Victoria's state-level emergency risk assessment method

Gabriel examines a new logarithmic method for initial comparative assessment of emergency-related risks at state level.

Abstract

Victoria's State Emergency Mitigation Committee has developed a method for initial comparative assessment of emergency-related risks at state level. Adapting existing municipal-level models, a method has been developed and successfully implemented. The main adaptations have been the use of a curve to represent the risk rating, the placement of coloured risk zones on the graph, the recalibration of consequence descriptors to the state-level context, and the use of logarithmic scales.

Introduction

The application of risk management to the emergency management sector commenced about a decade ago and has been implemented in a variety of contexts, most notably at local/municipal level or in relation to specific risks and/or localities. More recently, consideration has been given to application of the same approach at a state or even national level.

The importance of emergency risk assessment at state level arises from the fact that most expenditure on emergency risk reduction is either made by state governments, or is mandated by them through regulatory instruments often enforced by local government, and is made by the private sector. Communities expect governments to be active in monitoring risks and in implementing strategies to reduce the likelihood and/or consequences of emergencies. Emergency-related expenditure can have a number of drivers, the most obvious one being actual experience of major emergencies. It is a common phenomenon that increased investment in response resources follows major emergencies or disasters. This may be accompanied, later, when the reviews, inquests, reports and the like are issued, by an increased emphasis on mitigation (i.e. risk reduction) often expressed in the form of new or enhanced regulations or other control mechanisms.

As an expression of contemporary management practice, the application of risk management to emergency-related risks is a natural fit. However, the High Level Group that reported to COAG on natural disaster management in Australia several years ago identified the 'lack of independent and comprehensive systematic natural disaster risk assessments' as one of the main weaknesses in Australia's current emergency management arrangements. It also perceived 'a focus on response and reaction at the expense of prevention, mitigation and recovery of affected communities'. It then proposed that disaster management activities should be driven by better knowledge, including systematic risk assessments, in order to shift 'management arrangements further towards proactivity, from the more reactive approach of the past'. It went on to propose 'a stronger focus on anticipation, mitigation, and recovery and resilience in order to achieve safer, more sustainable communities, and a better balance compared with the effort and resources traditionally applied to disaster relief' (DOTARS, 2004).

It recommended 'that all Australian levels of Government commit to, and announce, 'a … programme of systematic and rigorous disaster risk assessments' and a 'system of data collection, research and analysis to ensure a sound knowledge base on natural disasters and disaster mitigation' (DOTARS, 2004).

In Victoria, the State Emergency Mitigation Committee (SEMC) was established in 2004, partly as a state response to the COAG report and its recommendations. The Committee's charter includes conducting a state-level risk assessment for Victoria, although not limited to the natural disaster risks that the High Level Group emphasised. When the committee looked for tools with which to undertake this task, it found no extant methodology, as the published guides in Australia were mainly geared to either community risks at municipal level or corporate risk perspective and process – strongly biased to risks in the engineering, manufacturing or insurance industry contexts.

Consequently, SEMC's first project was the adaptation of existing risk assessment models to the task of performing a state-level emergency risk assessment.

Existing models

The primary documents referenced for the development of the state level model were those of Victoria State Emergency Service (VICSES, 1999), Emergency Management Australia (EMA, 2004), and the Tasmania State Emergency Service's Tasmanian Emergency Risk Management project (Gilmour, 2003).

The report of the Tasmanian project contained maps of the locations of highest risk of flood, wildfire, storm and others. It was essentially an amalgamation of many local/regional level risk assessments. The SEMC considered that the output of each assessment was too complex and detailed to be practical as a state-level approach. The emergency risks to the State of Tasmania as a single geopolitical entity were not identified.
In summary, while it was a statewide risk assessment, it was not state-level.

Both the VICSES and EMA models are focused at municipal-level risk assessments. In each case there is a focus on local level consequences, expressed in fairly detailed and very local terms, for example 'There is a risk that a bushfire within the municipal reserve will cause significant damage to the College of Advanced Education timber buildings' (EMA, 2004).

However, their overall process and methodology were a useful starting point to adapt to a state-level model, and were sufficiently aligned to AS/NZS 4360:2004 to fulfil that particular criterion.

Needs specified for the state-level methodology

The state level risk assessment methodology was required to:

- enable an assessment of different risk types on a common basis;
- be able to incorporate qualitative as well as quantitative information;
- be able to incorporate as much verified data as is available;
- be relatively simple to enable understanding and use by a wide range of people;
- be consistent with accepted risk assessment methodologies; and
- cater for a range of event sizes/impacts and likelihood.

As a developmental project, it was considered important to be able to derive some useful results from an early stage, and to improve and refine the model progressively through later iterations.

In terms of a risk assessment process, the normal sequence as published in the Australian Standard is applied, using the stages of Identify Risks, Analyse Risks and Evaluate Risks, preceded by the stage of Establish the Context (AS/NZS 4360:2004).

