Risk Tolerance Methodology

July 2023

Risk tolerance is our willingness to bear a risk. Understanding risk tolerance helps us decide how to manage the potential impacts of a hazard on the things we value (such as our health, environment, economy, and buildings and infrastructure). This methodology seeks to fill a critical gap in Aotearoa New Zealand's well-established hazard risk management approaches. This will enable more robust and transparent risk-based decision-making.

Te Kāwanatanga o Aotearoa
New Zealand Government

Toka Tū Ake EQC

Toka Tū Ake EQC has a role to facilitate natural hazard research and education, and to contribute to the sharing of information, knowledge, and expertise in relation to natural hazard risk management, prevention or reduction of natural hazard impacts, and community resilience to natural hazards.

A risk tolerance methodology for central, regional, and local government agencies who manage natural hazard risks.

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Introduction

Risk tolerance is our willingness to bear a risk. Understanding risk tolerance helps us decide how to manage the potential impacts of a hazard on the things we value (such as our health, environment, economy, and buildings and infrastructure). To manage risks effectively and appropriately, we must assess our risk tolerance.

While Aotearoa New Zealand has well-established approaches for hazard risk management, we lack a nationally agreed approach for assessing and reviewing our risk tolerance. Furthermore, there is no framework (regulatory or otherwise) to understand what is tolerable, intolerable, or acceptable, and there is no consistent, agreed terminology to support this. This often leads to ambiguity in who manages risk and inconsistency in what risks are significant, as well as inconsistent approaches to risk across regions and organisations. This is a critical gap that this methodology seeks to address.

This methodology integrates a risk tolerance assessment into our current hazard risk management approaches, i.e., at the evaluation stage of the risk assessment process (typically based on ISO 31000:2018), as shown in Figure 1 (demonstrates a conceptual approach to hazard risk management in New Zealand with the addition of a risk tolerance assessment) and enlarged in Appendix A. This can be adapted for any hazard risk or policy framework. Appendix B provides an example of where a risk assessment approach, such as ISO 31000:2018, sits alongside/integrates into the framework.

The methodology provides consistency while being adaptable to suit varying contexts and timeframes, including for decision-makers across local, regional, and central government levels, and within the private sector. This will enable more robust, transparent, and documented risk-based decision-making. The paper also proposes nationally consistent risk terminology for risk tolerance.

This paper is aimed at central, regional, and local government agencies who manage natural hazard risks. It was developed following an extensive literature review titled 'Natural Hazards Risk Tolerance Discussion Paper' (Toka Tū Ake EQC, 2023).

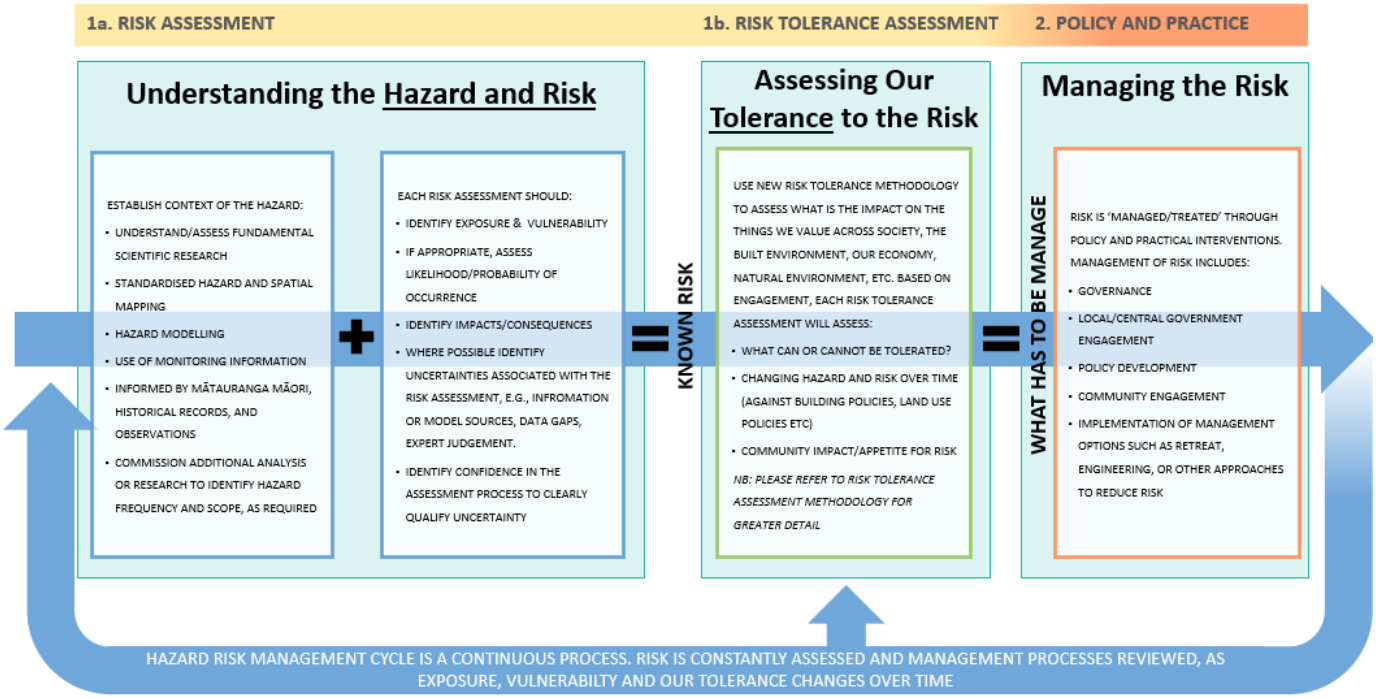

Figure 1 Approach to hazard risk management in Aotearoa NZ including the assessment of risk tolerance

New Zealand's current hazard risk management approach

How we understand and manage hazard risk in Aotearoa New Zealand can be conceptualised by:

1. Understanding the hazard in all its dimensions using data, models, and historic data to learn about possible scenarios that could impact us (including multi-hazard or cascading hazards). Our understanding of hazards is always improving with science and technology developments, which requires ongoing investment.
2. Understanding the risk the hazard presents (via a risk assessment) including the exposure and vulnerability of the things it might impact. This also includes considering the magnitude, intensity, duration, and evolution of the hazard scenario and likely consequences/impacts. If appropriate, the probability and likelihood of the hazard can also be assessed. Risk is not static and should be assessed regularly over time and as new science, data and knowledge are built, or as risk management measures are implemented (which will change exposure and vulnerability).
3. Managing the risk via policy, planning, and practice. When risk is understood in all its dimensions, (including uncertainty) an assessment of priorities for managing the risk can take place. This includes comparing all risks and identifying linkages and dependencies between risks to ensure risk-informed decision making for effective risk management.

