Hazard Risk Assessment for the Manawatu-Wanganui Region

horizons
regional council

October 2009

Hazard Risk Assessment for the Manawatu-Wanganui Region

October 2009

Author
Evan Lloyd
Risk Management / Health & Safety Coordinator

Front Cover Photos
Photo: David Lupton

October 2009

ISBN: 978-1-877556-08-1
Report No: 2009/EXT/1082

CONTACT	**24hr Freephone 0508 800 800**		**help@horizons.govt.nz**		**www.horizons.govt.nz**
SERVICE CENTRES	**Kairanga** Cnr Rongotea & Kairanga-Bunnythorpe Rds Palmerston North **Marton** Cnr Hammond & Hair Sts **Taumarunui** 34 Maata Street **Woodville** Cnr Vogel (SH2) & Tay Sts	**REGIONAL HOUSES**	**Palmerston North** 11-15 Victoria Avenue **Wanganui** 181 Guyton Street	**DEPOTS**	**Levin** 11 Bruce Road **Taihape** Torere Road Ohotu
POSTAL ADDRESS	Horizons Regional Council, Private Bag 11025, Manawatu Mail Centre, Palmerston North 4442 | **F** 06 9522 929				

ABSTRACT

The Manawatu-Wanganui Civil Defence Emergency Management (CDEM) Group Plan (2005) was reviewed through the latter part of 2008 and 2009, and a current hazard risk assessment was required to inform that process.

The project was undertaken in three stages:

1. Carry out a literature review of hazard information and draft a hazard list;

2. Draft the CDEM Group Environment, develop scenarios and risk descriptions; and

3. Carry out a risk analysis and evaluation, and draft the report.

The literature review generally fell into two categories: Information relating to hazard and risk assessment processes, and material relating to the hazards themselves. Initial research effort focused in locating and reviewing reports with relevance to hazards in the Manawatu-Wanganui Region, including a number of reports written since the last assessment in 2006.

Previous hazard risk assessments carried out in the Region were reviewed resulting in a refined list of hazards for this assessment.

The Ministry of Civil Defence & Emergency Management (MCDEM) (2009) Directors' Guide was conformed to as closely as possible and the recommended 'Risk Profile Template' was used in this project. The template is a simple spreadsheet based on the SMG (Seriousness, Manageability, Growth) methodology with the various criteria and factors weighted according. The template was populated initially by the author. This approach ensured a consistent rationale was applied to each of the criteria and factors for each of the hazards. Reviews and 'reality' checks were applied at several stages through consultation with the project sponsor, emergency management officers, and Coordinating Executive Group members.

A prioritised list of hazards resulted with riverine flooding heading the list. The results of this project are available to inform the Group Plan review process. It is clear that there is not enough information available on community vulnerability and it is recommended the CDEM Group consider further work in this area.

Acknowledgements

The contributions of Emergency Management Officers from around the Manawatu-Wanganui Region are acknowledged for providing information relating to hazard and risk in the districts and cities of the region, and for providing comment on the initial evaluation and analysis. The contribution of Shane Bayley of Horizons Regional Council and Brendon Morris of Brendon Morris Consulting Limited is acknowledged for providing support, advice and feedback during the evaluation and analysis process. The sponsorship provided by Horizons Regional Council for this project is acknowledged and greatly appreciated.

Contents

List of Figures

List of Tables

1. Introduction

The Manawatu-Wanganui Civil Defence Emergency Management Group Plan was first approved in March 2003. The Plan was reviewed in March 2005 following the 2004 Central New Zealand Flood Event. Pursuant to the Civil Defence Emergency Management (CDEM) Act 2002, the plan is required to be reviewed within 5 years of approval and may amend, revoke or leave the Plan unchanged. The review process was started mid-2008.

Section 17(1) of the CDEM Act 2002 requires CDEM Groups to:

- Identify, assess and manage relevant hazards and risks,
- Consult and communicate about those risks, and
- Identify and implement cost-effective risk reduction.

Section 49 of the CDEM Act 2002 requires CDEM group plans to have certain inclusions:

- The hazards and risks to be managed by the Group, and
- The Civil Defence emergency management necessary to manage the hazards and risks described.

The purpose of this project was to produce a supporting document to inform the review of the risk profile section of the Manawatu-Wanganui CDEM Group Plan. A fundamental part of the project will be to update the Manawatu-Wanganui Region hazard analysis.

The project was broken into three stages:

Stage 1: Carry out a literature review of hazard information and draft an initial hazard list

Stage 2: Draft the CDEM Group environment, develop scenarios and risk descriptions

Stage 3: Carry out a risk analysis and evaluation, and draft the report

2. Background and Significance

In November 2008 members of the Manawatu-Wanganui CDEM group Coordinating Executive Group (CEG) discussed the risk profile section in a mini-workshop and it was determined that there was a lack of up-to-date information to inform decision making. MCDEM indicated in 2008 that a director's guide would be produced to assist CDEM Groups review their plans with a nationally consistent approach and the group felt it would be wise to revisit the risk assessment so the nationally consistent approach could be applied to it. In addition to this, the last SMUG (Seriousness, Manageability, Urgency, Growth) hazard analysis was dated 15 February 2006 and it was clear that an updated analysis was required.

Very little background information was found relating to the 2006 analysis and the risk associated with the hazards requires further definition. Risk descriptions are essential for a robust risk assessment and needs to be revisited and documented. The group felt that a 'beginners guide to hazard and risk' would provide the review process with a consistent, basic level of information.

The Manager, Emergency Management Office, Horizons Regional Council, commissioned the project on behalf of the Manawatu-Wanganui CDEM Group. The project was accepted by the author who is nearing completion of the Graduate Diploma of Emergency Management from Massey University. The project is ideally suited as the basis for paper 130.703 *Project in Emergency Management* and is entirely relevant to the subject matter covered in the diploma course. It requires the author to draw on knowledge learned in papers 130.705 *Emergency Management,* 130.701 *Natural Hazards* and 130.702 *Coping with Disasters.* The learning from these last two papers was particularly useful in the literature review, and during the preparation of scenarios and risk descriptions.

It was expected the document would include a hazard analysis that is more targeted and specific than the SMUG analysis carried out in February 2006.

3. Literature Review

A large amount of literature has been reviewed during this project and it generally falls into two categories: Information relating to the hazard and risk assessment process, and material relating to the hazards themselves.

Late in 2009, MCDEM produced a document titled *CDEM group plan review: Director's guideline for civil defence emergency management groups (DGL 09/09)* to assist CDEM groups with the group plan review process. This document aims to provide a nationally consistent approach to the review of group plans (Ministry of Civil Defence & Emergency Management, 2009) and is fundamental to this project. During most of the period the project was undertaken, the Director's Guide was in draft form but it was sufficiently accurate to provide direction and clarification on a number of issues.
The Manawatu-Wanganui CDEM Group is well aware it is the first to review a CDEM plan and that the reviewed plan would be scrutinised as a 'model' for other group plans. The CDEM Group had significant input into the guide and, generally speaking, the guide and the CDEM Group Plan were developed side-by-side.

The *Risk Profile* section (Section 5) held the most relevance for this project and clearly identifies the process required to produce a robust risk profile. To maintain national consistency it was important that the guideline be followed as much as possible. MCDEM (2009) state the purpose of the Risk Profile Section is "To characterise the risk environment and provide an evidence base for sound prioritisation of resources and effort in risk management-based CDEM planning." MCDEM also lists the components of the Risk Profile Section as:

- A comprehensive summary of the natural, social, built and economic environments of the CDEM Group area.
- Descriptions of all hazards that could impact upon the CDEM Group and characterisation of their likelihood and consequences.
- A qualitative assessment of the risks in the CDEM Group area, through risk analysis and evaluation.
- An evaluation of the current and potential decisions and actions across the 4Rs in relation to the CDEM Group's prioritised risks.

The brief was for the project to cover the first three components mentioned above. The guide includes a word of caution about the requirement to keep the risk assessment and analysis to a 'reasonable' level and avoid the pitfall of 'paralysis by analysis'.

The use of the Risk Profile Template was strongly recommended in the guide. It is accepted that use of the template is fundamental to achieving greater consistency across CDEM Groups, and that no better tool exists to facilitate the process. The guide includes a description of how the template is structured and instructions on how it should be used. The template applies the SMG model (Seriousness, Growth and Manageability) to the evaluation process. The 'Urgency' criterion used in SMUG analysis of 2006 has been

removed on the justification that 'urgency' as an evaluation criterion, has already been addressed during the risk analysis (Ministry of Civil Defence & Emergency Management, 2009). An important point to note is that 'Seriousness' is weighted twice as important as the other two criteria, and within the Seriousness criterion, the four environments are weighted according to their relative importance:

- Social 50%
- Built 25%
- Economic 15%
- Natural 10%

Generally the Director's Guide was accepted as the authoritative document on hazard and risk assessment in the CDEM sector, and the processes outlined were used as much as possible for the reasons outlined above. It is however, worth noting that there are a number of hazard assessment processes available and in regular use around the world. These include the SMUG model and all its variants, the Seriousness, Manageability, Growth (SMG) model, the Federal Emergency Management Agency (FEMA) model, and a number of Australian models. All models have their advantages and disadvantages, and it is beyond the scope or requirement of this project to investigate and recommend a particular model to use. It was part of the brief that the Director's Guideline (Ministry of Civil Defence & Emergency Management, 2009), albeit in draft form, would be followed as much as possible.

The thesis written by Cunningham (2006) provides valuable background on the application of risk analysis tools when 1st generation CDEM Group Plans were produced following the introduction of the CDEM Act in 2002. Cunningham (2006) has an opposing view to MCDEM (2009) on the removal of the 'urgency' criterion and asserts that it will result in a focus on consequences at the expense of likelihood aspects. The result of this, Cunningham (2006) claims, is a lack of balance and accuracy in the picture of the risk posed by hazards. If Groups choose to use a SMUG analysis, Cunningham (2006) recommends using the Auckland CDEM Group methodology.

In 2005, the Auckland CDEM Group adapted and used the SMUG model developed by MCDEM during their 1st generation plan preparation. A numeric score was assigned to each of the four criteria, 1 being low and 3 high, however, MCDEM (2009) recommend a five point rating system. Due to the reasons already mentioned, the MCDEM recommendation was followed for this project.

The *Manawatu-Wanganui CDEM Group Plan* was adopted in March 2003. The Strategic Component of the plan identifies five natural hazards and seven man-made/technological hazards. Risk description in terms of context, likelihood and consequences are well defined for these twelve hazards. The hazards are not prioritised but the requirement to acquire further hazard information and carry out a more in-depth risk assessment was identified. A hazard analysis was carried out in 2006 and presented to the CEG on 22 March 2006. This analysis started with an initial list of 35 hazards and was

narrowed down to 15 with a high or extreme risk. Those 15 hazards were assessed in a SMUG model and ranked according to the final rating. This project updates and builds on information contained in the Group Plan and 2006 hazard analysis.

The Waikato CDEM Group Emergency Management Office produced a document titled *Hazard and Risk Analysis: Explanatory Notes 2004: A supporting document to the Waikato Civil Defence Emergency Management Group Plan 2005.* It is a seriously detailed document with a vast range of scenarios providing useful examples for hazard and risk analysis. However, the advice from its author was to keep the Manawatu-Wanganui assessment to a more concise format.

A review of the hazard assessments carried out by other CDEM Group members was carried out during the literature review. This review had a dual purpose: (1) it assisted in creating the initial list of hazards, and (2) it a provided a summary of prioritised hazards for each district and city allowing a comparison to be made with the new assessment result. This is discussed further in the Discussion section of this report.

4. Procedures

4.1 Information gathering

Initial research effort was focused on locating reports with any relevance to hazards in the Manawatu-Wanganui Region. A significant number of reports have been commissioned since the last regional hazard analysis and it was important that this information be taken into account in the 2009 analysis. Reports have been prepared for various departments within Horizons Regional Council and other members of the CDEM Group. Examples are the *Wanganui Tsunami Risk Assessment (Smith, Power, Lukovic, & Cousins, 2007)*, *Landslide Hazards of the Horizons Region (Dellow & Dymond, 2008)*and the *East Coast Tsunami Hazard Study – Stage 1(Chague-Goff & Goff, 2007).* For future reference, all reports and reference material have been collected into a single reference library in the Horizons Emergency Management Office, both in hard copy and electronic format (where available). All reports have been reviewed and information incorporated into the hazard scenarios and assessment process as appropriate. These reports, and all other publications researched, are referenced at the end of Appendix B.

4.2 Risk Management Context

Risk management is put into CDEM context by providing a comprehensive summary of the social, built, economic and natural environments for the Manawatu-Wanganui CDEM Group area. The purpose of this is to give the CDEM Group a clear and agreed picture of the broad parameters in which the Group operates (Ministry of Civil Defence & Emergency Management, 2009). The Manawatu-Wanganui CDEM Group Environment is attached at Appendix A.

4.3 Risk Identification

Hazards of relevance to the Group were identified through a review of the various hazard assessments carried out by CDEM Group members including the 2006 regional SMUG analysis. Informal consultation with emergency management officers and CEG members identified rural fire and widespread shallow-regolith landslides and erosion as new hazards that should be considered. Recent scientific reports were also reviewed with no further new hazards identified.

