The role of science in land use planning: exploring the challenges and opportunities to improve practice

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EXECUTIVE SUMMARY

The report is the output of a project funded through the GNS Science Strategic Development Fund to examine the relationship between natural hazard science and local government land use planning in New Zealand. In this project we looked at what prompts and incentives there are for including natural hazards science in decisions on land use; and assessed some of the barriers to successful uptake of natural hazards science in local government planning and policy development.

The project had three inter-related components:

1. A review of relevant literature exploring the known challenges; proffered solutions and current gaps relating to the specific context of natural hazard science and land use planning in New Zealand (**Section 2.0**);
2. An examination of the specific case of Hutt City Plan Change 29, where GNS Science acted as a corporate citizen and presented its science as a submission to the proposed plan change (**Section 3.0**);
3. A range of focus groups and interviews with scientists from GNS Science and NIWA; policy and planning staff from local and regional government agencies; as well as staff from Ministry for the Environment (MFE), and the Earthquake Commission (EQC). These were used to shape ideas about the context for generating and using natural hazards science for both stakeholders and researchers (**Section 4.0**).

The way in which natural hazards science is incorporated in local level decisions affecting land use is a complex process, influenced by numerous social levers and networks. There are many actors who have a role to play. Both research providers and policy and planning practitioners are aware of many of the challenges associated with enabling science-to-practice. However, efforts to improve the situation are sometimes misplaced and are often dominated by ideas about improved delivery and science communication that can place undue burden and expectations on only one component of a complex system.

In this review of the use of natural hazards science in land use planning, and in the specific case of Hutt City Plan Change 29, we found that the availability of technical information alone is not enough to ensure that natural hazards science is able to contribute to any planning decision. Rather, a mix of factors act to facilitate and constrain this. These include the time limits of existing planning processes, the skills and resources of planners and policy makers, the availability of consultants or knowledge brokers who can interpret technical information into compelling and plausible planning options and importantly, social and political pressure which shapes the decision context and directs it towards a specific planning outcome that may not accommodate natural hazard risk as a high priority.

Any contribution to improving the science-to-practice interface for natural hazards and land use planning, by an individual or an agency, is more likely to be successful when the system itself is better understood. This review showed numerous opportunities to support better capacity within planning and policy development to address natural hazards risk. This includes actions to support more long term, ongoing interactions between researchers and practitioners (particularly at the local level), and acknowledgment of the importance of knowledge brokerage. It also recognises the role for national agencies in providing stronger directives for the inclusion of natural hazards science in land use planning; and for national, regional and local agencies to become better at sharing the specific expertise associated with understanding and managing risk.

The case of Plan Change 29 illustrates that there is also value in research agencies acting as ‘concerned citizens’. Advocacy for the responsible inclusion of natural hazards information in decisions affected by natural hazard risk is a value that needs support from qualified experts within the planning process. While wholesale participation in planning processes across New Zealand is beyond the resources of science providers, considered involvement in select cases can greatly advance best-practice for how natural hazards science is included in land use planning decisions.

KEYWORDS

Use of science in planning; natural hazards; land use planning; science-to-practice

GLOSSARY OF ACRONYMS &TERMS

EQC	Earthquake Commission
GNS Science	Institute of Geological and Nuclear Science
GHD	International engineering, architectural and environmental consultancy with branches in New Zealand
Greater Wellington	Wellington Regional Council
LGNZ	Local Government New Zealand
NIWA	National Institute of Water and Atmospheric Research
NZPI	New Zealand Planning Institute
MBIE	Ministry of Business Innovation and Employment
MFE	Ministry for the Environment
PC29	Plan Change 29 referring to planned development in the area of Petone West
RMA	Resource Management Act 1991

1.0 INTRODUCTION

In 2013 GNS Science acted as a submitter to a local planning process – the Hutt City Petone Plan Change 29 (PC29). As a corporate citizen of the community affected by the proposed plan, GNS Science presented their views through the statutorily defined submission process. This raises questions about why this was necessary. Why wasn't this published, public good science information, which was relevant to the plan change area, incorporated earlier in the plan drafting process?

This report is the output of a project to examine the relationship between natural hazard science and local government land use planning in New Zealand. The experience of GNS Science acting as a submitter to a local planning process was in many ways positive. However, it highlighted some of the misplaced assumptions about the relationship between a research provider and the local government agencies that are one of the primary intended users of these science resources.

Land use planning is a key risk reduction tool that can increase New Zealand's resilience to natural hazards (Burby et al. 2000; Mileti 1999). The effectiveness of risk reduction provisions within land use planning is highly dependent on the successful understanding and implementation of natural hazard science. On the surface, there appear to be many opportunities for local government planners to incorporate the latest relevant hazards science in their policies, methods, and maps. They use scientific framings to understand and assess natural hazard probability, and rely on scientific expertise to support planning decisions. However, local government often complain of difficulties managing the natural hazard science and planning interface. They face challenges over:

- The scale of science information and its translation to local context;
- The often un-interpreted form in which research findings are presented;
- Having to reconcile inconsistent scientific views between experts;
- Managing uncertainty within policies, methods and maps; and
- The different time scale of research programmes and planning processes, which make it difficult to ensure planning decisions are made and planning provisions updated with the latest research findings.

Similarly, natural hazard science researchers are often frustrated by the lack of uptake of their science in land use planning decisions. They are unsure of the best way to interact with local government land use planning processes, including how to convey uncertainty and the limitations of findings.

Investigation and theorising on the challenges in the relationship between science and policy has been prolific over the past two decades, particularly in areas which involve high complexity, and high stakes decisions for human societies and the natural environment (e.g. Funtowicz & Ravetz 1993 Gallopín et al. 2001, Lemos et al. 2012). The literature provides numerous high level frameworks for considering how to improve science and policy interactions with a corresponding abundance of terminology, ranging from multi-disciplinary, integrated, and trans-disciplinary; to post-normal, collaborative, and citizen science (Cronin, 2008). While these diverge in emphasis, they share considerable commonality around the need for better understanding of the contexts for both stakeholders and researchers, as a basis for forming more productive relationships.

In this project, we review some of the expectations and experiences of natural hazard scientists and planners working to integrate science in local government planning processes. Stimulated by GNS Science's own direct experience of presenting their science to local government via a plan submission process, this work fills a needed gap in reviewing the practice of those working at the interface between science and planning – evaluating their needs, challenges, and assumptions of scientists and planners, as well as potential opportunities that neither group may currently be fully aware of.

The project had three interrelated components:

- A review of relevant literature exploring the known challenges; proffered solutions and current gaps relating to the specific context of natural hazard science and land use planning in New Zealand;
- An examination of the specific case of PC29;
- A range of focus groups and interviews with scientists from GNS Science and NIWA; policy and planning staff from local and regional government agencies; as well as staff from Ministry for the Environment (MFE), and the Earthquake Commission (EQC) to explore the direct experience of researchers, policy makers and planners in integrating science and planning.