Assessing risk tolerance - which involves reconciling different stakeholders' tolerances of risk, is generally missing from this process, given there is no standardised, agreed approach. To effectively treat and manage hazard risks a standardised approach to risk terminology and thresholds is required, as shown above in Figure 1 and in Appendix A.

Nationally agreed and consistent terminology

There is currently no consistent terminology for risk tolerability, for the definition of specific terms nor how they are used in Aotearoa New Zealand. This often leads to confusion on intent and thus inconsistent risk management outcomes. An example of this is the lack of direction on what 'significant risk' means under the Resource Management Act 1991, or how it is to be assessed, mapped, and planned for. Without national direction on what constitutes 'significant,' councils struggle to adequately plan for and manage risk.

A nationally accepted approach with agreed and adopted terminology—for example, 'intolerable,' 'tolerable,' and 'acceptable'—is a vital part of improving risk management. Additional clarifiers such as 'significant' or 'severe' could also be used to further describe risks beyond the overarching tolerability classifications.

Using agreed terminology will allow legislation and associated policies to describe risks in a consistent manner. For example, 'intolerable,' 'tolerable,' and 'acceptable' risks could correspond directly with 'removal,' 'reduction,' or 'monitoring' actions, respectively. This would allow for a consistent approach to how we treat the risk, while still allowing flexibility for specific hazards. It would also provide national direction to the response appropriate to that level of risk.

Toka Tū Ake EQC provided a recommendation for consistent terminology to the Environment Committee in their consideration of the Natural and Built Environments and Spatial Planning bills, provided in Table 1.

Table 1 - Risk terminology usage in NZ regional policy settings

LEVEL OF RISK	ASSOCIATED RISK TERMS	EXPLANATION	DESCRIPTIVE EXAMPLES
INTOLERABLE	Catastrophic Severe Unacceptable Extreme High	Risk cannot be justified except in extraordinary circumstances. Activity must cease until risk is removed or reduced.	Resilience of the land use has or will soon be exceeded beyond sustainable risk reduction measures, with continued use of the land no longer sustainable; and/or The coping capacity of a community or property has been exceeded, or will soon be exceeded; and/or Life safety and/or functionality of the building is threatened beyond risk reduction measures; and/or The consequential effects of the development on the environment will be irreversible. 'X' number of events leading to one or more of the points above have occurred in 'Y' years
TOLERABLE	Significant Substantial Medium Tolerable Acceptable	Risk is accepted only if the benefit gained is shown to outweigh the risk (using the 'As Low As Reasonably Practicable' principle[1]) Tolerable only if risk can be mitigated at a cost proportional to the benefit gained	The sustainable use of the land can continue with cost effective risk reduction measures; and Monitoring of the natural hazard and climate change risks is undertaken to allow changes in risks to be managed; and Communities can cope with the impacts from natural hazard events; and The life safety risk and/or functionality of the land use can be managed to safeguard the future of the land use.
ACCEPTABLE	Low Insignificant Negligible	Broadly acceptable Monitor and maintain assurance that risk remains at this level	Activity can occur with limited controls or restrictions.

[1] For a risk to be ALARP, it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained (Worksafe New Zealand, 2016), https://web.archive.org/web/20161009154527/http://www.worksafe.govt.nz/worksafe/information-guidance/all-guidance-items/hswa-fact-sheets/reasonably-practicable/reasonably-practicable.pdf).

Assessment of risk tolerance

A hazard and risk assessment does not have to follow a standard approach. Different methodologies exist and are used for different hazards and to serve different purposes. The companion risk tolerance literature review paper found that this allows the most appropriate methodology to be used. Various councils, sectors, and agencies have established unique hazard and risk assessment methodologies that are fit for purpose. For example, the approach to assessing risk for earthquake prone buildings is different to a climate change risk assessment.

However, to enable a consistent approach to assessing risk tolerance, the risk assessment should result in a clear level of known risk and include a transparent decision process. Once we understand a risk, we must consider whether we are willing to tolerate the consequences. Tolerance to the known level of risk should be assessed, by considering the following:

- The timeframe the level of risk will be present for. For example, policy cycles (~10yrs), spatial planning (~30yrs), built environment (~50yrs), climate change adaptation (~100yrs), etc.
- What is being impacted and to what extent. For example, numbers of deaths (social), cost to repair damage (economic), irreparably altered ecosystem (environmental), etc.
- Who bears the consequences of the risk or risk treatment option. For example, who are the stakeholders; do those who create the risk experience it or pay for its treatment, etc.
- Comparing the timeframes, consequences, and other factors against the pre-set risk thresholds (acceptable, tolerable, intolerable) to determine the overall risk tolerability.

Each part of the process should be well documented for transparency. These components are summarised in Figure 2 and in Appendix C.

