2013

Plan Topics

Natural Hazards

Natural Hazards

This guidance only includes changes to the RMA as a result of the Resource Management Amendment Act 2013 that are already in force. Part 3 of the Amendment Act will come into effect on 3 March 2015, which is 18 months from the date of Royal Assent (3 September 2013). For more information about the amendments please refer to the Ministry for the Environment's – Fact Sheets available from the Ministry's website.

New Zealanders are exposed to a wide variety of natural hazards that impact on people, property, infrastructure and the wider environment. As our use of the environment is instrumental in hazard creation, any increases in use or changes in activities can exacerbate the risks of hazards through increasing the likelihood or severity of their effects. Climate change is also likely to change the frequency and range of some hazards from what we currently understand from past experience. As such, it is ever more important for those managing and planning for natural hazards to improve systems and techniques for planning for and responding to, natural hazard risks. Planning for hazards can reduce the potential for loss of life and injury, damage and destruction of property, and negative impacts to our natural, social/cultural, economic and built environments and well-being.

This guidance note has been prepared for planners, but it is also aimed at informing politicians, hazards analysts, emergency management officers, technical specialists, consultants and others involved in natural hazard management.

This guidance note is primarily about RMA planning for natural hazards. Local authorities need to also consider the broader institutional arrangements for managing hazards and emergencies, notably under the Civil Defence and Emergency Management (CDEM) Act 2002. This note provides guidance on:

1. Natural hazard terms, the legislative framework and roles and responsibilities for natural hazard management
2. A risk-based approach to planning for natural hazards
3. An integrated approach to natural hazard management
4. RMA techniques and tools for managing natural hazards
5. Non-RMA techniques and tools for managing natural hazards
6. Managing specific hazards through resource management plans
7. Managing hazards through monitoring and review processes

Climate change is not dealt with as a hazard in itself but is recognized as an influence on the future frequency and severity of hazards such as flooding, drought, and erosion. Further information on climate change can be found in the Climate Change Guidance Note and on the Ministry for the Environment website. A summary of the climate change effects applicable to New Zealand is provided in this note.

Guidance note

Introduction to natural hazards and the legislative framework for hazard management

Risk-based approach to planning for natural hazards

Integrated approaches to hazard risk management

Overview of RMA tools for managing natural hazards

Managing specific natural hazards through RMA plans

Non-RMA techniques and tools for managing natural hazards

Managing hazard risk through the monitoring and review process

Summary of climate change effects applicable to NZ

Glossary

Introduction to natural hazards and the legislative framework for hazard management

Terms and definitions

Natural hazard management in New Zealand is underpinned by key concepts, terms and definitions. It is important to use the correct terms and definitions when referring to natural hazards to aid clarity and simplicity in understanding.

Where possible, use terms and definitions from key legislation and ensure that there is consistency between policy documents in how hazards are referred to.

Policy documents should provide a definition of a 'natural hazard'. The term is defined in the Resource Management Act (RMA) 1991 and Building Act 2004, while the CDEM Act defines hazards more generally. The definitions do differ somewhat due to the context in which they apply to. As such, the one you use is dependent on the type of plan or strategy being developed and the legislation it was developed under.

The ISO Guide 73: 2009, Risk Management – Vocabulary provides a collection of terms and definitions relating to the management of risk.

A glossary of key terms used in this guidance note is located at the end of this guidance note.

Adopting a 4 'Rs' approach

A key concept of the CDEM Act is applying the '4 Rs' (**R**eduction, **R**eadiness, **R**esponse, **R**ecovery) to hazard management. Reduction aims to mitigate or avoid the risks of hazards, readiness to minimise potential impacts from an event through preparedness steps, and response and recovery to address the impacts in an event including any escalation of them. Each 'R' is related to, and overlaps with, the others. For example, recovery can begin alongside response; and reduction measures can be part of recovery activities. RMA planning generally (but not exclusively) falls under 'reduction'. Reduction approaches are the primary focus of this guidance note, however, it is acknowledged that the recovery process can provide opportunities for building community resilience that may include RMA processes.

The legal framework for natural hazard management in New Zealand

Local Government Act 2002

The Local Government Act 2002 provides the general framework, obligations, restrictions and powers under which local authorities operate.

The key sections of the Act are:

Section 10	(1) The purpose of local government is— (a) to enable democratic local decision-making and action by, and on behalf of, communities; and (b) to meet the current and future needs of communities for good-quality local infrastructure, local public services, and performance of regulatory functions in a way that is most cost-effective for households and businesses.
Section 11A	In performing its role, a local authority must have particular regard to the contribution that the following core services make to its communities: (a)network infrastructure: (b)public transport services: (c)solid waste collection and disposal: **(d)the avoidance or mitigation of natural hazards:** (e)libraries, museums, reserves, recreational facilities, and other community infrastructure.
Section 145	Gives local authorities the power to make bylaws, including for the purpose of protecting, promoting, and maintaining public health and safety.
Section 163	Specifies powers in relation to the removal of works in breach of bylaws.
Sections 93-97	Provide for Long Term Plans that describe the activities of local authorities. This can include descriptions of local authority activities as well as the management of natural hazards.

Instruments of the Civil Defence and Emergency Management (CDEM) Act 2002

The CDEM Act aims at the comprehensive management of hazards and risks, and emergency response and recovery, through coordinated and integrated policy, planning and decision-making processes at the national and local level. It sets out the duties, functions and powers of central government, local government, emergency services, lifeline utilities and the general public.

The Act is administered by the Ministry of Civil Defence and Emergency Management.

The key instruments established by the CDEM Act include:

- establishment of a CDEM framework, including:
  - CDEM regulations
  - National CDEM Strategy
  - National CDEM Plan
  - CDEM group plans
  - Director's Guidelines

  - the Guide to the National CDEM Plan
  - other statutes
- appointment of a Director of CDEM
- establishment of Civil Defence Emergency Management Groups
- requirement for the preparation of Civil Defence Emergency Management Plans
- setting out emergency declarations and powers including states of emergency.

Building Act 2004

The Building Act 2004 provides for the regulation of building work, the licensing regime for building practitioners, and the setting of performance standards for buildings. It manages natural hazards in relation to the construction and modification of buildings.

Also relevant are the Building Regulations 1992 (including the Building Code) and Building (Specified Systems, Change the Use, Earthquake-Prone Buildings) Regulations 2005.

The key sections of the Act are:

Section 35	Content of project information memoranda
Section 37	Additional certificates that must be attached to project information memoranda
Section 71	Building on land subject to hazards. Includes a definition of natural hazard
Section 72	Building consents for building on land subject to natural hazards must be granted in certain cases
Section 73	Conditions on building consents granted under section 72

Local Government and Official Information and Meetings Act 1987

The Local Government and Official Information and Meetings Act provides for the public availability of official information held by local authorities, and to promote the open and public transaction of businesses at local authority meetings. Section 44A provides for land information memorandum (LIM) and includes the matters which must be included in a LIM.

Other relevant legislation

- Environment Act 1986: sets out the function of the Parliamentary Commissioner for the Environment (s16) and Ministry for the Environment (s31), including obligations in the management of natural hazards (s17 and s32).
- Soil Conservation and Rivers Control Act 1941: makes provision for the conservation of soil resources, the prevention of damage by erosion and aims to make better provision for the protection of property from damage by floods.
- Land Drainage Act 1908: establishes drainage districts and boards and powers of local authorities relating to watercourses and drains.
- Forest and Rural Fires Act 1977: provides for the safeguarding of life and property related to fire in forests and rural areas.
- Earthquake Commission Act 1993: makes provision with respect to the insurance of residential property against damage caused by certain natural disasters.

- Canterbury Earthquake Recovery Act 2011: to facilitate the recovery of Canterbury following the 2010/2011 earthquakes. Also see the Canterbury Earthquake Recovery Authority (CERA) website for a full list of legislation relating to the earthquakes.

Roles and responsibilities for natural hazards management

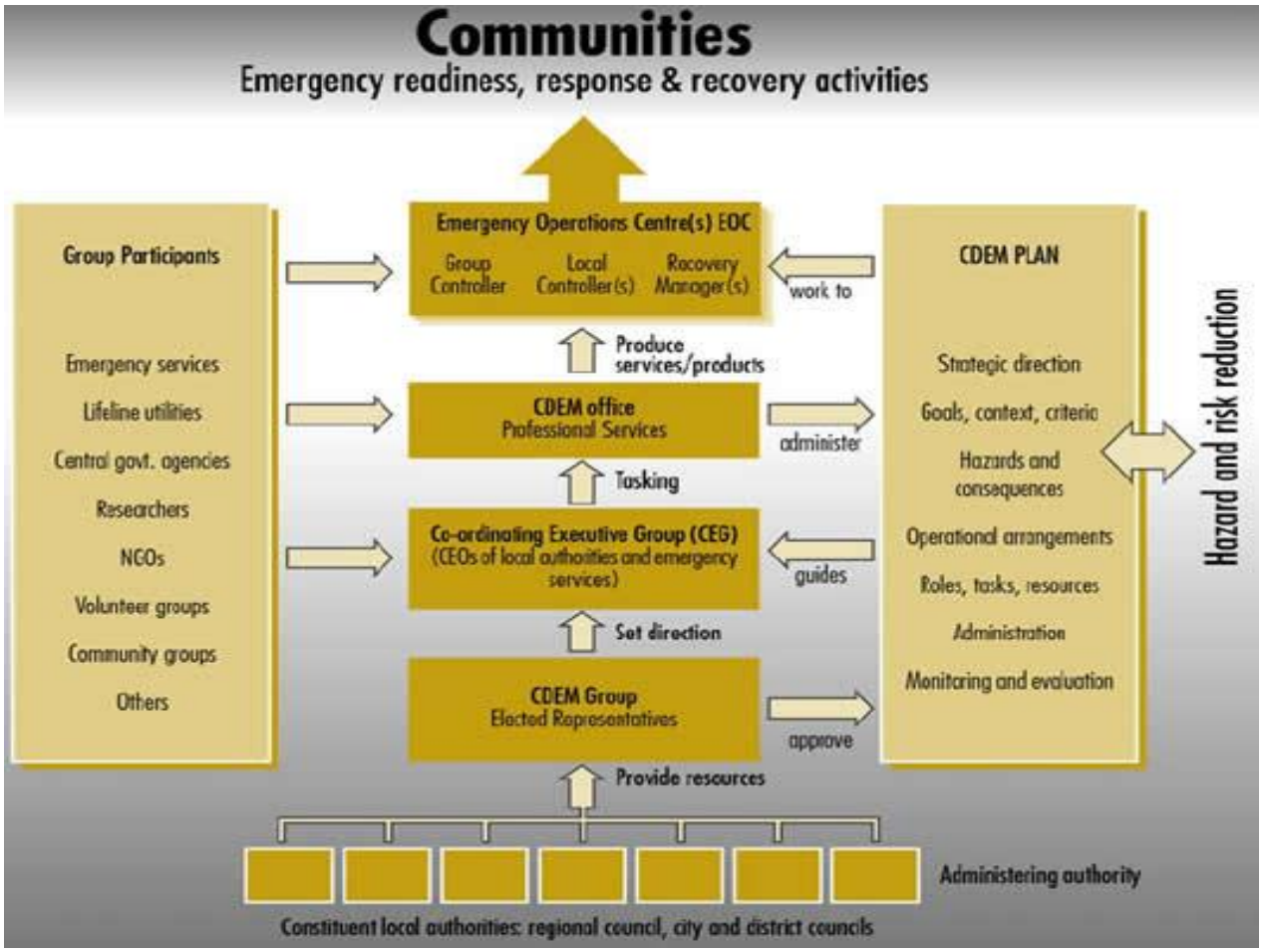
No one agency is responsible for natural hazard management in New Zealand. Rather, natural hazard management responsibilities extend to a wide range of organisations. However, local authorities play a pivotal role at the local community level.

Natural Hazards: Roles and Responsibilities

Ministry of Civil Defence and Emergency Management (MCDEM)	To support the functions of the Director of CDEM in overseeing that arrangements are in place nationally to manage hazards across the 4Rs in the event of a civil defence emergency. This involves promoting for, advising on and monitoring the integration and coordination of policies, planning, procedures and resources across agencies at both the national and local levels (CDEM Act 2002).
Regional councils	Control the use of land for the purpose of the avoidance or mitigation of natural hazards (s30 RMA 1991). Section 62(1)(i) of the RMA requires a regional policy statement to specify objectives, policies and methods relating to the avoidance and mitigation of natural hazards. In accordance with s62(2) of the RMA, if a regional council does not set out responsibilities for functions relating to natural hazards, then the regional council retains the primary responsibility.
Territorial authorities	Control the effects of the use of land for the avoidance or mitigation of natural hazards (s31 RMA 1991). Territorial authorities are also given the authority to control subdivision under s31(2) and have discretion under 106 to refuse a subdivision consent where the land is subject to hazards, or the subsequent use of the land will exacerbate the hazard.
Emergency management officers	Carry out specific initiatives and ensure that procedures are in place at the local level for hazard and emergency management (CDEM Act 2002).
Civil Defence and Emergency Management Groups	Based on regional boundaries, they comprise representatives from local councils, emergency services, health boards and other organisations that are involved with emergency management (see figure below) (s12-24 CDEM Act 2002).
Engineering Lifelines Groups	A voluntary group of organisations with representatives from territorial authorities and major utility and transportation sector organisations. These voluntary organisations support their members in meeting their obligations with respect to networks providing the basic necessities of life and services essential to limiting the extent of an emergency. Engineering lifeline groups are co-ordinated at the national level by the National Lifeline Engineering Committee.
Canterbury Earthquake Recovery Authority	The agency leading and coordinating the ongoing recovery effort following the devastating earthquakes of September 2010 and February 2011.

The following diagram from the Guide to the National Civil Defence Emergency Management Plan shows how the various organisations work together.

