End-user perceptions and use of natural hazard risk modelling across policy making, land use planning, and emergency management within New Zealand local government.

Miles H. Crawford
Joint Centre for Disaster Research
m.crawford1@massey.ac.nz

Wendy S. A. Saunders
GNS Science
W.Saunders@gns.cri.nz

Emma E. Hudson-Doyle
Joint Centre for Disaster Research
E.E.Hudson-Doyle@massey.ac.nz

David M. Johnston
Joint Centre for Disaster Research
GNS Science
David.Johnston@gns.cri.nz

ABSTRACT

While the development of risk modelling has focussed on improving model accuracy and modeller expertise, less consideration has been given to understanding how risk models are perceived and used by the end-user. In this think-piece, we explore how risk modelling is perceived and used by three different end-user functions for natural hazard risk management in New Zealand local government: policy making, land use planning, and emergency management. We find that risk modelling is:

- valued and used by strategic policy makers;
- less valued within operational land use consent planning and not as widely used, and
- valued within operational emergency management but not as widely used.

We offer our thoughts as to why this is the case with reference to focus groups and qualitative interviews held with local government natural hazard risk end-users across the Bay of Plenty, Gisborne, Hawke's Bay, Wellington, Nelson, Tasman and Canterbury regions of New Zealand. We conclude with recommendations for how risk modelling can be further developed to increase community resilience.

Keywords

End-user perception, risk modelling, natural hazards, local government, New Zealand.

INTRODUCTION

Researchers and practitioners are increasingly using risk modelling to scope the consequences for natural hazard scenarios where there is uncertainty over vulnerability and exposure (UNISDR, 2015; Donovan & Oppenheimer, 2015; Eiser et al., 2012). However, while research has focussed on developing better risk models, less consideration has been given to end-user perceptions and use of risk modelling for natural hazard management (Komendantova et al., 2014; Reiter et al., 2017).

Natural hazard management in New Zealand is achieved through the devolution of central government legislation down to local government for application. Three key pieces of legislation coordinate how natural hazard management is applied:

1. The Local Government Act 2002 (LGA) – provides for local government to meet the natural hazard management needs of communities through local infrastructure, local public services, and performance of regulatory functions;
2. The Resource Management Act 1991 (RMA) – land use consent planning assures avoidance or mitigation of natural hazards with respect to the use, development, or protection of land;
3. The Civil Defence Emergency Management Act 2002 (CDEMA) – emergency management supports the sustainable management of hazards in a way that contributes to the social, economic, cultural, and environmental well-being and safety of the public and also to the protection of property;

Each piece of legislation and its associated policies and processes are applied through separate local government functions. While it is intended that these functions work seamlessly together, it is shown that over time, integration remains limited, resulting in different perceptions and reduced effectiveness for natural hazard management (Becker and Johnston, 2000; Ericksen et al. 2004; Glavovic et al, 2010; LGNZ, 2014; Saunders et al., 2014; Saunders et al., 2015; Basher, 2016; Kilvington & Saunders, 2016; Crawford et al., 2018; Lawrence, 2018;).

This think-piece explores the differences between how end-users perceive and use risk modelling for natural hazard management across the functions of strategic policy making under the LGA, operational land use consent planning under the RMA and operational emergency management under the CDEMA. It refers to data captured from focus groups sessions and qualitative interviews held with end-users from the Bay of Plenty, Gisborne, Hawke's Bay, Wellington, Nelson, Tasman and Canterbury regions of New Zealand. We discuss the differences in how end-users perceive and use natural hazard risk modelling and conclude with recommendations for how natural hazard risk modelling can be further developed.

Through a better understanding of how each natural hazard end-user function perceives and uses risk modelling, we can improve the usability of risk modelling, increase its application, and therefore build community resilience to natural hazards.

METHODS

In the social sciences, risk perception is subjective, involving people's feelings, beliefs, attitudes and judgements (Barnes, 2001). As such, qualitative approaches were used because they "explore the views, experiences, beliefs and/or motivations of individuals on specific matters" (Gill et al., 2008. p. 292). Two qualitative approaches were used to better understand end-user perceptions towards the risk modelling and its use: focus groups and qualitative interviews.