This report has four main subject sections in addition to this introduction, which sets the scene and outlines the methodology used:

Section 2.0 Provides an overview of some of the known challenges in the science to policy interface, some of the proffered solutions, and apparent gaps in knowledge;

Section 3.0 Reviews the events surrounding the Hutt City Petone Plan Change 29, in particular the use of natural hazards science information at different stages in the plan change process;

Section 4.0 Reviews the collective understanding of planners, policy developers and science information providers regarding how the science to policy interface currently operates;

Section 5.0 Draws conclusions about key elements of the science to policy interface that drive current practice, with recommendations of where improvements to the planning-science interface could be made.

1.1 METHODOLOGY

Grounded theory forms the overarching methodological framework for this research (Glaser & Strauss, 1967). This is a widely used social research method. Grounded theory enables the development of theory which explains what is being observed in an area of interest, and can then be used to identify ways of addressing or changing this. It begins with asking large questions about the subject area which are progressively explored through qualitative and/or quantitative data. An idea about the situation is built up; then explored and validated and finally summarised.

In this research understanding about the interface between natural hazards research and land use planning practice was iteratively developed through six cycles of research data gathering and reflection (see **Figure 1.1**).

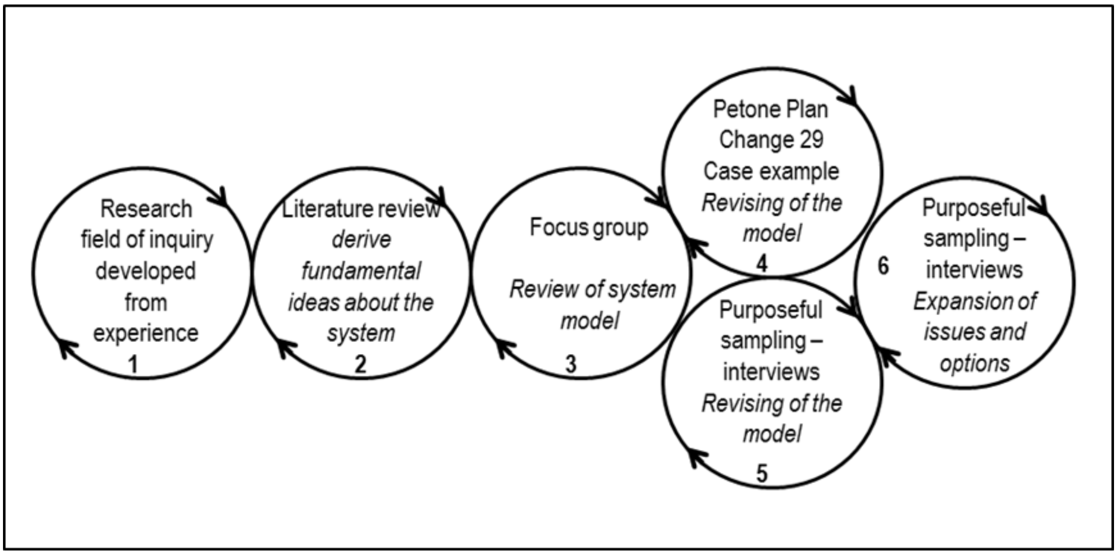

Figure 1.1 Research cycles for examining the relationship between natural hazards science and land use planning.

Cycle 1 was the starting point for the research. Questions about what was problematic in the science-land use planning interface were first posed by the research team, and discussed with GNS Science natural hazard researchers who had been involved in the GNS Science submission to PC29.

Cycle 2 involved a review of recent literature on the common observed issues in the environmental science-policy interface; some of the proffered solutions; and gaps in knowledge. In particular, we examined how the ideas in the literature could relate to the natural hazards science and land use planning context of New Zealand.

From Cycles 1 and 2, a rudimentary conceptual model of the interface between natural hazard science and land use planning in New Zealand was developed, highlighting key features, challenges and emerging questions. In Cycle 3 this was reviewed by a focus group of participants with expertise in applied natural hazards science, science communication, local and regional government planning.

Cycle 4 involved a specific review of events associated with PC29; in particular, the way in which natural hazards science information was introduced into the planning process.

Cycles 5 and 6 involved interviews with natural hazards researchers from NIWA and GNS Science; and key contributors to the natural hazards science–policy interface, including regional councils, MFE, and the EQC. In these interviews, ideas emerging from cycles 2 to 4 were given further reflection as to their usefulness for the natural hazards science and land use planning context of New Zealand (a summary of participants in these focus groups and interviews is provided in **Appendix A1.0**).

2.0 COMMON CHALLENGES IN SCIENCE-TO-PRACTICE

> *The extent to which knowledge generated through research is likely to inform policy and practice depends on its relevance, legitimacy and accessibility …. These aspects in turn depend on how knowledge is produced, shared with and between those who might use it, translated and/or transformed as it is shared, and the social context in which people learn about new knowledge (Reed et al. 2014, p. 337).*

This section provides a brief overview from the literature of some of the known challenges in the environmental science-policy interface; some of the proffered solutions, and apparent gaps in knowledge. In particular, we examine how this relates to natural hazards science and land use planning.

'Science-to-practice' is a convenient simplification of a complex idea. It implies linear and unidirectional information exchange but both theorists and observers of practice agree that the development of science as evidence, and its use in any public policy or planning processes, is far from straight forward (Green et al. 2009, Gluckman, 2013, Bremer et al. 2013, Thompson et al. 2015, White, 2015). Moreover, over the past two decades there have been many arguments ably offered about the need for a new theory-of-action for environmental science (e.g. Funtowicz & Ravetz 1993 2003, Gallopín et al. 2001), and for improved connection between science and stakeholders (Lee, 1993, Maarleveld, M.& Dangbégnon, C. 1999, Allen et al. 2011). These ideas have moved environmental science from a tech-transfer model which regards end-users as passive recipients of new information, through to models involving phases of multi, inter and transdisciplinary science. This places increasing demands on science researchers to develop meaningful ways of working across disciplinary and institutional boundaries and to better integrate research and on-the-ground decision making (Tress et al. 2005, Cronin, 2008).

In developing this research project, the research team was very aware of the need to provide ideas that could be of direct use to those working in the natural hazards science and land use planning space. This community of researchers, policy and planning practitioners need guidance on how to improve their context as it stands today. Despite genuine and ongoing efforts to improve the relationships between science information users and producers, research agencies still struggle in many ways to fully transition their communication practice towards new ideals. In other words, research programmes may be described as 'transdisciplinary', but the notion that science is generated and then disseminated to end-users remains an active premise; and efforts to improve the science–policy interface are still dominated by ideas about improved delivery.

This over emphasis on one aspect of a complex system can lead to a sense of failure and some unwarranted self-chastisement. The notions that 'scientists are poor communicators' and 'use too much jargon', are as equally likely to be heard by researchers themselves as by those in policy and planning circles (e.g. Likens, 2010). In practice, it is a multifaceted relationship between the interpretation of data and information developed in a science research context, and its transfer into meaningful knowledge that can be fully utilised by decision-makers. There are many actors who have a role to play in what is more accurately described as a knowledge exchange system (Reed et al. 2014, Bremer, et al. 2013). Knowing more about the system itself can help researchers and policy makers uncover hitherto under-explored opportunities to make improvements in the science-to-practice interface.