It was clear that the consequence descriptors, as well as the risk evaluation criteria and the presentation of the results of the risk assessments all needed to be adapted to meet the needs of the state-level context.

Context

The first step in the process was the development of the context statement. The key elements are that the assessment covers the whole state – treating it as a homogeneous entity. In other words, the fact that risks vary by location is not considered. It also means that only major risk events will be visible. This serves the purpose of the state-level risk assessment in providing a big-picture result.

While stakeholders include the community, the private sector and non-government organisations, the primary audience for the risk assessment is the state government. This emphasises one of the primary purposes of the exercise – to make a systematic high level contribution to the government's decisions about investment in mitigation. Those decisions can be driven by a range of factors; one of them should be the outputs of a reliable and systematic assessment of a range of emergency risks. Risk assessments offer us an improved basis for understanding risks, as distinct from events, and evaluating whether the high priority risks are receiving a proportionate commitment to mitigation, to guide expenditure priorities.

Risk has been defined as 'the chance of something happening that will have an impact on objectives'. (AS/NZS 4360:2004) In this context, the objective is the continued, safe functioning of the state, its communities and people. As is well understood, emergencies large and small can impact on the achievement of that general objective, and there is huge commitment to safety across all elements of our society.

In this assessment, it is clear that residual risk is being assessed, as distinct from inherent or raw risk, i.e. risk as it exists prior to or without the imposition of any controls. SEMC recognises that there are already controls in place modifying most or all of the risks assessed to some extent, and that it would be far beyond the scope of the exercise to assess the inherent risk.

Type of analysis

Noting that the risk assessment spans a number of emergency risk types, the information available about them is quite variable, and for some there is inadequate reliable data. The primary input is drawn from experts with detailed knowledge of the risk and the history of events, pooling their knowledge and opinions in a workshop process. A fully quantitative risk assessment/analysis has not been possible within the resources available. Therefore the approach can be classified as semi-quantitative, in that some numerical data are used. Experts' estimates of consequence and likelihood in relation to a number of potential emergency events are expressed numerically and the results are plotted on a standard risk matrix, with a graphical representation.

Statistical confidence levels are acknowledged as being not high, but this level of precision is appropriate for a screening or first-pass risk assessment, in that it provides little detail about each risk, but can identify, very broadly, a hierarchy of risks, specifically highlighting those that may warrant further attention by way of more rigorous and specific assessment.

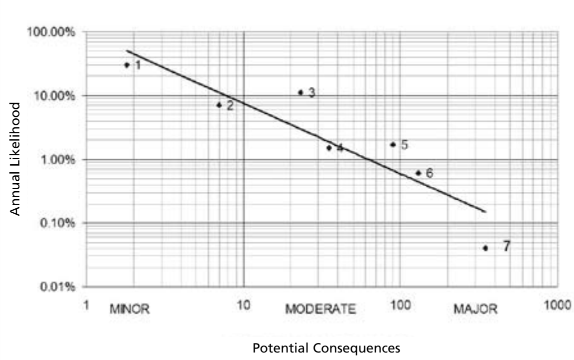
Outputs of risk assessments

One of the first customisations of the community-level risk model to state level was the decision to express each risk graphically as a curve located on a standard risk matrix of likelihood and consequence ranges. Each curve is a visual representation of a particular emergency risk, which makes it easier to appreciate the risk level, and expresses the fact that risks can manifest at a variety of scales. For example, a curve expresses the nature of many of the natural phenomena that can generate emergencies. There can be many small-scale natural hazard events that cause minor or moderate damage, and there are a few large natural hazard events that cause the most damage.

Use of curves also assists in enabling a comparison of disparate risks, by comparing the positions of the risk curves.

The curve is generated by the placement on a standard risk matrix of points representing a number of emergencies (risk events) that are either historical and adjusted to current values, or entirely synthetic but realistic. A spreadsheet tool is used to locate the points and generate the regression line, a sample of which is shown in Figure 1.

Figure 1 Sample risk curve overlaid on the log-log risk matrix.



The position and angle of the line can change over time, in response to such factors as climate change, where there may be fewer but more damaging emergencies such as floods or storms that move the curve to the right, or an improvement in mitigation, which would shift the curve to the left. While the precision of each curve's derivation may not be high, if frequency increases, some curves cluster closer to the more 'extreme' part of the matrix (towards the top right corner), thus allowing conclusions to be drawn as to the highest risks to the state.

As both the likelihood and consequence scales are logarithmic (as explained further below), the line is straight. This acts to reduce the sensitivity of the curve's position to small variations in the positions of the points representing events.

The consequence scale and descriptors

The consequence scale is built on five domains of consequence, derived from the recovery environments identified in Victoria's State Emergency Recovery Arrangements.