Focus groups sessions were held with the Bay of Plenty, Hawke's Bay, Wellington, Nelson, Tasman and Canterbury regional or unitary authorities. This method was used because the "explicit use of group interaction produces data and insights that would be less accessible without the interaction found in the group" (Flick, 2006. p.197). The sessions ranged in size from six to fifteen participants covering functions for strategic policy making, land use consent planning and emergency management, and also for engineering, hazard analyst and GIS technician roles. Participants were encouraged to discuss their perceptions of the use of risk modelling via a semi-structured approach framed by guiding questions as set out in Table 1.

Qualitative interviews were held in Wellington, Hawke's Bay and Gisborne. Twenty-three participants were individually interviewed covering functions for strategic policy making, land use consent planning and emergency management, as well as other roles for environmental science, building control, asset management, engineering and hazard modelling. As with the focus group sessions, an interview guide was developed to help steer the course of the interviews as set out in Table 2.

Both the focus group sessions and qualitative interviews lasted between 1 – 2 hours with data captured through dictaphone recordings and then transcribed. Transcriptions were thematically analysed as it "provides a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex account of data" (Braun & Clarke, 2006. p.5). The themes identified emerged through iteratively analysing the transcripts via an inductive, 'bottom-up' process (Patton, 2015). The NVivo software package was used to assist with the analysis, categorisation, and organisation of the data into main themes with contributing sub-themes.

Understanding information management: • How is this group linked with other departments and wider natural hazards risk management within the council? • How do you communicate risk and hazard information and make decisions across the council? • What information do you use? • Where does it come from? • Do you create or provide your own information? • How would you like to receive or share risk and hazard information? Discussion based on examples: • Do you have any examples of risk-informed decision-making or response? What went well in terms of information requirements? • What information was missing or what were the information gaps?

Table 1. Focus Group Session Guide

Thoughts, feelings and experiences on how natural hazard risk management policy works in that Council: • Its level of importance • How often policy is developed • How policy is applied • Links across council for natural hazard risk management • The local governance environment/mandate for policy development • Risk-based policy Views on the use of risk modelling software: • Whether it changes the way participants perceive natural hazard risk. • Whether it better communicates the risk, why and why not. • Whether it is better at creating efficacy for developing more risk informed policy and procedure. • What participants think are the barriers for the communication, perception, and efficacy for natural hazard risk. • What participants think are the enablers for the communication, perception, and efficacy for natural hazard risk.

Table 2: Qualitative Interview Guide

RESULTS

The themes identified from the transcriptions are examined across the strategic policy making, land use consent planning and emergency management functions in turn.

Strategic Policy making

When discussing how natural hazard risk management was achieved within their council, strategic policy makers were clear about how it was a holistic approach, incorporating different council roles and external influences:

> *You have the engineers and the building consents guys and the planners and they are all collectively are fully aware of the hazards, so as an organisation I think we are pretty good with it. We are constantly, collectively working on contingency plans.*

> *It doesn't always have to look like rules and regulations in a regional plan… you don't have to go anywhere near and RMA planning instruments in reality.*
>
> *Policy is, in my view, not just about local authority. It is about other industry sectors: very much insurance has a role, or lenders have a role to play in this, and they are having more and more of a role in this.*

While strategic policy makers were unanimous in supporting natural hazard risk management, they were also pragmatic about its relationship with economic development:

> *I guess it's how you meaningfully respond to the threat of natural hazards and what you can do which doesn't prevent people from living and undertaking their daily life and keeping the economy moving and cities growing.*

In line with their holistic, pragmatic view of natural hazard risk, strategic policy makers showed a good understanding of risk management concepts:

> *At the end of the day, what is a reasonable probability that you are willing to accept as a community for risk? [Some policies] would be too onerous to try and work your planning framework around, so there needs to be a bit of risk tolerance in every decision that you make.*

Considering this, strategic policy makers presented mixed perceptions of natural hazard risk modelling and its use. They appreciated its value for providing science-informed results:

> *Looking at what the risks are and establishing priorities… So we have used [risk modelling] as part of that with the fragility curves and working out what the assets are at risk.*
>
> *If we get a handle on the scale of what is at risk, it is always valuable for policy development.*
>
> *I wanted to have something to support me if I'm in a hearing in Environment Court or in a consent (Resource Consent) to show that these areas were at risk.*

However, the uncertainties and assumptions inherent within risk modelling meant that they had limited confidence in modelled results.