Activities for emergency readiness, response and recovery activities



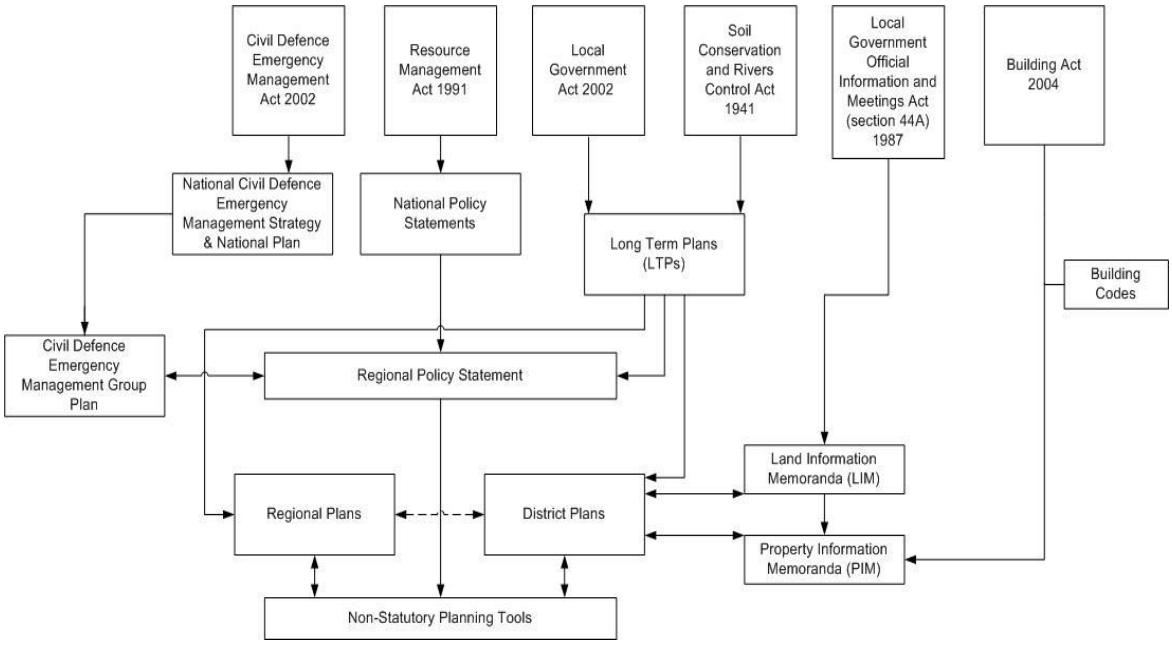
The diagram above shows the various groups involved in emergency readiness, response and recovery activities. Group participants are shown in a box on the left-hand side, CDEM organisations in the centre, and the contents of the CDEM Plan are set out on the right-hand side. Arrows show how these various components interact.

Natural hazard management activities undertaken by regional and territorial authorities

Regional councils (hazard identification)	**Territorial authorities (hazard management)**
Assess hazards of regional-level significance Providing direction through	Assess hazard risks of district-level significance Control the location of, or requirements for, engineering or other solutions for development in hazard-prone areas through provisions in district

provisions in regional plans	plans
Implement, maintain and monitor warning systems	Undertake works and services at the district level (e.g. hazard mitigation works)
Conduct research into hazard threats	Provide education and information
Provide education and information	Provide information on site-specific and localised natural hazards
Provide information on site-specific and localised natural hazards	Control development and activities in hazard-prone areas through their district plans and resource consents
Undertake works and services at a regional level (e.g. stopbank repair)	Prepare hazard management plans (e.g. flood management plans, contingency plans)
Maintain a 'regional natural hazards register'	Control stormwater discharges (through involvement in land-use planning and the control of building development)
Administer and update group civil defence emergency management plans	Ensure infrastructure is sited and designed to cope with hazards events (e.g.through asset management plans and provisions in district plans)
	Maintain a 'district natural hazards register'

Relationships between key legislation for the land use management of natural hazards



The figure above shows the relationship between the key pieces of legislation for the management of natural hazards in New Zealand. Each piece of legislation is represented by a box linked by arrows to other relevant legislation. The coordination role of the regional policy statement is clearly evident. In this diagram the regional policy statement draws on the long term plan (itself derived from inputs as diverse as Local Government Act processes and the Soil Conservation and Rivers Control Act), national policy statements and standards, and Civil Defence Emergency Management Group Plans (the latter being influenced by the National Civil Defence Emergency Management Strategy and National Civil Defence and Emergency Plan).

Principles for planning approaches

These guidelines are based on three overarching principles:

1. **Gathering accurate natural hazard information**: Identifying and accurately locating hazard sites or zones on planning maps is essential for communicating and mitigating hazard risk. Collecting information often requires specialised technical knowledge and surveys. Maps showing the location of hazards in the vicinity of a property must be developed at an appropriate scale. As the existence of a particular hazard may have a major effect on a decision to purchase or build on a property, all information on hazards should be as accurate as technology and resources permit.

2. **Planning to avoid natural hazards before development and subdivision**: Natural hazards can be avoided by preventing building and development on known hazard areas. Where natural hazards cannot be avoided, mitigation measures such as reducing risk through engineering works should be instigated. For example, the developer of a new subdivision may be required to avoid building directly on a landslide path and to mitigate its risk to other areas of the development through retaining structures. Whether outright avoidance or mitigation provides the best means in each case should be considered in terms of achieving an acceptable long-term solution. This consideration may include whether a decision now will create expectations for further development that would become unacceptable.

3. **Taking a risk-based approach in areas already developed or subdivided**: Land already subdivided, developed or used for specified activities will have some existing use rights attached. However, further development or changes in use should require that any increase in hazard risk is considered. Planning for land use in a hazard zone helps to avoid or mitigate the increased risks from natural hazards caused by land-use intensification (such as urban infill) and inappropriate building or use.
   ISO 31000: 2009, Risk Management – Principles and Guidelines provides principles, definitions and a process for managing risk. Key steps in the process (establishing context, risk identification, analysis, and evaluation) are summarised below. The remainder of the guidance note focuses on ways to manage or treat natural hazard risks (including the RMA tools to manage specific hazards).

(a) **Establishing the context**: Applying the risk management process to natural hazards management depends very much on the context, for example working within an RMA plan review process or the consenting process. It will also be influenced by the specific nature of the hazard, the community context and those directly affected or interested parties. The application of the process can therefore vary and organisations should adapt it to suit their particular needs. For assessing natural hazards in a planning context, the standard has been tailored and is briefly described below. Identifying all stakeholders and developing a communication plan are important parts of this process.

More detailed information on selecting and applying systematic techniques for risk assessment is contained in IEC 31010: 2009 – Risk Assessment Techniques.

(b) **Identification of risks**: Identifying the 'hazardscape' is an important step to understanding the risks posed to communities by natural hazards. For those planning

under the RMA, identifying the likely risks facing a district, city, or region is the first part in establishing whether issues, objectives, policies or rules need to be included for them in RMA plans. For those working on resource consents, checking for the presence of natural hazards is important in both preparing and considering assessments of environmental effects in accordance with Schedule 4 (clause 2(f)).

Hazard mapping

A starting point to identify hazards risks is a scan of hazard information, including recent hazard events (such as floods and slips) for the area. It is good practice for councils to map known hazards in their areas to help with plan preparation, and enable those processing consents to quickly understand the hazards that may impact on a proposal, or that may be exacerbated by a proposed activity or development.

The National Hazardscape Report, produced in 2007, provides a definitive snapshot of the knowledge on New Zealand's hazards and risks at that point in time.

In identifying risks through hazard mapping local authorities should:

- adopt an all-inclusive approach to hazard mapping, starting with the regional setting, then focusing into the detailed scale
- consider appropriate scales for hazard mapping to ensure information is portrayed accurately and not misrepresented. Suggested scales are:
    - National (1:1,000,000)
    - Regional (1:100,000 to 1:500,000) - QMAP series
    - Medium (1:25,000 to 1:50,000) - typically municipal or small metropolitan areas
    - Small (1:5,000 to 1:15,000) - typically site or property level This scale is recommended for district plan hazard mapping
- map hazards at a scale that is appropriate to the end-use purpose (the end-use maps, for example those used in district plans, should not be significantly different to the scale the hazard was originally mapped at to avoid errors or misrepresentation of the information contained in the maps)
- consider scale when combining hazard maps with other types of maps
- ensure that hazard mapping information is not distorted when using GIS by limiting the use of the zoom tool on GIS systems to the scale the original hazard was mapped at
- be mindful that hazard information available to the public should have clear statements as to its purpose and level of accuracy, any other limitations that are relevant, and may include disclaimers in this regard

The use of aerial photography

Aerial photography is useful for identifying various hazards, such as active faults and landslides. Comparing aerial photographs of an area over time can give an indication of the frequency and extent of various events. Different types of photography, including vertical (or oblique) aerial photos and orthophotos, provide different hazards information.

It is important to use photographs from different periods spanning as much time as possible, as land development can often conceal the presence of features (for example, earthworks can modify an environment so that the original features, such as fault lines and landslides, are 'removed' from the site).

Types of photography useful in natural hazard management

Vertical (or oblique) aerial photos: when taken as a series, these can be used to illustrate the features of concern, and highlight differences that have occurred over a period of time (for example, the erosion of coastlines over time).

Orthophotos: aerial photos with the distortion removed, and related to specific points on the ground. When overlaid with LIDAR (Light Detection and Ranging: a system used to measure the elevation of a surface, with greater than 1 metre accuracy), an accurate representation of the land use can be made in relation to natural hazards.

Orthophotos overlaid with LIDAR have the advantage of being able to be vertically exaggerated and manipulated as required.

Path of the 2007 lahar down the Whangaehu River valley

The photograph above shows the Whangaehu River channel at the location of the Round the Mountain Track (Tongariro National Park). It shows the path the 2007 lahar took down the Whangaehu River valley. This is an example of a digitally enhanced map from a LIDAR survey draped with a vertical orthophoto.

Identify natural hazard risk level

As part of risk identification ask questions about each of the key activities, projects or processes.

Good quality information is important in identifying risks. The starting point for risk identification is historical information and discussions with a wide range of stakeholders about historical, current and evolving issues. People involved in identifying risks are knowledgeable about the detailed aspects of the risk identification being undertaken.

Identifying risks can also require imaginative thinking and appropriate experience. Allow for the pooling of experience. Team involvement helps build commitment and ownership into the risk management process and helps ensure that risks to different stakeholders are considered where appropriate.

In order to understand the risk a hazard may pose, start by establishing the hazardscape (from hazard identification studies), location, social environment, economic environment, etc. Alternative information sources can be used in the absence of detailed hazard studies. Alternative sources of information could include:

- historical photographs, newspaper reports and firsthand accounts of prior events, and about changes to the environment that may mask or alter this pre-existing hazard
- information held by local libraries
- information collected for other purposes such as university research
- information collected by old catchment boards
- historical records for organizations such as the Ministry of Works and Development

Once the hazardscape has been defined, the hazard risks posed by different activities, processes or projects in a particular area can then be identified.

(c) Risk analysis: Having established the hazards that may be applicable to a given area, district or region the next step is to determine the significance of hazard risk. A risk analysis is often required to:

- obtain more information about the consequences or the likelihood of decisions so that priorities are based on information and data rather than guesswork
- better understand the risk and its causes so that treatment plans can be directed at true rather than superficial causes of problems
- help people choose between options where each has different costs and benefits and potential opportunities and threats
- provide a better understanding of risk to individuals who must operate with the risks
- provide an understanding of residual risk after treatment strategies have been applied

Risks that are considered to be high or significant may require further evaluation and possible treatment (actions to avoid, remedy or mitigate them). Conversely, for some hazards the risk level may be low so as to not require immediate, or further, consideration.

Risk analysis establishes an understanding of the level of risk and its nature. Aside from the absolute level of risk, analysis will help to set treatment priorities and options. The level of risk is determined by combining consequence (potential impact) and likelihood (probability).

Risk analysis can be performed either qualitatively (using words to describe the magnitude of potential consequences and the likelihood that those consequences will occur), quantitatively (uses numerical values for both consequences and likelihood) or a combination of both. Suitable scales and methods for combining consequence and likelihood should be consistent with the criteria defined when establishing the context. For more technical analysis, the nature of the data and required output will dictate the required analysis methods.

Decisions as to which risk analysis method should be used are influenced by the context, objectives of the risk analysis and available resources. Some risks may need to be examined in detail and a risk analysis may be undertaken to varying degrees of detail depending upon the risk, purpose, and the information, data and resources available.

The order of complexity and costs of analyses, in ascending order, is qualitative, semi-quantitative and quantitative. In practice, qualitative analysis is often used first to obtain a general indication of the level of risk and to reveal the major risk issues. It can be used as a way of screening overall hazard risks and assigning priority for those that need further evaluation. Later it may be necessary to undertake more specific, quantitative, analysis on the major risk issues.

Qualitative analysis: Qualitative analysis uses words to describe the magnitude of potential consequences and the likelihood that those consequences will occur. These descriptions can be adapted or adjusted to suit the circumstances, and different descriptions may be used for different risks. Qualitative analysis may be used:

- as an initial screening activity to identify risks which require more detailed analysis
- where this kind of analysis is appropriate for decisions
- where the numerical data or resources are inadequate for a quantitative analysis.

Qualitative analysis should be informed by factual information and data where available.

Semi-quantitative analysis: In semi-quantitative analysis, qualitative scales such as those described above are given values. The objective is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, without reaching the level of highly precise and accurate values for risk such as is attempted in quantitative analysis. However, since the value allocated to each description may not bear an accurate relationship to the actual magnitude of consequences or likelihood, the numbers should only be combined using a formula that recognises the limitations of the kinds of scales used. Care must be taken with the use of semi-quantitative analysis because the numbers chosen may not properly reflect relativities and this can lead to inconsistent, anomalous or inappropriate outcomes. Semi-quantitative analysis may not differentiate properly between risks, particularly when either consequences or likelihood are extreme.