Sea level rise was identified as a hazard in 2006 but current thinking is that sea level rise is not a hazard in its own right, but an amplifying or modifying factor to be taken into account when other hazards such as coastal flooding and erosion are analysed. It was therefore removed from consideration.

The threat of a dam break lahar from Mount Ruapehu has passed with the Crater Lake tephra dam breach and subsequent lahar on 18 March 2007, therefore this particular hazard was not considered. The remaining hazards posed by Mount Ruapehu, the explosive eruption, ash fall and lahar caused by explosive ejection of lake water, have been summarised into a single Mount Ruapehu volcanic hazard.
The 'Taranaki Zone' hazard identified in 2006 has also been removed from consideration, not because it does not pose a threat, but because the general

ash fall hazard has been considered as part of the Mount Ruapehu volcanic hazard.
Terrorism was not considered a hazard that the CDEM Group could plan for and mitigate, and it is the responsibility of other government agencies to manage and respond to such events.

4.4 Risk Description

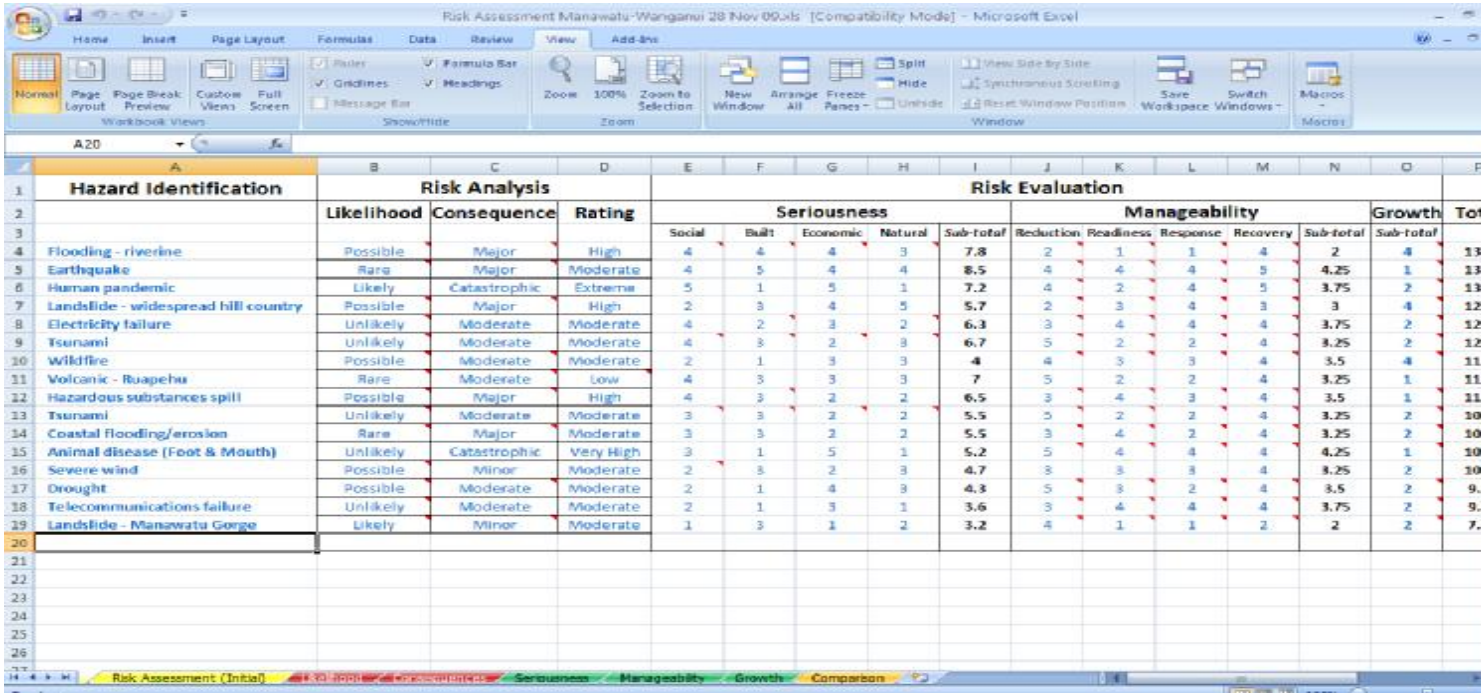
Risk descriptions are essential for communication with partners and are the basis for accurate risk assessment (Ministry of Civil Defence & Emergency Management, 2009). Generic risk descriptions for 12 hazards are located in the Manawatu-Wanganui CDEM Group Plan (Manawatu-Wanganui CDEM Group, 2005). The risk descriptions written for this project relate to specific scenarios in an attempt to focus thinking on the likelihood and consequences to affected communities. Maximum likely scenarios have generally been chosen as the most suitable for analysis.

Risk descriptions for the following scenarios are attached at Appendix B:

• Mount Ruapehu	Eruption, lahar and ash fall
• Earthquake	M_L 7.5 on northern end of Wellington Fault
• River flooding	2004 Lower North Island Flood event
• Tsunami	Distant source
• Landslide	Manawatu Gorge
• Landslide	Widespread shallow regolith landslide and erosion
• Coastal flooding and erosion	West coast flooding and erosion
• Rural fire	Santoft Forest fire
• Severe wind	1 in 50 year event, gusts to 150-180km/hr
• Electricity failure	Widespread power failure in Wanganui CBD
• Hazardous substances spill	Toxic chemical spill from truck on SH1 in Bulls
• Human pandemic	MidCentral and Whanganui DHB planning scenario
• Animal epidemic	Foot and Mouth, and Anthrax

4.5 Risk Analysis and Evaluation

The 'Risk Profile Template' recommended by MCDEM in the Director's Guide (2009) was used for risk analysis and risk evaluation. The template is a simple Microsoft® Excel® spreadsheet and is available in two versions – 'simplified' and 'detailed'. The simplified version is intended to be used where the hazardscape is small and relatively well defined, and a single maximum likely event is used for each hazard. The detailed version is applicable when Groups want to carry out a more in-depth assessment (Ministry of Civil Defence & Emergency Management, 2009). The detailed version was used for this project.



Hazard Identification	Risk Analysis			Risk Evaluation											
	Likelihood	Consequence	Rating	Seriousness					Manageability					Growth	Tot
				Social	Built	Economic	Natural	Sub-total	Reduction	Readiness	Response	Recovery	Sub-total	Sub-total	
Flooding - riverine	Possible	Major	High	4	4	4	3	7.8	2	1	1	4	2	4	13
Earthquake	Rare	Major	Moderate	4	5	4	4	8.5	4	4	4	5	4.25	1	13
Human pandemic	Likely	Catastrophic	Extreme	5	1	5	1	7.2	4	2	4	5	3.75	2	13
Landslide - widespread hill country	Possible	Major	High	2	3	4	5	5.7	2	3	4	3	3	4	12
Electricity failure	Unlikely	Moderate	Moderate	4	2	3	2	6.3	3	4	4	4	3.75	2	12
Tsunami	Unlikely	Moderate	Moderate	4	3	2	3	6.7	5	2	2	4	3.25	2	12
Wildfire	Possible	Moderate	Moderate	2	1	3	3	4	4	3	3	4	3.5	4	11
Volcanic - Ruapehu	Rare	Moderate	Low	4	3	3	3	7	5	2	2	4	3.25	1	11
Hazardous substances spill	Possible	Major	High	4	3	2	2	6.5	3	4	3	4	3.5	1	11
Tsunami	Unlikely	Moderate	Moderate	3	3	2	2	5.5	5	2	2	4	3.25	2	10
Coastal flooding/erosion	Rare	Major	Moderate	3	3	2	2	5.5	3	4	2	4	3.25	2	10
Animal disease (Foot & Mouth)	Unlikely	Catastrophic	Very High	3	1	5	1	5.2	5	4	4	4	4.25	1	10
Severe wind	Possible	Minor	Moderate	2	3	2	3	4.7	3	3	3	4	3.25	2	10
Drought	Possible	Moderate	Moderate	2	1	4	3	4.3	5	3	2	4	3.5	2	9.
Telecommunications failure	Unlikely	Moderate	Moderate	2	1	3	1	3.6	3	4	4	4	3.75	2	9.
Landslide - Manawatu Gorge	Likely	Minor	Moderate	1	3	1	2	3.2	4	1	1	2	2	2	7.

Figure 1 – Risk Profile Template

(There is a larger copy of this table is attached in Appendix E).

The qualitative risk analysis process prescribed by MCDEM (2009) uses measures of likelihood that were considered to be too generic. For example; *Almost Certain* - Is expected to occur in most circumstances, *Likely* - Will probably occur in most circumstances, and *Possible* - Might occur in some circumstances. Most scientific data refers to likelihood in terms of hazard return period therefore the descriptors used by the Auckland Local Authority Hazard Liaison Group (2002) were adopted.

The 'Likelihood' ratings used are:

Likelihood Rating	Hazard Return Period (years)
Almost Certain	0 - 5
Likely	6 - 19
Possible	20 - 99
Unlikely	100 - 999
Rare	≥ 1000

Table 1 – Likelihood Ratings

The Measure of Consequence of Impact described in the Director's Guide was suitable for the risk analysis but was not detailed enough for the risk evaluation. Again the more detailed descriptions used by the Auckland Local Authority Hazard Liaison Group were used, but were further defined by breaking them down into descriptions for each of the four environments - social, built, economic and natural. The Consequence Ratings for Risk Analysis is attached as Appendix C along with Manageability and Growth ratings.

Risk analysis was applied to the list of hazards using the Risk Profile Template. Because the list of hazards had already been defined as previously stated, the process was slightly superfluous. The intended purpose of the Risk Analysis is to cull a much larger list down to a size where the Risk Evaluation is more manageable in line with the priorities of the CDEM Group.

Risk Evaluation was applied to the same list, again through application of the Risk Profile Template. The initial evaluation was carried out by the author so that a consistent application of logic and thought process was applied to each of the rating criteria and factors. In many cases this was quite subjective and one suspects that results would be 'patchy' if it was carried out any other way i.e. by committee. As each criterion and factor was considered, a comment was entered into the applicable spreadsheet cell so that the rationale behind the decision and rating could be followed at a later date.

4.6 Consultation and Review

The initial results were reviewed by the project sponsor (Manager, Horizons Emergency Management Office) and some small alterations made following changes to certain assumptions, and subsequent application of logic based on those changed assumptions.

The results were discussed in detail at a meeting of the Region's Emergency Management Officers on 9 June 2009. The spreadsheet was further refined including the collation of the Mount Ruapehu lahar and ash fall hazard into a single Mount Ruapehu Volcanic hazard.

The results were discussed at a mini-workshop of CEG members in September 2009 and a presentation made on the assessment process undertaken to date. No further changes were made as a result of the discussion.

5. Results

A print-out of the completed Manawatu-Wanganui Hazard Risk Assessment (based on the MCDEM Risk Profile Template spreadsheet) is attached at Appendix D. The sheet has been sorted on the *Total Score* column resulting in a prioritised list of hazards as follows:

Priority	Hazard
1	Flooding -- riverine
2	Earthquake
3	Human pandemic
4	Landslide - widespread hill country
5	Electricity failure
6	Wildfire
7	Volcanic - Ruapehu
8	Hazardous substances spill
9	Tsunami
10	Coastal flooding/erosion
11	Animal disease (Foot & Mouth)
12	Severe wind
13	Drought
14	Telecommunications failure
15	Landslide - Manawatu Gorge

Table 2 – Prioritised Hazards Following Evaluation

The results are generally as expected with riverine flooding the number one hazard facing the Manawatu-Wanganui Region.

6. Discussion

It is clear that the results are very dependent on the particular scenarios chosen. If a scenario included fatalities, then its seriousness was automatically escalated into a major or catastrophic category by virtue of its higher numerical rating. This has a significant influence because the Social factor accounts for 50% within the Seriousness criterion and the Seriousness criterion is weighted twice as important as the other two criteria, Manageability and Growth. For example, the tsunami hazard scenario was based on a distant-source tsunami giving ample warning and time to carry out evacuations. An assumption was made that there would be no resulting fatalities but if that was not the case, and a 'sightseer' was to lose his or her life, the tsunami hazard would rise considerably in the list of prioritised hazards.

The same is true for the riverine flooding scenario. While it is based on the 2004 Central New Zealand Flood event where no fatalities occurred, it is generally accepted that this was an extremely fortuitous turn of events, and an assumption was made that next time we are unlikely to be so lucky.

Hazard assessments carried out by the local authorities that form the CDEM Group were reviewed during the literature review. A table listing the relative priority of each hazard is attached as Appendix E. A conclusion that can be drawn from this comparison is that there is a wide variation in results. However the 'major' hazards of riverine flooding, earthquake and human pandemic consistently feature towards the top of table, and other hazards in the top 15 are 'generally' accounted for.

The risk assessment template was not populated with data obtained during risk assessment workshop or any other widely cooperative process as recommended by MCDEM (2009), primarily due to time constraints. While there was some collaboration and debate on hazard and risk, the author concedes that the lack of comprehensive consultation with partners and subject matter experts was an opportunity lost to further identify issues, challenges and opportunities in relation to hazard management.