> *[Risk modelling] might be entirely valid as a tool to inform your high level strategic special planning but not be able to inform a land use regulatory Environment Court appeal kind of decision-making forum… It comes back to your policy advisors having an awareness of the potential but also the limitations of any of these risk models and also an awareness of the data availability.*

Overall, strategic policy makers appreciated risk modelling as a communication tool that informed policy making:

> *Modelling produces a visual, spatial map output and if there is one thing I know from many years of talking to the community and councils and people is that they can relate to any visual-graphic representation of something people can see. So they're hugely powerful tools for communicating risk and impact and disaster risk reduction.*
>
> *I'm a firm believer that any model is there to support decision making not to make decisions. Only humans can do that in full judgement of the information available. So as a communications tool risk modelling is still quite valid.*

Land use consent planning

While land use consent planners acknowledged the use of other legislation for achieving natural hazard risk management, a common thread for discussions was on using the RMA and associated plans to deliver regulation:

> *My colleagues think the RMA is the Bible and is the key means of delivering on land use planning decisions*
>
> *There are two different types of planner; I like to think that we are heading more towards the outcome focussed planner but, to be honest, I think we have gone more towards the book version [where] 'the book' [the District Plan] gives us the answers.*

Considering the land use consent planning focus on using existing rules and regulations, and due to stretched resources, there has not been the drive or capacity to learn different approaches for natural hazard risk management:

> *That's the problem - sophisticated spreadsheets and sophisticated modelling have never been a strong point in planning.*
>
> *People are stretched with their workloads and probably find it difficult to develop a new area.*

In conjunction with this, participants reported that risk modelling for less frequent natural hazard events was not synonymous with the policy timeframes used within land use consent planning:

> *As far as planning is concerned … they're dealing with the here and now, they're dealing with people who come in with development proposals, they're looking at a District Plan which maybe has a ten-year life*

As such, while there is an appreciation of risk modelling as a tool, it has not been readily adopted within land use consent planning:

> *I can see that being a really useful tool… there's a social component to it.*
>
> *Some of them know about [risk modelling], but I think it just hasn't hit the point where people see it as a valuable tool as far as how they make decisions.*
>
> *Maybe the software approach is just too much effort, with too little flexibility, to be of value on the day.*

Emergency management

An interesting theme that emerged from discussions was how the emergency management function interacted with other parts of the council. While natural hazard risk management is a primary focus for emergency management, it is a less important focus for land use consent planning and strategic policy making:

> *Hazards will be in the mix as part of that upcoming plan review exercise, but we have bigger fish to fry.*
>
> *Even though hazards and [emergency management] are important … when events aren't occurring it just drops down on the importance list.*

In addition, emergency management is commonly perceived as only an emergency response function, making it less relevant to other natural hazard risk management functions across the council:

> *[Emergency management] tends to operate much more on the response and recovery side and try as you might there's not actually a lot of crossover between and dialogue between the emergency management and the planning policy people.*
>
> *I still think that the Council think of us as the people that work responding to an emergency. [They] don't actually think about the value that can be added from other areas.*

Considering this challenging environment, emergency management has had to rely on influential personalities to better enable integration with other natural hazard functions:

> *She's playing the long game, she's been around for a while doing it, and because of the set of circumstances, she's able now to influence across a wide breadth within the Council, and show the value of [emergency management] to them.*

Emergency managers showed a good understanding of risk as part of achieving their function for natural hazard risk management.

