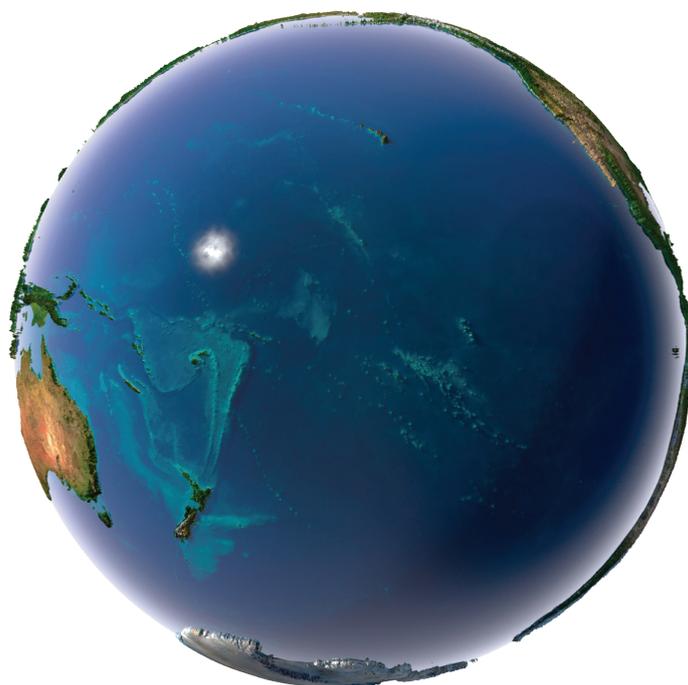


Exposed: Climate change and infrastructure

Guidance for councils

August 2019



**We are.
LGNZ.**

Te Kāhui Kaunihera o Aotearoa.



Contents

Foreword p3

1> Introduction and purpose p5

2> LGNZ sea level rise exposure project: Background p8

3> An assessment process for climate adaptation p11

4> Step 1: What is happening? p13

5> Steps 2-5: An overview p16

6> Key questions for elected members p19

7> Maturity index p22

8> Glossary p24

9> References p26

This paper is based on a report prepared for LGNZ by James Hughes and Rebekah Robertson, Tonkin & Taylor Ltd

Foreword



Foreword

In January 2019, LGNZ released its report *Vulnerable*, which identified the type, quantity and replacement value of local government owned infrastructure exposed to sea level rise. That report was significant. It identified that the replacement value of local government owned infrastructure at 1.0m above Mean High Water Springs was over \$3 billion.

But it was also significant because it marked the first time that councils across New Zealand had worked together to get a collective sense of councils' exposure to sea level rise.

For many councils, contributing to the *Vulnerable* report was the first time they had paused to take stock of how much of their infrastructure is exposed. Councils didn't do this because central government directed or required them to do so, but because of their increasing awareness that climate change is significantly impacting the way they operate (and will continue to do so).

Councils know that in order to make good adaptation decisions with their communities they need good information. They need information that is accurate, up-to-date and that can easily be shared with, and understood by, members of the community. Without good information, councils run the risk of making misinformed, poorly prioritised or suboptimal decisions. Such decisions undoubtedly have negative consequences for communities.

That's why local government in New Zealand has committed to doing more to better understand its exposure to climate change. This guidance document is designed to provide councils with support, and a consistent approach, for regularly assessing the exposure of their infrastructure to sea level rise and inland flood risk.

An exposure assessment is only the start of a more comprehensive process of assessing risk and vulnerability, developing an adaptation strategy and implementing it. That's why LGNZ intends to produce further guidance for councils on how to undertake these important subsequent steps.

Of particular importance is the support that this guidance document provides for the elected members of councils. Elected members have considerable responsibilities for meeting the needs of both current and future communities for good quality local infrastructure and local public services, and for ensuring community well-being. But for elected members to make good climate change adaptation

decisions they need good information. That's why we've worked with elected members and council officers from across the country to develop a list of suggested questions that elected members can ask of their officials, constituents and stakeholders, to ensure that they're being provided with accurate and up-to-date information, and have a good understanding of the challenges and work that their council and community is doing to address them.

I commend this document to councils, and encourage them to continue to show the strong leadership on climate change adaptation they are already demonstrating. I also encourage central government and other stakeholders to think about what they are doing to understand their exposure to climate change impacts, and welcome them to use this document as impetus to do even more.

Dave Cull
President

1 >

Introduction and purpose

Introduction and purpose

Background

Climate change and its far-reaching impacts

The impacts of climate change are being felt by local government and its communities now. Those changes include rising sea levels and changes in rainfall and temperature patterns. These changes can also lead to *gradual* impacts or stressors such as groundwater rise, or salt water intrusion, or more frequent *extreme* weather event hazards, such as coastal or inland flooding.

Climate change poses far-reaching and unprecedented levels of risk to New Zealand's natural and built environment, and the well-being of communities. Adapting to the challenges and opportunities of climate change is a significant issue for all of New Zealand, and demands that local government, central government, business and property owners think about how the investments they make contribute to adaptive and resilient responses.