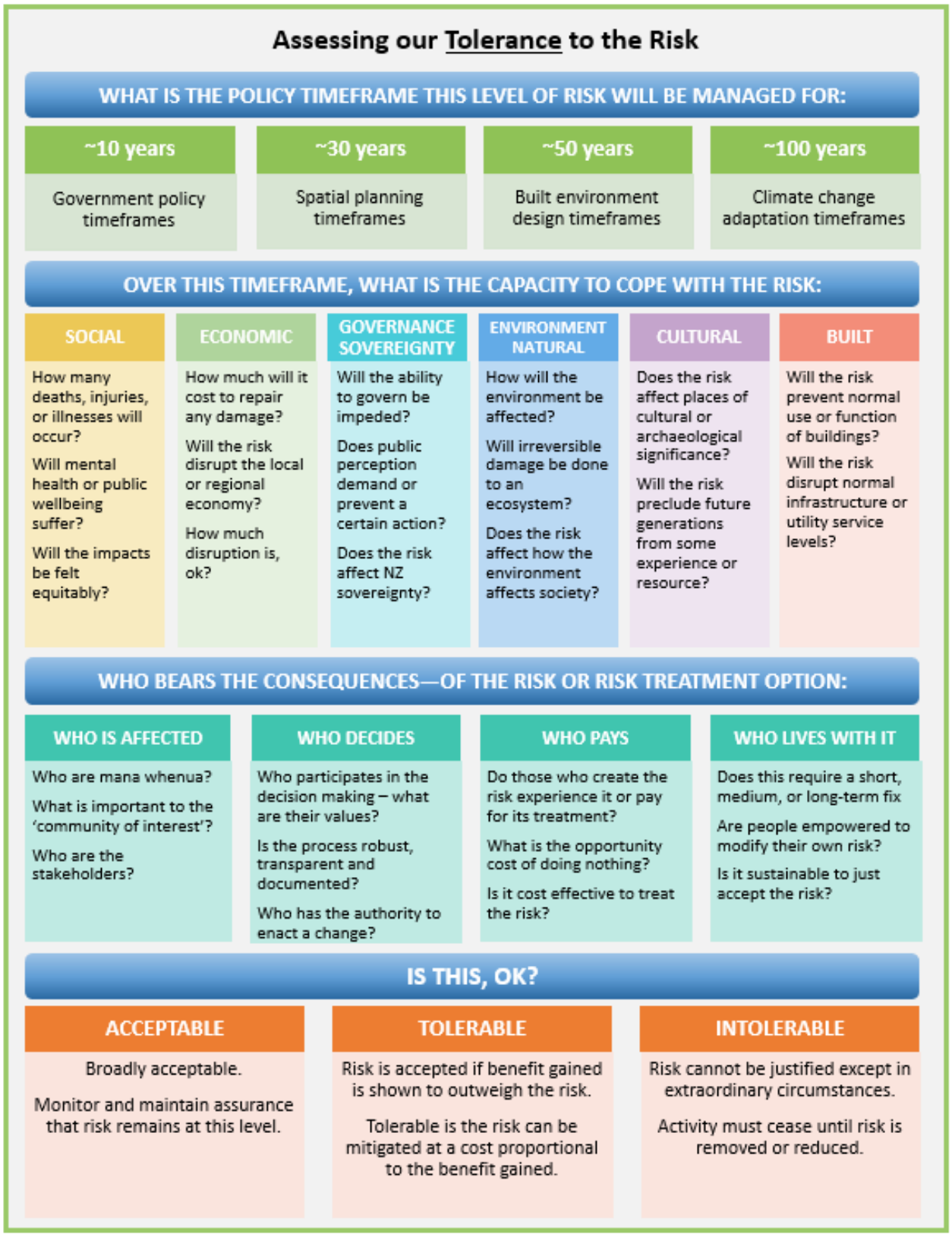

Figure 2 Assessment of risk tolerance

Tolerability Timeframes

Risk is a temporal phenomenon; it can vary over time due to changes in exposure, hazard, or vulnerability, or it may be acceptable in the present but become unacceptable at some point in the future. Additionally, the nature of some hazards (coastal flooding, for example) causes their impacts to grow exponentially with increasing timeframes. Scaling timeframes therefore does not necessarily directly correlate with scaling impacts or risk. A risk tolerance assessment should be able to reflect this by indicating a risk is presently one classification (e.g., currently 'tolerable') but will likely change over a different timeframe (e.g., become 'intolerable').

Government policies may be drafted for a 10-year period, while some climate change adaptation plans consider the next 100 years. Spatial planning considers matters for approximately 30 years, and the built environment typically assumes a 50-year design life for built assets. For example, a typical house in Aotearoa New Zealand is designed to be used for 50 years but may be in use well beyond this time. The risk associated with living in or using this house for those 50 years should be acceptable. But, living in the house for longer periods of time expose it to more—or more severe—hazards than intended, meaning the risk may increase to a point that is no longer acceptable (for example, the risk of living in a coastal location may be acceptable for 50 years, but after 75 years the coast has eroded metres and the risk is no longer acceptable).

Using the risk tolerance assessment framework shown in Appendix B reflects this. Assessing risk tolerance begins with understanding what timeframe the specific risk will be relevant for, as well as how it may change over time.

Consequences - what is being impacted and to what extent

Hazards can impact the things we value in different, and multiple ways, affecting our society, economy, the built environment, the natural environment, or culture and heritage. When hazard events result in a range of consequences, it is important to evaluate them in relation to each other. For example, how many deaths, injuries, or illnesses can a community or society cope with? Will a hazard impede the ability of a government to function? Will the local or national economy be able to absorb the cost of any damage or disruption? Will built assets be damaged or unusable, and for how long? Will an ecosystem undergo irreversible damage? Will places of cultural or archaeological significance be affected?

Impacts should be benchmarked against the possible range of outcomes for that specific type of consequence, and then considered against the risk threshold criteria (acceptable, tolerable, intolerable).

Engagement

Robust engagement must drive any risk tolerance assessment. Those who bear the consequences of the risk or risk management options are crucial in this process. Engagement will involve many diverse groups of stakeholders, therefore a rigorous process for reconciling different views or risk tolerances is also needed.

To be effective, engagement must consider:

- Who is affected, who is determined to be the 'community of interest,' and what is important to them.
- Who has been affected, and what their residual experience or attitudes are.
- Who contributes to the decision-making process. Do they have the authority to make a change?
- Who will pay either directly or through risk financing, for the risk management options.
- Who will live with the consequences, and are they empowered to make a change through this process.

A different engagement approach will be needed for Māori, whose timeframes for risk tolerance extend well beyond policy years to generations. In addition to the points above, other cultural factors need to be considered in any risk tolerance conversations with Māori, for example the protection of whakapapa, knowledge of their history, what Mātauranga Māori they hold, what local atua they may relate to, any sites of significance, connections to the whenua, and any Crown Te Tiriti o Waitangi obligations.