> *So that's where [emergency management] comes in, so you can't actually say "well what is the risk of developing that land there?", unless you understand that if that event happens, what is the impact and the response? We have to evacuate that, we have to house people, we have to this, we have to do that, we have to do planning and that takes resources and time.*
>
> *It's looking at it and saying "well these are the risks, this is what would need to happen for response" and therefore we could 'tutu' (muck around) with the design to make response easier and therefore carry on. Or go well, the chances are pretty low, therefore the risk is acceptable. Yes, there is a risk but it is acceptable.*

Given their understanding of risk management, emergency managers saw value in risk modelling:

> *It would be very powerful for [emergency] planning, through knowing what the potential impacts would be, in other words, what is the end game? If something happens, what's it going to look*

> *like? Then we can go back to the start and say this is our future recovery planning that we are going to have to think about.*

Emergency managers also found risk modelling valuable for:

- communication to the public and decision-makers;
- real-time event response;
- exercise development;
- contingency planning;
- generic plans such as land use and civil defence plans; and
- policy development such as Regional Policy Statements.

However, while emergency managers agree that risk modelling was a valuable tool for natural hazard risk management, on the whole, it isn't used. Emergency managers reported that this is because contributing data is not available and because risk models are not suitable for their specific needs:

> *In terms of CDEM, we need information that is as up to date as possible. We can use it as a response tool as long as the data is available.*

> *I know that … the [emergency management] people weren't too keen on it. Maybe because that is just too hard to use in an event.*

As such, emergency managers have looked to use their own community knowledge as well as other tools for assessing and communicating risk:

> *The Hazards Portal, you know, that's great, great, and [emergency management] is leading that, which is great.*

> *I can virtually do that myself on GIS by plotting all of our lifelines across it, all the residential areas, daytime populations are all going to be in the CBD around this area so we're going to get pretty good loss of daytime in this area. You know these residential areas at night, okay, these are the inundation maps we've got and they're not great but they're better than nothing.*

DISCUSSION

The themes set out in the results section present a complex and differing environment for the perception and use of risk modelling across the strategic policy making, operational land use consent planning, and operational emergency management functions for natural hazard risk management. We find that risk modelling is:

- valued and used by strategic policy makers;
- less valued within operational land use consent planning and not as widely used, and
- valued within operational emergency management but not as widely used.

While the data that informs this discussion represents a significant portion of New Zealand local government (seven of the seventeen regional and unitary authorities), it is not representative of all of New Zealand local government. Perceptions and uses for risk modelling may be different in areas that were not part of the study.

We offer our thoughts on the differences in perception and use of risk modelling of our case study area in turn.

Strategic policy making

Strategic policy making is central to achieving the strategic local government objectives for the social and economic development of their communities. While councils see natural hazard risk management as important (BOPRC, 2018; CRC, 2018; GDC, 2015; GWRC, 2015; HBRC, 2012), it is only a part of the strategic policy making function. Other foci for local government strategic policy making include management of infrastructure, environment, social issues and economic development. Strategic policy makers take a wider, holistic view to achieve natural hazard risk management outcomes. It is their role to see the 'big picture' and think 'outside the box', straddling all council functions and combining different legislations, policies, plans, tools and processes. Strategic policy makers also look to public-private partnerships to develop strategy that meets the current and future needs of our communities as per the Local Government Act (LGA) (New Zealand Government, 2002b).

Due to its importance, strategic policy making can easily connect to and integrate with other council functions in order to achieve objectives. It is also more easily able to influence decision-makers to financially support the use of methods and tools to achieve those objectives. Furthermore, strategic policy making's position of straddling all council functions, along with private sector business management, has enabled them to develop a more holistic

understanding of risk management. For example, ongoing management of ageing and vulnerable infrastructure has resulted in more developed risk-based local government policy focussed on asset management than for any other council function. Strategic policy makers are then able to transfer this knowledge to other areas like natural hazard risk management.

This understanding of risk, the readiness to use different methods and tools, along with its influence within the organisation, has meant that strategic policy makers are using risk modelling the most out of the three end-user functions. Examples of its use for natural hazard strategy development include for a cost-benefit analysis of residential development within Lower Hutt, impacts assessment as part of the Hawke Bay Coastal Strategy (T&T, 2016), and mitigation strategies for Gisborne District Council (GNS, 2016).

