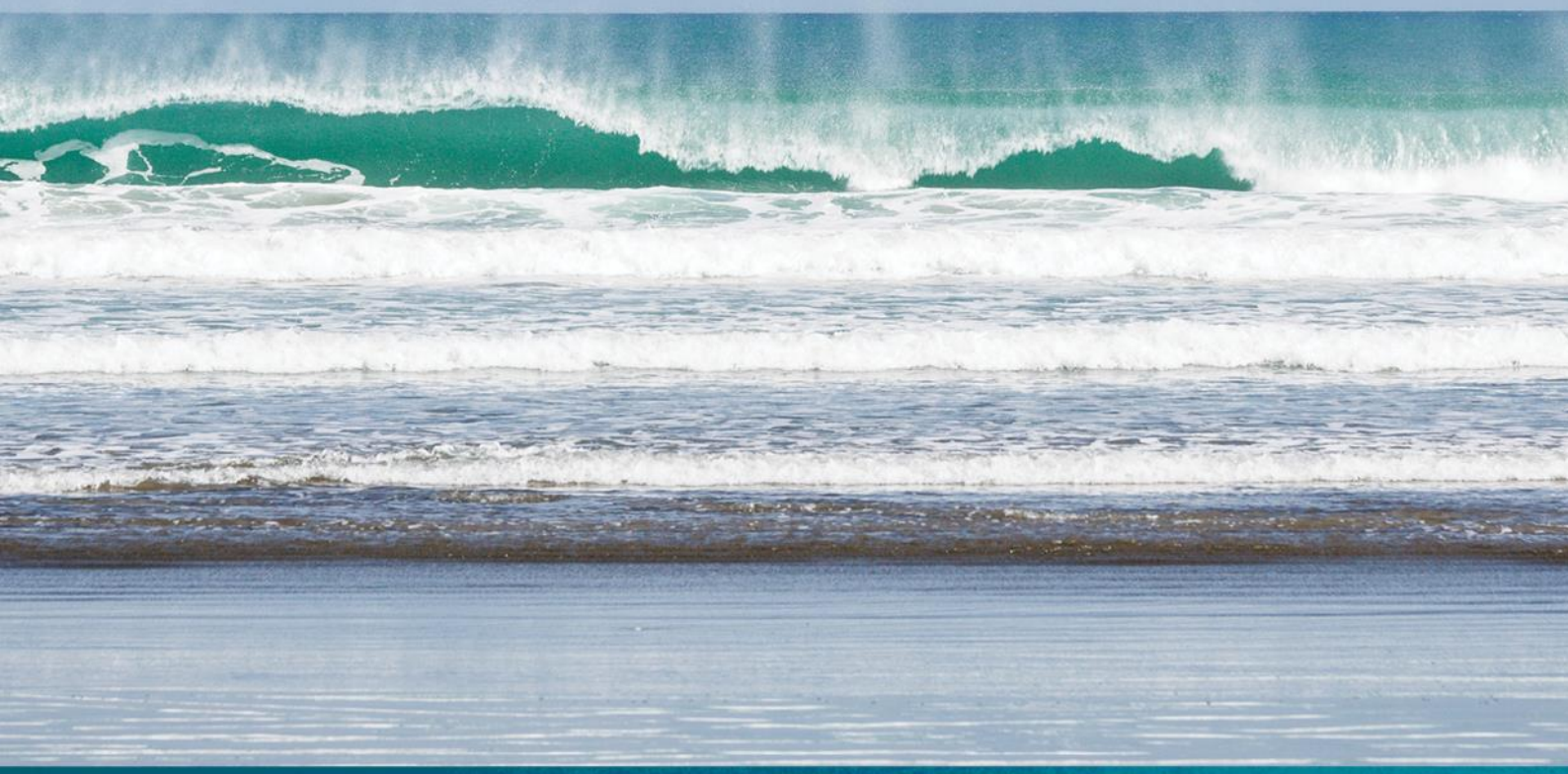
# NZCPS 2010 guidance note:
# COASTAL HAZARDS

## Objective 5 and Policies 24, 25, 26 & 27



Department of Conservation
*Te Papa Atawhai*

New Zealand Government

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# Preface

This guidance note covers the coastal hazard objective (Objective 5) and the four policies that primarily address coastal hazards (Policies 24–27) in the *New Zealand Coastal Policy Statement* (NZCPS) *2010* (DOC 2010).[1]

These share a common rationale and origin, and raise many of the same issues around interpretation and implementation.

The full text of the coastal hazard objective and policies is provided below for reference. Following this:

- Sections 1–5 outline various aspects of the coastal hazard objective and policies.
- Section 6 provides an in-depth commentary on each of the parts of Objective 5 and Policies 24–27.
- Section 7 provides a brief commentary on how the other NZCPS objectives and various other policies relate to Objective 5 and Policies 24–27, as well as particularly relevant provisions in the Resource Management Act 1991 and other legislation.
- Section 8 briefly outlines related information and ongoing work on coastal hazard management.

A separate Glossary is also provided at the end of the report, which explains and defines some of the terms used in this guidance.

[1] For questions and answers about the NZCPS 2010, see DOC (2011).

# *The coastal hazard objective and policies*

## *Objective 5*

*To ensure that coastal hazard risks taking account of climate change, are managed by:*

- *locating new development away from areas prone to such risks;*
- *considering responses, including managed retreat, for existing development in this situation; and*
- *protecting or restoring natural defences to coastal hazards.*

## *Policy 24: Identification of coastal hazards*

*(1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:*

(a) *physical drivers and processes that cause coastal change including sea level rise;*

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

(c) *geomorphological character;*

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

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

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

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

(h) *the effects of climate change on:*

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

(ii) *storm frequency, intensity and surges; and*

(iii) *coastal sediment dynamics;*

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

## *Policy 25: Subdivision, use, and development in areas of coastal hazard risk*

*In areas potentially affected by coastal hazards over at least the next 100 years:*

(a) *avoid increasing the risk of social, environmental and economic harm from coastal hazards;*

(b) *avoid redevelopment, or change in land use, that would increase the risk of adverse effects from coastal hazards;*

(c) *encourage redevelopment, or change in land use, where that would reduce the risk of adverse effects from coastal hazards, including managed retreat by relocation or removal of existing structures or their abandonment in extreme circumstances, and designing for relocatability or recoverability from hazard events;*

(d) *encourage the location of infrastructure away from areas of hazard risk where practicable;*

(e) *discourage hard protection structures and promote the use of alternatives to them, including natural defences; and*

(f) *consider the potential effects of tsunami and how to avoid or mitigate them.*

[The NZCPS 2010 glossary states that 'Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (AS/NZ ISO 31000:2009 Risk management—Principles and guidelines, November 2009)'.]

## *Policy 26: Natural defences against coastal hazards*

*(1) Provide where appropriate for the protection, restoration or enhancement of natural defences that protect coastal land uses, or sites of significant biodiversity, cultural or historic heritage or geological value, from coastal hazards.*

*(2) Recognise that such natural defences include beaches, estuaries, wetlands, intertidal areas, coastal vegetation, dunes and barrier islands.*

*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 so.*

# 1. Context of Objective 5 and Policies 24–27

Section 56 of the Resource Management Act 1991 (RMA) states that 'The purpose of a New Zealand coastal policy statement is to state policies in order to achieve the purpose of this Act in relation to the coastal environment of New Zealand'.[2,3]

The NZCPS 2010 (DOC 2010) gives substance to Part 2 of the RMA within the coastal environment.

The coastal hazard objective and policies contribute to the promotion of sustainable management of the coastal environment by directing the management of coastal hazard risks in those areas that will potentially be affected by coastal hazards (including the effects of climate change) over at least the next 100 years.

The overarching goal of the coastal hazard objective and policies is to manage coastal hazard risks so that the likelihood of them causing social, cultural, environmental and economic harm is not increased.[4] This includes harm arising from responses to those coastal hazards, such as the addition of hard protection structures. The adoption of long-term risk-reduction approaches is strongly encouraged.

Figure 1 summarises the relationships among the coastal hazard objective and policies, and between these and the overall NZCPS 2010 and RMA framework, including some of the key interactions with other policies in the NZCPS 2010.[5]

From this, it can be seen that:

- coastal hazard risk assessments provide the foundation for implementing the other NZCPS coastal hazard management policies;
- both the risk assessments and efforts to reduce the risk of harm need to be informed by the many other NZCPS policies concerning social, cultural, environmental, and economic values and threats in the coastal environment;
- the development of risk-reduction options also needs to be informed by NZCPS policies that are concerned with providing for use and development in the coastal environment;

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[2] Note that section 58 of the RMA provides that a New Zealand coastal policy statement may state objectives as well as policies.

[3] NZCPS Policy 1 addresses the extent and characteristics of the coastal environment. Guidance can be found at www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/.

[4] 'Social, environmental and economic harm' (from Policy 25(a)) is taken to include 'cultural' harm. See also RMA section 5, and NZCPS 2010 Objectives 3 and 6 and Policies 2 and 6.

[5] Please note that, for simplicity:
- only Objectives 5 and 7 are shown (the remaining objectives are adequately represented by the policies); and
- only the key interactions are shown (all of the policies in the NZCPS 2010 interact; for example, reducing the risk of social, environmental and economic harm contributes to and is informed by the environmental and use policies).

- Policies 26 and 27 contribute to the management of hazard risks in all affected areas and to the overall goal of risk reduction (Policy 25) by providing additional policies that are specific to situations involving natural defences against coastal hazards (Policy 26) and significant existing development (Policy 27); and
- there are important interactions between NZCPS policies that are concerned with the precautionary approach, integration and strategic planning, as well as with Objective 7, which is concerned with international obligations (e.g. the *Sendai Framework for Disaster Risk Reduction 2015*[6]).

The coastal hazard objective and policies are therefore closely related to the other objectives and many other policies in the NZCPS 2010, particularly Policies 1–4, 6–11, 13–20 and 23.

A commentary that summarises some of the particular ways in which these other provisions in the NZCPS 2010 relate to the coastal hazard provisions is set out in section 7.1, and some of the most relevant provisions of the RMA and other legislation are then discussed in section 7.2.

Readers of this guidance note for Policies 24–27 should also refer to the section entitled 'Application of this policy statement' at the beginning of the NZCPS 2010 (DOC 2010) and to the *NZCPS 2010 Implementation Guidance Introductory note* (DOC 2012), which contains general information and guidance that is important for implementing all of the objectives and policies in the NZCPS 2010.

[6] www.unisdr.org/we/coordinate/sendai-framework.

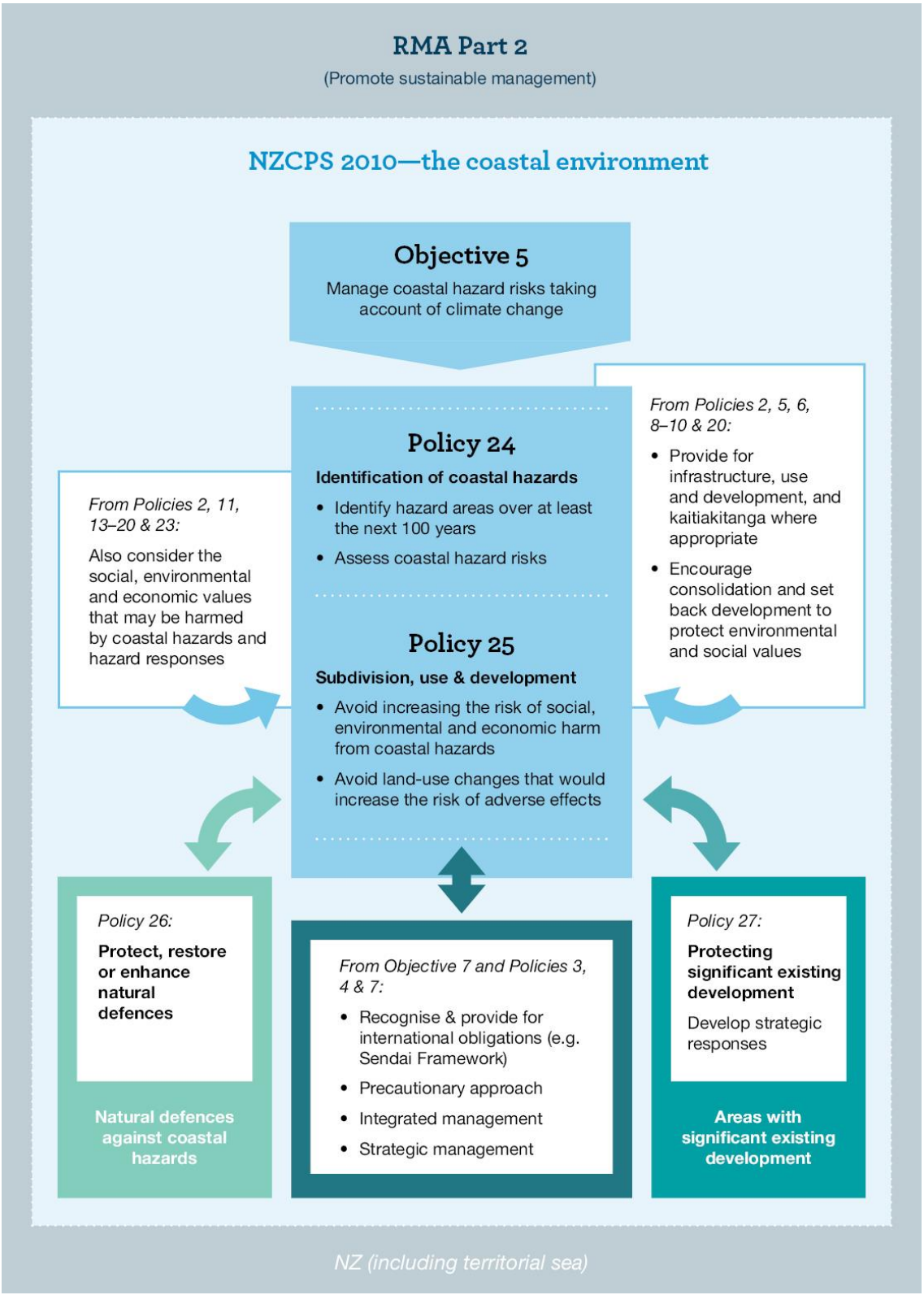


Figure 1. Where the NZCPS 2010 coastal hazard objective and policies apply, and some key interactions with other policies.

# 2. Overview of Objective 5 and Policies 24–27

Objective 5 reflects the coastal hazard challenges and issues described in the Preamble to the NZCPS 2010, and gives rise to Policies 24, 25, 26 and 27.

Objective 5 is the dedicated coastal hazard objective. It seeks to ensure that the management of coastal hazards is risk based and takes account of climate change. It requires proactive management: locating new development away from hazard-prone areas; considering managed retreat for existing hazard-prone development; and protecting and restoring natural defences. It is the objective that primarily gives rise to Policies 24, 25, 26 and 27.

Policy 24 lays the foundation for risk-based coastal hazard management. Areas that will potentially be affected by coastal hazards are to be identified (giving priority to high-risk areas). Hazard risks over at least the next 100 years are to be assessed for those areas (having regard to a range of factors that affect hazard risks and the effects of climate change on each of those factors). The identification of these risks is to take into account national guidance and the best available information on the likely effects of climate change on the region or district.

Policy 25 is the overarching policy for managing the risk of social, environmental and economic harm from coastal hazards. It applies to all areas in the coastal environment that are potentially affected by coastal hazards.

Policy 26 addresses the management of the large range of natural coastal landforms/features that provide natural defences, including beaches, estuaries, wetlands, intertidal areas, coastal vegetation, dunes and barrier islands.

Policy 27 specifically addresses areas with significant existing development. The opportunity to avoid the risks from coastal hazards has already passed for such areas. Under this policy, local authorities are encouraged to develop sustainable risk-reduction strategies in a way that includes assessing the range of strategic options as set out in Policy 27(1) and evaluating strategic options as set out in Policy 27(2). Policies 27(3) and (4) address the use of hard protection structures.

## 2.1 Rationale for Objective 5 and Policies 24–27

Coastal hazards pose a serious risk in New Zealand due to the many erosion-prone and low-lying coastal areas that have been intensively developed along the country's extensive coastline. This includes areas adjacent to beaches, unstable cliffs, harbours, estuaries and river mouths.

Sea-level rise and various other effects of climate change have already started to increase these risks (e.g. more frequent inundation and erosion events) and they will continue to increase, particularly with ongoing sea-level rise. Furthermore, this problem is accentuated by New Zealand having only a small population to fund and sustain long-term adaptation responses.

Unless action is taken to address both the likelihood and the consequences of damage from coastal hazard events in the future, the risk of harm will escalate (with risk being a combination of likelihood and consequences). The costs of responding could then lead to serious social and economic disruption for New Zealand's small population, as well as serious damage to natural character, public access, public amenity values and the quality of the environment in general. Actions to avoid this escalating risk will need to be ongoing and strategic, with an increasing focus on climate change adaptation.

Harm can come from hazard protection works as well as from the hazards themselves. In addition to economic harm, this includes social, cultural and environmental harm. This harm will affect property owners, local government and infrastructure owners (in terms of assets and utility services), as well as the wider New Zealand community.

National policy that requires proactive, well-informed, precautionary and risk-based management of coastal hazards is provided because:

- *The value of coastal assets is increasing:* A high proportion of urban, resort and infrastructure development has occurred in erosion-prone and low-lying coastal areas, including estuarine areas. A combination of intensified coastal development and dramatically increased coastal property values has occurred over the past few decades.
- *The likelihood of damage to coastal assets is increasing:* Coastal hazards already threaten a substantial amount of coastal development, including infrastructure. In the future, accelerating climate change effects will lead to an increasing frequency, severity and extent of coastal hazards, meaning that more properties and infrastructure will become increasingly likely to suffer damage from them. For example, a relatively modest sea-level rise of 0.3 metres in Wellington and 0.45 metres in Auckland would roughly equate to the present-day extreme coastal-storm inundation events that currently occur on average once per year (PCE 2015).
- *The timing and severity of climate change effects are uncertain:* There is, and will continue to be, uncertainty over the timing and severity of climate change effects because these will depend on the changes in climate and sea-level rise projections that eventuate over the next 100 years and beyond. However, based on current knowledge and modelling, as well as global

carbon emission scenarios, it is likely that effects such as sea-level rise and more severe wind and rain events will become obvious within current lifetimes, will significantly worsen coastal hazard exposure towards the end of this century and will continue to worsen well beyond the next 100 years.

- *There is a need for a well-informed assessment of risk:* Coastal hazard and hazard risk assessments are complex tasks that require robust information and methodologies, as well as community engagement and the involvement of expert practitioners.
- *Risk-based management is required:* A risk-based approach is now the accepted international framework for identifying and managing natural hazards. It is particularly appropriate where both the likelihood and consequences of natural hazard events will increase but there is uncertainty over the magnitude and speed of this change. The development of strategies to address identified risks is a complex task.
- *Harm can arise from both the coastal hazards and the hazard responses:* Harm can arise from both the coastal hazard events themselves, and the way in which the community, councils, infrastructure owners and private property owners respond to the threat of these events. Reducing the risk of social, cultural, environmental and economic harm requires engagement by the wider community and affected property owners, as well as a multi-disciplinary approach that will develop long-term strategies for responding to the rising coastal hazard threats.
- *The harm can be social, cultural and environmental, as well as economic:* Coastal hazards can lead to social, cultural and environmental harm, as well as economic harm, particularly over the long term, if inappropriate and unsustainable coastal hazard responses are chosen. 'Coastal squeeze' is a well-recognised phenomenon where hard protection structures are used to armour an erosion-prone coastline, leading in the long term to a loss of beaches, dunes, estuarine intertidal areas and wetlands (along with their habitats, biodiversity and ecosystem services).[7]
- *Substantial challenges are faced in adapting to coastal hazards and climate change:* There are barriers to making the shift towards long-term strategic approaches for sustainably managing hazard-prone coastal land and existing development, including:
    - challenges in terms of political and community awareness and understanding;
    - uncertainty and scepticism about the rising risks, particularly in the longer term, in relation to climate change;
    - a focus on short-term adaptation costs rather than long-term benefits; and
    - a reluctance to consider or commit to planning over long timeframes.

[7] See McClone et al. (2010) and McClone & Walker (2011) for climate change impacts on natural systems in New Zealand.

## 2.2 Origins of Objective 5 and Policies 24–27

The *New Zealand Coastal Policy Statement 1994* (DOC 1994) was the first NZCPS and contained a suite of coastal hazard policies. The NZCPS 2010 policies are substantially different from these, addressing some of the matters covered previously in a more specific, detailed and directed way, as well as introducing new issues (see Box 1).

The coastal hazard objective and policies are the outcome of a Board of Inquiry's deliberations after public submissions were received and heard on a draft NZCPS 2008 (Board of Inquiry 2009a, b). Revised coastal hazard provisions were drafted by the Board of Inquiry and recommended by the Minister of Conservation for approval.

A significant policy change from the NZCPS 1994 is the requirement for a risk-based approach to coastal hazard management. Local authorities are also directed to undertake coastal hazard risk assessments for a timeframe of 'at least the next 100 years'.

Another significant change is the way in which the potential/likely impacts of climate change are addressed. The risk-based approach is reinforced by the inclusion of specific requirements to assess the likely effects of climate change during the 100-plus-year planning horizon, as well as requiring that a precautionary

Box 1

Recent catastrophic coastal hazard events

The remarkable number of catastrophic coastal hazard events that have occurred in other countries since the NZCPS 1994 was published has increased awareness of coastal hazard risks in New Zealand, even though this country is not as prone to certain coastal hazards (such as cyclones and large storm surges) as some other coastal regions around the world.

These events include the Boxing Day 2004 Asian tsunami, the 2005 inundation of New Orleans by Hurricane Katrina, the 2008 inundation/flooding in Burma by Cyclone Nargis, the 2009 tsunami in Samoa, the 2010 tsunami in Chile, and the 2011 tsunami that devastated the northeast coast of Japan.

The strengthening of policy to reduce coastal hazard risks and the explicit requirement to address tsunami may well be in part a response to these catastrophic events (which were a driver for the 2015 Sendai Framework[8]).

There has also been the slow-moving catastrophe of more frequent inundations of many low-lying islands in the Pacific and Indian Oceans, and the threat that an ongoing sea-level rise will make the more vulnerable islands uninhabitable well within the next 100 years.

In general, economic losses from weather- and climate-related disasters have increased (albeit with large spatial and interannual variability) (IPCC 2012).

[8] www.unisdr.org/we/coordinate/sendai-framework.

approach is adopted for the use and management of coastal resources that are potentially vulnerable to the effects of climate change (in Policy 3(2)).