At the state level, the domains used for evaluating consequence are:

- personal: Capacity pressure on the hospital/health system, or the systems for supporting people who are displaced from home or otherwise seriously affected by an emergency;
- infrastructure: Interruption to supply of essential services or continued functionality of critical infrastructure;
- public Administration: Threat to or loss of public confidence in the State's ability to provide public services and govern;
- environment: Level and duration of impairment to environmental systems; and

- $ Economy: Significant economic losses or major disruption to one or more industry sectors.

One attribute that excites discussion with participants who are used to risk assessment in the engineering or hazardous materials disciplines is that human injuries or fatalities are not explicitly considered. In explanation, SEMC considered that, in the context of a State-level risk assessment method, the meaning and impact of the number of human fatalities may vary when applied to disparate emergency risks. The community's tolerance for human fatalities is inconsistent across the range of emergency risks, e.g. the community is likely to react differently to the same number of deaths occurring from bushfires as compared with road crashes. The number of injuries is, however, indirectly incorporated through the capacity pressure on the hospital/health system.

Figure 2 shows three levels of consequence to reflect the low-complexity model in use. The differences between the levels reflect order of magnitude steps. This is intended to simplify the primary differentiation between levels, noting that there is still a factor of 10 difference between the lowest and highest values within each level. This logarithmic scale is used because it suits the analysis of data where scales vary greatly. In particular, it allows practitioners to appreciate variations that occur when smaller values are used. On the risk matrix, levels of consequence are given an index value of 1 to 1000.

Figure 2: Consequence domains, levels and descriptors.

Level	Order of Magnitude	Description: Impacts on the State across 5 key sectors – People (P), Infrastructure (I), Public Administration (P), Environment (E) and Economy ($)	
3	Major	P	Health system unable to cope. General displacement of people beyond capacity of the State. State personal support system unable to cope.
		I	Critical failure impacts on community's functioning over a large area for an extended period.
		P	Loss of public confidence in the State's ability to manage. State's inability to manage the event causes serious public outcry. Policy goal or program abandoned.
		E	Very serious long term impairment or loss of ecosystem functions.
		$	Economic costs and losses exceed $1B. Significant widespread disruption to at least one industry sector.
2	Moderate	P	Health system operating at surge capacity; under severe pressure. Displacement of people within capacity of the State to cope. State personal support system operating at maximum capacity.
		I	Critical failure impacts on community's functioning over a medium to large area for a medium period.
		P	The State's capacity for normal activity is perceived as impaired. Significant diversion from public policy goal/s or program/s.
		E	Serious medium term impairment of ecosystem functions.
		$	Economic costs and losses exceed $100M. Disruption to at least one industry sector.
1	Minor	P	Health system operating at optimum capacity levels. Displacement of people within regional capacity to cope. Personal support needs being met.
		I	Critical failure impacts on community's functioning over a small area for a short period.
		P	The State perceived as able to continue business despite disruptions.
		E	Minor to moderate short term impairment of ecosystem functions.
		$	Economic costs and losses <$100M. Generally managed within standard financial provisions.

In applying the table, the highest level of consequence for a specific event across the five frequency domains is taken as the overall level of consequence. Future versions of the model could include weightings, or means, or some other mathematical refinement.

The likelihood scale

The likelihood scale shown in Figure 3 is similar to a community-level scale. Note that this scale is also logarithmic, so that each level is ten times more likely than the next lower level. There are also qualitative descriptors to differentiate between the levels.

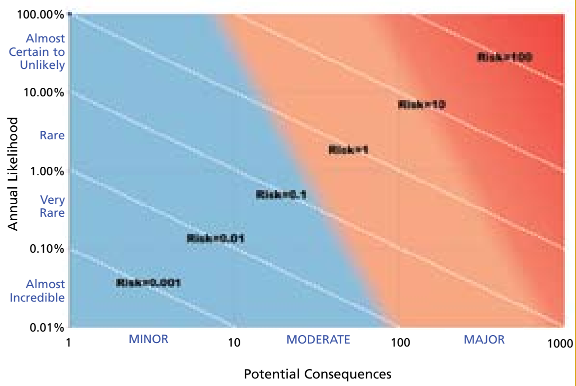
Figure 3: Likelihood scale and criteria.

Level	Descriptor	Description: In any one year, the likelihood of the event occurring is:
A	Almost Certain to Unlikely	>10% Many recorded events Many events in comparable jurisdictions Great opportunity, reason, or means to occur
B	Rare	>1% – 10% Some recorded events Some events in comparable jurisdictions Some opportunity, reason, or means to occur
C	Very Rare	0.1 – 1% Few recorded events or little indicative evidence Some similiar events in comparable jurisdictions Little opportunity, reason or means to occur
D	Almost Incredible	<0.1% No recorded events or any indicative evidence No recent events in comparable jurisdictions Minuscule opportunity, reason or means to occur

Risk evaluation – evaluation zones

It is probably not possible for a committee of public servants to finally determine the risk evaluation criteria on behalf of the community's elected representatives. However, ANZS 4360:2004 requires risk evaluation criteria to be developed. This has been done, in a way consistent with the expression of risk using curves, by overlaying coloured zones on the risk matrix.

