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The application of risk analysis tools in Civil Defence Emergency Management Planning in New Zealand

A thesis presented in partial fulfilment of the requirements for the degree of

Masters of Philosophy
in
Emergency Management

at Massey University, Palmerston North, New Zealand.

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2006

Abstract

Civil Defence Emergency Management (CDEM) Groups were formed in New Zealand in response to the introduction of the CDEM Act in 2002. These Groups were required to prepare CDEM Group Plans within two years of their formation. These Group Plans were to be based on a risk management approach, and be consistent with a Director's Guideline issued by the Ministry of CDEM at the time the legislation was passed (MCDEM, 2002). The Director's Guideline recommended a process of risk analysis called the SMUG (Seriousness Manageability, Urgency and Growth) risk analysis tool. The tool was to provide CDEM Groups with a mechanism for a more detailed risk analysis process than a simple likelihood and consequence assessment as described in the Australian and New Zealand Risk Management Standard (AS/NZS 4360:1999).

Most CDEM Groups in New Zealand implemented the SMUG (Seriousness, Manageability, Urgency & Growth) risk analysis technique, or adapted the model to suit their own requirements. The reported benefits of using the risk analysis technique included greater engagement of a range of agencies with a role in Civil Defence Emergency Management, and greater understanding of the risks faced by each CDEM Group. However the limitations of the technique included over-reliance on the numerical rating system, inconsistencies of application of the model, lack of risk evaluation criteria, and difficulty of application.

CDEM Groups must revise their CDEM Group Plans by 2010 and it is recommended that future approaches allow flexibility for the purpose of risk analysis to acknowledge different levels of understanding of risk in different parts of New Zealand, and continue to involve a large range of agencies in the analysis process. The focus of future risk analysis processes should be on the consequences of hazard events, rather than the hazards themselves. Also, future risk analysis processes should remain qualitative if this is necessary to prevent CDEM Groups becoming over-reliant on numerical rating systems which convey a sense of accuracy often not proportional to the data upon which the analysis was conducted. Measurements of community vulnerability and resilience should also be incorporated into future CDEM Group risk analysis processes.

Acknowledgements

The contribution of CDEM Group planners from around New Zealand is acknowledged for providing information regarding their risk analysis processes, and personal comments on the effectiveness of the processes undertaken. The contribution of Vince Neall of Massey University, Douglas Paton of University of Tasmania, David Brunsdon of Kestrel Group, Hans Brounts of the Ministry of Civil Defence and Emergency Management, Chris Peace of Risk Management Consultants, and David Johnston of the Institute of Geological and Nuclear Sciences is acknowledged in providing information and feedback during thesis development. The financial contribution of the Wanganui District Council and in-kind contributions of the Ministry of Civil Defence Emergency Management, Kestrel Group Ltd, and Greater Wellington Regional Council in preparation of this research is also acknowledged.

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1. Introduction

This research focuses on risk analysis in the context of Civil Defence Emergency Management (CDEM) planning in New Zealand.

For the purpose of this research, risk is defined as the likelihood of harmful consequences arising from the interaction of hazards, communities and the environment (Buckle, 2000). Risk is measured in terms of the likelihood of the event happening and the consequences of the event when it does occur (AS/NZS 4360: 1999). Risk can be expressed as follows:

Risk = likelihood x consequence

The likelihood of risk may also be referred to using terms such as *frequency* or *probability*. The consequence of the risk may also be referred to using terms such as *impact, effects* or *severity* (MCDEM, 2002). Throughout this document the terms **likelihood** and **consequences** are used when describing risk.

Risk is different to hazard, which can be defined as something that may cause, or contribute substantially to the cause of, an emergency (CDEM Act 2002). Hazards in the CDEM context are most often characterised as natural or non-natural (technological or man-made) and include events such as earthquakes, floods, volcanic activity, transportation accidents, technological failure or biosecurity incursion.

Many factors have the ability to influence the likelihood and consequences of hazards when they occur. These factors include community characteristics such as vulnerability (degree of susceptibility) and resilience (the ability to resist, bounce back and respond to consequences of adverse

events), the elements at risk in the community, as well as the existing controls or management mechanisms in place.

Risk analysis is the process by which these factors are taken into consideration to determine the level of risk posed by the hazard under consideration, so that risk treatment mechanisms can be developed. Risk analysis is necessary because there are limited resources to address all risks, and analysis can provide a means of prioritising risk so that the most appropriate and effective risk treatments can be undertaken. Risk analysis also informs understanding of risk, and can show trends such as increasing risk, or components of risk that require special attention.

CDEM organisations focus on those risks that have the potential to cause an emergency. According to the definition in the CDEM Act 2002 these are the risks that have very severe consequences and cannot be dealt with by normal emergency services responses, without CDEM co-ordination.

In the CDEM context, risk is addressed by risk treatments aimed at reducing either the likelihood or the consequences of adverse events which have the potential to cause an emergency.

This research investigates the risk analysis tools used in CDEM planning in New Zealand, and provides a comparison with tools used overseas. A particular focus of this research is the application of the SMUG (Seriousness, Manageability, Urgency and Growth) risk analysis tool by CDEM Groups in New Zealand. This research investigates various applications of the model and develops conclusions and recommendations as to how the risk analysis process could be enhanced in future CDEM planning processes.

The purpose of this research is to:

- Investigate the role of risk analysis within a comprehensive emergency management framework;
- Describe and assess the benefits and limitations of the SMUG risk analysis tool and other tools relevant for CDEM planning in New Zealand;
- Investigate the application of the SMUG risk analysis tool in New Zealand CDEM planning, and in particular to identify variations and changes made to the model during implementation;
- Identify alternative models and content, or changes to the SMUG model that may be appropriate for future use in New Zealand; and
- Make recommendations about processes and tools that should be considered for use in future CDEM planning in New Zealand.

2. New Zealand Risk Management Context

Risk management is the term used to describe the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring those risks that could prevent an organisation from achieving its strategic or operational objectives, or complying with its legal obligations (SNZ HB 4360:2000). Although the term 'risk management' is often used, it is the likelihood and consequences that make up a risk that are actually managed, rather than the risk itself per se.

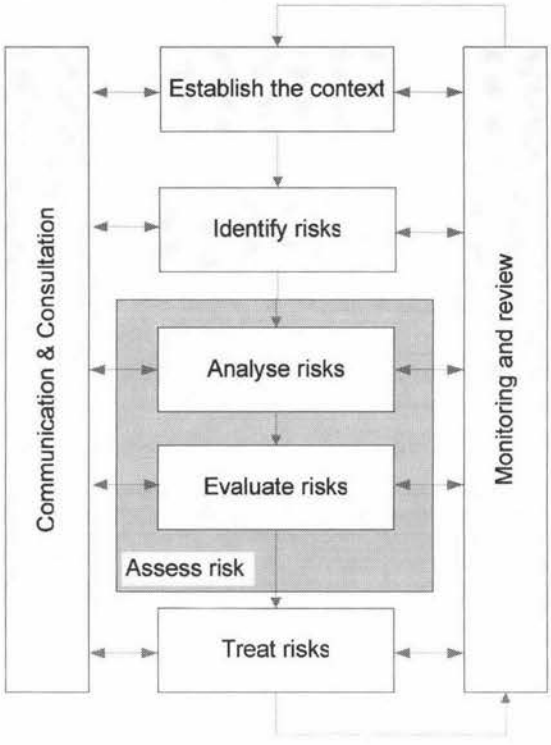
The foundation for best practice risk management in New Zealand was set with the introduction of the Australian New Zealand Risk Management Standard in 1999 (AS/NZS 4360 1999). This Standard, and subsequent updates and handbooks outlines the fundamental principles and processes to be followed when implementing risk management within an organisation.

Throughout this document references are made to the AS/NZS 4360 1999 Standard as this was the Standard in place when CDEM Groups were carrying out risk analysis processes. Subsequently a 2004 version of the AS/NZS 4360 Standard has been introduced with some enhancements and alterations from the 1999 version (AS/NZS 4360: 2004).

The principles and practice of risk management as outlined in AS/NZS 4360 have been widely accepted in New Zealand, in both the public and private sectors.

The key components of the risk management process can be seen Figure 1.

Figure 1. Risk Management Overview. (from AS/NZS 4360:1999, Risk Management)



The expected benefit for an organisation implementing the risk management approach is that through identifying and managing risks, organisational goals will be achieved, and losses associated with identified risks can be minimised. It is unlikely, however, that the final output of a risk management process is that risk will be reduced. This is largely due to risk constantly increasing in contemporary society.

However, the cyclical nature of the process means that over time an organisation can expect to have learned techniques of risk identification, analysis, evaluation, treatment or communication that can be applied when new or additional risks are encountered. Implementation of these techniques may give an organisation confidence that they have managed the likelihood and consequences of the risks they face to the best of their organisational ability.

The risk management framework particularly focuses on physical hazards and hazard processes, and less on social and individual issues (e.g. social dynamics).

As the type of hazards that CDEM Groups are responsible for managing are often complex interactions of physical and social networks, the nature of risk identification, analysis, evaluation and treatment within the CDEM sector is also complex, often requiring multi-agency activities rather than an organisational approach for which the risk management standard is primarily designed.

The risk management framework is designed to be adapted for the specific circumstances and contexts of the user. This adaptation allows interaction between decision makers, each within a different social, economic and political context.

2.1. Risk analysis

A key component of the risk management process, and the focus of this research, is the task of risk analysis. Risk analysis is the process by which information about a particular risk is further examined so that possible risk treatments are able to be appropriately developed and selected.

Risk analysis is different from hazard analysis. Hazard analysis attempts to assess the physical characteristics of a hazard e.g. the speed of wind in a cyclone, or the magnitude of energy released in an earthquake. Risk analysis however attempts to assess the consequences of the hazard when it occurs. Risk analysis generally involves both quantitative and qualitative assessment. That is, in its most simple form, assessments of the *likelihood* of the risk, and of the *severity of the consequences* of the risk when no treatment options are in place.

A simple risk analysis often involves a matrix approach whereby an organisation develops categories of likelihood and consequences at levels appropriate for the organisation, and the risks being considered.

An organisation might therefore define categories for likelihood such as:

Low	= once per year
Medium	= once per month
High	= once per day/week
or	
Rare	= once per 1000 years
Possible	= once per 50 years
Almost certain	= once per year

They may also define categories for consequence such as:

Low	= minor injury no treatment needed
Medium	= moderate injury involving first aid or hospital treatment
High	= serious injury or death
or	
Insignificant	= minor financial loss, less that $10,000
Moderate	= loss less than $100, 000
Catastrophic	= loss greater than $100,000

A matrix could then be developed using these categories. The matrix would identify those risks that could result in severe consequences, and that also happen frequently. These are the highest risks facing the organisation or community carrying out the risk analysis. A simple risk analysis matrix incorporated in the AS/NZS 4360 is illustrated in Figure 2.

Figure 2. Risk Analysis matrix (From AS/NZS 4360: 1999. Risk Management)

	Consequences				
Likelihood	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A (almost certain)	High	High	Extreme	Extreme	Extreme
B (likely)	Moderate	High	High	Extreme	Extreme
C (possible)	Low	Moderate	High	Extreme	Extreme
D (unlikely)	Low	Low	Moderate	High	Extreme
E (rare)	Low	Low	Moderate	High	High

Following an analysis process such as this, the risk management process calls for the development of treatment options to address the risks. As a result of the risk analysis, an organisation may decide to implement risk treatment options for the highest risks as a priority over those risks that occur less frequently, or with lower consequences.

The example given above is likely to be an over simplification of the analysis required in an organisation. This is due to the fact that often the consequences of a particular risk are multifaceted. That is, some risks may manifest themselves in financial losses, with little effects on people, and other risks may have significant human impact in terms of injury or social disruption. In addition, some hazard consequences may occur over a long duration while others have a quick timeframe, or some hazards may be highly controlled while for others there may be no existing capability to manage the hazards.

A simple risk analysis tool such as the AS/NZS 4360 matrix risk analysis as identified above is not likely to be able to take these complexities into account. As the results of risk analysis are frequently used to determine what actions are undertaken to safeguard citizens from risk, more detailed risk analysis tools are likely to be required to provide additional and more appropriate inputs into the risk analysis process.

These detailed risk analysis tools are often applied after an initial screening is carried out using the AS/NZS 4360 risk analysis matrix.

3. New Zealand Civil Defence Emergency Management Planning Context

Civil Defence Emergency Management is a term introduced to New Zealand in 2002 with the passing of the CDEM Act. Civil Defence Emergency Management is the application of knowledge, measures or practices that are desirable for the safety of the public or property, and are designed to guard against, prevent, reduce or overcome a hazard or harm or loss associated with an emergency. CDEM activities therefore include planning, co-ordination and organisation of people and organisations with a role before, during and after an emergency (CDEM Act 2002). Risk management is therefore a central activity within this context.

3.1. CDEM Groups

The introduction of the CDEM Act required the formation of CDEM Groups in New Zealand. These groups were formed along regional council boundaries and comprise a management group of the elected representatives of the Local Authorities in the area (Mayors and the Regional Council Chairperson), and a supporting executive group of senior managers from the Local Authority members, together with the NZ Police, NZ Fire Service and District Health Boards.

Through the CDEM Act 2002 these regional groupings were charged with the provision of civil defence emergency management within their area. The critical functions of these CDEM Groups are (summarised from S17(1), CDEM Act 2002):

a) In relation to relevant hazards and risks:
    i) Identify, assess and manage those hazards and risks
    ii) Consult and communicate about risks

iii) Identify and implement cost-effective risk reduction

b) Provide personnel, an organisation, information and resources to deliver CDEM in its area
c) Respond to and manage the adverse effects of emergencies in its area
d) Carry out recovery activities
e) Assist other CDEM Groups
f) Promote and monitor compliance with the CDEM Act 2002
g) Develop, approve, implement and monitor a CDEM Group Plan
h) Participate in development of the National CDEM Strategy and Plan
i) Promote CDEM in its area

Each CDEM Group therefore has a mandate (Section 17 1(a(i)) to carry out risk management for their area, and implement appropriate risk treatment options.

3.2. CDEM Group Plans

The mechanism used to document the risk management process of each CDEM Group is the CDEM Group Plan; which was required to be produced by each Group within 2 years of formation.

CDEM Group Plans have a number of legally required inclusions. Those relevant to the risk management process include the requirement to state (from S49, CDEM Act 2002):

- The hazards and risks to be managed by the Group (i.e. hazard identification and analysis)

- The civil defence emergency management necessary to manage the hazards and risks described (i.e. the risk treatment options selected to manage risk likelihood and consequences).

No additional definition is provided within the CDEM Act 2002 as to what constitutes best practice in CDEM Planning, or the purpose of CDEM Group Plans.

3.2.1. Ministry of CDEM Director's Guideline

In order to assist CDEM Groups with development of their Group Plans the Ministry of Civil Defence and Emergency Management issued a Director's Guideline entitled, "Working Together: Developing a CDEM Group Plan" (MCDEM, 2002).

Director's Guidelines are issued under the CDEM Act 2002 and therefore CDEM Groups are required to take them into account during their Plan preparation.

The Director's Guideline suggested that a CDEM Group Plan should have the following key components:

- **Strategic**

  Context, goals and criteria, hazard and risks identification, consequences and functions, assessment of management methods, prioritised risks and key issues, and objectives, targets and actions

- **Operational**

  Principles, agreed agency functions, and management arrangements for operational activities.

- **Administrative**

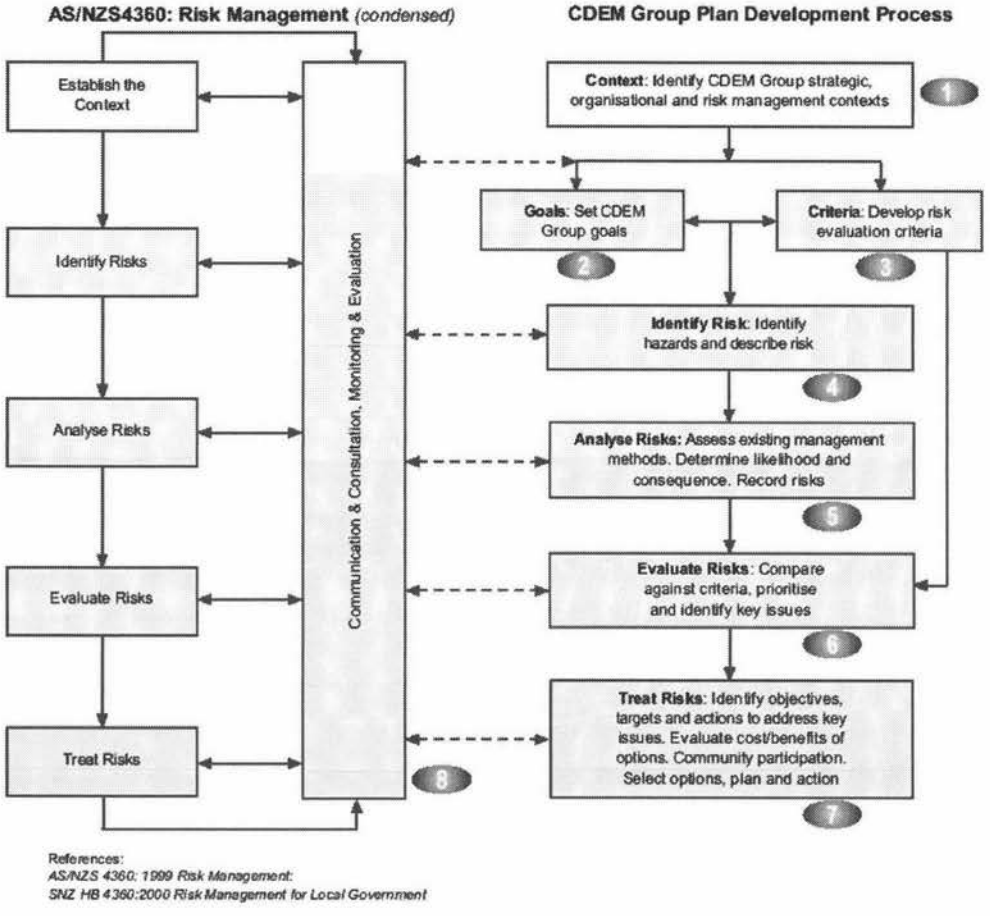
  Group composition and roles, procedural arrangements for meetings, appointments, funding, personnel and training, monitoring and evaluation.

Previous Civil Defence planning had primarily been focused on the operational aspects with limited strategic direction or analysis of the possible risks (Britton, 2001). The Plan structure proposed in the Director's Guideline was therefore significantly different from previous Civil Defence planning in New Zealand.

The Director's Guidelines state that CDEM Groups "must apply risk management", preferably based on the AS/NZS Risk Management Standard. The risk management processes to be undertaken by the Group are therefore primarily reflected in the strategic part of CDEM Group Plans.

The Director's Guideline suggested that the CDEM Group planning process was equivalent and parallel to the risk management process. This can be seen in the Figure 3.

Figure 3. Risk management outline and CDEM Group Plan development process (From MCDEM DGL 2/02)



The Director's Guideline outlines a recommended process for each step in the risk management framework, and how they can be incorporated into the strategic, operational and administrative parts of CDEM Group Plans.

3.2.2. Strategic planning within CDEM Group Plans

The Director's Guideline emphasises a number of planning considerations that are to underpin CDEM planning. Firstly the guidelines emphasise the importance of CDEM planning involving the community in decision making, and decisions being based on sound judgements of the costs and benefits of risk treatment options.

In addition, CDEM Groups were encouraged to focus on the consequences of the risks, rather than on the resources available to manage those risks. As past planning had primarily been response focussed, its typical starting point had often been the resources available within the district to mount a response. The risk management process suggested that the resources in a particular area should be driven by the risk they faced, and not the other way around.

Another principle introduced was a focus on functional rather than contingency based planning. Functional planning identifies the functions to be performed during an emergency as they arise from the consequences of the event. Therefore the same response functions would be carried out, irrespective of the particular event that may occur. Thus, the focus of planning was to move away from having specific contingency plans for each hazard. A critical part of the risk identification and analysis was therefore to identify those consequences common to multiple risks and develop risk treatment options around those. Functional planning involves identifying the mandate, process and resources required to carry out each function needed to address a particular consequence.

The Director's Guideline suggested that in order to make informed decisions about risk a thorough analysis was required. The purpose of this analysis was to:

- Ensure that all risks are identified
- Determine likelihood and consequences of each risk
- Compare risks against a common set of risk evaluation criteria
- Assess existing management methods
- Prioritise and identify key issues

Following this analysis, risk treatment options would be able to be developed with a thorough understanding of the risks faced by the CDEM Group.

The risk analysis process suggested by the Director's Guidelines was the SMUG (Seriousness, Manageability, Urgency, Growth) tool. This tool, and the risk analysis process used in developing CDEM Group plans, is the focus of the remainder of this research paper.

4. Risk analysis tools for CDEM planning

Many risk analysis tools have been developed to assist organisations to understand their risks. Some tools have been developed for specific industries or for specific purposes such as financial loss modelling (FEMA, 1993, Long et al 2000, Elms (ed) 1998.)

The tool recommended for the CDEM sector when developing CDEM Group Plans was the SMUG risk analysis tool (MCDEM, 2002).

4.1. SMUG risk analysis tool

4.1.1. History

The SMUG risk analysis tool has been used over the past 15 years in a number of sectors including public health (World Health Organisation 1998), emergency management (Natural Disasters Organisation, 1991), education (Charles Sturt University 2001, Monash University, 2002) and local government (Groves et al, 2001).

The SMUG risk analysis tool was developed by the Australian Natural Disaster Organisation (a predecessor to Emergency Management Australia) in the early 1990's. At this time it was developed as a tool to allow comparison and prioritisation of hazards by assessment of characteristics common to all hazards (NDO, 1991, P. Koob, pers.com. 2005).

Some organisations have also taken the model and adapted it as appropriate for their own requirements. This has led to variants such as the New Zealand SMG model (discussed fully in section 4.2 of this paper) and the Australian SMAUG model (Seriousness, Manageability, Acceptability, Urgency, and Growth) discussed in section 4.3.4 of this paper.

4.1.2. Description and Philosophy

The SMUG model recommended for use in New Zealand CDEM planning has four key components: Seriousness, Manageability, Urgency and Growth. The following definitions of each component are listed in the Director's Guideline:

- Seriousness: The relative impact in terms of people and/or dollars
- Manageability: The relative ability to reduce risk (through managing the hazard or the community or both).
- Urgency: 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: 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).

Each component is given a numerical rating, and the four ratings are summed to give the overall rating for a particular risk. The four categories may be weighted differently if considered appropriate by a particular CDEM Group.

The SMUG risk analysis tool is therefore a semi-quantitative analysis as qualitative scales are allocated numerical values. The ratings do not suggest any intrinsic value for risk, but rather are designed to allow greater differentiation between levels of risk than the simple AS/NZS 4360 likelihood and consequence matrix.

The Director's Guideline suggests two possible systems for allocating numerical ratings to the risk descriptors; either a rating of 1 to 3 for each of the four components, or a more detailed process with specific criteria and a rating of 1-5 for each of the components.

If the simple 1-3 rating system is used the scores would be allocated as illustrated in Figure 4.

Figure 4: Simple rating system for SMUG risk analysis

Seriousness	High = 3	Medium = 2	Low = 1
Manageability	High = 1	Medium = 2	Low = 3
Urgency	High = 3	Medium = 2	Low = 1
Growth	High = 3	Medium = 2	Low = 1

Note that the inverted score for Manageability reflects the principle that a highly manageable hazard has a lower risk than one that is difficult to manage.

The overall product of the SMUG risk analysis process would therefore be presented in a manner as illustrated in Figure 5.

Figure 5: Simple SMUG rating summary table.

Risk	Likelihood	Consequence	Level of Risk	Refinement				Rating	Priority
				S	M	U	G		
Earthquake	C	4	Extreme	3	2	2	2	9	2=
Bush Fire	B	4	Extreme	2	2	2	3	9	2=
Air Crash	D	5	Extreme	3	2	3	2	10	1

As the range of possible scores for each component is from 1-3, the lowest possible total score is 4 and the highest possible score is 12.

If the more detailed 1-5 rating system for each component was used the scores would be calculated according to detailed criteria as described below.

4.1.3. Seriousness

This rating is an extension of the consequence rating in a simple AS/NZS 4360 likelihood and consequence risk analysis matrix.