The impetus for these changes is summarised in Volumes 1 and 2 of the Board of Inquiry's report and recommendations (Board of Inquiry 2009a, b), and reflects:

- developments in best practice risk-based management;
- recognition that climate change is happening;
- recognition that the effects of climate change on coastal hazards threaten significant harm to the wellbeing of future generations of New Zealanders and the environment; and
- changes in law following the 2004 addition of section 7(i) to the RMA, which requires 'all persons exercising functions and powers … to have particular regard … to the effects of climate change'.

The Board of Inquiry's report addressed the wide range of submissions received. The Board of Inquiry also discussed the relevant legal framework that directs councils to initiate management responses in relation to hazards.

The NZCPS 2010 reflects the Board of Inquiry's concerns about the many types of adverse effects or harm that can be caused by coastal hazards and coastal hazard responses. The range of harm that needs to be managed and reduced is spelled out in Policy 25(a) with its reference to 'the risk of social, environmental and economic harm from coastal hazards', which should be read broadly to include cultural harm.

The potential harm that can result from responding to coastal hazards by building hard protection structures is addressed in Policies 25 and 27, and by way of encouraging the protection, restoration and enhancement of natural defences in Policy 26.

The Board of Inquiry included tsunami in Policy 25 because there was a need 'to consider necessary responses to a real threat to communities along the coast' (Board of Inquiry 2009a: 10).

The impetus for these changes is summarised in Volume 1 of the report and recommendations by the Board of Inquiry (2009a).

Further background to the hazards policies of the NZCPS 2010 is available in the working papers to the recommendations of the Board of Inquiry (2009b: 312–349).

# 3. Notes on terms used in the coastal hazard policies

(Please note that the NZCPS 2010 does not use the terms 'vulnerability', 'exposure' or 'resilience', other than in Policy 3. These terms are, however, often used in disciplines related to climate change adaptation and natural hazard risk management generally, and their meaning in the context of coastal hazard management is addressed in *Coastal hazards and climate change* (MfE 2017)[9].)

## 3.1 Consequence-related terms

The NZCPS 2010 coastal hazard policies include a number of terms that are related to the consequence component of the risk equation. These include 'consequences', 'being affected', 'harm', 'adverse effects' and 'costs'.

The NZCPS 2010 glossary sets out that 'risk' is often expressed as a combination of 'the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence', which is taken from Australian/New Zealand Standard AS/NZS ISO 31000:2009 (ISO 2009).

Policy 24 includes the phrase 'giving priority to the identification of areas at high risk of being affected'; Policy 25(a) uses the phrase 'risk of social, environmental and economic harm'; Policies 25(b) and 25(c) use the phrase 'risk of adverse effects'; and Policy 27(1)(d) uses the phrase 'environmental and social costs', Policy 27(3) uses 'adverse effects' and Policy 27(4) uses 'no significant public or environmental benefit' in relation to the consequences of permitting hard protection structures.

Based on present practice, it is noted that:

- 'Adverse effects' is a term used in the RMA, with the wide meaning of 'effect' being given in section 3. The full term, which is used in section 5 of the RMA, is 'adverse effects of activities on the environment'. Thus, use of the term 'adverse effects' in the NZCPS 2010 should be treated as shorthand for that full RMA term.

  Note that 'environment' is also given a very wide meaning in section 2 of the RMA, covering 'ecosystems … including people and communities, all natural and physical resources, and amenity values; and the social, economic, aesthetic, and cultural conditions affecting [them] …'.

- 'Social, environmental and economic harm' may well have a very similar meaning to 'adverse effects', with the Board of Inquiry wishing to make explicit the range of adverse effects that must be addressed (see section 2.2).

[9] See http://www.mfe.govt.nz/publications/climate-change/coastal-hazards-and-climate-change-guidance-local-government

'Social, environmental …' should be read as including 'cultural', given that Part 2 of the RMA has concern for social, economic and cultural wellbeing, along with:

- the RMA section 56 purpose for the NZCPS 2010;
- the Objective 6 and Policy 6 concern for social, economic and cultural wellbeing; and
- the Objective 3 and Policy 2 concern for the Treaty of Waitangi.

- 'Environmental and social costs' and 'public or environmental benefit' may have been intended to make explicit that hard protection structures may be associated with a range of adverse effects that need to be considered (due to both the presence of the structures themselves and their interaction with coastal processes), as set out in the Board of Inquiry's report where it was stated that 'hard protection structures often resulted in individual benefit to landowners but a loss to the community of public space, amenity values and natural values, such as native biodiversity' (Board of Inquiry 2009).

## 3.2 Likelihood-related terms

The NZCPS 2010 coastal hazard policies use a number of terms and phrases that are related to the probability or likelihood component of the risk equation. These terms include 'potentially affected', 'likely to be affected', 'high risk of being affected', 'areas at risk from coastal hazards' and 'likely effects'; and Policy 3 also uses 'coastal resources potentially vulnerable to effects from climate change'. For example:

- Policy 1(2) includes 'Recognise that the coastal environment includes: … (d) areas at risk from coastal hazards …'
- Policy 24 includes the phrases 'areas in the coastal environment that are potentially affected', 'giving priority to the identification of areas at high risk of being affected' and 'likely effects of climate change on the region or district'
- Policy 25 uses the phrase 'areas potentially affected'
- Policy 27(1) uses the phrase 'areas of significant existing development likely to be affected'

Several points are noted below about the interpretation of likelihood-related terms in each of these policies.

### Policy 1

Since Objective 5 seeks to ensure that coastal hazard risks are managed taking account of climate change and Policy 25 addresses itself to 'areas potentially affected by coastal hazards over at least the next 100 years', it would appear that the intention was to include all 'potentially affected' areas within the purview of this policy.

Policy 1(2)(d) can be interpreted as meaning that all areas identified as 'potentially affected by coastal hazards over at least the next 100 years' should be included within the coastal environment.

(Also see the commentary on Policy 1 in section 7.1.)

Policies 24 and 25

(i) The Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Working Group II Report (Burkett et al. 2014) has, in preparation for its Fifth Assessment Report (AR5), discussed the meaning of terms related to 'likelihood' and provided a table of standard terms used to define likelihood in the AR5 (Table 1).

Table 1. Definitions of terms related to 'likelihood' (taken from Burkett et al. 2014).

| Term | Likelihood of the outcome |
|---|---|
| Virtually certain | > 99% probability of occurrence |
| Extremely likely | > 95% probability of occurrence |
| Very likely | > 90% probability of occurrence |
| Likely | > 66% probability of occurrence |
| More likely than not | > 50% probability of occurrence |
| About as likely as not | 33–66% probability of occurrence |
| Unlikely | < 33% probability of occurrence |
| Extremely unlikely | < 5% probability of occurrence |
| Exceptionally unlikely | < 1% probability of occurrence |

These same likelihood categories are used in appendix F of *Coastal hazards and climate change* (MfE 2017), which also provides definitions of hazard probability terms such as 'annual exceedance probability' and 'likelihood' (over various planning timeframes).

This shows that 'likely' could be taken to mean a probability of > 66%. However, these terms do not assist with the meaning of 'potentially'.

The Local Government Official Information and Meetings Act 1987 (LGOIMA) uses the term 'potential' in the context of the likelihood of natural hazards (including erosion and inundation). Section 44A(2)(a) specifies that land information memoranda (LIMs) should include:

> *… information identifying each (if any) special feature or characteristic of the land concerned, including but not limited to potential erosion, avulsion, falling debris, subsidence, slippage, alluvion, or inundation …*

This meaning of 'potential' was considered in some detail by the High Court in *Weir v Kapiti Coast District Council*.[10] In paragraphs [49] to [53] of its decision, the High Court distinguished between the terms 'likely' and 'potential', and came to the conclusion in [51] that 'potential' related to possible future events and was used because:

> *… it is not feasible to attach probabilities to them. Instead, there is an obligation to refer in the LIM to information held by the Council and relating to such future events only if there is a possibility that they may occur in the future. By possibility, I mean a reasonable possibility objectively determined.*
> (Emphasis added)

In [52], Judge Williams goes on to say:

> *… a worst case scenario objectively identified and evidentially based, must, by definition, be a reasonable possibility – albeit the worst one. Indeed, the worst case is the boundary line between reasonable possibility and mere speculation*.
> (Emphasis added)

In [53], Judge Williams acknowledges that his interpretation establishes a relatively low threshold.

Nevertheless, the *Weir* case at least suggests that 'potentially' could reasonably be interpreted as falling somewhere below 'unlikely' in the IPCC table (i.e. < 33% probability of occurrence over at least a 100-year planning timeframe). It is further noted that:

- The main uncertainty for defining 'potentially affected' areas lies with future sea-level rise. Probabilities have not, and cannot, be assigned to the plausible range of greenhouse gas and sea-level rise scenarios over the next 100 years (see the suite of four scenarios considered in the IPCC Fifth Assessment Reports (AR5) and addressed in *Coastal hazards and climate change* (MfE 2017)). By contrast, estimates of the probability of coastal storm-related hazard events, relative to present-day situations before sea-level rise is added, are more tractable (depending on the quality and/or length of the datasets).
- There are also differences in the impacts or consequences of different coastal hazards, e.g. high coastal storm inundation events occur infrequently over a relatively short window of a few hours around the time of high tide, whereas a shoreline may exhibit a long-term irreversible erosional trend, particularly with rising sea levels, that is superimposed on short-term storm cut and accretionary variability. Tsunami are also treated differently, typically using very small probability events (because of their very high consequences, including casualties) to assess coastal areas that are 'potentially affected' (e.g. to

[10] *Weir v Kapiti Coast District Council [2013] NZHC 3522 (Williams J).*

develop evacuation zone mapping). These differences in temporal exposure and consequences between hazards influence how 'potentially affected' areas are determined.

- Current practice tends to take account of the types of coastal hazards that may affect different coastal areas, because each of these will have different impacts or consequences (see Box 2). However, while the severity of the consequences and the difficulty of reducing hazard risk may vary for different hazards, the identification of areas as hazard-prone will enable communities to plan to prevent any avoidable social and economic losses and harm from occurring. For example:
    - The identification of areas that may be affected by storm-tide inundation in the long term may enable the design of buildings and other assets to be altered at relatively little cost to reduce vulnerability to inundation damage.
    - The very high cost of damage to the Fukushima Daiichi Nuclear Power Plant during the 2011 tsunami was apparently primarily caused by the inundation of the back-up diesel generators as a result of tsunami walls being overtopped.

It will always be challenging to determine the many inputs (and values for inputs) for coastal hazard assessments and strategy development, and this will necessarily involve engagement with communities and professional judgement in order to give effect to Policies 3, 24 and 25 of the NZCPS 2010, including the choice of hazard event magnitudes to determine the extent of hazard-prone areas.

(ii) Policy 24 uses the phrase 'giving priority to the identification of areas at high risk of being affected'. There are a number of ways in which this phrase could be interpreted, including to mean areas with the highest likelihood of being affected by coastal hazards or areas at high risk of harm. Risk is a combination of likelihood and consequences: many coastal areas that have a high likelihood of being affected by coastal hazards have little or no development at risk or prospect of development, and so clearly it would not be a good use of local authority resources to prioritise such areas for initial hazard exposure screening assessments.

By contrast, there can be a high risk of harm in the future in many other types of hazard-prone areas, ranging from those that already have significant existing development through to those that have some development and where intensification is likely (particularly where this will degrade or compromise natural defences) and those that currently do not have much or any development but are proposed for significant development.

(Please also see the commentary on Policy 24(1) in section 6.2.)

### Policy 27

Policy 27(1) relates only to those areas that are *likely to be affected* and already have significant existing development (in contrast with Policies 24 and 25, which relate to all *potentially affected* areas). The range of strategic options that should be

assessed and evaluated when Policy 27(1) applies are onerous, and it may be that a higher bar has been set for that reason. In these cases, the opportunity to take preventative action has already passed, and so strategic action is now required and has the potential, given the substantial development, to achieve substantial risk reduction (or avoidance of increased risk).

Box 2

Present practice—identifying areas potentially affected by different hazards[11]

The following interpretations could be used when determining 'potentially affected' areas for each hazard following present or good practice:

*Coastal storm inundation and affected groundwater levels*

These hazards arise during individual events. Present practice and the recommendations presented in *Coastal hazards and climate change* (MfE 2017) are to adopt a ≤ 1% AEP event for hazard and risk assessments of coastal inundation or groundwater elevation for present-day situations.

A 1% AEP storm event would yield a probability of occurrence of 63% (or somewhat less than 'likely') over a 100-year planning timeframe (see MfE 2017: appendix F), which is appropriate for a temporary inundation hazard event that may span a few hours around high tide. When determining potentially affected areas, add on the effect of the highest 'potential' sea-level rise scenario[12] (MfE 2017: section 6.5.4), and any allowance for climate change effects on waves, storm surge and the influence of increased stream/river floods. These adjustments transform the present 1% AEP storm event to a similar probability inundation hazard event that could apply at the end of the planning timeframe if the highest 'potential' sea-level rise scenario has eventuated by then, or in any case that is reached some time later as the sea level continues to rise.

*Coastal erosion (including cliffs)*

Rather than being solely event-driven (e.g. storm cutback), coastal erosion is invariably complicated by long-term erosion trends from a number of influences, including changes in sediment supply. This is the case for cliffs as well as dunes. Any cumulative erosion will often be directly linked to the length of the planning timeframe, particularly with sea-level rise.

Some shorelines will be persistently trending landward, whereas in other areas erosion may be mainly in dynamic equilibrium over the planning timeframe (i.e. episodic storm-event cutbacks followed by recovery periods).

While a threshold of 63% or less for an occurrence probability (taking into account climate change effects) is relevant for the occurrence of infrequent and temporary events such as coastal inundation, a tighter threshold, e.g. 'very unlikely' or around 5% probability of being exceeded over the chosen (e.g. 100-year) planning

[11] R. Bell and S. Stephens, National Institute of Water and Atmospheric Research (NIWA), pers. comm. November 2016.

[12] There is a small chance, if polar ice sheet instabilities emerge earlier than anticipated, that sea-level rise could be higher than the highest RCP8.5 $H^+$ scenario used in *Coastal hazards and climate change* (MfE 2017), particularly well into the next century.

timeframe, is more relevant for determining areas that will be 'potentially affected' by ongoing and more permanent coastal erosion (see MfE 2017: case study F, section 6).

Once again, the effect of the highest 'potential' sea-level rise scenario (MfE 2017) on erosion set back should be added to the 5% exceedance probability of erosion from the other contributors to determine the cumulative erosion that could apply by the end of the planning timeframe if the highest 'potential' sea-level rise scenario has eventuated by then, or in any case is reached some time later as the sea level continues to rise.

*Tsunami*

When assessing 'potentially affected' coastal areas for the purposes of evacuation planning and mapping, and considering any targeted land-use planning provisions (e.g. the location of critical facilities), the Ministry of Civil Defence & Emergency Management (MCDEM) Director's guidelines (DLG 08/16)[13] for yellow zones should be followed. The yellow zone should cover all maximum credible tsunami, including the highest-impact events.

The intention is that the yellow zone provides for local-source maximum credible events based on locally determined risk. The yellow zone is to be based on the area that is expected to be inundated by a 2500-year-average recurrence interval (or 0.04% AEP) tsunami at the 84% confidence level of estimated wave heights at the coast (Power 2013). This low probability threshold includes large subduction interface earthquakes in those areas where they are considered possible.

This is not an absolute 'worst case', as this is not well-defined. Rather, it is a compromise between the very low probability of even larger events and the issues and risks that would be involved in a mass-evacuation in the aftermath of strong earthquake shaking. Sea-level rise should also be added for future planning purposes. Although for large, low-probability events, the relative increases in water levels for large tsunami may be modest, they may result in significant increases in exposure and consequences on the built environment. From these 'potentially affected' areas for the different hazards priority can be given to assessments of areas with higher risk.

See also Box 26, section 6.3 for further information on planning for tsunami hazards.

[13] www.civildefence.govt.nz/assets/Uploads/publications/dgl-08-16-Tsunami-Evacuation-Zones.pdf.

## 3.3 The 'at least 100 year' timeframe

The NZCPS 2010 directs that coastal hazard risks should be assessed, plans should be prepared and consent decisions should be made using a planning horizon (or planning timeframe) of 'at least 100 years' or 'at least the next 100 years'.

While this timeframe is not particularly precise, it does establish a minimum requirement and thereby removes any further debate over whether a shorter planning horizon (such as 50 years) is appropriate in potentially hazard-prone areas.[14]

*Coastal hazards and climate change* (MfE 2017) makes recommendations on how hazard and hazard risk assessments should address the length of the planning timeframe under different circumstances. Importantly, while response options or pathways over the planning timeframe may be formulated at the outset, implementation does not need to cover the entire timeframe if the response can be staged through time—but planning still needs to demonstrate that adaptation is feasible over a range of possible future scenarios without locking in a solution.

The RMA is concerned with promoting the sustainable management of resources, including meeting the reasonably foreseeable needs of future generations.

RMA case law already supported a 100-year planning horizon in most coastal hazard planning and consenting under the RMA (e.g. *Carter Holt Harvey HBU Ltd v Tasman District Council*[15]).

The inclusion of 'at least the next 100 years' in the NZCPS 2010 indicates that a 100-year timeframe for hazard assessments and hazard risk management will not be sufficient in many cases. Examples of where consideration should be given to a timeframe of more than 100 years may include:

- changes in land use, such as subdivision or intensification, that will significantly increase the value of assets for several generations (and are effectively irreversible);
- infrastructure that will influence, and be important for, development in communities for several generations;
- development on, or degradation of, natural defences that are important for protecting hinterland development (akin to a coastal hazard defence infrastructure);

[14] A 50-year timeframe has sometimes been justified in the past because of references in the Building Code. However, those references are concerned with the fitness of a building during its intended life (a minimum of 50 years, unless otherwise specified).

[15] *Carter Holt Harvey HBU Ltd v Tasman District Council [2013] NZEnvC 25*.

- the development or construction of hard protection structures in areas where 'coastal squeeze' as a result of climate change may result in the destruction or degradation of high-value habitats, public access or public recreational open space, or outstanding natural character or landscapes; or which will have adverse effects on threatened indigenous species;
- hazardous facilities where there would be human health and safety consequences if damage occurred; and
- other facilities where there would be human health and safety consequences if damage occurred (such as hospitals, schools, rest homes and child-care facilities).

# 4. Integrated management of coastal hazards in the coastal environment

Integrated management of coastal hazards and coastal hazard responses across the Mean High Water Springs (MHWS) and other jurisdictional boundaries is an important aspect of implementing the coastal hazard policies.

Policy 4(c)(iii) of the NZCPS 2010 requires an integrated approach where physical changes to the coastal environment or potential inundation from coastal hazards (including as a result of climate change) may affect development or land uses. (Also see the commentary on Policy 4 in section 7.1.)

The 'line of MHWS' boundary can be very mobile on sand and gravel shorelines, which can be both a challenge and a driver for integrated management. This is true regardless of whether the shoreline is in dynamic equilibrium (from cycles of storm cut and accretion), or experiencing a long-term trend of retreat or advance. With ongoing sea-level rise and other climate change effects, more coastlines will experience an increasing long-term trend of retreat, with the MHWS boundary migrating inland.

Movement of the MHWS boundary can impact on natural defences and public access, as well as existing development. It can also create difficulties in land-use planning, including the management of coastal hazard response activities (particularly the construction and maintenance of hard protection structures), unless the provisions in district plans and the regional coastal plan are consistent and coherent.

In particular, hard protection structures can initially be on land (e.g. a buried backstop wall) but then encroach on the coastal marine area during major erosion events and when the MHWS boundary migrates landward (particularly with sea-level rise). The converse can also apply, with seawalls that were built in the coastal marine area later being considered to be on land during periods of accretion.

Once built on a beach, a hard protection structure can also become the coastal marine area boundary (i.e. the only 'readily ascertainable line', as determined at Wainui Beach, Gisborne[16]).

The integrated management of coastal hazard issues includes coordinated approaches between regional and territorial authorities, as well as between neighbouring councils. This can be achieved by having consistent provisions across the coastal marine area boundary in regional policy statements, regional coastal plans, other regional plans and district plans, as well as cooperation over information sharing and risk identification.

Collaboration with other bodies and agencies can also be important (Policy 4(b) of the NZCPS 2010), such as in the preparation of non-statutory hazard management strategies.

[16] *Falkner v Gisborne District Council A82/94.*

Integrated coastal hazard management can also involve working collaboratively with the many bodies and agencies that are involved in civil defence and emergency management (CDEM). As well as preparing for and responding to hazard events, CDEM also has a hazard risk-reduction mandate that sits alongside hazard management under the RMA and is now further underpinned by the 2015 Sendai Framework. (See section 8 for a commentary on the CDEM regime in New Zealand.)

The guidance note 'Policy 4: Integration' in section 7.1.2 further discusses concepts and practice for integrated management to give effect to the NZCPS 2010.

# 5. Implementing Objective 5 and Policies 24–27

Risk-based coastal hazard management is a very complex task under climate change. Successful implementation of the NZCPS coastal hazard policies should also refer to the increasing amount of technical guidance and information that is now available.

This guidance is available to local authorities to help them on the journey of adapting to coastal hazards and climate change, and reducing the risks to their communities. In particular, *Coastal hazards and climate change* (MfE 2017) provides authoritative national guidance on these issues, and refers to and draws on many other New Zealand and international studies and guidance documents (including Stocker et al. 2013; Field et al. 2014).[17]

Local authorities have a primary role to play in achieving the strategic approach to coastal hazard management that is promoted by the NZCPS 2010. It is, however, clear that they face a number of substantial challenges in developing a coastal hazard management regime that will give effect to the NZCPS policies and objectives.

Despite legislative and national policy requirements now having been in place for some time, the change to risk-based management for coastal and other natural hazards has not happened rapidly in New Zealand:

- A 2010 analysis of land-use planning for natural hazards by Glavovic et al. (2010) found that the primary challenge for hazard managers is translating legislative provisions into practical reality in local communities.
- In a 2010 review of current council planning practices in relation to coastal adaptation to coastal hazards and climate change (Britton 2010), a NIWA-led team interviewed many regional council, unitary council and district/city council staff. The local authority staff surveyed were found to have a sound understanding of what adaptation to climate change entailed, but most did not consider that their council was doing enough to adapt to climate change. The review identified 11 different limitations or barriers to adaptation.
- The 2011 *Canterbury Fact Finding Project* by Hill Young Cooper Ltd (St. Clair & McMahon 2011), which followed on from the catastrophic Canterbury earthquakes in 2010 and 2011, found that while generic information was available about earthquake hazards, specific information was limited and was not factored into zoning and consent decisions. This report references a study that was undertaken 8 years earlier in 2002 by GNS Science (Becker & Johnston 2002), which found that not enough was being done to incorporate earthquake hazard information and policies into district plans.