Cunningham (2006) identifies a number of problems relating to the scenario approach used in SMG type hazard analysis. In many cases it is difficult to determine the distribution of actual impact and therefore it is difficult to estimate the consequences. The maximum likely scenario approach could also appear alarmist.

Social consequences in each of the hazards scenarios has been summarised, but there is a distinct lack of information to base the summary on. Most information is focused on the physical hazards and hazard processes, and very little is available in relation to the social consequences of hazard impact. The hazard assessment process has very little community vulnerability and resilience information to call upon in an attempt to more closely determine hazard impact from a social science perspective.

7. Recommendations

It is recommended that the Manawatu-Wanganui CDEM Group:

1. Utilise the findings of this project to inform the CDEM Group Plan review process, particularly in drafting of the Risk Profile chapter of the new Group Plan. Information contained in this report can be utilised directly in the Group Plan as applicable.

2. Utilise the learning from this project in regard to the hazard and risk assessment process for any future hazard assessment at local authority level.

3. Undertake a project to identify characteristics in the community that contribute to resilience and vulnerability. In 2009 MidCentral Health carried out a project for their area of responsibility and targeting health vulnerability. A continuation or extension of this work could be considered. A method of visually mapping community vulnerability should also be considered. A visual tool would aid future hazard risk assessments, and be particularly useful in identifying vulnerability 'hotspots'.

4. Repeat the assessment in five years to update and inform the next Group Plan review.

It is recommended that the Ministry of Civil Defence and Emergency Management:

1. Amend the publication *CDEM Group Plan Review: Director's Guideline for Civil Defence Emergency Management Groups [DGL 09/09]* to include descriptions of Consequence and Seriousness within the Social, Built, Economic and Natural environments. Clarification in this area would remove the requirement for CDEM Groups to develop their own descriptors and therefore increase the opportunity to achieve consistency across Groups.

8. References

Auckland Local Authority Hazard Liaison Group. (2002). Hazard guideline No. 2: Hazard identification and risk assessment for local authorities, *Technical Publication No. 106*. Auckland: Auckland Regional Council.

Chague-Goff, C., & Goff, J. (2007). *East coast tsunami hazard study - Stage 1* (No. CHC2007-074): NIWA.

Cunningham, D. J. (2006). *The application of risk analysis tools in civil defence emergency management planning in New Zealand.* Unpublished Masters Thesis, Massey University, Palmerston North.

Dellow, G. D., & Dymond, J. (2008). *Landslide hazards in the Horizons region* (No. 2008/175): GNS Science.

Manawatu-Wanganui CDEM Group. (2005). Manawatu-Wanganui CDEM Group Plan. Palmerston North, New Zealand:

Ministry of Civil Defence & Emergency Management. (2009). *CDEM group plan review: Director's guideline for civil defence emergency management groups [DGL 09/09]*. Retrieved 24 Nov 09. from http://www.civildefence.govt.nz/memwebsite.nsf/wpg_URL/For-the-CDEM-Sector-Publications-Index?OpenDocument.

Smith, W., Power, W., Lukovic, B., & Cousins, J. (2007). *Wanganui tsunami risk assessment* (No. 2007/308): GNS Science.

9. Appendix A CDEM Group Environment

Social environment

People

The Region had a usually resident population of 222,423 people at the 2006 Census, the sixth-largest population in New Zealand. The Region has a lower than average population density, 10.3 people per square kilometre, compared with 13.1 for New Zealand. Between the 2001 and 2006 censuses the population rose by 1.1 percent, or 2,334 people.

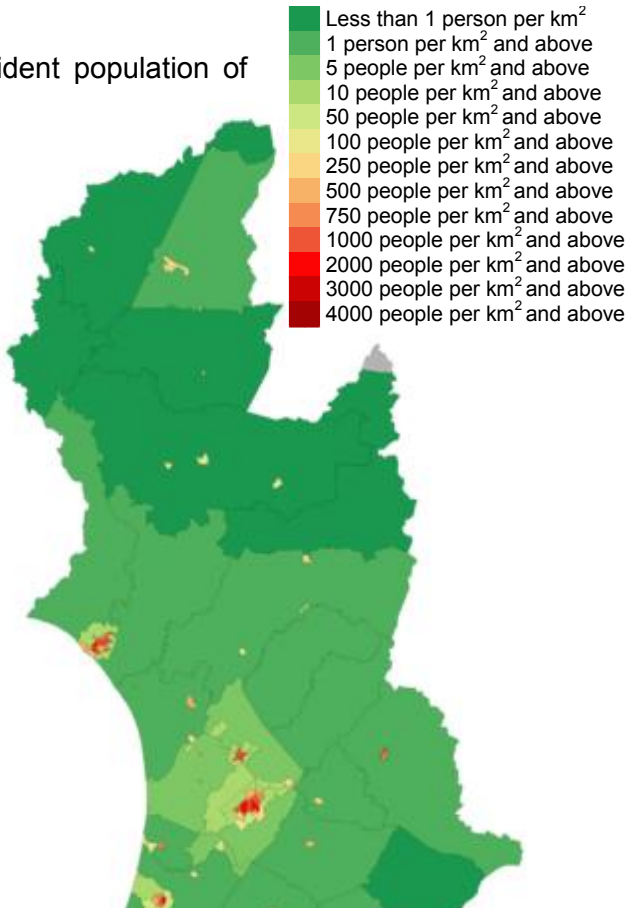


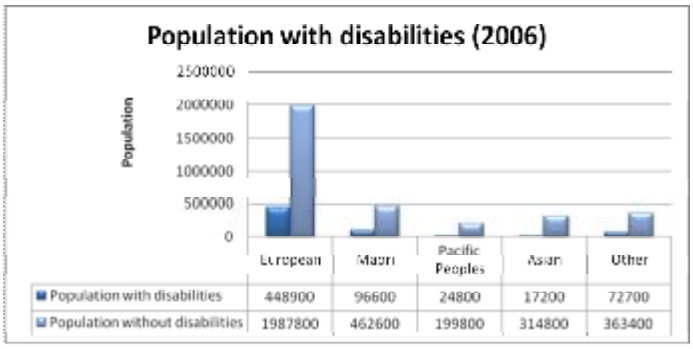
Figure 1 Population densities of the Manawatu-Wanganui Region

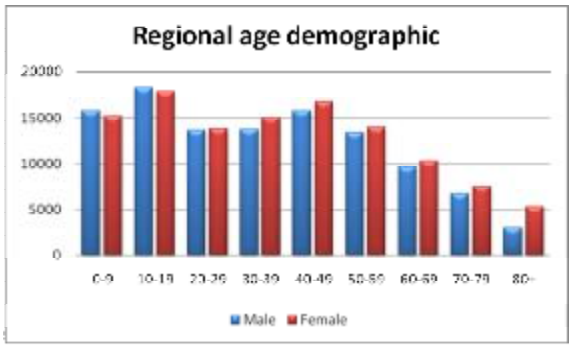
There are two major urban areas in the Region. Palmerston North, with an estimated resident population of 79,800, expanded as an educational centre and a supply centre for the surrounding rural hinterland. It became a city in 1930. The other major urban area is Wanganui, with an estimated resident population of 39,700 (June 2008 estimates). Other urban centres include Levin, Feilding, Dannevirke, Taumarunui, Foxton and Marton.

City life does not dominate the Region, as half the population lives outside a large urban area, and over a third in small towns or rural areas. While manufacturing has become an important part of the Region's economy, most businesses are agriculturally based, and agriculture remains the Regional linchpin. The dominance of agriculture, combined with the relatively small scale of most urban areas, gives a rural quality to the Region. The Region's rugged interior has also become one of the main training areas for New Zealand's defence force, which maintain three bases in the Region.

Table 1 - Ethnic Groups in Manawatu-Wanganui Region and New Zealand, 2006 Census

Ethnic Groups	Region/City/District	New Zealand
European	157,344	2,609,589
Māori	42,285	565,326
Pacific peoples	5,892	265,974
Asian	8,121	354,552
Middle Eastern/Latin American/African	1,098	34,746
Other ethnicity		
New Zealander	26,715	429,429
Other ethnicity–other	75	1,491





The population with disabilities table above is based on national level statistics from the 2006 census. The Regional age demographic is also based on 2006 data and is specific to the Manawatu-Wanganui Region.

Built environment

Number of dwellings counted

There are approximately 85,200 occupied dwellings and 9,700 unoccupied dwellings in the Manawatu-Wanganui Region.

For New Zealand as a whole, there are approximately 1,478,700 occupied dwellings and 159,300 unoccupied dwellings.

Of note from the 2001 census, is heating sources for private dwellings. Between the 1996 and 2001 census there was a decrease on the reliance on electricity and an increase on bottled gas for home heating.

Lifeline infrastructure

Each of the Territorial Authorities of the Region is responsible for delivering lifeline services in varying degrees to their local communities. These services include local road networks, potable water supplies, and sewerage and wastewater services. Detail on the extent of service and the location of infrastructure is maintained by each Territorial Authority.

Telecommunications

Telecommunications network providers in the Region include Telecom, Vodafone and Inspire.

Fifty-four point four percent of households in the Manawatu-Wanganui Region have access to the internet, compared with 60.5 percent of households throughout New Zealand.

In the Manawatu-Wanganui Region 71.2 percent of households have access to a cellphone, compared with 74.2 percent of households for New Zealand as a whole.

Household(1) Access to Phones, Internet and Fax Machines in Manawatu-Wanganui Region, 2006 Census		
	Region/City/District (%)	New Zealand (%)
No access	2.5	2.0
Cellphone	71.2	74.2
Telephone	89.8	91.6
Fax machine	22.1	26.0
Internet	54.4	60.5

In the above table, households can access more than one type of telecommunication device, therefore percentages do not add up to 100.

Energy

Natural gas is piped via the high pressure transmission network through the coastal plains and Palmerston North area. The transmission pipeline to Hawke's Bay passes through the Manawatu Gorge, and the Wellington pipeline follows the west coast through to Kuku, Otaki and beyond.

Some electricity is generated within the Region, mostly wind and hydro, and a significant portion of the national grid traverses the Region. The principal site within the Region for the national grid is the Bunnythorpe Substation.

There are some new power schemes operating within the Region including the southern hemisphere's largest collection of wind farms, with an increasing number of installed turbines and more planned.

Distribution companies distribute electricity to consumers within the Region. There are four distribution companies operating in the Region, including Powerco, the largest distributor in the North Island, Electra, ScanPower and The Lines Company. Electricity is sold to the consumer by an electricity retailer.

Transport

The Region includes State Highway 1, the main state highway, and the North Island Main Trunk Railway, the main railway line, which links Auckland and Wellington. The Palmerston North - Gisborne Line and State Highway 3 follow the Manawatu Gorge, linking the Region with Hawke's Bay. The Marton - New Plymouth Line provides a railway link with Taranaki, and from this line a short

branch line runs to Wanganui. Road and rail transport give the Region's exporters easy access to ports.

The Region has approximately 16 percent of the North Island's road length. There are 8,732 km of road, of which two-thirds are sealed. Approximately 12 percent of roads in the Region are classified as urban and three-quarters as rural, with almost half of the rural roads being unsealed. With 945.9 km, the Region has the second-highest length of State Highways in the North Island, after Waikato.

The Region is served by two airports, Palmerston North and Wanganui. A military air base is located at Ohakea.

Economic environment

Business

Agriculture dominates the economy in the Region. A higher than average proportion of businesses were engaged in the agriculture, forestry and fishing industries, 6.3 percent compared with 4.4 percent nationally. Businesses engaged in retail trade were dominant numerically. In 1997 there were 2,300 retail businesses in the Region, employing a total of 10,380 full-time equivalents (FTEs). The percentage of businesses engaged in manufacturing was slightly higher than the national average and manufacturing employed the greatest number of people (12,830 FTEs).

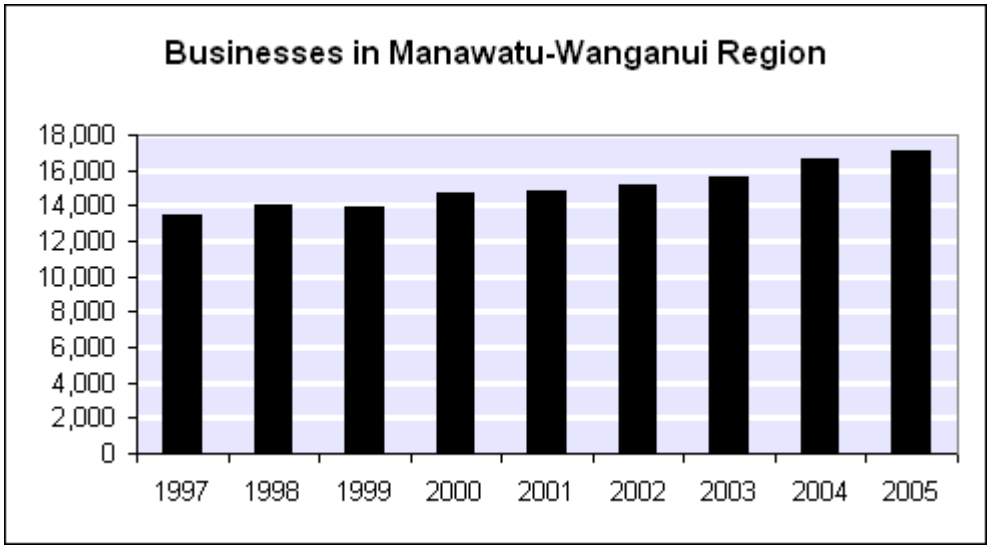


Figure 1 Businesses in the Manawatu-Wanganui Region

Agriculture

The Region is known for its strong agricultural base, which prompted the establishment of an agricultural college in 1928. The government wanted to promote scientific farming and established colleges in two of the most important farming areas, Canterbury and Manawatu. Research into animal genetics by members of the college in the 1930s led to the development of

new breeds of sheep, the Drysdale and the Perendale, which became commercially significant after World War II.