The consequences of hazards that may cause an emergency are likely to be experienced on many different fronts. The seriousness rating in the SMUG model therefore has five components, each with their own descriptors or levels of seriousness to be developed as appropriate for the CDEM Group:

- Human: Likely to include direct, personal human impacts such as deaths, injuries, distress.
- Economic: Likely to include direct financial losses, loss of ability to trade, international economic effects, temporary or permanent loss of businesses.
- Social: Likely to include disruption to community networks, dislocation of people from their homes, loss of community facilities.
- Infrastructure: Likely to include direct infrastructure losses and damage, loss of service continuity, cost of rebuilding
- Geographic: Likely to include physical geographical effects, environmental damage, loss of ecosystems or land use.

Each CDEM Group was charged with developing their own descriptors for each seriousness category. This allowed individual differences to be recognised, for example a smaller municipality may rank the loss of one life as an extreme Human rating, whereas in a larger city that rating may be for events that cause the loss of 50 or 100 lives.

By introducing five separate seriousness ratings the SMUG model ensures that risks that are high in each of the categories are ranked higher than those that may be high in one category but not another. There is no

weighting factor applied so the five categories are considered equally important within the model.

For example Northland CDEM Group defined the descriptors for the Economic component of Seriousness rating as follows in Figure 6.

Figure 6. Descriptors of Economic components of Seriousness rating (From Northland CDEM Group)

Seriousness – Economic component	
Level	*Description*: Cost for human and infrastructure recovery plus loss of business across all economic activity. Median income of people in Northland is $15,200 and Regional Gross Domestic Product of $3.3 billion (2001 Census).
1	Costs < 0.5% regional GDP (<$16M)
2	Costs between 0.5% and 2% regional GDP (<$66M)
3	Costs between 2% and 5% regional GDP (<$165M)
4	Costs between 5% and 10% regional GDP (<$330M)
5	Costs > 10% regional GDP (>$330M)

Ratings are allocated based on a hazard scenario or range of scenarios such as a Maximum Credible Event (or Maximum Likely Event), mid-range scenario, or declared emergency scenario.

The five ratings are averaged to give the overall Seriousness rating (later to be summed with the Manageability, Urgency and Growth ratings) as shown in Figure 7.

Figure 7: Seriousness rating methodology of SMUG model.

	Seriousness						
Hazard *Example*	Human	Economic	Social	Infrastructure	Geographic	*Total*	Average
Tsunami (distant)	**2**	**3**	**3**	**3**	**3**	*13.5*	**2.7**

4.1.4. Manageability

The manageability rating provides insight into both the consequences and the likelihood of the risk. The rating allocated is an inverse to the other ratings to recognise that a risk that is highly manageable should contribute a low score to the overall numerical risk rating.

The rating has two components:

- Current effort: An assessment of how much work has already gone into managing the risk. This work may have been work to reduce the hazard occurrence, mitigation work to reduce the impacts, education or readiness activities to prepare for the hazard, or response or recovery planning for the risk.
- Management Difficulty: An assessment of how difficult it is to implement management mechanisms for this hazard. This may be during risk reduction, or during response and recovery from the event occurrence.

A highly manageable risk will therefore have a high level of current effort with little difficulty in implementation. A risk that has low manageability (and therefore a high numerical manageability score) will characteristically have had low historical effort in managing it, and management personnel would have experienced difficulty in implementing management mechanisms. The matrix to calculate the rating allocated to Manageability is illustrated in Figure 8.

Figure 8. Manageability rating methodology of SMUG model

Management Difficulty	Current Effort (4R's)	Rating
Low	High	1
Low	Med	2
Med	High	2
Med	Med	3
High	High	3
Low	Low	4
Med	Low	4
High	Med	4
High	Low	5

The manageability score is important because it takes into account current work that is already mitigating the risk. Other simple risk analyses would focus on the risk if unmanaged, but this is an unlikely scenario in CDEM when most risks have been identified for some time and may have undergone considerable management already. The manageability risk rating is therefore a time bound rating as it reflects the particular moment in time when the rating was made. It would not be appropriate to assume that the same manageability rating would always apply to a particular risk.

4.1.5. Urgency

This rating is an extension of the 'frequency' rating of a simple risk analysis. It is designed to give an indication of how critical it is to address the risk. The rating scale is therefore based on the likelihood of occurrence, but with the option of increasing the rating if there is a factor that increases the urgency of carrying out risk treatment. Factors that may raise the rating would include things such as a critical legislative, environmental or organisational change that requires action, a known upcoming event (e.g. Y2K), or an opportunity for risk mitigation that may be lost if not carried out immediately.

The Director's Guideline offers little guidance on how to apply additional weightings if necessary and suggest the default rating scale is a simple qualitative probabilistic model such as is illustrated in Figure 9.

Figure 9. Urgency rating methodology of SMUG model

Level Rank	Descriptor
A (5)	Almost certain
B (4)	Likely
C (3)	Possible
D (2)	Unlikely
E (1)	Rare

4.1.6. Growth

The purpose of the growth rating is to take into account likely changes in the future risk due to either the characteristics of the risk itself, or due to changing impacts and consequences of the risk.

The rating therefore has two major components:

- Event occurrence probability rise: A measure of whether the risk is more likely to occur in the future than in the past. A risk scoring high on this rating would be tropical cyclones or flooding as the effects of climate change are likely to increase their frequency or intensity or both.
- Changing community exposure: A measure of whether the consequences of the event when it happens are likely to be more or less in the future. An example of a risk scoring high on this scale may be coastal erosion as more development is carried out in coastal areas and thus more assets and people are put in the path of future events.

The growth score is important as it will highlight areas where the risk is likely to rise in the future, and provides a basic diagnostic tool as to why that might be. It becomes useful when assessing risk treatment options to have identified the areas where communities are becoming more exposed to

risks, and to know which risks are likely to become more prevalent. It may also be useful in gaining a picture of what the future risk may be so that planning for future activities can take into account that heightened level of risk (e.g. structural mitigation decisions). As societal development is increasing it is likely that risk is also increasing as more elements are introduced that could be lost or damaged during an emergency event.

The various combinations of changing community exposure and event occurrence probability rise are grouped to allow ratings to be allocated as illustrated in Figure 10.

Figure 10: Growth rating methodology of SMUG model

Event Occurrence Probability Rise	Changing Community Exposure	Rating
Low	Low	1
Low	Med	2
Med	Low	2
Med	Med	3
Low	High	3
Med	High	4
High	Low	4
High	Med	4
High	High	5

4.1.7. Overall SMUG rating

The overall rating attached to a particular risk is determined by summing the four component scores of Seriousness, Manageability, Urgency and Growth.

At this stage a CDEM Group may consider that one of the four components is of more importance to their Group and apply any weighting factor they determine appropriate.

If the more detailed assessment were used and ratings from 1-5 allocated as per the descriptors provided, the overall product of the risk analysis process would therefore be presented in a manner as illustrated in Figure 11.

Figure 11. Detailed SMUG rating summary table

Risk	Likelihood	Consequence	Level	S						M	U	G	Total	Priority
				H	E	S	I	G	Av					
Earthquake	C	4	Extreme	4	4	4	3	3	4	4	1	1	10	2
Bush Fire	B	4	Extreme	2	1	1	1	3	2	2	4	3	9	3
Air Crash	D	5	Extreme	4	3	2	1	1	3	3	3	5	11	1

As the range of scores for each component in the detailed SMUG analysis is from 1-5 the minimum possible rating is 4 and the highest possible rating is 20. This wider range of possible scores provides an opportunity for more differentiation between hazards than the simpler rating system of 1-3 without detailed descriptors.

4.1.8. Process to apply the model

The SMUG model is an analysis tool in the risk management framework. It is therefore designed to be implemented following the development of risk evaluation criteria, and to provide more detailed analysis than the basic AS/NZS 4360 risk analysis matrix approach.

The Director's Guideline does not recommended a specific process for carrying out the risk analysis process. It does, however, suggest that the process should involve consultation with all agencies associated with the CDEM Group, and include review of existing plans and scientific studies.

The Director's Guideline also stresses that an outcome of the CDEM planning process is that the public and communities have the opportunity to

be involved, are able to determine an acceptable level of risk, and are educated on the hazards they face and the measures in place to manage those hazards. No guidance is provided as to how community involvement is to be achieved, or how an 'acceptable level of risk' is defined.

When applying the SMUG model it is necessary to develop a scenario which is to be analysed. The Director's Guideline recommends that this scenario should be the "Maximum Likely Event", that is, an event at a level that will need to be managed by the CDEM Group (i.e. not just a local area) with the support of national resources. It is also possible to carry out the analysis based on smaller scale scenarios such as a "Mid-range scenario", i.e. an event that is likely to be expected within the planning period and require CDEM Group involvement.

The scenario approach is necessary as the severity of consequences, likelihood and management mechanisms in place may be different for the same hazard event at a smaller scale (e.g. a Richter magnitude 5.5 earthquake compared to a magnitude 7.5). Selecting the maximum likely event scenario for each risk means that equivalent scales of emergency will be compared in the SMUG model i.e. it will not lead to comparison of an earthquake on a major faultline with a minor hazardous substances spill.

The risk analysis process is followed by comparison against risk evaluation criteria to determine priorities for risk treatment, and then the development of risk treatments in the form of Objectives, Targets and Actions within a CDEM Group Plan. These Objectives, Targets and Actions may be developed based on the need to address specific characteristics of a risk, or based on the issues that arose when carrying out the risks analysis.

4.1.9. Strengths of the SMUG model

There are a number of positive aspects of the SMUG model which make it valuable for use in CDEM planning in the New Zealand context.

The SMUG model of risk analysis fits neatly within the CDEM risk management framework. This enables the Groups to feel an element of confidence that they are following best practice risk management processes. Of course the value of the risk analysis process is only as good as the effort and inputs put into it.

The application of a particular model across New Zealand allows for an element of consistency and comparability between CDEM Groups. Although the model may be adapted within a particular region, for the first time it can be stated that each CDEM Group across New Zealand has carried out a process of risk identification and analysis. In some areas this may have been the first time that all the local authorities and emergency services in the area had combined their knowledge, skills and expertise to achieve a regional, or Group, perspective. This pooling of information within a Group area becomes a valuable resource which can now be built on in future planning.

A major benefit of the SMUG risk analysis methodology is that it is designed to bring together personnel from many agencies with a role in CDEM. These are likely to include emergency managers, politicians, scientists, utility owners, emergency services, and community volunteers. A by-product of the mix of perspectives and expertise from these personnel will be a greater mutual understanding of the roles of various agencies in an emergency. In addition, the consequences of a particular hazard on one organisation may be quite different to that of another, and need to be recognised in the Group's analysis.

The SMUG model has a focus on the future, and on the community rather that the CDEM organisations. This is a positive characteristic as it ensures that the Groups are looking ahead and outward, not behind and inward (Elms, 1998). In this way, the focus of the CDEM Group Plan becomes the affected community and their needs, rather than the emergency management agencies and their capabilities.

The four components of the SMUG model ensure that a range of aspects of each risk are identified and assessed. This is of significant value to the CDEM Group as it may highlight gaps in existing information about a risk, or it may highlight a particular aspect of a risk that could be focussed on for risk treatment. In this way the risk is broken down into multiple parts, each of which could give rise to a strategic issue in the following parts of the planning process.

The four components of SMUG provide a significantly more detailed analysis than a simple likelihood and consequence risk analysis matrix. Components of the Urgency, Growth and Manageability ratings provide more detailed information about likelihood, and components of the Seriousness and Manageability ratings provide detailed information about consequences. The Manageability rating contributes to both likelihood and consequences as it demonstrates how current effort may lower the likelihood of the event or the severity of the consequences, and low management difficulty in response and recovery may also reduce the consequent severity.

For example, the manageability rating is an aspect of risk that is missing from many simple risk analysis matrices. These simple analyses are carried out on an unmanaged risk. However, it is unlikely in a CDEM context that it is possible to describe an unmanaged risk as society has always employed

some risk treatments for high consequence risks such as these considered by CDEM Groups.

The manageability rating validates previous risk treatments that have reduced the overall risk faced by a community. It provides an opportunity for those treatments to be identified and documented and raises the profile of treatments which are within the control of the CDEM Group. This is important as the seriousness, urgency and growth ratings are largely characteristics of the hazards faced, and therefore may appear out of the direct control of CDEM Groups.

The consequence based approach of the SMUG model is useful as it removes pre-conceived ideas that may be present about which hazards and risks are the most serious. By identifying the consequences and their severity (in the seriousness rating) many different risks can be seen to have the same resultant consequences. Therefore any strategic issues that arise from a particular consequence will be relevant to more than on hazard. The value of implementing subsequent treatment options will therefore be increased as it can be demonstrated that the risk treatment mechanism will be effective for multiple hazards.

The Urgency rating in the SMUG model is useful as it acknowledges that for some risks there may be a difference between their historical frequency (e.g. those expressed as a return period or annual exceedance probability) and the urgency with which they need to be addressed. An example of how this might be useful can be seen in comparing the urgency of a particular earthquake or rainfall scenario. The earthquake fault line will have been allocated a particular return period. As the elapsed time since the last earthquake approaches the return period for the earthquake, the CDEM Group may wish to take more urgent action to mitigate this hazard as the likelihood of the quake happening in the short term may be higher than the

overall return period suggested when expressed as a probability. For example the return period of a particular earthquake fault may be one in 500 years, but if it has been 500 years since the last event scientists may review the current probability and state that the current probability may be expressed as a 1 in 10 chance in the next 50 years (clearly a higher probability than one in 500). However for a rainfall scenario the situation would be slightly different as a rainfall event of a particular size will have been allocated a particular return period. This return period when expressed as a probability will not change when it has been a long time since the last event, as it is not time bound (or cumulative over time) in the same way as an earthquake fault. For example if 100mm of rainfall over a 3 hour period is a 1 in 100 year rainfall event in a particular area, it does not matter whether it has been a month or a year since the last rainfall event, the probability of a rainfall event of that size is still the same.

The qualitative approach of the urgency rating is also useful as it allows a rating to be assigned for risks whose likelihood is less quantitatively known, such as technological hazards.

4.1.10. Weaknesses of the SMUG model

Some aspects of the SMUG model are less robust than is desirable and may need modification if the model is to be used in the future New Zealand CDEM context.

Quality of inputs

The hazard and consequence information available to many CDEM Groups is incomplete or contains a high level of uncertainty. Therefore all risk analysis that follows is based on interpretation of that uncertain information, or upon perceptions of risk with little backing in terms of scientific or factual information. The end outputs of the risk analysis therefore may not be as accurate or useful as they may have been if better information had been

available. An example of this is where a lack of likelihood information for non-natural hazards means CDEM Groups have to make inferences, based on their own experience of the hazards, of what the probability of occurrence is likely to be.

The quality of the inputs relies heavily on the quality of the relationships between emergency management professionals and other agencies and sectors (e.g. emergency services, technical and scientific community etc)

Purpose of analysis

The purpose for which the SMUG analysis is carried out is not clear in the Director's Guideline.

As risk analysis was a required process in the Director's Guideline it is possible that some Groups were undertaking the analysis purely because it was a requirement, rather than to gain any further understanding of their risk.

The step in the planning process that follows the SMUG risk analysis process is the identification of strategic issues. While the risk analysis process can provide useful information to inform the identification of strategic issues, it is not structured to explicitly do so. Instead, the purpose of the analysis process is often to allocate ratings that can be used to provide a more detailed analysis of the risk or to indicate an order of priority of risk. This priority is not, however, a priority order from which risk treatment options will be developed, which would be the natural next step in a regular risk management process.

This confusion arises because the result of the analysis is a prioritised list of hazards, whereas the following risk treatment is based on the strategic issues identified in the next phase of the process. As the strategic issues

arise from the hazard and risk consequences (a new approach recommended by the Director's Guideline) the risk analysis process is an essential step to identify those consequences, but the subsequent rankings become superfluous. This illustrates the danger of the analysis becoming technique based rather than issues orientated (Tweeddale, 1998 in Elms (ed) 1998).

Descriptors for ranking risks

A foundation of the SMUG model is that risk descriptors are developed that are appropriate for the particular organisation who will be applying the model. This is a positive aspect of the model as it allows the model to be tailored to individual needs and scales of risk. It does, however pose problems if the ratings from one Group were to be compared to another. Each Group would have ratings based on different descriptors and rating scales. SMUG ratings from one Group to another cannot, therefore, be compared.

The development of risk descriptors by each Group also poses problems for the integrity of the model itself. It is likely that Groups will have difficulty in determining what characteristics of risks are appropriate as risk descriptors. An example of this difficulty may be when determining what the risk description should be for the Economic part of the Seriousness component. The descriptor for a particular ranking may contain some but not all of the characteristics of the hazard. The Group may therefore have to make a judgement about whether a risk falls into a category where it meets some, but not all of the description.

In addition, there may be a temptation for Groups to misuse the scales by deciding on a ranking based on whether it is worse or better than a risk already ranked at a certain level. The risk descriptors would then become

useless as they were designed to describe the risk status objectively rather than comparatively.

Due to the ability to amend risk descriptors, it is possible that Groups may become focussed on the risks that can be quantified and ignore or downplay the intangible components of the risk. This problem could be reduced by ensuring a wide range of agencies are participating in the process, from a range of backgrounds and areas of expertise, particularly those with an understanding of the intangible components of risk.

Scenario approach

A limiting factor of the SMUG risk analysis tool is that it uses a scenario approach. While this is beneficial in ensuring that similar scales of risk are ranked, it can be dangerous as the overall risk rating is often attributed to the risk in general terms – rather than to the risk of the particular scenario investigated. This danger is evident when listing the priority risks as they are often expressed in terms of their family grouping (e.g. earthquake, pandemic) rather than the specific event that was considered (e.g. Richter magnitude 7.5 earthquake on the Wellington fault, influenza pandemic with return period of 1 in 100 years).

Even when the scenario approach is made explicit, the use of the ranking within a CDEM Group Plan, and understanding by senior management may be clouded by thinking that the rating reflects the risk as a whole. The scenario approach may therefore distort or overstate the risk with its focus on the maximum likely scenario.

In many cases it is also difficult to define a maximum credible event scenario. For example, even if the total losses for a particular scenario can be estimated, the actual distribution of impact would be difficult to determine. The maximum credible event may also be defined from the perspective of

CDEM personnel, when another agency may perceive that maximum impacts could be much more serious (for example a biosecurity event with few human casualties but large social disruption characteristics).

The scenario approach also carries with it an implicit assumption that planning for the maximum likely scenario will mean that all smaller scale events will also be covered. This may not be the case as larger events may require different mitigation or response arrangements. It is therefore essential that for each scenario considered, the likelihood, consequences and resilience of the community to that particular scenario are explicitly understood.

The maximum likely scenario approach also runs the risk of appearing alarmist, particularly when there may be less information available about larger scale events than those that occur more regularly. Nonetheless, if the maximum likely scenario is possible it is important to be considered, particularly as it is likely to raise many issues in terms of manageability.

A scenario focus also means that a SMUG analysis cannot pick up combinations of events and situations that may change the overall risk. That is because it separates the hazards from each other and considers each scenario separately. A combined analysis would be needed to determine the consequences of a combination of events occurring simultaneously, and the primary and secondary consequence of each scenario.

The scenario approach can become difficult for those CDEM Groups who have not undertaken comprehensive hazard identification, analysis or mapping, or who are unaware of the uncertainties in their available hazard information.

Numerical ranking system

The results of any numerical risk analysis tool are subject to misuse. In the case of the SMUG model this is possible as the final rating score may be taken by the CDEM Group to have a meaning that was not intended. The numerical ratings are designed to allow comparison of overall scores and the grouping of risks into those that are higher or lower than others. The numerical figure associated with each rating has little intrinsic value, but at times may assume a tangible status that exceeds the judgement used to compile the rating.

The development of indices for rating each component may also provide difficulties, as the range or distribution may not be appropriate to base a judgement upon.

The assumptions that lead to the numerical scores assigned in a semi-quantitative analysis such as this are often forgotten, or not recorded. The results are therefore often perceived as more tangible than appropriate, a problem which is only amplified if the ratings and criteria were based on estimates rather than technical information regarding likelihood and consequence.

Seriousness

The seriousness rating in the SMUG model (and in subsequent alterations) is often described as providing more detail than a general rating of the 'consequence' of hazards. This has elements of truth, as by providing sub-categories and descriptors more factors are likely to be considered than if no guidance was provided. However the seriousness rating does not provide all the information necessary to determine the consequence of a hazard. For example a number of CDEM Group Plans introduce the idea that the consequences of an event vary, and depend on:

- the particular *characteristics* of the hazard (e.g. high winds, degree of ground shaking),
- the *vulnerability* of the community (e.g. age, mobility, design of buildings and infrastructure),
- the *resilience* of the community (e.g. preparedness, community cohesion).

It is interesting to note that the SMUG model does not attempt to consider community vulnerability or resilience as specific factors in the analysis. This may be due to problems defining these terms or quantifying the level of each if they were able to be measured.

The seriousness rating also does not cover other characteristics such as the permanent or temporary nature of some hazards, the duration of hazard effects, the speed of onset (and thus potential time for warning and reducing consequences), or factors such as cultural, political or international consequences.

In addition, the seriousness ratings do not reflect the ability for positive consequences or impacts to be experienced as a result of a hazard occurrence. For example, rebuilding after the 1931 Napier earthquake and fires had significant benefits for the region that would not be taken into account in an analysis such as is proposed in this model.

Manageability

The Manageability rating of the SMUG model is difficult to apply as it allows only one rating for current effort, and management difficulty. Different ratings would be possible in the context of risk reduction, readiness, response or recovery. For example, a Group may have expended considerable effort in risk reduction for a particular hazard, but little on response planning. In the same way it may be very difficult to implement

management mechanisms to reduce a particular hazard, but management during an actual event may be quite simple. Considering these aspects separately may give rise to strategic issues that would not have otherwise been identified.

In addition, the 'current effort' component of manageability reflects only whether effort has been expended, but not necessarily how effective that effort has been, or whether the CDEM Group itself has control over all of the resources that would be necessary to effectively manage the risk.

Urgency

The content and value of the urgency rating may also be debated. Probability of occurrence (when available) is often used as de-facto criterion for urgency, whereas definitions of the rating include how urgent it is that something is done about the hazard immediately, or whether it can wait until the medium or long term (MCDEM, 2002, NDO, 1991). This is a very different rating to one based on probabilistic return periods, and considerably more subjective. However, the basis for this discussion relates to the notion of how acceptable the risk is to the community without further action. Confusion over the meaning and intent of this rating, and also the strong influence it has on the overall risk rating when all are summed, may suggest the urgency rating itself requires further development.

Growth

The growth rating allows for changing community exposure, which may increase or decrease over time. Decreases may be the result of mitigation activities carried out by prudent authorities, or by individual acceptance and preparedness for risk. However, risk acceptance does not necessarily endure through time, or through experience of the consequences of risk. Risk acceptance may therefore reflect short term cost benefit analyses, or

result in short term solutions being undertaken while the longer term risk remains present (e.g. insurance).

Overall rating as sum of individual components

The default situation for the SMUG model is to allocate each of the four components equal weight, and sum the individual rankings. Although there is some flexibility recommended in the Director's Guideline it is difficult for those applying the models, who are generally not statisticians, to determine the impact that changing a weighting would have on the authenticity of the results.

The drafting of the Director's Guideline introduces an element of confusion as to what range of scores should be allocated to each of the components. The Director's Guidelines first suggests a range of 1-3 as the maximum for each of the components (i.e. a total possible range of 4 – 12) and then goes on to describe a more detailed system where the possible range of scores for each component is 1-5 (i.e. a total possible range of 4-20). The wider range analysis is only suggested if further refinement is required because hazards fall within a small band of scores that cannot be differentiated. However no descriptors are provided for ranking using the range of 1-3, but only for the more detailed analysis. Therefore the Groups would be required to develop their own descriptors for each component. In some groups this confusion is evident where the stated methodology is that rankings of 1-3 are to be allocated, but then the descriptors are used and a wider range of results are achieved (West Coast CDEM Group 2005, Marlborough CDEM Group 2005).

It is interesting to note that a rating of 0 is not possible for any component of the analysis. The ability to rank a risk with a 0 score may be particularly important to differentiate risks from each other when the small range scale of 1-3 is used, as well as acknowledging unique situations such as when a

hazard may be in decline over time (i.e. a growth score of 0 is more appropriate than 1), or does not have the potential to cause any consequences (i.e. a seriousness score of 0 is more appropriate than 1).