Figure 4: Risk rating zones.



There are thee zones of risk identified by their colour. The boundaries between these zones are steeper than the lines of constant risk (shown as white dashed lines), reflecting societal intolerance of higher consequence events.

Blue: Most risk should be in this zone. The risks identified in this zone are effectively controlled by systems across government, industry and the community. Emergencies that do occur are mostly handled within the routine operations of emergency response and recovery agencies.

Expenditure on additional risk reduction may not achieve proportional reduction in risk for resources invested; there are higher priorities for such expenditure.

Orange: This is a smaller zone than the blue zone. In this zone, the consequences of emergencies will be higher than for the blue zone. This is an area in which active steps and financial investment in risk reduction are likely to be taking place because:

- a positive cost/benefit ratio for investment in risk reduction is expected; and
- the level of residual risk may be a matter of some public controversy.

Should further risk reduction for a particular hazard be impractical or unaffordable, the residual risk may be higher than is desired.

Red: This is the smallest zone and identifies that the risk is an alert for the state. Risks in this zone are generally associated with high consequence and low to very low likelihood of occurrence, which allows communities to operate in the presence of such risk. However, where likelihood is higher, risks in the red zone should be a stimulus to action to reduce the level of risk to more acceptable levels. One of the purposes of this project is to identify inadequately treated risks in the red zone.

Process of risk assessments

The risk methodology was pilot tested in 2006 on about twenty risks. For each risk assessed, a lead agency was appointed whose nominated contact person arranged and facilitated a workshop involving experts from the range of relevant agencies. While this proved generally effective, the results clearly demonstrated that different groups had applied a range of different assumptions about the project and varied in their interpretation of the instructions. The outcome was a reduced level of comparability of the results.

During 2008, a formal state emergency risk assessment was undertaken, again using the workshop process to assess 18 risks, with consultants MWH Australia facilitating each one. This did result in a higher level of consistency and comparability across the assessments.

The consultants also introduced some enhancements to the method, particularly in clarifying the relationships between hazards, risks and emergencies for the purposes of risk assessment. This is necessary as many hazards can generate a variety of types of emergency, and some emergencies can generate others which need to be recognised as possible consequences.

Assessment of controls

In addition, the consultants introduced in 2008 the concept of an analysis of the relative importance of current mitigation controls, the effectiveness of those controls and the prioritisation of options for future enhancement of controls.

This element was moderately successful and will be refined for future rounds of the assessment.

Validity of the methodology

The 2008 assessment engaged many people from state departments and agencies, plus a few academic experts, who engaged enthusiastically with the process and delivered a confirmation of its validity for the state-level emergency management context.

The confidence in the specific results is lower than would be desirable; this can be addressed for future rounds by developing more detailed instructions for participants as well as the facilitators, and encouraging participants to gather relevant data prior to attending workshops.

Conclusion

Work done to date in Victoria has shown that a viable state risk assessment method has been derived by fairly simple adaptations of the risk assessment component of the EMA Emergency Risk Management model (EMA, 2004). The introduction of a risk curve overlaid on the risk matrix, recalibration of the consequence descriptors and determination of risk zones, together with a model for assessing mitigation controls, have produced a method that has been well regarded at state level in Victoria across a variety of agencies with responsibility for emergency risk management.

References

Department of Transport and Regional Services (DOTARS) on behalf of the COAG High Level Group, 2004, *Natural Disasters in Australia – Reforming mitigation, relief and recovery arrangements.*

Victoria State Emergency Service (VICSES), 1999, *Community Emergency Risk Management Workbook.*

Emergency Management Australia (EMA), 2004, *Emergency Risk Management Applications Guide* 2nd Ed.

Gilmour, R. (ed), 2003, State Summary – *The Tasmanian Emergency Risk Management Project*, State Emergency Service, Hobart.

Standards Australia, 2004, AS/NZS 4360:2004: *Risk Management*.

Standards Australia, 2004, HB 436:2004 *Risk Management Guidelines*.

About the author

Paul Gabriel has been engaged in emergency management policy since 1986, prior to that working in the ambulance unit of the then Health Department. He has been a part of the Office of the Emergency Services Commissioner and its predecessors and has worked on a wide range of projects, including the production and maintenance of the Emergency Management Manual Victoria. Paul is a member of Victoria's State Emergency Mitigation Committee and is Victoria's representative on the National Risk Assessment Advisory Group. He may be contacted on Paul.Gabriel@justice.vic.gov.au