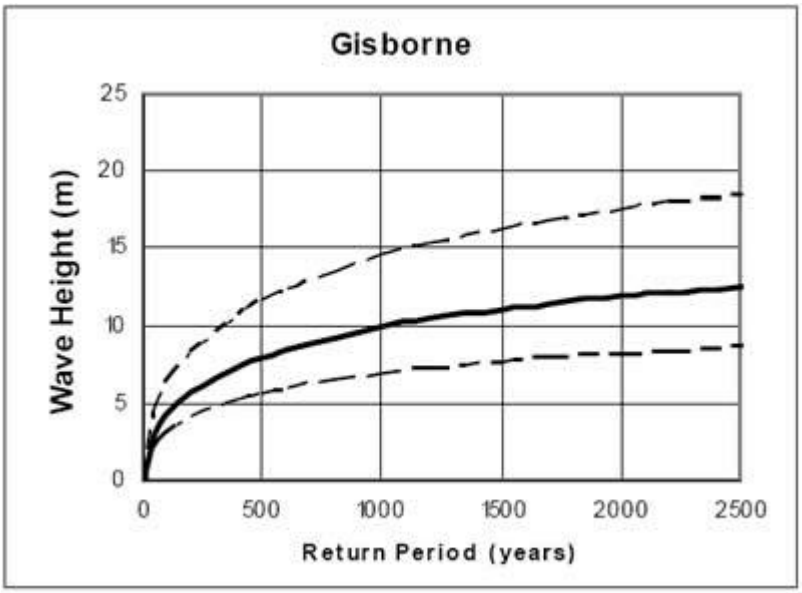
Quantitative analysis: Quantitative analysis uses numerical values (rather than the descriptive scales used in qualitative and semi-quantitative analysis) for both consequences and likelihood using data from a variety of sources. The quality of the analysis depends on the accuracy and completeness of the numerical values and the validity of the models used. Consequences may be determined by modelling the outcomes of an event or set of events, or by extrapolation from experimental studies or past data. Consequences may be expressed in terms of monetary, technical or human impact criteria. In some cases, more than one numerical value is required to specify consequences for different times, places, groups or situations.

The way in which consequences and likelihood are expressed, and the ways in which they are combined to provide a level of risk, will vary according to the type of risk and the purpose for which the risk assessment output is to be used. The uncertainty and variability of both consequences and likelihood should be considered in the analysis and communicated effectively.

Outputs of risk assessments can include susceptibility maps and matrices. For example, susceptibility maps for landslips or slumping can rank slope stability of an area into categories that range from stable to unstable. A susceptibility map can show where landslides may form.

Sensitivity analysis: Since some of the estimates made in risk analysis are imprecise, a sensitivity analysis should be carried out to test the effect of uncertainty in assumptions and data. A sensitivity analysis is also a way of testing the appropriateness and effectiveness of potential controls and risk treatment options. Consider engaging someone experienced in undertaking sensitivity analysis to undertake this task.

The example of a sensitivity analysis below shows bars of uncertainty for the tsunami risk. The dashed lines show the uncertainty at the 16th and 84th percentiles. The tsunami risk for each of the main centres was presented with these uncertainty bars in the Review of Tsunami Hazard and Risk in New Zealand (see the Ministry of Civil Defence and Emergency Management website).



(d) Risk evaluation and developing a treatment plan: Having established the presence of a natural hazard, and an approximation as to the level of risk associated with that hazard, the third step is to evaluate options in regard to managing risk (including the 'do nothing option'). This stage of the process helps inform s32 evaluation reporting, plan objectives and policies, or may form part of the process in considering whether avoidance or mitigation options proposed in a resource consent application are appropriate.

A s32 evaluation is a key requirement throughout the plan-making process and the Resource Management Amendment Act 2013 provides greater guidance and specificity about what is required in s32 reporting, particularly for the assessment of costs and benefits. These changes come into force on 3 December 2013 (3 months after Royal Accent) and require s32 evaluations to now:

- specifically assess the benefits and costs of the environmental, economic, social and cultural effects

- assess the opportunities for providing or reducing economic growth and employment
- quantify the costs and benefits of provisions, where practicable.

The s32 evaluation process will help identify the degree and nature of issues and the effects and provide a framework from which to consider and test appropriate objectives, policies, and methods in plans (refer to the Ministry for the Environment's Fact Sheet 6: Section 32 of the RMA for further information on the new requirements as a result of the Resource Management Amendment Act 2013).

Evaluating options involves weighing the relative costs of each option with the losses that will occur if the risk is not treated. The costs and losses to all parties should be considered, noting also that who benefits and who pays may vary across options. Some costs may be indirect, for example loss of business opportunities during an event. Also maintaining a readiness and response capability imposes a cost and the trade-offs between reliance on this capability and undertaking reduction should also be considered. Any losses realised or benefits gained from avoiding or reducing risk, may only accrue over time. As such, the likely costs and benefits arising over the full 'lifetime' of each option should be analysed in Net Present Value terms.

For those preparing plans and strategies, determining acceptable levels of risk and willingness to pay for risk reduction across a community will require effective communication and consultation processes. These processes begin with determining the communities' goals for hazard risk reduction and end with evaluating outcomes.

Decisions should take account of the wider context of the risk and include consideration of how tolerable the risks are to various parties who receive no benefit from them. In some circumstances, the risk evaluation may lead to a decision to undertake further analysis.

One of the most difficult problems concerning natural hazards is dealing with urban areas where buildings are constructed on, or close to, a particular hazard, such as an active fault, floodway, or landslide. The ideal approach in this situation would be to avoid further development in high-risk areas, to limit existing-use rights to rebuilding (i.e. replacement buildings can only be the same scale and density as those existing), and to limit the use of buildings. Non-regulatory methods can actively discourage people rebuilding and encourage them to move elsewhere.
The most realistic approach, however, is to accept the status quo whilst ensuring that:

- any further development and use of buildings is consistent with the level of risk posed
- district plan maps clearly show hazard zones, and information for individual properties is placed on LIM reports.

Non-regulatory approaches, such as hazard education and engagement programmes, also ensure that landowners and building occupiers are made aware of the hazard, and of the probability of hazard events occurring. Hazard education initiatives must reflect the complex socio-economic nature of communities; programmes need to target a range of at-risk groups, and may require a mix of approaches.

The principles recognise that a different planning approach is needed for an area that has not been developed than for an area that has been developed or subdivided (or where

there is an expectation to build). These principles are underpinned by a risk-based approach.

Risk prioritisation

A range of methods are available to prioritise risks. Generally, councils have used the Seriousness, Manageability, and Growth (SMG) analysis for prioritising hazards in their CDEM Group plans, based on the Risk Management Standard AS/NZ ISO 31000. There are also some other variations being used.

The SMG model is used to compare and prioritise hazards based on the seriousness, manageability, and growth characteristics of each hazard. SMG can also be used as a method of qualitative risk calculation.

Ideally, if undertaking a risk prioritisation process, councils should check what methods are contained in their CDEM Plan and adopt the same methodology where practicable. This will make it easier to ensure that the key priorities are the same under both CDEM and RMA processes (while recognising that a CDEM Plan is going to be wider than just natural hazards).

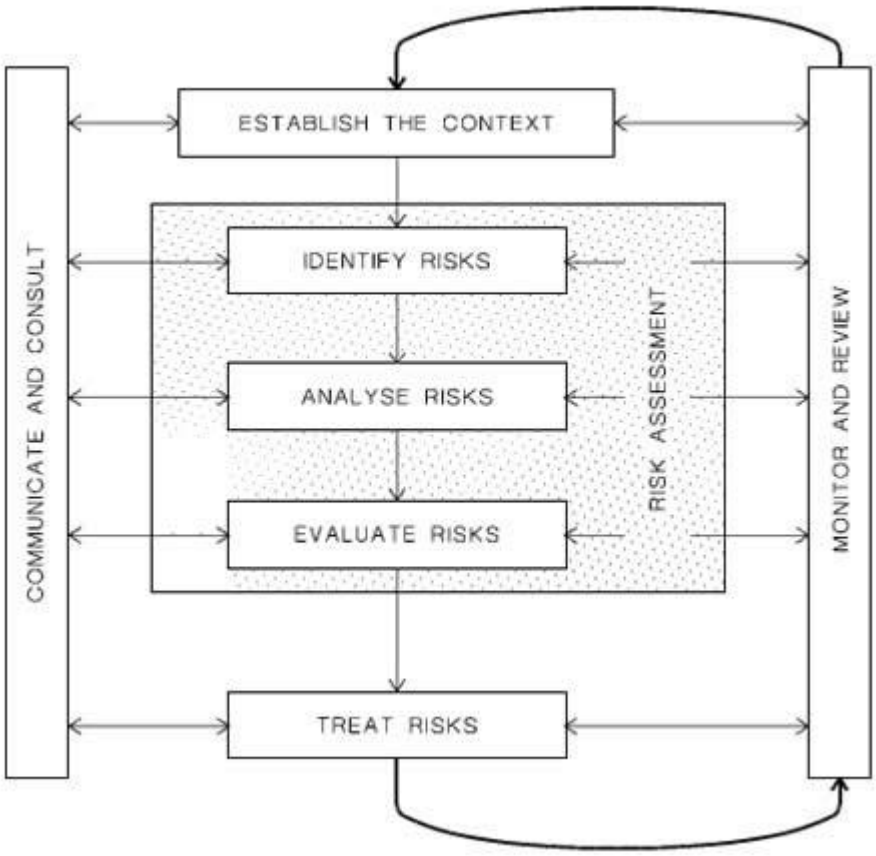
Residual risk

Residual risk is the risk that remains after all treatment steps are in place, in other words the fatalities, injuries and destruction that must be accepted either by default or because the costs of treatment are considered too high, and/or such outcomes are too uncertain or rare to plan for.

Supporting materials for risk management processes

The 2009 Australian/New Zealand Risk Management Standard – Principles and Guidelines 31000 provides organisations with guiding principles, a generic framework and a process for managing risk. I includes 11 risk management principles an organisation should comply with, and a management framework for the effective implementation and integration of these principles into an organisation's management system.

An overview of the risk management process



EXPLANATION: This figure shows the risk management process, with the key actions (establish the context, identify risks, analyse risks, evaluate risks and treat risks) shown as five separate boxes. The monitoring and reviewing, and communicating and consulting of the key actions are shown to either side to indicate that they take place throughout the process.

The final step of the process, treating risks feeds directly into the monitoring and review process which feeds into the next round of risk management through providing information on the context of the risk. Note that the three middle steps (identifying, analysing, and evaluating the risk) are all considered to be part of the risk assessment stage (as indicated by the stippled box in the centre of the diagram).

The risk management process for landslide hazard

RISK ANALYSIS
Step One: IDENTIFY THE NATURE OF THE LANDSLIDE HAZARD • Where are the landslides in the district or region? **Step Two: IDENTIFY THE NATURE OF THE LANDSLIDE HAZARD** • What is the likelihood of a landslide in the district? (landslide recurrence interval) • What is the nature of the landslide? (type, size, mechanism, complexity) **Step Three: IDENTIFY THE CONSEQUENCES OF THE LANDSLIDE HAZARD** • What are the elements at risk at the proposed development site? (people, recurrence assets) • What is the construction type? (building importance category) **Step Four: ESTIMATE THE RISK TO A SUBDIVISION OR DEVELOPMENT** • Likelihood of hazard x consequences?
RISK EVALUATION
Step Five: ASSESS AND EVALUATE THE LEVEL OF RISK TO A SUBDIVISION OR DEVELOPMENT • How does the risk compare with other hazards? • Is the risk acceptable? • Are there alternatives or options?
RISK MANAGEMENT
Step Six: TREAT THE RISK • What action should be taken to avoid or mitigate the risk within the landslide hazard area? • Regulatory planning methods • Non-regulatory methods • Limiting the risk posed by the building **Step Seven: MONITOR AND REVIEW**

- Are our outcomes being achieved?
- Is new information available?
- Does the district plan need to be updated?

EXPLANATION: The diagram above shows how the risk management approach can be applied to managing landslide hazards. The diagram is divided into three main boxes (labelled 'risk analysis', 'risk evaluation', and 'risk management' respectively). Within these three boxes there are seven steps that need to be undertaken.

Questions to assist in framing key hazard issues

In considering how to manage risks associated with natural hazards, the following questions can be of assistance in guiding decision makers:

- What is the source of each risk?
- What might happen that could:
  - increase or decrease the effective achievement of objectives of the risk management process?
  - make the achievement of the objectives more or less efficient (financial, people, time)?
  - cause stakeholders to take action that may influence the achievement of objectives?
  - produce additional benefits?
- What would the effect on risk management objectives be?
- When, where, why, how are these risks (both positive and negative) likely to occur?
- Who might be involved or impacted?
- What controls presently exist to treat this risk (maximise positive risks or minimise negative risks)?
- What could cause the control not to have the desired effect on the risk?
- What is the reliability of any information we have?
- How confident are we that the list of risks is comprehensive?
- Is there a need for additional research into specific risks?
- Are the objectives and scope covered adequately?
- Have the right people been involved in the risk identification process?

The SMUG model: a basis for hazard prioritisation

The SMG model was defined in the CDEM Group Plan review Director's Guideline on CDEM Groups (DGL 09/09). The definitions of seriousness, manageability and growth are as follows.

Seriousness
The relative impact in terms of people and/or dollars. The number of lives lost and potential for injury, and the physical, social and economic consequences of a hazard event were specifically considered while rating seriousness.

Manageability
Manageability includes both a measure of how difficult a hazard's risks are to address and

a measure of the cross-sector management effort being applied to hazards across the '4 Rs'.

Growth
The rate at which the risk from the hazard will increase through either an increase in the probability of the extreme event occurring, an increase in the exposure of the community, or a combination of the two.

Method for rating seriousness

Seriousness is defined as the relative impact in terms of people and/or dollars. When rating the seriousness of a hazard event, the following consequences are specifically considered:

- human (potential number of lives lost and potential for injury)
- economic
- social
- infrastructure
- geographic.