4.2. SMG model

The SMG model was developed by South Island MCDEM and CDEM Group personnel mid-way through the CDEM Group Plan development timeframe. At this time MCDEM personnel began to advocate the use of the SMG model as an alternative to the SMUG model. The SMG model was not, however, formally documented and distributed to all CDEM Groups, nor a revised Director's Guideline issued.

The model was developed to address limitations perceived by some South Island CDEM Groups, particularly in relation to low consequence but high likelihood events that were appearing to rank higher in SMUG analyses than was considered appropriate.

The SMG model removes the "Urgency" rating because CDEM Groups determined that for many hazards it was impossible to identify a return period or frequency of occurrence (as return periods were being used by many Groups as the basis for urgency ratings). For example, technological hazards such as infrastructure failure or hazardous substances spills were difficult to assign a frequency of occurrence to, as the only evidence available was historical records of occurrence which may or may not be relevant for predicting the frequency of future events.

The SMG model also significantly modifies the system for rating 'Manageability'. The model requires allocating a rating for each of the phases of emergency management, namely, Reduction, Readiness,

Response and Recovery. For each phase a numerical rating is assigned to the difficulty of implementing management mechanisms, and to the amount of current effort being put into managing the hazard in that phase of emergency management. The difference between the difficulty of management and the current effort scores is calculated and the sum of these scores across the 4 R's is the final Manageability rating. The rating methodology is illustrated in Figure 12.

Figure 12: Manageability rating methodology of the SMG model

	Manageability												
Hazard	Readiness		Difficulty - Effort	Response		Difficulty - Effort	Recovery		Difficulty - Effort	Reduction		Difficulty - Effort	Sum across 4 R's
	D	**E**		**D**	**E**		**D**	**E**		**D**	**E**		
Tsunami (distant)	**2**	**1**	**1**	**2**	**1**	**1**	**3**	**1**	**2**	**3**	**1**	**2**	**6**

4.2.1. Strengths of the SMG model

It is very helpful to rate manageability across each phase of emergency management. By doing this it can be acknowledged that for a particular hazard a lot of work had been done in response planning but very little had been done in the area of reduction or mitigation.

This kind of analysis is likely to identify strategic issues arising in relation to a particular phase of emergency management that may have been lost in a consideration of the manageability of the hazard generally.

In addition the consideration of each phase separately will allow for identification of management mechanisms of organisations and departments

other than CDEM agencies that may not have been otherwise considered e.g. environmental planning programmes, programmes addressing chronic hazards, other disciplines carrying out work relevant for emergency management.

4.2.2. Weaknesses of the SMG model

Urgency

Removal of the 'Urgency' rating from the SMUG model effectively removes the measurement of likelihood from the risk analysis process analysis. If the SMUG process is intended to put more detail into the analysis provided by the AS/NZS 4360 risk analysis matrix assessment it should therefore contain all of the components of the original AS/NZS 4360 matrix risk analysis.

The original risk management philosophy that risk is determined by a combination of the likelihood of an event occurring *and* the significance of the impacts when it does occur, should not be replaced without specific consideration and reasoning.

The original SMUG model attempted to capture the core components of risk with likelihood being represented in the Urgency and Growth (of the hazard) ratings, and impact being represented in the Seriousness, Manageability and Growth (of community vulnerability) ratings.

If some assessment of likelihood (such as the Urgency rating) is not determined in the risk analysis process, as is the case with the SMG process, then the analysis of risk is therefore being primarily based on an analysis of the potential impacts, without concern as to how often those impacts may be felt.

In many cases this may be a difficult problem to resolve if quantitative likelihood information is not available.

Manageability

The SMG model relies on calculating the difference between scores allocated for 'difficulty' of management and current 'effort' put into management. This relationship is described in the SMG methodology as follows:

> "MANAGEMENT CONTROLS = DIFFICULTY – TOTAL EFFORT
> Which gives a qualitative residual risk factor".
> *(From West Coast CDEM Group Plan)*.

This is different from the original SMUG model which simply allocated an overall score to a combination of qualitative ratings using a *matrix* e.g. low difficulty with corresponding high effort = a score of 1 (high manageability).

Using the SMG model, each phase of emergency management is allocated a rating. As difficulty and effort are measured on a scale of 1 to 3 and effort is subtracted from difficulty (D-E) the possible range for any one component is between -2 (i.e. difficulty score of 1, effort score of 3) to +2 (i.e. difficulty score of 3, effort score of 1).

The scores from each component are summed, so the maximum range for manageability score is therefore -8 to +8.

By introducing a numerical rating for difficulty and effort and then calculating the difference between these, the rating for manageability is suggesting these are measured on a comparable scale of units.

However, it does not follow that a high level of effort on a hazard that is highly difficult to manage means that it deserves to have a score that indicates it is highly manageable. On the original SMUG model this example would lead to a rating of 3 (middle of the range) however in the SMG model this example (assuming the same situation existed over the 4 R's) would lead to a score of 0. This is suggesting that high effort counteracts the high level of difficulty of management. However, to reach this conclusion would require an assessment of competence and capability, including the degree to which resources could be committed over time. This level of detailed analysis is not covered in the analysis process undertaken in the SMG analysis.

However, difficulty and effort are not the same scale or 'unit' of measure and therefore should not be subtracted from each other as is performed during the SMG analysis process.

The first organisation to suggest rating across each of the 4 R's was the Auckland CDEM Group. They avoided the problem that SMG faces by rating not the management difficulty but the 'ideal' amount of work that needed to be done. Rather than comparing difficulty with current effort they compared the ideal amount of effort required, with the actual amount of effort being put in.

This is clearly a comparable scale and therefore the rating was more meaningful. The Auckland model does not attempt to judge the difficulty of managing the hazard for each phase of emergency management, but instead the quantity of effort required.

The Auckland model also gives careful consideration to the ratings allowed by making the ideal score total always the maximum possible score and therefore indicating where most effort would be spent in the ideal world. The

overall manageability score is therefore always a positive number and the ratings are grouped into categories of High, Medium and Low to ensure they are given the same weighting as the other components of the model being used.

Growth

In most applications of the SMG model the Growth component is described by three descriptive categories, rather than as a matrix in the SMUG model. This is a limitation as it does not clearly convey that the potential growth of the hazard is based on variation on growth of the hazard and growth of community vulnerability to the hazard.

Ratings descriptions are most commonly listed in SMG methodology as follows:

> A 'High', 'Medium' or 'Low' rating for the 'Growth' component was used with their descriptions below.
>
> - **Low** risk increases from EITHER increase in the probability of an extreme event occurring OR an increase in the exposure of the community
>
> - **Moderate** risk increases from BOTH increase in the probability of an extreme event occurring AND an increase in the exposure of the community at a LOW-MODERATE RATE
>
> - **High** risk increases from BOTH increase in the probability of an extreme event occurring AND an increase in the exposure of the community at a HIGH RATE. (extract from West Coast CDEM Group Plan)

Sum of all components

This range of possible scores means that manageability effectively has a higher weighting than the other components of Seriousness and Growth which have maximum possible range scores between 1 and 5, and 1 and 3 respectively. As the scores for S, M and G are summed the manageability score has a higher ability to influence the overall score.

The ability to have an overall negative score for manageability also means that the manageability score has the ability to influence the overall score much more than the other scales which do not have the ability to produce a negative score.

There is no evidence that this weighting was intentional, and although the extremes of the scores for components such as Manageability were not often seen in analysis, the potential for one component to skew the overall result has been introduced. Rating components on different scales is not necessarily a problem, so long as allowing one factor to influence the overall rating more than another is desired and intended.

4.3. Other risk analysis tools

The tools used to compare and assess risks in CDEM planning vary across the world (FEMA, 1993, Ferrier, 2004, Jigillos 2003). Some of these tools have historically been used in the New Zealand CDEM context (Crozier et al 1999, Taranaki Regional Council 1991, Groves et al 1999). It is useful to briefly examine some of these models in order to determine aspects that may be useful for future CDEM planning.

4.3.1. FEMA approach

FEMA hazard ranking

The Federal Emergency Management Agency for the United States of America has developed a number of potential models for hazard and risk analysis. Of particular relevance for CDEM planning in New Zealand is the hazard ranking model that was used extensively in the early 1990's.

The hazard ranking model is a numerical rating system based on four key factors, each with standard risk descriptors and weightings, as illustrated in Figure 13.

Figure 13. FEMA hazard ranking model rating systems

- History: Previous occurrence of a damaging event (weighting factor x 2)

Criteria	Class	Score
0-1 time in the past 100 years	Low	2
2-3 times in the past 100 years	Medium	5
4 or more times in the past 100 years	High	10

- Vulnerability: The number of people and value of property affected by an event (weighting factor x 5)

Criteria	Class	Score
<1%	Low	2
1-10%	Medium	5
>10%	High	10

- Maximum threat: The percentage of the district/community who will be impacted by an event (weighting factor x 10)

Criteria	Class	Score
<5%	Low	2
5-25%	Medium	5
>25%	High	10

- Probability: The chances per year of an event (weighting factor x 7)

Criteria	Class	Score
Less than 1 in 1,000	Low	2
Between 1 in 1000 and 1 in 10	Medium	5
Greater than 1 in 10	High	10

Each factor is rated High, Medium or Low, with the correlating scores of 2, 5 and 10 points (although some applications have used alternate scores), and the weighting applied. The final score is the sum of the four factors as illustrated in Figure 14.

Figure 14: Example rating using FEMA hazard ranking model

Factor	Evaluation	Score	Weighting	Total
History	High	10	2	20
Vulnerability	Medium	5	5	25
Maximum Threat	High	10	10	100
Probability	Medium	5	7	35
Total				**180**

As the risk criteria for each factor are defined and unchangeable, analysis can be compared across different hazards. The FEMA hazard ranking model therefore suggests a threshold of 100 points above which hazards should receive higher priority for planning and mitigation.

It is important to note, however, that various applications of the original FEMA model have adopted different scores, or further refinement of scores within the 1 – 10 scale. Applications of the FEMA model where the scoring system has been changed may not be able to use the 100 point threshold.

FEMA factor analysis

Alongside the hazard ranking system, FEMA also developed a factor analysis model. This model outlines selected elements to be considered when describing a hazard that is to undergo hazard ranking. Consideration of these elements is designed to enable a more detailed understanding of the hazard and specific scenarios under consideration.

- Frequency: The likelihood of the event occurring within a defined period e.g. rare (one in 1000 years), medium (one in 100 years), high (one in 10 years).
- Duration: The length of time of direct hazard impacts e.g. long (weeks, seasons, years), medium (hours, days), short (seconds, minutes).
- Speed of onset: Time from first indication of hazard to the onset of effects e.g. instantaneous(seconds, minutes), medium (hours, days), prolonged (weeks, months)
- Areal extent/Scope: Wide (whole district), local (single community), restricted (single site)
- Threat to life/Intensity: The destructive potential of the worst case scenario e.g. for human impacts: Serious (e.g. several deaths), moderate (e.g. isolated deaths possible), low (e.g. deaths highly unlikely)
- Predictability: The extent to which forecasts can be made of place, time and magnitude e.g. high (successful predictions can be made), medium (indications only), low (no means of forecasting)
- Forewarning: The period between warning and impact
- Controllability: The extent to which the hazard itself can be modified e.g complete (can be removed, eliminated), partial (can be isolated or minimised), none (cannot change physical impact or occurrence of event)

It is unclear whether the factor analysis elements are designed to contribute directly to the hazard ranking, but they do provide a context and framework that can contribute to analysis of each hazard and scenario. (Ref A6 also)

Strengths

A beneficial aspect of the FEMA hazard ranking system is that the criteria for each component of the system are fixed. This means that results are comparable between hazards, and also between different groups who may apply the same model to their own hazards.

Another positive aspect is that the ranking criteria themselves are presented as percentages rather than as a fixed number. This means that the same criteria can be used for small or large communities (even nationally), and still be comparable.

The inclusion of a vulnerability rating is an interesting component of this model. This rating could incorporate a wide variety of factors including vulnerable groups of individuals (e.g. based on age, medical condition, income or other scale), as well as vulnerable property or people based on their proximity to hazard, or to vital facilities. The vulnerability rating could also incorporate aspects such as population density or property value to indicate which communities may be more or less vulnerable to the hazard. This rating could be investigated in some detail by developing a spatial representation of the vulnerable groupings and overlaying those with hazard impact maps.

The hazard element expressed in the factor analysis component of the FEMA model provides a level of detail that will assist those carrying out the analysis to appraise aspects of a hazard that may not have been previously considered. Although these descriptors have been defined they are not represented in the hazard ranking process.

Weaknesses

The History ranking in the FEMA model may not be appropriate for the New Zealand context as we have a short recorded history, and the last 100 years may not be representative of some New Zealand hazards that have a potentially high impact but low likelihood.

In addition, hazards which may have occurred recently may be over represented in the history ranking. For some hazards the occurrence of an event may mean that immediately afterward the risk is actually lowered.

The history rating does therefore not take into account future trends – but only those that have been historical. In some applications of the FEMA model this has been countered by the inclusion of an additional rating of trend in occurrence, similar to the Growth rating in the SMUG model (Crozier et al. 1999).

The FEMA model promotes a high reliance on scientific information to drive the analysis process. Therefore it would be possible for a CDEM Group to contract a research institution to come up with the desired result, with little or no consultation with emergency agencies or the community, but solely based on scientific research.

The ranking criteria and weighting applied history were developed in the USA and may not be appropriate for the New Zealand context. Of particular concern is that New Zealand is a geologically young country with maritime influence and may therefore experience a greater frequency, or intensity, of hazard events historically. In addition, assessment in the New Zealand context would need to consider that management resources and elements at risk are often concentrated in a small number of centres.

The Vulnerability ranking relates only to people and property directly affected by the hazard event. It does not take into account those communities, organisations or individuals who experience flow on effects from the event, for example, by social disruption or business interruption. The components and indicators of community vulnerability to hazards have been the subject of much research and should ideally be incorporated (Buckle 1998, Buckle et al 2000, King et al 2000, Paton, et al 2001). The vulnerability rating may therefore be an oversimplification of a complex construct.

The FEMA hazard ranking focuses on the worst case scenario only, and does not allow for the occurrence of secondary or concurrent hazards. In addition, the worst case scenario for one hazard may be at a completely different scale than that of another hazard. These two worst case scenarios may not therefore be comparable.

The inclusion of both a probability rating and a history rating may mean that the model is taking the same characteristics of a hazard into consideration twice. This may mean a greater emphasis is placed on these elements than is justified.

4.3.2. Australian Emergency Risk Management

Due to the Australian structures of State and Federal government, there is no one single approach to hazard analysis taken across the country. However, a variety of methods have been developed and those of relevance to the New Zealand context are discussed here.

Emergency Management Australia, a central government agency, has developed the Emergency Risk Management (ERM) framework (EMA, 2000). This framework takes the AS/NZS 4360 risk management standard and provides recommended methodology for how to implement the Standard for Emergency Management in Australia.

Risk analysis within the Emergency Risk Management framework is essentially the same as recommended in the original Standard. The ERM provides more detailed descriptors of consequences and likelihood, but does not break these down into any component elements, or suggest any qualitative values.

The value of the ERM process, however, is that it provides a strong drive towards community involvement and consultation. Specific guidelines on

how to involve the community in the process have been developed, and this is seen as a core element of the emergency management planning process (EMA, 2001).

4.3.3. Australian Disaster Risk Management (DRM)

The Queensland approach to Disaster Risk Management is "a blend of traditional disaster management and the risk management approaches outlined in AS/NZS 4360:1999 Risk Management" (Shire of Yarrah Ranges, 2000). Developed by the Queensland Department of Emergency Services, but implemented in more than one Australian state, it serves as a guide to the processes of risk management, with a focus on natural disasters.

The DRM process provides templates and formats to be used by authorities when carrying out risk assessment. The end product is a DRM report which covers the entire disaster risk management process. This report then contributes to the development of Disaster Mitigation Plans, and Counter Disaster Plans, required by the state government legislation (State Counter-Disaster Organisation Act 1975).

The risk analysis process requires the development of risk evaluation criteria in the areas of:

- Human and social factors
- Built and natural environment
- Economic loss
- Risk escalation
- Risk frequency
- Legal and social justice implications
- Political implications
- Manageability

In addition a vulnerability profile of the community and environment are developed. This profile is descriptive and relates to people, social structures, buildings, the environment, lifelines, critical facilities, local economic production, employment and other elements.

Each hazard is then identified and described and the risks and consequences of the hazard on the vulnerability elements assessed.

The final risk evaluation process is then to allocate the likelihood and consequence ratings to each hazard in the traditional manner advocated by the AS/NZ Standard.

A positive aspect of this methodology is the level of detail achieved, and guidance given in developing the risk evaluation criteria and vulnerability analysis. The evaluation criteria are not however linked to the final risk analysis and priority setting, so the benefit of this step in the process may be limited.

4.3.4. Australian SMAUG Analysis

Some Queensland authorities and organisations have adopted a modified version of the SMUG analysis tool. The SMAUG tool adds an additional rating for the 'Acceptability' of the risk being assessed.

Those risks that are least acceptable in terms of political, social, or economic impact will be given a high rating, whereas those that will have little political, social or economic impact will be given a low rating.

Acceptability is an interesting addition to the risk analysis process as it immediately raises the question of "Acceptable to whom?". If emergency management planning is done for and on behalf of a community, then they should have an involvement in determining whether of not they will accept a

particular level of risk. In the context of CDEM planning this will mean consultation with the community during the analysis phase, not merely in the decision about which treatment options to select.

A large body of research has been carried out on acceptability of risk and, as with vulnerability, it may be oversimplified to include in a ranking process that is essentially in one dimension only.

In addition, the acceptability of risks is difficult to describe without referring back to impacts such as social or economic effects. These elements are also considered in the 'Seriousness' rating of the SMAUG and SMUG models so it may be a rating duplication. Another potential duplication exists as acceptability considerations should be part of the 'Urgency' rating of a SMAUG analysis if it is defined as covering more than a simple rating of likelihood of occurrence.

Some users of the SMAUG model have found it limiting when considering multi-hazard analysis rather than each hazard individually, and for large areas of impact rather than small communities of interest (Granger et al 1999). It has been useful however, for individual organisations considering their natural and technological hazard risk (Monash University 2002, Charles Sturt University 2001).

4.3.5. Australian Adapted Earthquake Disaster Risk Index

A hazard specific risk evaluation tool of interest is the Earthquake Disaster Risk Index. Originally developed in the USA in 1997, it was subsequently applied to communities around the world (Granger 2001). In Queensland the earthquake risk evaluation tool was modified to cover the range of hazards faced in southeast Queensland, and uses spatial information as contributors to the assessment rather than a statistical numerical approach.

In this context, risk was described as:

Risk = hazard x elements at risk x vulnerability (Granger 2001)

The adapted EDRI model used in Queensland focuses on five key contributors to risk (Granger 2001):

- Hazard – severity, extent and frequency of the trigger phenomenon to which the community may be subject
- Exposure – size of the community, number of people and physical objects, the amount and type of activities they support
- Vulnerability – how easily the exposed people, physical objects and activities may be affected in the short or long term
- External context – how impact within a community affects people and activities outside the community
- Emergency Response and Recovery Capability - how effectively and efficiently a city can reduce the impact of the hazard through formal, organised efforts designed specifically for that purpose.

After gathering the qualitative information about the above contributors, vulnerability elements relating to the setting, shelter, sustenance, security, and societal elements at risk were determined and ranked. The outcome of this process was a comparative ranking of vulnerability to various hazards facing a community.

A limitation of this model is that it does not explicitly consider resilience, but on response and recovery capability provided by specialist responders. It would also require a framework for vulnerability analysis for each element at risk, which does not appear to have been carried out.

4.3.6. Loss modelling approaches

A number of risk analyses focus on modelling potential losses associated with specific emergency scenarios (FEMA Hazard US (HAZUS) modelling, Fulford 2002). These methodologies typically rely on computer modelling of impacts on physical infrastructure and assets, or populations according to formulae derived from previous emergency events.

These methodologies may be helpful in informing CDEM Groups of the scale of some consequences of emergencies, but are typically out of the reach of CDEM Groups because the costs of the required data inputs, and detailed scientific understanding to develop the scenarios and formulae, are beyond the capabilities of a CDEM Group.

5. Application of risk analysis tools for CDEM Planning in New Zealand

A risk analysis process was carried out by every CDEM Group in New Zealand when preparing their first CDEM Group Plans as required under the CDEM Act 2002. This section describes the various approaches and adaptations to the recommended MCDEM SMUG model, and highlights the strengths and weaknesses of each approach or adaptation.

5.1. Methodology

Information was collected from each CDEM Group in New Zealand. Information was primarily gathered in the form of:

- Ratings tables used during risk analysis
- Supporting papers outlining risk analysis methodologies
- Draft and/or approved CDEM Group Plans
- Personal interviews or comments of CDEM Group planners.

Information relating to each CDEM Group risk analysis process was assessed in terms of the following areas:

- The stated purpose of the risk analysis
- The process of risk analysis (including who was involved, how, when, what did they do)
- Characteristics and variations of the risk analysis models employed
- The end uses of the risk analysis
- Risk evaluation criteria
- Objectives, Targets and Actions arising from the risk analysis
- Qualitative issues with the models employed
- Quantitative issues with the models employed.

The strengths and weaknesses of the various models and adaptations employed were then considered, and conclusions and recommendations are made as to what models may be appropriate for future CDEM Group risk analysis processes.

5.2. Timeframes of CDEM Group Plan development processes

CDEM Groups carried out the tasks of risk analysis at different times, and with various amounts of guidance from MCDEM. The first groups to begin to develop their CDEM Group Plans began the process prior to enactment of the CDEM Act, which was prior to the requirement for CDEM Groups to be formed, and based on an information series document (MEM, 2000), rather than a formal Director's Guideline.

Groups who began their planning at a later date were able to refer to the Director's Guideline issued in December 2002, and to observe the experiences of other CDEM Groups. These Groups therefore had the ability to adopt or adapt the SMUG risk analysis process recommended in the Director's Guideline (see section 4.1) based on their observations and guidance received.

In addition, the SMG risk analysis methodology (see section 4.2) was developed and promoted during the timeframe of CDEM Group Plan development, and this influenced the methodology implemented by CDEM Groups who had not yet carried out their risk analysis process.

Figure 15 illustrates the approximate timeframes during which CDEM Group Plans were developed in the different parts of New Zealand, and the guidance documentation available to them at the time of Plan development.

Figure 15: Timeframes of development and completion of CDEM Group Plans

CDEM Group	Timeframe of risk analysis	Risk analysis methodology used	Date Final Plan effective
October 2000: Ministry for Emergency Management: CDEM planning. Information for Local Government			
Manawatu - Wanganui		No prioritisation	14 March 2003
Auckland	Feb 2001 – Jan 2004	SMUG	6 May 2005
Gisborne	June 2001 – Jan 2004	SMUG	28 June 2004
December 2002: Director's Guideline released promoting SMUG model			
Hawkes Bay	Jan – Aug 2003	4360 matrix SMUG	24 March 2005
Southland	March – June 2003	4360 matrix SMUG	8 March 2005
Taranaki	May – Dec 2003	4360 matrix SMUG	23 Nov 2004
Wellington	May – Dec 2003	4360 matrix SMUG	5 May 2005
October 2003: SMG developed and informally promoted by MCDEM			
Marlborough	Dec 2003	4360 matrix SMG	23 May 2005
Waikato	Aug 2003 – Nov 2004	4360 matrix SMG	3 May 2005
Canterbury	Aug – Dec 2003	4360 matrix SMG	22 April 2005
West Coast	Sept – Nov 2003	4360 matrix SMUG	18 April 2005
Northland	Sept 2003 - June 2004	4360 matrix SMG	7 December 2004
Nelson/Tasman	March – Aug 2004	4360 matrix SMG	29 March 2005
Bay of Plenty	Jan – April 2004	4360 matrix SMG Subsequently decided to use no prioritisation	16 May 2005
Chatham Islands	June - Nov 2004	4360 matrix SMUG	23 May 2005
Otago	June - Nov 2004	4360 matrix only	10 June 2005

5.3. Northland CDEM Group

5.3.1. Stated purpose of risk analysis

The Northland CDEM Group Plan outlines the purpose of the risk analysis process in the following statement:

> "The Northland Civil Defence Emergency Management Group Plan (the Plan) describes hazards and risks that the region is prone to. As the Plan is highly unlikely to be able to address all of the hazards and risks within Northland in the 5-year period of the Plan, it is necessary to identify those hazards and associated risks, which should be priorities for future risk treatment".