So what do we know about the knowledge exchange system for natural hazard science and land use planning, and what are some of the likely issues to be overcome if natural hazard science is to be fully utilised as evidence for environmental and resource planning? A review of recent international literature and specifically New Zealand oriented work reveals six likely problem areas for the natural hazard science-planning interface that are worth further exploration:

1. Information dissemination and management practices;
2. Institutional capacity;
3. Mutual misunderstanding and incompatibility;
4. Timely, targeted information;
5. Science and values in decision making; and
6. Clarify on where to target improvements.

Each are discussed in further detail below. At the end of each section we pose questions (highlighted in boxes) that were explored further through the focus groups and interviews undertaken in this project.

2.1 INFORMATION DISSEMINATION & MANAGEMENT PRACTICES

In 2013 a review of land use planners' perceptions of non-regulatory guidance material produced by research institutions such as GNS Science, NIWA and others was published (Kilvington & Saunders 2013). This review indicated that the oftentimes limited uptake of guidance material was as equally likely to be due to information dissemination and management practices, as to any feature of the material itself. Participants in the 2013 review spoke of lack of awareness that material existed, as well as difficulty or even prohibitive costs associated with gaining access. A common expressed ideal was for an easily accessed, centralised system for locating material or for directing people to sources. However, the minimum ask was that the generators of such material provide their content online so that it can be found with the use of basic web searching.

However, this only touches on one aspect of information management practices. Problems exist throughout the information chain – not least amongst the local government users who have inconsistent mechanisms for storage, retrieval, and raising awareness of the existence of information. They are often reliant on the memories and personal contacts of staff (Kilvington & Saunders 2013), a process made even more fragile by high staff turnover common amoungest councils (Saunders et al., 2014). As with all the factors listed here, this is not unique to the natural hazards arena. Writing about the science-policy interface for coastal management in New Zealand, Bremmer et al. (2014,p.113) note that science that does exist is poorly disseminated. It is often in an unusable form, has been lost through poor information management, or is held guardedly by private organisations and research institutes.

> **Question:**
>
> What information management and dissemination practices contribute to, or inhibit natural hazard science availability for use in land use planning?

2.2 INSTITUTIONAL CAPACITY

Applied natural hazards science for land use planning can come from four main sources:

1. An agency's own internal research capacity (including the ability to source and interpret national and international research);
2. Commissioned research from research institutions, private contractors or a mixture of the two;
3. Research commissioned by other agencies for broadly similar purposes e.g. MFE or EQC; and
4. A hybrid relationship which may involve internal capacity combined with external additions (e.g. consultants bringing specific skills).

In 2013, a report on a survey of New Zealand public policy agencies regarding their use of scientific evidence in policy development observed There is not always the culture and capability within the public service to seek out appropriate evidence and to critically appraise and apply it to a policy question (Gluckman 2013, p.6). Bremmer et al (2013) similarly commented on the variability of available resources and skill within agencies, such as the Department of Conservation (DOC) and regional councils, to spend on commissioned science relating to coastal management. What these two comments point to is often anecdotally attested - that at the local level there are often not the skills or resources available to undertake research, or to interact with the science that is available to reinterpret for local scale and context (Kilvington & Saunders 2013, Reed et al. 2014). This results in a heavy reliance on commissioning work, itself contingent on those with sufficient technical skill in-house to ensure there is good conceptualisation of the research and framing of the problem (Lunt & Davidson 2002). In a survey of Councils across New Zealand on their capacity and capability in regards to natural hazards, it was found that 49% of councils outsource their natural hazards advice (Saunders et al. 2014).

High staff turnover in the natural hazards arena (up to 100% within 12 months for some council planning teams (Saunders et al, 2014)), and resource competition from areas of high contention and public interest (such as freshwater management), are likely contributors to this observed capacity deficit at both local and central government levels. In addition, poor coordination of research needs across the principle agencies and the lack of a national framework for monitoring have been identified as influences on science deficits for other environmental policy areas (Bremer et al. 2013). This may also contribute to the availability of good, applicable, natural hazard science for land use planning.

Question:

What system capacity factors influence natural hazard science availability for land use planning?

2.3 MUTUAL MISUNDERSTANDING AND INCOMPATIBILITY

There are a number of elements that collectively contribute to a shared misunderstanding between both researchers, and those who would use their work in the development of public policy and plans. For scientists and researchers, this has been described as: naivety of the policy process (Gluckman 2013), or a lack of full comprehension of the role science needs to play in a context of high system uncertainty and high stakes decisions (Funtowicz & Ravetz

2003). Correspondingly, planners and policy makers viewing the science research process from the perspective of what they need to get out of it, can assume there is always an identifiable and specific end point of research – the 'a-ha, we've got it!' moment – where meaning is made of data and 'the answer' can be handed on to decision-makers. They can then find the reality of the nonlinear and alternating evolution and revolution processes by which science knowledge is developed frustratingly protracted (White 2015).

The literature identifies two main areas where a mismatch of cultures and practices commonly troubles relationships between science research and development of public policy and plans: 1) scale or focus; and 2) uncertainty or doubt.

The practice of scientific research often focuses on isolated processes or components of a system, to better understand how this system works. While scientists aim for objective answers, uncertainty is inherent (Ferguson et al. 2014); arguably doubt is fundamental to the scientific approach (White 2015). Planners and policy makers in contrast work to solve practical problems across a complex social and biophysical system. They use science alongside many sources of information in a decision that will be influenced by social, political and economic factors. Doubt attached to scientific information is not regarded favourably in this context. The desire to eliminate doubt wherever possible, thereby creating a robust decision that will negate the potential of future contest, and the hopeful belief that more data equals more evidence which equals more confidence (White, 2015, p140), can result in a perpetual search for a definitive answer that can place unreasonable demands on the research community and become a barrier to action (ibid). A differing scale of focus on the system can mean that scientists and policy and planning practitioners are operating on parallel, rather than convergent, ideas of the problem (Feguson et al. 2014).

Different scale of focus and questions of doubt present communication challenges in the science-policy interface to which authors propose various solutions. These include efforts by both groups to work on commonly defining and understanding the problem (Ferguson et al. 2014); and a responsibility for scientists to: clarify and communicate levels of scientific certainty and uncertainty; and be clear about the areas of subjectivity (White, 2015, MFE 2016).

Another source of mutual frustration in the science-policy interface is locating where the responsibility for the interpretation of science information lies. Ensuring that the science being worked on is relevant to the needs of stakeholders is a significant component of environmental research programmes in New Zealand today (Thompson et al. 2015). Such engagement with stakeholders can also mean there is anticipation that research programmes will provide readymade and interpreted material for end users. The stakeholders in a typical environmental research programme are an extensive and varied group. They can be policy makers and planners at local, regional and central government levels, independent consultancies, NGOs and researchers in other disciplines and institutions. Their needs for meaningful interpretation of research information vary widely in scale, and emphasis. If research programmes are unable to provide for the interpretation of information for all these groups, where else does the responsibility for generating contextually relevant and meaningful information lie?

Questions:

How does 'mutual misunderstanding' between natural hazards researchers and policy/planners affect the natural hazards science–land use planning interface?

Where does responsibility for the interpretation of science currently lie, and where should it be?