[17] For similar approaches in Australia, see Department of Climate Change (2009), Thom (2011) and DSE (2012).

- The Climate Change Research Institute project on community vulnerability, resilience and adaption to climate change in New Zealand[18] (Manning et al. 2011) identified some common features of dealing with climate change, including that:
    - the development of adequate responses is becoming urgent and needs to be linked to the social perceptions of values in both natural and managed resources; and
    - the need to plan for long-term continuing change in our environment raises major structural and social issues over a wide spectrum of domains, such as private and public sector dependence on property values through to inter-generational responsibility.
- The Parliamentary Commissioner for the Environment's report *Preparing New Zealand for rising seas: certainty and uncertainty* (PCE 2015) summarises the problems experienced in Auckland, Wellington, Christchurch and Dunedin in addressing coastal hazard risks from sea-level rise and incorporating appropriate long-term adaptation strategies in their district plans. The report also warns against haste in developing plan provisions, and identifies some of the difficulties and delays that rushed processes have caused.

The NZCPS 2010 supports the careful development of sustainable, long-term adaptation strategies. This direction is assisted by the increasing availability of authoritative technical guidance and tools to assist coastal hazard management in New Zealand, including *Coastal hazards and climate change* (MfE 2017).

It is intended that the combination of the NZCPS policies and national technical guidance, alongside the increased community awareness of climate change and increasing coastal hazard threats, will support local authorities and their communities as they face the task of successfully adapting to these threats and reducing the risks of harm to coastal communities and New Zealand as a whole.

[18] www.victoria.ac.nz/sgees/research-centres/ccri/research/community-vulnerability,-resilience-and-adaptation-to-climate-change,-2008-2013.

# 6. Clause-by-clause commentary on Objective 5 and Policies 24–27

In this section, each part or clause of Objective 5 and Policies 24–27 is shown in italics and followed by a commentary on that part or clause.

(Note: Briefer commentaries for Objectives 1–4 and 6, and Policies 1–4, 6–7, 10–11, 13–15 and 18–20 are provided in section 7.1, while section 7.2 also contains brief commentaries on particularly relevant legislative provisions.)

A summary of the overall RMA context of the coastal hazard objective and policies, and the key interactions between those provisions, Objective 7 and other NZCPS policies is shown in Fig. 1.

All readers of this guidance note should also refer to the *NZCPS 2010 Implementation Guidance Introductory note* (DOC 2012),[19] which contains general information and guidance that is important for implementing the NZCPS 2010.

## 6.1 Objective 5

### Introduction

Objective 5 is the dedicated coastal hazard objective. It has the goal of risk-based management of coastal hazards that takes account of climate change through proactive approaches that include locating new development away from hazard-prone areas; considering responses, including managed retreat, for existing hazard-prone development; and protecting and restoring natural defences.

This is the objective that primarily gives rise to Policies 24, 25, 26 and 27.

### Commentary

*To ensure that coastal hazard risks taking account of climate change, are managed by:*

This introductory statement gives the strong direction to 'ensure' in relation to managing coastal hazard *risks* (i.e. risk-based management). It also explicitly highlights the need to take account of climate change.

- *locating new development away from areas prone to such risks;*

  This first bullet point emphasises the importance of locating development away from risk-prone areas. It also underpins Policy 25(b), under which local authorities and other decision-makers are directed to avoid redevelopment or change in land use (including intensified development) that would increase the coastal hazard risk; and Policy 25(d), which encourages the location of infrastructure away from areas of hazard risk where practicable.

[19] www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/.

- *considering responses, including managed retreat, for existing development in this situation;*

  This second bullet point links to various parts of Policies 25, 26 and 27 that direct careful consideration of a range of responses where existing development is prone to coastal hazard risks:

  - Policies 25(c) and 25(e) apply to existing development in areas that are potentially affected by coastal hazards over at least the next 100 years, with Policy 25(c) encouraging responses that would reduce hazard risks (specifically including managed retreat), and Policy 25(e) discouraging the response of constructing hard protection structures and promoting the use of alternative approaches, including natural defences.
  - Policy 26 indicates that where existing development occurs in areas with natural defence landforms/features, responses including managed retreat may be appropriate for restoring or enhancing these natural defences.
  - Policy 27 promotes a strategic approach to managing coastal hazard risks in areas of significant existing development. Policy 27(1) and (2) direct a range of actions to assess and evaluate strategic response options, while Policy 27(3) and (4) require particular consideration of alternative responses before hard protection structures are used.

- *protecting or restoring natural defences to coastal hazards.*

  This third bullet point leads directly to Policy 26 and the way in which natural defences, such as beaches, estuaries and dunes, can protect important sites and values from coastal hazards. Along with the direction to consider natural defences as a way of protecting coastal land uses from coastal hazards, Policy 26 also directs provision for the protection, restoration or enhancement of natural defences that protect significant biodiversity, cultural or historic heritage, or geological values.

## 6.2 Policy 24: Identification of coastal hazards

### Introduction

Policy 24 lays the foundation for risk-based coastal hazard management.

A long-term risk assessment is a necessary first step towards developing strategic options that seek to reduce the risk of harm from coastal hazards over the long term. Hazard risk assessments need to be robust and defensible to underpin the development of policy statements and plan provisions (as well as for making consent decisions).

Although Policy 24 is titled 'Identification of coastal hazards', there is no ambiguity in its content that hazard risks are also to be assessed, not just the coastal hazards themselves.

National guidance on climate change, assessing the changing coastal hazards and undertaking risk assessments is provided in *Coastal hazards and climate change* (MfE 2017)—particularly sections 5, 6 and 8.

### Commentary

*24(1): Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years are to be assessed having regard to:*

*(a) …*

*….*

*(h) …*

*… taking into account national guidance and the best available information on the likely effects of climate change on the region or district.*[20]

Discussion around the meaning of 'potentially affected' is provided in section 3.2.

To implement 'giving priority to the identification of areas at high risk of being affected', local authorities need to undertake early scoping-level or screening assessments (of both hazard exposure and risk) across their district or region (see Box 3).

Such assessments will assist in determining priority areas for comprehensive hazard and risk assessments. This approach is explained more fully in *Coastal hazards and climate change* (MfE 2017)—e.g. see sections 6, 8 and 9.

Prioritising the identification of high-risk areas is, in part, recognition that coastal hazard risk assessments require a comprehensive approach and can be both time

[20] Note that although the use of (1) in Policy 24 suggests there is more than one clause, there is only 24(1) with a list of paragraphs. The final phrase therefore applies to the above matters and is not a new clause.

Box 3

Which high-risk areas should be prioritised for the investigation of coastal hazards?

A suggested approach for conducting screening assessments of the district/region to identify areas where the greatest risk avoidance or reduction can be achieved includes identifying areas where:

- significant new development (or significant intensification) is proposed that may be hazard prone (where the greatest amount of risk avoidance would be achieved);
- development is proposed on or adjacent to natural defence landforms/features—particularly where protecting, restoring and enhancing those natural defences would also reduce the risk of harm to other existing or proposed development nearby (thereby both avoiding and mitigating substantial risks); and
- significant existing development may be more hazard prone (for these areas, the development of adaptive risk-reduction strategies required under Policy 27 will need detailed hazard and hazard risk assessments).

Areas in the coastal environment often have a wide range of environmental, social, economic and cultural values. The presence and nature of these other values should be considered as part of the coastal hazard risk identification and management.

consuming and expensive. This is evident from the number of factors set out in Policy 24 that risk assessments must have regard to, the need for detailed geospatial information on various hazard-prone assets, and the high public interest in how the information is gathered and used.

As a general principle, decisions on development, redevelopment and changes in land use in the coastal environment should be informed by coastal hazard and coastal hazard risk assessments.

In areas with less development (and fewer development prospects), it may be more efficient to undertake assessments if and when general or individual development is proposed for the area. Deferral of the detailed assessment requires an assessment of the likelihood of development occurring. The principle remains that areas that are at risk should be identified and planned for, rather than reacting to hazard events and/or development proposals on an ad hoc basis.

Local authorities will need to bring together a range of expertise, including knowledge of development pressures, infrastructure services, demographic trends, and the adaptive capacity of the community and/or infrastructure services, when deciding on priority areas for early screening assessments—and then again when using the results of these screening assessments to prioritise where detailed comprehensive risk assessments will be undertaken.

Local authority staff and the community can bring to the table both value-based and evidence-based aspects drawing on their regional and local knowledge (e.g. regarding development pressures, low-lying or exposed areas, areas previously

impacted by coastal hazards and potential risks in general). This input will help inform the prioritisation of early screening assessments.

Expert and experienced coastal hazard and risk management practitioners can also provide invaluable knowledge and skills in their respective fields to help local authorities undertake the broad hazard and risk screening assessments. This, in turn, will help inform public and stakeholder engagement processes, and will be an important step towards addressing coastal hazards, climate change and risk reduction.

Similarly, the involvement of expert and experienced coastal hazard practitioners as well as local authority staff—working collaboratively with the community and stakeholders (e.g. infrastructure and utility operators)—will also be essential for the subsequent steps that are involved in undertaking comprehensive hazard risk assessments in the priority areas and ultimately in other coastal hazard-prone areas in the region or district.

Guidance on undertaking these assessments and engaging with the community is provided in *Coastal hazards and climate change* (MfE 2017). All responses will need to fit the local context and consider local issues and communities. Box 4 provides two examples of such local responses.

Importantly, the requirement to take into account national guidance and the best available information on the likely effects of climate change on the region/district is taken to apply to all of the subclauses of Policy 24 (i.e. (1)(a)–(h)).

Examples of current assessments of the likely effects of climate change on regions and districts are provided in *Coastal hazards and climate change* (MfE 2017) and in occasional updates on regional climate change projections (temperature, rainfall, wind) released by the Ministry for the Environment (MfE). Also see Box 4 for additional recent New Zealand guidance.

The reference to 'likely effects on the region or district' highlights the fact that climate change effects, including sea-level rise, will not be of equal magnitude around the coast of New Zealand. For example:

- Climate change effects on wind, rain, storm surge, waves and swells may vary significantly between the north and south of the country, and between the east and west coasts.
- While absolute sea-level rise itself will not vary greatly around the New Zealand coast, relative sea-level rise may vary spatially as a result of a rise or fall in land elevation caused by tectonic movements between or during major earthquake events, or subsidence of large sedimentary basins (see Box 5).
- The impact of sea-level rise on permanent tidal or episodic storm inundation will also vary substantially around New Zealand, depending on the tidal range on different parts of the coastline (see Box 6).

Box 4

Recent New Zealand guidance on undertaking coastal hazard assessments

- *Peer review of the Christchurch coastal hazards assessment report* (Kenderdine et al. 2016):

  This is the report of the independent peer review panel led by former Environment Court Judge Kenderdine that was set up to assess the Tonkin & Taylor Ltd (2015) report prepared for Christchurch City Council to inform the development of coastal hazard provisions in the Proposed Christchurch Replacement District Plan (CRDP).

  The goal of the Tonkin & Taylor report was to provide information on areas of Christchurch and Banks Peninsula that were considered susceptible to coastal hazards over both a 50-year and 100-year planning timeframe, taking into account the potential impact of sea-level rise.

  The Peer Review Panel report reviews the Tonkin & Taylor assessment, but also goes beyond that initial goal to address in some detail the purpose of Policy 24 and its relationship with the other NZCPS objectives and policies, including the steps that a council needs to go through to address the management of coastal hazards.

- *I can live with this—The Bay of Plenty Regional Council public engagement on acceptable risk* (Kilvington & Saunders 2015):

  In October 2013, Bay of Plenty Regional Council (BOPRC) began work on a variation to the natural hazards component of its proposed Regional Policy Statement (RPS), with an interest in providing a framework that would support risk-based planning in the Bay of Plenty.[21]

  BOPRC took the position that:

  - the key to a risk-based approach to land-use planning is the delineation of the thresholds of acceptable, tolerable and intolerable risk; and
  - this determination of risk acceptability requires public input.

  This report records how BOPRC took on the challenge of including the views of their local community in deciding where the threshold for acceptable risk lay, based on the level of consequences for an individual hazard event.

[21] A report by Bell et al. (2006) provided information on the impacts of climate change on the coastal margins in the Bay of Plenty region.

Box 5

Increased relative sea-level rise with subsidence

If coastal land subsides over time (or suddenly, as occurred in some areas in the northeast of Christchurch during the 2010/2011 Canterbury earthquakes), the relative sea-level rise in those areas will be greater than the absolute rise in the ocean level.

Therefore, the effects of sea-level rise, including an increasing frequency of coastal inundation, will be greater in these areas than in other areas that are stable or where the land is gradually rising. (See section 5.3 in *Coastal hazards and climate change*; MfE 2017.)

Box 6

Increased impacts where the tidal range is small

Coastal areas with smaller tidal ranges (e.g. along the central east coast and in Wellington) will require only a modest sea-level rise to reach a stage where every high tide will exceed the present upper high-tide mark. Further, the frequency of coastal inundation events will substantially increase with time.

By contrast, for the same increase in sea level, coastlines with bigger tidal ranges will have a somewhat slower increase in the frequency of coastal inundation.

For example:

- In Wellington, only a very modest sea-level rise of 0.3 metres is required for a 1% AEP storm-tide inundation event to become an annual occurrence on average due to the small tidal range (1.05 metres average).
- In Auckland, a larger sea-level rise of 0.45 metres is required for a 1% AEP event to become an annual occurrence on average because of the bigger tidal range (2.5 metres average).

  (Source: PCE 2015.)

Tsunami hazards are specifically addressed in Policy 24. The NZCPS Board of Inquiry included tsunami because there was a need 'to consider necessary responses to a real threat to communities along the coast' (Board of Inquiry 2009a: 10).

The inclusion of tsunami hazards amongst the suite of coastal hazards to be addressed under the NZCPS 2010 encourages local authorities to undertake more of an all-encompassing approach to the management of coastal hazards, including risk reduction as well as emergency response and recovery. (See section 4 for a discussion of integrated management and CDEM, and section 6.3, Policy 25(f) for further discussion of tsunami.)

*24(1)(a) physical drivers and processes that cause coastal change including sea level rise;*

This subclause is the first of a list of physical factors to be assessed when undertaking a coastal hazard assessment.

Physical drivers and processes include tides, cyclones, storms, wind, waves, swells, storm surges and sediment sources/sinks, as well as erosion, deposition and sediment transport processes. This also includes the way in which these processes shape the land. Groundwater processes in low-lying coastal areas, influenced by rising tides and sea level, will also drive changes in drainage patterns and other terrestrial characteristics.

Sea-level rise and other climate change effects may modify these processes and create or exacerbate coastal change which, in turn, may influence the scale and extent of the coastline to be considered (see Box 7).

It is noted that large, infrequent tsunami events have the potential to considerably change the coastal environment through scour and deposition processes, as well as inundation and physical damage (see section 6.3, Policy 25(f) for further discussion of tsunami).

*24(1)(b) short-term and long-term natural dynamic fluctuations of erosion and accretion;*

This subclause highlights the difference between:

- short-term fluctuations in shoreline positions or river mouths (as part of a 'dynamic equilibrium' involving irregular cycles of storm erosion or river floods and subsequent recovery); and
- longer-term trends of erosion or accretion on sedimentary coasts (comprising muds or sands in semi-enclosed estuarine systems, and sand, gravel or mixtures of these). Cliffed coasts are by nature erosional features, where both short- and long-term changes are irreversible.

Box 7

The wide range of sea-level rise impacts

Sea-level rise will not only increase erosion and inundation during storms that coincide with high spring and/or king tide events (as a result of increased storm-tide levels), but will also have other impacts that cause significant coastal change, such as:

- Creating a permanent and ongoing increase in spring high tide inundation around coastal margins, which will affect shoreline assets, as well as estuarine ecosystems such as intertidal seagrass and saltmarsh, and other coastal habitats and vegetation.
- Causing water tables in coastal aquifers or inland ponds, which presently fluctuate with the tide level, to be raised further. In combination with intense rainfall (and capacity issues with stormwater and drainage systems), one impact of this will be increased flooding.

The guidance on defining coastal hazard zones that is provided in *Coastal hazards and climate change* (MfE 2017) and Ramsay et al. (2012) contains further discussion on these short-term fluctuations and long-term trends.

In the case of long-term dynamic fluctuations in particular, it is really the combination of natural variability and human-induced influences that needs to be determined when making hazard and hazard risk assessments, because the two cannot be disentangled (see Box 8). Therefore, this subclause is closely linked to 24(1)(f), which is related to human influences (see below).

The assessment of short-term fluctuations provides an indication of the width of the dynamic buffer that is naturally required for the irregular cycles of erosion and accretion. Typically, short-term fluctuations need to be considered over a timescale of several days to a few years. The extent of these fluctuations is not always solely related to the impacts of individual storms because it can be compounded by earlier conditions and sequences of storms (see Box 9 for information on the impact of a sequence of storms).

The assessment of long-term changes in the shoreline position, which occur at a scale of decades to centuries, provides an indication of the erosion or accretion trend that is superimposed on the short-term fluctuations. Unfortunately, however, the assessment of long-term trends is seldom straightforward (see Box 10).

It is important that both types of dynamic fluctuations are recognised when assessing how effective and appropriate different response options (and combinations of responses) are likely to be for reducing risk now and into the future. Differentiating between them is crucial to the development of long-term strategies for responding to coastal hazards over a timeframe of at least 100 years.

Box 8

Natural variability and human-induced influences cannot be disentangled

Many coastlines are still responding to natural, long-term climate cycles (such as glacial and interglacial periods) and to ongoing geological processes that are associated with active tectonic activity in the New Zealand region. These active processes include faulting, differential uplift/subsidence and earthquake-generated sediment sources in catchments (e.g. large landslides), which may still be contributing to coastal sediment budgets and other coastline changes.

The impacts of these natural influences cannot be disentangled from the effects of rapidly progressing human influences, such as:

- Sea-level rise and other human-induced climate change effects, which will compound any natural, long-term changes, generally leading to erosion and inland migration of the shoreline that will be effectively irreversible (leaving aside interventions such as protection measures).
- Groynes, seawalls, breakwaters, moles, sand extraction or nourishment, nearshore dredging or sediment disposal, dams on rivers and river mouth training works, or operational management (e.g. periodic excavated openings), which will affect longer-term trends of erosion and accretion along a large extent of coastline.

Box 9

The impact of a sequence of storms

A storm will lead to erosion (storm cut-back), which is typically followed by an accretionary phase (post-storm beach re-building).

However, this cycle can be interrupted when there is a rapid sequence of large (or even moderate) storms, which can substantially increase the 'short-term' fluctuations, resulting in more severe erosion.

An example of this is the sequence of storms that occurred in the mid-1970s, affecting northeast coast North Island beaches (e.g. Omaha). In 1976, Raumati on the Kapiti Coast experienced severe dune erosion and the loss of houses as a result of this storm sequence.

Climate variability also plays a role where, for some climate phases, earlier conditions can result in under-nourished beaches and exacerbate storm cut-back (Bryan et al. 2008).

Box 10

The difficulty in determining long-term trends

Short-term to multi-decadal fluctuations are present on most coastlines (except rocky coastlines with no fringing sediment) and will often mask any underlying long-term trend—including from historic and ongoing sea-level rise and tectonic activity.

This is because:

- the range of short-term shoreline fluctuations ('noise') is often high compared with the relatively slow long-term trend ('signal'); and
- there are few reliable long-term records (or aerial photographs) of shoreline position. Records seldom cover more than one cycle of the 20–30-year Inter-decadal Pacific Oscillation[22] and often comprise only very occasional measurements (e.g. tied to a historic aerial photographic survey or a beach profile after a major storm).

In practice, it can be difficult to determine whether a particular sedimentary coastline has a long-term erosion or accretion trend, let alone what the magnitude of the trend is. Care is required to ensure that contributors to short-term and long-term fluctuations are not counted twice, and that historic and future sea-level rise are separated out (bearing in mind that there may be a considerable lag in the shoreline response to incremental rises in sea level).

[22] www.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Atmosphere-and-climate/interdecadal-pacific-oscillations.aspx.

*Coastal hazards and climate change* (MfE 2017) provides a case study on erosion hazards in Northland. This guidance emphasises the key message that maintaining and enhancing the monitoring of coastal profiles and topography (e.g. with light detection and ranging; LiDAR) is critical to being able to discern exactly what long-term trends are occurring within the masking effects of dynamic short-term fluctuations. In addition, Rouse et al. (2011) provided case studies of coastal adaptation to climate change, including for estuaries/enclosed waters.

A long-term trend of erosion will mean that armouring the shoreline by building hard protection structures will lead to 'coastal squeeze' (see Box 22, section 6.3).

Short-term fluctuations arise from seasonally changing wind and wave climates, as well as from individual large storms or a series of storms. Somewhat longer fluctuations can arise from the 2–4-year El Niño and La Niña cycles, which cause changes in the persistence of winds and mean sea level around New Zealand. Even longer fluctuations can arise from the 20–30-year Interdecadal Pacific Oscillation (IPO), which can cause substantial coastal changes (Bryan et al. 2008) and can appear to indicate a long-term trend if beach profile records are too short to pick up complete IPO cycles.

Sea-level rise will tend to create a long-term trend of erosion. However, this trend can be modified by associated sediment budget changes (see Box 11), which result from either natural changes or human activities. Many of the changes to sediment budgets will be caused by:

- new or existing structures blocking sediment flows (including river dams, breakwaters, groynes and river moles);
- changes to sediment flows due to changing land use in catchments, sea-level rise and other climate change effects;
- beach extraction or nourishment schemes, or the disposal of dredged material in the nearshore zone; and
- any other changes that will affect the dynamic equilibrium (e.g. the loss of binding shellfish beds as a result of a changing climate or harvesting).

(See Policy 24(1)(f) below for further discussion of human influences.)

Box 11

Climate change effects on long-term trends

Sea-level rise as a result of climate change will tend to shift shorelines that are in dynamic equilibrium towards a long-term trend of erosion.

While there is uncertainty over how the rate of sea-level rise and changes in sediment budgets will impact on different coastlines, improved methods are being developed, including use of the probabilistic approach, which can provide a plausible distribution of the likelihood of shoreline positions for a given timeframe.

Considerable uncertainty remains around both sea-level rise scenarios and the local erosion response to rising sea level.[23]

There will be even more uncertainty for shoreline change projections where there are sensitive sedimentary features such as tidal inlets, sand spits and river mouths, which are often in a fine balance with sediment budgets, ocean/climate drivers and (where applicable) river flows.

(See Ramsay et al. (2012) and section 6 of *Coastal hazards and climate change* (MfE 2017) for guidance on methods.)