5.3.2. Process of risk analysis

Twenty-seven hazards were identified as being relevant to the Northland area. The CDEM Group then determined that the analysis would focus on those hazards that would require the CDEM Group to play an active role in pre-event mitigation and readiness and/ or post-event response. Hazards such as sea-level rise, urban fires, road and rail crashes, coastal instability and large tsunami generated by space debris were therefore excluded. Twenty three hazards were then analysed.

Hazard reports and plans were reviewed and discussions were held with people involved in management or research about hazards in Northland. Research was commissioned to bring together this hazard information, particularly information relating to weather related and coastal hazards. Summary statements were developed for each hazard, as were indicative scenarios of the Maximum Credible Event. Where insufficient hazard information was available, notional scenarios were developed.

During this process information gaps and areas of future work were identified.

A basic risk analysis was carried out for each hazard based on AS/NZS 4360. This involved analysing the likelihood and consequences of each hazard. The result was an initial screening of the hazards into Extreme, High, Medium and Low categories.

The Northland CDEM Group then considered the requirements and recommendations of the Ministry of Civil Defence and Emergency Management (MCDEM) Director's Guideline and the experience of other CDEM Groups. It was decided to use the SMG model to rate hazards.

A two stage process of carrying out ratings was used. First a CDEM Group stakeholder workshop developed initial ratings, and then a consultant was engaged to facilitate an analysis process to verify the original ratings. Both stages delivered similar ratings.

The overall ratings were then divided into groupings of the highest, medium and lowest priority hazards. Those in the highest priority category were described as having "high potential for impact, still a considerable amount can be done to manage them, and have high residual risk for which regional co-ordination would be required if occurred".

5.3.3. End uses of the risk analysis

An outcome of the risk analysis process was a list in the CDEM Group Plan of highest, medium and lowest priority hazards.

5.3.4. Risk evaluation criteria

The Northland CDEM Group established risk evaluation criteria to be considered as important when setting risk priorities. The criteria included:

- whether there could be severe injury or loss of life,
- whether substantial damage to buildings, infrastructure, or lifeline utilities could be likely,
- whether anything can be done to reduce the risk.

It could therefore have been expected that the final list of priority hazards would have a focus on those hazards which rate high on seriousness of impact on humans and infrastructure, and on the Reduction component of the manageability rating. In general terms this was the case, although some hazards which rated high in these areas but not others were not listed in the highest priority group. The rating system did not allocate additional weighting to factors included in the risk evaluation criteria.

5.3.5. Objectives, Targets and Actions

The Plan states that "the Northland CDEM Group will focus risk treatment on the highest priority hazards". It then goes on to describe in some detail what the CDEM Group will do for those hazards in the highest priority category. These actions are to include:

- determining whether the current level of risk is acceptable,
- reviewing the risk treatment currently in place - there may be alternatives which are more cost effective and/or more sustainable,
- identifying and evaluating a range of risk treatment options,
- selecting and implementing appropriate risk treatment options. These might range from upgrading existing flood protection schemes, introducing automated warning systems for river flows, district plan changes, through to targeted education campaigns and contingency (response) plans.

These actions are to be turned into risk treatment activities as part of the Targets and Actions of the Plan during its implementation period. There is evidence of this occurring in one Target and Action which states:

> "Hazard studies and investigations: These studies will be targeted at the higher priority hazards in Table 2.3, and take account of the gaps identified in Annex B2".

This is the only Action point that specifically mentions the priority hazards, other Actions are general and of relevance to all hazards, priority or not.

The Northland CDEM Group Plan has excellent linking of hazard consequences to operational activities. The operational part of the Plan identifies major consequences of hazards and the response activities necessary to address those hazards.

The Northland CDEM Group Plan achieves its stated purpose of identifying which hazards are priorities for future risk treatment, and goes some way to describing how this will be done. However, no clear pathway was developed to specifically address those hazards identified as highest priority, other than in the area of further research and investigation.

5.3.6. Qualitative issues

Seriousness

Considerable effort was put into developing descriptors of the various ratings that were relevant for the Northland context. For example the descriptions of Human impact in the Seriousness component were modified to ensure the number of casualties was appropriate compared to the Northland population.

Manageability

As described in Section 3.2, the use of "management difficulty minus effort" introduces a greater weighting to the manageability score, and may not be a rating with any inherent value. This issue is of relevance to all Groups who used the SMG methodology.

5.3.7. Quantitative issues

Seriousness was rated on a scale with a possible range of 1 to 5, Manageability on a scale with a possible range of -8 to +8, and Growth on a scale with a possible range of 1 to 3. As the total score was a sum of these ratings there was effectively a higher weighting given to Manageability, over seriousness and of both over Growth. This weighting may be appropriate given the risk evaluation criteria focus on human impact, infrastructure damage and potential for reduction activities. However, there was no evidence that the weighting was a conscious decision as no reasoning was provided. Consequently the value of the outcome is reduced as it lacks methodological rigour. The tendency to perceive numerical rankings as having greater validity than is justified makes this a serious problem of relevance to all Groups who used the SMG methodology.

5.4. Auckland CDEM Group

The Auckland Region CDEM Group was one of the first CDEM Groups to begin planning, as they were a pilot project of the CDEM arrangements prior to the introduction of the CDEM Act in 2002.

5.4.1. Stated purpose of risk analysis

The Auckland Region CDEM Group Plan states that the purpose of the risk analysis process is to "identify which hazards should be priorities for future work to be undertaken by the CDEM Group".

5.4.2. Process of risk analysis

Twenty eight hazards were identified as having the potential to affect the Auckland region.

The Auckland Regional Council Hazard Management section facilitated the risk analysis process in the Auckland region. For each hazard a description was developed, as well as scenarios. A review was undertaken of relevant hazards, risk reports, and plans. Discussions were then held with people and organisations with a role in researching or managing hazard in the Auckland region.

The scenarios developed for each hazard represented a severe event on the threshold of causing major disruption. This was done to ensure that a similar threshold was used to enable the consequences of a given hazard event to be prioritised against another hazard event of a comparable scale. For example, the scenario for a flood event was a 1 in 100 year flood, whereas the scenario for earthquake was based on a 1 in 2000 year earthquake event.

The SMUG process was the tool for prioritising the hazards.

The SMUG rating system used was that for each component a rating of High, Medium or Low was allocated, each with a numerical value as below:

High	= 3 points
Medium	= 2 points
Low	= 1 point.

If different scales were used for rating each of the individual components (SMUG), the score for each component was converted to H, M or L and allocated the points as above. Due to the methodology used for the Manageability rating it was not necessary for the Auckland CDEM Group to have an inverse rating for this component as is described in the SMUG methodology in the Director's Guideline.

The overall rating for the hazard was calculated as the sum of each of the components. Each of the four components was therefore given equal weighting because each was measured on a scale of 1-3. In a change from the original MCDEM guideline, an additional score of 0.5 was added to those hazards that may be exacerbated by climate change.

The possible range of scores for the overall hazard rating was therefore between 4 and 12.5.

The rating allocation above was also a variation of the MCDEM guideline in that the rating for Manageability was the same as for all the other components, and not reversed. This was intended to ensure that hazard for which a high amount of future work was required would receive a high numerical rating and therefore be higher on the priority list.

Hazard summaries and scenarios were provided to a range of CDEM Group organisations and each individually rated the hazards. The organisations that carried out the ratings included: NZ Police, Auckland Public Health Protection Service, North Shore City Council, Auckland City Council, Auckland Engineering Lifelines Group, Auckland Regional Council, NZ Fire Service and the Ministry of Civil Defence and Emergency Management.

A separate workshop was held to rate the manageability component with these same agencies present.

The final ratings allocated to each hazard were calculated by collating the scores allocated by these organisations.

An assessment of Likelihood and Consequence using the AS/NZS 4360 definitions was carried out by the ARC Hazard Management Section, although this assessment did not form part of the CDEM Group Plan. The results of this assessment were roughly parallel to the outputs of the SMUG process.

5.4.3. End uses of the risk analysis

The outcome of the risk analysis process was a list in the CDEM Group Plan of highest, medium and lower priority hazards. Within each category the hazards are listed alphabetically rather than by the order in which they were ranked.

The hazard ranking is included in an appendix to the Plan, but due to the uncertainties of the information used in the analysis it was deemed more appropriate to represent them in their groupings than to list them with their rankings and scores.

The decision as to which were High, Medium and Lower priority was based purely on the overall score. The range of ranking scores was from 5 – 9.5 (compared to a possible range of 4 – 12.5).

5.4.4. Objectives, Targets and Actions

The Plan states that it "prioritises the hazards that could affect Auckland, and outlines how the CDEM Group intends to manage them". The prioritisation is stated as being needed to "efficiently reduce the impacts of these hazards".

However, when specific risk treatments are developed, these do not focus on the higher priority hazards. For example the only Actions to mention the prioritised list are:

- The CDEM Group will undertake, as a priority, research of hazards with an emphasis on those hazards considered a priority in this Plan.
- During the term of the Plan, the ARC and the TAs will undertake, as a priority, research on the consequences of hazards, with an emphasis on those hazards having a priority in their districts.

In addition the following relevant Action is listed:

- Territorial Authorities will prioritise the hazards and risks in their districts.

5.4.5. Risk evaluation criteria

The Auckland CDEM Group established risk evaluation criteria to be considered as important when setting risk priorities. The criteria included:

- "risks which have the potential to result in loss of life or cause severe injury are unacceptable.
- risks that have the potential to cause substantial damage to buildings, infrastructure or lifeline utilities are priorities for treatment.

- hazards with associated risks that can be significantly reduced by additional risk treatment undertaken by CDEM Group Partners will be considered priorities".

These risk evaluation criteria indicate that the CDEM Group places a greater priority on the hazards which may rate highly on the Human and Infrastructure components of the Seriousness rating, and on the Reduction component of the Manageability rating. At one stage during the risk rating process the reduction rating of manageability was doubled to reflect the importance of this element of managing the risk. However, this rating system was eventually discarded as it is not the system ultimately used in the ratings listed in the CDEM Group Plan.

An analysis of the actual ratings achieved through the SMUG process shows that those hazards that rated higher in these seriousness ratings were generally in the higher priority grouping of hazards, but not all of the hazards that rated highly on the reduction component of manageability were reflected in the higher priority hazards. Indeed, some hazards that rated very low for potential reduction activities still rated as higher priority hazards (e.g. volcanic hazard).

5.4.6. Qualitative issues

Seriousness

The seriousness rating used by the Auckland CDEM Group focused on four vulnerable elements: lives lost and injuries, physical, social, and economic components of the community. This is different from the MCDEM guidelines which suggest Human, Economic, Social, Infrastructure, and Geographic scales. The Auckland example therefore potentially may not have adequately considered environmental and geographic effects and other human impacts such as psychological trauma.

When calculating this rating the current risk treatment measures were taken into account. For example, those hazards for which warning time was available may have scored low on human impacts because the warning system was expected to give adequate warning to save lives. By taking into account current management mechanisms, the seriousness rating introduces duplication with the manageability score which allocates a score based on the amount of current effort in place.

Manageability

The Auckland CDEM Group reasoned that the manageability rating was an indication of *how easily* the hazard could be managed in the future.

Manageability was therefore measured in units of effort. The rating system calculated manageability by measuring the ideal amount of effort required to manage the hazard, compared to the actual amount of effort being expended. This approach to the manageability rating was unique within CDEM Groups.

A total of 12 points was spread across each of the reduction, readiness, response and recovery phases of emergency management to represent the ideal amount of effort to be spent in each phase. Each phase was then rated in relation to the ideal score and the differences tallied as illustrated in Figure 16.

Figure 16: Auckland CDEMG Manageability rating methodology

Hazard	4R's	Ideal	Actual	Ideal-Actual	Total
e.g Flooding	Reduction	4	3	1	
	Readiness	3	1	2	
	Response	3	2	1	
	Recovery	2	0	2	
		12			6

If more effort was being expended than was ideal it was possible to score a negative rating to contribute to the overall manageability score. The difference between the actual and ideal amount of effort was described as the 'future effort' required. The summed score across the 4R's contributed to the overall SMUG rating as illustrated in Figure 17.

Figure 17: Auckland CDEMG Manageability rating ranges

Manageability Rating	**Future effort score**
High (i.e. a Manageability score of 3)	> 7
Medium (i.e. a Manageability score of 2)	5 ≤ ≥ 7
Low (i.e. a Manageability score of 1)	≤4

Using this rating system, hazards which had a large difference between the actual and ideal amount of effort therefore scored a high manageability rating and contributed to a higher overall score.

This approach to the manageability rating is particularly effective because it uses a consistent measurement of the 'units' of manageability and gives priority to those hazards for which insufficient effort is being expended.

Urgency

Hazard return periods were used as the basis for determining the score for urgency as illustrated in Figure 18.

Figure 18: Auckland CDEM Group Urgency rating methodology

Urgency Rating	**Return period**
High	< 20 yr
Medium	20-200 yr
Low	> 200yr

The return periods for each hazard were those relevant to the scenarios developed for each hazard. These scenarios were for events on the

threshold of causing major disruption. In this way major hazard scenarios could be compared using the same rating system. Although probabilistic information was not available for every hazard, it was constructive to determine return periods appropriate for the Auckland context, and thus allow comparison of a hazard for which return periods were available.

The urgency criterion was described as "a measure of how imperative or critical it is to address the hazard". As probabilistic information was not available for a number of hazards (especially non-natural hazards) this criteria is difficult to effectively assign. This difficulty was acknowledged by the CDEM Group in their Plan.

5.4.7. Quantitative issues

The potential rating for each component of the Auckland SMUG assessment is between 1 to 3. This is maintained even when each component is calculated on a variety of scales. This conversion is important as it ensures the four components are weighted evenly in the final rating.

The process of collating the overall rating using ratings by each agency is unique to the Auckland region. In most other regions ratings were reached by consensus, or by expert opinion being presented to a wider group for approval or amendment. The benefit of the consensus approach is that a range of perspectives and experience of each hazard is communicated by the various agencies. This process may be educative to all parties involved.

A benefit of the approach taken by the Auckland CDEM Group is that those agencies that carried out ratings were each able to rate the hazards based on their own knowledge and experience. A wider range of perspectives may have been reflected in the ratings, than may have occurred in a joint session where agencies with divergent views of the hazards may not be heeded.

A potential risk of this approach is that not all agencies were represented in the prioritisation process, although the Plan approval process was an opportunity for that input. Another risk of this approach is that each agency may have interpreted the rating system or terminology differently and therefore not be applying the system consistently.

Seriousness

Ratings from 1 to 5 were allocated for potential Human, Economic, Social, Infrastructure, and Geographic (HESIG) impacts. Rather than then taking the average of the five components as per the MCDEM guideline, these ratings were summed to give a seriousness score in the range of 5- 25. The top third of these scores was then allocated a rating of High, the middle third a rating of Medium and the bottom third a rating of Low.

This rating allocation is problematic as it does not allow for all of the hazards being considered to have a high seriousness rating. It is not a valid assumption that the hazards facing the Auckland region have an even spread of how serious their impacts may be (from high to low).

For example it is possible that all hazards may be rated and end up with scores in the range of 20 and 25 (the maximum possible). These results would indicate that all of the hazards had the potential for very serious impacts. However, the bottom third of these scores (potentially all with ratings over 20 out of a maximum possible 25) will be allocated a serious rating of low and therefore score only 1 point towards the total SMUG rating.

This approach to seriousness is effectively a *relative* rating score rather than a score based on the characteristics of the hazard itself.

Growth

The introduction of an additional score based on potential effects of climate change effectively duplicates the component of the growth score whereby any potential increase in the likelihood or severity of consequences of the hazard event (such as due to climate change) could have been taken into account.

5.5. Waikato CDEM Group

Waikato CDEM Group has established three Emergency Operating Areas (EOAs) within its Group boundary. These EOAs are responsible for providing emergency response and recovery activities within their boundaries and supporting CDEM Group activities.

Each of these EOAs also has a different range of hazards it is exposed to. Hazard analysis was therefore carried out for each of the EOAs separately to ensure sub-regional hazard characteristics could be identified and prioritised.

5.5.1. Stated purpose of risk analysis

The purpose of ranking the hazards was stated in the Waikato CDEM Group Plan. The stated purpose was to:

- "Increase awareness of the most important hazard-risks to the community
- Prioritise hazard-risks in order to inform the priorities for the Resource Management Act and other studies/analysis/funding
- Raise awareness of significant hazards
- Identify specific gaps in the 4Rs for targets and actions – thus improving hazard-risk management e.g. Biological Readiness

- Influence operational arrangements given the consequences of the top hazards e.g. flooding means a requirement for evacuation planning and welfare support, whilst pandemic means a need to link EOCs closely with the DHB
- Establish priorities for addressing issues
- Inform hazard researchers
- Identify specific hazard management gaps
- Drive Resource Management Act processes
- Guide operational arrangements".

5.5.2. Process of risk analysis

An initial list of all potential hazards was identified by the Group Emergency Management Office. This list comprised 43 natural hazards (physical processes), 19 technological hazards (human induced) and 4 biological hazards. From this total list, the three Emergency Operating Areas (EOAs) in the Waikato region developed a refined list of probable hazards that may affect each part of the Waikato region.

Hazards were removed from the list for a variety of reasons including:

- level of risk considered minimal/too low for inclusion in the analysis (e.g. most road accidents do not warrant CDEM involvement),
- lack enough information available to make any assessment,
- timeframes of risk too long for consideration (e.g. chronic hazards such as sea level rise)
- a large number of management mechanisms in place already reduce the hazard (e.g. redundancy in place protecting against telecommunications failure, detailed response plans of day to day management agencies)
- likelihood too low to warrant consideration (e.g. enemy attack)
- effects are indirect (e.g. Tsunami effects on inland communities)

The refined hazard list comprised 20 hazard types, although not all hazards affected each EOA.

Hazard descriptions and scenarios were developed for each hazard within each EOA. For some hazards more than one scenario was developed, e.g. relating to the maximum likely event, a declared event or an undeclared event. Therefore a hazard which may affect one part of the Waikato region in a different manner to another part was recognised in the scenarios for each EOA.

Each EOA carried out a risk analysis of the hazard scenarios developed for their part of the Waikato region. In total 63 hazard scenarios were assessed, seven of which were common to all EOAs. Twenty-seven hazard scenarios were assessed for the Thames Valley EOA, 27 for the Waikato Valley EOA and 23 for the Southern EOA.

Assessments were carried out in workshops with a wide range of agencies in each EOA, and results of draft analyses fed back to the CEG and CDEM Group for consideration.

The process of assessment began with a modified AS/NZS 4360 matrix analysis of likelihood and consequence. The matrix in the MCDEM guideline was modified as it was considered that the guideline heavily weighted the two extremes of events (extreme and low), therefore making the gradient between those two extremes overly steep. The Waikato assessment therefore allowed ratings from very low to extreme as indicated in the matrix illustrated in Figure 19.

Figure 19: Waikato CDEMG amended AS/NZS 4360 risk analysis matrix

	Consequences				
Likelihood	**1 Insignificant**	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
A (almost certain)	Moderate	High	Very High	Extreme	Extreme
B (likely)	Low	Moderate	High	Very High	Extreme
C (possible)	Low	Moderate	Moderate	High	Very High
D (unlikely)	Very Low	Low	Moderate	High	Very High
E (rare)	Very Low	Very Low	Low	Moderate	High

Priority lists for each EOA were developed based on this AS/NZS 4360 risk analysis.

Following this assessment those hazards that rated High, Very High, Extreme, and hazard scenarios that would result in a declaration of an emergency were selected to undergo a SMG analysis.

Seriousness was calculated as the average of H, E, S, I and G impacts. However, a weighting factor was applied to each of the components in line with CDEM Group priorities. Human and Economic impacts were weighted by 0.25, Social and Infrastructure impacts weighted by 0.20 and Geographic impacts by 0.1.

Manageability was calculated using the MCDEM guideline rating system, with descriptors developed to assist allocation of management difficulty and current effort. Growth was calculated using the MCDEM guideline method.

The descriptors for rating current Management Difficulty are illustrated in Figure 20.

Figure 20. Waikato CDEMG Management Difficulty descriptors

	Management Difficulty
Low	Risk easily identified and few challenges posed in addressing
Medium	Risk not always identified and there are challenges in addressing
High	Hard to define and very difficult to manage

Current Effort was rated across the 4R's as shown in the worked example in Figure 21.

Figure 21: Waikato CDEMG current effort ratings worked example

	Low (1)	Medium (2)	High (3)	**Current Effort total**
Reduction	1			
Readiness		2		
Response			3	
Recovery		2		
Total	1	4	3	**8**

Scores from the current effort rating were allocated scores of High, Medium or Low, depending on the score from the rating as shown in Figure 22.

Figure 22. Waikato CDEM Group current effort scores

	Current Effort
Low	4-6
Medium	7-9
High	10-12

The High, Medium and Low scores were then converted for use in the matrix provided in the Director's Guideline as shown in Section 3.1.2.

The Waikato CDEM Group rated Growth using the SMG analysis methodology.

The outcome of the SMG process was a score of 1-5 allocated to each of the SMG components.

This rating, however, would have allocated equal weighting to the three components. The Waikato CDEM Group's weighting that produced a priority list acceptable to the EOA representatives was as follows:

Seriousness: = 60%

Manageability: = 20%

Growth: = 20%

This weighting was selected after testing other weighting options such as 50/30/20 and 40/40/20.

The method for final calculation of overall rating can therefore be seen in Figure 23 (for an example Maximum Likely Event scenario).

Figure 23: Waikato CDEMG overall SMUG rating calculation example

Risk	S					Sub-total	Total S	M	G	Rating Score
	H	E	S	I	G					
Overall multiplier							*0.6*	*0.2*	*0.2*	
Seriousness multiplier	*0.25*	*0.25*	*0.2*	*0.2*	*0.1*					
Ashfall from Mt Ruapehu eruption (maximum likely event)										
Raw score	1	2	3	2	1	9	9	2	1	
Weighted score	0.25	0.5	0.6	0.4	0.1	1.85	1.11	0.4	0.2	1.71

Due to the weighting system used, the final results of the Waikato risk analysis process was a rating score of between 1 and 5 for each hazard scenario considered. This approach is quite different from other Groups who did not apply weighting factors and therefore had scores that could have fallen within a much wider range.

5.5.3. End uses of the risk analysis

The final output of the analysis process is a list of 26 hazards, with possible scores of 1-5, grouped into Very High, High, or Moderate categories.

5.5.4. Objectives, Targets and Actions

The two objectives relating to the list of priority hazards are:

> "To develop a comprehensive and co-ordinated approach to hazard risk reduction across the Waikato region."
> "To improve our understanding of the consequences of the priority hazard risks and acceptable levels of risk for each hazard".

Specific targets then include development of a Regional Hazard Risk Management Programme, developing and strengthening risk reduction partnerships, reassessing the consequences of priority hazard risks, developing acceptable levels of risk, and assessing the consequences of hazards of national significance.

There is also a section in the Plan entitled "Hazard Specific Management". This section does not however, describe the management activities for each of those hazards, but provides more background into the issues that will be addressed as part of a Regional Risk Reduction Management Plan. This will cover all risks, and is to be developed following a full cost benefit assessment of the various treatment options. This management plan would not only cover the high priority hazards, however, because other lower priority hazards may continue to be addressed by agencies other than the CDEM Group and progress on those management activities would be monitored by the CDEM Group.

5.5.5. Risk Evaluation criteria

The Waikato Region CDEM Group established risk evaluation criteria to be considered as important when setting risk priorities. These criteria were described as 'principles' to be considered when setting risk priorities. The principles include:

1. Risks that have the potential to cause a significant number of deaths or injuries to people are unacceptable.
2. Human life and safety will therefore take precedence over all other priorities (such as property and infrastructure)
3. Risks that have the potential to cause severe economic losses (particularly for agriculture and tourism), substantial damage to buildings, infrastructure or lifeline utilities
4. Risks that are readily manageable are of the most concern to local communities
5. Risks that can be readily addressed by improving co-ordination and co-operation between emergency management agencies
6. Risks that have the greatest potential consequences will receive priority regardless of the likelihood
7. Risks with a high likelihood and high consequence will be give priority over those of low likelihood and consequence
8. Risk reduction activities will be implemented through a combination of LTCCPs, District Plans, plans of key partner agencies and other methods.