For each of the applicable hazard types a seriousness score of 0-5 is assigned to each of the above five consequences. These are then averaged to give a total seriousness score.

Method for rating manageability

Manageability is defined as the relative ability to mitigate or reduce the hazard.

Manageability includes both a measure of how difficult a hazard's risks are to address and a measure of the cross-sector management effort being applied to hazards across the '4 Rs' directly or indirectly assisting in reduction of risk. The level of difficulty may, in some cases, be inversely proportional to the level of management effort, particularly where a hazard appears too big to address, and therefore little effort is being applied. Conversely, a lot of effort may be expended on a relatively easily managed hazard.

Method for rating growth

Growth is defined as the rate at which the risk from the hazard will increase through either an increase in the probability of the extreme event occurring, an increase in the exposure of the community or a combination of the two.

Assign a low, medium or high rating for the 'growth' criteria using the descriptions below.

Rate of growth

Low (1): risk increases from **either** an increase in the probability of an extreme event occurring **or** an increase in the exposure of the community.

Moderate (2): risk increases from **both** an increase in the probability of an extreme event occurring and an increase in the exposure of the community at a **low-moderate rate.**

High (3): risk increases from **both** an increase in the probability of an extreme event occurring **and** an increase in the exposure of the community at a **high rate**.

Note of caution: difficulties with prioritising hazards

There are several difficulties associated with assigning ratings to each of the above SMG criteria:

- the seriousness rating assigned to a given hazard depends upon the magnitude of the hazard event under consideration.

- there may be a lack of sufficiently robust quantitative data to evaluate all hazards and risks, particularly in ways that enable comparisons across hazards and risks. Lack of quantitative data means that evaluations of hazard consequences or risks may have to be qualitative only. Including advice from as many different experts as possible will strengthen such evaluations.

A toolbox for risk based land use planning for natural hazards

GNS Science has developed a toolbox which aims to support risk-based land use policy and plan development in local government. It offers a new approach where consequences of natural hazard events are the focus. It presents techniques, practice steps and options for enabling local government to review multiple natural hazard risks, both within councils and with external stakeholders. The toolbox is available on the GNS Science website.

Managing common hazards over council boundaries

Some natural hazards are site specific while others may cover large areas and cross local authority boundaries. Local authorities with overlapping hazard issues can work collaboratively to manage hazards in their districts or across a region/s. It is also necessary to determine together which council is responsible for:

- researching and providing the key information on each natural hazard (and what should the information consist of)
- identifying and mapping each hazard, and how to go about sharing this information
- carrying out public education and communication campaigns
- planning for and managing each aspect of hazard risk, including responding to hazard events (under the RMA as well the CDEM Acts)
- developing and implementing hazard mitigation plans for particular hazards.

These responsibilities can be formalised by agreements or memorandums of understanding between authorities on hazard management responsibilities and roles, or outlined in the regional policy statement. Triennial agreements under the LGA are tied into the Regional Policy Statement (RPS) preparation process by Clause 3A of Schedule 1 of the RMA. They require a more collaborative process for the development of RPSs, and provide a possible means around which relationships can be built between regional councils and territorial authorities.

Wherever possible, local authorities should collaborate so that an area-based approach to hazard management can be taken. Note that while this guidance note considers the response to hazards within the context of the RMA, collaboration may include a coordinated response across more than just the RMA, particularly for territorial authorities.

Other techniques that can assist integration include:

- pooling resources between councils
- adopting and formalising agreements as to responsibilities

Addressing multiple, inter-related hazards

It is important to adopt an all hazards approach. One hazard event can trigger a range of secondary hazard consequences to manage. For example, an earthquake can trigger landslides and changes to water courses leading to flooding. In this regard, response to a significant emergency more often involves a series of specific incidents or consequences that requires a level of general contingency planning.

For risk reduction steps, consideration should be given to how hazards may interact and result in higher levels of risk (in terms of either likelihood or severity). For example, in assessing slope stability for a development it may seem satisfactory except when factoring in a known earthquake risk for the area.

Overlaying various hazard information within GIS or similar systems can be used to identify and address multiple risks in specific locations.

Once a hazard has been identified, the significance of the risk evaluated, and a decision made to treat the risk, the next decision is deciding how best to treat [manage] the hazard risk.

This section outlines the RMA tools for managing hazard risk, but it is important to also consider the non-RMA tools available to manage hazards. Ideally, there should be an integrated and coordinated approach using a combination of RMA and non-RMA tools.

National policy statements and national environmental standards

National policy statements (NPSs) (prepared under Part 5 of the RMA) can provide direction to local government on how competing national benefits and local costs should be balanced. National environmental standards (NESs) are regulations that set baseline nationwide minimum standards for particular issues. To date there are no national policy statements or national environmental standards for particular hazards. The New Zealand Coastal Policy Statement 2010 (NZCPS 2010) identifies coastal erosion and other natural hazards as a key issue facing the coastal environment. The NZCPS includes policies on the identification of coastal hazards: subdivision, use and development in areas of coastal hazard risk; natural defences against coastal hazards; and strategies for protecting significant existing development from coastal hazard risk.

Local authorities will need to stay aware of developments at the national level in the event that new NPSs and NESs are developed and consider whether and how to incorporate such documents into their RMA plans and decision-making.

Regional policy statements

Regional policy statements integrate the management of natural and physical resources across a region. The requirement for RMA plans to 'give effect to' regional policy statements makes them particularly influential and useful for coordinating RMA policy responses across two or more territorial authority areas.

To ensure integration with other hazard management activities in a region, the preparation of hazard provisions in a regional policy statement should be linked with work being undertaken, and priorities established, as part of the CDEM Group Plan.

Regional plans

Regional plans can address specific hazard issues relevant to regional council functions including coastal hazards, floodplain management, land stability, and geothermal hazards. A regional council can prepare a specific natural hazard regional plan; however, the interrelated nature of hazards with other environmental features or effects means that natural hazard provisions are generally dispersed amongst various sections of other regional plans.

Regional plans can contain objectives, policies and rules addressing natural hazards. Unlike district councils, regional councils can have rules in regional plans for controlling land (for the purposes of avoiding or mitigating natural hazards) that are exempt from

existing use right clauses under s10(4) of the RMA. This makes them particularly useful in managing hazard risk in areas where development has taken place before plan rules to manage risks could be implemented.

Regional plans generally include rules requiring resource consents and set out specific objectives and policies against which such consents are measured.

District plans

Every territorial authority is required to prepare a district plan for its district. District plans are required to give effect to regional policy statements. Territorial authorities, when reviewing their district plan, need to be conscious of the direction outlined in a regional policy statement, and how that should be implemented through their district plan.

Even if no direction is provided through the regional policy statement, a district plan should include risk-based objectives, policies and rules to control the effects of the use of land for the avoidance or mitigation of natural hazards.

Zones and overlays within district plan maps can identify the location of specific hazards within a city/district and specific requirements can be applied to these areas. See the section on Hazards Mapping for more information about how to identify and map hazards.

A local authority should provide:

- clear direction through plans and other means on the hazard information that needs to be included in any resource consent application
- policies within the plan giving clear guidance on the matters addressed during consideration of a resource consent and the desired outcome sought in managing hazard risk.

Note that rules in district plans may be rendered less effective in controlling development in hazard prone areas where existing use rights apply. In circumstances where the management of both existing and new development through RMA plan rules is desired, regional and territorial authorities may need to work together on an integrated approach that uses a combination of regional and district plan provisions.

Iwi management plans/planning documents

Sections 61(2A) and 74(2A) of the RMA require that regional and district plans take into account relevant planning documents recognised by an iwi authority and lodged with the council.

An iwi management plan is a policy document that identifies important issues to iwi regarding the use of natural and physical resources within their area. Māori can have a unique interest in the management of hazards. For example, some hazards and proposed hazard management works may be in areas containing wahi tapu sites and other places of significance for Māori.

Some iwi planning documents can be a useful source of information in relation to past hazard-related events. Linking iwi management plans with council documents (for example, regional policy statements) or processes can help when taking account of iwi concerns with respect to natural hazard management (for example, cultural concerns over diversions of water courses or the location of disposal sites for debris).

Resource consents

Resource consent applications (including any to subdivide, use or develop on, by or near land subject to natural hazard risk) must be accompanied by adequate assessments of environmental effects (AEEs). Clause 2(f) Schedule 4 of the RMA states that an AEE should consider 'any risk to the neighbourhood, the wider community, or the environment through natural hazards'. Where natural hazards are present, it would be good practice for the AEE to:

- identify the particular hazard present
- provide a risk analysis of the effects of the activity on the hazard [if one exists], and also how the hazard impacts on the effects of the activity
- consider alternatives to avoid the hazard (such as locating away from the area affected by the hazard)
- identify mitigation measures
- determine the residual risk and include appropriate mitigation to address it.

When assessing applications where hazards are present, it is important to consider the wider context for natural hazards beyond the site. Matters to consider include:

- risk to life, property and the environment posed by the natural hazard
- likely frequency and magnitude of the hazard event
- type, scale and distribution of any potential effects from the natural hazard
- degree to which the subdivision, use or development activity can avoid or mitigate the effects of the natural hazard
- accuracy and reliability of any engineering and geotechnical information
- whether use or development of the land will exacerbate the hazard, whether the hazard is on the same site, or on any adjacent or nearby sites.

Where significant effects from hazards are identified as a result of proposed land development or structures, then appropriate mitigation needs to be identified or the application should be declined (if provisions in the plan allow for the consent to be declined).

A site-specific risk checklist can be used to assess individual consent applications where there are known hazard risks.

Checklist for assessing risk
Identification of hazards Have all hazards that have the potential to affect the application been considered? • Has the primary hazard been identified? • Have secondary hazards that could be triggered by primary hazards been considered? **Have cross-boundary hazards been identified, i.e. any risk from neighbouring property?**
Analysis and description of hazards • What is the chance of occurrence of each hazardous event? • How often can it occur? • What will the magnitude and length of each hazardous event be? • How rapidly can it occur and what warning systems and evacuation procedures are in place? • What areas can be affected?
Identify gaps in knowledge and understanding of hazards • Have gaps in knowledge or understanding about the hazard and its consequences been identified and explained? • Is it imperative that these gaps are filled before the consent process proceeds further?
Identify and describe the important elements of the community and environment • Are there any critical facilities (medical and emergency services, fire and police stations) that need special consideration in terms of operation for hazard mitigation or relocation? • Are there any engineering facilities (transport, power and water supply, sewerage and telecommunications) that need special consideration?
Describe and analyse the community's vulnerability • What is the proximity of the community to hazards? • What is the level of access to emergency services? • What is the level of awareness within the general community? • What is the level of mobility should evacuation be necessary? • Are the engineering services (water, sewerage etc.) robust or frail? • Have the existing civil defence emergency management response and recovery plans, prepared under the CDEM Act, been tested, and are they adequate?
Identify risks • Are all credible risks, including residual risk, identified? • Has each risk been identified in such a manner that treatment priorities and treatment requirements can be determined?
Other considerations • Has any hazard assessment undergone peer review? • Have any identified risks been adequately treated to reduce the risks to acceptable levels?

When there is uncertainty about the risks associated with development then specialist technical advice or a peer report should be sought as part of the assessment of the application. Likewise, technical reports submitted with resource consent applications need to be prepared by a professional qualified to assess hazard risk.

Subdivision, use or development on or near land subject to natural hazard risk can give rise to cumulative effects. These effects need to be considered when considering application for these activities.

Making a decision under section 106 of the RMA

Local authorities can refuse consent for subdivision where the land is subject to certain hazards under s106 of the RMA. When making a decision under s106, councils have to consider whether the land is suitable for subdivision, taking into account any measures proposed by the applicant to protect the land from the effects of natural hazards.

Section 106 requires consideration of whether there is likely to be material damage to land or structures from erosion, falling debris, subsidence, slippage, or inundation from any source. Consideration must also be given to whether 'any subsequent use that is likely to be made of the land is likely to accelerate, worsen, or result in material damage to the land, other land (for example, neighbouring or downstream properties) or structure'.

When making a decision under s106, a council is able to take into account any measures put forward by the applicant. The courts have provided a test for councils to use to determine if measures proposed by an applicant are sufficient to meet the requirements of s106.

Using this test, a council does not have to ensure that the whole of the land is free from the risk of inundation but does have to ensure that in its judgement the land is sufficiently protected to be suitable for subdivision.

Managing specific natural hazards through RMA plans

Introduction

The following section sets out how specific hazards can be managed through RMA plans.

The primary classes of natural hazards in New Zealand are:

- earthquake/seismic
- landslip/landslide/land instability/subsidence
- coastal
- flooding
- geothermal
- meteorological
- tsunami
- volcanic.

An overview of these hazard classes and the principal means for managing them across the 4Rs is contained in the National Hazardscape Report (2007). They are referred to here as classes in that, for effective management, a specific hazard or risk by location must be considered. For example, the Hutt Valley flood hazard is not the same as the Matuara River flood hazard as a different set of risks are involved in each case.

Generally, resource management plans can contain objectives, policies and rules to manage:

- the effects of hazards themselves (such as coastal erosion)
- the effects of land use on hazard risk (such as the removal of dune vegetation)
- the effects of treating hazard risk (such as the loss of coastal access following the construction of a seawall).

The management response for specific natural hazards is highly dependent on the nature, location and effects of the particular hazard, and the community in which the hazard is located. No one policy response to natural hazards can address all hazards or all locations. Natural hazards policy should consider adapting the 'best fit' hazard response to the nature of the particular hazard relative to its location, recognising that the methods (or mix of methods) used to address the risk will often be different.

Many local authorities take an ‘all-hazards' approach to developing hazard-related objectives and policies in their plans. This provides simplicity and may be acceptable for an overall hazard objective and some policies. However, a hazard-specific approach is likely to be more effective and easier to implement and monitor as the guidance it provides to those making decisions on, or monitoring, resource consents is more likely to be stronger, clearer, and more targeted towards the issues that need to be dealt with.