*24(1)(c) geomorphological character;*

The geomorphology of the seabed, foreshore, hinterland and catchments affects the way in which coastal processes will act in changing the coastline. Therefore, the wider geomorphological and geological context (including beyond the coastal environment) needs to be understood to make more informed projections of coastline evolution:

- in the light of geological events with long-term but finite effects; and
- when there are changes in the physical drivers, processes and land uses at the coast and in adjoining catchments, including from climate change.

(See Box 12.)

The NZ Coastal Sensitivity mapping tool (Goodhue et al. 2012)[24] has been used to map layers of some of the geomorphological features around New Zealand's coastline.

[23] See Mastrandrea et al. (2010) on the consistent treatment of uncertainties.

[24] www.niwa.co.nz/climate/research-projects/coastal-adaptation-to-climate-change.

Box 12

The importance of geomorphological and geological context

- Slugs of sediment that were mobilised during past volcanic or earthquake events are finite and may be diminishing or have passed through the system, e.g. at South Island West Coast erosion hotspots and on Taranaki beaches with their iron sands from Mount Taranaki.
- At Wainui Beach, Gisborne:
  - the sand largely originates from past volcanic events;
  - the beach is a pocket beach isolated from a new sand supply; and
  - the volcanic sand is underlain by mudstone (which will be lost to the beach system when scoured and dissolved by large waves striking the seawalls, i.e. will not be available to rebuild the beach post-storm).

*24(1)(d) the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;*

This subclause highlights the fact that there are a number of potential sources of inundation in the coastal environment, including:

- storm tides (comprising storm surges, high tides and short-term fluctuations in mean sea level at timescales of seasons to years);
- high spring or larger 'king' tides;
- wave set-up and run-up;
- short-term fluctuations in mean sea level (seasons to years);
- river flooding (which can also be influenced by storm surge and tide conditions);
- groundwater (from rising water tables with tidal connectivity);
- sea-level rise; and
- tsunami (which ride on the back of the sea level at the time of the event).

Therefore, the combined effect of these sources will need to be considered, including the combined, cumulative effects of sea, river/stream catchment and groundwater influences.

This subclause draws attention to the need to identify the various pathways/flowpaths that the different flooding events will follow (as occurs when making river floodplain assessments). Inundation pathways may include public access beach routes, boat ramps, artificially-lowered dunes and berms, drainage/stormwater networks, waves overtopping seawalls or rock revetments, or around the back of settlements via rivers and estuaries.

Inundation can also be compounded from below ground through elevation of the water table during high spring tides or storm tides (if hydraulic groundwater connectivity has relatively short response times).

'Overland extent' is how far inland the water is expected to reach and the area that is predicted to be inundated during any event (or combination of events) that the hazard risk assessment is based on. This can depend on a range of factors, such as the complex behaviour of overland catchment flow, water tables, and the waves that overtop stopbanks, embankments and other barriers. Other factors include the duration of inundation and the capacity of the stormwater or drainage system to drain the water away from developed areas.

*24(1)(e) cumulative effects of sea level rise, storm surge, and wave height under storm conditions*;

This subclause recognises that these factors (as well as high tides) act together to increase the exposure of coastal areas to inundation hazards and coastal shoreline change.

Since the assessment of hazard risks needs to cover at least the next 100 years, the 'cumulative effect over time'[25] from climate change for each of these contributing factors, individually and combined, is expected to be addressed.

Even a modest rise in sea level can have a substantial effect on the frequency and severity of coastal hazards when combined with storm-tide water levels and waves that currently occur during storm conditions and/or king tides. Such changes in the frequency of damaging events, including those from sea-level rise, will vary in each coastal location, notably depending on tidal range (see Boxes 6 and 13).

Box 13

The impact of sea-level rise in addition to other existing inundation hazards

The cumulative effect (or combined impact) of sea-level rise and other existing storm inundation hazards can be demonstrated by examining either the frequency or the magnitude of overtopping, damaging or extreme coastal inundation events in the future relative to a present-day threshold:

- *Frequency*: Each hazard-prone local area will have a particular sea-level rise threshold when frequent (e.g. yearly), small, nuisance coastal inundation events become larger, more disruptive/damaging events. This threshold will depend on the local topography behind the shoreline, overland flowpaths, tidal range, and wave and storm-surge exposure.
- *Magnitude*: In hazard-prone areas, damaging inundation events that are currently rare will become regular events, and eventually frequent or everyday events.

For example, in Christchurch, a coastal storm inundation hazard assessment may find that a damaging 1% AEP coastal storm-tide water level today will occur on average once per year (63% AEP) with a sea-level rise of 0.3 metres (which is likely to occur in c. 2050–2060); whereas the same present-day 'extreme' water level would occur every day with a sea-level rise of 0.7 metres (which could occur within the next 100 years). (See PCE 2015: 29; and Box 6.)

[25] See section 3 of the RMA for a definition of these 'effects', including cumulative effects.

If climate change also increases the frequency or intensity of storms, then the larger waves and storm surges will be a further cumulative effect, although in New Zealand any such effects will be much smaller than those from sea-level rise (see sections 5–6 of *Coastal hazards and climate change*; MfE 2017).

*Inundation*

In most situations, the first tangible sign of an increase in sea level is the increasing frequency of damaging coastal inundation (or high water tables) in low-lying coastal areas (see Box 13).

Because storm surges in New Zealand seldom exceed 0.6 metres and rarely reach 1 metre, permanent sea-level rises of 0.5 metres or more as a result of climate change will tend to dominate the combined inundation hazard and will greatly increase the frequency of damaging inundation events. This will be particularly true towards the latter half of this century.

*Erosion*

Erosion hazards during storms will also be increasingly impacted by sea-level rise. However, storm surges, storm waves/swells and any coincidental high/king tides (as well as the impact of any recent storms on shoreline profiles, the state of natural and built defences, and any changes in sediment budgets) will continue to be key drivers of short-term erosion hazards and erosive episodes on dynamically fluctuating coastlines. (See Box 9 and the commentary on 24(1)(b).)

*24(1)(f) influences that humans have had or are having on the coast;*

(Note that the influence of built development on hazard consequences, and hence hazard risk, is addressed in the commentary on 24(1)(g) below.)

Human influences on the coast can arise from coastal engineering projects, such as hard protection structures, marina/port breakwaters, port entrance groynes/moles, gravel/sand extraction, beach renourishment and river mouth cutting.

Human influences can also arise from other less obvious activities that will affect the dynamic equilibrium of coastal processes (both physical and biological) not only in enclosed bays and estuaries, but also on the open coast. These can include:

- Activities that may be quite distant, such as dams, dredging and the disposal of sediments from estuarine channels, catchment land erosion, low flows in rivers as a result of irrigation take-off, and river works (whether inside or outside the coastal environment) that affect sediment budgets along the coast or the flood peaks in estuaries, river mouths and harbours.
- Impacts on plants and animals, their habitats, and the ecosystem services they provide, such as the loss of binding shellfish beds as a result of harvesting, the drainage of wetland habitats in the coastal environment and the removal or grazing of sand dune or estuarine plants.
- Human-induced climate change, which will have substantial impacts on many physical processes and ecosystems on the coast (see Boxes 14 and 15).
- Human responses to climate change. In addition to hard protection structures, existing influences that already significantly affect more

developed estuarine systems can be expected to increase. These include reclamations to reinstate shoreline buffers (see NZCPS 2010: Policy 10), alterations to drainage patterns, and pressure for channelisation through dredging and stopbanks to reduce inundation.
(See section 6.3, Policy 25(e) for a discussion of the influences that hard protection structures can have on the coast, including 'coastal squeeze'.)

Such human influences can also affect coastal sediment budgets, and can result in longer-term fluctuations and trends of erosion and accretion (Policy 24(1)(b)). They will affect the assessments under Policy 24(1)(b), (d) and (e), and overlap with subclause (g).

Box 14

Climate change

Climate change is a human influence, as recognised in the definition provided in section 2 of the RMA: 'climate change means a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods'.

Climate change effects on coastal hazards will include an irreversible ongoing rise in sea level for at least the next few centuries, even if $CO_2$ emissions are better controlled by the end of this century, with the rate of increase and final peak magnitude determined by the actual global $CO_2$ emission trajectory.

Sea-level rise will generally lead to more frequent inundation events in low-lying coastal areas and more coastlines permanently advancing inland.

See *Coastal hazards and climate change* (MfE 2017) for a detailed analysis of projected climate change and its effects.

Box 15

Climate change impacts on estuaries and enclosed bays

Although we often focus on the impacts of climate change effects on open-coast communities that will face storm waves and erosion, it is possible that the environments and communities in estuaries and enclosed bays will experience even more pronounced changes. This is because they are often low-lying, have evolved with less exposure to storm waves and erosion, and will now be exposed to substantial changes from higher sea levels (and the resultant higher storm surges and king tides). Climate change effects in catchments running into estuaries (e.g. increased flooding and sedimentation) will exacerbate marine pressures on these coastal systems.

The many impacts of climate change on important estuarine environments have been examined as part of a Department of Conservation workshop on freshwater conservation under a changing climate (Kettles & Bell 2016).

*24(1)(g) the extent and permanence of built development;*

The extent and permanence of the built development will generally have little effect on the coastal hazards themselves (i.e. the likelihood and magnitude of an erosion or inundation threat or event) unless natural defences have been compromised by the development. However, it can have a major impact on the potential consequences of hazard events—and hence on the long-term hazard risks and the available (or affordable) response options.

This subclause implies that hazard risk assessments should include realistic consideration of the permanence of development, including domestic housing settlements and associated services and infrastructure, rather than applying a nominal design or building life (such as 50 years under the Building Act 2004) to hazard-risk assessments.

Hazard exposure of built development can be exacerbated by changes to natural defences associated with that development (e.g. accessways cut through dunes, lowered dune systems, sand dune areas that have been made non-porous, mangrove removal and grazing of coastal wetlands) and by changes to the built development area itself
(e.g. increased velocities around buildings and other structures during large storm-tide and tsunami events, building materials becoming flotsam, and non-porous areas).

Valuable and unrelocatable development will increase the cost of retreat or redevelopment. It will also increase the difficulty of finding other response options that are affordable and sustainable for a number of reasons, including associated high land value and property-owner expectations.

Ultimately, the extent and value of the built environment and associated infrastructure will have a major impact on the consequences of any coastal hazard events that are large enough to overwhelm natural and/or built defences and which occur *while the development remains in the area*. The design of that built environment, including services and infrastructure, will increase or decrease the vulnerability to such hazard events, and hence also influence the consequences and overall hazard risks.

The permanence of the built development will affect the ability of people and communities to redevelop or relocate it if it is threatened by coastal hazards *before* it is damaged by large hazard events, and hence affects the potential consequences over the long term. There is a greater ability to reduce future consequences and long-term risks if the built development is impermanent/relocatable (or will soon be reaching the end of its design life) and is relocated or redeveloped to reduce risks before hazard events actually affect the area.

*24(1)(h) the effects of climate change on:*
*(i) matters (a) to (g) above:*
*(ii) storm frequency, intensity and surges; and*
*(iii) coastal sediment dynamics;*

This subclause expands on section (i) of the RMA, and directs local authorities to consider all of the effects of climate change on hazards affecting the coastal environment (which can include changes in sediment delivery to the coastal marine area arising from changes in rainfall, catchment run-off or other climate processes outside the coastal environment that affect coastal hazards).

(See Box 14 regarding human-induced climate change, and Box 15 regarding the effects on estuaries and enclosed bays.)

National guidance on climate change and its effects is provided in *Coastal hazards and climate change* (MfE 2017).

As discussed in the commentary on 24(1) at the beginning of this section, subclause (1)(h) is followed by the direction (applying to all of the subclauses (1)(a)–(h)) that hazard risk assessments should take into account national guidance and the best available information on the likely effects of climate change on the relevant region or district. The earlier commentary also discusses 'the likely effects of climate change on the region/district'.

## 6.3 Policy 25: Subdivision, use, and development in areas of coastal hazard risk

### Introduction

Policy 25 is the overarching policy for managing coastal hazards and hazard risks that are identified and assessed in accordance with Policy 24. Both policies refer to all areas in the coastal environment that are *potentially affected* by coastal hazards.

Policy 25 directs that in areas that will potentially be affected by coastal hazards over at least the next 100 years, an increase in the risk of social, environmental and economic harm from coastal hazards is to be avoided. This policy encourages redevelopment or change in land use that would reduce risk, and also contains policy relating to all redevelopment and changes in land use (which includes new development); infrastructure; hard protection structures and alternatives to them; and tsunami.

*Coastal hazards and climate change* (MfE 2017) provides guidance (and references to other guidance) on how local government can develop options to avoid and reduce hazard risk.

The relationship between Policies 25, 26 and 27 and other NZCPS provisions are shown in Fig. 1.

### Commentary

*In areas potentially affected by coastal hazards over at least the next 100 years:*

This policy covers all areas that are potentially affected by coastal hazards,[26] including those areas with significant existing development (which are further addressed in Policy 27).

The phrase 'at least the next 100 years' is discussed in section 3.3.

*25(a) avoid increasing the risk of social, environmental and economic harm from coastal hazards;*

This clause directs decision-makers to avoid increasing the risk of harm from coastal hazards. This policy is written in a directive way, with the meaning of 'avoid' having been informed by court decisions since the gazettal of the NZCPS 2010, including the Supreme Court's decision on *Environmental Defence Society Incorporated v The New Zealand King Salmon Company Limited*.[27]

The clauses that follow set out specific ways to contain or reduce the risk of harm from coastal hazards.

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[26] See section 3.2 for a discussion on the interpretation of 'potentially'.

[27] *Environmental Defence Society Incorporated v The New Zealand King Salmon Company Limited [2014] NZSC 38.*

In a sense, all of the clauses in the coastal hazard policies act to contribute to avoiding any increase in the overall risk of harm from hazards and reducing the overall hazard risk wherever manageable.

The challenge in implementing this requirement is acknowledged. Climate change will significantly increase coastal hazards over at least the next 100 years and there is already a very large extent of high-value, vulnerable development that is within areas that will be affected by those coastal hazards within the 100-year-plus timeframe. In addition, there is ongoing pressure for both new development and intensification of development within coastal areas, many of which will also be affected by those coastal hazards within the 100-year-plus timeframe.

Coastal hazard risks will therefore significantly increase with time unless local government, communities, iwi/hapū and stakeholders can meet the difficult challenge of developing and implementing sustainable, long-term risk-reduction strategies for hazard-prone areas (see Box 16).

Use of the phrase 'social, environmental and economic harm' rather than the more standard RMA term 'adverse effects' highlights the social and environmental adverse effects that can result from coastal hazards and coastal hazard responses, in addition to recognised economic effects (see Box 17).

As noted earlier, social and environmental harm should be read broadly to include cultural harm.

Box 16

Community engagement

As indicated elsewhere in this guidance and discussed extensively in *Coastal hazards and climate change* (MfE 2017), community engagement by local authorities as part of developing locally-relevant response options will be crucial for:

- growing community understanding of physical changes that will affect their coast;
- achieving a collaborative and transparent process that engenders community trust; and
- enabling the implementation of long-term risk containment/reduction strategies.

Community engagement will be needed during the technical hazard and hazard risk assessments, as well as in the evaluation and implementation of response options, such as the dynamic adaptive pathways planning approach that is recommended in *Coastal hazards and climate change* (MfE 2017).

(For further information, see section 5.)

Box 17

'… the risk of social, environmental and economic harm'

This phrase indicates that decision-makers should take a broad view and consider the potential harm to biodiversity, natural character, public space, public access and amenity values, as well as to settlements and infrastructure (Board of Inquiry 2009a: 4 & 7).

Policies 3, 24, 25 and 27 of the NZCPS 2010 set down an explicit requirement to consider social and environmental harm as well as economic harm *at all stages of coastal hazard management in New Zealand*—from risk assessment, to evaluation of strategic response options, to taking a precautionary approach for the use and management of coastal resources, to consent decisions on proposed developments or protection works.

*25(b) avoid redevelopment, or change in land use, that would increase the risk of adverse effects from coastal hazards;*

This clause reflects a risk management approach and the intention to avoid increasing the risk of adverse effects from coastal hazards. In particular, it recognises that some redevelopment or changes in land use can increase the consequences or harm from coastal hazards (and hence the risk), even if the coastal hazard itself remains unchanged. Examples of areas where such an increase has occurred include places where there has been:

- intensified land use and increased asset values;
- an increased vulnerability of assets (including infrastructure) to damage from coastal hazards;
- a greater likelihood that assets (including infrastructure) will be damaged by coastal hazards; and/or
- a greater likelihood that other social, cultural and environmental values will be adversely affected.

(See Box 18.)

Clause 25(b) does not require local authorities to avoid all redevelopment and changes in land use in hazard-prone areas. The commentary on Policy 25(c) below looks at instances where redevelopment or changes in land use can reduce the risk of adverse effects from coastal hazards.

Redevelopment or a change in land use in a hazard-prone area that involves intensification of development (be it more development or more expensive redevelopment) will usually increase risk unless there is a commensurate reduction in the vulnerability of the development to damage (see Box 19 and the commentary on Policy 25(c) below).

Box 18

'... changes in land use'

Subdivision, new built development, intensification and changes to agricultural use are all taken to be 'changes in land use'.... the risk of adverse effects from coastal hazards'

It is important to emphasise that, in line with the Policy 25(a) reference to 'social, environmental and economic harm', the increased risk of adverse effects is not confined to damage to development.

An increased risk of adverse effects from coastal hazards where new development, redevelopment or subdivision is allowed in hazard-prone areas can result from:

- economic damage to public and private assets from a hazard event;
- immediate or long-term social and environmental effects resulting from a threat, or hazard event, when hard protection structures are built; and
- situations where the development or associated activities adversely affect natural defences by degrading them or precluding their restoration and enhancement (e.g. placing accessways through dunes; building on foredunes; flattening of dunes to create views or flat areas; removal or grazing of vegetation).

Both the development and any hard protection structures that are built to protect it can increase the risk of adverse effects on:

- the wellbeing of other property owners and the wider community (particularly when they develop or intensify developments with reliance on the protection works); and
- natural character, biodiversity, and public space, access and amenity.

(See the commentary on Policy 25(e) below for further discussion on the effects of hard protection structures, including 'coastal squeeze'.)

Box 19

Examples of redevelopment and changes in land use that may not increase risk

- Redevelopment that intensifies land use in hazard-prone areas but reduces vulnerability to hazard risks as part of the redevelopment, taking into account increasing risks and changes in vulnerability that may be non-linear over a 100-year period.
- A change in land use to enable councils to provide infrastructure and services to existing hazard-prone communities where it is a transitional part of a long-term risk-reduction strategy.
- A change in land use on hazard-prone land where it is a case of making land with low hazard exposure available for the relocation of development from hazard-prone areas, as part of a long-term managed retreat strategy, or to enable restoration of foredune or estuarine natural defences.

Consideration of such proposals is expected to take into account the permanence of the redevelopment or change in land use and the long-term risks, particularly in the face of ongoing sea-level rise.

This consideration also takes place in the context of:

- other relevant policy in the NZCPS 2010;
- other relevant RMA national direction; and
- relevant RMA plan provisions and strategies developed for the hazard-prone community that address adaptation to coastal hazards (and containing or reducing the hazard risks) over at least the next 100 years.

*25(c) encourage redevelopment, or change in land use, where that would reduce the risk of adverse effects from coastal hazards, including managed retreat by relocation or removal of existing structures or their abandonment in extreme circumstances, and designing for relocatability or recoverability from hazard events;*

This clause is closely related to clause 25(b) (see Box 19).

It encourages a proactive approach to redevelopment that will reduce coastal hazard risks. This reduction can be achieved through a combination of reducing the likelihood of damage (e.g. through reduced hazard exposure) and/or reducing the consequences of a hazard event (e.g. through reduced vulnerability to damage).

Again, adverse effects on environmental and social values are to be assessed, as well as on economic values (see Box 20).

Box 20

Social and environmental harm, and residual risk

Alongside the risk of harm to the built development, the risk of adverse effects from coastal hazards also includes the risk of social and environmental harm.

For example:

- largely positive effects from setting development further back or enhancing natural defences (including natural defence buffers); and
- largely negative effects from some types of hard protection structures that are proposed now or in the future to protect the redevelopment.

Local authorities also need to include an appraisal of residual risks from coastal hazards as a consequence of implementing Policy 25(c), e.g. the likelihood that natural defences or hard protection structures will be breached or overtopped by hazard events in the future, and the adverse effects that would flow from such a breach or overtopping.

(See Box 30 and Policy 27(3) in section 6.5 for further discussion of residual risk.)

This clause provides specific examples of approaches that should be encouraged in coastal hazard decision making. These include relocating some developments or removing them altogether if the coastal hazard threat is severe; or designing the redevelopment to reduce the likelihood and/or consequences of a hazard event.

Other Policy 25 clauses and Policy 27 state a preference for the relocation of development if coastal hazard damage is imminent, rather than relying on hard protection structures given their potential environmental and social costs in the short and long term.

Where the coastal hazard results from periodic and infrequent inundation, or storm shoreline cut-backs on a sedimentary coastline in dynamic equilibrium, structures can be designed to survive temporary inundation or erosion (e.g. a bach on tall, deeply-founded piles). However, climate change will lead to an irreversible ongoing rise in the relative sea level, which will generally lead to more frequent inundation events and more coastlines permanently advancing inland.

*Managed retreat*

This clause lists 'managed retreat' as a risk-reduction option to be considered (see Box 21).

The suggestion of managed retreat can be very challenging for some coastal communities and property owners in New Zealand who place high value on their coastal lifestyle and have a high attachment to a place.[28]

Managed retreat is not expected to be a quick process unless it is required following a catastrophic event. Rather, managed retreat will involve extensive engagement with the community and stakeholders, and will be a staged process that is developed and implemented over a period of time.

Managed retreat is also an option for local and central government where local or national coastal assets are involved, including infrastructure such as roads, underground services and public facilities. Managing public coastal assets and infrastructure in hazard-prone areas requires long-term asset management planning to avoid ongoing expensive repairs and declining levels of service and disruption at the existing hazard-prone location.

(See the commentary on clause 25(d) below, as well as the commentary on Policy 27(1)(c) in section 6.5 for existing infrastructure of regional or national importance.)

Box 21

Managed retreat

Policy 25(c) recognises that in some situations the managed retreat/relocation of assets will be the best approach. As indicated by the word 'managed', retreat is best approached as part of an overall strategy for long-term adaptation by the coastal community and wider community (including iwi/hapū and stakeholders), especially given the many barriers to relocating development away from prime seaside locations.

Designing redevelopment in hazard-prone areas for relocatability—and setting agreed trigger or decision points when relocation will have to occur—is a form of managed retreat.