The above principles can be seen to have guided the process used for assessing the risks. For example, principle 2 is reflected in the additional weighting given to Human and Social components of the Seriousness rating, and principle 6 would explain the reason why the SMG model was used and not the SMUG model which considers the urgency (and therefore likelihood) of the hazard event.

A tension exists between principles 6 and 7 because the latter retains a requirement to assess likelihood, thus placing some weighting on it for the priority assessment of the hazards.

This tension appears to have been overcome by the Waikato CDEM Group by carrying out an AS/NZS 4360 risk analysis matrix (thereby taking into account likelihood) and then selecting a SMG assessment weighted to reflect these same priorities.

Some of the principles stated were not 'principles' as they did not describe the action the CDEM Group wished to take with regard to the issue (e.g. principles 3, 5)

5.5.6. Qualitative issues

The selection of scenarios for maximum likely event, declared and undeclared events is unique to the Waikato region. Although this meant a large number of scenarios needed to be assessed for each hazard, it enabled the assessment to differentiate between different scales of hazard events, and did not attempt to consider only the worst case scenario, or to treat each hazard as if it was always expressed as an event of a certain size.

The decision to determine scenarios for each EOA is also unique to the Waikato region and allows hazards expressed differently in different parts of the region to be assessed separately.

This method of using scenarios eliminated a problem common in other CDEM Group analyses, because hazards were not considered to have homogenous effects across the whole group area, or that a particular scenario was sufficient to describe the total threat from that particular hazard.

Manageability

The Waikato CDEM Group used the standard MCDEM matrix for calculating manageability based on management difficulty and current effort. However, they developed more detailed criteria to assist decision making by those carrying out the assessment.

5.5.7. Quantitative issues

The weighting factors used by the Waikato CDEM Group reflect their priorities as identified in the risk evaluation criteria, particularly with regard to the emphasis on potential consequences (reflected in the seriousness rating) of a hazard event. However, two of the risk evaluation criteria also discuss priority being given to those hazards which can be *readily addressed*. These hazards would be those that have a low manageability score (i.e. low management difficulty and high current effort). However, as the manageability rating is given less weighting and is an inverse score, those hazards that have low manageability scores are not afforded priority in the overall priority list.

5.6. Bay of Plenty CDEM Group

5.6.1. Stated purpose of risk analysis

The CDEM Group Plan states that a sufficiently rigorous assessment was carried out to differentiate between groups of higher risk (hazards) from groups of relatively moderate or low risk. It also states that hazards were identified to:

- Raise awareness
- Inform hazard based research
- Assess management activities
- Guide operational arrangements.

5.6.2. Process of risk analysis

A review of the hazard reports and CD plans was carried out and a list of potential hazards affecting the Bay of Plenty was developed. Hazard workshops and meetings of scientific experts, CDEM personnel, MCDEM, lifeline utilities, emergency services as well as CEG representatives refined the lists.

Twelve natural hazards and 13 man-made hazards were identified. From this list hazard scenarios were developed. For some hazards more than one scenario was developed, e.g. relating to the maximum likely event or a mid-range scenario for different hazard sources (e.g. volcanic eruption sources). A total of 38 hazard scenarios were developed for analysis.

Detailed hazard summaries were developed for each hazard type, describing the potential impacts, management mechanisms in place, and the potential for future growth of the hazard or of community vulnerability.

An AS/NZS 4360 matrix analysis was carried out for each hazard scenario as per the Director's Guideline. In addition, Environment Bay of Plenty, with specialist scientific advisors, allocated ratings for Seriousness, Manageability and Growth using the SMG methodology. The 'urgency' rating was discarded as it was determined that it was more important to identify the hazards than to rate them and possibly give the wrong message that the chance of occurrence is not that high (J. Thurston, pers.com. 2005).

The CDEM Group then determined that the process of developing the hazard summaries had resulted in a significant increase in clarity about the characteristics of the hazards which face the Bay of Plenty Region. It was decided that the priority hazards could therefore be identified without the need to use a rating system. The priority hazards were therefore agreed upon by consensus of the CDEM agencies represented at the workshops

and meetings. Hazards were grouped into higher priority hazards and other hazards. It was commented that there was general agreement on those hazards that warranted a high priority (J. Thurston, pers.com. 2005).

Detailed descriptions of the hazards described as higher priority are included in the Plan, including specific comment on the expected probability of the hazards, hazard scenarios and consequences, and management mechanisms in place and possible in the future.

5.6.3. End uses of the risk analysis

The final output of the analysis process is a listing of seven higher priority hazards and 14 other hazards, grouped into those that may require a CDEM Group declaration and those that have other lead agencies.

In addition, the information gained during risk analysis about the existing and possible future management mechanisms is described in the Plan for the higher risk hazards. It is not clear how, or if, these possible future management mechanisms are linked to the Objectives, Targets and Actions listed in the Plan.

5.6.4. Risk evaluation criteria

No risk evaluation criteria were developed.

5.6.5. Objectives, Targets and Actions

The majority of Objectives, Targets and Actions relating to hazard and risk are generic and refer to all hazards facing the BOP region. However a small number refer to the listing of the higher priority hazards as the focus for the activity. For example:

Objective:

To increase community education about high priority hazards

Action:

Focus hazard studies on collecting new information on the nature, extent and potential impact of high priority hazards that could significantly affect the Bay of Plenty and to develop a common understanding within the community of these hazards and how they should be managed.

Target:

Focus high priority hazard studies on:

- Quantifying by 31 December 2005 the potential for hazchem incidents within the region and assess the associated risks.

5.6.6. Qualitative issues

The Bay of Plenty approach was purely a qualitative approach because, although rating systems were used, the final decision on which hazards were a higher risk was based on the consensus of CDEM and related personnel.

Within the Plan the stated purpose of identifying a group of higher 'risk' hazards is amended, when later that grouping is referred to as the higher 'priority' hazards. Higher risk is therefore taken to be equivalent to higher priority, although no risk evaluation criteria were considered to determine which priority should be allocated.

5.6.7. Quantitative issues

No quantitative measures were used in the final decision of higher priority hazards. Given that agreement was able to be reached about which hazards were a higher priority to the Group, a more quantitative process may not have been necessary.

The representation of the higher risk hazards in the Plan does however, give the impression that these were derived directly from the semi-quantitative AS/NZS 4360 matrix analysis and SMG analysis processes, when this was not the case.

5.7. Taranaki CDEM Group

5.7.1. Stated purpose of risk analysis

The Taranaki CDEM Group described the purpose of the hazard and risk analysis process as being to identify the significant hazards to be addressed in the Group Plan for Taranaki.

5.7.2. Process of risk analysis

Hazards were identified and the risk from each hazard described. Considerable research had been done on hazards in the Taranaki region, so preliminary hazard analysis documentation (from 1991) was reviewed to include 'all hazards'. Thirty-eight natural hazards were identified, including multiple risks resulting from the same hazard (e.g. volcanic ash and pyroclastic flow), and different 'at risk' geographic areas for each hazard where appropriate. Thirty-three non-natural hazards were also identified including failure of infrastructure and essential services (e.g. Police).

Separate workshops were held to rank the hazards for likelihood and impact using the AS/NZS 4360 matrix process outlined in the Director's Guideline. A wide range of agencies were represented at the workshops including local government, emergency services, health agencies, lifeline utilities, schientists and some major private industry organisations. Co-ordinating Executive Group input (Chief Executive Officers) was sought into the rating process.

Forty-seven hazards were rated High or Extreme using the AS/NZS 4360 matrix analysis. These hazards underwent further evaluation using the SMUG analysis process as per the Director's Guideline.

For each hazard, explanatory notes were developed including scenarios, issues, the AS/NZS 4360 matrix analysis and SMUG analysis results, and specific elements to be highlighted for each hazard. As some hazards contained multiple expressions, in some cases a range of scenarios and consequences were described.

The SMUG model was refined to reflect the view of the CDEM Group that the human element of the seriousness rating was considered the most significant element for determining those risks which should be addressed at a CDEM Group level. The model was run in three ways to observe the effects of different weightings on the Human element of the Seriousness rating. The ratings were calculated first using the average of the five components of Seriousness (HESIG), then secondly by allocating a rating of 5 (the highest score) for Seriousness when the human elements received this rating, no matter what the ratings for the Economic, Social, Infrastructure or Geographic components were, and thirdly taking whichever score was greater; the average or the human seriousness rating.

In each case the calculation did not affect the overall standing of the risks in relation to the other risks. The top ten and bottom ten hazards remained the same. It was therefore decided to use the second methodology of rating the overall Seriousness score as 5 (the highest score) in every case when the human element was allocated the score of 5.

The top 10 hazards for the Taranaki region were identified based on the SMUG ratings. These hazards were described as the 'significant hazards

for Taranaki' and were to be addressed through the CDEM Group Plan. Three hazards were identified as being of national significance

5.7.3. End uses of the risk analysis

The final output of the analysis process is a prioritised list of the top ten 'significant hazards' in Taranaki. These hazards are listed in the Plan along with their AS/NZS 4360 and SMUG ratings.

5.7.4. Risk evaluation criteria

No risk evaluation criteria are explicitly stated.

However, key questions to be answered when identifying opportunities to reduce risks are listed. These include:

- Is there a way to avoid the risk?
- Is there a way to reduce the probability of the risk?
- Is there a way to reduce the consequences of the risk?
- Is there a way to transfer the risks?

These questions perform a similar function to risk evaluation criteria in that they are a common set of criteria that must be reviewed and implemented in order to have considered the hazards fully. The principles of risk avoidance, reduction, and transfer were all carried over into the risk treatments identified as Targets and Actions for the top ten significant hazards for Taranaki.

5.7.5. Objectives Targets and Actions

The Plan develops specific management mechanisms for all hazards and then for each of the top ten significant hazards.

Individual Targets and Actions are developed for each of the top ten significant hazards in the areas of Reduction and Readiness activities.

These Targets and Actions are in addition to the general Targets and Actions listed for all hazards.

This approach is unique in the level of detail afforded to managing those hazards deemed as significant for the region. The only other similar approaches are the Waikato and Gisborne CDEM Groups but the Waikato group lists the management mechanisms in a general sense for each of the hazards, and the Gisborne Group related the Objectives, Targets and Actions to the issues arising from the hazard rather than to the hazard characteristics themselves. The level of detail prescribed by the Taranaki CDEM Group is far greater than either of these approaches.

This approach is consistent with the stated purpose of the Group in performing analysis. By identifying the significant hazards and then implementing management mechanisms for those hazards the Group is meeting its stated objective, and also explicitly meeting the requirements of the CDEM Act 2002 which states that the CDEM Group Plans must state:

- The hazards and risks to be managed by the group; and
- The Civil Defence Emergency Management necessary to manage the hazards and risks described.

Other CDEM Groups who describe management mechanisms for 'all hazards' may be giving an impression that the CDEM Group is going to manage all of those hazards, when no specific provision is made for specific CDEM mechanisms for specific hazards.

In addition to the analysis process, an illustration is incorporated in the Plan that plots likelihood and impact (the AS/NZS 4360 assessment) but also colours the hazards as to the 'consequences'. It is not clear where the assessment of consequences arises from (as opposed to seriousness, or likelihood which were both explicitly recorded).

5.7.6. Qualitative issues

No more detail is provided to the rating descriptors for the SMUG elements than that provided in the Director's Guideline. It is possible therefore that the consensus decisions made when ranking the hazards may not have been as specific as necessary because little guidance was provided for what rating score should be allocated.

In this way, even if good quality data had been available, the lack of detailed descriptors may have meant that the analysis would not benefit from the availability of that data. For example the Urgency rating was based on descriptors such as "should occur at some time" without specific ranges of return periods allocated to each description. Another example is the manageability rating which describes the "level of cross sector management effort being applied across the 4R's either directly or indirectly". This descriptor may not provide adequate guidance for rating, and does not reflect variations in effort across the different components of Reduction, Readiness, Response and Recovery, even though this information was commonly available in the explanatory notes for each hazard.

5.7.7. Quantitative issues

The only alteration to the methodology recommended by the Director's Guideline is the change to the Human element of the Seriousness rating. This was carried out explicitly to add a higher weighting to this factor.

The ratings for each component of SMUG were the same range of 1-5, meaning that equal weighting was given to each of the components in the final analysis. This was appropriate given the absence of any risk evaluation criteria to alter the weightings to be applied.

5.8. Gisborne CDEM Group

5.8.1. Stated purpose of risk analysis

The purpose of the risk analysis carried out by the CDEM Group was stated as to "identify those hazards which should be priorities for future risk treatment".

5.8.2. Process of risk analysis

The Gisborne District Council, as a unitary authority, co-ordinated the risk analysis process with the CDEM Group members and member organisations.

Hazards reports and plans were reviewed and a list of 27 hazards was identified.

A dedicated Hazards Liaison Group was established to identify the options available to manage the effects of hazards in the Gisborne area.

Workshops were held with relevant agencies and hazard summary sheets were developed for each of the hazards. These sheets described the likelihood in terms of urgency and growth of the hazards and the consequences in terms of seriousness of the hazard impacts (human, social, physical, economic). The sheets also listed the manageability of the hazards given the current controls in place. Where there was a difference in manageability between the four phases of emergency management this was described. Specific gaps in knowledge or management mechanisms were also noted for each hazard.

The Hazard Liaison Group then carried out a SMUG analysis process using the same methodology as the Auckland CDEM Group.

Ratings from 1-3 were allocated to each of the components of SMUG. A factor of 0.5 was added to the final rating to those hazards that will 'probably be adversely impacted by climate change'.

5.8.3. End uses of the risk analysis

The final output of the analysis process is a list of the twenty seven hazards (one of these was not assessed) broken into three groupings called "Study Groups". These groups were described as follows:

- Study Group 1: More work is required to ascertain vulnerability to these hazards
- Study Group 2: These hazards only require special projects on an identified gaps basis.
- Study Group 3: Special projects only on an identified gap

The hazard that was not rated (snow and hail) was highlighted for incorporation into the next CDEM Group Plan.

5.8.4. Risk evaluation criteria

No specific risk evaluation criteria are described.

5.8.5. Objectives, Targets and Actions

A key outcome of the development of the hazard summary sheets was the identification of gaps and issues. These are described as the 'real problem areas' in the Group Plan.

Objectives, Targets and Actions in the Plan are based on the key issues that arose during the Plan development process. Key issues relating to the top 10 hazards on the SMUG prioritised list are incorporated into the Plan and specific Objectives, Targets and Actions developed based on those issues. It is interesting to note that these issues relate to all of the hazards in Study Group 1 and only the first five hazards in Study Group 2. The Plan therefore

addresses issues arising from the hazards identified as the highest priority hazards, but in a different grouping than that identified in the Plan. No specific issues relating to the rest of the hazards in Study Group 2, or the hazards in Study Group 3 were incorporated into the Objectives, Targets and Actions, but issues common to more than one hazard are identified and have Objectives, Targets and Actions to address them.

The actions required in the CDEM Group Plan are then turned into projects and critical dates and responsibilities allocated for their implementation.

The Gisborne CDEM Group Plan also includes a rather unique table where the hazards are listed and the gaps in reduction activities are described and linked to the readiness and response activities required. This linkage is a strength of the Gisborne CDEM Group Plan as it relates how a gap in the existing management mechanism causes an effect (a consequence) that then needs to be managed in terms of readiness or response actions when the event occurs.

This component of the analysis provides a current snapshot of the likely impacts of the hazards under the current management mechanisms. If this process were to be repeated at the end of the 5 year programme of CDEM Group projects it is possible that this part of the plan could be revised and the improvements in the reduction activities quantified in terms of whether they have reduced the potential affects of the hazards.

5.8.6. Qualitative issues

No specific scenarios were developed to base the hazard ratings on. Therefore each hazard rating may be based on a range of potential scenarios and not comparable to each other.

5.8.7. Quantitative issues

No initial screening process was carried out using the basic AS/NZS 4360 matrix risk analysis process. This may not have been a problem because the full analysis was carried out on all hazards that have been identified.

5.9. Hawke's Bay CDEM Group

5.9.1. Stated purpose of risk analysis

The purpose of the risk analysis process is not explicitly stated, but within the text of the CDEM Group Plan those hazards that are ranked as highest priority as a result of the risk analysis are described as those with the potential to significantly affect the Hawke's Bay, and are therefore the main focus of the CDEM Group Plan.

5.9.2. Process of risk analysis

Forty-two hazards were identified following a review of existing CDEM plans, hazard research reports, lifelines study reports and the list of hazards included in the Director's Guideline. These hazards were categorised into categories of natural, man-made, biological, coastal, drought, fire, hazchem incident, lifeline utility failure, major transportation accident, lifeline utility failure, environmental pollution, soil stability, and extraterrestrial hazards.

Ratings were allocated in a workshop session with all CDEM Officers from the region present. These rankings were refined by Hawke's Bay Regional Council staff after reviewing technical hazard reports available for the region.

The maximum likely event scenario was used for the analysis, and hazards where the CDEM Group was not the lead agency were only considered at the level that the CDEM Group would be involved.

Hazards were rated using the AS/NZS 4360 matrix method with likelihood being assessed as the probability of each hazard occurring in the next 50 years.

A SMUG process was then carried out using the methodology described in the Director's Guideline. The approach used by Hawke's Bay CDEM Group was the basic SMUG analysis with ratings of 1-3 allocated for each component.

5.9.3. End uses of the risk analysis

The final output of the analysis process is a list of 38 hazards listed in priority order and grouped into three groups: Priority 1, 2 and 3. Hazards not included in the plan included hazards such as commercial crisis (e.g. stock market crash), and hostile acts (e.g. war, nuclear threat).

Those hazards with a priority ranking were considered hazards with the potential to significantly affect Hawke's Bay and are therefore stated as being the main focus of the CDEM Group Plan.

The priority hazards are described as having the major immediate consequences of the potential for loss of life or serious injury to people, the destruction or damage to property, the need to evacuate people to safety at short notice, and general distress to the public.

It was noted that of the nine priority hazards, five were managed by controlling legislation other than the CDEM Act 2002. It was also noted that four of the priority hazards, and five other hazards were thought to be of national significance.

In addition to the prioritised list of hazards, fifteen hazards were selected and plotted to show the relationship between return period (within a 50 year timeframe) and impact. The definition of 'impact' was not described but this plot reflected the AS/NZS 4360 matrix analysis of selected hazards for which return period information was available. This plot is an interesting way to represent the hazards as it may offer some comparison between those hazards with low likelihood but high consequence and those which occur regularly with little consequence. Unfortunately inadequate information about probabilities is likely to mean that it is not possible to plot all hazards.

5.9.4. Risk evaluation criteria

No specific risk evaluation criteria are stated in the CDEM Group Plan, and therefore additional weighting factors were applied to any of the components of the analysis.

5.9.5. Objectives Targets and Actions

Three objectives are defined specifically relating to the hazards listed as priority one hazards. These are:

- Determine acceptable levels of risk for the priority one hazards
- Undertake effective mitigation measures to lessen the consequences of the priority hazards
- Develop contingency plans and standard operating procedures to effectively respond to and recover from the priority hazards.

These Objectives are translated into specific Actions with responsible agencies listed.

No hazard specific Objectives are developed for those hazards listed as priority one. However, hazard specific Action points are listed for four of the priority one hazards. The remainder of the Actions refer generally to natural or technological hazards, not explicitly those listed as priority one.

5.9.6. Qualitative issues

The range of hazards identified in the Hawke's Bay CDEM Group Plan is the most extensive of any group. It includes both chronic and acute hazards, as well as hazards managed by other controlling legislation and organisations (some outside of the CDEM Group). The inclusion of all of these hazards is a benefit in that the full range of causes of consequences that may require CDEM intervention can be identified, as well as additional consequences specific to these hazards.

However, the wide range of hazards does raise problems in defining when, and indeed if, a CDEM Group would be involved in management of some of these hazards, which of the consequences are the responsibility of the CDEM Group to address, and whether the CDEM Group have adequately integrated the 'responsible' agencies.

Although an assumption is stated that the maximum likely event scenario was used as the basis for the analysis, these scenarios are not stated with the analysis so there is no guidance to the reader as to the characteristics of the scenario being analysed.

No evidence is provided that descriptors were developed when assigning a rating to each component of the analysis. This may be due in part to the Director's Guideline listing possible descriptors for a rating scale of 1-5 rather than 1-3 as used in the Hawke's Bay.

5.9.7. Quantitative issues

The Hawke's Bay CDEM Group used the SMUG methodology with a possible rating range of 1-3 for each of the components, unlike other Groups such as Taranaki and Wellington who used the rating scale of 1-5 listed in the Director's Guideline.

This resulted in a smaller possible range of results from the ranking process, with a number of hazards grouped at similar levels and priorities. However, this may not have been a factor of relevance in the Hawke's Bay example as a good spread was observed, and a normal distribution may not necessarily be expected when considering hazards.

5.10. Manawatu-Wanganui CDEM Group

The Manawatu Wanganui CDEM Group Plan was approved on 14 March 2003. The Plan was the first to be approved under the CDEM Act 2002 and the majority of the Plan was developed before the enactment of the CDEM Act 2002, and the issue of the Director's Guideline on preparation of CDEM Group Plans. At this time most other CDEM Groups had not yet formally been formed, and were only beginning the Plan development process.

The development of the Plan was guided, in part, by the then Ministry for Emergency Management (now MCDEM) information series document (MEM, 2000), and not the subsequent Director's Guideline (MCDEM, 2002). Consequently, the Manawatu-Wanganui CDEM Group Plan has a slightly different approach, although it still contains the main elements found in most other CDEM Group Plans, and meets the requirements of the CDEM Act. At the time of writing, the Plan was in the process of revision.

No ranking or prioritisation of hazards is found in the 2003 Manawatu-Wanganui CDEM Group Plan. This is stated as being due to a lack of information available about *all* the hazards facing the region. The CDEM Group Plan identifies this as an opportunity for improvement for future plans, and is carried over as an action item into the work programme for the CDEM Group.

However, the CDEM Group Plan does contain detailed risk descriptions for over half of the 20 hazards listed as being significant to the whole or major parts of the Manawatu-Wanganui region. For each of these hazards the context is described, as well as the likelihood and potential hazard consequences. In this way, the information needed to carry out a simple AS/NZS 4360 matrix analysis of the hazards described is available.

5.10.1. End uses of the risk analysis

Objectives, Targets and Actions are incorporated into the Plan based on the issues that arose when describing the known hazards in the region. The issue identified as relating to hazards was that while many hazards have been identified, they require more in depth analysis in terms of likelihood and consequence. The subsequent objective is to improve risk descriptions to cover all hazards and to define likelihood and consequences for each hazard. This work was to be completed for incorporation into the revised CDEM Group Plan planned for approval in 2005.

In addition to regional scale risk descriptions, districts were also tasked with developing risk descriptions for their own areas. It is interesting to note that in the area covered by the joint Wanganui Rangitikei EM committee the risk description process has been followed by an AS/NZS 4360 matrix analysis of 63 hazards, followed by a SMUG analysis of these same hazards using the methodology described in the Director's Guideline.

No hazard specific Objectives, Targets or Actions were identified for particular hazards above other hazards.

5.11. Wellington Region CDEM Group

5.11.1. Stated purpose of risk analysis

The purpose of the SMUG ranking was described by the Wellington Region CDEM Group as to:

- "Develop a common understanding of the hazards and risks by all agencies with a CDEM role
- Identify the hazards and risks that the Group will manage (as opposed to those to be managed by individual agencies).
- Identify the hazards that are of national significance.
- Facilitate the identification of issues to be addressed by the Plan.

In addition the Wellington Region CDEM Group Plan states a desire to ensure that issues to be addressed by the CDEM Group Plan are based on sound hazard and risk information. The CDEM Group documentation states that the purpose of rating the hazards using the SMUG system will be to:

- "Ensure that all aspects of the hazard and risk were considered
- Provide a method of comparing the hazards and risks on similar scales
- Determine gaps where information was missing
- Determine if there were any hazards that need to be addressed with a higher priority than others
- Facilitate discussion about all aspects of the hazard so that the full range of issues could be identified."