Plan provisions should focus on the effects that need to be addressed to achieve natural hazard objectives, and state how those effects are going to be dealt with. Plan provisions should also provide for a review of current policy where increased knowledge of a hazard becomes available.

Earthquake/seismic

New Zealand has earthquake hazards that can impact on the built environment in a number of ways including, shaking, liquefaction and mass movement.

A fault is a fracture in the Earth's crust. Opposite sides of the fracture are held together by pressure and friction, but as stress builds up a fault may suddenly rupture. In a large rupture, shock waves cause the earth to shake violently and produce an earthquake. An active fault is a fault that has ruptured repeatedly in the past, and whose history indicates that it is likely to rupture again. Active faults include faults that weren't previously identified. An active fault therefore creates a fault hazard risk.

When the ground shakes, and/or when there is surface rupture on a fault line causing ground deformation, there is likely to be damage and/or destruction of structures built across the fault line or within the crush zone. Earthquakes may also trigger other hazards, such as liquefaction, tsunami, landslides, and flooding.

Councils can plan for active faults through the identification of active faults on planning maps, with specific rules that limit development in higher risk areas.

Natural Hazard Mapping: Wellington City Council fault hazard map example

The map above is taken from the Wellington City Council District Plan, Planning Map 18. It shows the area around Thorndon to the immediate west of the rail yards. Running from the top right to the bottom left is the Wellington Fault , marked out as a red crossed-hatched area running more or less parallel to the northern side of Tinakori Rd.

Councils should provide specific objectives, policies and rules to address fault hazard risks for known active faults. Approaches to address fault hazard risks through plans could include one or more of the following:

- Mapping active faults and using buffer zones to exclude development, or to restrict the type of development that occurs within the buffer zone

- Requiring that structures, infrastructure or other development or activities in the vicinity of active faults are designed in such a way that minimises risk to life and property

- Using non-regulatory methods such as the provision of information and advice, to raise public awareness and to encourage good practices.

For more detail, the Institute of Geological and Nuclear Sciences Active Fault Guidelines provide specific guidance on how the earthquake hazard can be managed through planning documents and the mapping of active faults

The guidelines set out how councils can:

- actively identify and assess the actual and potential effects of the natural hazards associated with landslides/land instability/subsidence

- develop methods to reduce the risk associated with such events

- develop methods to avoid activities in areas prone to these hazards.

Landslip/landslide/land instability/subsidence

Land instability includes landslides, subsidence, and issues around alluvial fans. There are many types of landslides, including earth flows, topples, debris flows, rock falls, block slides, debris avalanches, lateral spreads, and rotational and translational landslides. The most common trigger of landslides is prolonged or intense rainfall, however large earthquakes, volcanic eruptions and geothermal activity can also trigger landslides.

Land instability can result in threats to life, property, and infrastructure. In hilly or mountainous areas with limited access, landslides and landslips can isolate communities and have disruptive side effects such as clogging water treatment facilities with silt.

The general approach taken in plans to landslides, land instability or subsidence is to reduce the risk and avoid activities in areas prone to these hazards. RMA plan provisions (typically district plans) can manage the hazard risk through:

- the identification and mapping of areas of land instability
- zoning to avoid development in areas subject to the hazards
- requiring site investigations and/or possible engineering works to assess and reduce risk in areas of identified land instability where avoidance is impractical or not warranted
- developing rules and standards to assess consents for activities in areas prone to these hazards.

Where risks are identified in policy statements and plans, councils should adopt a precautionary approach to development.

The precautionary principle

'where there are threats of serious or irreversible damage, lack of full scientific evidence shall not be used as reason for postponing cost-effective measures to prevent environmental degradation' (1992 Rio Declaration)

To enable it to be used effectively, the precautionary principle needs to be considered within a risk management framework. This ensures that legal and fiscal responsibilities are met, and that decisions are made in a way that incorporates community participation.

Using the precautionary principle within a risk management framework can provide the following benefits:

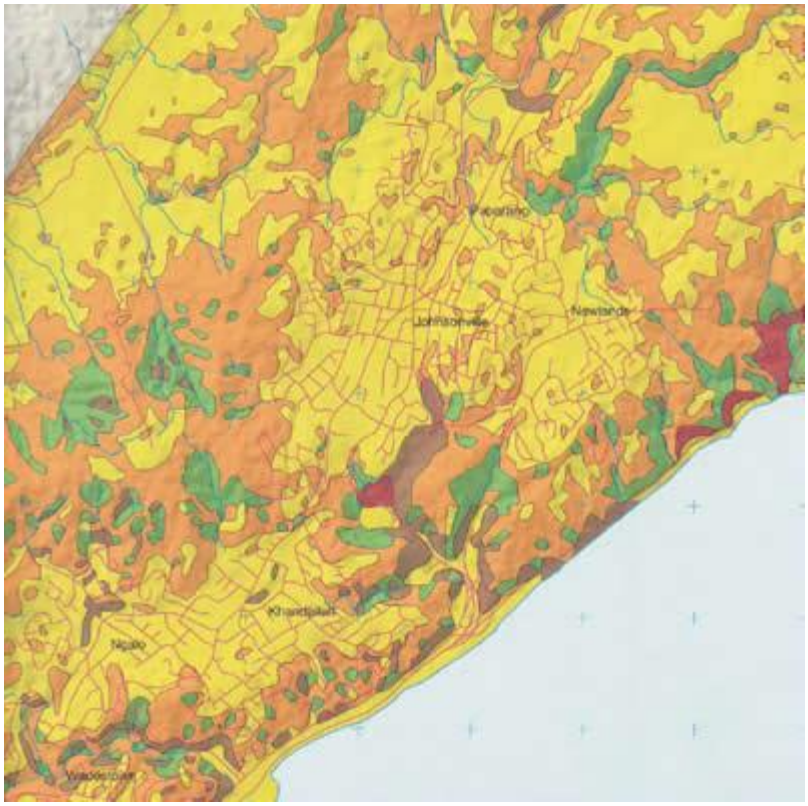
- a transparent and clear understanding of the risks involved and how taking a precautionary approach can affect a decision.

- community buy-in can be documented and inform the risk definitions, particularly where the benefits and costs of a decision can be made known.

- the risk management approach used should be flexible enough to allow the approach to decisions to be flexible enough to incorporate changing or new data on the nature and extent of the hazard, and how this impacts on risk.

Guidelines for assessing planning policy and consent requirements for landslide prone land have been published that detail how a risk-based approach can be taken to planning for land instability risk, plan methods that could be employed, and mapping of land instability risk.

Slope failure potential for an area of Wellington City: Susceptibility map example



LEGEND

SLOPE FAILURE POTENTIAL

SLOPE FAILURE SUSCEPTIBILITY ZONES	EARTHQUAKE SCENARIOS		
	Scenario 1 [MM V-VI]	Intermediate Scenario [MM VII-VIII]	Scenario 2 [MM IX-X]
Very Low	Very Minor	Very Minor	Minor
Low	Very Minor	Very Minor	Significant
Moderate	Very Minor	Minor	Severe
High	Minor	Significant	Very Severe
Very High	Significant	Severe	Very Severe

The diagram above shows slope failure potential for an area in Wellington City. The slope failure susceptibility zones are shown in different colours ranging from very low in yellow through to very high in red.

Coastal hazards

Coastal hazards include storm surge, coastal erosion, sea-level rise, coastal flooding, and tsunami. These are all natural processes that become a hazard where they pose a threat to property and life.

The NZCPS 2010 aims to ensure that coastal hazard risks are managed by locating new development away from areas prone to coastal hazard risk, considering responses for existing development in coastal hazard areas and protecting or restoring natural defences to coastal hazards. Regional policy statements, regional plans and district plans are required to give effect to the NZCPS 2010.

Coastal hazards are generally well recognised in existing RMA plans with provisions aimed at managing coastal erosion and the inundation of land from coastal flooding, storms and sea-level rise.

There are a range of methods available for managing coastal hazards through resource management plans, including:

- mapping where coastal erosion will occur in the future (hazard zones)
- setting back buildings an appropriate distance from the shoreline to minimise risk from erosion (building setbacks)
- placing only appropriate structures (for example, relocatable buildings) not key facilities in areas of known risk
- restoring sand dunes and vegetation which provide protection from the sea via a buffer zone
- removing structures from areas of risk via a programme of managed retreat
- installing engineered protection in the form of appropriate seawalls and rock walls
- beach nourishment (introducing extra sand to a beach system)
- doing nothing and letting the sea dictate.

Plans may identify and map areas that are subject to coastal hazards and include objectives, policies and methods, and standards that look to:

- reduce the risk of coastal hazards (such as through directing sensitive developments away from hazard prone areas)
- manage effects of, or effects of development on, hazards
- provide buffer areas between development and areas of high hazard risk
- identify engineering solutions
- control activities by consent activity status and using standards.

In areas subject to existing or new development, councils should consider both structural and non-structural options to managing coastal hazards. Coastal plans should provide guidance when considering which option is appropriate.

There is on-going debate about the best methods for determining the positioning of hazard zones and setback zones. As there is no one fit-all approach for coastal areas, councils need to determine the appropriate hazard and setback zones for their particular section of the coast.

A methodology for identifying hazard zones and setbacks should take into account the physical characteristics of a location, the quality of information available regarding the particular hazard, and the resources and expertise available. The hazard zone should be able to be easily understood by the community. EnviroLink has produced a guide to good practice – Defining Coastal Hazard Zones for Setback Lines (PDF) which focuses on approaches to defining present and future coastal hazard exposure as an input to development setbacks to manage risk from coastal-related hazards and the effects of climate change.

Details on how to incorporate climate change effects and sea-level rise into planning for coastal hazards can be found in the Ministry for the Environment publication Coastal hazards and climate change: a guidance manual for local government in New Zealand.

Flooding

Flooding in this context is defined as the inundation of land by water. Coastal flooding is addressed in the coastal hazards section.

The magnitude of the flood risk is dependent on the probability of a flood occurring, the value and type of assets or resources exposed to the risk, and the vulnerability of those assets or resources to damage.

The effects of flooding include the movement of debris, the build-up of debris against structures, silt and/or mud deposition, erosion, and water damage to buildings and vehicles. Consequential contamination and health effects may arise from overloaded sewerage systems or transportation of hazardous substances.

Flooding can be caused by a range of factors and circumstances including:

- high, or particularly intense, periods of rainfall
- snowmelt (which may also coincide with high rainfall)
- blocked waterways or drainage systems (including natural damming after landslips or earthquake, or vegetation blocking drains, creeks or streams).

Human activity can also contribute to, or exacerbate, flood hazards by, for example:

- obstructing natural overland flow paths (such as by placing buildings, raised roadways, embankments and other similar obstacles in the flow path or flood channel)
- increasing the flow of water into natural or man-made drainage systems (removing vegetation, increasing areas of impermeable surfaces, or increasing the number of stormwater outlets, and thereby the amount of stormwater, that enters a particular drainage system).

There are many ways to mitigate the flood risk, but generally they fall into two groups:

- structural works: designed to contain floods and to limit erosion and deposition by controlling river behaviour

- non-structural methods: including land-use planning, emergency management planning, and flood-proofing of buildings. These methods are designed to either remove people and assets from risk or to manage exposure to flood effects.

In the main, RMA plans primarily address non-structural methods. However it is important that those preparing plans are mindful of structural works and the possible need to accommodate them when drafting plans. Plan provisions may need to consider such matters as the placement, building, maintenance, operation and protection of structures such as stopbanks, weirs, groynes, flood gates, diversions, or other flood protection measures when writing objectives, policies and rules. District councils may also find that they have designations or notices of requirement for such structures that need to be included in their plans.

The potential tools available for land-use planning to manage flood risks through RMA plans are outlined below. As a general rule, the level of control imposed through plans should be commensurate with the potential flood risk.

Tool	**Use and links to RMA plans**	**Level of control imposed**
Identifying flood hazard through mapping and description of issues and scenarios	Generally used as an information tool that informs RMA plan provisions. It can either be part of a plan rule, or may dictate when plan provisions for managing flood risk apply. In other guises, it can be used to inform PIMs and LIMs.	Low when used as an information tool only. High when linked to plan rules.
Plan provisions that direct sensitive development away from areas of high flood risk (areas that experience frequent flooding and where there is a high potential for damage due to water level or water velocity)	Zoning land for less vulnerable land uses, such as 'open space recreational use', conservation, or hazard management. Such zoning may be linked to areas identified as being at most risk in mapping and scenarios. Provisions will generally exclude land uses such as commercial, residential, or industrial uses.	High
Rules that restrict the type of development that may occur	Often associated with hazard overlays linked to particular plan objectives, policies and rules. These work in a similar way to zoning, but do not replace the underlying zone. Plan rules restrict the type of development allowed to occur to those that are less vulnerable to flooding (e.g. grazing or recreational activities). Rules may also be written specifically to exclude activities that may obstruct flow paths (such as raised road embankments, concrete block walls,	Moderate to high

	buildings, raised spectator facilities for sports grounds, or other barriers). Some regional plans also contain provisions relating to management of vegetation and structures in waterways that would otherwise clog or diminish the ability of a waterway to drain in a flood event.	
Development standards for activities located in flood prone areas.	Activities located in areas identified by zoning, overlays or other hazard mapping may be required to comply with objectives, policies and rules specifying: • minimum floor or ground levels necessary to avoid a prescribed flood scenario (e.g. a 1% AEP event) • restrictions on the ground coverage of any building or extension to an existing building • minimum lot size or maximum building density controls (e.g. one building not exceeding 100 m^2 per hectare) • a requirement that buildings have 'sacrificial basements' or ground levels (areas under buildings that can be used for such things as garaging, but that are designed to ensure areas of the building vulnerable to flood damage are clear of anticipated water levels).	Low to moderate
Plan provisions concerning the establishment, ooperation, maintenance and protection of flood protection works.	Regional plan rules or consent conditions that: • require the operation of flood protection works to be carried out in accordance with an approved management plan • protect works such as stopbanks from unauthorised removal, partial removal, lowering, or undermining (including vehicle or stock access over or along a stopbank or other flood protection work) • permit the use and repair of flood control structures on the beds of rivers and lakes provided that they	Moderate to high

	have been legally established • require resource consent applications for new structures or work that are located in a flood channel, bed of a river or lake to include an assessment of effects that includes consideration of impacts on existing flood protection works (such as increasing scouring, erosion, or decreasing flow rates) • encourage the use of wetlands and restoration of natural channels where such action can avoid or mitigate flooding and erosion.	