Managed retreat can also include a strategy where existing development can only be maintained and not redeveloped within high hazard zones/setbacks (which are regularly adjusted); or where existing development cannot be replaced once it reaches the end of its economic life or is damaged by coastal hazard events.

In addition, managed retreat can include measures such as the creation of new allotments inland where assets can be relocated to (or re-development can be located).

[28] In 2016, the New Zealand Society of Local Government Managers (SOLGM) prepared guidance on conducting a conversation with communities about managed retreat options.

Managed retreat planning should recognise the role that shifting and relocating roads and other services can play in initiating and enabling threatened sections of the community and businesses to follow.

*Case studies:*

- Managed retreat can include the relocation of a dwelling within a property, as was undertaken in the 1990s by some residents of Wainui Beach, Gisborne, who moved dwellings towards the rear of their long, narrow beachside properties.
- In the Whakatane District Plan, an adjoining property title has been set aside for the relocation of houses if an erosion trigger is reached.
- The surf club at Port Waikato has now moved a surf observation tower twice and the surf club building once.
- Managed retreat is under consideration as one of the possible medium- to long-term response options for exposed parts of the Cape Coast (Clive to Clifton) in the development of the Hawke's Bay *Coastal Hazard Strategy 2120*.[29]
- Research is underway at several universities and as part of the National Science Challenges (Resilience to Nature's Challenges and The Deep South Challenge) to better resolve planning processes and governance arrangements to enable 'managed retreat' in the New Zealand context, including possible funding/insurance models.

*25(d) encourage the location of infrastructure away from areas of hazard risk where practicable;*

This clause directs that infrastructure should be located away from hazards where practicable.

It differentiates between infrastructure and other new development. While other new development is to be avoided where it would increase the risk of adverse effects from coastal hazards (clause 25(b)), this clause implicitly recognises that some infrastructure has a functional need to be located on the coastline or in other areas of risk in the coastal environment, or cannot readily be located elsewhere.

Infrastructure is also often essential to social and economic wellbeing—the development of infrastructure to service communities cannot be simply avoided unless practicable alternatives are available. *Coastal hazards and climate change* (MfE 2017) recommends a long-term strategy that involves dynamic adaptive pathways planning for retreating infrastructure (and communities in general) away from hazard-prone areas over the long term. (Also see the commentary on clause 25(c) above for a discussion of infrastructure and managed retreat.)

For existing infrastructure of regional or national importance, this clause needs to be read alongside Policy 27(1)(c).

[29] www.hbcoast.co.nz/.

*25(e) discourage hard protection structures and promote the use of alternatives to them, including natural defences;*

The discouragement of (or need for rigorous justification for) hard protection structures is explicitly addressed in several clauses in Policies 25 and 27. In addition, Policy 26 elaborates on the use of natural defences as a preferred alternative to hard protection structures.

Hard protection structures[30] can cause adverse effects on the immediate coastal environment and adjoining stretches of coastline, and can often compromise amenity values for the wider community or tourism. There can be many environmental and social costs from hard protection structures over the long term (as indicated in Policy 27(1)(d)).

Hard protection structures such as groynes and seawalls affect sediment flows both between the shore and the sea and along the coastline, including in estuaries and harbours. Hardening of the shoreline (e.g. by building hard protection structures) to prevent the landward migration of the coastal profile and its landforms and habitats will lead to 'coastal squeeze' where there is:

- an episode of erosion;
- a long-term trend of erosion; or
- sea-level rise.

(See Box 22.)

As discussed further in section 6.5 (Policy 27(3)), it is important to recognise that the loss of a beach or foredune in front of a seawall (and the loss of other coastal features such as saltmarsh and wetlands along an armoured coastline) is not the result of wave reflection or some other active impact of the seawall that can be readily mitigated by good design—it is the result of preventing the natural dynamic mobility of that shoreline.

Appendix 1 provides some examples and a discussion of natural shorelines compared with shorelines that are armoured with hard protection structures.

[30] The NZCPS glossary gives the following definition for 'hard protection structure': 'Includes a seawall, rock revetment, groyne, breakwater, stop bank, retaining wall or comparable structure or modification to the seabed, foreshore or coastal land that has the primary purpose or effect of protecting an activity from a coastal hazard, including erosion' (DOC 2010).

Box 22

'Coastal squeeze'

'Coastal squeeze' is the process where natural coastal features, habitats and ecosystems are 'squeezed', and ultimately disappear, between the waves and an armoured shoreline (i.e. hard protection structures) that protects coastal development.

'Coastal squeeze' particularly occurs where a coastline is in retreat due to ongoing erosion and/or relative sea-level rise. The further seaward the seawall is located, the sooner the 'coastal squeeze' will commence.

Even on a coastline that is in dynamic equilibrium, hard protection structures that are located well within the active 'erosion/accretion envelope' will have a similar 'coastal squeeze' effect—the beach, mudflat, foredune, saltmarsh, etc. may or may not be successful in re-establishing during periods where coastal processes would normally be conducive to accretion (especially as the sea-level rises).

'Coastal squeeze' is an important coastal hazard management issue in the face of climate change, as sea-level rise, as well as other climate change effects on local climate/wave conditions, will cause the shoreline profile and natural features to migrate inland—and many more coastlines will begin to retreat as climate change progresses.

This description of 'coastal squeeze' is expanded from the description/definition of 'coastal squeeze' provided in Agard et al. (2014), which focus on the effects of climate change.

Hard protection structures can cause social and environmental harm as a result of the loss or degradation of any foreshore, beaches, dunes, saltmarsh and wetlands on the coastline, and can also have associated adverse effects on natural character, habitats, biodiversity, public access and amenity values. These impacts will be both direct and indirect.

Hard protection structures can also cause social and economic harm because they will become exposed to ever-increasing wave forces as the natural defences (the buffer of the foreshore, beaches, dunes, wetlands and coastal vegetation) diminish, and so will require substantial maintenance and upgrading (or possibly alternative measures such as large-scale and ongoing beach renourishment) to survive those increasing and more frequent hydrodynamic forces (see Box 23).

Box 23

Hard protection structures—the potential harm or costs

The harm or costs from hard protection structures can include:

- High financial costs to build them and the increasing maintenance commitment required, particularly with ongoing sea-level rise and other climate change effects.
- Increased future social costs if development increases as a result of the perceived long-term coastal hazard protection they provide and a large coastal hazard event then causes damage despite their presence (which becomes more likely over time with climate change). ('Residual risk'—see Box 20.)
- Increased future social costs if the upgrading or re-construction they require to resist increasing coastal hazards becomes financially unsustainable for communities or there are resource limitations (e.g. sourcing beach nourishment material).
- Degradation or loss of the natural coastal features in front of them as a result of 'coastal squeeze', the timing of which will depend on how far seaward the structures are located. This can include beaches, dunes, saltmarsh, wetlands and lagoons, with their associated natural character, landscape, public amenity, recreation and public access values.
- The immediate loss of parts of the beach or shore within the footprint of the hard protection structure. This issue has become more common with the increasing use of sloping rock revetments (i.e. boulder seawalls), which can occupy a significant swath of a beach or shore platform. Furthermore, sloping rock revetments that are built on public land can reduce the useable public open space and public access along the coastal marine area, and degrade other public values.
- Impacts on ecological, natural character and landscape values caused by changing a natural, soft shoreline into a hard, rocky shoreline. Impacts on public access and amenity values will also result if the seawall or rock revetment acts as a barrier for access to and along any remaining beach. Ecological impacts can include the loss of lagoon, wetland and saltmarsh habitat for coastal species such as wading birds and shellfish.
- Adverse effects on other properties along the coastline. Hard protection structures generate 'end effects' (substantial erosion around the ends of the structure) and 'downstream effects' that can extend a considerable distance away from the structure (e.g. erosion when groynes trap sediment and/or inhibit bypassing around the seaward end, and therefore reduce the downstream sediment supply).
- Adverse effects on natural coastal features 'downstream' along the coast and their values as a result of reduced, interrupted or diverted sediment flows. Interrupted and diverted sediment flows are more pronounced when shore-perpendicular structures such as groynes are used to encourage accretion upcoast to address a localised erosion issue or to stabilise a river entrance.

Different types of hard protection structures can have different effects and cause different types of harm. For example, shore-perpendicular structures (e.g. groynes) and shore-parallel structures (e.g. seawalls) differ in the following ways:

- Groynes may succeed in building beaches and dunes in their vicinity, but are more likely to cause beach loss further 'downstream' along the coastline (although this effect can be reduced by combining their use with beach renourishment).
- Seawalls, when positioned in the regularly-active back beach, generally do not trap sand in front of them and so, where a coastline is naturally retreating, the dunes, beaches and then foreshore between the seawall and the sea will be lost in time to 'coastal squeeze'.

Even in purely economic and engineering terms, hard protection structures are likely to become unsustainable in many situations as climate change progresses and sea-level rise continues. The effects of climate change will:

- reduce the level of protection from hard protection structures in a number of ways; or
- result in hard protection structures requiring more substantial or more frequent maintenance and upgrading (both repair and strengthening sometimes with a wider footprint, as well as replacement); and
- stretch the resources of property owners (via targeted rates under sections 16–18 of the Local Government Rating Act) and the community (via local, regional and national funding contributions, as well as from consent process costs, legal liability actions and emergency works onsite or on other impacted sections of coastline).

*25(f) consider the potential effects of tsunami and how to avoid or mitigate them.*

This clause directs consideration of the potential effects of tsunami and the options to manage these effects.

Tsunami have been an important source of significant or catastrophic events in New Zealand (see Box 24).

Tsunami are high-energy, long waves that bear little resemblance to ordinary wind-generated waves (see the tsunami factsheet in the appendices of *Coastal hazards and climate change*; MfE 2017). They can impact the coast in a number of ways, with their potential effects going beyond inundation.

If tsunami waves are large enough and coincide with particular tides and seas, they will run up beyond the high-water mark on beaches and estuaries to flood land areas (both natural and developed) that are not ordinarily subject to wave action and salt water inundation.

Tsunami waves can advance inland at high velocity, causing erosion and inundating and possibly destroying buildings and infrastructure (e.g. road, rail, port, water and sewerage). Debris such as beach sediment, boats, buildings, cars,

vegetation and gravel/rocks may be carried further inland. This debris can accumulate as the inundation proceeds inland, potentially increasing the

Box 24

New Zealand's experience of tsunami

Although New Zealand has escaped damage from recent tsunami in the Pacific and Indian Oceans, this has not always been the case:

During European settlement, there were four substantial and damaging tsunami within 30 years, ranging from moderate to very large. The most notable was the large (up to 10 metres in Cook Strait) tsunami of 1855 that was generated by the rupture of the Wairarapa Fault and flooded some parts of Wellington City. This tsunami followed a 2-metre-plus tsunami in 1848 that was caused by an earthquake in Cook Strait. Following this, there were two large distant-source tsunami in 1868 and 1877 that were generated from large earthquakes in South America (M8.8–9.5 in Peru and M8.8 in northern Chile). The larger, more damaging 1868 tsunami affected parts of the east coast, especially Banks Peninsula and the Chatham Islands (where a village was destroyed and one person killed).

Looking further back, Goff & McFadgen (2001) considered that it is likely that Māori societies in central New Zealand were severely impacted by up to six large tsunami in pre-European times (between 1220 and 1717), and that these led to an extensive abandonment of coastal settlements around the central New Zealand coastline. Darren King's recent review also discusses Māori oral traditions of tsunami hazards (King 2015).

More recently, an earthquake in the Gisborne area in 1947 generated a tsunami 30 minutes later, swamping the coast from Muriwai to Tolaga Bay, with reports of waves of up to 10 metres.[31]

In May 1960, a large earthquake in Chile led to tsunami being reported at more than 120 locations throughout New Zealand. In this case, the largest surges generally occurred within 12–15 hours after the first arrival, with some occurring within the first 2–4 hours. In the most affected areas, houses, roads, sheds and paddocks were inundated; bridges, fences and sheds were damaged; and stock were killed.[32]

In August 2003, an earthquake in Fiordland generated a smaller tsunami in the area.[33]

destructive force of the wave even as the velocity and depth reduces with distance travelled.

Damage to coastal infrastructure and buildings invariably introduces pollutants, contaminants or hazardous substances into the coastal environment and inundated areas.

[31] www.teara.govt.nz/en/tsunamis/page-3; http://info.geonet.org.nz/display/tsunami/Gisborne+tsunami,+25+March+and+17+May+1947.

[32] http://info.geonet.org.nz/display/tsunami/Chile+tsunami%2C+23+May+1960.

[33] http://info.geonet.org.nz/display/tsunami/Fiordland+tsunami%2C+22+August+2003.

Several larger waves (rather than a solitary peak wave) may be generated in an event. These waves may vary in height and the first wave is not necessarily the largest. Each of the waves may therefore inundate varying amounts of land for different lengths of time in proportion to both the wave size and local topography. Differences in inundation may also occur depending on the angle of the waves (relative to the coastline) as they travel towards the coast from its source and the shoaling characteristics of the coastal seabed bathymetry.

On steep slopes, large tsunami waves can run-up on land to elevations that are around double their arrival height at the coast. On gentler, low-lying slopes, large tsunami waves have the energy to travel up to several kilometres inland until their energy is dissipated.

The flooding seawater will then surge back towards the sea (or into estuaries and rivers, etc.) as the sea level temporarily drops in the trough between the tsunami waves. Turbulent, high-velocity receding water and debris will do further damage during the outrush, where substantial scour can occur as the water seeks out the lowest parts of the coast.

Analysis and modeling of potential tsunami inundation from various sources of seismicity and undersea landslides is needed to:

- underpin mapping and planning for evacuation purposes, which is different from that required for land-use planning (Saunders et al. 2011) (see section 8 for a summary of the CDEM legislation and regime in New Zealand, and the MCDEM Director's tsunami evacuation guidelines DLG 08/16[34]); and
- inform some aspects of land-use planning, e.g. the location of critical facilities and buildings, the layout of roads and shared path networks for timely evacuation, and the consideration of major greenfield developments (alongside climate change effects).

(See Boxes 25 and 26.)

[34] www.civildefence.govt.nz/assets/Uploads/publications/dgl-08-16-Tsunami-Evacuation-Zones.pdf.

Box 25

Tsunami analysis and modelling

Understanding tsunami hazard risks requires knowledge and modelling of the potential sources and scales of tsunami that may affect New Zealand, including earthquake rupture, underwater volcanoes and underwater landslides. In particular, knowledge of the:

- Tsunami travel time to New Zealand coasts is crucial for managing life safety risks. Potential sources are categorised as local (< 1 hour travel time), regional Pacific (1–3 hours travel time) and distant (> 3 hours travel time). These categories help with the development of warning and evacuation responses.
- Wave height and velocity together with topography, which govern wave run-up heights, is of primary importance for managing the risks to fixed property and infrastructure. In addition, the direction of travel from the source, the local New Zealand coastal bathymetry and areas that are prone to resonate or amplify tsunami waves will also influence the pattern of overland inundation for different event scenarios.

A key resource for tsunami-hazard exposure is the 2013 update of the review of tsunami hazard in New Zealand (Power 2013). In some areas, local authorities may also have undertaken more detailed modelling to identify and map evacuation zones, which need to follow the MCDEM Director's guideline DLG 08/16 (referred above).

Box 26

Tsunami hazards: land-use planning (including for evacuation)

Larger and rarer tsunami events, which could happen at any time and produce waves of 5–10 metres or more (e.g. from a Hikurangi Subduction Zone megathrust earthquake), can be a challenge to include in land-use planning. This is in part because, as for other extreme geological risks, their average return period far exceeds usual planning timeframes.

However, taking account of such tsunami threats (combined with sea-level rise) is an important and prudent part of a risk-reduction approach to land-use planning—particularly for existing critical facilities in the coastal area, new significant greenfield development, important lifeline infrastructure and supporting evacuation planning. The effect of the March 2011 tsunami on the Fukushima Daiichi Nuclear Power Plant is an example of the catastrophic impact of large tsunami.

More moderate tsunami events are more likely and should also be addressed as part of integrated risk-based land-use planning in coastal areas when considering major new developments, subdivisions or other land-use changes (such as levelling of dunes, mangrove removal, grazing of coastal wetlands and other degradation of natural defences).

The inclusion of tsunami threat as part of integrated risk-based coastal hazard management will provide an opportunity to reduce the exposure and/or vulnerability of some forms of development and land use to moderate tsunami

events (as well as improve evacuation for larger events to protect people). While not all risk can be avoided, policies and methods that optimise preserving life and sustaining necessary lifeline services are good starting points, and include:

- Planning for evacuation; for example:
  - Providing for vertical evacuation structures in areas of development with restricted evacuation routes.
  - Aligning road and shared-path networks and public spaces in ways that facilitate quick access to safe 'high ground' or inland evacuation areas.
- Planners working with emergency management officers and vice versa to integrate warning systems, evacuation plans, community response plans and land-use activities in at-risk areas; for example:
  - Working together to develop risk-reduction policies and associated provisions within the regional policy statement/coastal plan, district plan and emergency management group plan, and in the development of growth strategies.
- Taking a risk-based approach to land-use planning; for example[35]:
  - Restricting development activities in high tsunami risk zones that involve vulnerable groups, e.g. rest homes, pre-schools and schools.
  - Restricting critical facilities in high and medium tsunami risk zones, e.g. hospitals, emergency services and key infrastructure.
  - Restricting some types of development intensification in high tsunami risk zones, e.g. development that will be highly vulnerable to tsunami damage or that will substantially increase life safety risks.

An example of risk-based land-use planning can be found in the Bay of Plenty where, as part of the 'Smartgrowth' initiative, tsunami have been incorporated into the future plans for greenfield development, including the construction of tsunami evacuation mounds.[36]

[35] See Saunders et al. (2011) for other relevant options.

[36] www.smartgrowthbop.org.nz/media/1438/a-2013-smartgrowth_strategy_update_-_discussion_paper_-_implications_of_tsunami_risk_february_2013.pdf.

## 6.4 Policy 26: Natural defences against coastal hazards

### Introduction

Policy 26 addresses the management of the large range of natural coastal landforms/features that should be recognised as natural defences against coastal hazards.

The inclusion of a separate policy for natural defence landforms/features highlights the role they can play in protecting coastal land uses. This policy also supports many other objectives and policies in the NZCPS 2010, particularly those relating to significant biodiversity, cultural or historic heritage, and geological values.

### Commentary

*26(1) Provide where appropriate for the protection, restoration or enhancement of natural defences that protect coastal land uses, or sites of significant biodiversity, cultural or historic heritage or geological value, from coastal hazards.*

This clause links to Policy 25(e), which promotes the use of natural defences as an alternative to building hard protection structures. It is also underpinned by the third item under Objective 5 (protecting or restoring natural defences to coastal hazards).

It recognises the value and importance of natural coastal hazard defences for coastal development, as well as for sites with significant natural values, cultural heritage or historic heritage.

Reliance on protected, restored and/or enhanced natural defences rather than on hard protection structures (like seawalls or groynes) can reduce the risks of long-term social, environmental and economic harm from coastal hazards.

The restoration of natural defences can sometimes involve the removal of substantial development or hard protection structures (see Box 27).

Aside from the environmental and social values that are listed, protecting and restoring natural defences will promote many other values associated with other NZCPS policies and objectives (e.g. coastal habitats, natural character, public access, public recreation, public amenity and landscape).

As a result of climate change, the protection, restoration and enhancement of natural defences will often require protective measures to ensure that a sufficient landward buffer is protected from development that would otherwise compromise the functioning of the natural defence over the long term by restricting its ability to migrate inland with sea-level rise (or as a result of long-term coastal retreat for any other reason).

Box 27

Restoration through the removal of development

Where natural defences and coastal habitats have already been compromised or lost through 'coastal squeeze', the removal of existing development may be warranted to achieve the goals of a long-term coastal strategy.

In the UK, coastal realignment projects have been undertaken that involve the removal of protection works to enable the re-establishment of natural coastal landforms and habitats that can provide biodiversity and natural defences (Turner et al. 2007; Luisetti et al. 2011; Hudson et al. 2015).

In Vancouver, officials have produced a report that lays out options for dealing with sea-level rise, including barriers, dykes and seawalls (Lyle et al. 2015). However, the report also suggests that, at least in some parts of the city, it may be worth considering a managed retreat to allow natural adaptation and maintain beaches.

Natural coastal defences are likely to be the best option for protecting 'sites of significant biodiversity, cultural or historic heritage or geological value', especially given the values these sites possess. The setting of such sites will often be of importance to the site and complement its values, whether the surrounding area is a natural or simply undeveloped buffer.

By contrast, the use of hard protection structures may interfere with a range of the social/cultural and environmental values on or around such sites, both immediately and over time as they interact with the natural coastal processes (see section 6.3, Policy 25(e)).

However, when assessing the appropriateness of relying on natural defences, it should be noted that there are some differences between protecting sites with natural values and sites with cultural, historic heritage or geological values (see Box 28).

The appropriateness of investing in protecting, restoring or enhancing a coastline's natural defences is best determined as part of an integrated strategy to manage coastal hazards (including tsunami) as part of adapting to climate change (while addressing other coastal management issues). Such strategies should be in accordance with the NZCPS 2010 and other RMA requirements. (See also *Coastal hazards and climate change*; MfE 2017.)

Policy 26(1) is an important consideration when development or other uses are proposed on or adjacent to natural defence landforms/features, or in locations where they will or could adversely affect such natural defences (including through the construction of accessways, boat ramps or hard protection structures).

Box 28

Natural habitats vs. cultural and historic heritage sites

Natural defences with a landward buffer will be able to migrate with sea-level rise (and erosion trends in general), thereby maintaining the natural coastal landforms and their associated natural habitats and biodiversity, as well as the natural defence function—at least until the landward buffer area (development setback) is exhausted.

However, historic heritage sites and many cultural heritage sites do not have the same ability to migrate.

Long-term coastal changes such as sea-level rise, and perhaps the mobile natural defence landforms themselves, may eventually threaten some cultural or historic heritage sites unless it is practicable and affordable to adequately enhance the natural coastal defences.

At this time, consideration of the use of available alternatives, such as hard protection structures, needs to weigh up:

- the likely damage to a valuable historic or cultural site that would result from allowing natural erosion processes to occur; versus
- the impacts of hard protection structures on the other cultural, heritage, biodiversity and social values that such sites possess (although a landward, buried backstop wall may be a viable compromise that would buy time for a finite period).

For example, at Wainui Beach, Gisborne, the mana whenua addressed the erosion of the dunes and the exposure of urupā (burial grounds) in those dunes by taking any emerging kōiwi (human bones) and re-burying them in another urupā further inland.

Also see Bickler et al.'s (2013) case study on climate change impacts on archaeology of the Whangarei District.

Again, the management or protection of threatened historic and cultural heritage sites may best be considered as part of a long-term integrated coastal hazard management strategy.