The approach in Wellington is therefore similar to the Gisborne and Manawatu-Wanganui CDEM Group Plans, as the focus of the Wellington Plan is on the *issues* that arise during the process of risk analysis, rather than the prioritisation of one hazard over another.

5.11.2. Process of risk analysis

Twenty-four hazards were identified for consideration by the CDEM Group. For each of these hazards detailed hazard summary sheets were developed by the Greater Wellington Regional Council staff with input from researchers and non-CDEM lead agencies where appropriate.

The hazard summary sheets described the potential impacts of the hazard on the Wellington region in terms of human, economic, social, infrastructural and geographic impacts, as well as the existing management mechanisms and gaps, the likelihood of the hazard (where known) and the factors that may contribute to growth of the hazard.

Maximum likely scenarios and mid-range scenarios were developed for each of the hazards.

Hazards that could be managed by one agency, or wouldn't need management under the CDEM Act were not included in the list of potential hazards. In the same way hazards for which the CDEM Group was not the lead agency were only considered at the level of CDEM Group involvement.

Workshops were held focusing on specific groupings of hazards. Workshops were attended by CDEM officers, hazard researchers, lifeline utilities, emergency services, health agencies, response agencies, government departments, and the Ministry of Civil Defence and Emergency Management.

At each workshop, agencies were asked to refine the hazard summaries based on their experience and knowledge of the hazards, to ensure a common understanding, and information transfer between agencies at the workshop. Workshop participants were then asked to identify the strategic issues raised by each component of the hazard summary sheets in the

areas of Risk reduction, Readiness, Response and Recovery. This approach was unique to the Wellington region and ensured that all aspects of hazard and risk were discussed and issues relating to the management of the hazard identified.

A working group of individuals who had attended each of the workshop sessions developed initial ratings based on the maximum likely event scenarios developed as part of the hazard summary sheets. Assessment was first carried out using an amended AS/NZS 4360 matrix. The Wellington CDEM Group suggested timeframes for the likelihood ratings as illustrated in Figure 24.

Figure 24: Wellington CDEM Group likelihood descriptors

Level	**Description – refer to the maximum likely scenario.** **(If available, use return periods as a guide)**
A (almost certain)	Is expected to occur in most circumstances (0 – 5 year return period)
B (likely)	Will probably occur in most circumstances (0-19 year return period)
C (possible)	Might occur at some time (0 – 99 year return period)
D (unlikely)	Could occur at some time (0 – 999 year return period)
E (rare)	May occur only in exceptional cases (> 1000 year return period)

Following the initial AS/NZS 4360 matrix analysis, a SMUG process was carried out using the process described in the Director's Guideline. Ratings of 1-5 were allocated to each of the components, with descriptors defined for each component. The components were then summed for an overall risk rating.

The draft ratings were presented to workshops of all agencies with a role in CDEM in the Wellington region and revised, based on feedback from researchers and practitioners.

5.11.3. End uses of the risk analysis

The final outputs of the analysis process were a ranked list of the 24 hazards considered, and a list of strategic issues identified through the risk analysis process.

The Plan states that those hazards ranked highly in the analysis have a priority for action, although medium and low risk hazards still form part of the work programme. There is, however, little evidence of the rankings being used to determine priority for the works programme activities.

5.11.4. Risk evaluation criteria

No risk evaluation criteria were identified.

5.11.5. Objectives, Targets and Actions

Objectives, Targets and Actions were developed based on the strategic issues identified during the risk analysis process. Many of the strategic issues that arose were relevant to more than one hazard and therefore these were described in general terms rather than as a hazard specific Objective. A small number of hazard specific Targets and Actions were identified, but all Objectives were stated in general terms.

The Actions listed in the Plan are translated into a work programme for the 5 year term of the CDEM Group Plan, and task allocations made.

5.11.6. Qualitative issues

The hazard summary sheets developed by the Wellington CDEM Group were a useful tool that was used effectively to pool information from various sources and organisations. The use of the hazard summaries as the basis for workshops achieved the stated goal of the analysis process that was to

"develop a common understanding of the hazards and risks by all agencies with a CDEM role".

Seriousness

Descriptors of the seriousness ratings were tailored for use in the Wellington region. For example infrastructure consequences were described in terms of the ability of lifeline utilities to operate and continue to provide their services as illustrated in Figure 25.

Figure 25: Wellington CDEM Group Infrastructure component of Seriousness descriptors

Level	Descriptor	Detail description: Infrastructure
1	Insignificant	Few or no effects
2	Minor	Disruption or loss of one lifeline service for a period of hours to a day.
3	Moderate	Business or physical damage to one or more infrastructure systems cause service disruption or intermittent loss of service for period of up to one week.
4	Major	Total loss of one lifeline service with effects lasting weeks or simultaneous disruption to multiple infrastructure systems for period of weeks.
5	Catastrophic	Total destruction of multiple infrastructure systems – business and service aspects, total rebuild required.

Urgency

The instructions for rating the urgency score included reference to the likelihood rating, with an increased score if there are "particular issues that increase the need to manage the hazard in the short term".

The nature of these 'particular issues' is not described and therefore this factor may have been inconsistently applied across the various hazards. However the intent behind the statement is sound because opportunities or pressures that exist to address a hazard may make it more imperative to

address the hazard sooner rather than later. The flexibility to acknowledge the positive opportunities associated with risk is not a factor in many other analyses. The Wellington CDEM Group Plan does not use the rankings to prioritise actions relating to specific hazards; this was a lost opportunity.

5.11.7. Quantitative Issues

When assigning the likelihood ratings to each risk during the original AS/NZS 4360 matrix rating process, return periods were inserted as a guide for deciding which score to allocate. However return periods were stated as ranging from 0 – 5 years, 0 – 19 years, 0 – 99 years, 0 – 999 years and >1000 years. Because the first four range statements each start from 0 years, it is possible that a hazard with a return period of 5 years could be counted within any of the four categories. The range statements therefore lose their value in estimating how the likelihood of occurrence contributes to the overall risk.

5.12. Marlborough CDEM Group

5.12.1. Stated purpose of risk analysis

The Marlborough CDEM Group Plan states that the major purpose of the Plan is to meet the CDEM Act requirement to state which hazards are to be managed by the group, in an attempt to improve and promote the sustainable management of hazards, and enable communities to achieve an acceptable level of risk and plan and prepare for emergency response and recovery.

The Plan also states that as it is unlikely they will address all the hazards and risks within the district in the 5 year period of the CDEM Group Plan it is necessary to identify those hazards which should be priorities for future risk treatment.

5.12.2. Process of risk analysis

The Marlborough District Council, as a unitary authority, co-ordinated the risk analysis process with the CDEM Group members and member organisations.

Twenty three hazards were identified by the CDEM Group (11 natural and 12 technological) after reviewing hazard reports and existing plans and holding discussions with people experienced in managing or researching hazards in the Marlborough district.

For each hazard a risk description was developed that included information on the hazard context, likelihood and consequences including potential human-social, economic-infrastructural, and environmental effects. No comment was made in these risk descriptions about management mechanisms in place or potential growth of the hazard.

An AS/NZS 4360 analysis, and then a SMG process were applied in a workshop of CDEM personnel, facilitated by MCDEM. Agencies represented at the workshops included emergency services, lifeline utilities, volunteer organisations, and CDEM. The rankings developed at these workshops were discussed with the Plan Working Group and at a wider stakeholder's workshop before being finalised and included into the Plan.

5.12.3. End uses of risk analysis

The final output of the analysis process was a ranked list of the 23 hazards relevant for the Marlborough District, grouped into High, Medium and Low priority hazards.

In addition, issues relating to specific hazards are listed, although at time the description of the issue is not clear and reads more as a description of the hazard.

5.12.4. Risk Evaluation Criteria

No risk evaluation criteria were developed.

5.12.5. Objectives, Targets and Actions

The Marlborough CDEM Group Plan states that the CDEM Group agreed to focus on the hazards listed as high priority. It is commented in the Plan that the highest priority hazards are primarily those for which a regionally co-ordinated response is required in terms of reduction, readiness, response or recovery. It then states that this is linked to the Targets, Actions and Work programme listed in the Plan.

However, the Targets and Actions listed do not have a specific focus on the high priority hazards, and where individual hazards are specifically mentioned, these are not listed in priority order as per the ranking achieved through the risks analysis process.

One of the purposes of the CDEM Group Plan was to 'enable communities to establish acceptable levels of risk'. However this is not followed through in assessment of acceptable risk for each hazard, or in specific Targets and Actions to identify and work towards acceptable levels of risk.

5.12.6. Qualitative Issues

The hazard ranking included in the Group Plan is based on the SMG analysis carried out. However, the risk descriptors are in the format of an AS/NZS 4360 matrix analysis with little information about manageability or growth. This inconsistency makes it difficult for readers of the Plan to see the information on which that risk analysis was based.

The methodology stated in the Plan as being used for assessing the manageability of hazard in Marlborough is not the methodology shown as being implemented in the table in the Plan. The methodology states that an "Ideal – Actual" score will be calculated, whereas in reality a "Difficulty – Effort" score was actually calculated.

Interestingly, Marlborough CDEM personnel observed that when "a lack of information was known or held about a particular hazard, the greater the perceived risk". This conclusion led the staff to believe that some hazards may be overstated, particularly when they only have the potential to affect parts of the district. This observation may be relevant to other CDEM Group areas who also reported lack of information to be a key limiting factor to the risk analysis process.

5.12.7. Quantitative Issues

As with other SMG analyses the possible scores for each of the components of the SMG analysis were different, thereby introducing a weighting which was not stated as being intended.

5.13. Nelson Tasman CDEM Group

5.13.1. Stated purpose of risk analysis

The Nelson CDEM Group describes the purpose of risk analysis within the CDEM Group Plan as to prioritise the hazards that could affect Nelson Tasman, and outline the CDEM required to manage them. It also describes the risk analysis process as a method to prioritise those hazards which represent the greatest risk, and can be effectively treated in the future by putting effort into managing the risks posed by those hazards across each of the 4 R's.

5.13.2. Process of risk analysis

An initial list of 19 hazards that could affect Nelson Tasman was identified based on local knowledge of the region, along with recommendations of the Director's Guideline and the experience of the other CDEM Groups. The list focused on those hazards for which the CDEM Group would be required to play an active role in pre-event mitigation, and readiness and/or post-event response. Long term hazards such as drought, and incremental changes such as sea-level rise, were excluded. Hazards limited in terms of regional impact, or CDEM involvement, such as urban fires, road crashes, coastal instability and large tsunami generated by space debris were also excluded.

Hazard and risk reports and CDEM plans were reviewed, and discussions held with people with experience in either managing or researching hazards in the Nelson Tasman region. Based on this information summaries of the risk posed by each of the hazards were developed. Indicative scenarios were developed for each hazard, including Maximum Credible Event scenarios and notional scenarios where insufficient information was available. The Maximum Credible Event scenarios were used as the bases of analysis, as well as to consider the effectiveness of risk controls and response functions.

An initial screening process was carried out involving an AS/NZS 4360 matrix analysis of likelihood and consequence. The descriptors for consequence were modified to reflect the level of impact appropriate for the Nelson Tasman area.

A small group of CDEM personnel, including MCDEM representation, then applied the SMG methodology to 16 hazards taken from the original listing, including additional scenarios for some hazards to reflect impacts on different parts of the region. Insufficient information was available about six other hazards, so these were not analysed.

5.13.3. End uses of risk analysis

The final output of the analysis process was a prioritised list of the 16 hazards which underwent the SMG analysis. Nine of these hazards were grouped as higher priority hazards, and the remainder as lower priority hazards (although in an Appendix to the Plan these are referred to as high and moderate priority hazards).

The highest risk hazards are described as those that have the potential to seriously impact the region, and for which there is still a considerable amount that can be undertaken to manage the hazards in terms of reduction, readiness, response or recovery. The highest priority hazards are also described as having high 'residual risk' – that is the risk that remains after risk treatment has been taken. The final output of the analysis process was a ranked list of the 23 hazards relevant for which CDEM Group response would be required if the hazard occurred.

In addition to the prioritised list of hazards, information gaps relating to the hazards were identified and documented during the risk analysis process.

5.13.4. Objectives, Targets and Actions

The Plan states that those hazards identified as priority hazards will be the focus of risk treatment activities. The Plan states that this risk treatment would include:

- Determining whether the current level of risk is acceptable.
- Reviewing the risk treatment currently in place – there may be alternatives which are more cost effective and or more sustainable
- Identifying and evaluating a range of risk treatment options
- Selecting and implementing appropriate risk treatment options.

These activities are translated into a Target that states:

- "Risk treatment options for priority hazards have been reviewed by 30 June 2007".

Another target was developed to address the information gaps identified during the risk analysis process.

A "Reduction Committee" established by the CDEM Group was tasked with achieving the Targets and associated actions.

5.13.5. Risk evaluation criteria

Three principles were developed to test the hazard priorities against. They were considered by the CDEM Group to be important when setting risk priorities:

- Risks which have the potential to result in significant loss of life or cause severe injury are priorities for treatment.
- Risks that have the potential to cause substantial damage to buildings, infrastructure or lifeline utilities are priorities for treatment
- Risks that can be significantly reduced by additional risk treatment undertaken by CDEM Group Partners will be considered priorities.

The Plan states that these criteria were considered as part of the SMG prioritisation method used to arrive at priorities. However, the components of the SMG process relating to the risk evaluation criteria were not given additional weighting when carrying out the analysis.

5.13.6. Qualitative issues

The hazard summaries developed for the analysis process contained a light level of detail including scenarios and the AS/NZS 4360 matrix analysis ratings. They did not, however, include information relating to manageability and growth, which were analysed in the SMG analysis. It may therefore be

difficult for readers to establish how the SMG ratings were achieved without sighting the information upon which that assessment was made.

A significant difference can be seen between the initial AS/NZS 4360 matrix analysis and the SMG results. This may have been due to the inability to determine maximum credible event scenarios for a number of the hazards, and the lack of quantitative data. These limitations are acknowledged in the Nelson Tasman CDEM Group Plan.

5.13.7. Quantitative issues

As with other SMG processes the ratings for each of the components of the analysis were rated with a different range of potential scores, therefore applying a weighting factor not explicitly stated as being intentional, or in line with the risk evaluation criteria stated.

5.14. West Coast CDEM Group

5.14.1. Stated purpose of risk analysis

The purpose of the risk analysis process undertaken by the West Coast CDEM Group is stated as the prioritisation of regional hazards. The Plan goes on to state that those hazards which represent the greatest risk can be effectively treated in the future by putting effort into managing the risks posed by those hazards, across the 4R's.

5.14.2. Process of risk analysis

Twenty-six hazards were identified for analysis. The West Coast Regional Council reviewed the available hazard information and developed hazard summaries for each hazard. These summaries contained information about the hazard context, likelihood and consequences (broken down into potential human-social, economic-infrastructure, and environmental

impacts). Some hazard scenarios were developed (based on a severe event on the threshold of causing major disruption) but these scenarios are not stated or described in any detail in the Plan.

A joint workshop was held of CEG members with lifeline utilities to rate the hazards using an initial AS/NZS 4360 matrix analysis screening, and then an amended SMUG process on 13 of the hazards. It is not clear why these 13 hazards were selected for further analysis as some hazards identified as lower risk in the AS/NZS 4360 matrix analysis screening were further analysed when others identified as a higher risk were not.

5.14.3. End uses of risk analysis

The final output of the analysis process was a prioritised list of the 13 highest priority hazards for the West Coast CDEM Group. These hazards are described as the hazards for which a regionally co-ordinated response is required, and that Group members need to work closely together to manage the hazards.

In addition, the Plan states that gaps, weaknesses, issues and shortfalls in planning and knowledge about the hazards were identified during the analysis process.

5.14.4. Risk evaluation criteria

No risk evaluation criteria were developed by the West Coast CDEM Group.

5.14.5. Objectives, Targets and Actions

Targets and Actions, Timeframes, Costs and Priorities are identified in the Plan. The Plan states that these targets have been identified and prioritised to address the issues facing the region.

The issues are, however, not stated in the Plan, and there is no correlation between the priorities afforded to each Target, and the prioritised list of hazards.

The Targets listed for 'Hazard Work" do not relate to specific hazards, or to those identified as priorities in the Plan.

5.14.6. Qualitative issues

There is evidence that an initial AS/NZS 4360 analysis process was carried out because the analysis tables show the results. However, the Plan does not state that this process was part of the methodology, or the process that was undertaken to carry out that analysis.

No descriptors were developed to assist allocation of score on any of the components of the analysis. For example, the description of how urgency is to be rated simply states:

> "Urgency: a measure of how imperative or critical it is to address the hazard (associated with the probability of the hazard). A 'High', 'Medium" or 'Low' rating for the Urgency component, based upon the hazard return periods where applicable."

It is very difficult to achieve credible risk analysis results without descriptors for what score should be allocated to the hazard being considered.

5.14.7. Quantitative issues

The Group Plan outlines the methodology to be used in implementing the SMUG analysis. However, the methodology used during the analysis is not that stated in the Plan.

The methodology states that all components are to be scored from 1-3.

For the Seriousness score the methodology states that each component (Human, Economic, Social, Infrastructure, Geographic) will be rated from 1-5, and then summed. The top third of scores are then to be allocated a score of 3, the middle third a score of 2 and the bottom third a score of 1. The possible range is therefore to be a score of 1-3. However the actual methodology used is that the components are rated on a scale of 1-5 which is then *averaged* to give a Seriousness score between 1 and 5.

In the same way the Manageability methodology used is the same as that for the SMG model with Current Effort being subtracted from Difficulty of Management. This rating system allows a score between -8 and +8, not a score of between 1 and 3.

Although the analysis considered Seriousness, Manageability, Urgency and Growth, the methodology bore more resemblance to the SMG methodology than to the SMUG methodology described in the Director's Guideline.

5.15. Canterbury CDEM Group

5.15.1. Stated Purpose of risk analysis

The specific purpose of the risk analysis undertaken by the CDEM Group is not stated in the Plan, but documentation from the analysis workshops indicates that the focus of the risk analysis was not on prioritising the hazards, but on identifying the strategic issues to be addressed in the Group Plan, and the consequences arising from the hazards and how these are to be addressed in operational planning.

5.15.2. Process of risk analysis

Three separate hazard analysis workshops were held in different parts of the Canterbury Region. These workshops were attended by CDEM personnel, planners, engineers, community development officers and emergency services. Neighbouring CDEM Groups also participated in the workshops.

The workshops developed a summary hazard register which identified the relevant hazards, and described their context, critical factors, consequences and a Maximum Credible Event scenario. Information about hazards was sourced from existing CDEM plans, maximum credible event scenarios, recent and historical events, general knowledge and experience of workshop participants, and hazard research reports. Thirty-six hazards were identified and documented during this process.

A further regional workshop was attended by CDEM personnel, Ministry of Agriculture and Forestry, Police, Fire, District Health Boards and Ambulance. This workshop applied an AS/NZS 4360 matrix risk analysis process to roughly sort hazards (this does not appear in the Group Plan) and then a more detailed SMG analysis process as developed and promoted by MCDEM personnel.

The SMG process was used because the Group determined that the likelihood of most hazards considered was poorly understood, and that the inclusion of likelihood estimates as in the 'immature' AS/NZS 4360 matrix model tended to give much less serious but relatively common hazards too much priority.

However, the main focus of this workshop, and a subsequent CEG workshop, was the management of the consequences of all hazards across the 4R's, and the identification of strategic issues to be addressed through

the Group Plan. This is reflected in the Plan documentation, as the specific methodology used for the risk analysis is not referred to or described in the Plan.

5.15.3. End uses of risk analysis

The final output of the analysis process was a prioritised list of the hazards divided into three groups called higher, medium and lower priority hazards. The distinction as to where the cut off point for each of the groups was arbitrary, but the Plan states that the high Priority hazards represent a good cross-section of hazards and consequences for the CDEM Group to focus it's initial reduction, readiness, response and recovery planning on.

A summary of ten of the top twelve hazards are included in the body of the Plan. A full listing of the summary hazard register is included as an appendix to the Plan.

5.15.4. Risk evaluation criteria

No risk evaluation criteria are defined in the Canterbury CDEM Group Plan.

5.15.5. Objectives, Targets and Actions

The risk analysis process was focused on identifying strategic issues to be addressed in the Plan. These strategic issues were turned into goals (sometimes also called Objectives in the Group Plan) for the CDEM Group. These goals support the overall mission and objectives described in the Plan.

The six goals arising from the hazards analysis process were to:

- better understand the consequences of all of the hazards we face;
- focus on human consequences (direct and indirect);
- enhance community resilience/capacity;

- further develop response agency partnerships ;
- enhance collective disaster response and recovery capabilities;
- support and further develop existing hazard reduction measures.

These goals are each described in detail in the Plan and referred back to in the specific elements of the work programme. In addition the Plan describes how the hazard analysis process will be further developed to identify:

- Potential enhancements to existing regulatory hazard reduction measures– rules in RMA plans, etc; (Reduction project Red04/01)
- Community-based reduction measures – public education programmes in relation to specific hazards; (Reduction project Red04/02)
- A more thorough appreciation for the CDEM Response functions and dependencies that are identified through the more in-depth analysis of the consequences of all or specific hazards. (Response project Res04/05)

The prioritised list of hazards is not referred to in the goals/objectives or the work programme items. This reflects the strong emphasis placed on the all hazards methodology when carrying out the risk analysis process, and the lesser importance placed on implementing specific risk treatments for individual hazards. It is interesting to note, however, that two hazard-specific projects are identified, without these hazards being specifically identified as priority hazards (meteorological hazards and fuel supply hazards).

In addition to the formation of projects in the work programme, another output of the analysis process was identification of the consequences of the individual hazards as the basis for planning in the operational part of the Plan.

The individual hazards were reviewed in terms of their corresponding:

- Consequences
- Processes
- Agencies
- Resources
- Dependencies
- Mandate(s)
- Arrangements
- Agreements

A specific project is mentioned in the Plan to further research the consequences of hazards in order to develop a greater understanding of the likely impacts of emergency events on the communities and environment of Canterbury.

5.15.6. Qualitative issues

Detailed risk descriptors were developed specifically for the Canterbury Region. For example, Figure 26 illustrates the risk descriptors used for the Human element of Seriousness rating.

Figure 26: Canterbury CDEM Group Human component of Seriousness descriptors

Level	Description
1	No deaths; 0 – 2,500 affected 0.5% of affected community injured / displaced
2	No deaths; <5,000 affected 0.5 - 1% of affected community injured / displaced
3	0-50 deaths; <12,500 affected 1 - 2.5% of affected community injured / displaced
4	0-100 deaths; < 25,000 affected 2.5 - 5% of affected community injured / displaced
5	0->100 deaths; >25,000 affected >5% of affected community injured / displaced

In the same way the economic impact was assessed using figures based on the Canterbury regional GDP as illustrated in Figure 27.

Figure 27. Canterbury CDEM Group Economic component of Seriousness descriptors

Level	Description
1	Costs less than .5% regional GDP (<$72,500,000)
2	Costs between .5% and 2% regional GDP (<$290,000,000)
3	Costs between 2% and 5% regional GDP (<$725,000,000)
4	Costs between 5% and 10% regional GDP (<$1,450,000,000)
5	Costs greater than 10% regional GDP (>$1,450,000,000)

These descriptors allowed a consistency of rating across the variety of hazards being assessed.

5.15.7. Quantitative issues

As with other SMG analyses the three components S, M and G were rated on different scales. The methodology used for the analysis is not contained in the Group Plan. Each element of manageability is scored separately and summed, thus giving the manageability components of the rating greater weighting than other elements.

5.16. Otago CDEM Group

5.16.1. Stated Purpose of risk analysis

The stated purpose of the Otago risk analysis process was to identify the potential hazards which may affect the Group and the likelihood and consequences of their occurrence.

This was to be achieved by:

- Identifying and assessing relevant hazards based on a comprehensive listing
- Determining the appropriate level of responsibility and delivery for the management of the relevant classes of hazards
- Ensuring that each relevant hazard and risk is being addressed in the existing processes of a Group member or an associated agency in a co-ordinated manner.

5.16.2. Process of risk analysis

Potential hazards were identified by Group members and representatives of other agencies with a role in managing or responding to an event. Forty-one hazards were identified. A workshop was held at which the agencies responsible for management of each hazard across each phase of the 4R's were identified.

Maximum credible event scenarios were developed and an AS/NZS 4360 matrix analysis was carried out using the basic descriptors contained in the Director's Guideline.