Note that for district plans there are limitations in how effective land-use restrictions may be if existing use rights apply.

Councils should incorporate new flood risk-information into resource management plans as it comes to hand.

Flood hazard map example: Palmerston North City Council

The image above is from Map 5 of the Palmerston North City District Plan. It has been included to demonstrate how that plan depicts the Flood Hazard Zone described in the provisions above.

Map 5 covers the area in the immediate vicinity of Palmerston North Airport in the suburb of Milson. The airport is towards the bottom right of the image. The Flood Hazard Zone is shown in blue (with a black dashed outline marking the boundary), and generally follows the line of a stream from the top right of the image toward the bottom left.

Geothermal

Geothermal activity is generally restricted to a few locations around New Zealand.

Geothermal hazards include scalding hot water, geyser eruptions, geothermal chemicals in water (including sulphur), boiling mud, steam and other gases, geothermally altered ground (prone to subsidence and landslides), landslide, and hydrothermal eruptions.

Geothermal hazards are natural in origin and can be induced by human activity such as large-scale geothermal extraction activities. They can result in:

- changes in surface geothermal activity, including hydrothermal eruptions
- subsidence
- increased micro seismic activity
- effects on ecosystems, flora and fauna.

Regional and district plans should provide objectives, policies and methods for significant geothermal resources in their jurisdiction [if any]. Approaches to managing geothermal hazards include:

- scientific investigations to identify the scale, extent and nature of geothermal hazards, both when plans are developed or when consents are applied for in areas prone to geothermal hazards
- conditions on resource consents for geothermal extraction providing for specific monitoring of geothermal hazards. If monitoring establishes that there is a risk to life or property the resource consent should be reviewed under s128 of the RMA
- ensuring development avoids areas of high geothermal hazard risk
- where limited information is available, adopting a precautionary principle approach towards planning for activities in areas of actual or likely geothermal hazard risk
- re-injection of geothermal water in order to limit subsidence and land instability in geothermal areas
- requiring the provision of assessment of the effects of development on geothermal hazard risk in resource consent applications through RMA planning documents.

Local authorities should find a balance between the use of geothermal resources and protection from geothermal hazards in their policy responses.

When preparing plans, plan changes or variations local authorities should consider including assessment criteria for applications to use and develop geothermal resources to address geothermal hazards.

Meteorological

Meteorological hazards include weather-related events such as:

- flooding
- drought
- sea-level rise including storm surges
- extreme wind (including tornado)
- snow, frost, extreme temperature
- hail, lightning and fire (caused by lightning strike).

The effects of these hazards can be damage to infrastructure and property and the loss of life.

Modelling suggests climate change will increase the frequency and severity of such events to varying extents around New Zealand. The Ministry for the Environment has produced a guide to assist local government in planning for the effects of climate change: Preparing for Climate Change – A Guide for Local Government in New Zealand (PDF). NIWA has also produced a toolbox on the Impacts of Climate Change on Urban Infrastructure and the Built Environment.

Relatively few RMA plans currently contain provisions for meteorological hazards. In part this is largely due to the unpredictable nature of some of these events. However, a number of planning responses can be investigated for specific metrological hazards. Some aspects, such as building performance, are covered by the Building Code under the Building Act.

Issues and options that could be addressed through RMA plans could include:

- drought: the impact of drought is closely related to the availability and use of water. Objectives, policies, methods and rules in regional plans can be used to address the allocation of water resources. District plans can include rules requiring water storage for new subdivision and development.
- wind: district plans can include a requirement to mitigate the effects of wind on, or exacerbated by, new development
- fire can be caused by lightning strike. District plans can include fire setbacks for residential areas.

Outside the RMA, the Building Code and various standards provide some options for dealing with meteorological hazard risks.

The Building Act 2004 contains requirements for design to address issues associated with meteorological hazards. AS/NZS 1170 Structural Design Actions Set and 4203 General Structural Design and Design Loading for Buildings address earthquake forces, wind forces, snow loads, rainwater ponding loads, ice loads, soil loads and groundwater loads.

Tsunami

Tsunami are a series of large waves generated by sudden displacement of water (caused by earthquake, volcanic eruption or submarine landslide) capable of propagation over large distances and causing a destructive surge on reaching land. (The US National Oceanic and Atmospheric Organisation website has some useful material on tsunami).

Tsunami pose a risk to life, property and the environment by the inundation of water, which may also contain debris. Information on the risk to New Zealand and our level of preparedness is available via reports (compiled by GNS Science) on the Ministry of Civil Defence and Emergency Management website. The latest modeling was updated in mid-2013.

To date, few plans have addressed tsunami risks beyond general provisions and taking a precautionary approach. Councils should provide more direction by planning for the tsunami hazard and the management of its effects. This can be achieved by mapping areas susceptible to tsunami hazard and taking a precautionary approach in areas vulnerable to effects from tsunami.

The publication 'Designing for Tsunami: Seven principles for planning and designing for tsunami hazards' provides some concepts and ideas relevant to second-generation RMA plans based on United States experience. Key ideas that may be useful in a New Zealand context include:

- identifying areas that may be at risk of tsunamis and incorporating this information into short and long-term planning decisions. Incorporating information on tsunami risks into hazard registers can be used to help evaluate consent applications for major developments in coastal areas
- acquiring, designating or zoning areas at high risk from tsunamis for public open space use
- avoiding new development in identified or likely tsunami run-up areas. Development that may be directed away from such areas could include: residential, commercial, and industrial uses (especially those involving hazardous materials), and critical facilities and systems (communication, emergency response, electrical power, water supply, and natural gas systems)
- in areas where it is not feasible to restrict land to open-space uses, using other land-use planning measures. These include strategically controlling the type of development and uses allowed in hazard areas, and avoiding high-value and high-occupancy uses to the greatest degree possible. This approach could form the basis of objectives, policies and rules in RMA plans
- considering site-specific mitigation measures aimed at slowing, blocking, or redirecting water, or raising structures above the area of expected inundation. Such considerations could form the basis of resource consent conditions.

GNS has also produced guidance for integrating tsunami inundation modeling into land use planning(PDF).

Any land-use planning for tsunami needs to be integrated with a warning system and evacuation plan as, without these, many measures will not be effective. Good urban design can aid evacuation, such as the layout of roads and pathways (for example,

ensuring there are roads that facilitate quick evacuation away from vulnerable areas by running perpendicular to areas such as beaches).

Overview of site-specific tsunami options

No one solution will fully address tsunami risk in all situations. Professional advice and design input should be sought when considering the following measures to reduce the risk of damage caused by a tsunami.

- Slowing techniques -
  These involve creating friction that reduces the destructive power of waves. Specially designed forests, ditches, slopes and berms can slow and strain debris from waves.
- Steering techniques
  These guide the force of tsunamis away from vulnerable structures and people by strategically spacing structures, using angled walls and ditches, and using paved surfaces that create a low-friction path for water to follow.
- Blocking
  Hardened structures such as walls, compacted terraces and berms, parking structures, and other rigid construction can block the force of waves. Blocking, however, may result in amplifying wave height in reflecting or in redirecting wave energy to other areas.
- Building design
  Where buildings are to be constructed in a tsunami hazard area, the design and construction of the buildings (including construction materials, building configuration and tsunami-specific design features), can reduce loss of life and property damage. Design and construction of new buildings should address forces associated with water pressure, buoyancy, currents and waves, debris impact, scour and fire. Substantially constructed buildings of concrete, masonry and heavy steel frames are likely to perform fairly well in a tsunami unless compromised by earthquake shaking. Wood-frame buildings, manufactured housing and light steel-frame structures at lower elevations close to the shoreline are likely to fare poorly in a tsunami.

Volcanic

Volcanic hazards include:

- lava flows
- ash fall
- gases
- lahars
- earthquakes
- debris avalanches (landslides)
- and pyroclastic flows.

These hazards are demonstrated in a diagram of volcanic features produced by the United States Geological Society. More information on the types and nature of volcanic hazards is available on the United States Geological Society website.

Pyroclastic flows can travel in excess of 15 kilometres from a volcano, and, depending on the wind, ash clouds can travel around the world from a single eruption.

Ashfall of 1 millimetre covers road markings, affects vehicle motors, water supply, wastewater, agriculture, horticulture, aircraft safety, electricity, buildings (for example, roof collapse) and communications. There are many areas in New Zealand where volcanic activity is now dormant, but may reoccur in the future.

To date, plan provisions addressing volcanic events and the management of the effects of this natural hazard have been limited to engineering solutions, emergency management planning, monitoring, and specific volcanic contingency plans. These plans are predominantly reactive, emergency management operational plans rather than specific land-use plans.

Councils should take a proactive approach to managing volcanic hazards through the inclusion of appropriate provisions in regional policy statements and plans (objectives, policies and methods) and encouraging good urban design. This could include:

- avoiding or restricting the location of facilities such as hospitals, schools, and other facilities that may be difficult to evacuate quickly in areas at risk from lahars, lava and pyroclastic flows, and debris avalanches
- requiring buildings in volcanic hazard areas to be designed and located in such a way that minimises risks (such as requiring strengthening of the roof and frame to withstand ash falls, or locating on higher ground away from likely mud or debris flow paths). These site-specific and activity-specific measures could be addressed through conditions on consents such as where design features to reduce risks from volcanic hazards are a matter of control or discretion. In Japan, buildings are designed to mitigate the effects of ashfall. This includes changes to roof design and stormwater collection from impervious surfaces
- designing safeguards for critical community networks (for example, water supply).

In Washington State (US) all counties are required to regulate land use and development within critical areas (for example, those defined as habitat and hazard).

Non-RMA techniques and tools for managing natural hazards

Long Term Plans

The Local Government Act 2002 requires local authorities to prepare Long Term Plans to describe the activities and strategic direction of the local authority over a 10-year period. Long Term Plans can include descriptions of local authority activities in relation to functions of regional councils and territorial authorities including the management of natural hazards. Long Term Plans can also outline desired community outcomes in respect of natural hazards that can in turn inform other plans and strategies such as RPSs, regional plans and district plans. A Long Term Plan is quite broad in what it can contain. It can contain maps and general information that can be used to help educate the community about local hazards. The special consultative procedures under the Local Government Act 2002 allow local authorities to identify activities and funding for the management of natural hazards. The Ministry for the Environment and the Ministry of Business, Innovation and Employment provide information on the community consultation processes under the Local Government Act.

Asset and infrastructure management plans

Asset and infrastructure management plans deal with the procedures and works required to meet functional requirements of assets and infrastructure. They are generally prepared by local authorities (under the Local Government Act 2002) and network utility providers, and specify levels of service and performance measures for infrastructure. Asset management plans for stormwater systems can directly address flooding by setting specific levels of service for stormwater infrastructure and specifying performance measures to assess the success of these activities. Asset management plans can also serve as mechanisms for setting aside funds for future hazard mitigation.

In some areas, climate change will lead to more frequent high intensity rainfall requiring specific responses such as higher capacity stormwater systems. See climate change resources on:

- preparing for climate change:
- climate change effects and impacts assessment:
- coastal hazards and climate change:

Building Act 2004

The Building Act 2004 prescribes the legal requirements for all buildings in New Zealand.

Section 37 of the Act allows local authorities to delay building work until a resource consent is gained. This provision can be used where development is taking place on hazard-prone land and plan rules require a resource consent.

Sections 71 to 74 relate to building consent limitations and restrictions for the construction of buildings on land subject to natural hazards.

Sections 71-74 of the Building Act 2004

Section 71: requires a building consent authority (such as the council) to refuse to grant a building consent for construction of a building, or for major alterations to a building if the land on which the building work is to be carried out is subject or is likely to be subject to one or more natural hazards, or the building work is likely to accelerate, worsen, or result in a natural hazard on that land or any other property. However, s71 provides an exception that allows the building consent to be granted if adequate provision has been made to protect the land or building work, or to restore any damage to the land or other property as a result of the building work.

Section 72: building consent authorities must grant building consent for building work on land subject to natural hazards if the building work will not accelerate, worsen, or result in a natural hazard, and it is reasonable to grant a waiver or modification of the building code in respect of the natural hazard concerned.

Section 73: provides for the insertion of a notification condition (on the title for the property) within any consent granted under s72. These conditions can relate to structural requirements for flood, wind, fire, earthquake and volcanic hazards.

Section 74: provides that where a building consent has been granted for land subject to a natural hazard, the building consent authority must notify the Surveyor-General, the Registrar of the Maori Land Court or the Registrar-General of Land. The District Land Registrar will then include an entry on the certificate of title to the land (i.e. a covenant) that building consent has been issued in respect of building on land which is subject to erosion, avulsion, alluviation, falling debris, subsidence, inundation or slippage.

The Building Code is a regulation that accompanies the Building Act 2004, and outlines the performance expectations for buildings. One method of demonstrating compliance with the Building Code is the AS/NZ 1170 Structural Design Actions standard. The standard includes loading requirements for soil, wind, earthquake, ice, and snow. The standard does not include loading requirements for land movement, volcanic activity or tsunami.

The Building Act 2004 also covers dam construction and dam safety management for large dams. This was introduced to ensure that dams are well built, that larger dams are regularly monitored, and that the potential risks to people and property are minimised. See more information on the Building Act 2004 and dam safety.

Hazard registers

A hazard register is a collection of resources that identify man-made and/or natural hazards on properties in a district and region. Some examples of hazards are flooding risk, land instability, fire risk, active faults and coastal erosion. These hazards should be recorded to ensure that people can make best use of their properties and avoid potential issues of health and safety to both people and property in the future.