Councils' climate change responsibilities

Climate change affects local governments' roles and responsibilities in a number of ways, as documented in LGNZ's July 2017 publication, [How climate change affects local government: A catalogue of roles and responsibilities](#).

That document summarises where changes in the climate have been assessed as having a "definite" impact on local government roles and responsibilities, both from an emissions mitigation and climate change adaptation perspective. The document identifies a wide range of roles and responsibilities that are affected by climate change – Local Government Act decision-making obligations, the provision of services, setting of policies for resource use, preparing District Plans, acting as a consent authority, consenting new development under the Building Act, and so on.

Despite the relevance that climate change has to the many and varied roles that councils perform, the focus of this guidance document is on how councils can factor climate change into their planning and decision-making specific to the core infrastructure that they are responsible for.

Resilience of council-owned infrastructure; councils' obligations and climate change

Councils have statutory obligations to develop long-term plans (LTPs), financial strategies and infrastructure strategies. The purpose of those plans and strategies is to provide a long-term focus for local authority decisions and activities, and for how rates, debts and levels of service might be affected. In making those plans, local government is responsible for meeting both the current and future needs of its communities for good quality local infrastructure

and local public services, and for ensuring communities' cultural, economic, environmental and social well-being.

With climate change impacting communities now, and a clear understanding that its impacts will continue well into the future, it is imperative that councils keep resilience to climate change front of mind when fulfilling their decision-making and regulatory responsibilities, and particularly when making decisions related to council-owned infrastructure.

The resilience of council-owned infrastructure, particularly roading, three waters networks and buildings/facilities to climate change impacts, is critical to the long-term viability and prosperity of our communities. As these vital assets come under stress from the changing climate, so too will the fabric that binds our communities together.

What councils do to ensure the resilience of infrastructure (or not, as the case may be) will have significant consequences for communities. The decisions a council makes about how it continues to invest (or not) in existing infrastructure in light of climate change impacts will affect things such as the continued availability of infrastructure to current and future communities, their preparedness for natural disasters, and their safety. Decisions relating to existing and new infrastructure will directly or indirectly impact where people can live, how people go about their lives and how they conduct their business. Councils need to carefully balance the needs of current communities against those of future communities, which will involve consideration of who bears the costs for decisions, and when. That raises issues of intergenerational equity; how much impact should current or future communities face at the expense of the other.

< But what is clear is that in order to address the impacts of climate change on critical local government infrastructure, a data-driven understanding of the problems, and close engagement with the community on how to address them, is critical. >

There are legal risks for councils to consider too. A paper prepared for LGNZ by Jack Hodder QC, [Climate change litigation: Who's afraid of creative judges?](#), suggests that it seems increasingly likely that, in the absence of national direction from the Government on how councils should be adapting to climate change, individuals and communities will look to the courts for redress, with councils being an obvious defendant. Councils may be liable for failing to take adaptation measures, or for making decisions that were not appropriate in light of known information about exposure to known climate impacts.

The challenges are complex and how best to address them is not always obvious. But what is clear is that in order to address the impacts of climate change on critical local government infrastructure, a data-driven understanding of the problems, and close engagement with the community on how to address them, is critical. Without an understanding of which infrastructure is exposed to climate change impacts, and where it is located, councils, communities and stakeholders will be unable to put in place plans and other measures to bolster the resilience of infrastructure, or will make investment or regulatory decisions that are suboptimal.

< Councils will only be able to determine the most effective options and plans for ensuring their infrastructure is resilient to climate change if they have a clear understanding of what their greatest risks are. >

Councils will only be able to determine the most effective options and plans for ensuring their infrastructure is resilient to climate change if they have a clear understanding of what their greatest risks are. That makes it critical that councils are undertaking exposure assessments on a regular basis, and use actual quantity and replacement value data to inform risk assessments and adaptation decision-making.

Purpose of this guidance document

This document focuses primarily on gathering relevant, accurate and up-to-date climate information, with which exposure and risk analyses can be undertaken, leading to better informed decisions around improving the long-term resilience of infrastructure. It builds on LGNZ's report, [Vulnerable: The quantum of local government infrastructure exposed to sea level rise \(LGNZ, 2019\)](#), which was based on a similar exposure assessment that identified the type, quantity and replacement value of local government owned infrastructure exposed to sea level rise.

This document has intentionally been developed to provide a brief overview of the types of information gathering and analysis that can and should be undertaken to inform more detailed risk assessment and adaptation decision-making processes. However, notably, in some cases the information gathered from a simple exposure assessment may be sufficient for prioritising action on key infrastructure, or making decisions on LTPs and infrastructure strategies.

LGNZ intends to prepare additional, more detailed, risk-assessment guidance in the future.