Any engagement requires consideration of the past, present and future experiences and events. Empathy, respect, and compassion needs to be shown, with an understanding of any equity challenges that communities may face.

Risk tolerance thresholds

The risk tolerance thresholds refer to 'acceptable,' 'tolerable,' or 'intolerable' levels of risk.

Risk thresholds must be determined independently of any individual risk assessment. Risk thresholds should reflect societal views and priorities, e.g., how many deaths or what cost of damage becomes unacceptable, regardless of the hazard or risk. Results from individual risk assessments are compared to these thresholds to contextualise the results, and then direct risk management. Following consideration and assessment of the known risk against timeframes, consequences, and through engagement, risk can be effectively prioritised and managed through existing policy frameworks. Risk tolerance criteria should be monitored over time, to review any changes in risk tolerance as, for example, events of a time dependent nature evolve, or as new information emerges, or market conditions change, etc.

With any type of risk assessment there is uncertainties (e.g., in modelling, data) in the outcome. Decision makers need to have a certain amount of confidence in the information they have (including how risk tolerance has been assessed), considering these uncertainties. To help with this, the precautionary principle should be used i.e. where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (UNGA, 1992).

Risk tolerance needs to be considered at national, regional and local levels, and some of the considerations will overlap (see Figure 3), as discussed below.

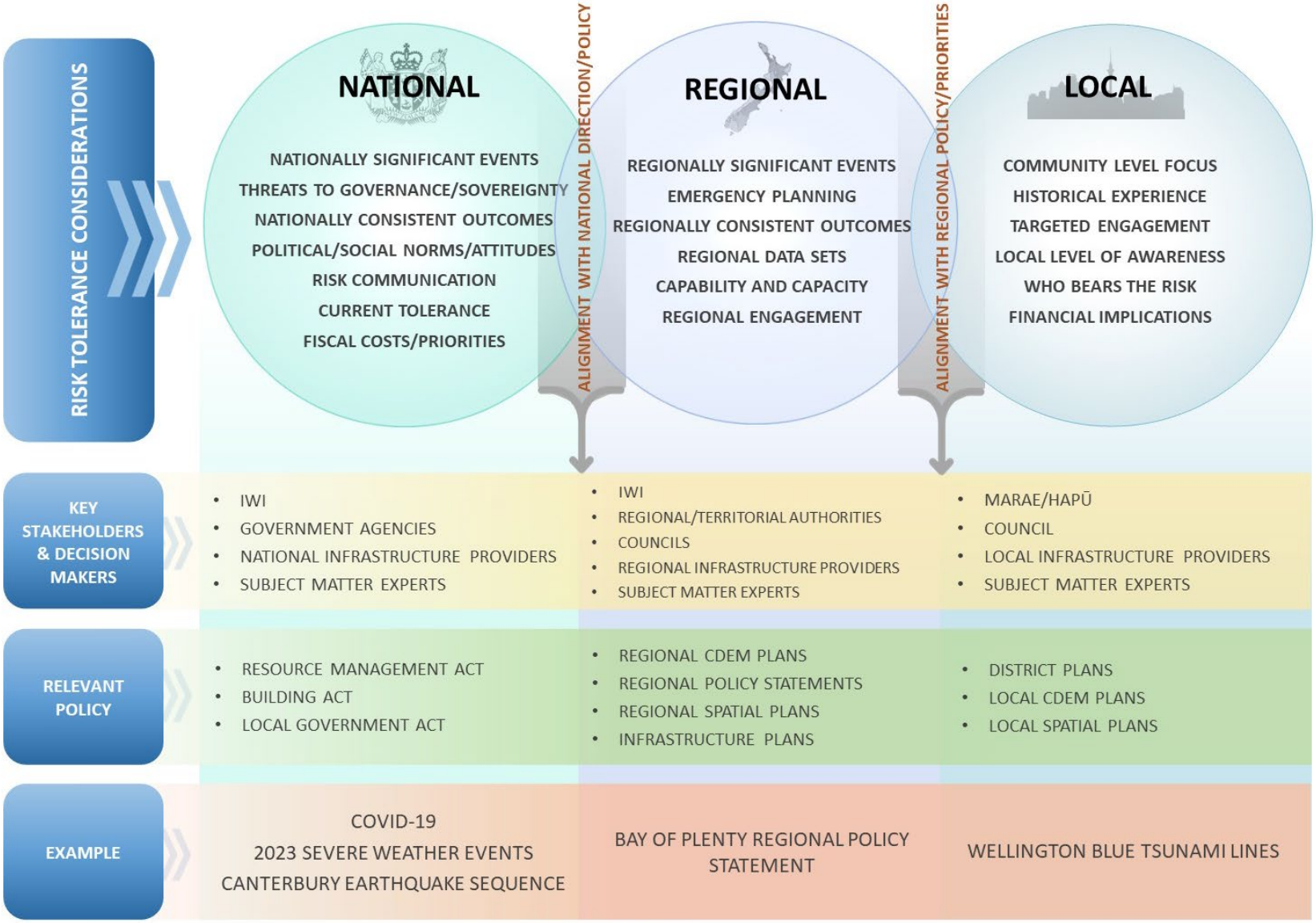

Figure 3 Example of National, Regional and Local risk tolerance considerations

National level

Nationally there are various policies, codes, and standards that manage natural hazard risk, including understanding, planning for, and responding to, natural hazard risk. Consistent approaches and implementation for risk tolerance and thresholds should ideally sit in national legislation, for example, the Building Act 2004 and The Resource Management Act 1991. When assessing a known or new risk at the national level, or whether new policy instruments are required to manage the risk, key aspects to consider include:

- Current Government priorities.
- General political appetite.
- Implications for other priorities and policies (e.g., regulatory impact)
- Scope and scale of impact.
- Cultural impacts.
- Impact on governance and sovereignty.
- Fiscal priorities, budgetary or other financial implications.
- Community expectations of how government should manage the risk.
- Impacts on communities, including past experience of impacts.
- What is currently tolerated, and will this change in the future (e.g., with the climate change impacts).
- Political will vs public perception and acceptance.
- How the risk will be communicated or is communicated (e.g., how the probabilities of the Covid-19 pandemic were described, before and during the management of the pandemic).