2.4 TIMELY, TARGETED INFORMATION

Policy analysts and planners working with natural hazard management constantly make use of science information. Nevertheless, the challenges for improving the science-policy interface for natural hazards include addressing issues of timing and focus in the development of knowledge. Demands for science to support planning and policy decisions (e.g. evidence-based decision making), can occur simultaneously from multiple users who have overlapping but distinct requirements. Authors Bremmer et al. (2013), writing about integrated coastal management, warn that lack of coordination between the major agencies in the field of coastal management results in siloed science collections and a disintegrated and patchy knowledge base (p.113).

In natural hazards management and planning in New Zealand, there is considerable non-regulatory guidance available. There are three main sources of this information:

1. Quality Planning (QP) website (www.qualityplanning.org.nz). The aim of this website is to promote good practice by sharing knowledge about all aspects of practice under the Resource Management Act. The QP website is now the primary tool for delivering robust information on RMA processes and environmental policy to resource management practitioners.
2. Ministry for the Environment (MFE). Guidance is available on climate change adaptation, flood risk management, planning for development on or close to active faults.
3. Other information providers e.g. GNS Science and NIWA. Both of these crown research institutes have released a number of guidance documents for land use planners around sea level rise, coastal hazards, flooding, geological hazards, and risk-based land use planning.

As the above examples of guidance are produced at a national level, the guidance is not specific to regions or districts. Discretion is required by those applying the guidance, to ensure local context is taken into account. While this allows flexibility for local solutions to local problems, it can also be a challenge to set specific upper and lower limits e.g. sea level rise, which differ across New Zealand.

Research agencies may also not be fully aware of the different functions their research work plays in the overall natural hazards management system. Authors Bremer et al. (2013) identify three types of science being used in coastal management: (i) state of the environment; (ii) resource consent research; and (iii) issues based research. Reed et al. (2014) describe the impact of science in environmental policy making in general as being usually in one of three areas: (i) conceptual (raising awareness and changing beliefs or thinking); (ii) instrumental (direct changes to policy or practice); or (iii) symbolic (justifying existing policy or practice).

Satisfying any one of these different uses of natural hazard science information requires different output and communication forms. These can range from guidance documents that provide practical and real examples to support implementation of findings, through to long term ongoing peer learning communities. Whatever the associated communication strategy, its effectiveness is highly dependent on how well the target audience and need have been understood (Kilvington & Saunders 2013).

Lemos et al. (2012) highlight that producers of information may make the assumption that knowledge is useful when they engage in research they think users need. However, because they do not completely understand or know potential users' decision-making processes and contexts, the knowledge produced remains on-the-shelf. Users in turn, may not know how this knowledge fits their decision-making, and choose to ignore it, despite its usefulness.

Questions:

Are researchers aware of the different purposes, and scales for the research that they generate for natural hazards and land use planning?

Is there sufficient overview and future projection for research needs in the area of natural hazards and land use planning?

Are policy planners aware of the science available, and what exactly it is that they need?

2.5 SCIENCE AND VALUES IN DECISION MAKING

Science institutions and researchers often hold a deep attachment to claims of objectivity and neutrality. However, in practice the subject and direction of environmental science is driven by societal values, and research institutions regularly engage with society in different ways to determine and prioritise what is researched (White 2015; Hurley & Walker 2004). Furthermore, while the science process and the findings from any given research effort can be conducted with a view to objectivity, scientific claims are inherently contestable. Indeed, scientific validity is based on there being the possibility of questioning expert knowledge, or of experts disagreeing with each other (White 2015).

Experience in New Zealand and elsewhere has shown that science used to support particular positions in resource management policy and planning is frequently subject to contestation. This is particularly so where the stakes are high, and where there will be winners and losers associated with the outcome (Gunningham 2011). This contesting can take the form of doubt in the findings, interpretations, and occasionally even the research process or researcher themselves. An example of this is the coastal erosion hazard assessment disputed in Kapiti in 2012, and similarly in Christchurch in 2015.

This disputation is characteristic of oppositional styles of decision-making. However, such politicising of science can be uncomfortable for scientists and for those planners and policy makers who perceive science as value neutral and desire to place it outside the arena where values are debated. Hurley & Walker (2004, p.1529), state that land use planning can be regarded as a competition between different groups *over which 'landscape visions' …will guide the planning process* and emphasise the potential of science to lend legitimacy and power to particular visions in the land use planning process.

This idea of value neutrality in science is rarely openly examined, and scientists, when advocating for their science, may be surprised at the notion that they were in any way attempting to guide a decision towards a particular 'vision'. Yet by presenting evidence, for instance on climate change, and its likely impacts on communities, scientists are expecting these findings to be regarded as important and to shape the final decision. Indeed, they often go as far as promoting specific precautions. This is a value position albeit derived from the collective experience of a research community rather than a geographic community or interest group. Hurley & Walker (2004) advocate a greater openness about the anticipated shift in values associated with any science presented to environmental planning decisions. They argue that greater clarity about what vision is being supported would enable any contest to be focussed on the values rather than attacking the research itself.

Question:

How des contesting of science influence the way natural hazard science information is used in land use planning?

2.6 Clarity On Where To Target Improvements

> *The research world favours grant acquisition and academic publication over knowledge synthesis and engagement…. Researcher to researcher communication about the next study ('more research is needed') is well organised and all too common; researcher to practitioner dialogue about implementing findings ('actionable messages') is poorly organised and all too rare (Lomas 2007).*

While many research institutions and programmes are making considerable efforts to improve their relationships with stakeholders (e.g. incorporating greater stakeholder input in setting research agendas and in contributing to research programme governance), they continue to be hampered by two challenges. The first is poor conceptual understanding of the overall knowledge management and decision-making system (Funtowicz & Ravetz 2003); and the role of science institutions within this. This means actions taken by research institutions are made in isolation from supporting actions required by others. It can also mean that significant players in the system are overlooked. The role of boundary organisations or knowledge brokers that mediate relationships between knowledge and practice is frequently highlighted in discussions on knowledge integration (Lemos & Morehouse 2005; Forsyth 2003), but in practice individuals or groups that perform this role are not always recognised.

The second challenge is the need for a more systematic approach to knowledge exchange that builds on known theory, methods, and deliberately learns from experience. While efforts to improve the knowledge exchange system in environmental management abound – particularly driven by research programmes and institutions – this has been largely on a 'what seems to work' basis. The result is that despite the growing interest in improving the way research influences decisions, there has been only limited collating of tangible evidence to help the wider community learn (Fazey et al. 2014). Work by Ferguson et al. (2014) and Reed et al. (2014) are amongst those that have attempted to bridge this gap. They offer a framework of heuristics and practices for improved knowledge exchange in environmental management, based on the collated experience of multiple initiatives. One of the five key principles that Reed (et al. 2014) offers is reflection. Reflection and evaluation are important to system improvement. They ensure that steps to better knowledge integration are not treated as recipes that can be applied without an understanding of the specific research and policy context. All institutions and agencies involved need a way to recognise existing strengths and to build on these, and to acknowledge gaps and to address these (Fazey 2014).

Questions:

What are researchers' and policy makers' understanding of the challenges involved in improving the relationship between natural hazard science and practice?

How can the situation be improved?

