.pdf">http://www.boprc.govt.nz/media/33532/Report-100203-Env0907CoastalHazardRiskIndicatorsReview2007.pdf</a>	<p><i>2007 Hazard Risk Indicators Review: Environment Bay of Plenty Environmental Publication 2009/07</i></p> <p>Bay of Plenty Regional Council has developed a set of seven coastal hazard risk indicators that are to be monitored on a 3-yearly basis. The 2009 year was the first time there indicators had been reviewed, thereby setting a base line of information. Results from this study show all of the coastal territorial authorities have adopted or are in the process of adopting coastal hazard zones and subsequent rules and policies. Opotiki District Council has only set zones and policies for the Ohiwa Spit. In the 2005 Pilot Report, only two of the four councils in the region had identified hazard zones in their plans.</p>
UK	<a href="http://www.channelcoast.org/">http://www.channelcoast.org/</a>	<p>A website of the <b>Strategic Regional Coastal Monitoring Programmes of England.</b></p> <p>(also useful for <b>Step 2</b> )</p>
USA	<a href="http://www.coastalstates.org/wp-content/uploads/2010/07/CSO-2008-Climate-Change-Report2.pdf">http://www.coastalstates.org/wp-content/uploads/2010/07/CSO-2008-Climate-Change-Report2.pdf</a>	<p>Carter, D., Fisher, E., et al., 2008. <i>The Role of Coastal Zone Management Programs in Adaptation to Climate Change: Synthesis Report from the CSO Climate Change Work Group.</i> The Coastal States Organizations.</p> <p>This is a monitoring report on coastal zone management programs which address climate change, in various states. In particular it explores: the role of state coastal zone management programs in addressing climate change; delineates not only the unmet needs of coastal states in regard to climate change planning and data, but an attempt to quantify the cost of those unmet needs; and provides an information exchange among coastal states and territories. It attaches the 2007 report as being the most comprehensive assessment of the various states' coastal program's climate change initiatives as well as the statement of national policy needs.</p>