Examples of when the risk tolerance assessment would be used nationally include when deciding on managing a national risk that either frequently occurs across many areas with low impact (but high overall associated cost), or a risk that has high consequence and high associated costs but occurs less frequently. Management of these risk(s) needs to be prioritised and a risk tolerance assessment supports pragmatic decision-making and prioritisation based on the above bullet points.

Regional level

Risk tolerance criteria should be determined by the appropriate national-level policy and then applied with a regional focus considering the stakeholder tolerances in the regional context, for example with building requirements, emergency management planning, engineering options, insurance, regional data sets, community appetite for the risk threshold or the risk management, and expert opinion. A key aspect of using the risk tolerance methodology regionally is the level of engagement required. Engagement with territorial authorities, regional councils, Māori, infrastructure providers, private sector stakeholders, and others should be ongoing, and regularly monitored. Taking a regional approach to assessing risk tolerance extends consistency to the sub-national level.

Local level

Locally, risk tolerance criteria are directed by regional level policy and any outcomes reached from their risk tolerance assessment. The key and most important difference with the local approach to assessing risk tolerance is that the assessment has a community level focus. Local risk tolerance criteria are informed and developed with cross community engagement to assess levels of risk tolerance with marae, hapū, local community service providers, different community representatives (e.g., disabled, youth, elderly, religious, and other subject-matter experts) using best available local data. Before engaging with communities, the level of understanding of the risk across the community should be assessed. Without this, working through a decision on tolerability will become complex, and misunderstanding. may arise within the community about what the risk represents.

Things to consider when engaging with the community include, but are not limited to:

- Who is bearing the impacts of the risk management decision?
- Has there been any exposure to previous events?
- Age range of the communities - this related to decisions regarding age care facilities, schools and play facilities, alongside other related community needs.
- Cultural views.
- Expectations for their whānau and community.
- Levels of awareness and understanding of risk, risk management, and the impact of these events on the things a community values.

An example of when the risk tolerance assessment would be used locally is when making decisions on options for climate adaptation using the dynamic adaptative pathways [2]approach. A community's tolerance for sharing the costs based on a set level of protection, the expected life of that protection, and what other actions will still be required, all need to be assessed. The community's risk tolerance will influence which options are decided upon and the associated adaptive pathway triggers and thresholds.

[2] Dynamic adaptive planning specifies actions to be taken immediately to be prepared for the near future, and actions to be taken now to keep options open to adapt if needed in the future (www.deltares.nl/en/expertise/areas-of-expertise/sea-level-rise/dynamic-adaptive-policy-pathways)

Using the Methodology

The risk tolerance methodology should be used for the assessment of current and future risks. In all cases, the following must be considered and thoroughly documented:

- What information has been used to ascertain the risk. This should be based on the best available information such as scientific data and/or, modelling. In the absence of scientific information, the most practicable information should be used, such as local knowledge or historic accounts. Any limitations of that information should also be documented.
- The risk tolerance criteria appropriate for your sector: e.g., 'acceptable,' 'tolerable,' or 'intolerable' risk thresholds. These can be agreed and accepted via engagement, especially with those managing, paying for, or living with the risk and risk treatment option.
- What timeframes you are assessing the risk against e.g., district planning time horizons, governance times frames, or hazard return periods.
- Who will be impacted: this could include councils, organisations, Māori, infrastructure providers and communities. Develop an engagement plan that outlines the known risk, and the assessment process being undertaken to determine how the risk will be managed.
- What policies, codes, standards, etc. can help manage the risk: review current tools before committing to any option.
- Different options available for managing the risk: this may look like an options matrix and include looking across various sectors and policy initiatives.
- An agreed and documented review period: understanding of hazard, risk, and risk tolerance will change over time, as will the effectiveness of policies and risk management approaches. There should be commitment to a frequent review period for risk assessments, risk tolerance assessments, and evaluation of the policy effectiveness.
- Any uncertainties should be articulated and ways to address these in the future proposed.

The result of the risk tolerance assessment should be a clear risk classification (i.e., 'acceptable,' 'tolerable,' or 'intolerable'). Policies aligned with risk tolerance thresholds will enable consistent and effective management of the risk. Engagement on the available policy options will then direct the implementation of the chosen risk management response.

National, regional, and local policy options should be developed or adapted to align with the risk classifications. For example, an 'intolerable' risk should directly trigger policies that enable the appropriate response, such as avoiding or controlling the risk.

Groups affected by either the risk or the risk treatment option should be engaged on their preferred risk management approach associated with the resulting risk classification. Groups or communities who live with the outcomes of the risk management solutions must be empowered through the decision-making process. But central government should monitor the process and outcomes for consistency across risk management.

Appendix D provides examples for how this methodology could be used to manage earthquake-prone buildings.

Acknowledgements

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- Don Bogie – Department of Conservation
- Dr. Gill Jolly – GNS Science
- Scott Kelly – GNS Science