2.7 SUMMARY

This section provides a brief overview of some of the known challenges in the environmental science-policy interface; some of the proffered solutions, and apparent gaps in knowledge. In particular, we examine how this relates to natural hazards science and land use planning. This review reveals six likely problem areas for the natural hazard science-planning interface that are worth further exploration:

1. Information and dissemination practices;
2. Institutional capacity;
3. Mutual misunderstanding between science providers and users;
4. Timely targeted information;
5. Science and values in decision making; and
6. Clarity on where to target improvements in the science-to-practice interface.

Collectively these areas generate a number of questions.

- What information management and dissemination practices contribute to, or inhibit, natural hazard science availability for use in land use planning?
- What system capacity factors influence natural hazard science availability for land use planning?
- How does mutual misunderstanding between natural hazards researchers and policy/planners affect the natural hazards science – land use planning interface?
- Where does responsibility for the interpretation of science currently lie and where should it be?
- Are researchers aware of the different purposes, and scales for the research that they generate for natural hazards and land use planning?
- Is there sufficient overview and future projection for research needs in the area of natural hazards and land use planning?
- Are policy planners aware of the science available, and what exactly it is that they need?
- How is contesting of science influencing the way natural hazard science information is used in land use planning?
- What are researchers and policy makers understanding of the challenges involved in improving the relationship between natural hazard science and practice?
- How can the situation be improved?

Exploration of these questions occurred through interviews and discussions with research providers, and natural hazards planning and policy practitioners and through the analysis of the case study. This resulted in a revised view of the science-to-practice process (presented in **section 4.0**) and in ideas about how to improve land use planning use of natural hazards information (**section 5.0**).

The next section focuses on a specific case-study in Hutt City involving the use (or not) of natural hazard information in land use planning. By taking on the role of a submitter in the Hutt City PC29, GNS Science moved from being an information producer to actively promoting the specific use of that information. We explore why GNS Science was motivated to take this step, and the implications of such a practice for improved use of natural hazard science in land use planning.

3.0 THE GNS SCIENCE SUBMISSION ON PETONE PLAN CHANGE 29

In June 2012, the Hutt City Council notified a plan change[1] referred to as Plan Change 29 (PC29) covering Petone West, the south western portion of Petone, Lower Hutt. Prior land use in Petone West was predominantly business and commercial. This plan change allowed for an increased level of activity and encouraged a mixture of uses including residential development as well as educational and emergency facilities.

Petone West is subject to a number of natural hazards including fault rupture, ground shaking, subsidence, sea level rise, liquefaction, flooding and tsunami (Saunders & Beban 2014). This accumulation of potential hazards makes Petone West the most hazard prone area within the Hutt valley (ibid). The previous district plan provisions for the area had limited rules to address and mitigate the risks from natural hazards, and no new rules were proposed as part of the plan change. GNS Science, as a corporate citizen of the Hutt valley, lodged a submission opposing PC29 based on the lack of provisions to address the potential impact of the natural hazards in the plan change. A number of GNS Science staff (who live locally), were also personally concerned with the plan change (ibid).

A report by Saunders & Beban (2014) outlines the natural hazards that have the potential to affect Petone West. It describes the proposed plan change and the alterations that occurred to the natural hazard provisions as a result of the submissions by GNS Science. As part of this project to understand the role of science in land use planning, we reviewed the PC29 process further through interviews with Hutt City staff and consultants involved with the plan change (see **Appendix A1.0** for details). Questions that were explored included:

- What had been the role of natural hazard science in the decisions that led to the proposed Petone West plan change?
- What science information about natural hazards was introduced during the various planning stages, and what factors had influenced the way this information was considered?
- What were the implications of having natural hazard science introduced at the submission stage by GNS Science?

We were also interested to assess if the experience of the interviewees would suggest that what happened in Lower Hutt was typical of land use planning practice elsewhere in the country, and whether this case added anything to the six themes on the science and policy interface identified through the literature review (outlined in previous section).

3.1 PLAN CHANGE 29 – AN EXAMPLE OF LAND USE PLANNING PRACTICE

Developing a plan change has many stages even before it is notified and made available for public comment. **Figure 3.1** is a schematic of the process for PC29. In this section we examine how decisions affecting natural hazard risk and consideration of available science on natural hazards were explicitly or tacitly determined at various stages.

[1] The notification of a plan (or plan change), occurs after a period of consultation and policy analysis. It triggers the formal process of submissions, hearings and decision-making http://www.qualityplanning.org.nz