Agriculture dominates land use in the Region although there are areas of forestry and horticulture. Soils and climate favour pastoral farming. There were 6,344 farm holdings in the Region on 30 June 1996, which was almost a tenth of all farm holdings in New Zealand. Farming occupied 72.5 percent of land in the Region, which was much higher than the national average of 60.1 percent. Approximately 80 percent of this land is used for agricultural purposes (grazing, arable, fodder and fallow land). In the Manawatu, Rangitikei and Tararua Districts this percentage rises to over 90 percent of total land.

The Region is one of the most important areas of pastoral farming in New Zealand. The Region had 6,746,989 sheep (at 30 June 2007), the largest number of sheep in the North Island and the second-highest figure in the country behind Canterbury. The Region also produces a significant proportion of vegetables in the North Island and is particularly noted for its abundant potato crop. Barley, which is used for the manufacture of stock feed and for malting, is grown in the Region. The Region produces the largest quantities of barley in the North Island.

Forestry

The Region is one of the most significant forestry areas in the southern North Island. The predominant soil type in the Region, yellow-brown earths, when enhanced by the use of fertilisers, is very suitable for forestry. Forestry has a long history in the Manawatu since Palmerston North developed as a saw-milling town and the Region's initial prosperity depended on heavy exploitation of native timbers, however land use practices inhibited the long-term viability of this indigenous forestry industry. Severe burn-offs destroyed large areas of native forest and subsequent overgrazing affected the Region's soils. Forestry largely disappeared until the early twentieth century. In an attempt to combat erosion problems in sandy soils, the government planted forests in the Foxton/Levin area in the early twentieth century. Inland forests were planted later. Some private native forest in the Region has been set aside for sustainable logging but most forestry in the Region depends on exotic plantings.

Natural environment

Topography

The Manawatu-Wanganui Region takes up a large proportion of the lower half of the North Island. It is the second-largest Region in the North Island and the sixth-largest in New Zealand; totalling 22,215 km^2 (8.1 percent of New Zealand's land area). The Region stretches from north of Taumarunui to south of Levin on the west coast, and across to the east coast from Cape Turnagain to Owhanga. It borders the Waikato, Taranaki, Hawke's Bay and Wellington Regions and includes river catchment areas that run from the volcanic plateau to the sea. The Pacific Ocean is the eastern boundary and

the Tasman Sea on the western boundary. The Ruahine Ranges form a natural boundary between much of the Region and Hawke's Bay.

The area includes a variety of landscape formations. Districts close to the volcanic plateau are higher and more rugged, often subject to harsh temperatures in winter. The Manawatu District has a much gentler topography, consisting mainly of the flat, tree-studded Manawatu Plains that run between the ranges and the sea. The land was under the sea until about 500,000 years ago and still has a very thick layer of marine sediment, which is about five or six million years old. A block faulting system underneath the thick sediment has raised a series of domes and gentle depressions. These structures can provide natural storage areas for oil and some of the Manawatu domes have been drilled. The domes have shaped the course of the Manawatu River, giving it a meandering path which, uniquely among New Zealand rivers, begins close to the east coast and exits on the west coast. The Manawatu River begins just inside the Hawke's Bay Region, then flows through a deep gorge to the Manawatu Plains before exiting in the Tasman Sea. The Wanganui District is more rugged, with canyon-like valleys and gorges carved out of the soft rock by rivers and ocean waves.

The Region includes a series of mountain ranges, notably the Tararua and the Ruahine Ranges and the three major active volcanoes of the North Island. Mount Ruapehu at 2,797 m is the tallest mountain in the North Island, Ngauruhoe 2,291 m and Tongariro 1,968 m. During the last 100 years Ruapehu has experienced six significant eruptions, and the last series of moderate eruptions was in 1995 and 1996.

Three major rivers divide the Region: the Whanganui (290 km), Manawatu (182 km) and Rangitikei (241 km). The Whanganui is the second-longest river and has the second-largest catchment in the North Island, draining most of the inland Region west of Lake Taupo. There are few roads in this area, which contains some of the largest surviving areas of native bush in the North Island.

Soil and climate

Soils in the Region are productive with the addition of fertiliser. In the Manawatu and Horowhenua Districts there are sandy soils and swampy hollows around the coast with loess-covered terraces and river flats inland. These river flats and swamp areas contain fertile alluvial and organic soils. On the drier terraces inland, yellow-grey earths predominate. The flatter more fertile soils suit intensive sheep farming and cropping while the hill country of Rangitikei favours semi-intensive sheep and beef farming. Areas close to the volcanic plateau consist largely of pumice soils, which lack some essential trace elements, but within the Region much of this land is occupied by national parks.

The Region has a comparatively mild climate with greater climatic extremes inland. Chateau Tongariro experienced the lowest temperature recorded in the North Island, falling to -13.6°C on 7 July 1937. In summer the Region is warm, with a maximum mid-summer daily average of between 20.1 and 22.9°C. Sunshine hours approximate the national average for much of the Region (1,800-2,000 hours per annum) but Palmerston North is defined as cloudy with an average of 1,725 sunshine hours. In the winter the minimum

mid-winter daily average for coastal areas is 4.0 to 7.9°C, while inland areas are considerably colder. Waiouru has a minimum mid-winter daily average of 0.1°C.
Rainfall on the plains is slightly below average, with Palmerston North receiving 960 mm, while the rest of the Region receives the New Zealand average rainfall of 1,000-2,000 mm.

Conservation and parks

The Region contains areas of great ecological significance, reflected in the designation of approximately a seventh of its land area as part of the nation's conservation estate. Tongariro National Park is the largest park in the Region (795.98 km2) and is the oldest national park in the country, established in 1887. The volcanoes Tongariro, Ruapehu and Ngauruhoe are sacred to Māori and were gifted to the nation by Te Heuheu Tukino IV, paramount chief of Ngati Tuwharetoa. They form the nucleus of the park, which is designated a world heritage area.

Whanganui National Park is slightly smaller (742.31 km2) and was established 99 years later when a series of reserves were incorporated into one area and given national park status. There are two state forest parks in the rugged, bush-clad Ruahine and Tararua Ranges. The four parks offer skiing, tramping, jet boating and white-water rafting and the opportunity to appreciate the environment.

The Regional Council, responsible for managing natural and physical resources, provides flood protection and monitors environmental problems such as pest infestation and pollution. Invasive plant pests such as African feathergrass, goat's rue and nodding thistle pose a threat to pastureland in this heavily agricultural-dependent region, and the Regional Council has instituted control campaigns. The Regional Council has also instituted animal pest control programmes. Possums are perceived as the major animal pest since they damage native forests and endanger cattle production through the spread of bovine tuberculosis. Eradication programmes also concentrate on rabbits, rooks and feral goats, while other exotic species such as wallaby, wasps, ferrets, stoats and weasels are a source of concern.

Summary of CDEM Group Environment

In summary, the Manawatu-Wanganui CDEM Group has the following characteristics that have particular importance to CDEM:

- A large geographical area with widespread small population centres subject to a wide range of hazards;
- An increasing population and significant development pressure on land subject to a range of natural hazards including river flooding;
- A changing population with increasing numbers of new migrants and elderly people;
- Perceived low levels of household awareness and preparedness for emergencies;
- A strong and diverse yet rurally focused local economy that produces a significant proportion of New Zealand's GDP; and
- Important lifelines infrastructure and transport corridors.

10. Appendix B Risk Descriptions

Ruapehu Volcanic

The principle hazards from Mount Ruapehu are pyroclastic fall and lahars triggered by eruptions through the Crater Lake. The scenarios below are based on 1:1000 year event however smaller destructive eruptions have occurred in 1945, 1969, 1975 and 1995. Since the first historic lahar in 1861, there have been 22 lahars down the Whangaehu River. The lahar that caused the Tangiwai Disaster of 1953, and the dam-break lahar of 2007, were not caused by eruptions, but occurred when part of the Crater Lake drained catastrophically.

Scenario 1 - Ruapehu eruption – Lahar

It is a fine mid-winter day in the midst of a bumper ski season and there are approximately 10,000 skiers, climbers, visitors and workers on Mount Ruapehu. Skiers have flocked to ski fields at Whakapapa and Turoa.
The event starts with a major explosive eruption of Mount Ruapehu, accompanied by an earthquake of M_L 5 at 1 km below the volcano, quickly followed by a series of smaller tremors. The explosion ejects 30% of the water in the Crater Lake, and lake floor mud, as surges and fall deposits from a low eruption column. Ballistic projectiles fall within a 2 km radius. Several climbers near the summit are killed instantly by falling debris.
Within three minutes lahars are generated by flooding, and grow by melting, eroding and incorporating snow and ice from the summit area and glaciers. The Whangaehu River, and Whakapapanui and Whakapapaiti Streams are affected. Lahars damage ski installations, buildings, tracks and bridges on the mountain. The Eruption Detection System (EDS) has operated and provided some warning but up to five people are feared dead after being caught in lahar down the Whakapapanui Stream.
Lahars also flow down the Manganuiateao and Mangatoetoenui Streams. Collapse of the crater rim discharges the remaining lake water, mainly into the Whangaehu River, but some into the Mangatoetoenui Stream. A catastrophic lahar of ~10^7 m^3 in volume flows down the Whangaehu River over 200 km to the coast damaging bridges and flooding roads. No deaths have been reported further down the Whangaehu River, probably because it has been possible to get a warning out through well established CDEM warning procedures.

Mount Ruapehu has demonstrated many periods of unrest. In 1953 151 people died in the Tangiwai disaster when a lahar from the Crater Lake destroyed a rail bridge sending a train crashing into the Whangaehu River. Destructive eruptions have also occurred in 1945, 1969, 1975 and 1995 (Hodgson & Houghton, 1999).
While Mount Ruapehu is located in a part of the Manawatu-Wanganui Region that is normally less densely populated than other districts, this event has occurred during the ski season when a large number of visitors are in the area making the most of the good ski conditions.

Magnitude of Event
1/1000 year

Recurrence Interval
As above

Consequences
Social

- Fatalities
- Injuries
- Loss of income for those affected by loss of tourism
- Isolation due to damaged roads and bridges
- Disruption to daily activities
- Temporary closure of roads
- Temporary closure of roads/airports

Built

- Many tramping tracks, bridges and huts on the mountain damaged or destroyed
- Ski installations at Iwikau damaged or destroyed
- Road and rail bridges at Tangiwai damaged or destroyed
- Upper Whangaehu Valley Road bridge destroyed
- Mangamahu and Fields Track bridge destroyed
- Farm bridges at Aranui and Tainui destroyed
- Flooding of lowest terraces between Omahanui and Renegair
- No damage downstream Kauangaroa as lahar confined to river channel
- Power generation shut-down until rivers clear

Economic

- High repair costs for damage infrastructure on mountain and down Whangaehu River
- Tourism affected due to loss of ski facilities, tramping infrastructure and fisheries
- Some loss of agricultural production due to erosion and silting
- Agency response costs
- Clean-up costs (esp. roads)
- Loss of power generation while hydro-electric stations shut-down

Natural

- Water contamination – acidity and turbidity
- Erosion of stream beds and banks
- Overbank flows strips, buries and kills vegetation
- Fish and insect kills - Impacts to trout fishery

Scenario 2 - Ruapehu eruption – Ash fall

Following the initial eruption sequence described above, a further five eruptions of Mount Ruapehu occur over a five month period. Eruption columns extend 8-12 km high. Two of these eruptions occur during northerly winds with pyroclastic falls spread between Ruapehu and Levin. During one eruption, south-easterly winds direct pyroclastic fall deposition north-west towards Taumarunui. A total of at least one millimetre of ash covers much of the Region.
The wind blows from the west ~32% of the time at 2,000 m, upwards to ~44% of the time at 12,000 m. Prevailing wind acts to distribute fall deposits away from the Region. Most of the pre-historic pyroclastic fall deposits are distributed in the north east sector (Horizons Regional Council, 1999).