*26(2) Recognise that such natural defences include beaches, estuaries, wetlands, intertidal areas, coastal vegetation, dunes and barrier islands.*

This clause makes explicit the wide range of natural coastline features/landforms that can provide valuable natural defence—implementing Policy 26 requires consideration of more than just sand dunes.

Sand bars (or barrier islands) and a well-nourished foreshore and beach, as well as dune and mangrove vegetation (e.g. in southern Firth of Thames) provide an important buffer or defence against waves, storm tides and, in some cases, moderate tsunami.

The removal of coastal vegetation, notably saltmarsh and mangroves, from particular sites was identified as having increased the consequences (i.e. the

damage) of events like the Asian tsunami on Boxing Day 2004 and Hurricane Katrina in New Orleans in 2005 (Narayan et al. 2016).[37]

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

### Introduction

Policy 27 specifically addresses areas of significant existing development.

The inclusion of a separate policy for hazard-prone areas with significant existing development highlights the challenges that are faced in managing such areas—there is no longer an opportunity to avoid the risks from coastal hazards and so comprehensive strategies will be needed to sustainably manage the potentially accelerating risk of harm into the future.

There are no straightforward options to reduce or even contain (through remedy and mitigation) the overall harm that is likely to occur to significant existing development that is under threat from increasing climate change effects including ongoing sea-level rise. This is particularly true when environmental and social harm are taken into account, as directed by the relevant NZCPS coastal hazard policies (see in particular Policies 25(a) and 27(1)(d)).

Policy 27 directs local authorities to develop long-term adaptive strategies for areas of significant existing development by assessing a range of options for reducing coastal hazard risks that include, but are not limited to, those set out in Policy 27(1)(a)–(e). The evaluation of the options selected for assessment is to be guided by the matters set out in Policy 27(2)(a)–(c).

The preparation and implementation of long-term, sustainable risk-reduction strategies that take account of climate change is a complex and rapidly developing multi-disciplinary process. Policy 27 (and Policy 25) sets out national policy direction and informs whatever strategy development process is chosen and followed by a local authority.

Guidance on detailed hazard and risk assessment methodologies that will be required for significant existing development is provided in *Coastal hazards and climate change* (MfE 2017).

[37] Also see http://blog.nature.org/science/2016/10/24/how-much-do-wetlands-reduce-property-damage-during-storms-and-hurricanes/.

Commentary

*27(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: …*

This clause (along with Policy 27(2)) focuses on areas in the coastal environment that already have significant existing development and *are likely to be affected* by coastal hazards. It is in such areas that the risks of harm are generally both high and difficult to reduce.

Areas of significant existing development may include areas of residential development, coastal resort development, tourism infrastructure, commercial and industrial development, marinas and small ports, council services and utilities, and infrastructure such as energy transmission, road, rail and airports. Large, commercial ports will tend to self-manage coastal hazard threats and there is policy regarding the need for an efficient national network of safe ports in Policy 9 of the NZCPS 2010.

A range of strategic planning processes and methods are set out in section 10 of *Coastal hazards and climate change* (MfE 2017).

The consideration of a wide range of options in strategy development is consistent with good practice and Policy 7 of the NZCPS 2010. Strategy development will involve both the listed options and additional options—the mixture of which is likely to change over time as the strategy is implemented, reviewed and adjusted—as envisaged by the dynamic adaptive pathways planning approach recommended in *Coastal hazards and climate change* (MfE 2017) (see Box 29).

Box 29

Dynamic adaptive pathways planning

Dynamic adaptive pathways planning is the strategic approach to long-term risk reduction that is recommended in *Coastal hazards and climate change* (MfE 2017).

Rather than adopting a specific pre-determined climate change trajectory, this approach provides an adaptive framework for working through the many uncertainties (e.g. the timing of a threshold sea-level rise). It includes moving to an alternative pathway at various trigger or decision points, to avoid reaching thresholds where objectives (e.g. risk tolerance, frequency of events or levels of service) are no longer being met.

Like other adaptive management approaches, it is critical that dynamic adaptive pathways planning is supported by regular monitoring that is comprehensive and relevant (environmental, social, economic and policy pathway effectiveness) in tandem with regular reviews (e.g. Is the particular approach still meeting the set objectives? Should the objectives be reviewed? Has sea-level rise slowed down or accelerated relative to the next decision point?).

*27(1)(a) promoting and identifying long-term sustainable risk reduction approaches including the relocation or removal of existing development or structures at risk;*

This subclause focuses on long-term sustainability. It recognises that the costs of protecting development may not be sustainable in the long term with increasing climate change effects including ongoing sea-level rise, and so ultimately the relocation or removal of some development will have to be considered alongside other long-term or transitional options for reducing hazard risks (see Box 30).

As part of the process of identifying, developing and assessing different strategies, local authorities and communities are encouraged to carefully consider issues of uncertainty in their assessments (see MfE 2017), and the use of prudent and precautionary approaches when making decisions on adaptation strategies and any adaptive pathways planning.

*27(1)(b) identifying the consequences of potential strategic options relative to the option of 'do-nothing';*

This subclause directs local authorities to assess and compare the likely outcomes ('the consequences') of a range of strategies for reducing coastal hazard risks and the 'do-nothing' option (see Box 31).

Assessing the likely outcomes from any strategy over a timeframe of 100 years or more is a complex task, and requires a careful and considered approach in collaboration with communities, iwi/hapū and stakeholders to be meaningful (see Box 32)

Implementing this subclause will help local authorities and communities to become more aware of the risks and limited life of 'doing nothing' as a way of responding to the escalating risk of harm from coastal hazards under climate change.

Box 30

Adopting a new risk-based and strategic approach

Policy 27(1)(a) directs local authorities to investigate and promote approaches other than the historical approach of resorting to hard protection structures.

The relocation or removal of development can be expected to be disruptive to the local community in the short to medium term. However, the alternative of building hard protection structures to protect the existing development is likely to result in greater and potentially more widespread economic, social and environmental harm in the medium to long term. This outcome is particularly the case:

- for areas already facing significant risk exposure, which will only increase with ongoing sea-level rise and other climate change effects; and
- if the community expects that the protection afforded by hard protection structures will be sustainable over the long term and so undertakes more development (or development intensification) in reliance on that protection.

(See section 6.3, Policy 25(e) for a discussion of hard protection structures, and Policy 27(3) below for a discussion of residual risk.)

Box 31

The 'do-nothing' option

The 'do-nothing' option is taken to mean that no interventions are undertaken to reduce hazard risks. However, a 'do-nothing' option still requires some action such as the identification of risks followed by an informed decision to take no action. Also, some maintenance and redevelopment (and even new development) would likely continue under existing regulatory settings.

The 'do-nothing' option will lead to increased risk and possibly to the eventual abandonment of developed areas in extreme hazard events (Policy 25(c)) which, in turn, may well lead to a liability (cost) on councils to remove such development and associated infrastructure, as well as legal or political action by property owners for compensation (with substantial costs to be met by ratepayers regardless of the outcome).

Box 32

Using dynamic adaptive pathways to assess the consequences of a strategy over a timeframe of 100 plus years

Identification of the consequences of a strategy will require examination of the objectives, hazards, responses and outcomes up to and beyond 100 years. To do so meaningfully over such a long timeframe in the face of large uncertainties effectively dictates that strategies must incorporate a number of decision or trigger points where the strategy needs to be reviewed and adjusted in light of:

- what has actually happened;
- any new social, economic, climate change and local monitoring information that is available;
- any new management techniques and emerging best practice; and
- changing community values and goals.

Dynamic adaptive pathways planning, as recommended in *Coastal hazards and climate change* (MfE 2017), provides such an adaptive framework.

An important feature of the dynamic adaptive pathways approach is that it can help decision-makers and communities to better understand that different responses at a number of decision or trigger points will take them along different pathways to very different long-term outcomes.

The dynamic adaptive pathways approach will also make it clearer that decisions made in the near-term will need to build in flexibility, both to reduce exposure and to enable changes to actions or pathways that can accommodate higher sea levels over longer timeframes. Decisions should be explicit about the decision life-time, in order to signal the need for review and the likely need for changes and ongoing flexibility (MfE 2017).

(Also see the commentary on Policy 27(1)(a) above.)

*27(1)(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;*

This subclause recognises the challenges faced in determining the appropriate response to coastal hazard threats that are likely to affect existing infrastructure that is of national or regional importance.

It acknowledges that there can be a role for hard protection structures in protecting important built infrastructure that needs to be at the coast for functional reasons or where there is no viable alternative. (See section 6.3, Policy 25(e) for further discussion of hard protection structures.)

There is a focus on meeting the reasonably foreseeable needs of future generations. 'Sustaining the potential' may include undertaking the early construction of hard protection structures as part of a long-term strategy to meet both the immediate and future needs of the community for important infrastructure.

This subclause is also strongly focused on major infrastructure—not local infrastructure or private development. It particularly applies to infrastructure such as national energy and transport networks, including the National Grid, State Highways, railways, and commercial ports and airports.

In some instances, important infrastructure that has been located along the coastline does not require a coastal location. For such infrastructure, hard protection structures could possibly be used to protect the existing infrastructure assets as part of a long-term strategy that includes relocating this infrastructure inland when it needs to be upgraded or replaced, or when some other opportunity arises.

In other instances, such as the main commercial ports that are dependent on a coastal location, hard protection structures are generally the only practical means of protecting the core port facilities (as well as being required for creating deep water berthage). Hard protection structures will generally have less environmental and social costs in such a highly-developed commercial setting—although downtown ports do impact on communities and there are opportunities to locate at least some port facilities away from the coast, e.g. 'inland ports' for the storage and processing of containers.

Decisions on major infrastructure protection works will also need to consider other relevant NZCPS policies (see Box 33).

Box 33

Major infrastructure protection—design opportunities

Policy 27(3) directs that where hard protection is considered necessary, the protection structure is to be designed in a way that minimises adverse effects on the coastal environment.

There is also the opportunity to create or enhance beaches with dredged sediments (perhaps in tandem with a buried backstop seawall) or to use other soft-engineering approaches that will provide public amenity while also contributing to coastal hazard protection, e.g. around the fringes of commercial ports and airports.

*27(1)(d) recognising and considering the environmental and social costs of permitting hard protection structures to protect private property;*

Several parts of Policy 27 focus on discouraging the use of hard protection structures in relation to private property and promoting other responses that will lead to long-term risk reduction. This subclause sets out the explicit requirement to recognise and consider the environmental and social costs of hard protection structures for the protection of private property. (See section 6.3, Policy 25(e) for discussion of the potential costs of, or harm from, hard protection structures, which is the subject of considerable controversy and confusion in the community.)

Relevant matters to consider when assessing the environmental and social costs of permitting hard protection structures to protect private property include assessments of:

- the short- and long-term direct and indirect costs from the proposed hard protection structure (e.g. long-term 'coastal squeeze');
- the impacts of sea-level rise and other climate change effects, and how long the proposed hard protection structure would be viable;
- the likelihood that more development (or development intensification) will be undertaken in reliance on the hard protection structures providing long-term protection (see the discussion of residual risk in the commentary on Policy 27(3) and Box 30); and
- the impacts on communities (including future costs and liabilities for councils) associated with:
    - any future abandonment of hard protection structures (particularly where constructed on public land); and
    - assistance to (and compensation actions by) private property owners in the event of failure of the hard protection structures and damage to private property.

*27(1)(e) identifying and planning for transition mechanisms and timeframes for moving to more sustainable approaches;*

This subclause acknowledges that the implementation of strategies that involve more sustainable approaches for managing climate change and coastal hazard risks will take time in areas of significant existing development, and will likely involve transitional response options.

The shift to sustainable coastal hazard management, and the development and implementation of strategies to reduce long-term risks up to and beyond 100 years strongly support the adoption of a dynamic adaptive pathways planning approach, using several stages and a range of management actions over time, as discussed in *Coastal hazards and climate change* (MfE 2017).

Local authorities are encouraged to take the initial steps that are necessary to transition towards a strategic approach that will achieve long-term risk reduction for their coastal hazard-prone communities, particularly in priority areas (Britton et al. 2011; MfE 2017).

*27(2) In evaluating options under (1): …*

Having directed local authorities to assess a range of options (including but not limited to those listed), Policy 27 gives further guidance and direction on what matters to include in the evaluation of the range of options selected for assessment by the local authority. These matters are described and discussed below.

*27(2)(a) focus on approaches to risk management that reduce the need for hard protection structures and similar engineering interventions;*

This subclause follows Policy 25(e) ('discourage hard protection structures and promote the use of alternatives to them, including natural defences'; see section 6.3), providing further guidance for the particular case of hard protection structures in more-hazard-prone areas with significant existing development.

Here, the use of hard protection structures is put in the context of multi-response approaches or strategies. The reference to 'reduce the need' acknowledges that for areas with significant existing development, there may be a need for some hard protection structures, at least as an initial part of a long-term strategy—until there is an opportunity for relocation or redevelopment to reduce vulnerability (which would reduce the need for hard protection structures over time).

In relation to existing infrastructure of national or regional importance, this subclause needs to be read alongside Policy 27(1)(c).

*27(2)(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;*

This subclause repeats the direction in Policy 24 (and section 7(i) of the RMA), emphasising the importance of taking into account the changing nature of a coastal hazard risk and how that risk will evolve over 100-plus years for each of the strategic options (or adaptive pathways) being assessed.

Policy 27(2)(b) directs that areas of significant existing development that are likely to be affected by coastal hazards should be included in the areas to be prioritised for more detailed hazard and risk assessments, as set out in Policy 24. Such detailed risk assessment is a necessary first step in developing the risk-reduction strategies envisaged by Policy 27 as a whole. (See the discussion of 'giving priority to areas at high risk of being affected' in section 6.2, Policy 24(1).)

Changes to coastal hazard risks will result from a combination of changing hazards and the evolving management of development. Uncertainties are associated with both matters, including:

- the range of different sea-level-rise scenarios and how the coastal hazards may change over the next 100-plus years; and
- the response options that will be put in place and their effect on overall coastal hazard risks.

Approaches such as the dynamic adaptive pathways planning recommended in *Coastal hazards and climate change* (MfE 2017) can meaningfully take account of the many uncertainties affecting coastal hazard risks over 100-plus years (see Box 34).

*27(2)(c) evaluate the likely costs and benefits of any proposed coastal hazard risk reduction options;*

This subclause directs local authorities to identify and estimate the costs and benefits of the proposed coastal hazard risk-reduction options that are being considered as part of the evaluation of strategic options. In accordance with the Policy 25 requirement to manage the risks of social, environmental and economic harm, this evaluation will have to consider all relevant social, environmental and economic costs and benefits.

Box 34

The unique nature and trajectory of coastal hazard risks for each strategic option

The nature of a coastal hazard risk and how it might change (as opposed to the coastal hazard itself) is, in part, dependent on the amount and type of development in the area (and how that development will change over the 100-plus-year timeframe).

Therefore, the process of assessing the nature of the risk and how it might change is usually iterative—each strategic option (or pathway) that is being assessed will have a unique outcome in terms of the development in the area over time, and so the unique character and quantum of the coastal hazard risk over the 100-plus years of operation for each strategic option will need to be assessed.

This issue is addressed in both the iterative Decision Cycle approach and the dynamic adaptive pathways approach that are recommended in *Coastal hazards and climate change* (MfE 2017).

This evaluation will help councils to meet the requirements of section 32 of the RMA for any risk-reduction option that is selected and proposed for inclusion in a plan or policy statement.

*Coastal hazards and climate change* (MfE 2017) sets out a number of evaluation criteria when using the dynamic adaptive pathway planning approach.[38]

*27(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.*

Inclusion of the word 'necessary' in this clause contrasts with the criterion of 'best practicable option' in the NZCPS 1994.

When considering the necessity for a hard protection structure, the availability of alternative approaches, such as enhancing natural defences, relocation or redevelopment to reduce the vulnerability of the assets, will have to be carefully assessed, including an assessment against Objective 5.

In contrast to clauses 27(1)(d) and 27(4), this clause addresses all hard protection structures, not only hard protection structures that aim to protect private property. It therefore relates to locating and designing hard protection structures for infrastructure or community facilities, as well as for private property. Note that clause 27(4) sets out additional location requirements/criteria for private property protection.

Several new approaches to the design (and location) of hard protection structures are emerging internationally that may provide examples of best practice,[39] one of which is referred to as 'green engineering'.[40]

Hard protection structures include groynes, moles, breakwaters, offshore submerged structures or artificial reefs, as well as the more common rock revetments and seawalls.

The design and location of groynes needs to consider the 'downstream' effects of trapping sediment that would otherwise have continued to move along the coast. In cases where that sediment is in abundance and the 'downstream' sediment supply

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[38] Evaluation criteria as part of adaptive planning include (MfE 2017):

- the robustness and 'shelf life' of options to perform over a range of sea-level-rise scenarios;
- checking for path dependencies;
- the feasibility for implementation; and
- the ability to meet community values, and provide co-benefits, timing of options and environmental effects.

[39] Note: This discussion provides a generalised summary of some matters that are relevant to the design and environmental effects of seawalls and groynes. However, the actual design of hard protection structures on the coast (in consideration of environmental effects, fitness for purpose, cost, durability, maintenance, expected life, etc.) requires the expertise of professional engineers and other specialists with appropriate qualifications and experience. The design of each hard protection structure will have to take into account the particular circumstances and characteristics of the site, and the coastal processes affecting it. Also see Pilkey & Wright (1988).

[40] http://architectureau.com/articles/barangaroo-reserve-opens-to-public/; www.worldharbourproject.org/workgroups/green-engineering/.

is only briefly interrupted, or where the sediment would otherwise be lost to active beach systems in any case (such as going into deep water), there are likely to be fewer adverse effects on the coastal environment. However, if the sediment supply is constrained, re-nourishment with similar sediment may need to be considered in tandem with the use of groynes.

Seawalls, particularly rock revetment seawalls, remain by far the most common hard protection structure response to coastal hazards.

The careful location of a seawall further landward can, in some situations, at least delay adverse effects on the coastal environment. Where there is sufficient space between the shoreline and hazard-prone development, locating the seawall more landward as a backstop wall and burying it in any dune that remains will, at least initially, help minimise adverse effects, as discussed in Box 35.

Local authorities can avoid or reduce placement loss (from covering the dune, beach or foreshore with a seawall) by locating the seawall further landward behind these natural areas or by reducing the area that the seawall will cover (using alternatives to sloping rock seawalls).

The location of seawalls in relation to public dunes, beaches and foreshore is further addressed under clause 27(4).

Good design can also address some of the adverse effects of seawalls (see Box 36).

Design using construction materials that blend in with the natural setting is usually beneficial and already directed for reclamations in Policy 10(2)(b)). For example, where a seawall is well designed, the materials used in its construction, such as rocks and geotextiles, will not be scattered onto the beach or into the sea. Good design can also provide for secure and convenient access to the beach or coastal

Box 35

To what extent can *good location* reduce the adverse effects of seawalls?

The following example relates to a backstop wall buried in a dune.

If the coastline remains in dynamic equilibrium and the buried backstop wall is outside the active erosion/accretion envelope for all but large/extreme periodic storms, the adverse effects on the coastal environment will remain small. The wall will be exposed infrequently, and the foredune should re-establish and re-bury the wall.

If, on the other hand, the coastline experiences significant erosion (due to sea-level rise and/or other reasons), good design will only be effective in minimising effects as long as coastline retreat or erosive episodes do not expose the backstop wall frequently or for prolonged periods. Otherwise, the 'coastal squeeze', amenity and landscape effects of the 'buried' backstop wall would become the same as for a standard exposed seawall that is located within the active beach erosion/accretion envelope.

Because backstop seawalls may well, in the future, be exposed after any storm event (particularly if sea-level rise initiates long-term coastal retreat along that coastline), their design should consider any possible future end-effects on adjacent properties, esplanade reserves and natural features.

marine area, as well as for public uses on and/or behind the hard protection structure.

The landscape impacts of hardening a soft shoreline are not easily mitigated. Some mitigation of adverse effects is potentially achievable for the impacts on values, such as public access to the beach and amenity values. However, overall, there are limitations in what can be achieved through good design to address some other adverse effects of seawalls. This is particularly true for 'coastal squeeze' effects.

Box 36

To what extent can *good design* reduce the adverse effects of seawalls?

There are limitations to what can be achieved through good design in reducing the adverse effects of hard protection structures.

While good design will increase the likelihood that the structure will withstand coastal processes/hazards for its design life, it will generally be more difficult, if not impossible, to achieve a significant reduction in some of the adverse effects on the coastal environment.

This is particularly true for those effects that are related to its very function of tightly constraining dynamic sediment processes—for example, in the case of a seawall on a sandy shoreline, the interchange of sediment between dune and beach.

This means that, to the extent that a seawall achieves its purpose of preventing erosion of the land behind it, 'coastal squeeze' will happen regardless of its design. The more seaward the wall or revetment is located, the larger the environmental effects will be or the sooner they will occur (e.g. successive historic seawalls at St Clair in Dunedin have been placed seaward of the previous wall, thus exacerbating the loss of the beach and its amenity values).

The design features of a seawall or revetment will seldom be able to reduce 'coastal squeeze' effects and their impacts/harm on natural character, biodiversity, habitats, public amenity and public access, which will flow from the degradation or loss of the beach/foredune/saltmarsh when the coastline is retreating (either during an erosive period on a shoreline experiencing shorter-term fluctuations or as a result of a longer-term trend of retreat).

Notably, a sloping rock revetment design for a seawall will not mitigate 'coastal squeeze' effects such as loss of the high-tide beach. While such designs can reduce wave reflection during storms (and thereby avoid adverse effects on the seawall itself by reducing wave scour, which can undermine the foundations), it will not address the truncation of the shore profile as it moves inland with the retreating coastline. (It is not wave reflection that usually causes such beach loss, as scour from storm waves is generally rapidly filled in by the smaller post-storm waves transporting sand back from the near-shore sand bars—another instance of the natural dynamic interchange of sediment in larger beach systems.)

(Also see section 6.3, Policy 25(e) and Box 22 for further information on the effects of seawalls and 'coastal squeeze'.)

*Residual risk*

The issue of residual risk—that is the risk that remains after the construction of hard protection structures—also needs to be considered when implementing Policy 27(3).

While a hard protection structure can be designed to withstand the most extreme wave hazard events (but probably not large tsunami), it is rarely economically feasible to do so. Cost and other pressures can lead to a design that will be breached or overtopped during a less-than-extreme event. Such events are likely to become relatively frequent in 100 years' time due to sea-level rise and other climate change effects.

If such a breaching or overtopping does occur, the hard protection structures may in effect be responsible for additional adverse effects on the coastal environment, particularly if development in the area has intensified in reliance on the coastal hazard protection works that are in place (and the damage and harm from the hazard event has therefore increased) (see Box 30).