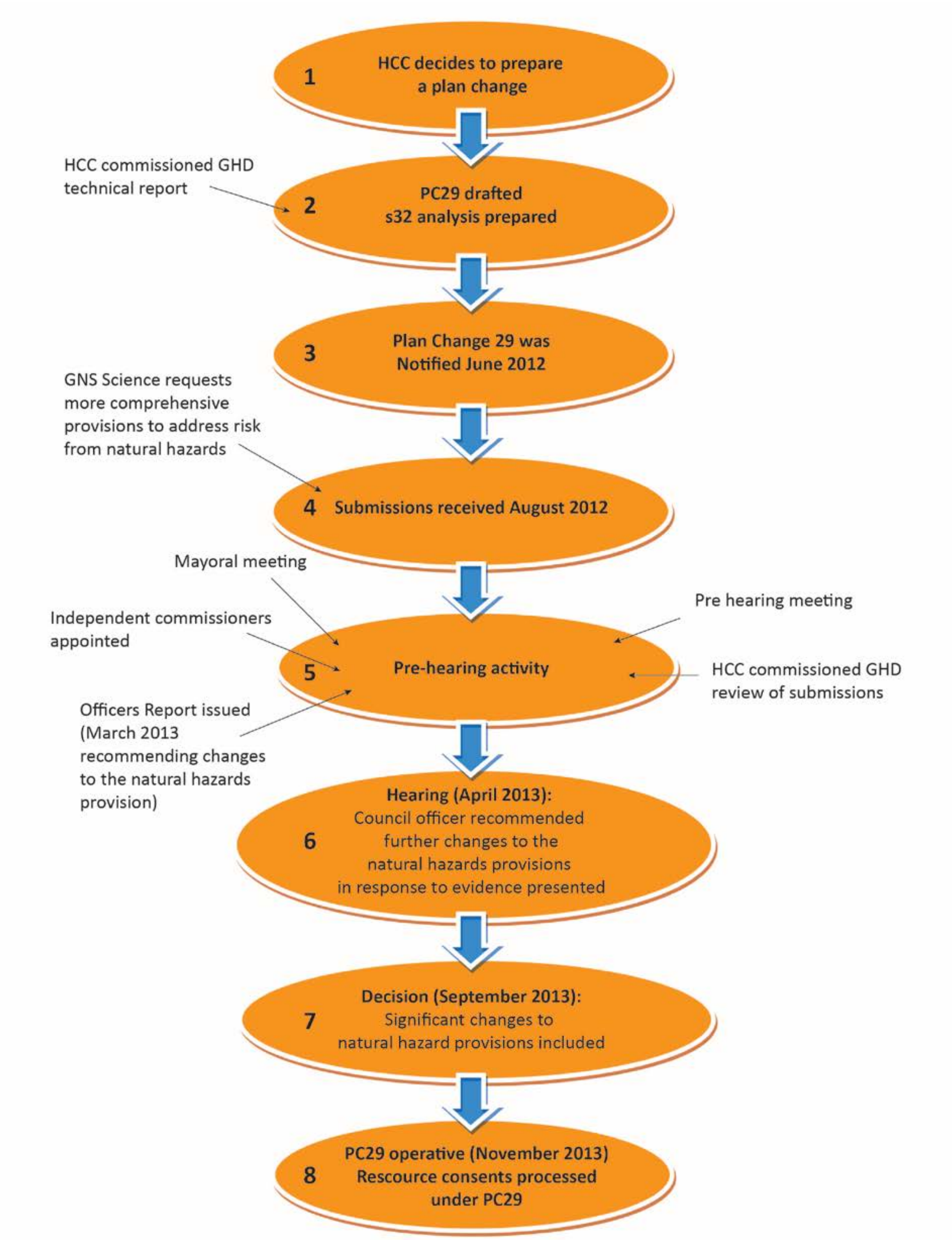

Figure 3.1 Schematic of PC29 process

3.1.1 Stage 1: The Decision to Make A Plan Change

Any change to a statutory land use planning document is done as a response to an identified land use planning need for which current plan regulations, (those that create both constraints and options), are deemed inadequate. The impetus for change can come from many sources and be based on many concerns, including pressure from specific sectors in the community or national or regional government directives. It is not uncommon that a process that ultimately results in a plan change has narrowed in focus from a wider review of generic issues, and a consideration of different statutory and non-statutory means to address these.

The stimulus for PC29 began back in 2009 when interest was expressed (via public representatives of the Hutt City Council), in creating mixed use development and greater intensification across the whole of the Petone area. This prompted an early and wide ranging review of options, including those that were outside the remit of the district plan. Discussions were held with key community groups such as the Petone Planning Action Group (who were later vocal in submissions on PC29). A vision document was prepared which, along with a vision statement, was released in 2009 (HCC 2009)

In April 2010, a consultant undertook a scoping exercise on the basis of the vision document. The consultant was tasked to look at boundaries for the proposed change in land use, and what key issues might influence the planning process and require further investigation. Eight issues were identified including, transport, urban design and natural hazards. At this stage, natural hazards were highlighted as an issue for consideration in a generic sense, rather than from an anticipated increased risk as a result of the proposed development.

A subgroup of the Hutt City Council public representatives was appointed to overview the direction of the work on mixed use development for Petone. This group made a decision to limit the scope of the work to the smaller area of West Petone. This had significant bearing on how some of the most strategic of the eight key issues identified by the consultant were assessed, including natural hazards. In particular, the oversight group concluded that as they were now dealing with a subset of a wider area it was not desirable to address natural hazards in any way that could be considered unique as this would: (i) set a precedent for the wider city; (ii) pre-empt decisions that might make better sense or go a different way when looking at city as a whole; and (iii) potentially inadvertently result in a perverse outcome – i.e. new and greater restrictions in Petone West would drive development elsewhere, when the plan was to increase development. Ultimately, this led to a decision to retain the status quo provisions for natural hazards already in the operative district plan rather than examine these any further, and to postpone or rely on a future (but indeterminate) review of natural hazards provisions for the Hutt City as a whole.

In August 2010, following several months of ongoing discussions, a workshop with the Petone Community Board and the full Hutt City Council (HCC) public representatives came to a decision to progress PC29. The brief for PC29 was narrower in scope than the initial vision for mixed use development that was considered early in the process. The decision to limit the scope was a political level decision, and, like many local government processes was shaped by the expectations and assumptions of the political representatives about the preferred way forward. These views can be formed well ahead of the planning project itself and can be very influential on what information is subsequently deemed relevant to the decision. In the case of PC29 attempts by the consultant to introduce strategic considerations (such as the need to explore open spaces and public parks to meet urban living goals) were rejected as not needed.

3.1.2 Stage 2: Drafting PC29

Following a temporary halt in proceedings, preparation of PC29 began in May 2011. As part of the plan change process, a section 32 report was required (step 2 in **Figure 3.1**). This report examines the plan change for its appropriateness in achieving the purpose of the RMA. In a section 32 report, the benefits, costs, and risks of new policies and rules on the community, the economy and the environment need to be clearly identified and assessed; and the analysis must be documented, so stakeholders and decision-makers can understand the rationale for policy choices. At this stage in the preparation of PC29, Council officers determined a need for more science, resulting in a direct invitation from HCC to GNS Science to investigate the natural hazards for the area. However, the GNS Science response was judged to have time-line and cost issues, and a few months later (November 2011), another trusted consultant of technical information (GHD consulting) was engaged to provide a report on the natural hazard risk profile for Petone West, and options for how to address this. GHD personnel involved in the report had good connections and familiarity with relevant GNS Science natural hazard risk work, including emergent work from the ‘It’s Our Fault’ research programme. This was incorporated in the report. Council officers considered that the material met all technical requirements, but thought there was still a significant gap between the technical findings and the planning implications - a view often expressed by land use planners regarding science reports (Kilvington & Saunders 2013).

After reviewing the GHD report, the HCC subcommittee decided there would be no need to incorporate any changes to natural hazards provisions in the proposed plan change; and that the Building Act (2004) would be sufficient to address natural hazards concerns.

The introduction of new information at this stage of a plan change development can have a significant impact on the plan direction. However, the availability of technical information alone is not enough; rather, an interpretation of this technical information into compelling and plausible planning options can also affect how influential it is in any planning decision. In the case of PC29, consideration of natural hazards had already been constrained by the previous decision to not address what could be considered strategic city wide issues via a plan change that would only affect one area. Furthermore, particular public representatives who had a predetermined preference for what shape PC29 would take, had an impact on the way in which science knowledge about natural hazard risk was viewed. As one participant in the interviews observed:

> *When presented with science information for PC29, they said that the Building Act would deal with it. In this way, the Councillor who wanted to ignore the science found - what sounded like - a legitimate way to side-line the science.*

3.1.3 Stages 3 & 4: Notification of The Plan Change and Receipt of Submissions

In June 2012, PC29 was formally notified. There had been no pre-consultation before this or discussion with regional policy planners at Greater Wellington[2]. However, the regional council subsequently made submissions on the PC29 relating to flooding hazard.

A substantial number of submissions were received on PC29 – and over one third of these made mention of concerns about sufficient provisions for addressing natural hazard risk. Although few of these had specific details, they collectively conveyed a wide general interest in the issue of natural hazards. This general interest provides important context and influences how any specific submission on natural hazards might be received.

3.1.4 Stage 5: Pre-hearing activity

Realising the constraints to development that the natural hazards of the area could affect, HCC officers organised a meeting with GNS Science and the HCC Mayor, to outline concerns with the lack of natural hazard provisions. This meeting involved the Manager of the Natural Hazards Group, the project manager of the 'It's Our Fault' research programme, and the natural hazards planner, along with the Council policy planner. The result of this meeting was that independent commissioners were appointed to hear the submissions, rather than the Council representatives on the Policy and Regulatory Committee.

In the prehearing phase of the development of PC29, meetings were held with a number of submitters, including the Petone Plan Action Group (PPAG). This group had been an active contributor to discussions about development in the Petone area prior to the decision to focus on Petone West, and to pursue a plan change. Their concerns included that PC29 was not a match for the vision for the area agreed during prior consultation. They also placed pressure to insure that the hearing was presided over by independent commissioners, thereby removing it from political influence.