Magnitude of Event
1/1000 year event (Horizons Regional Council, 1999)

Recurrence Interval
As above

Consequences

Social
- Disruption to daily activities
- Temporary closure of roads/airports
- Health effects from ash fall inhalation (infections of respiratory tract and asthma)
- Irritant to lungs and eyes

Built
- Possible contamination of water supplies, particularly roof-fed tanks
- Water supplies may be cut or limited due to failure of electricity to pumps
- Dust (or mud) affects road visibility and traction for an extended period
- Minor damage to houses will occur if fine ash enters buildings, soiling interiors, blocking air-conditioning filters, etc
- Electricity may be cut; ash shorting occurs at substations if the ash is wet and therefore conductive. Low voltage systems more vulnerable than high
- High water-usage will result from ash clean-up operations
- Roads may need to be cleared to reduce the dust nuisance and prevent storm-water systems from becoming blocked
- Sewage systems may be blocked by ash, or disrupted by loss of electrical supplies
- Damage to electrical equipment and machinery may occur.
- Airports will close due to the potential damage to aircraft

Economic
- Possible crop damage

- Some livestock may be affected. Most will not be unduly stressed but may suffer from lack of feed, wear on teeth, and possible contamination of water supplies
- Agency response costs
- Clean-up costs (esp. roads)
- Some loss of business income
- Loss of agricultural and horticultural production
- $100 million loss to region by the 3 ski fields being closed (Te Ara – The Encyclopaedia of New Zealand)
- Electricity suppliers lose $22 million due to damaged infrastructure (Te Ara)

Natural

- Fish and insect kills - Impacts to trout fishery

Earthquake

The Manawatu-Wanganui Region is geologically diverse with numerous potential earthquake sources. The Region encompasses some of the most seismically active parts of New Zealand. Small earthquakes have occurred regularly throughout c.150 years of recorded history and several moderate events remind us that the threat is a real one. Recent events include:

1843	Wanganui	~M7
1849	Wanganui	~M7
1934	Pahiatua	~M7
1990	Weber	<6.5
1990	Weber	<6.5

The **likelihood** of earthquake events from all sources are:

- A 1-in-10 chance in any 15 year period of experiencing a MM[1] 7 - 8.2 earthquake (commonly referred to as a 1-in-150 year event)

- A 1-in-10 chance in any 100 year period of experiencing a MM 7.5 – 9.8 earthquake (commonly referred to as a 1-in-1,000 year event)

The consequences to the built environment become progressively more severe towards MM10, and it is anticipated that the human health and safety, social and economic damage expected would mirror the damage to the built environment.

[1] MM refers to the Modified Mercalli index – a measurement of the intensity felt from an earthquake at a given location, rather than the strength of the earthquake at its source.

Scenario – Earthquake on Wellington Fault

An earthquake of M_L 7.5 has occurred centred on the Wellington fault. Dextral strike-slip movement of about 5 m has occurred repeatedly on the section southeast of Palmerston North. Fifty km of the fault has ruptured extending from Putara northeast to Woodville.
Ten aftershocks greater than M_L 5 occur within 12 hours of the main shock. Fifteen hours after the main shock the largest aftershock occurs, an M_L 6.5 event causing considerable further damage to buildings already weakened.

Magnitude of Event
M_L 7.5 with MM X up to 15 km from epicentre

Recurrence Interval
1000 years

Consequences

Social

- Multiple fatalities
- Crush injuries
- Evacuation and loss of habitable dwellings in multiple towns
- Trapped survivors in a number of buildings
- Closure of schools
- Increased requirement for social services (counselling, relocation, food etc)
- Requirement for increased morgue and autopsy facilities
- Mass evacuation and displacement
- Distress and associated suicides and on-going mental health problems
- Removal of local government staff from other districts to assist
- Mobilisation of armed forces, Urban Search and Rescue (USAR), fire and police

Built

- Bridges and approaches destroyed
- Substation at Bunnythorpe out of commission (supplies electricity to central North Island)
- Some communications networks off-line (cellular networks down)
- Water supply out of action
- Sewerage lines broken causing some contamination and hence affecting water supplies for (which have 2 days supply only)
- Larger community buildings collapsed, including council offices at Dannevirke and Marton
- Closure of rail link (Manawatu Gorge)
- Oxidation ponds leaking
- Closure of all roads east-west (Manawatu Gorge, Saddle Road, Pahiatua Track)

- Palmerston North airport closed, with western part of runway liquefied and uplifted
- Long-term cost and timing of repair to destroyed/damaged infrastructure
- Stop banks collapsed in places and liquefaction sand boils visible at the base of others
- Some damage to buildings in Palmerston North and Wanganui and associated loss of productivity

Economic

- Loss of income (self-employed)
- Dairy loss due to power and water outage
- Closure of major transportation routes
- Loss of tourism
- Loss of export dollars (agricultural, mining and tourism)
- Insurance adjustments after event (national implications) and Earthquake Commission (EQC) payouts
- Health costs
- Response costs (food, clothing, shelter, transportation)
- Heavy equipment costs
- Cleanup of sewerage
- Repair of infrastructure, communications and power systems
- Cost of earthworks stabilisation on roadslips

Natural

- Change in riverbed alignment along the Rangitikei River with flooding of previously dry land
- Wetland contamination
- Effects on aquaculture/marine farming with milk supplied dumped due to lack of power and water supplies

River Flooding

River flooding is the most frequent and widespread hazard throughout the Region. River flooding hazards are of most concern on the intensively developed Manawatu and Rangitikei flood plains, and in Wanganui City.

River flooding has resulted in extensive river control systems throughout the region including 30 river and drainage schemes, 460 km of stop banks, 700 km of drains, 20 pumping stations and 53 dams. The level of flood protection is highly variable, ranging from 1-in-5 year standards in isolated rural areas to between 1-in-1,000 and 1-in-2,000 year standards for Palmerston North. Generally, the protection standards are designed for 1-in-20 to 1-in-50 year events.

There are several major river systems within the Region including the:

Whanganui River: this is the largest river system, and it drains a significant proportion of the land area within the Ruapehu and Wanganui Districts. The

headwaters are located on the western slopes of Mount Ruapehu, and the river system flows south to enter the Tasman Sea at Wanganui. The primary hazard area is Wanganui, with some hazards also present at Taumarunui. and Ohura.

Manawatu River: this is the second largest river system in the Region, and covers much of the land area within the Tararua and Manawatu Districts, and Palmerston North city. The upper catchment drains the eastern side of the Ruahine and Tararua Ranges, extending almost to the east coast, while the lower catchment encompasses a large area between the Ruahine and Tararua Ranges and the Tasman Sea. The primary flood hazard areas within the lower river system are Palmerston North, Filiding, Foxton and Foxton Beach, while Pahiatua is the primary hazard area in the upper catchment.

Rangitikei River: this is the third largest catchment in the Region, and it covers much of the land area within the Rangitikei District. The river is sourced from headwaters in the Kaimanawa and Ruahine Ranges, and flows into the Tasman Sea near Tangimoana. The primary flood hazard areas are Marton, Bulls and Tangimoana.

Whangaehu River: this river is sourced from the eastern side of Mount Ruapehu, and flows in a south-west direction towards the Tasman Sea south of Wanganui. Flood hazards are largely confined to the main channel – particularly those associated with lahars from Mount Ruapehu.

Scenario – Lower North Island Flood Event 2004

The February 2004 storm and resulting flood created the largest civil defence emergency management event in the past 20 years, and was the first major event since the passing of the Civil Defence Emergency Management (CDEM) Act in December 2002. The event was focused on the local authority areas of the Manawatu-Wanganui Region.

During the event, heavy rain on both sides of the ranges led to the Manawatu River overtopping its banks. In the Manawatu-Wanganui region, 4 bridges were destroyed, and 21 were seriously damaged, several showing signs that masses of trees and other debris lodged against piers had contributed to their failure.

Other effects included widespread loss of power, telecommunications outages, water reticulation systems failure, and an estimated 2,500 people being displaced from their homes. The gale force winds led to a large number of trees being toppled. It is understood that the overall economic impact is estimated to be close to $400 million. The social impacts will continue to be felt for some time.

Despite the scale of the event there was no direct loss of life. There were however, several lucky escapes in very hazardous circumstances, and many people were unaware of the potential danger. In some areas, the 2004 flood event exceeded the 1-in-100 year return period, and is probably the best example of a maximum credible flood event within any CDEM Group in New Zealand.

Consequences

Social

- Possible drownings
- Injuries
- Significant social disruption
- Closure of schools
- Temporary closure transportation links
- Increased requirement for social services (counselling, relocation, food etc)
- Evacuation and loss of habitable dwellings
- Flooding of commercial buildings
- Substantial evacuation and displacement
- Distress and on-going mental health problems
- Removal of local government staff from other districts to assist

Built

- Bridges and approaches washed out
- Closure of roads including SH1, 2 and 3.
- Substation at Bunnythorpe out of commission (supplies electricity to lower North Island)
- Some communications networks off-line
- Some water supplies inoperable
- Sewerage lines broken and some washed away, localised contamination
- Community centres flooded (alternate evacuation centres required)
- Temporary closure of rail link (Manawatu Gorge)
- Long-term cost of repair to destroyed/damaged infrastructure

Economic

- Loss of income (self-employed)
- Large loss of farm productivity
- Loss of marine farming due to sewerage contamination
- Closure of major transportation routes
- Loss of tourism
- Loss of export dollars (agricultural and tourism)
- Insurance adjustments after event (national implications)
- Health costs
- Response costs (food, clothing, shelter, transportation)
- Heavy equipment costs
    - Cleanup of sewerage
    - Repair of infrastructure
    - $66 m to estimated to repair roads in region (Trafford, 2004)
    - $4 m to estimated to repair state highway damage
    - $112 m estimated insurance bill

- $2.5 m estimated sheep stock losses
- $300 m estimation of economic impact on region
- $25 m estimated damage to residential housing and $10.2 m for contents (Vision Manawatu, 2004)

Natural

- Loss of stock and agricultural land
- Wetland contamination

Tsunami

The Region is vulnerable to tsunami hazards on both the east and west coasts. The primary sources of tsunami hazards include:

- Distant: South America, particularly southern Peru, and to a much lesser extent Cascadia (North America) and the Aleutian Islands
- Regional: Solomon Islands, and to a much lesser extent the southern New Hebrides
- Local: the Hikurangi Margin, located off the east coast of the Region and local faults including undersea faults located off the west coast.

The most likely sized tsunami event that could be expected to occur once in any 500 year period is:

- 2-4m above mean sea level on the west coast
- 6-8m above mean sea level on the east coast

The impacts of tsunami events vary greatly depending upon the type and size of the event, local topography and in the case of human life and safety, the time of day.

Typical consequences include:

- Loss of life and injuries from debris, and the accompanying social consequences
- Damage to infrastructure, particularly buildings near the coast, and to transportation, coastal utilities and maritime facilities
- Economic impacts to local businesses and industries
- Damage to coastal ecosystems and changes to local coastal processes

On the national scale, the consequences of tsunami events on the Region are considered to be relatively low, due largely to the small number and population of coastal communities, and the relatively short coastline within the Region.

Scenario - Distant Source Tsumani

A large earthquake off the Peruvian coast triggers a tsunami that travels westwards across the Pacific. The Pacific Tsunami Warning Centre (PTWC) in Hawaii estimates that the tsunami will arrive in New Zealand waters in 16.5 hours time. Maximum wave heights are expected to be up to 6m. Areas most

at risk in the Region are the beachside settlements on the Tararua coastline. The time-scale of the waves will be between 2 and 20 minutes and persist for more than 15 hrs after the arrival of the first wave.
Estuaries, coastal wetlands and river mouths will be particularly vulnerable to the tsunami's impacts. Immediately prior to the arrival of the tsunami there will be an extreme reduction in coastal water levels followed by a sudden surge of water that could inundate areas up to 50m inland.

Consequences

Social

- Displacement of people for short periods of time
- Minor disruption to daily activities
- Precautionary evacuation
- Closure of schools and support services
- Increased requirement for counselling, relocation, etc
- Potential loss of habitable dwellings

Built

- Saltwater intrusion/contamination
- Water supply may be out of action in some areas
- Minor damage to coastal structures (e.g. wharves, boat ramps, navigational equipment)
- Sewerage lines broken

Economic

- Loss of tourism
- Health costs
- Insurance adjustment after the event
- Heavy equipment costs
- Minimal agency response costs

Natural

- Erosive damage to coastline
- Change in stream and estuary mouth geometry

Landslides

The Region is susceptible to various types of landslide event over a significant proportion of the region, and in particular the hill country within the Ruapehu District, the north-eastern Wanganui District, the central Rangitikei District and the eastern Tararua District. Landslide hazards are highly dependent upon the type and slope of the terrain, the land use and vegetation cover, climate and susceptibility to seismic events. The primary hazards within the Region are:

- Hill country: the most hazardous events are debris flows associated with lahars from Mount Ruapehu. There are also moderate hazards from shallow landslides in steep areas that have a pastoral land use.

- Lowlands: the primary hazards are from fast, sudden landslide events along the banks of active river channels such as the Pohangina and Turakina Rivers

The consequences of landslides are generally localised in scale, and relate mainly to damage to infrastructure including roads, railways, farm infrastructure and occasionally buildings. The threat to human life is relatively low, except for sudden events such as the Pohangina River tragedy in 2006, where three lives were lost.

Scenario – Manawatu Gorge Slip

A large rock and debris slide (80–100,000m^3) has blocked SH3 in the Manawatu Gorge. The landslide occurs after weeks of wet weather and a M_L 4.1 earthquake 4 km north on the Ruahine Fault. It is about 3 months before the road is re-opened and delays occur following 6 further failures. The Saddle Road is still open as an alternative route as is the Pahiatua Track.