Ideally, hazard registers are stored on a Geographical Information System (GIS) system, with a system in place for updating, validating, and storing the hazard information. Information for hazard registers can be obtained from a number of sources.

An important aspect of a hazard register is ensuring that hazard information from regional and district councils is included, and that the information stored is linked into other council functions, such as the provision of information in LIMs and PIMs. This means information must be in compatible formats. A hazard register should include a disclaimer outlining the limitations of any information recorded.

Research and investigation

Hazard research and investigation increases the current state of knowledge of natural hazards. Central and local government, crown research organisations, academic institutions and private companies are all engaged in natural hazard research and investigation. Research can:

- contribute to a better understanding of the impact of natural hazards on New Zealanders
- increase public awareness about natural hazards and their effects
- improve understanding about ways of managing natural hazard risk

It is important that new information obtained through research and investigation is included and collated in the hazards register as it becomes available.

Non-statutory plans and guidelines

Structure plans and growth strategies can provide for the integrated management of an area. As part of the development of these mechanisms, areas susceptible to natural hazards can be identified and avoided before the expectation for development occurs. Most structure plans are implemented, to a large extent, by provisions in district plans.

Coastal management strategies provide the policy basis and direction for management in coastal areas. Because such strategies are non-statutory, they are able to provide direction for a wide range of council and community functions within coastal areas, including natural hazards, and for community engagement.

Design guidelines can provide guidance on how to develop and design for particular natural hazards. For example, low impact design approaches can encourage recognition and development within hazard limitations for a site.

Specific hazard strategies, mitigation and contingency plans

Specific hazard plans can be used to set out actions for a specific hazard. They are often more CDEM/operationally focussed than land use planning focussed. Specific hazard plans include risk mitigation plans, contingency plans and management plans.

Acquiring or purchasing land and the relocation of development

The acquisition, purchasing or relocation of a development due to a natural hazard risk is still very much a reactionary rather than a proactive approach in New Zealand, and is often used as a last-minute solution to a problem.

Ideally, a strategy should be in place before an event occurs, and should cover all three options if an area is at high risk from a hazardous event. Otherwise, a post-event discussion should be held to decide whether to reinstate an area (with mitigation measures) or relocate. Any decision will need to consider social, environmental and economic factors, and a full risk assessment should be completed on any new site.

Section 229(a)(v) of the RMA anticipates that esplanade reserves and esplanade strips can be used for the mitigation of natural hazards. The acquiring of land adjacent to waterways can be used as a means of creating 'no-build' buffer areas against flooding, inundation and erosion.

Community awareness, education and engagement

Community awareness, education and engagement are important factors to consider when managing risk from natural hazards. Research has shown that good general community development strategies will enhance a community's resilience to natural disasters, by creating a more empowered and capable community.

Education can also enhance community understanding of processes related to resource management planning (for example, if educated, people may understand that they need to check for hazards on LIMs when purchasing a house). Information needs to be presented using terms and concepts that people can understand.

The Long Term Plan, and its associated consultation process, can collect and display information about community understanding of hazards, and requirements for future plans regarding hazard management.

Managing residual risk needs to be addressed through community engagement and development programmes as RMA planning alone cannot solve such issues.

Coordinating hazard risk management

A range of statutes are applicable to the management of natural hazards in New Zealand. The integration of the functions and responsibilities required under each of these statutes is key to developing an integrated approach to natural hazards. The following are some ways that territorial authorities can achieve greater integration.

The Building Act 2004

- ensures that structural mitigation approved through the building consent process is consistent with the hazard approach set out in the applicant's RMA plans and, conversely, that those RMA plans are not inconsistent with the Building Code.
- ensures that information collected for PIMs is recorded and stored in a hazards register and is made available for those preparing plans or assessing resource consents.

The Resource Management Act 1991

- hazard information from PIMs and LIMs should be fed into a hazards register that is able to inform the preparation of plans.

- information from resource consent applications should be collated and, if possible, checked, and then entered into a hazards register to assist those processing PIMs and LIMs, other resource consents, and the preparation of RMA plans and other council planning documents.

The Local Government Act 2002

- Long Term Plans should take into account council hazard functions under the RMA and CDEM Acts.
- The Long Term Plan can be used as a way of coordinating and feeding hazard management plans into RMA policy statements and plans, council asset management plans, annual plans, and other documents such as reserve management plans.

The Local Government Official Information and Meetings Act 1987

- ensures that the information collected for LIMs is stored in a central hazards register (or similar) and is available for the preparation of district and regional plans.

The CDEM Act 2002

- ensures that the preparation of the RPS, regional plans and district plans takes account of the CDEM Group Plan and vice versa.

The coordination between the RMA and emergency management plans can be strengthened by involving policy staff in the review of the CDEM Group Plan and vice versa. The lessons learnt in this process will strengthen links between these two council functions and the staff involved in them.

It is important to encourage cooperation between emergency management and RMA staff and coordination of their hazard risk management approaches. Internal council governance structures for managing hazards (at officer and political levels) need to bridge RMA and emergency management specialisations. One way to achieve this is through an officers' working group that advises on hazard issues across a council and region.

Knowledge changes over time as the information regarding hazards improves and is updated. It is important for local authorities to identify how this information is passed on to staff. This is a particular issue where the turnover of staff assessing proposed developments is high or where important information is obtained while on the job. One way to improve staff knowledge of issues is through the development and implementation of hazard guidelines for staff which cover the use of hazard registers, GIS and databases, and external data sets. Staff should be trained to increase their awareness of the guidelines and to understand their role in managing natural hazards. A framework for capturing, storing and retrieving data should consider:

- who is responsible for the content of the database/register
- how data is collected and captured
- when, and what, information is included
- how information can be consolidated
- how, and to whom, the information will be distributed or communicated.

Once a framework is implemented, staff should ensure their knowledge of a particular site is included.

Local authorities can also improve internal hazard management integration by:

- assigning responsibility for hazard management to a specific position or department
- improving the connections between policy development and policy implementation
- improving the knowledge and awareness of staff and elected members through education
- involving other departments (for example, engineering, planning, and resource management) in hazard management activities.

LIM and PIM Information for natural hazards

A LIM (land information memorandum) is a summary of all the information that a council holds on a particular piece of land or building and is prepared in accordance with the Local Government Official Information and Meetings Act 1987. A LIM is a council report prepared for people considering purchasing a property. It provides information identifying each (if any) special feature or characteristic of the land concerned, including potential natural hazards. This includes, but is not limited to, potential erosion, avulsion, falling debris, subsidence, slippage, alluvion, or inundation. (See the list of information provided in a LIM).

A PIM (project information memorandum) is a summary of all the information the council holds on the land relating to a particular building consent, project or work, and outlines other consents required to complete that project or work. A PIM is prepared by council on request in accordance with the Building Act for all larger projects, new houses, large alterations and new commercial or industrial buildings. A PIM is useful in establishing the feasibility and design practicality of a project. (See the list of information provided in a PIM.)

When including hazard information on LIMs and PIMs, councils need to verify the accuracy of information and identify the liability issues associated with hazard identification.

A central hazards register should be used and updated as a source of information for LIMs and PIMs. Any hazards register should have a well documented process in place for collecting, storing and retrieving information. Any information that is documented within a council may be subject to official information requests, and therefore if certain hazard information is not included within the hazard register for LIMs and PIMs, councils may be vulnerable to liability issues in the future.

Information provided in a land information memoranda (LIM)

LIMs are issued under s44A of the Local Government Official Information and Meetings Act 1987. They may include the following information:

(2) a. Information identifying each (if any) special feature or characteristic of the land concerned, including, but not limited to potential erosion, avulsion [removal of land by water action and its possible attachment to other land], falling debris,

subsidence, slippage, alluvion [deposition of silt from flooding], or inundation, of likely presence of hazardous contaminants, being a feature or characteristic that -

i. Is known to the local authority; but
ii. Is not apparent from the district scheme under the Town and Country Planning Act 1977 or a district plan under the Resource Management Act 1991

b. Information on private and public stormwater and sewerage drains as shown in the territorial authority's records
c. Information on any rates owing in relation to the land
d. Information concerning any consent, certificate, notice, order, or requisition affecting the land or any building on the land previously issued by the territorial authority (whether under the Building Act 1991, the Building Act 2004 or any other Act)
e. Information concerning any certificate issued by a building certifier pursuant to the Building Act 1991 or the Building Act 2004
f. Information relating to the use the land may be put and conditions attached to that use [for example, plan provisions associated with the zoning]
g. Information which, in terms of any other Act, has been notified to the territorial authority by any statutory organisation having the power to classify land or buildings for any purpose
h. Any information which has been notified to the territorial authority by any network utility operator pursuant to the Building Act 1991 or the Building Act 2004.

(3) In addition to the information provided for in subsection (2) of this section, a territorial authority may provide in the memorandum such other information concerning the land as the authority considers, at its discretion, to be relevant.

Note that notwithstanding anything to the contrary in the Local Government Official Information and Meetings Act 1987, there are no grounds for the territorial authority to withhold information specified under s44A or to refuse to provide a land information memorandum where this has been requested.

Information provided in a project information memoranda (PIM)

PIMs are issued under s34 of the Building Act 2004. On receiving an application for a building consent, the building consent authority (which may or may not be the local authority itself) must apply for a PIM from the territorial authority within whose district the work is being carried out. Alternatively, a property or building owner may apply directly to the territorial authority for a PIM if they are considering carrying out building work and a building consent will be needed for that work.

The content of a PIM is set out in s35 of the Building Act:

(1) A project information memorandum must include:

a. Information likely to be relevant to the proposed building work that identifies-
   i. the heritage status of the building (if any); and
   ii. each special feature of the land concerned (if any)
b. Information likely to be relevant to the proposed building work that, in terms of any other Act, has been notified to the territorial authority by a statutory

authority

c. Details of any existing stormwater or wastewater utility systems that-
   i. relate to the proposed building work; or
   ii. are on, or adjacent to, the site of the proposed building work
d. details of any authorisation in respect of the proposed building work that the territorial authority, on its own behalf and on behalf of any network utility operator (if the territorial authority is acting as agent for a network utility operator by prior agreement with the network utility operator), is authorised to refuse or require under any Act, except this Act, and in respect of each authorisation,-
   i. a statement of the requirements to be met in order for the authorisation to be granted or imposed; and
   ii. the conditions to which an authorisation will be subject
e. if the territorial authority considers that the owner of the building or proposed building to which the project information memorandum relates is likely to be required, under s21A of the Fire Service Act 1975, to make provision for a scheme that provides for evacuation from the scene of a fire, a statement to that effect
f. if the territorial authority considers that notification to the New Zealand Historic Places Trust is likely to be required under s
g. 39, a statement to that effect
h. either-
   i. confirmation, subject to this Act, that building work may be carried out subject to the requirements of a building consent and subject also to all other necessary authorisations being obtained; or
   ii. notification that building work may not be carried out because any necessary authorisation has been refused , despite the issue of building consent
i. if s75 applies, the statement referred to in s75(2);

(2) In this section,-

land concerned-

a. means the land on which the proposed building work is to be carried out; and
b. includes any other land likely to affect or be affected by the building work.

special feature of the land concerned includes, without limitation, potential natural hazards, or the likely presence of hazardous contaminants, that-

a. is likely to be relevant to the design and construction or alteration of the building or proposed building
b. is known to the territorial authority; and
c. is not apparent from the district plan under the Resource Management Act 1991.

Note that information provided under s35 that is relevant to hazards could include:

- information on special land features such as:
  - erosion
  - avulsion (removal of land by water action)
  - falling debris

    - subsidence
    - slippage
    - alluvion (the deposition of silt from flooding)
    - known active faults
    - presence of hazardous contaminants which are likely to be relevant to the design, construction or alteration of your proposed building which are known to council
- information notified to council by any statutory organisation, such as the New Zealand Historic Places Trust or the Department of Conservation, which has the power to classify land or buildings for any purpose
- details of stormwater or wastewater utility systems which relate to your proposed building work, or which are adjacent to your building site
- details of any authorisations under other Acts which the council requires, and details of the requirements to be met in the granting of these authorisations and the conditions they will be subject to. The most common authorisations will be resource consents required under the Resource Management Act 1991.

The memorandum will also include either:

- confirmation, subject to other provisions of the Act, that you may carry out the building work subject to the requirements of the building consent and subject also to all other necessary authorisations being obtained, or
- notification that building work may not be undertaken.

Managing hazard risk through the monitoring and review process

Consent monitoring

Consents involving hazard mitigation should be monitored to ensure adequate construction and maintenance and that measures are proving effective. Where hazard mitigation works are proven to be ineffective in managing the risk then the resource consent should be reviewed.

It is important that information from development applications that reveal the presence of hazards is recorded, even if the risk is avoided or mitigated through engineering works. This provides valuable information later on if assumptions made at the time prove to be wrong and the issue needs to be revisited.

Plan monitoring

Section 35 of the RMA requires local authorities to monitor: the state of the environment; the efficiency and effectiveness of policies, rules or other methods; and a range of other matters set out in s35(2). This includes gathering information, monitoring and keeping records for natural hazards. Local authorities also need to keep records of natural hazards as per s35(5)(j) of the Act.

Hazard objectives in resource management plans should be written in such a way that enables progress towards them to be measured. There are a number of ways that councils can monitor the effectiveness of natural hazard provisions in their plans.

Councils may need to revise the provisions in their plans when:

- monitoring indicates that the provisions in a plan are not reducing natural hazard risk
- new information becomes available, altering the level of acceptable risk
- advances in scientific information and technology create new data.

Regional and district plan reviews are good opportunities to consider new information and data relating to natural hazards. A programme of consultation should accompany any changes to hazard information gained by the council. This ensures that communities are aware of the hazards that they face.