This document provides councils with guidance to:

- Assist with understanding and managing climate risk to the essential infrastructure that they own – particularly in relation to sea level rise, coastal hazards (such as storm inundation and erosion), and inland (pluvial) flooding;
- Assist councils with addressing the issues that completion of the previous survey, which fed into the *Vulnerable* report, identified; and
- Help our community leaders prime and test council staff, constituents and stakeholders to engage in the most effective long-term planning for infrastructure investment, and make sensible investment decisions now, which don't preclude future options for infrastructure provision.

2 >

**LGNZ sea level
rise exposure
project:
Background**

LGNZ sea level rise exposure project: Background

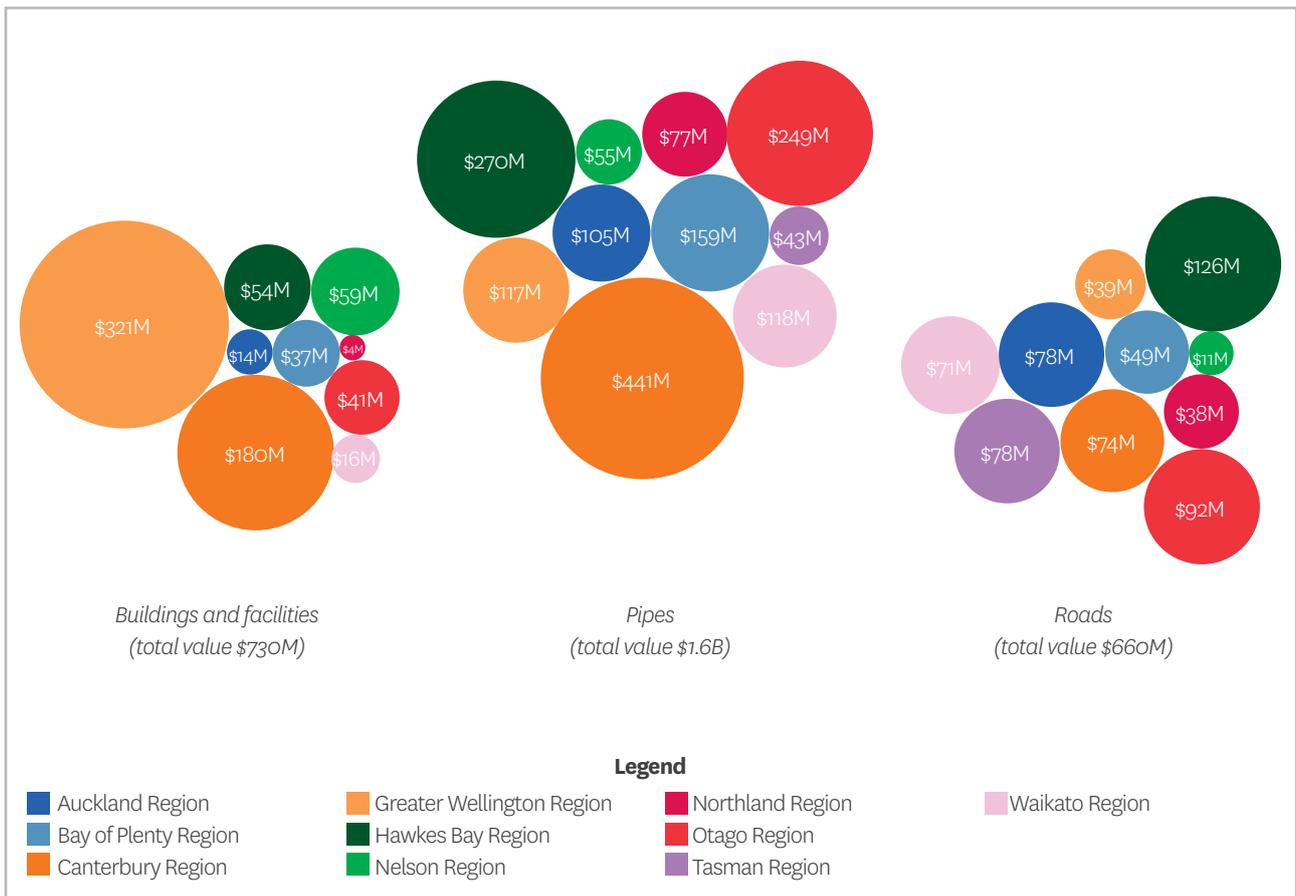
In 2018, LGNZ sent out a survey to the 62 coastal councils in New Zealand, asking them to provide information on the type, quantity and replacement value of local government owned infrastructure exposed to the impacts of sea level rise at intervals of 0.5 metres, 1.0 metre, 1.5 metres and 3.0 metres above Mean High Water Springs (MHWS). Data was primarily collected for roads, three-waters infrastructure and buildings/facilities. The results of the survey and associated recommendations were published in the report, [Vulnerable: The quantum of local government infrastructure exposed to sea level rise](#) (LGNZ, 2019).

The aim of that project was to quantify potential exposure of council-owned infrastructure to a range of possible sea level rise increments. The intention was that it would enable councils and communities to build a clearer understanding of the quantity and value of infrastructure exposed, and initiate a discussion both within the local government sector, and with other key users of infrastructure to assist in better decision-making and prioritisation of adaptation responses.