GNS Photo: GH2287,12/3/04

Magnitude of Event
80-100,000m^3

Recurrence Interval
Unknown

Consequences
Social

- Closure of SH3 creates on-going distress at lengthy delays for several months
- Inconvenience caused by detours

Built

- Road blockage at SH3
- Extensive scarp stabilisation work required
- Reinstatement of damaged rock fall protection works

Economic

- Cost of infrastructure repair (road)
- Temporary closure of main road transportation route
- Insurance adjustments after event (national implications for transportation costs)
- Heavy equipment costs for removal of debris and recovery of vehicles
- Possible loss of tourism dollars

- Increased transportation cost due to diversions
- Increased maintenance cost to the Saddle Road, and to a lesser extent, the Pahiatua Track, due the increase in heavy traffic

Natural

- Re-activation of landslip scarp possible
- Redistribution of failed slip material required (Resource Consent implications)

Scenario –Shallow-regolith landslides and erosion


GNS Photo: GH1848

In February 2004 the region experienced a rainfall event with a greater than 150 year return period over more than 300,000 hectares, which resulted in 62,000 landslides (Tait et al., 2005). The most severely damaged areas were in Mangawhero, Whangaehu, Turakina, and Pohangina valleys (Hancox & Wright, 2005).
Most of the landslides occurred on steeper (25–40°) pasture-covered hill slopes, gullies, and terrace edges. Gully and river bank failures, however, contributed considerable sediment and trees to flooded rivers, with the latter causing some bridge failures. All sandstone and mudstone hill country is susceptible to landsliding, no matter what the slope. (Dymond, Ausseil, Shepherd, & Buettner, 2006).

In this type of country (Tertiary sediments) the probability of failure is greater than 0.5 during a storm with a return period of approximately 20 years (Dellow & Dymond, 2008).

Consequences

Social

- Support for families affected
- Support for roading contractor works and emergency services personnel
- Closure of local roads creates on-going distress at lengthy delays for several weeks
- Distress caused by detours
- Stress to members of farming communities
- Assistance from roading contractor personnel and district council staff

Built

- Local road blockages

Economic

- Loss of agricultural production
- Pasture recovery costs
- Insurance adjustments after event
- Health and social services costs
- Heavy equipment costs for removal of debris from roads and farm infrastructure
- Cost of infrastructure repair (roads and farms)
- Increased transportation cost due to diversions
- The combined cost of land sliding, flooding and siltation was NZ$170 million (Trafford, 2004)

Natural

- Damage to aquatic and terrestrial biodiversity
- Redistribution of failed slip material required (Resource consent implications)

Coastal Flooding and Erosion

The east and west coasts of the Region are very different in character. The east coast has rugged topography, with a few low-lying areas that are dominated by isolated pocket beaches. Coastal flooding and erosion both have the potential to present hazards to property and infrastructure at Akitio and Herbertville.

The west coast is characterised by a continuous sediment system that is backed by an extensive dune system. Coastal flooding and erosion is limited to low-lying areas around river mouths such as Wanganui, Koitiata, Scott's Ferry, Tangimoana, Himatangi, Foxton Beach and Hokio Beach. The most active area of coastal erosion on the west coast is the cliff coastline north of Wanganui, particularly at Kai Iwi Beach.

The consequences of coastal flooding and erosion are mainly limited to localised property and infrastructure. This is largely due to limited development along the coastal margins.

Scenario – West coast flooding and erosion

A storm of tropical origin is tracking very slowly southwards into the Tasman Sea and is bringing with it gale force winds, heavy rain and low atmospheric pressure. MetService has issued a Severe Weather Warning stating that rainfall in excess of 250mm could fall over parts of Manawatu, Wanganui, Rangitikei, Palmerston North and Horowhenua. MetService has also issued a wave warning for the west coast from Wanganui to Kapiti, combined wave heights rising to 6.5m. SSE winds of 90 km/hr with gusts up to 130 km/hr are currently being experienced in exposed areas.
As a result, the coastal settlements from Foxton Beach to Wanganui have been inundated by high sea levels caused by the combination of a high spring

tide and storm surge. However damage has been minimised in Foxton Beach thanks to the recently completed protection works.

Magnitude of Event
100 years

Recurrence Interval
1%

Consequences
Social

- Medical treatment required for conditions caused or aggravated by wet and cold
- Evacuations and displacement of beach front residents
- Stress and anxiety among communities
- On-going mental health problems
- Removal of local government staff from other districts to assist

Built

- Complete loss of some beach front residential and community buildings, widespread damage to others
- Roads damaged by erosion
- Temporary closure of some roads
- Storm water pipes broken (some washed away)
- Damage to water supply, and storm water and sewerage systems
- Saltwater intrusion/contamination
- Electricity failure (localised)

Economic

- Loss of income (self-employed)
- Response and declaration costs
- Large agency response costs
- Cleanup of sewerage and debris
- Welfare costs (food, clothing, shelter, transportation, etc)
- Loss of tourism, particularly if event occurred during summer months
- Insurance adjustments after the event
- Health costs
- Heavy equipment costs
- Repair of infrastructure
- Closure of schools
- Increased requirement for social services (counselling, relocation, etc)
- Business failure (limited)
- Costs of damage to residential home, businesses and community facilities (high)
- Large clean-up costs to residents and Councils

Natural

- Loss of foreshore (chronic erosion)
- Change in stream mouth geometry
- Widespread deformation of the regional landscape

Rural Fire

Over 70 % of the Manawatu-Wanganui Region has a wildfire hazard rating of high, very high, or extreme. The areas of extreme wildfire hazard are the Ruahine ranges and the northern Rangitikei district (where the 1983 Ohinewairua fire broke out); followed by southeast Tararua district and isolated inland pockets in Wanganui and southern Rangitikei districts.

Most of eastern Tararua district is classified as a very high wildfire hazard, as are the smaller areas just west of Palmerston North and north and south of Mount Ruapehu. Wildfire frequency is closely related to drought frequency, as lower than normal rainfall is the main cause of higher than normal fire outbreaks. The consequences of rural fires are normally to vegetation, infrastructure and occasionally buildings rather than a direct threat to human life and safety.

Scenario – Santoft Forest fire

In this scenario the cause is unknown but it could be from either a lightening strike, arson, or by accidental means (e.g. from a cigarette butt or spark from a motorbike or agricultural machinery).
A fire has broken out in Santoft Forest, north-west of Palmerston North. The blaze is spreading rapidly through large areas of mature pine plantation due to strong NW winds, high air temperatures, and low humidity. No significant rain has fallen in the area for 2.5 weeks.
The fire front is 0.5 km across and widening and is travelling at 1km/hr. The fire is not expected to affect any inhabited areas at this time, unless the wind changes to a more easterly direction. The Principal Rural Fire Officer for Manawatu and Rangitikei Districts is the Incident Controller, with NZ Fire Service, Earnslaw One and NZDF personnel and equipment in support. Four helicopters with monsoon buckets have been called in to assist.

Consequences

Social

- Injuries (to the fire fighters)
- Potential for evacuation
- Distress due to the unpredictable nature of the event and potentially being forced from home
- First aid and medical support services
- Loss of recreational asset

Built

- No losses to built environment

Economic
- Significant loss of un-harvested timber
- Insurance implications (adjustments likely after the event)
- Agency response costs

Natural
- Loss of native plant and animal species
- Increased erosion

Severe Winds

The southern part of the region is subject to frequent high winds associated with the low section of the Tararua Range around the Manawatu Gorge. The maximum gust speed for low lying areas that is expected to be equalled or exceeded once in every 50-year period for most of the Manawatu-Wanganui R egion is about 150–180 km/hr. The areas to the east of the Taraua and Ruahine Ranges are at risk from severe lee winds from the west and north-west.

Shannon is vulnerable to high (lee) winds from the south-east and has been hard hit on a number of occasions, the most recent being July 2008. During this storm, approximately 25,000 households in Horowhenua, including Levin, Otaki and Shannon, were without power for up to 17 hours. It would take many days more to get power restored to another 1000 households. Many farmers without power struggled to milk heavily laden cows. Roads were closed by fallen trees and slips.

Recurrence Interval
1/50 year

Consequences
Social
- Injuries from falling trees and wind-driven debris
- Temporary closure of some roads
- Anxiety

Built
- Roof damage to residential houses and businesses
- Damage to buildings and lifeline infrastructure from falling trees and debris
- Roads closed by fallen trees and debris
- Electricity failure (localised)
- Damage to water supply and sewerage systems

Economic
- Cost of damage to residential homes and businesses
- Lost revenue for businesses forced to close due to power outage
- Lost revenue to dairy farmers unable to milk cows or have milk collected

- Clean-up costs to residents, councils and roading authority

Natural
- Widespread temporary deformation of the regional landscape
- Loss of amenity values in some areas

Drought

This scenario is based on the 1978 drought, which for many areas, was the most severe drought on record. Large areas of the region have not experienced significant rain for several months (January, February, March and April). Some areas had decreased soil moisture deficits from as early as November. Most monitoring sites in the region recorded 40-60 days of severe soil moisture deficit. Foxton recorded 88 days with severe soil moisture deficit, 84 days at Hunterville, 78 days in the Wanganui hill country, and 53 days in Pahiatua. River flows and groundwater levels are at record or near record lows in March and April throughout the central and lower North Island. The Ohau River runs dry south of SH1 and smaller streams stop flowing (Tait et al., 2005).

Recurrence Interval
1/50 year

Consequences
Social
- Loss of agricultural and horticultural productivity
- Stress and anxiety

Built
- Metropolitan water supplies severely limited
- Rural domestic water supplies limited
- Irrigation water supplies restricted

Economic
- Crop failure
- Feed shortages
- Cow herds dried off several months early
- Sheep and cattle lose condition
- Loss of dairy production
- Extra cost of water cartage
- Cost of fighting fires
- Cost of extra feed and supplements
- Drought affects businesses relying on rural economy
- Some individual farms face losses up to $200K in lost production and expenses
- $180 million estimated cost to rural economy

Natural

- Stress to trees and shrubs
- Forest fires break out
- Flora and fauna die as result of rivers and streams running dry

Electricity failure

The Manawatu-Wanganui Region is a central corridor for the national electricity grid. The single most important TransPower asset within the region is the Bunnythorpe Substation between Palmerston North and Feilding. Electricity distribution is centred on Bunnythorpe, with most local feeder lines distributing outwards from the Palmerston North/Feilding area.

The primary cause of large-scale system failure is most likely to be a 1-in-150 year or greater earthquake event centred in the southern part of the Region. Earthquake shake zones and susceptibility to liquefaction are considerably higher in the Palmerston North/Feilding area than other parts of the Region. Storm and flood events also present considerable risk to the electricity network due primarily to the loss of bridges and landslides.

Scenario – Widespread power outages

A 1 in 150 year earthquake has struck the lower North Island and the Bunnythorpe Substation has been severely damaged cutting power to a very large number of customers on the networks of Transpower, Powerco and Electra. Power is not expected to be restored at all for 3 days with many more facing power outages of up to 8 days. It is mid-winter.

Consequences
Social

- An increase in deaths as a result of cold related illnesses
- Health care in homes and hospitals compromised where power is critical (dialysis and surgery)
- Increase in theft from homes due to a lack of urban lighting
- Looting and vandalism
- Retail stores, businesses of all types, and schools forced to close
- Guests at hotels and motels without power forced to leave or find other accommodation
- Increased requirement for social services (relocation, food, etc)
- Increase in injuries due to a lack of essential lighting (people using stairs etc)
- Increased pressure on health providers as people eat compromised food, improperly cooked
- Loss of perishable food stocks in homes and food retailers
- Inadequate hot water to sanitise
- Fumes from generators and poor ventilation
- Personal hygiene issues (unable to flush toilets, wash clothes, shower etc)

- Potential for Legionnaires' disease due to inadequate water flow
- People stranded in lifts
- Some automatic doors may stay closed trapping people

Built

- Traffic lights fail at major intersections resulting in an increase in accidents
- Wastewater, water and natural gas reticulation systems rendered inoperable
- Sprinkler and alarm systems deactivated
- Absence of heating and/or air conditioning
- Lifts inoperable
- Shortage of generators
- Disruptions to communications such as email, faxes and phone lines
- Impacts to other lifelines services that rely on power such as water supplies, fuel and communications equipment

Economic

- Loss of business
- Agency response costs
- Loss of Eftpos and ATM transactions
- Delays in any proposed sports fixture (such an international cricket or rugby match - particularly those scheduled at night)
- Loss of products (particularly food)
- Loss of international reputation and effect on tourism
- Disruption to banking and other financial services
- Insurance adjustments after the event
- Impacts on businesses and industry such as farming
- Impacts on transportation networks such as roads and railways

Natural

- Effects on waterways due to sewerage contamination

Hazardous Substance Spill

An articulated truck and trailer unit laden with toxic chemicals and paint has burst into flames while travelling along State Highway (SH)1 through the township of Bulls. The chemicals include formaldehyde, pesticides and a large quantity of paint.