Monitoring plan effectiveness

Plan effectiveness can be monitored by examining the:

- number of structures being built on at-risk land
- type of structures being built (construction and use)
- amount of land subject to hazards being set aside/purchased
- level of awareness of the community and their acceptance of risk-based plan provisions.

Summary of climate change effects applicable to New Zealand

This map provides an indication of the potential regional impacts of climate change in New Zealand. It is not an attempt to provide a comprehensive summary of all the impacts.

(Source: Ministry for the Environment 2013)

The map above indicates the following effects:

Snowlines and glaciers

- increased length and area of glaciers
- rise in snowline
- possible increase in snowfall
- possible increase in avalanches

Coastal

- sea-level rise
- increased storm surge
- coastal inundation
- increased coastal erosion

Drier northern and eastern parts of North and South Islands

- less rainfall
- decreased run-off to rivers
- increased evaporation
- increased drought for already drought-prone areas
- increased irrigation demand

Wetter west and south of North and South Islands

- increased precipitation
- increased intensity in weather events
- increased flooding for already flood-prone areas
- increased slips
- increased soil erosion

Cyclones

- increased intensity (leading to increased wind, waves, storm surge and rainfall)

Wind

- increased westerly winds in the south, more north easterlies in the north

Natural areas

- species distribution changes
- changes to/loss of habitat
- increased pressure from pests, animals and plants.

Climate change effects by local authority function

Local authority area of responsibility	Asset or activity affected	Climate change influence	Possible effects
Water supply and irrigation	Infrastructure	Reduced rainfall, extreme rainfall events and increased temperature	• Reduced security of supply (depending on water source) • Contamination of water supply
Wastewater	Infrastructure	Increased rainfall	• More intense rainfall (extreme events) will cause more inflow and infiltration into the wastewater network • Wet weather overflow events will increase in frequency and volume • Longer dry spells will increase the likelihood of blockages and related dry weather overflows
Stormwater	Reticulation Stopbanks	Increased rainfall Sea-level rise	• Increased frequency and/or volume of system flooding • Increased peak flows in streams and related erosion • Groundwater level changes • Saltwater intrusion in coastal zones • Changing flood plains and greater likelihood of damage to properties and infrastructure
Roading	Road network and associated infrastructure (power, telecommunications, drainage)	Extreme rainfall events, extreme winds, high temperatures	• Disruption due to flooding, landslides, fallen trees and lines • Direct effects of wind exposure on heavy vehicles
Urban land-use planning/policy development	Management of development in the private sector Expansion of urban areas Infrastructure and communications planning	All	• Inappropriate location of urban expansion areas • Inadequate or inappropriate infrastructure, costly retrofitting of systems
Land	Rural land	Changes in	• Enhanced erosion

management	management	rainfall, wind, and temperature	• Changes in type/ distribution of pest species • Increased fire risk • Reduction in water availability for irrigation • Changes in appropriate land use
Water management	Management of watercourses/lakes/ wetlands	Changes in rainfall and temperature	• More variation in water volumes possible • Reduced water quality • Sedimentation and weed growth • Changes in type/ distribution of pest species
Coastal management	Infrastructure Management of coastal development	Temperature changes leading to sea-level changes Extreme storm events	• Coastal erosion and flooding • Disruption in roading, communications • Loss of private property and community assets • Effects on water quality
Civil defence and emergency management	Emergency planning and response, and recovery operations	Extreme events	• Greater risks to public safety, and resources needed to manage flood, rural fire, landslip and storm events
Biosecurity	Pest management	Temperature and rainfall changes	• Changes in range of pest species
Open space and community facilities management	Planning and management of parks, playing fields and urban open spaces	Temperature and rainfall changes	• Changes/reduction in water availability • Changes in biodiversity • Changes in type/ distribution of pest species • Groundwater changes • Saltwater intrusion in coastal zones • Need for more shelter in urban spaces
Transport	Management of public transport Provision of footpaths, cycleways, etc	Changes in temperatures, wind and rainfall	• Changed maintenance needs for public transport (road, rail) infrastructure • Disruption due to extreme events
Waste management	Transfer stations and landfills	Changes in rainfall and temperature	• Increased surface flooding risk • Biosecurity changes

			• Changes in ground water level and leaching
Energy	Transmission lines	Extreme wind, high temperatures	• Outages from damaged lines

Glossary

General

AEP (Annual Exceedance Probability)	A term used to describe the frequency or probability of floods occurring. Large floods occur rarely, whereas small floods occur more frequently. For example, a 1% AEP flood occurs (or is exceeded) on average once every 100 years. A so-called 100-year flood does not mean that there is only one flood of this size every 100 years. It means that there is a 1 in 100 chance in any given year that a flood of this size or bigger will happen; it is therefore more correctly called a 1% AEP flood. In any given year, there is about a 65 percent chance that there will be at least one 1% AEP flood in populated catchments of New Zealand (NIWA 2007).
Block slide:	A translational slide in which the moving mass consists of a single unit or a few closely related units that move downslope as a single unit (Wold, 1989). EDITORIAL NOTE: Translational in this context means the movement of a mass in such a way that every point moves in the same direction from one place to another more or less over the same distance.
Debris avalanche	A very rapid to extremely rapid landslide on a steep slope which is unconfined to a channel. Debris avalanches often initiate debris flows.
Debris flow	A form of rapid mass movement in which soils, rocks, and organic matter combine with entrained air and water to form a slurry that then flows down a slope in a confined channel. Debris flows are associated with steep confined gullies (Wold, 1989).
Earth flow	A bowl or depression forming at a head where unstable material collects and flows out. The central area is narrow and usually becomes wider as it reaches the valley floor. Flows generally occur in fine-grained materials or clay-bearing rocks on moderate slopes and with saturated dry conditions. Dry flows of granular material are also possible. Earth flows have a characteristic 'hour glass' shape (Wold, 1989).
Hazardscape	The landscape of all hazards in a particular place or the net result of natural and man-made hazards and the risks they pose cumulatively across a given area.
Lateral spreads	The result of the nearly horizontal movement of geologic materials, distinctive because they usually occur on very gentle slopes. The movement is caused by liquefaction triggered by rapid ground motion, such as that experienced during an earthquake (Wold, 1989).
Liquefaction	A process that causes some soils to lose their strength and behave more like a liquid than a solid during an earthquake.
Mitigation measures	Mitigation involves taking steps to reduce the likelihood of a natural hazard occurring or the consequence of its impact. Mitigation aims to reduce the likelihood of a natural hazard occurring and/or reduce the consequences of a natural hazard event. Mitigation measures will differ depending on the activity, location and nature of the particular hazard but may include: • structural measures, for example, constructing a stopbank and raising floor levels within areas subject to flood hazard • non-structural measures, for example, revegetating a hillside to reduce landslide hazard.

Natural Hazard	**RMA 1991 definition of natural hazard** 'Natural hazard means any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.' **CDEM Act 2002 definition of hazard** 'Hazard means something that may cause, or contribute substantially to the cause of, an emergency.' **Building Act 2004 definition of natural hazard** 'Natural hazard means any of the following: • erosion (including coastal erosion, bank erosion, and sheet erosion) • subsidence • inundation (including flooding, overland flow, storm surge, tidal effects, and ponding) • slippage.'
Net present value	The net present value (NPV) method of evaluating a major project allows the changing value of money over time to be considered. Essentially, it helps find the present value in 'today's dollars' of the future net cash flow (or the value) of a project. It is then possible to compare that amount with the amount of money needed to implement the project. If the NPV is greater than the cost, the project will be beneficial. If there is more than one project being evaluated, it is possible to compute the NPV of each, and choose the one with the greatest difference between NPV and cost.
Overland flow path	The route taken by stormwater which becomes concentrated as it flows overland, making its way downhill following the path of least resistance towards the stormwater network, streams or the coast. Overland flow paths vary in width depending on the shape of the ground over which they flow, but once the contributing catchment area exceeds 30,000 m^2, they are referred to as major overland flow paths. Overland flow paths include secondary flow paths which result when the piped stormwater system gets blocked or when the capacity is exceeded. Secondary overland flow paths are the backup stormwater system.
Precautionary Principle	Defined as "the lack of full scientific evidence shall not be used as reason for postponing cost-effective measures to prevent environmental degradation"(1992 Rio Declaration).
Qualitative analysis	In the context of natural hazard management qualitative analysis means using words to describe the magnitude and likelihood of potential consequences arising out of a natural hazard event.
Quantitative analysis	In the context of natural hazard management means using numerical values for both the magnitude and likelihood of natural hazard consequences that may occur.
Readiness	Developing operational systems and capabilities before an emergency happens. These include self-help and response programmes for the general public, as well as specific programmes for emergency services, utilities, and other agencies.
Recovery	Activities beginning after initial impact has been stabilised and extending until

	the community's capacity for self-help has been restored.
Reduction	Identifying and analysing long-term risks to human life and property from natural or man-made hazards, taking steps to eliminate these risks where practicable and, where not, reducing the likelihood and the magnitude of their impact.
Response	Actions taken immediately before, during or directly after an emergency, to save lives and property, as well as to help communities recover.
Rockfall	One or more pieces of rock falling from a steep rocky slope whether one at a time or all at once.
Rotational landslide	A landslide in which the surface of the rupture is curved concavely upward (spoon shaped) and the slide movement is more or less rotational about an axis parallel to the contour of the slope (Wold, 1989).
The SMUG system	Acronym for Seriousness, Manageability, Urgency, Growth where: **Seriousness** is the relative impact in terms of people and/or dollars **Manageability** is the relative ability to reduce the risk (through managing the hazard or the community or both) **Urgency** is the measure of how imperative or critical it is to address the risk (associated with the probability/likelihood of the risk from the hazard, including return period considerations) **Growth** is the rate at which the risk will increase (through an increase in the probability of the extreme event occurring, an increase in the exposure of the community, or a combination of the two). The SMUG system, advocated by the Ministry in 2002, has been subsequently modified by many CDEM groups. Many groups removed the 'urgency' component (as it may be adequately covered under 'seriousness') and expanded the 'manageability' table to include the subcomponents of 'difficulty' (how difficult the hazard is to manage) and 'effort' (how much effort is currently being put into managing the hazard). Manageability ratings were then given to each subcomponent for each of the 4 'Rs' (reduction, readiness, response and recovery), thereby a manageability rating derived from eight manageability values.
The 4 'Rs' of community resilience	Reduction, Readiness, Response, Recovery
Topple	A block of rock that tilts or rotates forward, eventually to fall, bounce, or roll down the slope as a rockfall (Spiker & Gori, 2003). Often also used for the whole event, including the rockfall deposit.
Transitional slide	A landslide in which the mass of soil and rock moves out or down and outward with little rotational movement or backward tilting (Spiker & Gori, 2003).

Risk management definitions: as per AS/NZS standard 4360

Consequence	Means the outcome or impact of an event. NOTE 1: There can be more than one consequence from one event. NOTE 2: Consequences can range from positive to negative. NOTE 3: Consequences can be expressed qualitatively or quantitatively. NOTE 4: Consequences are considered in relation to the achievement of objectives.
Event occurrence	Means: of a particular set of circumstances. NOTE 1: The event can be certain or uncertain. NOTE 2: The event can be a single occurrence or a series of occurrences.
Frequency:	A measure of the number of occurrences per unit of time.
Hazard:	A source of potential harm.
Likelihood:	Used as a general description of probability or frequency. NOTE: Can be expressed qualitatively or quantitatively.
Monitor:	To check, supervise, observe critically or measure the progress of an activity, action or system on a regular basis in order to identify change from the performance level required or expected.
Probability:	A measure of the chance of occurrence expressed as a number between 0 and 1. NOTE 1: ISO/IEC Guide 73 defines probability as the 'extent to which an event is likely to occur'. NOTE 2: ISO 3534-1:1993, definition 1.1, gives the mathematical definition of probability as 'a real number in the scale 0 to 1 attached to a random event'. It goes on to note that probability 'can be related to a long-run relative frequency of occurrence or to a degree of belief that an event will occur. For a high degree of belief, the probability is near 1' NOTE 3: 'Frequency' or 'likelihood' rather than 'probability' may be used in describing risk.
Residual risk:	The risk remaining after implementation of risk treatment
Risk:	The chance of something happening that will have an impact on objectives NOTE 1: A risk is often specified in terms of an event or circumstance and the consequences that may flow from it. NOTE 2: Risk is measured in terms of a combination of the consequences of an event and their likelihood. NOTE 3: Risk may have a positive or negative impact. NOTE 4: See ISO/IEC Guide 51, for issues related to safety.
Risk analysis:	A systematic process to understand the nature of and to deduce the level of risk. NOTE 1: Provides the basis for risk evaluation and decisions about risk

	treatment. NOTE 2: See ISO/IEC Guide 51 for risk analysis in the context of safety.
Risk assessment:	The overall process of risk identification, risk analysis and risk evaluation.
Risk avoidance	A decision not to become involved in, or to withdraw from, a risk situation.
Risk evaluation:	A process of comparing the level of risk against risk criteria. NOTE 1: Risk evaluation assists in decisions about risk treatment. NOTE 2: See ISO/IEC Guide 51 for risk evaluation in the context of safety.
Risk identification:	The process of determining what, where, when, why and how something could happen.
Risk management:	The culture, processes and structures that are directed towards realising potential opportunities whilst managing adverse effects.
Risk management process:	The systematic application of management policies, procedures and practices to the tasks of communicating, establishing the context, identifying, analysing, evaluating, treating, monitoring and reviewing risk.
Risk management framework:	A set of elements of an organisation's management system concerned with managing risk. NOTE 1: Management system elements can include strategic planning, decision-making, and other strategies, processes and practices for dealing with risk. NOTE 2: The culture of an organisation is reflected in its risk management system.
Risk reduction:	Actions taken to lessen the likelihood, negative consequences, or both, associated with a risk.
Risk treatment:	Process of selection and implementation of measures to modify risk NOTE 1: The term 'risk treatment' is sometimes used for the measures themselves. NOTE 2: Risk treatment measures can include avoiding, modifying, sharing or retaining risk.