2.1 Findings from the LGNZ sea level rise survey

The survey highlighted that across New Zealand the total replacement value for three-waters infrastructure, roads, and building/facilities exposed at 1.0m above MHWS was **over \$3 billion** (Figure 2.1). Regional data showed that there is significant exposure in nearly all regions, with Canterbury, Greater Wellington, Hawke's Bay and Otago being notably higher than others.

Figure 2.1: The replacement value of infrastructure by region (at 1.0m above MHWS). Source: LGNZ (2019).



In addition to illustrating the value and quantity of exposed infrastructure across regions, the survey also highlighted:

- That access to, and understanding of, base data relating to climate, natural hazards and infrastructure is essential if exposure and impacts are to be clearly understood and managed.
- The importance of having exposure data to support an understanding of potential risk, so this can be factored into council decision-making.
- That the *long-term* decisions that councils face require an understanding of future climate risks, and that these need to be considered along with other current and future pressures relating to land use, growth and renewals, as well as the real possibility of insurance retreat over the medium to longer term.
- That the value at stake from climate change is significant, and decisions on funding models have not yet been addressed either at a national or local level.
- That there is significant potential for, and benefit from, better co-ordination and integration of effort within and across councils to create efficiencies in data collection and analysis, and to share practice and resources. The data collection component of the recent LGNZ survey highlighted a number of coordination issues that are considered to be representative of the wider local government sector, including:
 - Variation across councils in terms of asset and financial data availability, as well as systems and formats in which the data is held;
 - Lack of integration between spatial infrastructure data and financial information; and
 - Issues with internal communications between departments and general oversight.
- Local government has a strong leadership role to play in national policy setting on climate change issues.

3 >

**An assessment
process
for climate
adaptation**

An assessment process for climate adaptation

Figure 3.1 describes a 5-step process councils should follow to plan for climate adaptation. This is based on the Ministry for the Environment’s *Coastal Hazards and Climate Change – Guidance for Local Government* (2017) and should be informed by an appropriate level of data and analysis, bearing in mind that there is a significant level of uncertainty involved (both in terms of magnitude and timing of climate-related hazards and risks). The process below can be applied to a range of climate-related hazards including coastal hazards/sea level rise, inland flooding, groundwater rise, drought and extreme temperature impacts.

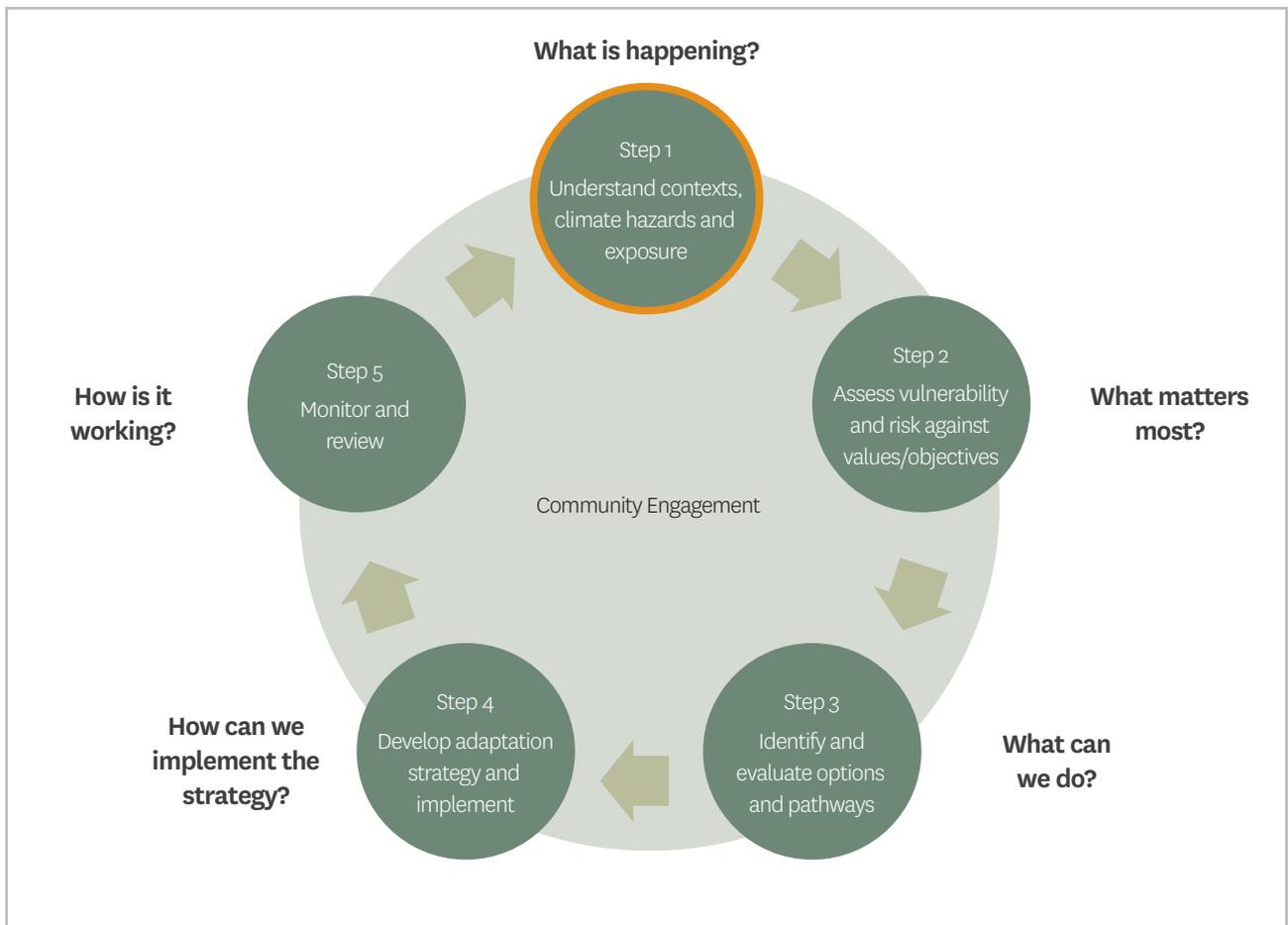
This guidance document focuses on Step 1 of the process (highlighted below), and in particular, assessing the *exposure* of local government owned infrastructure to sea level rise as well as coastal and inland flooding.