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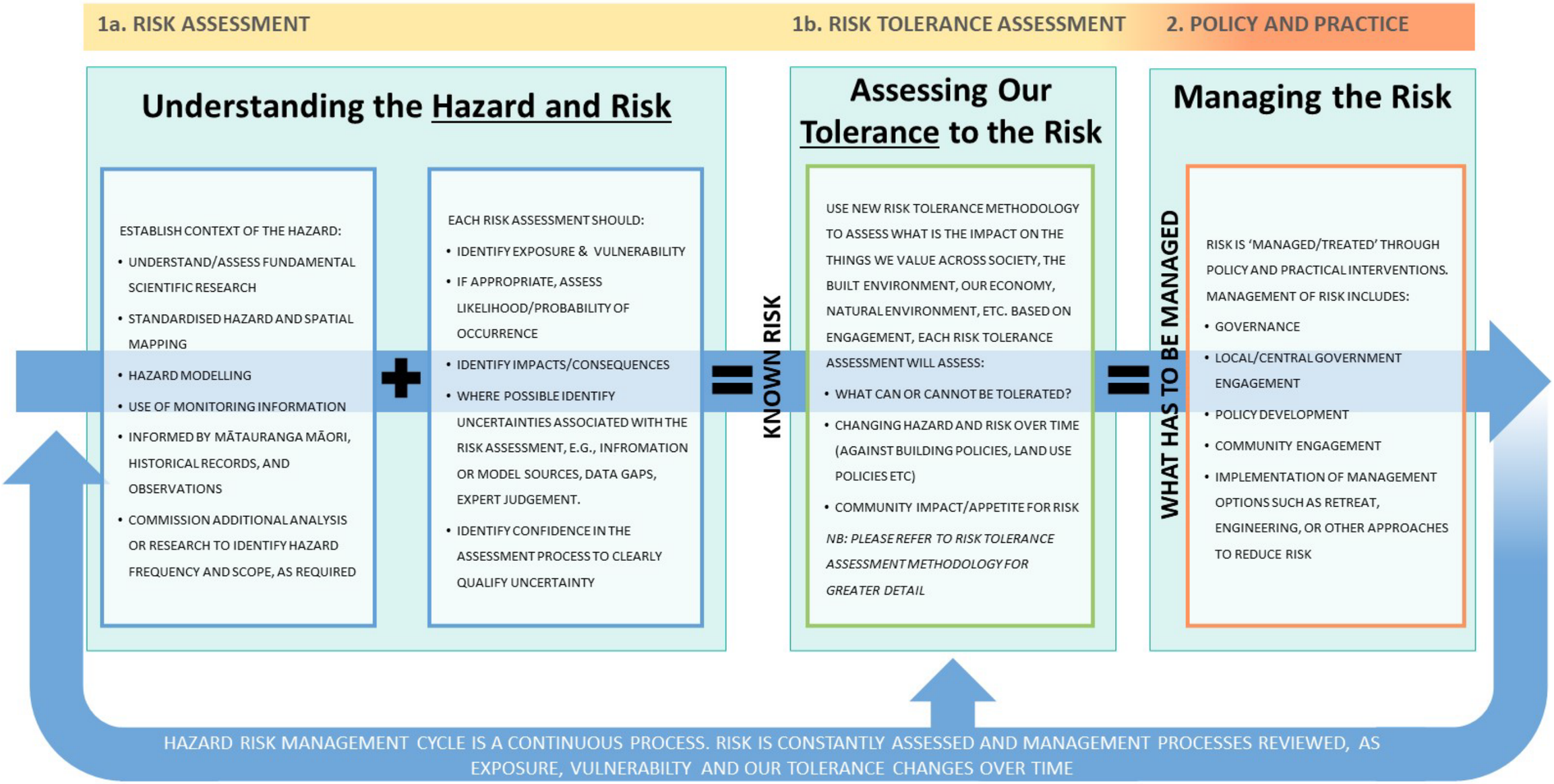
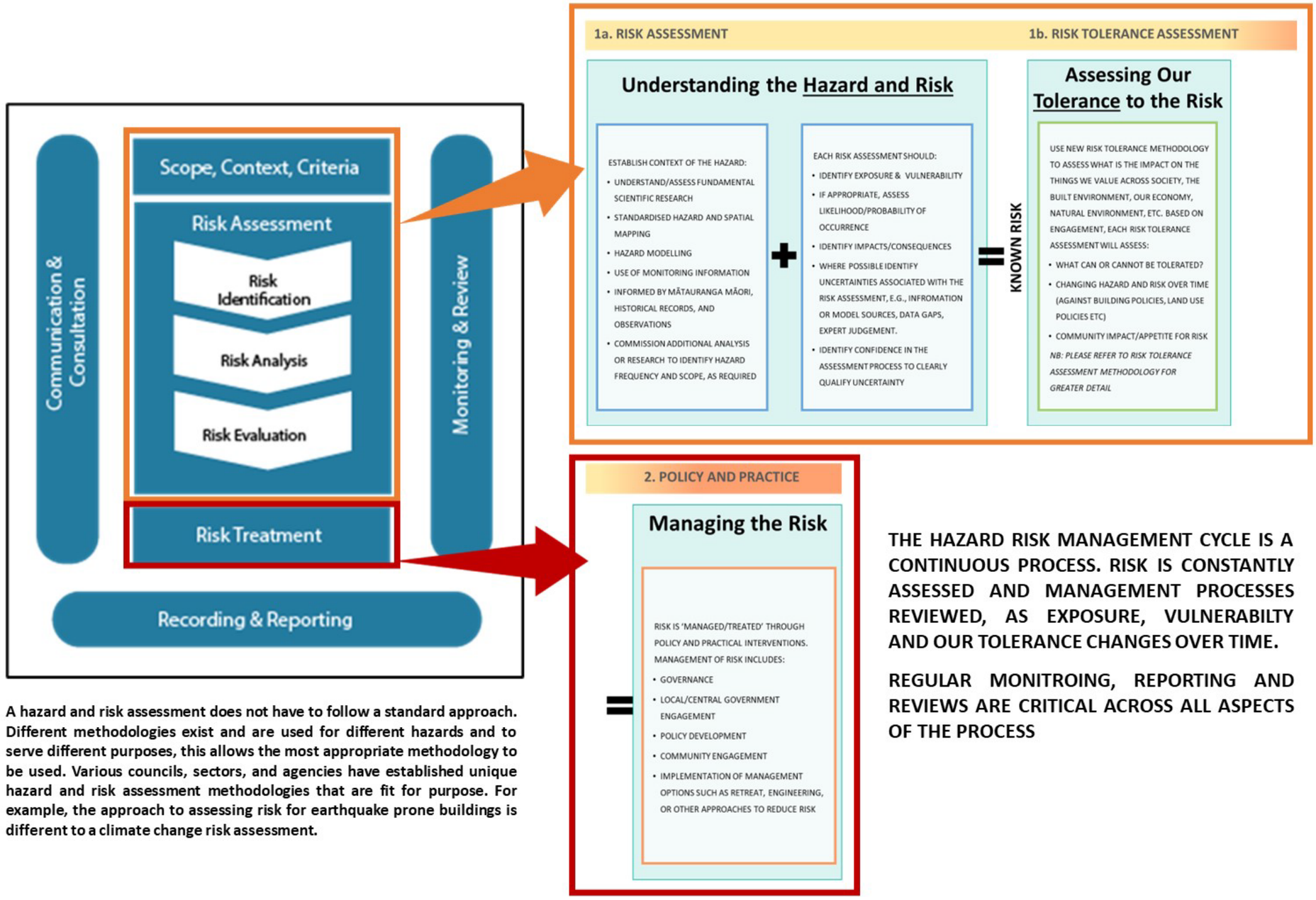
Appendix A: Aotearoa New Zealand's Hazard Risk Management Framework

The figure below details the high-level approach to hazard risk management in Aotearoa New Zealand, including the assessment of risk tolerance. Once risk is known, risk tolerance should be assessed in order to identify the appropriate risk management considerations, interventions, and options.