Balancing residual risk and factors such as cost to minimise adverse effects on the coastal environment while still producing a feasible design will therefore be difficult if a hard protection structure is to play more than a transitional role in a long-term risk-reduction strategy.

*27(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 so.*

Clause 27(4) directs that, unless there is significant public or environmental benefit in locating a private property protection structure on public land, that structure (if found to be necessary) should be located within the private property.

This clause applies to hard protection structures that have the purpose of protecting private assets. It recognises the values of public access along and within the coastal marine area and of public open space, and the many values of the public space and assets of wetlands, saltmarsh, lagoons, dunes, beaches and foreshore. It is also related to the direction in Policy 27(3) to locate any hard protection structure in a way that minimises adverse effects on the coastal environment.

Historically, there has been limited recognition or consideration of the loss of public space, amenity values and natural values to the wider community, leading to significant adverse public and environmental effects.

The form and overall design of the hard protection structures addressed in this clause are covered by Policy 27(3).

# 7. Related objectives, policies, provisions and other legislation

This section highlights the links between the various provisions of the NZCPS 2010, the RMA and other legislation in terms of the management of coastal hazards.

## 7.1 NZCPS 2010

Implementing Objective 5 and Policies 24–27 of the NZCPS 2010 requires careful consideration of all of the NZCPS objectives and policies. This section discusses the following key objectives and policies that have strong links with these four policies:

| Key related objectives and policies | Other related objectives | Other related policies |
|---|---|---|
| Objectives 1, 2, 3, 4 & 6<br>Policies 1, 2, 3, 4, 6, 7, 10, 11, 12, 13, 14, 15, 18, 19 & 20 | 7 | 5, 7, 8, 9, 16, 21, 22, 23 & 29 |

### 7.1.1 NZCPS objectives

#### Objective 1

Objective 1 seeks to safeguard the integrity, form, functioning and resilience of the coastal environment, and to sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land. An important component of this objective involves maintaining or enhancing natural biological and physical processes in the coastal environment, and recognising their dynamic, complex and interdependent nature.

Objective 1 is directly related to Policies 24–27 because the natural coastal processes that shape the coastal environment and create its habitats and biodiversity are sometimes the same processes that can become coastal hazards when they threaten human development. Thus, understanding the dynamic, complex and interdependent nature of coastal systems is very important for the sustainable management of coastal hazards. In addition, the coastal processes that safeguard the coastal environment and sustain its ecosystems can also be constrained and adversely affected by hard protection structures and other human interventions.

#### Objective 2

Objective 2 seeks to preserve the natural character of the coastal environment, and to protect natural features and landscape values by recognising the matters that make up natural character, and by identifying and protecting areas where various

forms of subdivision, use and development would be inappropriate. This objective also encourages restoration of the coastal environment.

As detailed in Policy 13, natural character includes the dynamic, natural coastal processes themselves and so the implementation of Policies 24–27 will need to carefully consider the effects of coastal hazard response options on the preservation of natural character, as well as on the protection of natural features and landscape values. In some situations, restoration of the coastal environment can benefit hazard management, as is the case with the restoration of natural defence landforms/features.

### Objective 3

Objective 3 requires that the principles of the Treaty of Waitangi are taken into account. It recognises the role of tangata whenua (indigenous people) as kaitiaki (guardians) and provides for tangata whenua involvement in the management of the coastal environment. Taking account of the principles of the Treaty, and the roles and values of tangata whenua should be a key component of engagement with the community and stakeholders by local authorities and consultants when preparing plan provisions or developing strategic options that seek to reduce the risk of social, environmental and economic harm from coastal hazards.

As well as needing to give effect to Objective 3 alongside the coastal hazard policies, the reference to social and environmental harm in Policy 25(a) is taken to include cultural harm, and encompasses harm to tangata whenua and mana whenua, and their coastal taonga (treasures).

### Objective 4

Objective 4 seeks to maintain and enhance the public open space qualities and recreation opportunities of the coastal environment, and sets out the ways in which this is to be achieved. These matters include 'recognising the potential for coastal processes, including those likely to be affected by climate change, to restrict access to the coastal environment and the need to ensure that public access is maintained even when the coastal marine area advances inland'.

Policies 24–27 are key policies for giving effect to this objective. Policy 18 (Public open space) and Policy 19 (Walking access) are also relevant.

### Objective 6

Objective 6 seeks to enable people and communities to provide for their social, economic and cultural wellbeing, and their health and safety.

This objective sits alongside all other objectives and policies in the NZCPS 2010, and will particularly need to be considered alongside Objective 5 and the four coastal hazard policies (Policies 24–27) within hazard-prone areas of the coastal environment.

This objective sets out a number of matters to be recognised regarding subdivision, use and development in the coastal environment. Within hazard-prone areas of the coastal environment, many subsections of the coastal hazard objective and policies

can also be relevant to Objective 6 matters,[41] depending on the particular development and location.

The following clauses from Objective 6 highlight these areas of overlap:

*[recognising that] the protection of the values of the coastal environment does not preclude use and development in appropriate places and forms, and within appropriate limits;*

To avoid increasing harm to the values of the coastal environment from coastal hazards and coastal hazard responses over the longer term, the appropriateness of new use and development within coastal-hazard-prone areas would include consideration of the first part of Objective 5 (locating new development away from hazard-prone areas) and Policy 25(b) (avoiding redevelopment or change in land use that would increase the risk of adverse effects from coastal hazards).

If that new use and development could compromise any natural defences, its appropriateness would need to be considered in terms of the third part of Objective 5 and Policy 26, both of which promote the protection and restoration of natural defences.

If the use and development relates to protecting existing development or involves the building of a hard protection structure, its appropriateness would need to be considered alongside the second part of Objective 5 and the many subsections in Policies 25 and 27 that address managed retreat and hard protection structures (including containing/reducing the risk of harm to the values of the coastal environment).

*[recognising that] some uses and developments which depend upon the use of natural and physical resources in the coastal environment are important to the social, economic and cultural wellbeing of people and communities;*

*[recognising that] functionally some uses and developments can only be located on the coast or in the coastal marine area;*

Infrastructure and infrastructure networks that are important to people and communities may depend, in part at least, on the use of land or other resources in the coastal environment (including within the coastal marine area). Similarly, locating residential and community facility developments (e.g. surf clubs, toilet facilities, boat/yacht/rowing clubs) in the coastal environment and close to the coastline can be important to people and communities (e.g. for closeness to employment, as well as to coastal recreation and coastal landscapes).

However, within coastal-hazard-prone areas, the importance of any such use and development to people and communities now and into the future, and the vulnerability of the proposed use and development to coastal hazards should include consideration of the:

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[41] *Gallagher v Tasman DC [2014] NZEnvC 245*.

- Objective 5 direction to ensure that the coastal hazard risks taking account of climate change are managed by proactively controlling development;
- Policy 24 direction to identify hazard-prone areas and assess the risks from coastal hazards in those areas over at least 100 years;
- Policy 25(a) direction to avoid increasing the risk of social, environmental and economic harm from coastal hazards;
- Policy 25(b) and (c) direction to manage redevelopment and changes in land use in order to reduce the risk of adverse effects from coastal hazards; and
- Policy 27 direction (if the use and development is in an area of significant existing development that is likely to be affected by coastal hazards) to assess a range of strategic options for the area, including the promotion of long-term, sustainable risk-reduction approaches.

### 7.1.2 NZCPS policies

#### Policy 1: Extent and characteristics of the coastal environment

Policy 1 is directed at identifying and understanding what lies within the coastal environment. It also recognises that the extent and characteristics of the coastal environment will vary between regions and localities, with potentially different issues and effects requiring management.

Policy 1(2) includes the need to 'Recognise that the coastal environment includes: … (d) areas at risk from coastal hazards; …'

Policy 24 sets out a 100-year timeframe for assessing hazard risks and Policy 25 addresses 'areas potentially affected by coastal hazards over at least the next 100 years'. Therefore, Policies 1(2)(d), 24 and 25 need to be read together to help identify these areas. The extent to which areas at risk from coastal hazards extend inland will vary with the type of hazard, e.g. areas that will be vulnerable over time to sea-level rise vs low-probability but high-consequence events, including tsunami, that may extend further inland.

The implementation of Policy 1 will be important for achieving Objective 5 and implementing Policies 24–27.

It is noted that the landward extent of the coastal environment will increase over time, particularly in low-lying areas where the coastal marine area and the influence of coastal processes (Policy 1(2)(c)) will track inland and up through lowland surface and below-ground freshwater systems (Kettles & Bell 2016).

#### Policy 2: The Treaty of Waitangi, tangata whenua and Māori heritage

Taking account of the principles of the Treaty of Waitangi and of kaitiakitanga (guardianship) will include consultation with iwi/hapū and consideration of iwi/hapū management plans as part of avoiding harm from coastal hazards and coastal hazard responses (see also section 7.1.1, Objective 3).

The recognition and protection of coastal sites and values of cultural significance will be an important part of community engagement and the development of strategic options and plans that will reduce the risk of adverse effects on iwi and their taonga.

### Policy 3: Precautionary approach

Policy 3(1) requires a precautionary approach towards activities whose effects are uncertain, unknown or little understood but may be significantly adverse.

Policy 3(2) requires that, in particular, a precautionary approach is adopted in the use and management of coastal resources that are potentially vulnerable to the effects of climate change.

It should be noted that the effects of climate change on coastal resources are broader than just the direct effects on coastal hazards, including the direct threats to ecosystems and biodiversity (e.g. from ocean acidification, salinisation of freshwater systems, and the effects of higher temperatures on the survival of coastal species and habitats) (Kettles & Bell 2016).

Therefore, under Policy 3, coastal hazard responses also need to take account of a broad range of effects of climate change on coastal resources.

In addition to natural resources, coastal resources also include built development (including hard protection structures).

A precautionary approach to the use and management of hazard-prone coastal resources is appropriate because the effects of projected climate change on coastal hazards inherently contain:

- a degree of uncertainty (mainly in the *rate* of sea-level rise); and
- some unknown aspects (e.g. quantifying the effects on water tables and groundwater aquifers, the morphological changes in complex tidal inlet and sand-spit systems, and the onset of polar ice sheet instabilities);

and may be significantly adverse depending on the timeframe.

There are very close links between Policy 3(2) and Policies 24–27. Giving effect to these policies in an integrated way will achieve better coastal management outcomes. There are also strong links with Policy 7 (Strategic planning; see below).

### Policy 4: Integration

Policy 4 is relevant because coastal hazards require coordinated management across administrative boundaries and coastal hazard responses (Policy 4(a)). This policy directly relates to the containment and reduction of risk; the management of (and consideration of alternatives to) hard protection structures, which often span or cross the MHWS boundary over time; and the development of a strategic approach to hazard management, as directed in the suite of coastal hazard policies. (See section 4 for further discussion.)

Providing for integrated and strategic management specifically requires 'particular consideration of situations where … development or land management practices may be affected by physical changes to the coastal environment or potential inundation from coastal hazards, including as a result of climate change' (Policy 4(c)(iii)).

The line of MHWS as a jurisdictional boundary is not fixed—it moves with erosion and accretion cycles over a range of timescales (e.g. seasonally, decadally, with each

storm), and will tend to migrate landward with climate change (particularly as a result of ongoing sea-level rise).

The projected movement inland of the line of MHWS within the 100-year-plus planning timeframe is a relevant consideration when giving effect to Policies 24, 25 and 27.

### Policy 6: Activities in the coastal environment

Within coastal-hazard-prone areas, Policy 6 is relevant when giving effect to Policies 25, 26 and 27. For example:

- Policy 6(1)(a) and (b), which relate to the provision of infrastructure, will particularly need to be considered alongside Policies 25(d) and 27(1)(c), which address the management of infrastructure.
- Policy 6(1)(h), which relates to the visual impacts of development, will need to be considered alongside Policy 25(a), (b), (c) and (e), and Policy 27(1)(d), (2)(a), (3) and (4), which address the adverse effects of hard protection structures, and the development of strategic options to reduce hazard risks and adverse effects, particularly when considering hard protection structures or development that may require protection from coastal hazards within at least the next 100 years.
- Policy 6(1)(i), which promotes the set back of development from the coastal marine area to protect the natural character, open space, public access and amenity values of the coastal environment, reinforces Objective 5 and Policy 25 where they seek to locate new development away from coastal-hazard-prone areas, and generally seek to avoid increasing the risk of social, environmental and economic harm from coastal hazards. Setbacks are an example of a precautionary measure to 'avoid redevelopment, or change in land use, that would increase the risk of adverse effects from coastal hazards' (Policy 25(b)), to 'provide … for the protection … or enhancement of natural defences' (Policy 26(1)), and to recognise 'the potential for coastal processes, including those likely to be affected by climate change, to restrict access … and the need to ensure that public access is maintained even when the coastal marine area advances inland' (Objective 4).
- Policy 6(2)(a), (c) and (d), which relate to the importance of and functional need for activities in the coastal marine area (e.g. maritime aids, jetties, boat ramps, marinas, surf clubs, toilet facilities, boat/yacht/rowing clubs) to people and communities, and the vulnerability of the activity as proposed, needs to be assessed against various subsections of Policies 25, 26 and 27 (see the discussion under Objective 6, section 7.1.1). (Note that ports are also important national infrastructure, which are specifically addressed in Policy 9.)

### Policy 7: Strategic planning

Policy 7 directs strategic planning in the preparation of regional policy statements, regional plans and district plans. Priority is given to three strategic planning actions:

- consider where, how and when to provide for activities in the coastal environment (Policy 7 (1)(a));
- identify where uses are inappropriate (Policy 7(1)(b)); and
- identify coastal processes, resources or values that are under threat or at significant risk from adverse cumulative effects and, where practicable, set thresholds in plans to help determine when activities causing adverse cumulative effects are to be avoided (Policy 7(2)).

The management of coastal hazard risks is an important consideration for strategic planning processes that affect the coastal environment.

Under Policy 7(1)(a), the concentration of existing development in coastal areas together with the expected future effects of climate change are important considerations for local authorities when undertaking strategic planning. To give effect to Policies 25 and 27, local authorities are directed to provide development and activities in ways that avoid increasing the risks of social, environmental and economic harm from coastal hazards.

Under Policy 7(1)(b), identifying areas that are, or may be, potentially affected by coastal hazards (in accordance with Policy 24) is one important example of strategically identifying areas where development is inappropriate or will need to be undertaken with particular care and attention to coastal hazard risk. Specific direction for strategic planning in more hazard-prone areas with significant existing development is given in Policy 27.

Under Policy 7(2), local authorities are to identify in policy statements and plans those coastal processes, resources and values that are at significant risk from adverse cumulative effects.

Ongoing sea-level rise and other climate change effects, as well as any responses involving hard protection structures, are likely to put coastal processes, resources and values at significant risk from adverse cumulative effects, with 'effect' being defined in section 3 of the RMA as including '… any cumulative effect which arises over time or in combination with other effects …'.

### Policy 10: Reclamation and de-reclamation

Policy 10(1) directs the avoidance of reclamation unless specified criteria that relate to need and significant benefit are met. Policy 10 sits alongside Objective 5 and Policy 25(b), which direct local authorities to ensure that coastal hazard risks are managed by locating new development away from hazard-prone areas and to avoid any new development that would increase the risk of adverse effects from coastal hazards.

When considering the form and design of a reclamation, there is a specific direction to 'have particular regard to … the potential effects on the site of climate change, including sea level rise, over no less than 100 years' (Policy 10(2)(a)).

The de-reclamation of redundant reclaimed land that is encouraged in Policy 10(4) is in accordance with the Objective 5 and Policy 25 encouragement of managed retreat, and can reverse 'coastal squeeze', allowing beaches, dunes, mangroves, saltmarsh and other such natural features to re-establish.

Policy 11: Indigenous biological diversity (biodiversity);

Policy 13: Preservation of natural character;

Policy 14: Restoration of natural character; and

Policy 15: Natural features and natural landscapes

Policies 11, 13, 14 and 15 set out policy direction relating to indigenous biodiversity, natural character, the restoration of natural character, and natural features and landscapes. These policies are very relevant to promoting the sustainable management of coastal hazards and coastal hazard risks.

Coastal hazards (such as erosion, inundation, cliff collapse and tsunami) are natural coastal processes that have the potential to interact with human development in an adverse way. It is important to recognise that these hazardous coastal processes (which are often extreme dynamic events) are the same coastal processes that shape a coastal area and result in its natural features, natural character, habitats and biodiversity that are so highly valued in Part 2 of the RMA and in these NZCPS policies.

In some situations, coastal hazard management responses that interfere with those natural coastal processes (such as hard protection structures and similar engineering interventions) (see section 6.5, Policy 27(2)) may run counter to the goals of protecting biodiversity and natural features and landscapes, and preserving and restoring natural character.

Read together, the policies encourage the identification of practicable alternative risk-reduction approaches that can work with natural coastal processes (such as restoring or enhancing natural defences) or that can avoid interfering with them (such as a managed relocation or removal of development), thereby safeguarding the natural character and other natural values of the coastal environment.

Proactively managing coastal hazards by restoring or enhancing natural defences and by keeping or moving development away from shorelines that are advancing inland (see section 6.1, Objective 5) will also avoid 'coastal squeeze' and thereby protect biodiversity, natural character, and natural features and landscapes, as well as public access along the coastal marine area and amenity values (see section 6.5, Policy 27(3) for further discussion of 'coastal squeeze').

Broad recognition of the effect of human-induced climate change on natural coastal processes will also be necessary to achieve good coastal outcomes for communities and places.

Policy 18: Public open space;

Policy 19: Walking access; and

Policy 20: Vehicle access

Policies 18, 19 and 20 are very relevant to the implementation of Policies 24–27 and, as with other related objectives and policies, there is a strong case for approaching implementation in an integrated way.

In coastal areas with soft shorelines, the continued existence of a dry beach at high tide is particularly important for public open space adjacent to the coastal marine area, as well as for public access to and along the coastal marine area.

Public areas of wet and dry beach can be diminished, and ultimately lost altogether, as a result of 'coastal squeeze' when a coastline is subject to erosion and hard protection structures have been built on the beach or foredune.

With ongoing sea-level rise and other climate change effects, the cumulative effects of beach and dune degradation are likely to become significant within the 100-year-plus planning timeframe required by Policies 24, 25 and 27, particularly where soft shorelines are not common along a coastline. Examples of places where this trend may be an issue include isolated pocket beaches, soft shorelines close to populations centres, and areas where much of the soft shoreline has already been armoured and high-tide dry beaches have already been lost or diminished.

Policy 18 promotes the active provision for good-quality public open space into the future, and directs local authorities to consider 'the likely impact of coastal processes and climate change so as not to compromise the ability of future generations to have access to public open space' (Policy 18(d)).

Policy 19 specifically directs local authorities to identify opportunities to enhance or restore public walking access 'where the long-term availability of public access is threatened by erosion or sea level rise' (Policy 19(2)(c)). It is noted that while esplanade strips move with the line of MHWS, this is not the case for esplanade reserves.

Controlling vehicle access to the coast under Policy 20 is, in part, to avoid damage to dunes and dune vegetation, which also damages the integrity and effectiveness of these sensitive natural defences. Even walking access can damage dune vegetation and contribute to dune erosion—Policy 19(3)(b) provides for walking access restrictions where necessary to protect dunes.

## 7.2 Resource Management Act 1991 provisions

All objectives and policies of the NZCPS 2010 are directly linked to Part 2 of the RMA through section 56 and section 58.

Given that the NZCPS 2010 gives substance to Part 2 of the RMA within the coastal environment, there is no need to refer back to Part 2 unless the NZCPS does not 'cover the field'. The requirement to give effect to the NZCPS in policy and plans is intended to constrain decision-makers (see the *King Salmon* Supreme Court decision[42]).

There are also a number of provisions in the RMA that more specifically address the management of coastal hazards and climate change (and page 7 of the NZCPS 2010 also lists a number of RMA requirements in relation to the NZCPS).

### Section 56: Purpose of the New Zealand coastal policy statements

Section 56 sets out that: 'The purpose of a New Zealand coastal policy statement is to state policies in order to achieve the purpose of this Act in relation to the coastal environment of New Zealand'.[43]

The purpose of the RMA is set out in section 5 of the RMA, which itself cannot be read in isolation from the rest of Part 2 of the RMA, namely sections 6, 7 and 8.

### Section 6: Matters of national importance

Section 6 was amended in 2017 to include '(h) the management of significant risks from natural hazards' to be recognised and provided for as a matter of national importance.

### Section 7(i): Part 2 Other matters

Section 7 of the RMA was amended in 2004 to include at paragraph (i) the effects of climate change:

> *In achieving the purpose of this Act, all persons exercising functions and powers under it … shall have particular regard to – (i) … the effects of climate change.*

### Section 30(1)(c)(iv), (1)(d)(v) and (1)(g)(iv): Functions of regional councils

Regional councils are required to control the use, development and/or protection of land for the purpose of 'the avoidance or mitigation of natural hazards'. The three cited subsections relate to land, the coastal marine area and the beds of water bodies, respectively, all of which can be within the coastal environment and affected by coastal hazards.

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[42] *Environmental Defence Society Incorporated v The New Zealand King Salmon Company Limited [2014] NZCS 38*, at [85] and [88] in particular.

[43] Note: Section 58 provides that a New Zealand coastal policy statement may state objectives as well as policies.

### Section 31(1)(b)(i): Functions of territorial authorities

This section requires territorial authorities to control any actual or potential effects of the use, development or protection of land for the purpose of 'the avoidance or mitigation of natural hazards'.

### Section 62(1)(a), (1)(i) and (3): Contents of regional policy statements

A regional policy statement must state the significant resource management issues for the region and the local authority(s) responsible for the control of the use of land to avoid or mitigate natural hazards, and must give effect to the relevant NZCPS.

### Section 65(3)(c): Preparation of other regional plans

This section requires a regional council to consider the desirability of preparing a regional plan when certain circumstances arise, including 'Any threat from natural hazards … which may be avoided or mitigated'.

### Section 106: Consent authority may refuse subdivision consent in certain circumstances

The consent authority (a territorial authority) may (in summary) refuse or impose conditions on a subdivision consent if the land is subject to material damage from natural hazards, or if any subsequent use is likely to create or exacerbate material damage from natural hazards (including erosion and inundation) to the land, to other land or to structures.

### Sections 229 and 230: Esplanade reserves and esplanade strips

These sections set out the purposes of esplanade reserves or esplanade strips and when they are to be set aside.

The purposes include 'mitigating natural hazards', and enabling public access and public recreational use.

Esplanade reserves are set aside when land is subdivided, while esplanade strips can be set aside at any time by negotiation.