In brief, **Step 1** involves using the latest climate change projections and guidance, and selecting appropriate projections for relevant regions (including the uncertainty where possible).

In reference to the above process, LGNZ’s sea level rise survey involved overlaying council owned infrastructure with various increments of elevation above Mean High Water Springs (MHWS) to understand *exposure*. This relates to Step 1 as shown in Figure 3.1, which is discussed in further detail below.

Figure 3.1: The climate change adaptation process (adapted from MfE Coastal Hazards and Climate Change – Guidance for Local Government, 2017).

Note: This guidance document focuses primarily on step 1 outlined in orange.



4 >

**Step 1: What is
happening?**

Step 1: What is happening?

4.1 Data needed to understand contexts, climate hazards and exposure

Accurate data collection is critical to better understanding the exposure of infrastructure to climate change hazards and to plan for the impacts caused by climate change. These include both long-term gradual impacts (stressors), as well as event-based changes/hazards, such as extreme weather events.

Councils should collect the types of data outlined in Figure 4.1 which includes both environmental/topographical data and infrastructure data. The various data types provide useful information, which can be used to understand exposure, vulnerability and risk¹. For example, rainfall data and catchment data can be used to develop flood models. Information relating to the type/age/material and elevation of infrastructure or property can then be utilised to understand flood exposure and risk.

It is noted that some of the data should be collected on an ongoing/periodic basis to enable trends and changes to be understood over time.

In addition to the raw data collection, it is important that councils recognise the need for modelling (based on data collected) at an appropriate level of detail, and relevant to their region, in order to enable good decision-making. This may include flood modelling, groundwater modelling, and coastal inundation and erosion modelling.

4.2 Exposure assessment processes

Councils should prioritise either an exposure assessment such as that recently published by LGNZ, or complete a more comprehensive risk assessment in order to better understand and plan for the impacts from sea level rise and coastal/inland flooding.

As noted earlier, a simple exposure assessment may be sufficient for the purpose of making decisions about how to address the impacts of climate change in LTPs and infrastructure strategies, and prioritise action.

The following steps outline a simple exposure assessment process that councils can follow:

- 1. Gather available data on sea level rise and coastal/inland flooding.** This could include:
 - Developing simple coastal inundation extents, based on up-to-date topographical data (LiDAR). This would allow definition of bands of elevation such as 'MHWS +0.5m', etc.
 - Developing modelled coastal inundation extents relating to specific return period events, such as a 1 in 100 year event, in association with a given sea level rise increment².
 - Developing modelled inland flood inundation extents relating to specific return period events such as 1 in 10 year and 1 in 100 year events, with appropriate allowances for climate change and tailwater levels (comprising storm-tide and sea level rise - refer MfE, 2017).
 - Developing groundwater models based on appropriate monitoring data and where a tidal signal is present in groundwater monitoring data, add in sea-level rise increments.
- 2. Gather asset data.** Ideally this would include spatial GIS data for key infrastructure types (3-waters, transport, buildings and facilities etc), as well as valuation data. Refer to Figure 4.1 for more details.
- 3. Overlay the asset information with coastal or inland inundation extents.** Using appropriate GIS analytical tools, calculate the quantities of infrastructure exposed within each chosen scenario/elevation increment. For the same infrastructure calculate the replacement value, and if required, calculate the depreciated value.