Appendix B: Example of where ISO 31000:2018 sits in the Natural Hazard Risk Management Framework

The figure below is an example of how any risk assessment methodology can be integrated into the hazard risk management framework that includes the assessment of risk tolerance.



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THE HAZARD RISK MANAGEMENT CYCLE IS A CONTINUOUS PROCESS. RISK IS CONSTANTLY ASSESSED AND MANAGEMENT PROCESSES REVIEWED, AS EXPOSURE, VULNERABILTY AND OUR TOLERANCE CHANGES OVER TIME.

REGULAR MONITROING, REPORTING AND REVIEWS ARE CRITICAL ACROSS ALL ASPECTS OF THE PROCESS

Appendix C: Risk Tolerance Assessment Criteria

The figure below expands on the risk tolerance assessment 'box' shown in Appendix A. It details the criteria for assessing risk tolerance.

Assessing our Tolerance to the Risk

WHAT IS THE POLICY TIMEFRAME THIS LEVEL OF RISK WILL BE MANAGED FOR:

~10 years	~30 years	~50 years	~100 years
Government policy timeframes	Spatial planning timeframes	Built environment design timeframes	Climate change adaptation timeframes

OVER THIS TIMEFRAME, WHAT IS THE CAPACITY TO COPE WITH THE RISK:

SOCIAL	ECONOMIC	GOVERNANCE SOVEREIGNTY	ENVIRONMENT NATURAL	CULTURAL	BUILT
How many deaths, injuries, or illnesses will occur? Will mental health or public wellbeing suffer? Will the impacts be felt equitably?	How much will it cost to repair any damage? Will the risk disrupt the local or regional economy? How much disruption is, ok?	Will the ability to govern be impeded? Does public perception demand or prevent a certain action? Does the risk affect NZ sovereignty?	How will the environment be affected? Will irreversible damage be done to an ecosystem? Does the risk affect how the environment affects society?	Does the risk affect places of cultural or archaeological significance? Will the risk preclude future generations from some experience or resource?	Will the risk prevent normal use or function of buildings? Will the risk disrupt normal infrastructure or utility service levels?

WHO BEARS THE CONSEQUENCES—OF THE RISK OR RISK TREATMENT OPTION:

WHO IS AFFECTED	WHO DECIDES	WHO PAYS	WHO LIVES WITH IT
Who are mana whenua? What is important to the 'community of interest'? Who are the stakeholders?	Who participates in the decision making – what are their values? Is the process robust, transparent and documented? Who has the authority to enact a change?	Do those who create the risk experience it or pay for its treatment? What is the opportunity cost of doing nothing? Is it cost effective to treat the risk?	Does this require a short, medium, or long-term fix Are people empowered to modify their own risk? Is it sustainable to just accept the risk?

IS THIS, OK?

ACCEPTABLE	TOLERABLE	INTOLERABLE
Broadly acceptable. Monitor and maintain assurance that risk remains at this level.	Risk is accepted if benefit gained is shown to outweigh the risk. Tolerable is the risk can be mitigated at a cost proportional to the benefit gained.	Risk cannot be justified except in extraordinary circumstances. Activity must cease until risk is removed or reduced.

Appendix D: Risk Tolerance Assessment Criteria

A worked example for including risk tolerance evaluation within risk management in Aotearoa New Zealand is provided below. It is an illustrative example only and draws on existing risk management tools. The worked example below indicates where certain considerations (e.g., timeframes or explicit risk tolerability levels) should be considered but where there are not necessarily well-defined criteria. Part of adopting this risk tolerance methodology would be to better align and define these criteria.

Managing earthquake-prone buildings

Aotearoa New Zealand is a seismically active country. While many of our buildings built to modern building codes and standards are well designed to withstand seismic shaking, some older buildings or buildings built using specific techniques are now known to be more vulnerable to damage—and potentially collapse—in earthquakes. The national earthquake-prone building (EPB) system addresses the worst risks to people from these buildings.

The system is founded on a wealth of experience, information, and research that has come from past earthquakes in Aotearoa New Zealand. Our understanding of earthquakes is constantly growing through targeted scientific research or monitoring like through GeoNet, and it contributes to shared tools like the National Seismic Hazard Model. Engineering practitioners apply this understanding to existing buildings and assess how well buildings are expected to withstand certain levels of earthquake shaking. Depending on the capacity of the building to resist earthquake shaking, and the seismic hazard in the area it is located, the building may be required to be strengthened to a certain level, or demolished, within a specific timeframe.

The EPB system carries an inherent risk tolerance assessment, though aspects are unclear. Engineering assessments of existing buildings provide a known level of risk. The level of risk is then considered for specific timeframes specified in legislation ranging from 7½ to 35 years. The primary objective of the EPB system is to protect human life, a social impact. Other cascading impacts also include damage to the built environment, disruption of normal function due to building damage, the economic costs of damage and disruption, and environmental impacts from damaged building debris. Building owners are seen as major stakeholders in the system as they ultimately decide to either strengthen or demolish, and how quickly. However, public life safety is still the primary objective.

The EPB legislation only specifies actions (demolish or strengthen) for building risks effectively deemed ‘intolerable’. However, commercial and non-regulatory pressures can result in other actions occurring with lower risk buildings than the EPB system specifically targets. Because the EPB system only demands action for certain buildings or within certain timeframes, it can be interpreted that the associated risk of other buildings is tolerable, at least for now. Even a designated EPB (<34%NBS) that is not a ‘priority’ building and is in a ‘High seismic risk’ area is effectively deemed ‘tolerable’ for 15 years, because the benefit of its use is gained without any additional risk treatment being required in that time. However, beyond the 15-year timeframe, that level of risk becomes intolerable.