Prior to the plan change hearing, HCC commissioned GHD scientists to review the GNS Science submission and other submissions. HCC Council officers produced a report in March 2013 recommending changes to the provisions for natural hazards in PC29, based on submissions received.

3.1.5 Stages 6 & 7: Hearing and Decision

In April 2013, the PC29 hearing was held. GNS Science was one of a number of submitters who presented on their previously written submission. Those interviewed on the PC29 process commented that the GNS Science presentation was very persuasive – both due to the manner of presentation and the reputation of GNS Science as a trusted source of information on natural hazards. They noted that science information was frequently presented by submitters in land use planning hearings, and the standing of the individual and organisation presenting it was an important influence on how this information was received by the hearing panel.

[2] Pre-consultation can reduce the amount of time, complexity and cost of a plan change if the Council is made aware of any issues that can be addressed before the plan change is notified (i.e. the number and complexity of submissions is reduced).

Contesting and dispute of science evidence can happen in public hearings. However, because natural hazard science had not played a significant part in shaping PC29 during the plan development stage (rather, it was introduced via the submission process), those who might have reason to contest it were not alerted to it. There had been no draft document pre-release for PC29. If a draft was released, there may have been debate about the science at that stage, and then again at the hearing.

In the final decision on PC29 (released in September 2013), there had been significant amendments to the provisions for managing natural hazard risk. **Table 3.1** summarises these.

Table 3.1 Summary of changes to PC29 following submission on natural hazards by GNS Science and the panel hearing by independent commissioners (Saunders & Beban 2014)

Before submission process **Proposed Plan Change 29 (26/6/12)**	**After submission process** **Decision for Plan Change 29 (24/9/13)**
Wellington Faultline – Retaining current requirements to cope with the extra risk of building within the Wellington Fault Area. Building heights and density provisions within the fault area would be the same as elsewhere in the area.	Include a natural hazard specific objective: To avoid or mitigate the vulnerability and risk of people and development to natural hazards to an acceptable level.
	All new buildings require a case-by-case assessment of the natural hazard risks and consequences. These are specific references to the ground rupture, subsidence, liquefaction and tsunami risks as well as the requirement for sea level rise to be considered.
	Emergency facilities were made a Non-Complying Activity for the entire Petone Mixed Use Area, in response to the risk from natural hazards.
	In response to the natural hazard risk, Places of Assembly, Childcare Facilities, Education and Training Facilities, Commercial Activities (accommodating more than 300 people), Community Activities/Facilities, Housing for the Elderly and Residential Facility were made a Discretionary Activity. Any development that includes these activities must consider the natural hazard risk and measures to avoid or reduce this risk.

3.1.6 Stage 8: Consent Application Under PC29

PC29 became fully operative in November 2014. This effectively means that the PC29 provisions have been incorporated into the operative Hutt City Plan. Resource consent applications for the plan change area are now processed under the provisions and information requirements stipulated under the plan change through the operative plan. HCC resource consent planners have a number of checklists, prompts and access to GIS mapping layers; and are able to review consent applications on the grounds of their natural hazard implications. However, applicants can resist requirements to use adequate technical information, as prospective developers consider this as an increased upfront cost rather than something that can improve their project design.

3.2 Implications For The Role Of Natural Hazard Science In Land Use Planning

The PC29 planning process is a useful case study for exploring the way in which science knowledge is shared, translated and transformed within the very specific social context of land use planning. Examination of the PC29 process illustrates multiple situations where natural hazards and natural hazard science were referenced during the planning process:

1. during the initial scoping phase when it was identified as a significant issue (stage 1);
2. during the plan change development phase when a report was commissioned from a technical consultancy (stage 2);
3. via general submissions from multiple submitters and in detailed submissions by GNS Science and Greater Wellington (stage 4);
4. in prehearing meetings and council officer reports (stage 5); and
5. in the PC29 hearing when the GNS Science and Greater Wellington submissions were presented (stage 6).

Also, once a plan becomes operative, natural hazards science and technical information is used to assess resource consents. Ensuring consent applicants are adequately informed of the natural hazard effects relating to their application, in order to manage these in accordance with the plan, is part of the requirements for consent application. Applicants are expected to seek input from properly trained technical advisors.

This illustrates that representation of science into the planning process can come from numerous sources. Council officers and consultants are key amongst these sources. Others include: the regional council (through pre-plan consultation or submission); stakeholders; and the public (through submission or potentially through consultation). National agencies (such as MFE) can be the source of nationally relevant science information in land use planning, but critically are seldom active representatives of science in specific planning decisions. Rather, they create the context which validates the need for science consideration through national standards and guidance.

Some of the researchers involved in the GNS Science submission expressed surprise that they needed to go to such lengths to advocate for natural hazard risk inclusion in a planning process. However, the review of the PC29 process illustrated that there were many avenues by which such information could, and indeed was, made available to the decision makers. Ultimately, the reason natural hazard science was included so apparently late in the process was not due to the absence of science in the planning process; ignorance of available science; or a dispute over the implications of natural hazard science. Rather, the decision parameters that were shaped during the development of the plan change effectively acted to unduly discount the role of natural hazard science information.

This surprise about the process could be a result of a mistaken belief in the methodical and comprehensive nature of planning decisions, where all relevant information would be brought to the table and considered. Historically termed 'rational comprehensive decision making', this notion has been heavily critiqued in literature on planning and policy practice (Hostovsky 2006: Lindblom 1959). No decision can be truly comprehensive; rather, values, goals and sheer pragmatism act as filters by which decision makers determine what is included or discarded. In the development of a planning response to any perceived issue, decision makers juggle the question of 'what information is necessary?' Furthermore, with resource constraints being a consistent concern, they may also consider 'what can we get away without having to do right now?'

In the case of PC29, the initial goal (or value base) for the entire planning proposal was to increase development opportunities within Petone West. As participants in the case study remarked:

> *you have to face the reality of the context – some places are desperate for growth.*

As natural hazard management was not the primary focus of the planning initiative, natural hazards concerns entered the planning arena as one of many potential factors to consider; moreover, one that might modify or even run contrary to the primary value of the planning initiative. Discussions with GNS Science researchers who contributed to the PC29 submission suggested that they regarded the material presented as fundamentally factual and objective. However, in a local government planning context natural hazard information - and by association, natural hazards science - is not regarded as value neutral information. Rather, it is regarded as likely to place constraints on the amount and direction of growth. Its inclusion inevitably poses a very challenging question: What are we prepared to compromise on now, to safeguard against possible loss in the future? For local government decision makers facing active lobbying from local communities, interest groups, and genuine financial pressure to grow their rating base, there are few negative consequences associated with ignoring evidence of future risk, and far more immediate negative consequences of being perceived as inhibiting the agenda for growth and development.