This data can then be summarised to represent the overall exposure by asset type or location and highlight areas where exposure may be imminent (and require action), or where it will likely occur sometime in the future.
- 4. Ground-truth within and across teams.** Present exposure analysis to teams within your council to ground-truth results, understand any examples of exposure that may already be occurring, and gather initial thoughts on related vulnerabilities and risks.

¹ Refer glossary for definitions.

² For more detail refer MfE (2017).

Figure 4.1: Recommended data to be collected by councils to enable exposure and risk assessments, and for climate adaptation planning

Environmental (hazard) and Topographical Data¹	
Sea level rise/coastal flooding and erosion	Inland flooding
LiDAR topographical data to allow modelling of inundation depths.	LiDAR topographical data to allow modelling of inundation depths.
Monitoring data for sea level, tide, and waves – often collected by other organisations.	Rainfall data - Generally collected by other organisations (eg NIWA and Metservice).
Monitoring data/surveys relating to coastal erosion - undertaken at regular intervals depending on rates of change (eg annually). The type of monitoring may vary for beaches, cliffs, dunes etc – and can include traditional land based methods or drone technology.	Catchment characteristics data such as imperviousness, vegetation type and land use change (e.g. urbanisation, afforestation or deforestation – via satellite / aerial photos).
Wind speeds and directions. This is often collected by organisations such as airports, Regional Councils etc.	Groundwater depth monitoring data - collected at appropriate intervals to allow an understanding of variation. For example, 15min data capture allows tidally influenced groundwater to be monitored.
Salinity levels in rivers used as sources for potable water supplies.	In-stream flow and depth data to allow calibration of models. Can also be particularly useful for drought planning.
Infrastructure and Property Data (three-waters infrastructure/transport infrastructure/buildings/facilities/coastal structures)²	
Sea level rise/coastal flooding and erosion	Inland flooding
Core asset/property information within GIS spatial software - location, type, material, age, elevation etc.	Core asset/property information within GIS spatial software - location, type, material, age, elevation etc.
Condition of infrastructure - based on best practice methods, tailored to different asset locations and functions – for example coastal defence structures would require a more robust condition assessment methodology, including post-storm surveys. ³	Condition of infrastructure - based on best practice methods. For example stopbanks, culvert structures and other infrastructure or property that may be within a flood plain. ³
Criticality rating of infrastructure - based on best practice methods. ³	Criticality rating of infrastructure - based on best practice methods. ³
Asset valuation data (replacement and depreciated values) – ideally linked to core asset data.	Asset valuation data (replacement and depreciated values) – ideally linked to core asset data.

¹ LiDAR and catchment characteristics data should be collected and updated periodically, as new information becomes available. Environmental monitoring data (rainfall, coastal, groundwater, wind, flows) should be collected on an ongoing basis. Additionally, councils should reference and utilise up-to-date climate projections (MfE, 2018), high intensity rainfall data with climate factors (HIRDS), sea-level rise projections (MfE, 2017) etc.

² Infrastructure and property data should be collected and updated periodically, as new infrastructure is constructed or new information becomes available.

³ Further information on approaches to assessing condition and criticality can be found within the International Infrastructure Management Manual (IPWEA, 2015).

Note: post-event data is also useful to collect and can allow improved planning. This may include data relating to impacts/damage from extreme events such as flood depths, debris lines, records of infrastructure and property damage, etc.

5 >

**Steps 2-5:
An overview.**

Steps 2 – 5: An overview

While this guidance focuses primarily on Step 1, this section briefly discusses subsequent Steps 2, 3, 4 and 5 for your reference (refer Figure 3.1).

Step 2: Assess vulnerability and risk against values/objectives

Step 2 involves first establishing a collaborative process to explore values and objectives to guide the adaptive decision-making process. Secondly, once exposure has been assessed, additional work can be carried out to assess *vulnerability* and *risk*. This requires more information around the potential likelihood and consequences of climate-related impacts occurring.

This step should consider specific impacts and implications to council infrastructure and services (for example saltwater intrusion into water supply sources). Noting this particular guidance is focusing on infrastructure, however this could be extended to other aspects such as social, economic, cultural etc.