A hazard analysis table containing this information was developed, and workshops were held in each local authority area to identify issues, gaps and vulnerabilities in the Group's planning and preparedness for emergencies. Two hazards (one natural and one non-natural) were

selected for discussion at these workshops to assist identification of strategic issues.

5.16.3. End uses of risk analysis

The final output of the analysis process was a list of 42 hazards categorised by their 'risk level' of extreme, high, moderate or low as per the AS/NZS 4360 matrix analysis.

5.16.4. Risk evaluation criteria

Four risk evaluation criteria were used by the Group to determine which hazards were relevant to them. The criteria were that:

- The hazard met the definition of emergency in the CDEM Act 2002
- There was a credible role for the Group or its members in mitigation, preparation, response or recovery in relation to the hazard
- The scale of the impact was not likely to go beyond the scope of the Group or its members to manage (i.e. was not a national event). (It is recognised the Group would still have responsibility for its area in such an event)
- The timeframe of the hazard event would require urgent co-ordination or response.

There is no evidence that these risk evaluation criteria were used to assess the output of the AS/NZS 4360 matrix analysis process.

5.16.5. Objectives, Targets and Actions

General "Group Actions" are stated for each of the hazards. These are general statements about the importance of preparing or planning for specific characteristics of the hazard. It is not clear if these Group Actions will become part of the Group's work programme, or be audited to ensure compliance.

One objective relating to hazard information was developed. This objective required progressive improvement of the hazard and risk information of the Group with a particular emphasis on consequences. The Targets and Actions relating to this objective were developed to be implemented by the Group and Local Authorities during the period of the Plan.

The Objectives, Targets and Actions do differentiate between the hazards listed as higher or lower risks in the Plan. No specific objectives were developed for higher risk hazards.

5.16.6. Qualitative issues

Hazards and risks are not described in the CDEM Group Plan, other than a few words describing the Maximum Credible Event for each hazard, and some general statements describing the whole of the CDEM Group area. It is therefore not clear what level of detail was developed to describe each hazard, and whether a common understanding of each hazard was achieved by all members when carrying out the AS/NZS 4360 matrix analysis process. Many CDEM Groups reported that the process of developing detailed summaries of the characteristics of each hazard (such as in a SMUG or SMG analysis) was very beneficial to gain a greater understanding of the hazard and its consequences.

As no further detailed analysis is carried out beyond an AS/NZS 4360 matrix analysis, some of the hazards rated as extreme are probably overstated. For example Road/Rail Accident is in the extreme risk category, but the description of the hazard states that the scale of event is unlikely to reach Group proportions. As the involvement of the Group was one of the risk evaluation criteria established by the Otago CDEM Group, there should have been an additional process undertaken to review the ratings in light of the risk evaluation criteria, and adjustment or more detailed analysis carried out as appropriate.

5.17. Southland CDEM Group

5.17.1. Stated purpose of risk analysis

The Southland CDEM Group states that the risk analysis process was undertaken to rank the hazards according to their associated risk. The Plan also states the hazards that will, and will not be managed by the CDEM Group.

5.17.2. Process of risk analysis

Thirty two hazards were identified of relevance to the Southland region. These were considered to collectively constitute the greatest risk to the Southland community, but were not portrayed as a complete list.

For each hazard the management mechanisms and agencies responsible for management across the 4R's were documented.

These hazards were considered from a regional perspective and an AS/NZS 4360 matrix analysis carried out. Separate AS/NZS 4360 matrix analyses were carried out by a group of Civil Defence Officers, and a wider group including other agencies with a role in emergency management. In addition, 17 of the higher risk hazards underwent a SMUG analysis process using the methodology described in the Director's Guideline.

The AS/NZS 4360 matrix analysis and the SMUG analysis results were brought together into four categories of risk: High, Moderate, Intermediate and Low.

5.17.3. End uses of risk analysis

The final output of the analysis process was a list of 32 hazards categorised into groupings of High, Moderate, Intermediate and Low risks.

Considerable care is taken in the Plan documentation and risks analysis process to emphasise that these rankings are not absolute or perfect, but do help to provide a focus for reduction, readiness, response and recovery activities. A poignant comment is made by the Plan drafter that no matter what the risk analysis process determines, the community still have an expectation that the emergency services and Civil Defence Emergency Management agencies will respond to anything.

5.17.4. Risk Evaluation Criteria

The Plan states five risk evaluation criteria, each with an explanation of what they mean. The risk evaluation criteria listed are:

- This Plan does not attempt to list/enumerate all existing readiness, reduction, response and recovery arrangements
- This Plan only pursues matters under the CDEM Act where no other more specific legislation exists to address the matter
- Residual Risk
- This Plan is an evolutionary step not a revolutionary step
- Some risk is acceptable.

These risk evaluation criteria are most useful to determine whether to include or exclude hazards from consideration. They are very general criteria and are not useful to distinguish which risks are acceptable or unacceptable, or whether risk treatment should be carried out. Because of their general nature, the risk evaluation criteria are not directly used to determine risk treatment priorities.

5.17.5. Objectives, Targets and Actions

General responsibilities of the Southland CDEM Group for all hazards are incorporated into the Plan. In addition, specific responsibilities relating to natural and technological hazards are also incorporated.

Objectives, Targets and Actions are listed in the Plan relating to issues identified during Plan consultation processes. These issues did not arise from the risk analysis process, or reflect the different levels of risk identified during the risk analysis process. Two hazard-specific Actions were developed relating to developing a greater understanding of pandemics and hazardous chemical risks. These hazards are both listed as moderate risks in the risk analysis process, and there is no indication as to why these hazards were singled out for particular attention.

5.17.6. Qualitative issues

No hazard descriptions or maximum likely scenarios were developed during the risk analysis process. Within the Plan a single page of text describes the hazardscape of the region, and this text focuses only on some of the hazards listed in the risk identification process.

It is possible that agencies therefore had a different understanding of the hazards that were being rated. Considerable effort was put into describing the existing management mechanisms, but little was spent describing the characteristics and consequences of the hazards. No specific descriptors were developed or referenced for the SMUG analysis process, but basic descriptors were used for the AS/NZS 4360 matrix analysis.

The Plan states that there were significant differences of opinion on the rankings that should be assigned to some hazards, in particular meteorite impact, pandemic, and terrorism. This difference of opinion was seen in the variation of ratings between the Civil Defence Officer's ratings and the wider group or response agencies. It was suggested that the reason for this was that the likelihood of these events was highly uncertain and therefore so were the consequences. In addition, differences of opinion existed over the rankings to be assigned to marine incidents (environmental), tsunami and volcanic hazard. In these cases the likelihood of these events is better

known, so it was considered that lack of education or knowledge of the hazard by all agencies may have been the reason for the differences in ratings.

5.17.7. Quantitative issues

The final categories of High, Moderate, Intermediate and Low risks were not determined using any formal process. The listing was a result of combining two separate AS/NZS 4360 matrix analyses and a SMUG analysis on some of the listed hazards. Therefore variations in the results of these three ranking processes were not reconciled in any systematic manner, but rather judgement was used to determine which rankings were the most appropriate.

5.18. Chatham Islands CDEM Group

5.18.1. Stated purpose of risk analysis

The Chatham Islands CDEM Group Plan states that the risk analysis process was carried out to identify options to mitigate the effects of hazards identified that would impact on the islands.

5.18.2. Process of risk analysis

A Hazard Liaison Group was formed to carry out the risk analysis. The Hazard Liaison Group was made up of the Mayor and a Councillor of the Chatham Islands Council, and a representative from the Department of Conservation.

Twenty hazards relevant for the Chatham Islands were identified. Hazard summary sheets were prepared for each hazard following review of hazard reports and discussions with technical experts. Hazard summary sheets

contained information about each hazard, potential effects and likelihood, as well as existing management mechanisms.

A SMUG risk analysis process was used, similar to that implemented by Auckland CDEMG. However, adaptations were made to the scoring system as shown in Figure 28.

Figure 28: Chatham Islands numeric scoring system

Component	Score		
Seriousness	High = 4-5	Medium = 2-3	Low =0-1
Manageability	High = 7+	Medium =5-7	Low = 0-4
Urgency	High = 20yr >	Medium = 20<	Low = 100yrs
Growth	High =3	Medium =2	Low = 1

5.18.3. End uses of risk analysis

Two different tables of results of risk analysis are found in the Plan. It is not clear which are the final results as nowhere in the plan is a summarised list of the findings of the risk analysis displayed The two different analysis show some similar and some disparate results.

As there are no results of the risk analysis specifically listed, there are no statements in the plan about whether there will be differential treatment of those hazards that rank highest in the risk analysis.

5.18.4. Risk Evaluation Criteria

No risk evaluation criteria are specifically listed, and there is no evidence of risk analysis results being compared to any such criteria.

5.18.5. Objectives, Targets and Actions

Objectives, Targets and Actions are incorporated into the Chatham Islands CDEM Group Plan. These are based on key issues rather than the outcomes of the risk analysis process.

Two relevant Objectives are listed, each with specific targets and actions.

- **"Objective 2:** Sustainable communities planned according to a long-term strategy that is consistent with known hazards and vulnerabilities.
- **Objective 4:** Risk management is used as a key tool to ensure that social, economic and environmental issues are incorporated into planning processes where human activities interact with natural and technological hazards".

Specific Objectives, Targets and Actions are listed for seven hazards. These hazards are not those that ranked highest in either of the risk analysis results included in the Plan, and some hazards that ranked highly are not covered.

5.18.6. Qualitative issues

The methodology undertaken for rating Seriousness differs from the stated methodology in the Plan, as the average of the scores was taken, whereas the methodology states that scores will be allocated based on whether they are in the top, middle or bottom third of the resulting scores. Limitations to the Seriousness rating were noted in the Plan as no ratings were allocated for Human or Economic components as the Hazard Liaison Group had not assessed those components.

The methodology undertaken for Manageability is also different from the stated methodology in the plan. The methodology stated that an "actual minus ideal" score will be used, whereas a "difficulty minus effort" rating was

in fact undertaken. These errors may have simply come from copying methodology from other Group plans.

5.18.7. Quantitative issues

The two sets of risk analysis results had different possible ranking scales. One of the scales had the possible scores of 1-3 for each of Seriousness, Urgency and Growth, and a score of 0-12 for Manageability. The other scale had possible scores of 1-5 for Seriousness, -8 to +8 for Manageability, and 1-3 for Urgency and Growth.

As there is considerable uncertainty associated with the methodology that was intended to be used by the Chatham Islands Council the validity of the results are in question. However, the results themselves were not put to any consequential use in the Plan development process so the effects of this uncertainly are likely to have been minimal.

6. Discussion

The examination of the risk analysis process undertaken by the CDEM Groups in New Zealand identified some key themes and issues which warrant further discussion and analysis. These themes are addressed below under the following categories:

- Process of risk analysis
- Purpose of risk analysis
- Factors to be considered in risk analysis
- Resilience and vulnerability
- Risk evaluation criteria
- Acceptability of risk
- Effective risk treatment
- Risk analysis and the consequence based approach
- Quantitative risk analysis tools and CDEM planning
- National picture of risk
- Alignment of the Risk Management framework and CDEM planning

6.1. Process of risk analysis

The overwhelming feedback received from CDEM Groups about the value of the risk analysis process was that it allowed interaction and relationship building between a wide range of organisations, each with a role in CDEM. Those CDEM Groups who included a range of agencies in their risk identification and analysis processes reported significant increases in understanding of risk by all agencies, including CDEM, as a wider range of perspectives and hazard consequences were identified.

It is not possible to ever know everything there is to know about the risks that face a region, but it is important that future CDEM Group risk analysis processes continue to involve as many agencies as possible. The process does, however, become more difficult to manage as more agencies are represented. For example, some groups ran a large number of workshops focussed on particular emergency sectors, or on components of the risk analysis process. At times this meant that timeframes for the risk analysis process were long, and the administrative arrangements were complex in order to ensure every agency had the opportunity to participate. However, despite these potential difficulties, the engagement of a wide range of agencies was reported by many Groups as the major positive outcome of the risk analysis process.

For some CDEM Groups the process of engaging agencies in the risk analysis process did not appear to consider how these organisations could be integrated into emergency management for the long term, but rather on one-off interactions. This is reflected in the fact that many of the actions listed in the Group Plans are only for local authorities, whereas actions for many other agencies could have been developed in partnership with those agencies to ensure their continued participation in CDEM activities.

In addition, the involvement of community based organisations representing public interests should also be considered. It is possible that the perspective of organisations providing voluntary services to the community in an emergency (such as religious groups, welfare agencies, community groups, boards and clubs) may have a very different perspective of hazard consequences and priority issues, than CDEM professionals do. Even if the understanding of the risks is not high within the general public, it is important to understand their perspective as that is the context in which emergency management activities are carried out. Without that understanding it may be that CDEM organisations are inadvertently addressing issues or needs that

are not perceived as important by the community. In addition, community involvement in processes such as this is likely to increase community risk understanding and acceptance as well as develop a sense of trust in emergency management agencies.

6.2. Purpose of risk analysis

It was clear from study of the CDEM Group risk analysis processes that many of the Groups did not have an understanding of the purpose for which they were carrying out risk analysis. It appears that for many Groups, risk analysis was driven simply by the fact that it was recommended in the Director's Guideline. Many groups did not state why they were carrying out risk analysis, and most of the Groups did not use the direct outcomes of the risk analysis to develop risk treatment options.

Among those groups who did define the purpose of their risk analysis there was also a very wide range of motivations. The range of purposes described by Groups can be summarised as:

- to further describe and understand the risks arising from hazards in their area
- to identify the highest risk hazards
- to determine which hazards would be managed by the CDEM Group (a requirement of the CDEM Act 2002)
- To determine which hazards faced by the CDEM Group are deemed 'significant'
- to determine priorities for future work or risk treatment
- to identify strategic issues facing the area
- to identify gaps in information
- to develop a common understanding of hazards and their consequences among all agencies with a role in emergencies

The Director's Guideline explains the purpose of risk analysis as to prioritise risks in order to achieve realistic levels of control and treatment, as not all risk must be addressed immediately. It also states that by explicitly prioritising which hazards and risks that need to be addressed the community can provide feedback (through the consultation process) on whether the remaining risks are acceptable or whether the CDEM Group should invest more of their resources into addressing these.

The different motivations expressed by CDEM Groups and the Director's Guideline may be reflecting different stages of development within CDEM Group areas. The different purposes have varying degrees of validity, and it is clear that no one approach is 'wrong'.

For example, those Groups who have spent considerable time and effort on hazard research and analysis may be in a position where they wish to focus on risk treatments and priorities, whereas those Groups who do not have adequate hazard information may wish to focus on developing their understanding of the hazards and risks they face.

In the same way, those Groups who were formed as pilot projects, or worked closely together before Group formation may have already achieved a common level of understanding of all agencies involved in emergency management.

It therefore may be appropriate for Groups to have different reasons for carrying out the risk analysis process. As these Plans were the first each Group had developed it may be that in subsequent Plans the groups may determine a different need from the risk analysis process. For the first round of Plans a focus on filling gaps and problems and developing understanding may be sufficient, whereas for subsequent Plans approaches may include increasing Group's confidence that they have identified the highest risk

hazards, and then subsequently a more targeted focus on addressing the specific higher risk hazards.

Most of the CDEM Groups indicated that the output of the risk analysis process (generally a ranked, grouped or prioritised list of risks) would be used as the basis for determining the hazards that would be addressed by the Group Plan. However in reality, many Groups carried out the risk analysis process, and then implemented Objectives, Targets and Actions based on the issues facing the region, or for all hazards the region faces, rather than referring to the analysis' results. This diminishes the value of the risk analysis process, as the same outcome could have been achieved simply by describing the hazards and their consequences and brainstorming on the key issues. The process of ranking and scoring individual hazards did not, in many cases, add value to the overall risk management process.

When developing future CDEM Group Plans it would be beneficial for Groups to identify the purpose for which they want to analyse their risks, and then select an evaluation method that is appropriate for that purpose. In this way those Groups who wish to carry out prioritisation can choose a ranking based system, whereas those Groups who simply wish to understand the range of hazards they face could select a descriptive methodology.

Future versions of the Director's Guideline would be most helpful if they were to describe a range of possible purposes and analysis methodologies for Groups to choose from, depending on what they wish to achieve with each Plan revision.

6.3. Factors to be considered in risk analysis

The original SMUG methodology recommended to CDEM Groups identified four key components for analysis: Seriousness, Manageability, Urgency and Growth. These components were to provide a more detailed analysis than a simple AS/NZS 4360 likelihood and consequence matrix. In general terms Seriousness was taken to be a more detailed analysis of consequence, Manageability a more detailed analysis of some aspects of likelihood (e.g. if risk can be reduced this decreases the likelihood of occurrence), as well as consequence (e.g. effective readiness, response or recovery activities may reduce the consequences of the event when it occurs), Urgency as more detailed analysis of likelihood, and Growth having a focus on both likelihood (e.g. if the risk is likely to occur more often in the future) and consequence (e.g. if the impacts are likely to be worse in the future).

6.3.1. Seriousness

The Seriousness component of the risk analysis process is a significant enhancement on the AS/NZS 4360 matrix analysis descriptors of consequence. It allows CDEM Groups to understand particular characteristics of consequences in more detail. For most CDEM Groups the identification of Human, Economic, Social, Infrastructure and Geographic consequences of hazards broadened their understanding of the range of impacts that could be expected, and would need to be managed during an emergency. There was also no limitation on Groups adding in additional categories of Seriousness if they so desired. No Groups chose to do this, but factors such as political and international impacts were discussed by some groups in their hazard summaries, as they did not neatly fit within the other categories.

The weighting process and comparison to risk evaluation criteria allow for Groups to differentiate between any consequences they see as more significant or higher priority than others.

6.3.2. Manageability

The introduction of the Manageability component of the SMUG risk analysis tool is effective because it provides a mechanism for determining the existing controls in place to manage some of the hazard consequences. The methodology introduced by Auckland to rate the actual amount of effort undertaken to manage the risk compared with the ideal amount of effort was particularly effective as it quantified the level of controls in place, although it did assume that the measures in place are all effective in achieving what they set out to do.

In order to take this factor into account other Groups also considered the difficulty of implementing management mechanisms to address a risk (as opposed to the amount of management). Assessment of difficulty of management allows the Groups to see where current effort may not be as effective as they expected, but does not address why, or how this management difficulty could be remedied.

The methodology that determined manageability by subtracting management effort from difficulty is not a positive enhancement to risk analysis models, as it introduces a wider range of possible scores than other components of the model (hence effectively a greater weighting) and also may not be a meaningful measure of manageability because difficulty and effort are not the same units of measure. The intent behind the assessment of the gap required to be bridged to address manageability is, however, commendable, but could be achieved through the Auckland/Gisborne methodology, or the matrix approach suggested in the original methodology.

The assessment of manageability across each of the four phases of emergency management (reduction, readiness, response and recovery) is a useful enhancement as it added to the Groups' understanding of where and how they might put more effort into managing risks. When carrying out risk treatment the same phases should also be considered in order to place more effort in areas where it is difficult for existing controls to address the risk.

Introducing individual ratings for the four phases of emergency management did increase the complexity of the arithmetic required. Those who used this to best effect were Groups who averaged the ratings of the four components (e.g. Auckland) or who had a process in place to translate the ratings into the matrix approach recommended in the guideline (e.g. Waikato). Those Groups who summed the individual ratings of the four phases (those who used an unaltered SMG methodology) inadvertently introduced a greater weighting to the manageability factor.

Due to the complexity of manageability ratings across the 4 R's it may be that this component of the analysis is more useful as a descriptive tool rather than as a numerical rating tool. In future Group Plans it may be appropriate to simply describe the management mechanisms and gaps across each of the 4R's rather than have these incorporated as a numerical component of a risk analysis tool.

6.3.3. Urgency

The removal of the Urgency rating by some groups in response to the SMG methodology promoted by MCDEM personnel mid-way through the Plan development timeframe indicated a particular focus on the consequence aspects of risk rather than the likelihood aspects. This same focus on consequences could also be seen in the majority of risk evaluation criteria developed by Groups. The reasons for this focus may have been a

deliberate decision to follow the consequence-based approach recommended by the Director's Guideline, but was most likely due to limitations of available information on likelihood.

Whatever the reason, the focus on consequences is likely to reflect the community expectation (and legislative mandate) that CDEM Groups have particular responsibility for those hazards with high consequences but low likelihood.

However, risk is made up of both consequence and likelihood. Therefore when attempting to fully understand the risk posed by hazards, it is not sufficient to describe only the consequences of the hazard as this does not give an accurate picture of the *risk* posed by those hazards. If a particular focus on consequence is desired this should be introduced in the risk evaluation stage of risk management rather than during the analysis stage.

6.3.4. Growth

The incorporation of the Growth component of the analysis was effective as it encourages Groups to focus on future risk development, not just on the current status of risks. Given that risk treatments included in CDEM Group Plans were to be implemented over a five year period, and that many of the risks faced by the Groups are likely to grow over time, this forward focus was an appropriate enhancement.

6.4. Resilience and vulnerability

Most CDEM Groups state that community resilience is their vision, mission or goal. The concept of resilience is variously defined by Groups including the following examples:

> Community resilience is the capacity of people, communities and organisations to draw upon their resources and competencies to manage and learn from the demands, challenges and changes encountered during emergencies. Resilience describes a capability for "bouncing back", adapting or being able to sustain prior functions and activities as much as possible during extraordinary events. (Auckland)

> Resilience describes a capability for "bouncing back", adapting, or being able to sustain (normal) activity following exposure to adverse events. A resilient Waikato Region is therefore one in which social and economic activity will return within the shortest possible time following an emergency. (Waikato)

> Resilient communities are ready for emergencies and have the knowledge, skills and resources to respond to and recover from an emergency event. (Wellington)

> A resilient community:
>
> - is well informed about the hazards they face and their consequences,
> - is committed to managing risks sustainably,
> - takes steps to be prepared for emergencies,
> - is prepared to manage and learn from the demands, challenges and changes encountered during emergencies,

- can sustain prior functions and activities as much as possible during an emergency,
- integrates CDEM planning with everyday decision making. (Nelson)

A resilient Canterbury will exist when communities are environmentally, socially and physically resilient to the impact of emergency events. (Canterbury)

If the risk analysis process carried out in Group Plans is to enable risk treatment options to be developed which contribute to the overall vision of the CDEM Group, then the risk analysis process must gather sufficient information about the existing level of resilience of the communities to the risks being considered. The risk analysis techniques used by CDEM Groups during Plan development did not explicitly consider community resilience. However, in all of the Group definitions resilience is described as an ability or a quality that a community or individuals possess. The characteristics and contributors to resilience should therefore be identifiable.

However, little evidence was found of CDEM Groups identifying the characteristics of resilience that can be assessed in order to measure progress towards their goal. An exception is the Auckland CDEM Group who identified this as a project that needed to be carried out and are in the process of developing such indicators for resilience in their region. Without these indicators there is a risk that CDEM Groups will simply use the progress on implementing their risk treatment mechanisms as their contributors to resilience, without any concern as to whether those activities are actually contributing to resilience as defined in their own definitions.

In addition, CDEM Groups may consider risk and vulnerability as a continuum and make the mistake of assuming that reducing vulnerability will

increase resilience. This is incorrect, and vulnerability and resilience factors co-exist and need to be managed as such (Paton & Johnston, 2006)

Groups considered various community characteristics during their risk analysis as part of determining the level of consequences that would be experienced (Seriousness rating) and also in the Growth of each hazard (as an increase in hazard impacts is one component of that analysis). Some described community characteristics (such as population, age, ethnicity) and also interpreted the significance of those characteristics for CDEM. It would therefore be useful for CDEM Groups to extend this analysis to include characteristics that contribute to resilience. These may be things such as shared community values, established social infrastructure, positive social and economic trends, partnerships and networks, communities of interest, and resources and skills (Buckle 2000).

If the characteristics that contribute to community resilience could be identified and described, this would enable Groups to develop risk treatments that enhance those contributors to community resilience.

In addition to community resilience, community vulnerability should also be analysed, as a greater understanding of community vulnerability would also allow development of risk treatments that reduce factors that contribute to vulnerability.