Esplanade reserves and esplanade strips are a way of creating setbacks for development away from coastal hazards, and of protecting both natural coastal margins and public uses from 'coastal squeeze'. The width of an esplanade reserve or strip is important, as even a 20-metre esplanade reserve can be lost over time on a retreating coastline. Esplanade strips move with the line of MHWS but development may have occurred up to the landward side of the original location of the esplanade strip before that occurs.

## 7.3 Other legislation

### 7.3.1 Civil Defence Emergency Management Act 2002

The Civil Defence Emergency Management (CDEM) Act 2002[44] sets in place a framework for coordinated planning for hazard risk management at national and local levels across the 4Rs—[risk] *reduction*, [emergency] *readiness* and *response*, and [post-event] *recovery*. This framework includes addressing coastal hazards. As such, this Act complements and integrates the various roles and responsibilities that Crown agencies and local authorities have in coastal hazard management, including those under the RMA.

At a national level, the National CDEM Strategy and Plan sit alongside the NZCPS 2010. At a local level, CDEM group plans sit alongside regional policy statements, regional coastal plans and district plans. CDEM plans at both levels have an operational focus on emergency management arrangements.

The CDEM tools identify the options and capabilities of communities, agencies and lifeline services to prepare for, respond to and recover from emergencies. This information can help communities and decision-makers to determine appropriate levels of risk reduction under the RMA so as to avoid or lessen any impacts that could arise in an emergency.

In the case of coastal hazards, the link with CDEM applies particularly to the management of tsunami risks (see section 6.3, Policy 25(f)). However, the frequency of coastal inundation on the back of even a modest sea-level rise (PCE 2015) may require affected communities and lifeline utilities to move beyond dealing with isolated events to recognising broad-scale environmental change, including the cumulative damage or disruption of services from repeated events.

Local authorities are encouraged to integrate the RMA's and NZCPS 2010's the hazard risk avoidance and mitigation planning with the CDEM Act's emergency management planning, as appropriate.

The National CDEM Strategy, which sits within the wider emergency management framework, is currently under review, with a revised strategy proposed for completion by 2018. The vision of this strategy is 'Resilient New Zealand: communities understanding and managing their hazards'. In March 2015 the New Zealand Government made a commitment to the international Sendai Framework for Disaster Risk Reduction 2015–30 to reduce disaster risk and losses and enhance resilience to hazards. The current review of the CDEM strategy provides an opportunity to incorporate aspects of the Sendai Framework into national civil defence emergency management.[45]

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[44] www.legislation.govt.nz/act/public/2002/0033/latest/DLM149789.html?search=ts_act%40bill%40regulation%40deemedreg_Civil+Defence+and+Emergency+Management+Act+2002_resel_25_h&p=1.

[45] https://www.civildefence.govt.nz/cdem-sector/cdem-framework/national-civil-defence-emergency-management-strategy/

### 7.3.2 Building Act 2004

Sections 71–74 of the Building Act 2004[46] include restrictions on the granting of building consents where the land is subject to natural hazards, and require that notification of the natural hazard is added to the Certificate of Title for the property when a building consent is issued or at any time that a significant hazard to the building is identified. Local authorities must include information on natural hazards in any project information memorandum issued by them.

In relation to the granting of building consents, when a territorial local authority is considering an application for consent and has determined that a natural hazard is likely to affect the land concerned:

- under section 71 of the Act, the Council must first refuse the consent unless the applicant can satisfy the Council that the land and building will be protected from the hazard or that any damage caused by the building work will be restored; but
- if the building work will not accelerate, worsen or result in a natural hazard on the land or on any other property, and it is reasonable to grant a waiver or modification of the Building Code, the Council must grant the waiver or modification and issue the building consent under section 72 of the Act. If a building consent is issued in this way, the Council must notify the consent under section 73, so that the existence and details of the natural hazard can be entered on the Certificate of Title.

In the past, some local authorities have tended to rely on the Building Act, with its restrictions on building and placement of warnings on the Certificate of Title, as the primary approach to managing coastal hazards in relation to the built development.

However, the Building Act is concerned primarily with the fitness of a building during its lifetime. This contrasts with the RMA and its sustainable management purpose, which includes 'sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations'. The Building Act and Building Act Regulations also have no explicit requirement to consider climate change impacts on coastal hazards (although they do implicitly cover the increased probability of coastal hazards such as inundation and erosion that will occur in the future as a result of climate change; e.g. see Clause E1 of the Building Code).

The Building Act refers to a minimum 50-year economic life of new development or re-development being built on a property. The RMA has a broader scope and, while not explicit, requires consideration of a much longer timeframe than 50 years to manage subdivision, use and development. NZCPS Policies 24 and 25 make a longer planning timeframe explicit by directing that coastal hazard risks over at least 100 years are to be assessed and considered for sustainable resource management.

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[46] www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html.

# 8. Related guidance and ongoing work

The Ministry for the Environment publishes national guidance for local authorities to support them in planning for and managing the projected impacts of climate change.[47]

The updated version of *Coastal hazards and climate change* (MfE 2017) is specific to managing changing risks in coastal areas. It recommends dynamic adaptive pathways planning for managing the increasing risk and uncertainties from sea-level rise and other climate change effects, and provides extensive guidance on how local authorities can implement this approach, based on both the latest IPCC reassessment reports and research results for climate change impacts on New Zealand.

As discussed in section 5, the NZCPS 2010 together with the authoritative national guidance provided in *Coastal hazards and climate change* (MfE 2017) direct the development of sustainable, long-term adaptation strategies by local authorities and their communities.

References to other related guidance, as well as ongoing work on coastal hazard studies and guidance, can be found in *Coastal hazards and climate change* (MfE 2017).

[47] See http://www.mfe.govt.nz/publications/climate-change/coastal-hazards-and-climate-change-guidance-local-government.

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# 10. Glossary

(Also see section 3 for additional notes on the terms used in the coastal hazard policies.)

Annual exceedance probability (AEP): The probability that a coastal hazard event of a particular magnitude or greater (storm severity, storm-tide level, etc.) will occur in any one year. This is usually expressed as a percentage (e.g. 1%), but can be expressed as a decimal (e.g. 0.01). This probability will change over time if the hazard (e.g. storm-tide level) is changing, for example from climate change effects. See also the definition for 'return period' below.

Please note that in terms of accumulating probability/likelihood over the long timeframes specified in the NZCPS:

1. Assuming that the hazard is unchanging (initially setting aside climate change, etc.), there is a c. 63% chance of a 1% AEP (2016) event occurring within a 100-year timeframe; or a c. 39% chance of a 0.5% AEP (2016) event occurring within a 100-year timeframe.
2. To address the major factor of sea-level rise (through the consideration of scenarios) and other climate change effects (e.g. waves and storm surge), the simplest approach is to add these effects over the required planning timeframe to the appropriate present-day coastal hazard magnitude, e.g. the 1% AEP in 2016. This transforms the hazard magnitude to the equivalent AEP at the end of the planning timeframe (e.g. the 1% AEP in 2120).

(See appendix F in *Coastal hazards and climate change* (MfE 2017) for tables on AEP and the likelihood and number of exceedances over various planning timeframes.)

Climate change: '… a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods' (RMA: section 2).

Coastal hazard event: The occurrence of a coastal hazard (or combined hazards) where there is the potential threat of adverse effects or damaging impacts on people, land, assets, land-use activities, ecosystems, heritage and cultural sites, and the environment.

Coastal hazards: Hazards in the coastal environment, such as erosion, inundation, tsunami and cliff collapse. It is noted that as coastal hazards become increasingly affected by climate change, it could be argued that some are no longer entirely natural hazards (or natural coastal processes). Earthquakes and volcanic activity are coastal hazards if they cause coastal erosion, inundation, tsunami, subsidence and cliff collapse, as well as instability, subsidence and liquefaction (e.g. on sandspits and reclamations). Coastal hazards can be single,

sequential or combined in their origin and effects. Each hazard is characterised by its timing, location/scale, intensity and probability.

Coastal squeeze: Where natural coastal features, habitats and ecosystems are 'squeezed' and can disappear between the sea and an armoured shoreline protecting an area of coastal development (i.e. hard protection structures), particularly where erosion and/or sea-level-rise trends are causing the shoreline profile and natural features to migrate inland; i.e. where natural coastal margins are squeezed between an advancing sea and fixed hard defences.

(See Box 22 and section 6.3, Policy 25(e).)

Hard protection structure: 'Includes a seawall, rock revetment, groyne, breakwater, stop bank, retaining wall or comparable structure or modification to the seabed, foreshore or coastal land that has the primary purpose or effect of protecting an activity from a coastal hazard, including erosion' (NZCPS 2010).

Return period (or average recurrence interval): The average time period between repetitions of a coastal hazard event of a certain magnitude or greater *if the hazard is unchanging*. It is near to the reciprocal of the AEP *if the hazard is unchanging* (for return periods > 10 years).

(Also see the discussion of Average Recurrence Interval (ARI) in appendix E of *Coastal hazards and climate change*; MfE 2017.)

(*Important note: This is an inappropriate measure when a hazard is changing over time and therefore is generally inappropriate for use under climate change. It is only included here because it is still commonly used in New Zealand in relation to coastal hazards.)*

Risk: 'Risk is often expressed as a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (AS/NZS ISO 31000:2009 Risk management—Principles and guidelines, November 2009)' (NZCPS 2010).

(Please note that this explanation of risk comes from a note on the definition of risk in the AS/NZS standard rather than from the definition itself.)

# Appendix 1: Natural vs. armoured shorelines

The following examples and diagrams summarise some typical responses to coastal hazards. They do not substitute for professional advice on where and when these responses are needed, and nor should they be taken as technical or legal advice. (Note: M.S.L. refers to the Mean Sea Level.)

1. On a natural sandy coastline that is experiencing a sediment deficit or sea-level rise, the resulting erosion of the foredune will nourish and re-form the beach, maintaining over time a shore profile that has the same sequence of sandbars, high-tide beach, saltmarsh/foredunes, etc. *but that has moved landward* (see Fig. A1.1).

   It is this mobility of the soft shoreline that creates and maintains natural coastal features such as a high-tide beach, foredunes, saltmarsh, wetlands, swales and backdunes on our dynamic coastline.

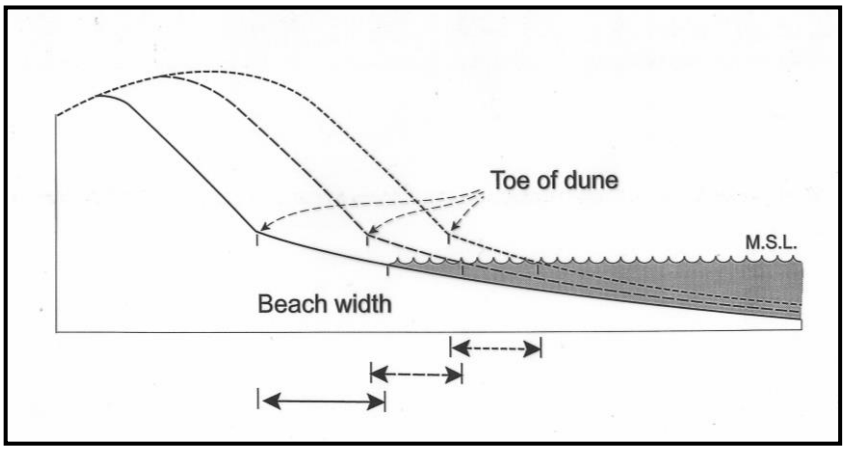


Figure A1.1. The beach width is maintained as the dune nourishes the beach during natural beach erosion (from Jacobson 1997).

2. On an armoured sandy coastline that is experiencing a sediment deficit or sea-level rise, a seawall will (initially at least) halt the erosion of the coastal land behind it, but will not stop or remedy the sediment deficit or respond to the additional sediment demand due to sea-level rise.

   Sediment will continue to be lost from the beach in front of the seawall and will not be replaced from the dunes. The beach therefore diminishes in volume and the high-tide beach will begin to disappear.

   This process is known as 'coastal squeeze' (see Box 22), which sees natural features squeezed and disappearing between the sea and a seawall. It can be visualised *either* as a shoreline profile moving landward and being truncated by the seawall, *or* as the seawall marching seaward and swallowing the foredune and beach (see Fig. A1.2).

   However, if a seawall is deemed necessary, 'coastal squeeze' can be delayed by positioning the seawall further landward.

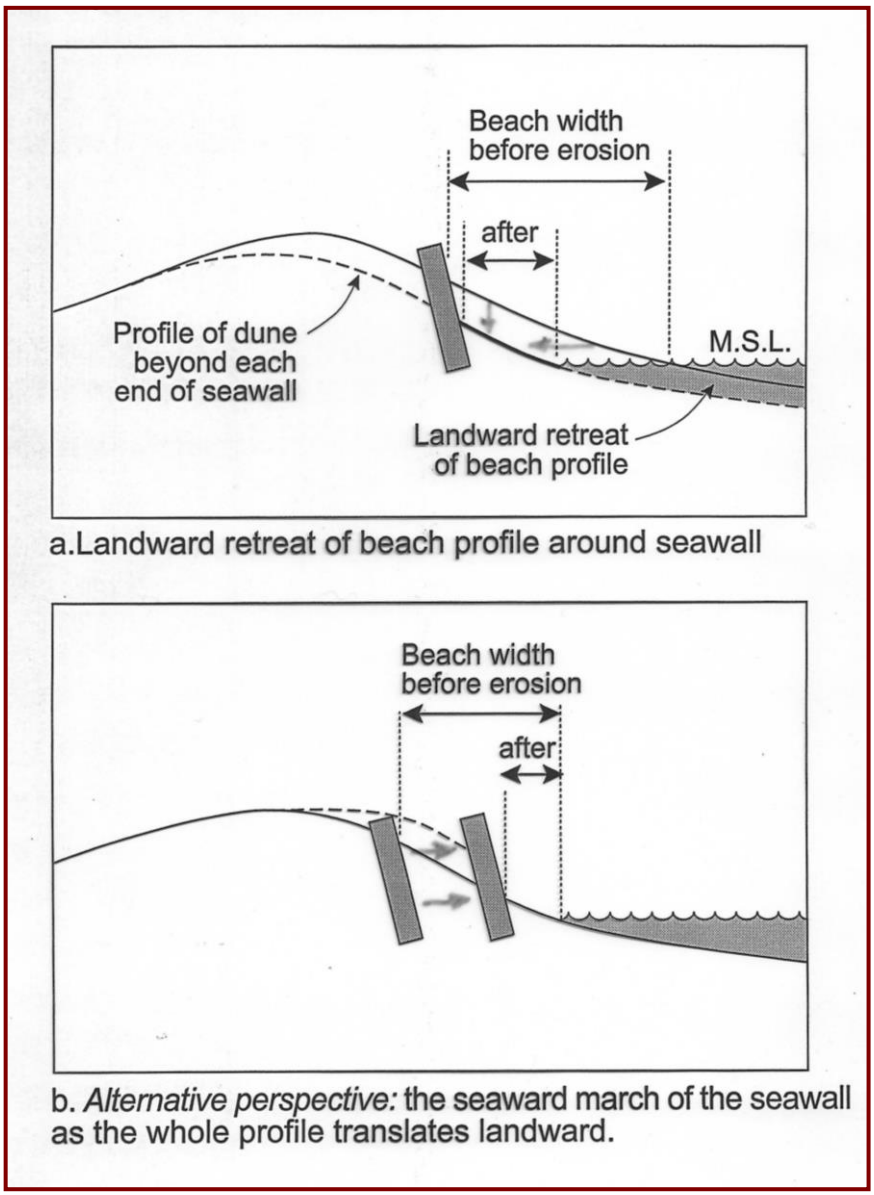


Figure A1.2. Cross-sectional view of beach loss in the presence of a seawall when the coastline is in retreat (from Jacobson 1997).

3. Figure A1.3 shows a 'before' and 'after' plan view of such beach retreat/loss in front of a seawall where the shoreline profile is moving landward with erosion and/or sea-level rise.

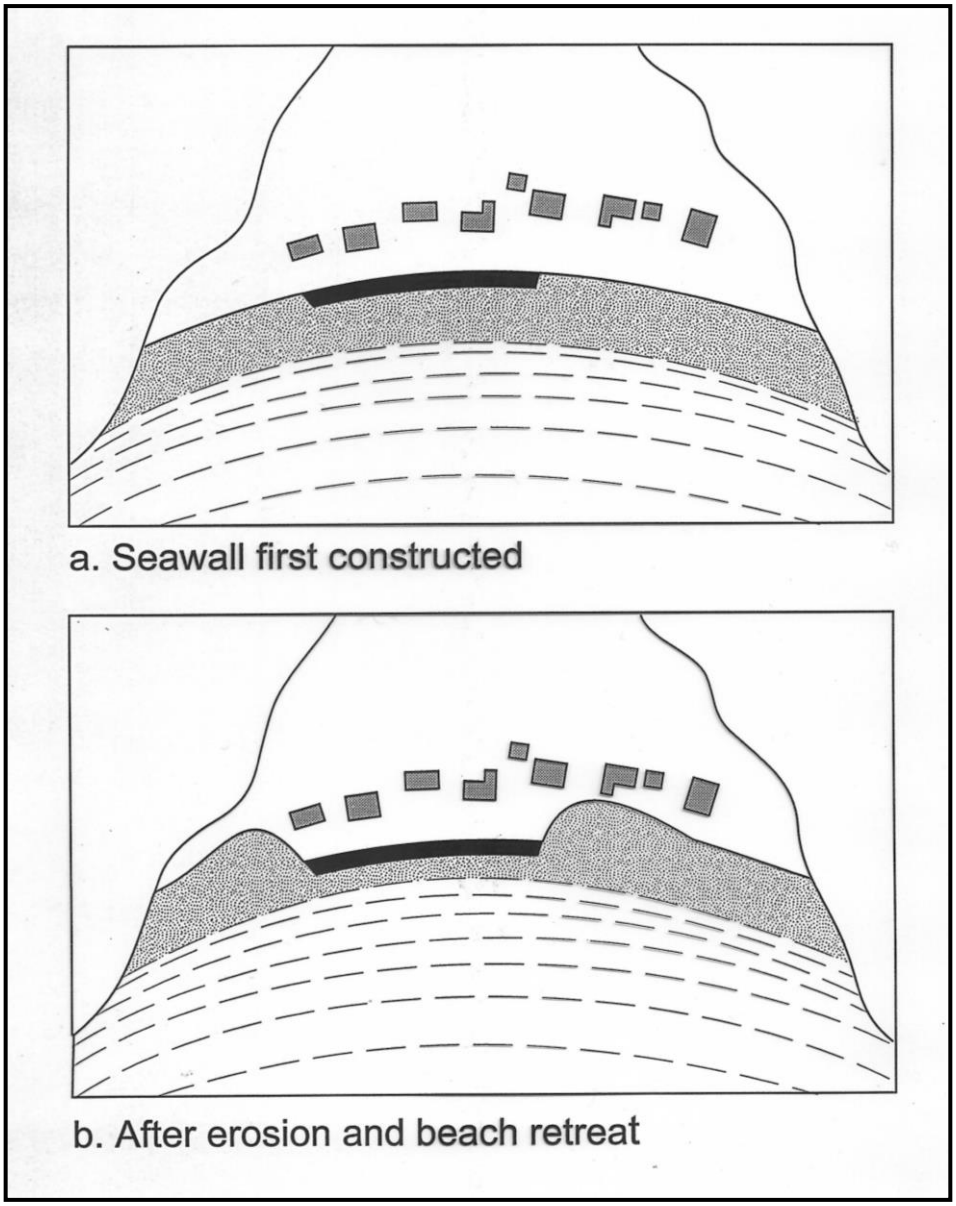


Figure A1.3. Plan view of beach loss in the presence of a seawall when the coastline is in retreat (from Jacobson 1997).

4. Figure A1.4 compares the presence of a seawall with the presence of a rocky headland where a shoreline is in retreat. In just the same way as the beach will be narrower or absent in front of a rocky headland (rather than following the shoreline as an even-width ribbon beach), the beach in front of a hard protection structure will similarly be narrower (or absent). In both cases, this occurs regardless of the geology/material and the slope of the headland/seawall (see Box 36 regarding the design of a seawall).

   (The *amount* or *duration* of beach loss over time from storms and sea-level rise can be delayed or reduced by locating the seawall more landward and, to some extent, through design.)

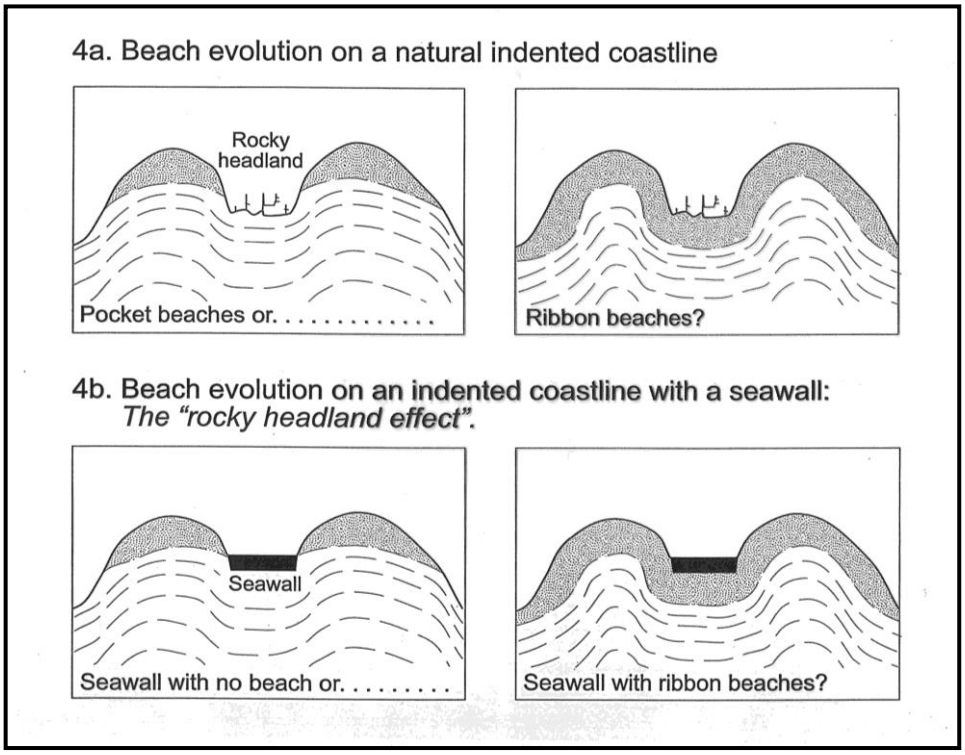


Figure A1.4. Beach evolution on A. a natural indented coastline and B. a coastline with a seawall (from Jacobson 1997).

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