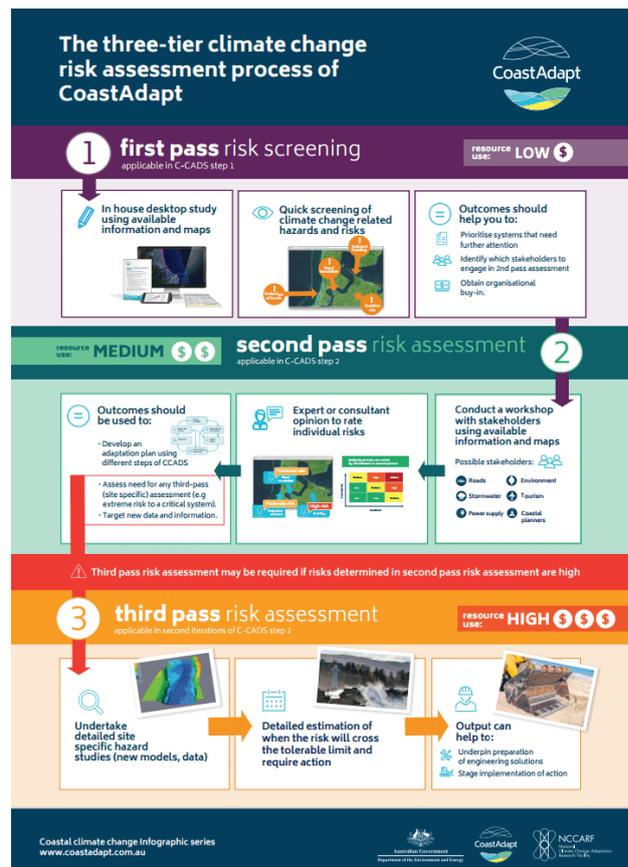
While there is not sufficient space to set out a complete risk assessment methodology, there are a range of accepted methods that can be followed.

Examples include:

- MfE Coastal hazards and climate change - Guidance for Local Government (2017) – including Dynamic Adaptive Pathways Planning (DAPP). Link [here](#).
- AS5334 – 2013: Climate change adaptation for settlements and infrastructure - A risk based approach. Link [here](#).
- European Climate Adaptation Platform - Adaptation Support Tool. Link [here](#).
- National Climate Change Adaptation Research Facility (NCCARF) C-CADS Tool. Link [here](#).

Note: LGNZ are proposing to develop a more comprehensive guidance document for local government covering methodologies for vulnerability and risk assessments.

Figure 5.1: Example 3-tier risk assessment process (NCCARF)



Step 3: Identify and evaluate options and pathways

This step involves developing and understanding options/pathways for adaptation, over the short, medium and long-term. These can include defending (holding the line), accommodating (adjustment to existing assets, such as raising floor levels), or retreating. Adaptation can also include avoidance strategies that prevent people from developing within harm's way.

Step 4: Develop adaptation strategy and implement

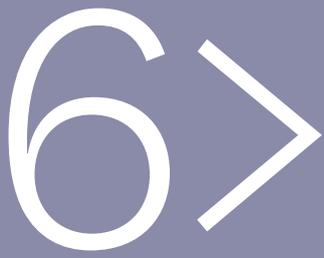
This involves developing an adaptation plan, including agreed options, timeframes, funding sources and responsibilities. An adaptation plan should include agreement around when the occurrence of particular, identified climate changes or events (triggers) may necessitate changes to the adaptive actions that are being taken.

Step 5: Monitor and review

Given the uncertainty involved in the magnitude and speed of changes, monitoring the effectiveness of adaptation actions is essential. This may lead to adjustments and improvements over time. This should also include monitoring of whether agreed changes in climate or hazards/events have taken place, which may necessitate changes to infrastructure needing to be signalled to communities.

MfE's *Coastal hazards and climate change – guidance for local government* (2017) provides guidance on one approach that can be taken to completing each of these steps.

Regardless of the approach that is taken to completing each of these steps, stakeholder engagement is the key element to successful outcomes of climate change planning and initiatives, and needs to be central to all climate change adaptation work (as indicated in Figure 3.1).



Key questions for elected members

Key questions for elected members

Elected community leaders play a major role in determining the approach that a community takes to climate change adaptation. As noted in the introductory section of this document, elected members are responsible for meeting the needs of both current and future communities for good quality local infrastructure and local public services, and for ensuring communities' cultural, economic, environmental and social well-being. Climate change has a significant bearing on those responsibilities.

However, in order to make the most optimal adaptation decisions, elected members need to be provided with the right information.

This section of the guidance is designed to support elected members to prime and test council staff, constituents and stakeholders, to allow them to engage in the most effective long-term planning and infrastructure investment decision-making. It provides some guidance for elected members around the types of questions to ask in relation to sea level rise and inland flooding, data requirements, and cross-council integration. It also sets out some questions that elected members can ask to get a sense of how engaged the community is with the work that the council is doing to identify climate change risk, and plan accordingly (given the criticality of community engagement to the success of climate change initiatives).

The primary focus for councils should be, as a starting point, to assess (and monitor) levels of exposure, as done so in LGNZ's sea level rise survey project. In part, the following questions will help elected members to ascertain whether their council is undertaking that kind of analysis, and will help to elicit appropriate information to guide future planning and decision-making. The following questions will also help elected members to understand how climate change relates to their roles and functions, and to have a good understanding of how engaged the community is in the council's work to address climate change, and where improvements can be made.