Yet even though strategic policy makers use natural hazard risk modelling the most, they show the least confidence in its outputs. This correlation makes sense. With greater exposure to the uncertainties and assumptions contained within risk modelling, comes a greater appreciation of its limitations. We also think that strategic policy makers' more developed understanding of risk better informs them of how much tolerance they have for risk modelling uncertainties and the assurance that risk modelling provides.

Nevertheless, while strategic policy makers are consistent in saying that risk models are too uncertain for re-zoning type applications, they are valued for cost-benefit analyses and communicating risk for high-level policy making.

Land use consent planning

Similar to strategic policy making, land use consent planning is central to achieving the strategic local government objectives for sustainable development. District plan provisions (under the Resource Management Act (RMA)), applied through land use consent planners, are a useful and wide-ranging legislative instrument. As with strategic policy making, natural hazard risk management is only part of the land use consent planning function. Planners regulate a number of other community activities including development, industry, transport, water, noise, heritage, hazardous substances, and air quality. Due to the similarities between the two functions, land use consent planners have a more established relationship with strategic policy makers than with emergency managers.

Land use consent planning is operationally focussed. It looks to regulate community activities through regional and district plan resource consents, monitoring and enforcement. While it is not a strategic function like policy making, it is still viewed as important for how councils achieve their objectives. As such, the land use consent planning function is a well-established, embedded, process orientated and valued participant in council strategy development.

We suggest that the strength of the RMA is both a benefit and a detriment for how land use consent planners achieve natural hazard risk management. It is a benefit because it is able to enforce community compliance and therefore more easily achieve natural hazard risk management outcomes. However, it is a detriment because the robust and prescriptive legislation means that many land use consent planners choose to use established processes rather than exploring new methods and tools to achieve outcomes. In addition to this, the ten-year cycle for district plans is considered by some to be too long for flexible responses for natural hazard risk management, and the three-year political cycle is too short for consideration of risks emerging over longer timeframes (Lawrence et al., 2015). While innovative new risk-based approaches for natural hazard management are being developed (BOP, 2014; CCC, 2017) the results indicate that land use consent planners less inclined to 'think outside of the box' to better achieve natural hazard risk management outcomes.

It is interesting to note that the subject of risk management did not enter into many of the discussions with land use consent planners. This may be because land use consent planners are less familiar with the subject compared to the strategic policy making and emergency management functions. While efforts for land use consent planners to think about risk within the RMA have been ongoing (Saunders & Beban, 2012), appreciation for risk management has been slow to develop. This could have been because risk management has not been a focus of the RMA, however now that Section 6 of the RMA has been amended to include 'the management of significant risks from natural hazards' as a matter of national importance (Section 6, New Zealand Government, 1991), there is the potential for comprehensive risk-based planning to be implemented.

As such, results show that whilst the land use consent planning function is able to use risk modelling for natural hazard risk management, it has not generally been adopted. However, land use consent planners are beginning to see its value, and with the recent changes to how the RMA manages natural hazards risk, there is greater opportunity for it to be used more.

Emergency management

The results suggest that emergency management is not perceived as being as important as strategic policy making or land use consent planning as it is commonly viewed as only an emergency response function. This perception is supported in the literature (Lawrence et al. 2015; Lee, 2010; LGNZ, 2014; Saunders et al., 2015) and also by emergency managers themselves. Many report how they have historically been employed from response focussed organisations such as the army or the police, and as such tend to put more effort into response. While emergency management also operates across reduction, readiness and recovery to achieve natural hazard risk management, these other activities have less visibility across the council than response. Strategic policy makers have some interaction with emergency managers as part of policy development, however in many cases, the only interaction land use consent planners have with emergency management is during emergency response focussed exercises.

In addition to this, we suggest that The Civil Defence Emergency Management Act (CDEMA), under which emergency managers operate, does not have the same standing for council strategy and management as the LGA or the RMA. Where the LGA and the RMA are central to community development and have wide-ranging responsibilities requiring community compliance with policy initiatives, the CDEMA is not perceived as being as central for community development and has no penalties for non-compliance (New Zealand Government, 2002a, DPMC, 2017). This creates a challenging environment for how emergency management achieves its natural hazard risk management function, where they are less integrated with council strategy than policy making or land use consent planning. While recent events such as the Canterbury Earthquakes have helped increase council awareness of emergency management's broader role, the emergency managers interviewed commonly reported being misperceived as only there for emergency response.