Vulnerability is the degree of susceptibility of the community to hazards, and can include elements such as setting, shelter, sustenance, security and society (Granger 1999). Social indicators of vulnerability may be groups such as the very old, very young, disabled, single-parent households, one-person households, newcomers to the community, migrants, people lacking communication and language skills, and low income earners (King & MacGregor 2000). Many of these cannot be managed as such (e.g. age,

income level) but it may be helpful to identifying potential management issues during an emergency when groups of people with these characteristics are present (Paton et al 1999, Paton, 2000). The information collected in the census would be one tool to gather this data. In addition to social aspects of vulnerability however, the exposure to damage of services, infrastructure, and economic activity must also be considered.

It is important to be clear that vulnerability is not necessarily the converse of resilience. While all people may be exposed to risk and therefore be vulnerable, some may possess qualities that reduce vulnerability. For example low income earners may be classed as vulnerable, and high income earners as more resilient, but when looking at the occupations of these earners, low income earners who are employed in occupations such as the trades may be more resilient than high income workers in less 'practical' occupations.

Both resilience and vulnerability should therefore be analysed separately. This does not necessarily require a quantitative or semi-quantitative ratings system, but may simply be a descriptive process against the pre-identified components of resilience or vulnerability.

When assessing community resilience or vulnerability it is important to involve the community. This is because where CDEM professionals may focus on topics, issues and risks, local people will be aware of demographic changes, changes to the environment and business practices, and critical issues relating to safety and risk (Buckle 2002).

Risk treatments should also consider mechanisms directly aimed at increasing resilience or reducing vulnerability. These treatments may include activities such as identifying specific groups at risk and their needs, information provision, resources, increasing community management

capabilities, support, identifying special services and infrastructure required, and providing for community involvement in CDEM.

6.5. Risk evaluation criteria

A central tenet of the risk management approach is the development of risk evaluation criteria. These risk evaluation criteria provide a mechanism to determine whether or not a risk should be treated, and may be used to determine priority of risk treatment between risks that have been analysed as having a similar level of overall risk.

Risk evaluation criteria are also described as real world constraints imposed on the theoretical risk evaluation process (MCDEM 2002). Criteria may reflect the operational, technical, financial, legal, social, humanitarian, or other values of the CDEM Group.

Risk evaluation criteria are the opportunity for the CDEM Group to determine what characteristics of a particular risk are important to them and the conditions under which a risk would not be acceptable and immediate risk treatment would be required.

Risk evaluation criteria are intended to be used following the risk analysis process to set risk priorities. Therefore in the context of CDEM Group Plans following the initial AS/NZS 4360 matrix screening and subsequent more detailed risk analysis (such as SMUG or SMG), risks should have been compared to risk evaluation criteria set by the Groups. However, there is little evidence of a systematic process of comparison against risk evaluation criteria being undertaken by any CDEM Group in New Zealand. The majority of Groups did not develop risk evaluation criteria in the first place, and those who did, did not undertake a process of comparing the rated risks against the evaluation criteria. In most cases Groups who had developed

criteria simply stated that these were taken into account when carrying out the risk analysis process rather than demonstrating a systematic process of comparison to their risk evaluation criteria.

A small number of CDEM Groups did take their risk evaluation criteria into account by weighting the components of the risk analysis in line with the risk evaluation criteria. However, it was not clear in any of these cases whether this had been an intentional weighting, or whether the amount of the weighting was appropriate, given the criteria that had been established.

A likely reason for the lack of uptake of risk evaluation criteria is that the difference between the risk analysis process and the risk evaluation process was not clearly spelt out in the Director's Guideline. In particular, the SMUG analysis process was included in the Guideline under the "Risk Evaluation" section, whereas it would fit more appropriately as a detailed risk analysis process.

Another possible reason why risk evaluation criteria were either not developed or not referred to may have been that CDEM Groups believed that the descriptors used when carrying out risk analysis (e.g. their scales for a particular Seriousness rating) were actually their risk evaluation criteria.

The lack of risk evaluation criteria by CDEM groups indicates a greater level of understanding is need by Groups on the difference between risk analysis and risk evaluation. The Risk Management Standard (AS/NZS 4360) makes it clear that risk analysis is the process of determining the level of risk posed by a hazard by determining the likelihood and consequences of the risk. The process of risk evaluation is the subsequent step whereby risk management priorities are determined by comparing the level of risk against pre-determined standards or criteria.

It is interesting to consider why Groups had difficulty developing risk evaluation criteria. One possible reason may be that Groups struggled to put standards or criteria against potential hazard consequences. For example, Groups who did develop criteria most often used general statements such as "those hazards which have the potential to seriously affect people and property are the highest priority". It may have been difficult for these groups to be more specific and develop criteria such as "Hazards with the potential to cause over 50 deaths or 200 hospital admissions are the highest priority", as firstly the Group may not have had information to be able to determine which hazards would meet this criteria, and secondly the criteria may give the impression that a smaller number of deaths or hospital admissions was an acceptable hazard, which was not a conclusion they would wish to convey. In any case, some Groups felt that the community expectation was that they would respond to all hazards, no matter what the scale, and therefore prioritisation against such criteria was not productive.

It may be that because the output of the SMUG analysis process was a numerical ranking, this gave the impression of assigning priority for risk treatment. However, priority should have been assigned after comparison with pre-determined risk evaluation criteria, not merely the descriptors of the various scales used in the analysis process. Had each Group implemented a weighting system based on their risk evaluation criteria, this may have achieved the same outcome as comparing against specific risk evaluation criteria.

In future CDEM Group planning processes, the use of risk evaluation criteria should be considered by all Groups. The process of developing these criteria will enable Groups to determine what their values are, which risks are priorities to be addressed, and whether there are some levels of risk, or

characteristics of hazards that are not under any circumstances acceptable to the Group.

6.6. Acceptability of risk

None of the CDEM Groups made an explicit statement in their Group Plans to accept a particular level of risk associated with one or many hazards. Many Groups did, however, state the converse; that their focus for addressing risks would be those that ranked more highly in the risk analysis process.

Risk acceptance was however, indicated in many Groups by their statements about which risks the Group would *not* manage. These included risks for which other lead agencies could be identified, which did not require CDEM input, or which were not of sufficient scope to require co-ordination across the Group area. This differentiation of which risks the CDEM Group would manage is important because it assists the identification of who 'owns' the risk. In the CDEM context this is a difficult question as multiple agencies are involved in management and each has their own mandate or community expectation to address the risks. By narrowing the range of risks to be considered CDEM Groups can focus on those risks for which they are responsible. These risks are inherently those with larger possible consequences, and therefore may not be possible to accept due to community expectations of CDEM Groups to respond to those risks.

Risk acceptance in a CDEM context may not be a viable option. This is because of the nature of the risks that CDEM agencies are responsible for. Inherently the focus of CDEM agencies is on the identification and avoidance of *unacceptable* risk, rather than the identification of acceptable risk. In the CDEM context this often results in generic risk treatments being put in place for multiple risks, and these monitored and reviewed.

6.7. Effective risk treatment

Most Groups used Objectives, Targets and Actions (or a variation on this nomenclature) to describe their risk treatment activities. However, Groups took differing approaches as to what was being addressed by the risk treatment activity. For example some Groups designed risk treatments to address a particular hazard consequence (e.g. by developing an operational plan), while others designed risk treatments to address strategic issues (e.g. by commencing research to address a gap in information).

A wide variety of risk treatments were developed by Groups to manage the risks identified through the analysis process. In many cases, however, risk treatment was not a systematic process. For example there is little evidence of a range of risk treatment options being identified for a particular risk, or of analysis of risk treatment options using techniques such as cost-benefit analysis.

This trend may have occurred as these are the first CDEM Group Plans to be developed, and this level of detail of risk treatment may not have been possible within the timeframes allowed, with the current levels of understanding of hazards and risks, or within the technical capabilities of all Groups.

In general terms, most risk treatment options that were developed by Groups focussed on reducing consequences or managing residual risk. A very small number focused on treatment options such as risk avoidance, reducing risk likelihood or risk transfer. No risk treatments were aimed at elimination of risk as the nature of the CDEM risks being addressed is such that risk elimination is not often a realistic goal. This is quite different from risks experienced in a corporate situation, for example, where risk elimination may be possible.

Many Groups did not develop specific risk treatments for risks identified as extreme. This was primarily evident in Groups who developed risk treatments based on strategic issues rather than individual sources of risk. Their focus on strategic issues did not allow opportunity for a more detailed risk treatment to be developed to address an individual risk characteristic or consequence. It is therefore possible that some risks determined to be extreme did not receive adequate consideration of the full range of risk treatment options available.

The identification of strategic issues is however, still a valuable process. These strategic issues often relate to more than one risk, and are therefore an efficient mechanism to enable a single risk treatment to address multiple risks. When using strategic issues as the basis for risk treatment, it therefore becomes important to have a parallel process in place to manage the potential for overlooking risk specific treatments required.

It is also important to ensure, when implementing risk treatments for strategic issues, that addressing the strategic issues will contribute to reduction of risk. For example, a common strategic issue was lack of information regarding hazards. If that issue was addressed through a treatment activity and more information gained, it is not clear how that will actually contribute to managing the risk. Risk treatments should specifically focus on reducing the level of risk posed. Monitoring of risk treatments should therefore focus on re-analysing the levels of risk following treatment (preferably using the same tools used to analyse risk in the first place), following treatment, and not just monitoring whether the treatment activity was carried out. This may be a challenge for CDEM Groups as most risk treatments are projects to address issues and it is not clear whether the treatments will actually contribute to reducing the levels of risk posed by the hazards considered.

If the risk analysis processes undertaken by Groups during their Plan development processes were to be repeated again in their next Plan revision, it is unclear whether the risk analysis tools are specific enough to be able to detect changes in levels of risk due to effective risk treatments. The main components of the analysis tools that would be likely to pick up these changes would be the manageability rating and the growth rating (particularly the component relating to growth of community vulnerability). However the components of the simple consequence and likelihood matrix (or even the Seriousness and Urgency ratings of SMUG) have such large ranges within their descriptors that risk treatments would need to have caused significant changes in order to change the overall risk rating allocated to the hazard scenario being considered.

6.8. Risk analysis and the consequence-based approach

The risk analysis and evaluation process described in the Director's Guideline made it difficult for Groups to practice the consequence-based approach to risk management that was promoted by MCDEM in the same guideline. The reasons for this are that the analysis processes all required separation of hazards from each other for analysis, and further development of specific hazard scenarios on which to base risk analysis.

If a consequence-based approach is desired the starting point for analysis should instead be the identification of those consequences that the Group wishes to manage. These consequences would need to be those that arise from the controlled or residual risk after risk treatments are in place.

If this had been undertaken in the current round of CDEM Group Plans the output of the risk analysis process would have been quite different. Rather than a list of hazards ordered in terms of level of risk (or priority for

treatment), the output would be a list of *consequences* ordered in terms of priority for risk treatment.

Instead of developing descriptors of possible consequences such as for the seriousness rating of SMUG, Groups would identify the level of consequence that they would not find acceptable, and prioritise risk treatments for those consequences. For example a Group may determine that no matter what the hazard, a consequence of 50 people being killed is not acceptable, or a consequence of loss of 5% GDP is not acceptable.

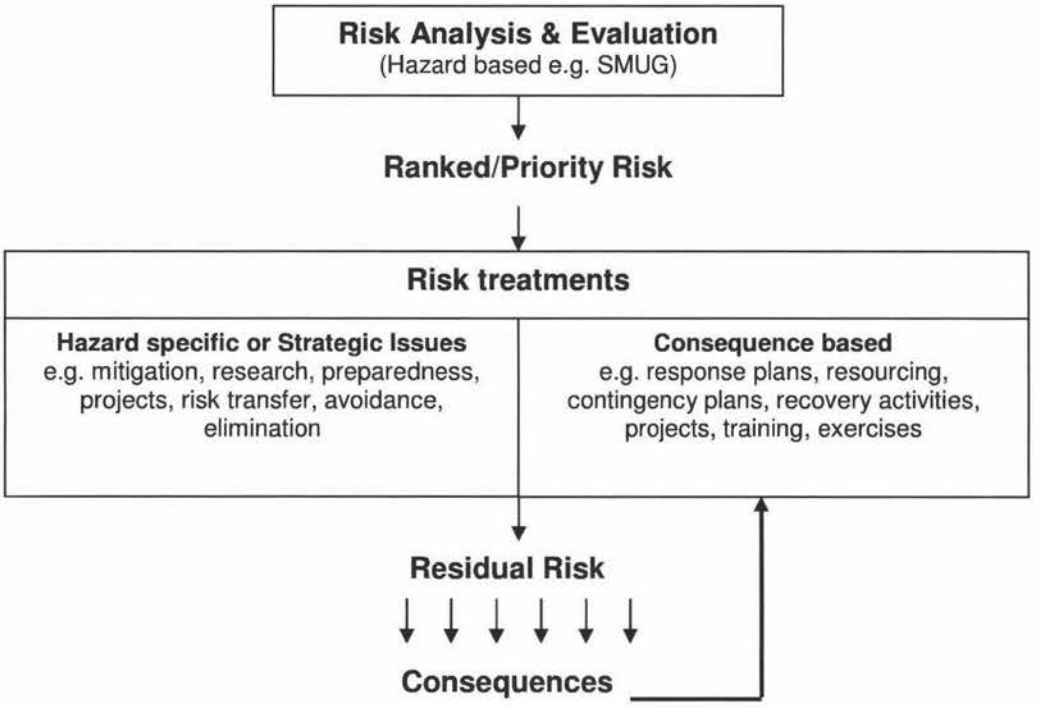
Groups would be able to look at the hazards facing their region and determine which have the potential to cause the particular consequences they are concerned about. But the focus would remain on addressing the consequence rather than addressing the particular hazard that could cause that consequence. Groups who have likelihood information could also use that information as subsequent risk evaluation criteria to distinguish between consequences which all rate highly.

Those Groups who developed detailed descriptors of different levels of seriousness (HESIG) during the analysis may already have the tools to identify the level of consequences they wish to manage. The Group may decide that the descriptors used of Major or Catastrophic scores on those components of the rating are the level of consequences they wish to manage.

Because the outcome of the SMUG analysis process was a listing of one hazard scenario above another, the focus on the consequences of those hazards was hidden. In future CDEM planning processes this emphasis needs to be amended if a consequence-based approach continues to be advocated by MCDEM.

It may be possible, however, to reconcile the hazard-based, and consequence-based approaches by acknowledging the benefits of each approach. Figure 28 illustrates how the two approaches could work together.

Figure 29. Reconciling hazard and consequence based risk treatments



When developing risk treatments, Groups should also be careful not to limit themselves to response or recovery treatments only. Avoidance, elimination, reduction, and transfer risk should also be considered.

6.9. Quantitative risk analysis tools in CDEM planning

The SMUG and SMG tools used by most CDEM Groups in developing their Group Plans are semi-quantitative tools. That is, they are essentially descriptive scales that have a score allocated to them, as opposed to a quantitative scale where the score itself has an inherent value.

Many CDEM Groups reported that they had difficulty assigning numerical scores to the risks they were analysing as the information on which they based the analysis was primarily qualitative, or descriptive. Therefore, even when risk descriptors were developed that allowed clear differentiation between scores that should be allocated, Groups were not able to accurately score the risks due to a lack of quantitative information. Many Groups acknowledged that in these cases professional judgement was used to allocate the most appropriate score.

The lack of quantitative data was the primary reason cited as to why the Urgency component was removed to create the SMG analysis tool. In particular many non-natural hazards did not have adequate information available on their likelihood.

The end results of the semi-quantitative risk analysis tools used was, in most cases, a listing of risks with an associated numerical score. However, some Groups chose to represent their risks in groupings of higher, moderate or lower risks instead of referring to the numerical score. This approach acknowledged the uncertainties contained in the numerical score, and reduced the significance of the numerical score.

However, the opposite approach was taken by some Groups who referred to the numerical scores, some even listing the scores to the nearest decimal point. This approach conveyed a value upon the numerical ratings that was

above the quantitative value inherent in the information upon which the scores were based. The use of the numerical scores in these cases implied a level of specificity that would not be reflected in the level of detailed information upon which component scores were assigned.

If semi-quantitative risk analysis tools are to be used in future CDEM Groups Plans the problems associated with their use should be considered. Future methodologies should ensure that if numerical scores are assigned to risks, they reflect the level of detail available to describe the risk, differentiate properly between risks, and adequately acknowledge the limitations of the process that was undertaken.

6.10. National picture of risk

The analysis of CDEM Group Plans showed a number of similarities in risk analysis processes, but also significant differences. These differences meant that risk analysis results cannot be meaningfully compared from one CDEM Group to another. While most offered some ranked, prioritised or grouped listing of hazards, these were each based on individually modified and tailored risk analysis processes. In addition, Groups around New Zealand had many different reasons for carrying out their analyses and therefore used the results of the analyses differently.

It is understandable that national organisations such as MCDEM may wish to build up a national picture of risk. The CDEM Act 2002 in fact requires the Director to identify those hazards and risks of national significance. This is achieved through the National CDEM Plan and user guide. It is logical that this national picture of risk should be based on the analyses of Groups as local people and organisations are likely to have the best understanding of the risks that they face.

However, the scale and type of information required to determine nationally significant hazards is likely to be different from that relevant to the CDEM Group. For example, a risk that has a potential consequence of loss of 5% of a region's GDP is not likely to rank highly on a national scale, but may have ranked highly in a local analysis in a Group which has a slowly growing economy which they wish to protect. In addition, factors such as the effect on New Zealand's international obligations and use of new technologies are likely to be less relevant to a CDEM Group and probably not considered in their risk analysis process.

Some CDEM Groups involved neighbouring Groups in their risk analysis processes, and Plan drafters from all the Groups met together to facilitate discussion on particular processes during Plan drafting. These inter-group arrangements introduced an element of consistency and understanding between Groups, but should be further strengthened when drafting future Plan revisions. National support from researchers and risk analysts would be useful support to these interactions, and may achieve consistency over time rather than developing a single national system which does not meet the needs of the CDEM Groups.

6.11. Alignment of risk management framework with CDEM planning.

The Risk Management framework as described in AS/NZS 4360 was promoted by the Director's Guideline as the process most appropriate for CDEM planning. However, some CDEM Groups did not follow all of the steps in this risk management process, and appeared to pick and choose those steps in the process that were simplest to achieve, or for which they had strong guidance.

For example, as discussed previously, risk evaluation criteria were not effectively used, and when identifying Objectives, Targets and Actions (risk

treatments), and there was little evidence of a range of options being assessed using techniques such as cost/benefit analysis.

There are a number of reasons why the risk management framework was not more consistently followed. It may have been that Groups were not familiar with the process in the CDEM context and found it difficult to apply, or that they found that the process was not applicable in it's entirety to the CDEM context.

For example the nature of risks that CDEM Groups have a responsibility to manage is quite unique. In most cases, risks relevant to CDEM Groups are large scale and by their very nature have high consequences (and often low likelihood), are not easily quantifiable, and are not necessarily 'owned' by one agency to treat. Another significant characteristic of risks relevant to CDEM Groups is that often they cannot be 'accepted' or significantly reduced.

These characteristics mean processes such as establishing risk evaluation criteria are difficult as CDEM Group agencies may have different perspectives on what criteria would make a risk a high priority. Also risk treatments are the responsibility of a wide range of agencies, including community-based organisations and individuals. The ability of the CDEM Group to influence the effective implementation of risk treatments for those risks may therefore be limited.

Risk treatments should also be focused on the risks themselves. In many CDEM Groups, the focus on strategic issues was helpful to identify gaps that needed to be addressed, but meant that the focus of risk treatment was taken away from the risks facing the Group and the consequences of those risks.

It is acknowledged that CDEM Group Plans are just one of the tools used to manage the risks identified by the CDEM Group. Each agency with a role in CDEM is expected to be applying risk-based approaches to their own planning. However, as the CDEM Group only fulfils a co-ordinating role in ensuring risks are addressed, it is not directly able to ensure commitment from members to address risk when those decisions have financial, asset or procedural consequences for other agencies also responsible for managing the risks.

In some cases the risk analysis process was the dominant part of their risk management process and therefore other important steps such as considering risk evaluation criteria and assessing risk treatment options were not given equivalent attention.

7. Conclusions & Recommendations

CDEM Group planning must be based on a sound understanding of the hazards and risks (likelihood and consequences) facing each region of New Zealand. With each revision of CDEM Group Plans it is essential that the understanding of the risks facing a region, and the consequences of those risks is strengthened. This will require adequate storage and recording of information gathered during risk analysis processes, so that future Plans can build on past experiences rather than be repetitious.

If the understanding of CDEM Groups of their risk is not constantly being increased it may be lost as personnel change and community awareness is not maintained. Understanding of risk must be encouraged for all agencies with a role in emergency management and for the community as a whole.

The risk analysis process in the context of developing a CDEM Group Plan is an ideal opportunity to further develop the understanding of risk, and should be embraced by all agencies. With this goal in mind, it may be possible to simplify risk analysis processes, and still achieve the same end objective.

The following recommendations are a synopsis of the major points that could rectify or enhance future CDEM Group risk analysis processes.

- Involve as many agencies as possible in the risk analysis process. This will develop understanding and build relationships among agencies. Consider involving the recipients of CDEM services in the analysis process to gain an understanding of the perspectives of risk held by the community.

This could be achieved through workshops focussing on particular hazards, or on particular components of the analysis process. If risks are primarily managed by groups other than the CDEM Group, have those groups lead the risk analysis process. These groups are likely to benefit from exposure to different perspectives they may not have considered in their own internal risk analysis processes.

- Clearly define a purpose for risk analysis and select appropriate methodologies to achieve that result.

- Focus the risk identification process on descriptions of consequences of hazards that the Group feel are unacceptable and wishes to manage, rather than on the hazards themselves. The categories of consequences such as human, social, economic, infrastructural and environmental may be used, or additional categories developed as required such as duration, scope/areal extent, or political consequences, as used in other models.

  If the Group wishes they can then determine which hazards have the potential to cause that level of consequence, but risk analysis and treatment should be based on managing the consequences identified by the Group.

- Be clear about which risks (either consequence or likelihood, or both) the CDEM Group 'owns'. Focus risk analysis only on these risks, and contribute CDEM information to the risk analyses of the agencies who own the risks for which the CDEM Group is a support agency.

- Develop risk evaluation criteria that will determine what risks are priorities to be addressed. These criteria should reflect the values of the

Group and the characteristics of the consequence of hazard, not individual hazards themselves.

- Use risk analysis tools (including those such as SMUG) to identify levels of risk, not set priorities. Priority setting should be related to risk evaluation criteria and therefore risk treatment should focus on specific characteristics of risk rather than the overall risk associated with a particular hazard.

  If the SMUG risk analysis methodology is favoured by CDEM Groups for future Plans, the Auckland CDEM Group methodology should be used. The SMG methodology should not be used as a risk analysis tool, unless the rating methodology is reviewed and its use is followed by a process that incorporates available likelihood information so as to incorporate probability as well as impact when defining risk.

- Include in risk analysis an assessment of the resilience and vulnerabilities of communities that may be affected by risk. This will enable a more detailed assessment and understanding of risk consequences. (Durham et al 2001, Buckle 2000)

- Base risk treatments on specific consequences of hazards, rather than on the hazard as a whole. The particular consequences that are important to address are those that align with the risk evaluation criteria determined by the Group. If risk treatments are developed to address strategic issues, be sure these are included *in addition* to addressing consequences of risk, as both are likely to be required to ensure CDEM goals are achieved.

- Include resilience-building and vulnerability-reducing activities in risk treatment mechanisms. Although these may identify issues beyond the

narrow focus of Civil Defence Emergency Management, they may be able to be dealt with through other programmes, and thereby achieve CDEM benefits.

- Downplay the significance of numerical scores obtained as a result of semi-quantitative analysis processes. The relative positioning of the risks should be focused on, rather than the specific score achieved by each risk. This will take into account some of these limitations of the analysis process, most importantly the lack of quantitative data which CDEM Groups have access to about their risks.

- Consider the principle behind each step of the risk management process and ensure these functions are addressed in CDEM planning. It may not be necessary to rigidly follow the linear process of the risk management process, so long as the principles behind each step are addressed.

- Introduce formal interactions *between* Groups when carrying out risk analysis. MCDEM and national research institutes could support and guide these interactions with the aim of achieving national consistency by agencies working together, rather than imposing a particular methodology that does not meet the needs of the CDEM Groups.

These recommendations are designed for implementation by CDEM Groups and for consideration by the Ministry of CDEM if it prepares an updated Director's Guideline for the next round of CDEM Group Plan development.

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