Figure 6.1: Questions for elected members

Local government's role/ context	Community engagement	Data/information collection and reporting processes	Planning, capacity and decision-making	
<ul style="list-style-type: none"> Do we understand local government's role in addressing climate change? Despite the uncertainty, why should we act? What has our council committed to doing to address climate change already? Have we addressed climate change in our long-term plan and/or infrastructure strategy? What are the biggest climate change related issues that our council needs to address? Is there any relevant national direction or guidance that we should be aware of? How is that direction or guidance informing the approach we are taking? 	<ul style="list-style-type: none"> Who are the key stakeholders/members of the community that we need to engage with? Have we engaged with iwi/Māori? Have we allowed sufficient time to engage with communities/stakeholders? How much time has been allowed? Have the views of the community been sought on this information/issue/decision? What was the focus of the engagement that was undertaken? What are the community's views? How did we seek the views of the community on this decision/issue? Which members of the community have we not sought views from, or not heard from? How will we seek their input? Are there any members of the community with expert knowledge that we should seek views from? Should we be discussing the issue/decision with anyone at a national level? If so, who? 	<ul style="list-style-type: none"> Who is responsible for data capture? Which teams/departments are using the data? Are steps being taken to avoid duplicating data being collected by other councils? Are we exploring options for taking a regional approach to data collection, if such an approach isn't being taken already? How is our data on climate, natural hazards and assets being reported and updated? What data gaps are there? What programme do we have in place to address these gaps? Is there funding in our Long Term Plan to address data gaps? If not, why? If we don't have data available, how long will it take to have data collected and then available to report on? Are various council departments working together on collecting and reporting on data, eg environmental, land use planning, civil defence, finance, asset management staff etc? 	<ul style="list-style-type: none"> What is our most exposed/at-risk infrastructure? What is the value of it and where is it located? What climate, natural hazard or asset data is this based on, and is the data current? Is there any information that we should have, which would help with decision-making, that we don't have? What are the limitations of the data or the analysis undertaken, and do we understand the uncertainty? Does our council have a robust environmental/natural hazards monitoring plan that captures relevant data on an ongoing basis, at an appropriate frequency and granularity, in order to enable planning for both gradual and event-based climate hazards? 	<ul style="list-style-type: none"> Is there sufficient technical capacity within our staff to plan for climate change? What additional resourcing might we need? Do we have sufficient information on current and future exposure/risk to allow robust prioritisation of adaptation decisions and investments, based on what is most highly exposed or at risk? Are we adopting robust processes to inform climate change planning? Which 'best practice' processes are being followed? How and when are we communicating with affected communities about climate change risks and adaptation options? What does our community engagement model for climate change look like? When making decision on adaptation, are other opportunities and benefits also being considered (eg carbon reduction, water quality etc)? What additional resources or support do we need in order to do more to adapt to climate change?

7 >

Maturity index

Maturity index

This simple maturity index (Figure 7.1) can be used by councils in order to gauge their approaches to managing climate risk and planning for adaptation. The levels range from 'starting out' to 'leading' and cover actions relating to *networks and cooperation* both internally and externally, *leadership and governance*, and specific *risk assessment and adaptation planning approaches*.

Figure 7.1: Example maturity index for climate adaptation



Level	Networks and cooperation	Leadership and governance	Risk assessment and adaptation planning
1. Starting out	<ul style="list-style-type: none"> No meetings with other councils or stakeholders regarding Climate Change. No working group within council. No public engagement. 	<ul style="list-style-type: none"> Climate change not on the radar. 	<ul style="list-style-type: none"> There is no or limited understanding of infrastructure exposed to climate change. No understanding of risks to communities or to councils finances or reputation etc.
2. Making progress	<ul style="list-style-type: none"> Some ad-hoc meetings and cooperation beginning to take shape. 	<ul style="list-style-type: none"> Commitment to understand climate exposure and risks. 	<ul style="list-style-type: none"> Risk and vulnerability assessment framework developed and commenced.
3. Developed	<ul style="list-style-type: none"> Regular cooperation, working groups established. 	<ul style="list-style-type: none"> Climate risks identified and communicated internally and with the public. Adaptation plan developed and signed off. 	<ul style="list-style-type: none"> Risk and vulnerability assessments undertaken, high risks prioritised and options/pathways developed.
4. Leading	<ul style="list-style-type: none"> Regular cooperation, working groups established across disciplines and stakeholders. Linking to central government direction. Strong integration with civil defence, land use planning, asset planning etc. 	<ul style="list-style-type: none"> Adaptation plan implemented, monitoring and review regularly undertaken. Climate change is a strategic priority that influences all plans and decisions. 	<ul style="list-style-type: none"> Defend/accommodate/retreat options (could be part of a DAPP approach) are developed and implemented via appropriate channels/mechanisms. Risks reviewed and updated regularly. Community are aware and engaged in decision-making - within a robust and transparent process.

8 >

Glossary

Glossary

Adaptation: The ongoing process of adjustment to observed climate change and a plausible range of future climate effects.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Good-quality: In relation to local infrastructure, local public services, and performance of regulatory functions, means infrastructure, services and performance that are efficient, effective and appropriate to present and anticipated future circumstances.

Mitigation (of climate change): A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.

Transformation. Note this is closely related to the concept of adaptation.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Note: The above definitions are sourced from the glossary within the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report: *AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability* (IPCC, 2014).

9 >

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