Given the misperceptions of emergency management's role, along with having less integration within the council organisation, emergency management is obliged to be a dynamic function that develops relationships and thinks 'outside of the box' in order to gain influence and achieve its natural hazard risk management function.

As such, emergency management cannot rest on the strength of legislation and established processes as land use consent planning has and is similar to strategic policy making where it looks to use different legislations, policies, plans, tools and processes, working across the public and private sectors. Also similar to strategic policy makers; emergency managers show a more developed understanding of risk. We think this is more to do with the risk-based approach that emergency management takes to natural hazard risk management (MCDEM, 2018) than from inclusion into council long-term strategy management.

Given their understanding of risk, emergency managers value risk modelling as a tool. While they can see its value across a number of functions, emergency managers are quicker to see risk modelling's value as a response tool than as a risk reduction tool. This could be because of emergency management's tendency to focus on response, but also because emergency managers own the emergency response role, where they would need to collaborate with policy and consent planners to achieve risk reduction.

Even though emergency management is a dynamic function that looks to use different tools to achieve their natural hazard risk management function, on the whole, they do not use risk modelling. Emergency managers value risk modelling but the challenges associated with being a less integrated and misperceived function mean they are not as enabled to use it. Historically, risk modelling was not used due to the limited capability of risk modelling software to fit emergency management requirements. However as risk modelling has developed, the issue rests more with risk data not being available for emergency management's use, and challenges for emergency management to generate their own data.

RECOMMENDATIONS AND CONCLUSION

This think-piece gives our views on end-user perceptions of natural hazard risk modelling across the strategic policy making, land use consent planning, and emergency management functions for natural hazard risk management within New Zealand local government. We paint a thought-provoking picture of how risk modelling is perceived and used. Risk modelling sits within a complex, interrelated environment where perceptions of importance; levels of integration; understanding of risk; and willingness to use different methods and tools; combine in various ways to influence its use.

As such, we make the following recommendations to develop end-user perceptions of risk modelling and better enable its use for natural hazard risk management:

- Structured collaboration for natural hazard risk management – By structuring for greater collaboration across the strategic policy making, land use consent planning, and emergency management functions, a shared understanding of roles and responsibilities can be developed. As such, issues relating to misconceptions of roles can be broken down, enabling greater

integration across the functions, shared perceptions of risk modelling and improved risk model application (Doyle & Paton, 2017).

- Participatory co-development of risk modelling – Involving strategic policy makers, land use consent planners and emergency managers to work together, co-developing risk models through a bottom-up, participatory approach. This will enhance understanding of the capability of risk models, develop confidence in the information that they provide, and build the value of risk modelling across the council for natural hazard risk management (Newman et al., 2017).
- Regular risk management workshops – Natural hazard risks are constantly changing depending on shifts in community vulnerability and exposure. Regular workshops to review the risks and what measures can be employed to reduce them can build an understanding of risk management for decision support, promote its use across the end-user functions and add value for natural hazard management (Saunders & Beban, 2012).
- Data development – Combine resources to enable greater capacity and capability for natural hazard risk data collection, management and use. Natural hazard risk modelling end-users can collaborate on standardised controls for data collection, quality, and format so that it is open, shared, usable and used.

In conclusion, this think-piece focusses on the less researched area of how end-users perceive and use risk models. We explore how risk modelling is perceived and used by three different end-user functions for natural hazard risk management in New Zealand local government finding that risk modelling is valued and used by strategic policy makers, less valued within land use consent planning and not as widely used, and valued within emergency planning but not as widely used. Through a better understanding of how each natural hazard end-user function perceives and uses risk modelling, we have made recommendations for how end-users can work together to develop their perceptions and use of risk modelling. With improved end-user perception and use of risk modelling, it can be applied more widely, better support decision-making for natural hazard risk management, and therefore build community resilience to natural hazards.

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