Example: Earthquake-prone buildings

Hazard Risk Assessment

Understand the Hazard

Establish The Context
- *New Zealand is a seismically active place*
- *Buildings built with older standards or practices are now known to be more vulnerable to damage in earthquakes*

Understand/Assess Fundamental Scientific Research
- *Ongoing research from GNS Science, universities, researchers, engineers, etc.*

Hazard Mapping
- *New Zealand National Seismic Hazard Model*
- *New Zealand seismic loading standard seismicity maps*

Hazard Modelling
- *New Zealand National Seismic Hazard Model*

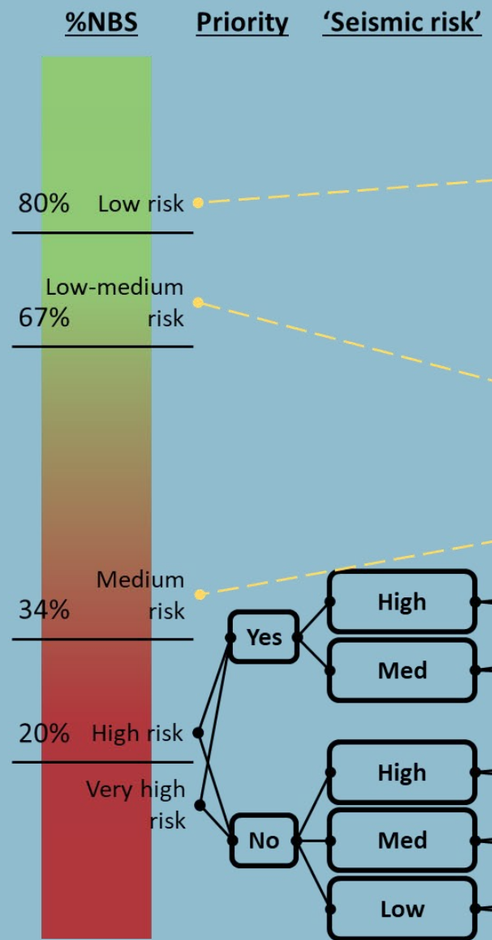
Assess Available Data
- *Building damage trends following past earthquake events*
- *New Zealand seismic record*

Use Monitoring Information
- *GeoNet*
- *GeoNet Built Environment Instrumentation Programme*

Use Historical Records And Observations
- *Canterbury Earthquake Sequence 2010-2011*
- *Kaikōura Earthquake 2016*

Understand the Risk

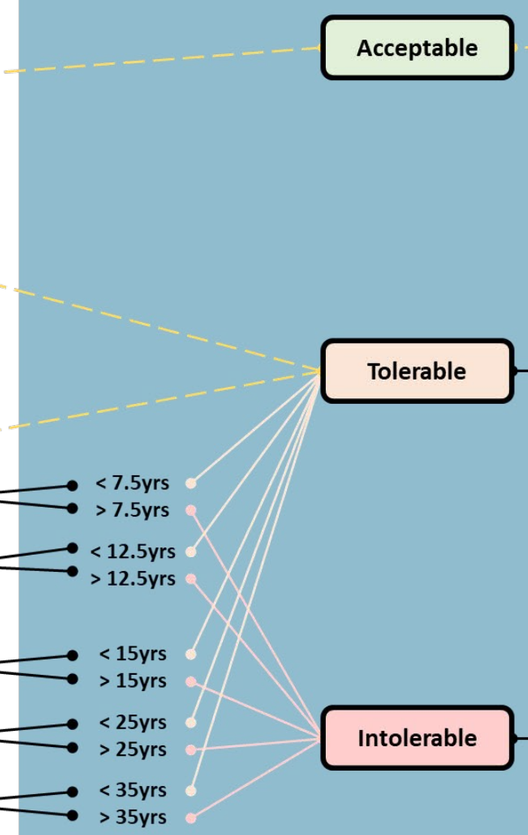
EPB methodology
- *Recognised and administered by MBIE*
- *Assessments are undertaken by qualified technical professionals*
- *Assess building vulnerability against expected 'code' level earthquake shaking*
- *Determine expected consequential building damage*



Risk Tolerance Assessment

Assessing our Tolerance to the Risk

- *Building damage is used as an indicator of life safety (human health/fatality risk)*
- *Timeframes set in legislation*
- *Tolerability to %NBS levels set in legislation*

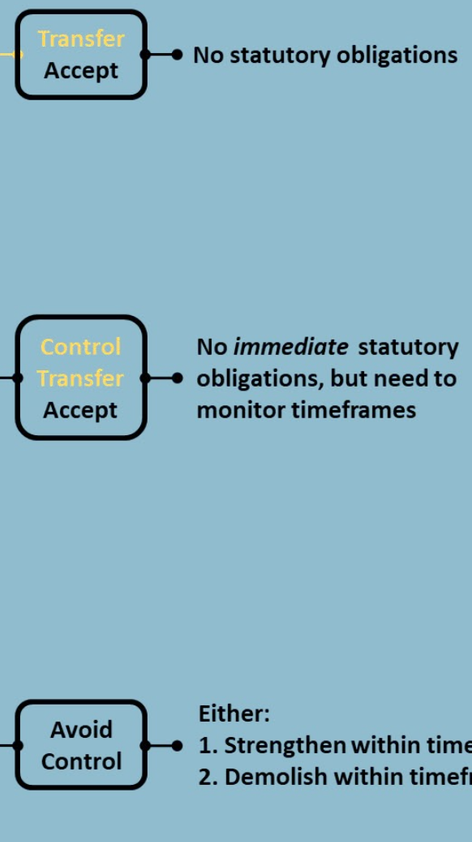


Policy and Practice

Managing the Risk

Building (Earthquake-prone buildings) Amendment Act 2016
- *National policy*
- *Sets requirements for local government*
- *Sets requirements for owners of earthquake-prone buildings*
- *Involves significant engagement with and support for owners of earthquake-prone buildings*

**Commercial (non-regulatory) drivers*



Te Kāwanatanga
o Aotearoa
New Zealand Government

Toka
Tū Ake EQC