Consequences

Social

- Closure of nearby schools and businesses
- Increased requirement for relocating evacuees (welfare)
- Possible fatalities: up to 5 people during peak traffic times
- Injured pedestrians/bystanders

- Entrapped persons and injuries
- Significant pressure on emergency services
- Toxic fumes may affect residents downwind
- Evacuation and loss of habitable dwellings

Built
- Fire and structural damage to nearby buildings and/or homes
- Road damage
- Diversions in place over less suitable roads
- Electricity transmission lines repairs

Economic
- Closure of major transportation route (SH1 and SH3)
- Closure of businesses
- Responding agency costs

Natural
- Fuel and contaminants flow into waterways

Telecommunications failure

Telecommunications facilities are widespread throughout the Region. Most landline infrastructure is located in the south-west, while cell phone networks are clustered along the main state highways. There are also numerous radio links in the central hill country that provide for radio communications.

The primary causes of system failure are similar to the electricity network, but there is also a critical dependency upon electricity supply. Like the electricity network, the consequences of failure are primarily social and economic:

Social
- Disruption to emergency communications both from the public to emergency services, and amongst emergency response organisations
- Significant disruption to ATM, EFTPOS and banking/financial systems, which will impact upon the ability of people to purchase essential supplies.

Economic
- Major disruptions to routine business operations

Human pandemic

A pandemic is an epidemic of infectious disease that spreads through populations across a large region. The last worldwide pandemic started in 1918, and infected up to 5% of the world's population. The 1918 pandemic resulted in at least 25 million deaths worldwide.

Since 2004, the potential of the H5N1 avian influenza virus to create a pandemic has been the cause of considerable concern to governments worldwide, including the New Zealand Government. Considerable research, planning and preparation has been undertaken within New Zealand to prepare for response to a pandemic, including the Manawatu-Wanganui CDEM Group Pandemic Plan.

While the likelihood of a pandemic is uncertain, the consequences of a 'full-blown' event would certainly be severe, for the Region and New Zealand.

Scenario - Pandemic

This scenario has been developed in consultation with MidCentral Health District Health Board (DHB) and Whanganui DHB. Pandemics have the potential to cause widespread illness, death and disruption. Factors that need to be present for a pandemic to occur include the emergence of a new viral subtype, the capacity for the virus to spread efficiently from person to person, and being virulent enough to cause disease. The most likely scenario is that of an influenza pandemic. Influenza pandemics are characterised by the spread of a novel type of influenza virus to all parts of the world, causing unusually high morbidity and death for two to three years. Most people are susceptible to influenza.

Magnitude of Event:
Variable

Recurrence Interval:
It is not possible to predict when the next pandemic will occur or how long it will last. The last true pandemic was in 1968.

Consequences
Social

- 1,800 deaths – most at risk are he elderly and very young
- 9,000 hospitalisations and a 40% infection rate across the population
- Closure/attempted closure of or limitations on places of 'mass gatherings', eg schools, factories, churches, marae, restaurants, sporting events, etc
- Limited/curtailed movement around the country
- Increased unemployment
- 'Siege mentality', especially in smaller communities
- Possible social unrest
- Loss of income/ability to support family/whanau
- Inability to provide key services (emergency services, health, education, transport, and utility) due to absence of workers
- Isolation of some communities, exacerbated if infrastructure (eg telecommunications, power) fails

Built

- Due to widespread sickness and deaths as above, a decreased capacity for the workforce to provide essential lifelines services

- Breakdown/failure of key utilities due to the above

Economic

- Direct costs of response and management to the healthcare system
- Loss of worker productivity for internal and export production, with major impacts to businesses and industry
- Insurance adjustments after event (national implications)
- Loss of the tourism industry
- Loss of overseas investment and business confidence
- Exchange rate reduction
- Sharemarket downturn

Natural

- Contamination and spread of infection

Animal Epidemic

A number of cases of anthrax are detected on the banks of the Manawatu River, near Foxton. While anthrax is endemic with sporadic incidence in many countries, the disease has not been diagnosed in New Zealand since 1954 and is now treated as exotic. Anthrax affects animals and humans, and may be fatal, so is considered a serious public health risk. An incursion would require significant public communications assuring the safety of the New Zealand meat products. Trade would also be severely affected. Public health officials will be overwhelmed with the demand for information.
In addition to the above hypothetical example, since 2000, The Ministry of Agriculture and Forestry (MAF) has responded to Varroa (bees), Mycoplasma response (dairy), *Brucella suis* (pigs), Parrot Pox (birds) and Postweaning Multisystemic Wasting Syndrome (pigs).
Both scenarios above have been taken from the Ministry of Agriculture and Fisheries report titled "Advice to Civil Defence/Emergency Management Groups on Hazard Identification and Emergency Management".

Likelihood

Foot-and-mouth disease (FMD) has never occurred in New Zealand. New Zealand has some of the strictest import restrictions internationally. FMD is a low probability but high consequence risk for New Zealand due to increased global travel and trade. Recent experiences in Taiwan 1997 (FMD-free since 1929), South Africa 2000 (FMD-free since 1956 in domestic livestock), South Korea 2000 (FMD-free since 1934), Japan 2000 (FMD-free since 1908) and the UK (FMD-free since 1967) underline that the threat of this disease is ever-present.
Mid-range event such as anthrax, formerly present in New Zealand and abundant in other countries or avian influenza with a strain that affects humans have greater probability. There have been six instances of bird flu recently (UK 1996; China 1998, Hong Kong 1997, 1999 and 2003 and the Netherlands 2003). Human-to-human transmission of avian influenzas is thought to be extremely limited. The exact mode of transmission from birds to

humans is not known. It is this unknown factor that results in high levels of public concern that would exceed the technical issues.

Consequences

Social

- Public concern and panic are greater than actual human illness or death from zoonotics as a relatively small proportion of the population interact routinely with livestock and poultry
- Food safety issues will come to the forefront with diseases such as anthrax, bovine spongioform encephalopathy or other transmissible encephalopathies of animals due to the linkage with new variant Creutzfeldt Jakob disease, a degenerative fatal human encephalopathy
- Other public health priorities also compromised

For Foot-and-Mouth Disease:

- 15-20,000 increase in unemployed
- Reduced household wealth due to drop in exchange rate and investment.
- Loss of ability to work for large portion of the workforce
- Psychological impacts including fear and confusion, paranoia and other trauma
- Stigma of biosecurity breakdown placed on those affected
- Loss of rural community fabric due to devastation of rural economy

Built

- Challenges on infrastructure are dependent on circumstance. They may include demands on water supply due to the need for cleaning and disinfection for conveyances and for premises decontamination, heavy equipment demands and environmental degradation due to carcass disposal, demand on municipal landfill for disposal of potentially infected material, or bio-secure transport of carcasses over public roads to mass burial sites.

Economic

For Foot-and-Mouth Disease:

- A loss of GDP $6 billion in first year; $10 billion after 2 years
- 8% drop in export of goods and services in first year
- Loss would continue because output lowered and exacerbated by slumps in domestic demand and negative reaction of trading partners
- 20% drop in exchange rate, recovering over ~ 2 1/2 years
- Reduced overseas and local investment (short term by 20%, longer term 6%)
- Reduced tax revenue $3.5 billion over 4 years

- Doubling of net debt (2009-10 projected 12.1%, rises to 25.6%)
- Cost of emergency response to the outbreak = $200 million includes controlling outbreak & compensating for animals slaughtered
- Tourism drop could be significant (in the UK during 2001, tourism was impacted 10 times more than the primary production sector)

Natural

- Dairy in Waikato, Taranaki, Southland
- Sheep and beef in South Island - Otago, Southland
- Poultry and pigs around Auckland and Christchurch

References

Dellow, G. D., & Dymond, J. (2008). *Landslide hazards in the Horizons region* (No. 2008/175): GNS Science.

Dymond, J. R., Ausseil, A.-G., Shepherd, J. D., & Buettner, L. (2006). Validation of a region-wide model of landslide susceptibility in the Manawatu–Wanganui region of New Zealand. *Geomorphology, 74*(2006), 70-79.

Hancox, G. T., & Wright, K. (2005). *Landslides caused by the February 2004 rainstorms and floods in southern North Island, New Zealand* (No. 2005/10): Institute of Geological & Nuclear Sciences.

Hodgson, K. A., & Houghton, B. F. (1999). Volcanic hazard assessment. In *Hazard analysis manual: Volume I - Volcanic*. Palmerston North: horizons.mw.

Horizons Regional Council. (1999). *Hazard analysis manual: Volume I - Volcanic* (No. 99/EXT/373). Palmerston North.

Tait, A., Bell, R., Burgess, S., Gray, W., Ladd, M., Mullan, B., et al. (2005). *Meteorological hazards and the potential impacts of climate change in the Manawatu-Wanganui region* NIWA Client Report WLG2005-17 prepared for Horizons Regional Council.

Trafford, L. (2004). *Storm: Civil emergency: Storm and flood report* (No. 2004/EXT/591). Palmerston North: Horizons Regional Council.

Vision Manawatu. (2004). *Manawatu-Wanganui Floods: Economic evaluation - Interim report (Final)*: Manawatu Wanganui Group Recovery Economic Task Group.

Bibliography

General

Cunningham, D. J. (2006). *The application of risk analysis tools in civil defence emergency management planning in New Zealand.* Unpublished Masters Thesis, Massey University, Palmerston North.

Officials' Committee for Domestic and External Security Coordination. (2007). *National Hazardscape Report*. Wellington: Department for the Prime Minister and Cabinet.

Tonkin & Taylor Ltd. (2006). *Natural hazard management: Research report*: Ministry for the Environment Quality Planning website (www.qualityplanning.org.nz).

Volcanic

Horizons Regional Council. (1999). *Hazard analysis manual: Volume I - Volcanic* (No. 99/EXT/373): Horizons Regional Council.

Horwell, C. J., & Baxter, P. J. (2006). The respiratory health hazards of volcanic ash: a review for volcanic risk mitigation. *Bulletin of Volcanology, 69*(1), 1-24.

Manawatu-Wanganui Lifelines Project. (2005). *Risks and responsibilities: Manawatu-Wanganui regional lifelines project report* (No. 2005/EXT/622): Manawatu-Wanganui CDEM Group.

McCormack, D. D. (Cartographer). (1987). *Volcanic hazard map of Tongariro National Park region* [Scale 1:100,000].

McSaveney, E., Stewart, C., & Leonard, G. (5 November 2007). 'Historic volcanic activity', Te Ara - the encyclopedia of New Zealand. Retrieved 17 May 2009, 2009, from http://www.TeAra.govt.nz/EarthSeaAndSky/NaturalHazardsAndDisasters/HistoricVolcanicActivity/en

Paton, D., Millar, M., & Johnston, D. (2001). Community resilience to volcanic hazard consequences. *Natural Hazards, 24*(2), 157-169.

Earthquake

Butcher, G. (1998). *The Edgecumbe earthquake: a review of the 2 March 1987 Eastern Bay of Plenty earthquake*. Christchurch: Centre for Advanced Engineering, University of Canterbury,.

Downes, G. L. (1995). *Atlas of isoseismal maps of New Zealand earthquakes*. Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Limited.

Horizons Regional Council. (1999). *Hazard analysis manual: Volume II - Seismic analysis* (No. 99/EXT/383): Horizons Regional Council.

Jackson, J., Van Dissen, R., & Berryman, K. (1998). Tilting of active folds and faults in the Manawatu region, New Zealand: evidence from surface drainage patterns. *New Zealand Journal of Geology and Geophysics, 41*(4), 377-385.

Manawatu-Wanganui Lifelines Project. (2005). *Risks and responsibilities: Manawatu-Wanganui regional lifelines project report* (No. 2005/EXT/622): Manawatu-Wanganui CDEM Group.

Melhuish, A., VanDissen, R., & Berryman, K. (1996). Mount Stewart-Halcombe anticline: A look inside a growing fold in the Manawatu region, New Zealand. *New Zealand Journal of Geology and Geophysics, 39*(1), 123-133.

Ministry of Civil Defence and Emergency Management. (2009). Major Wellington Earthquake National Initial Response Plan. Wellington: Ministry of Civil Defence and Emergency Management.

River Flooding

Environmental Management Services Ltd. (2004). *Review of Horizons Regional Council February 2004 flood response* (No. 2004/Ext/590): Environmental Management Services Ltd.

Gray, W., Ibbitt, R., Turner, R., Duncan, M., & Hollis, M. (2005). *A methodology to assess the impacts of climate change on flood risk in New Zealand* (No. CHC2005-060): NIWA.

Horizons Regional Council. (1999). *Hazard analysis manual: Volume III - Flooding* (No. 99/EXT/374).

Manawatu-Wanganui Lifelines Project. (2005). *Risks and responsibilities: Manawatu-Wanganui regional lifelines project report* (No. 2005/EXT/622): Manawatu-Wanganui CDEM Group.

Mulholland, M., Riley, P., Tate, D., & Sutherland, A. (2004). *Preliminary review of flood protection failures on the Manawatu and Rangitikei River systems* (No. 2004/EXT/583): Horizons Regional Council.

Reid, P., Brunsdon, D., Fitzharris, P., & Oughton, D. (2004). *Review of the February 2004 flood event*.

Tait, A., Bell, R., Burgess, S., Gray, W., Ladd, M., Mullan, B., et al. (2005). *Meteorological hazards and the potential impacts of climate change in the Manawatu-Wanganui region (*No. WLG2005-17): NIWA.

Tait, A., & Sturman, J. (2008). *Annual rainfall maps for the Horizons-Manawatu region* (No. WLG2008/69): NIWA.

Thompson, C. (2004). *Average recurrence intervals of the February 2004 storm over southern North Island* (No. WLG2004-44): NIWA.

Trafford, L. (2004). *Storm: Civil emergency - storm and flood report* (No. 2004/EXT/591). Palmerston North: Horizons Regional Council.

Vision Manawatu. (2004). *Manawatu-Wanganui Floods: Economic evaluation - Interim report (Final)*: Manawatu Wanganui Group Recovery Economic Task Group.

Tsunami

Berryman, K. (2005). *Review of tsunami hazard and risk in New Zealand* (No. 2005/104): Geological & Nuclear Sciences Limited.

Chague-Goff, C., & Goff, J. (2007). *East coast tsunami hazard study - Stage 1* (No. CHC2007-074): NIWA.

Dudley, W. C., & Lee, M. (1998). *Tsunami!* (2nd ed.). Honolulu: University of Hawaii Press.

GeoEnvironmental Consultants. (2001). *Wellington regional tsunami hazard scoping project* (No. WRC/RP-T-01/23): GeoEnvironmental Consultants.

Leonard, G. S., Power, W., Lukovic, B., Smith, W., Langridge, R., Johnston, D., et al. (2008). *Tsunami evacuation zones for Wellington and Horizons regions defined by GIS* (No. 2008/30): GNS Science.

Ministry of Civil Defence and Emergency Management. (2007). Draft national distant source tsunami contingency plan: Author.

Smith, W., Power, W., Lukovic, B., & Cousins, J. (2007). *Wanganui tsunami risk assessment* (No. 2007/308): GNS Science.

Steinbrugge, K. V. (1982). *Earthquakes, volcanoes, and tsunamis: An anatomy of hazards*. New York: Skandia America Group.

Tibballs, G. (2005). *Tsunami: the world's most terrifying natural disaster*. London: Carlton Books.

Walters, R. A., & Goff, J. (2003). Assessing tsunami hazard along the New Zealand coast. *Science of Tsunami Hazards, 21*(3).

Wanganui District Council. (2009). Tsunami contingency plan.

Webb, T. (2005). *Review of New Zealand's preparedness tsunami hazard, comparison to risk and recommendations for treatment* (No. 205/162): Geological and Nuclear Sciences Limited.

Landslides

Dellow, G. D., & Dymond, J. (2008). *Landslide hazards in the Horizons region* (No. 2008/175): GNS Science.

Dymond, J., & Shepherd, J. (2006). *Highly erodible land in the Manawatu-Wanganui region* (No. 0607/027): Landcare Research.

Dymond, J. R., Ausseil, A.-G., Shepherd, J. D., & Buettner, L. (2006). Validation of a region-wide model of landslide susceptibility in the Manawatu–Wanganui region of New Zealand. *Geomorphology, 74*(2006), 70-79.

Evans, S. G. (2002, Jun 16-21). *Single-event landslides resulting from massive rock slope failure: Characterising their frequency and impact on society.* Paper presented at the NATO Advanced Research Workshop on Massive Rock Slope Failure - New Models for Hazard Assessment, Celano, ITALY.

Glade, T., Anderson, M., & Crozier, M. J. (Eds.). (2007). *Landslide hazard and risk*. Chichester: John Wiley & Sons, Ltd.

Glade, T., & Crozier, M. J. (1999). *Landslides of New Zealand: A selected bibliography*. Wellington: Victoria University.

Hancox, G. T., & Wright, K. (2005). *Analysis of landsliding caused by the 15-17 February 2004 rainstorm in the Wanganui-Manawatu hill country, southern North Island, New Zealand* (No. 2005/11): Institute of Geological & Nuclear Sciences.

Hancox, G. T., & Wright, K. (2005). *Landslides caused by the February 2004 rainstorms and floods in southern North Island, New Zealand* (No. 2005/10): Institute of Geological & Nuclear Sciences.

Horizons Regional Council. (2009). One Plan - Chapter 5: Land. In *Proposed One Plan*.

Jones, H., Clough, P., Höck, B., & Phillips, C. (2008). *Economic costs of hill country erosion and benefits of mitigation in New Zealand: Review and recommendation of approach*: Scion (Forest Research Institute Ltd).

Ko, C. K., Flentje, P., & Chowdhury, R. (1999, Nov 08-11). *Landslide risk assessment - Development of a hazard-consequence approach.* Paper presented at the International Symposium on Slope Stability Engineering (IS-SHIKOKU 99), Matsuyama, Japan.

Coastal Flooding and Erosion

Carter, R. W. G. (1988). *Coastal environments: an introduction to the physical, ecological, and cultural systems of coastlines*. London; New York: Academic Press.

Manawatu-Wanganui Lifelines Project. (2005). *Risks and responsibilities: Manawatu-Wanganui regional lifelines project report* (No. 2005/EXT/622): Manawatu-Wanganui CDEM Group.

Ministry for the Environment. (2008). *Coastal hazards and climate change: A guidance manual for local government in New Zealand*. Retrieved 21 March 2008. from http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/coastal-hazards-climate-change-guidance-manual.pdf.

Shand, R. D. (2008). *Foxton Beach erosion hazard assessment* (No. 2008-10 REP): Coastal Systems Ltd.

Standards New Zealand. (2008). NZS 9401:2008 Managing flood risk: A process standard. Wellington: Standards New Zealand.

Tait, A., Bell, R., Burgess, S., Gray, W., Ladd, M., Mullan, B., et al. (2005). *Meteorological hazards and the potential impacts of climate change in the Manawatu-Wanganui region (*No. WLG2005-17): NIWA.

Severe Storms

Manawatu-Wanganui Lifelines Project. (2005). *Risks and responsibilities: Manawatu-Wanganui regional lifelines project report* (No. 2005/EXT/622): Manawatu-Wanganui CDEM Group.

Tait, A., Bell, R., Burgess, S., Gray, W., Ladd, M., Mullan, B., et al. (2005). *Meteorological hazards and the potential impacts of climate change in the Manawatu-Wanganui region* NIWA Client Report WLG2005-17 prepared for Horizons Regional Council.

Trafford, L. (2004). *Storm: Civil emergency - storm and flood report* (No. 2004/EXT/591). Palmerston North: Horizons Regional Council.

Human Pandemic

Manawatu-Wanganui CDEM Group. (2006). Manawatu-Wanganui CDEM Group Pandemic Plan: Version 2. Palmerston North: Horizons Regional Council.

MidCentral District Health Board. (2006). MidCentral District Health Board Pandemic Plan. Palmerston North: MidCentral District Health Board.

Ministry of Health. (2006). New Zealand Influenza Pandemic Action Plan. Wellington: Ministry of Health.

11. Appendix C Measures of Consequence for Risk Analysis and Seriousness Rating in Risk Evaluation

Level	Descriptor	Environment	Detail description
1	nificant	Social	No fatalities, no injuries, little disruption to community
		Built	Only very minor damage if any
		Economic	Low financial loss
		Natural	No measurable impact on environment
2	Minor	Social	No fatalities, small number of injuries, first aid treatment required, some displacement of people (very short period of time e.g. 24 hours), some personal support required, some disruption (short period of time)
		Built	Some damage
		Economic	Some financial loss
		Natural	Small impact on environment with no lasting effects
3	Moderate	Social	No fatalities, medical treatment required, some hospitalisation, displacement of people (very short period of time e.g. 24 hours), personal support satisfied through local arrangements, normal community functioning with some inconvenience
		Built	Localised damage which is rectified by routine arrangements
		Economic	Significant financial loss
		Natural	Some impact on environment with no long term effects or small impact on environment with long term effects
4	Major	Social	Fatalities, extensive injuries, significant hospitalisation, large number displaced (more than 24 hours duration), external resources required for personal support, community only partially functioning
		Built	Significant damage that requires external resources, some services unavailable
		Economic	Significant financial loss – some financial assistance required
		Natural	Some impact on environment with long term effects
5	Catastrophic	Social	Significant fatalities, large numbers of severe injuries, large numbers requiring hospitalisation, general and widespread displacement for extended duration, extensive personal support, community unable to function without significant support
		Built	Extensive damage
		Economic	Huge financial loss – unable to function without significant support
		Natural	Significant impact on environment and/or permanent damage

12. Appendix D Manageability and Growth Rating

Manageability Rating

Management Difficulty	Current Effort	Rating
Low	High	1
Low	Medium	2
Medium	High	
Medium	Medium	3
High	High	
Low	Low	4
Medium	Low	
High	Medium	
High	Low	5

Growth Rating

Event occurrence probability rise	Changing community exposure	Rating
Low	Low	1
Low	Medium	2
Medium	Low	
Medium	Medium	3
Low	High	
Medium	High	4
High	Low	
High	Medium	
High	High	5

13. Appendix E Manawatu-Wanganui Hazard Risk Assessment

Hazard Identification	Risk Analysis			Risk Evaluation											
	Likelihood	Consequence	Rating	Seriousness					Manageability					Growth	Total
				Social	Built	Economic	Natural	*Sub-total*	Reduction	Readiness	Response	Recovery	*Sub-total*	*Sub-total*	
River Flood	Possible	Major	High	4	4	4	3	7.8	2	1	1	4	2	4	13.8
Earthquake	Rare	Major	Moderate	4	5	4	4	8.5	3	3	4	5	3.75	1	13.3
Human Pandemic	Likely	Catastrophic	Extreme	5	1	5	1	7.2	4	2	4	5	3.75	2	13.0
Landslide - Widespread hill country	Possible	Major	High	2	3	4	5	5.7	2	3	4	3	3	4	12.7
Electricity Failure	Unlikely	Moderate	Moderate	4	2	3	2	6.3	3	4	4	4	3.75	2	12.1
Wildfire	Possible	Moderate	Moderate	2	1	3	3	4	4	3	3	4	3.5	4	11.5
Volcanic - Ruapehu Lahar & Ashfall	Rare	Moderate	Low	4	3	3	3	7	5	2	2	4	3.25	1	11.3
Hazardous Substances Spill	Possible	Major	High	4	3	2	2	6.5	3	4	3	4	3.5	1	11.0
Tsunami	Unlikely	Moderate	Moderate	3	3	2	2	5.5	5	2	2	4	3.25	2	10.8
Coastal Flooding/Erosion	Rare	Major	Moderate	3	3	2	2	5.5	3	4	2	4	3.25	2	10.8
Animal Epidemic (Foot & Mouth)	Unlikely	Catastrophic	Very High	3	1	5	1	5.2	5	4	4	4	4.25	1	10.5
Severe Wind	Possible	Minor	Moderate	2	3	2	3	4.7	3	3	3	4	3.25	2	10.0
Drought	Possible	Moderate	Moderate	2	1	4	3	4.3	5	3	2	4	3.5	2	9.8
Telecommunications Failure	Unlikely	Moderate	Moderate	2	1	3	1	3.6	3	4	4	4	3.75	2	9.4
Landslide - Manawatu Gorge	Likely	Minor	Moderate	1	3	1	2	3.2	4	1	1	2	2	2	7.2

14. Appendix F Comparison of Hazard Assessment Results in Manawatu-Wanganui Region

Hazard	Region 2009 SMG	Region 2006 SMUG	Manawatu	Palmerston North	Wanganui	Ruapehu	Tararua	Horowhenua	Rangitikei
Flood - Riverine	1	8	1	5	5			3	9
Earthquake	2	1	1	1	1			1	8
Human Pandemic	3	2	3	2	3			2	2
Landslide - Widespread hill country	4								
Electricity Failure	5	15	8		17			7	13
Wildfire	6		19	8	25			20	
Volcanic - Ruapehu	7	16	30	2	7			19	15
Hazardous Substances Spill	8	12	8	6	23			12	11
Tsunami - Distant Source	9		8	9	11			6	
Coastal Flooding/Erosion	10	7						16	3
Animal Epidemic (Foot & Mouth)	11	11	5	3	12			17	1
Severe Wind	12								
Drought	13	9	5					13	7
Telecommunications Failure	14	14	8	1	13			8	12
Landslide - Manawatu Gorge	15								
Tsunami - Local		2	8		4			4	5
Sea Level Rise		5	19		2			10	4
Cyclone		10	8		5			5	6
Terrorism		13	28		21			11	14
Taranaki Zone		6	3		8			9	10
Ruapehu		4	8		8				
Whangaehu Valley Lahar					14				
Major Passenger - Road			19	8	22				
Major Passenger - Air			5	9	27				
Lifelines - Gas			19		26			21	
Beach Erosion and Flooding			19		24				
Cliff Erosion/Coastal Instability			30		14				
Civil Disorder				9	20				
Fire - Urban Structural			19	7	18			18	
Lifelines - Civil			19		10			21	
Taupo Volcanic Zone								14	
Dam/Structure Failure			30					15	
Biological - Introduced Species/Pests			8					21	
Land Instability			8	9				21	
Tornado			30					21	
Computer Systems Failure			18					21	
Snow								21	
Major Passenger - Rail			28	9				21	
Major Passenger - Marine			30					21	
Criminal Acts			8					21	
Storms				1					
Clandestine Laboratories				4					

11-15 Victoria Avenue
Private Bag 11 025
Manawatu Mail Centre
Palmerston North 4442

T 0508 800 800
F 06 952 2929
help@horizons.govt.nz
www.horizons.govt.nz