Council officers and consultants can make recommendations on what factors they view are important to a planning decision. However, without a requirement to consider hazards, stemming from a higher level / priority in the planning and policy framework (i.e. regional or national guidance), politicians may not choose to take this advice. As one case study participant observed

> *This is not ignoring the science, but deciding that they don't have to consider the implications.*

This also highlights the potential vulnerability of planning processes to the personal priorities of politicians. While local government politicians frequently do accept the direction of council officers and planning consultants, PC29 highlights how influential political representatives can be in determining the parameters of the decision, and what information would and would not be deemed relevant. A number of the case study participants observed that in PC29 the level of consideration of issues, such as natural hazards during the scoping phase, was normal for such a planning process but the level of political influence was greater than normal.

Both planning and technical consultants had a significant role in PC29. This is common in local government agencies – particularly smaller territorial authorities with limited in house capacity. In this way consultants – and the act of consultancy which many major research institutions undertake - can be an underestimated conduit for science in land use planning. Typically, consultants have wide experience across a number of agencies and planning situations. However, where consultants provide technical input into a planning decision, as in PC29, there is still a challenge in determining the implications for planning. Participants in the case study interviews described this as a translation gap, that is best resolved through direct conversation between the planner and technical advisor. Case study participants further added that they saw there was a tension in the task set for the technical advisors:

You need to give scientists a context, but can't ask them to make planning recommendations.

Council officers are not only direct users of science and technical information; they also have an influence on what science is required in any planning process. Land use planning timelines are notoriously pressured. In determining the science input into any planning project, council officers will foremost rely on existing personal awareness of what science is available; in-house knowledge; and information that can be readily accessed. In many ways this reliance on the capacity of council officers to ensure current and relevant science input to land use planning projects is highly variable across local government. Councils have fluctuating staff turnover which can compromise institutional memory (Saunders et al. 2014). Participants in the case study expressed a lack of confidence that information made available to higher levels of the organisation (such as via membership of research programme steering committees, or the Chief Executive Officer (CEO) attendance at CEG (Coordinating executive group) meetings[3]), always filtered throughout the organisation. Furthermore, many agencies (particularly small district councils), have limited resources to support staff professional development – particularly on topics that are not regarded as core to their role. Participants in the case-study interview noted that while some policy planners might go to non-discipline conferences, many would not; citing the need for such extension training to be low cost and preferably at times such as late afternoon when this could easily fit within a working day (e.g. webinar based training). In contrast, one of the participants from the consultancy commented that their employer actively supports and encourages attendance at non-core discipline conferences - another way in which consultants are facilitating links between science and land use planning.

The review of the PC29 process showed that there were both positives and negatives associated with GNS Science making a contribution to PC29 via the submission process. As a submitter to the plan change, it was not possible for council officers to discuss the science and its implication for the plan change directly with the scientists involved unless through formal mediation, a tool that was not utilised. However, the submission process was a good avenue for making clear the values attached to the science. The fact that one third of submissions received on PC29 mentioned natural hazards highlighted that there was a climate of public interest in the issue of natural hazard risk; and a desire for HCC to address this with an appropriate management response. Furthermore, it lent meaning to the science-based submission on the risk profile for the Petone area, and clarified what vision is being supported (Hurley & Walker 2004), i.e., natural hazard management as a priority concern. This clarity of role and purpose in the science contribution to the land use plan, and its timing in the plan change development process, effectively circumvented any potential for misleading contesting of the science by those whose concerns more honestly rest with perceived loss of property values[4].

Although access to natural hazards science did not prove to be a major issue in the PC29 case, participants in the interview did discuss some generic issues around how science information is managed and sourced when preparing supporting material for a planning

[3] The CEG is a regional committee operating under section 20 of the Civil Defence and Emergency Management act 2002. Membership typically includes representatives from emergency services, district health boards, lifeline utilities as well as community boards and business associations. The CEOs of each local authority in the region are statutory members.

[4] Contesting of science can be a significant component of natural resource planning. Participants in the case study commented that a mechanism to help address this, that is growing in usage, is the expert caucus; where experts are brought together to clarify and narrow the scope of disagreement.

initiative. At the beginning of the PC29 process council officers looked at consents that had been processed in the area as a source of technical information. They commented that it would be a useful practice if policy and consents officers talked more regularly and shared information. Similarly, they observed that CDEM staff was also a useful source of information; however, while regular exchange between policy and CDEM staff may occur in small councils, this was less likely in larger councils.

Participants noted a fervent need to improve the overall science information base, so that all planners are aware of what information is available and how to find it. They noted that the Quality Planning website[5] was currently the most likely first source they would look to. They cautioned that it was important to be aware of the purpose and methodology of science information to determine how relevant it is to the specific planning context. This can include needing to be aware of the assumptions behind the science. They cited the example of flood modelling which has multiple approaches with inconsistent assumptions and limits, across a range of scales. Overall, the greatest limitation they felt was the sheer time pressure they regularly operated under, observing that a staff member with a dedicated role to facilitate access to science information would have a positive impact on science access in their organisation.

[5] http://www.qualityplanning.org.nz

3.3 OVERALL OBSERVATIONS

The review of events that led to PC29 showed that the issue of natural hazards had not been deliberately or accidentally excluded from the plan development process; nor had the science information that described the natural hazard risks in the Petone area been directly contested. In the PC29 process, natural hazards had suffered from being side-lined as a priority issue due to limitations placed on the scope of the decision and a choice by decision makers to direct it towards a specific planning outcome.

Interestingly, the participants in the PC29 case study group interview did not believe that the example of PC29 implied a need for greater science literacy amongst public representatives. They observed that information overload is already one of the greatest challenges councillors face in their role. Training that local politicians receive primarily focuses on good process and making good decisions[6]. Local government politicians and the planning process itself constantly juggle long and short term needs and the multiple concerns and objectives innate in any planning decision. In order to become forefront amongst these competing elements, the issue of natural hazards needs an advocate in the planning process. This can be through increased community consciousness of the need for greater risk management; or through legislative guidelines that increase the imperative for decision makers to actively consider natural hazards (e.g. a National Policy Statement). There is also a need for information that lends greater credence to the notion that planning for natural hazards implies ‘smarter development’, and is not synonymous with ‘no development’.

Scientist themselves may be uncomfortable with the notion that they are advocates within a planning process. However, the experience of GNS Science as a submitter to the PC29 planning process, where they effectively engaged in shaping the agenda for change in land use planning priorities, is illustrative of the usefulness of presenting science in a way that unambiguously connects with a value proposition (in this case, the importance of improved management of natural hazard risk).

[6] For example, the ‘Making Good Decisions Programme’ and certification process helps councillors, community board members, and independent commissioners make better decisions under the Resource Management Act 1991 (http://www.mfe.govt.nz/rma/making-good-decisions-programme)

4.0 REVISING THE VIEW OF SCIENCE-TO-PRACTICE IN LAND USE PLANNING

In this section we examine and revise ideas about the interface between natural hazard science and local government land use planning in the New Zealand context. These ideas derive initially from generic observations about the science and policy interface (outlined in **Section 2.0**); but have been shaped into a more specific model through input from focus group participants, individual interviews and the PC29 example (**Section 1.0**).

4.1 FUNDAMENTALS OF THE NATURAL HAZARDS SCIENCE AND LAND USE PLANNING SYSTEM

Figure 4.1 is a mind map of ideas about the science and land use planning interface gleaned from the literature and the project team's own experience. This mind-map formed the starting point for a conversation with researchers and planners and policy makers involved in natural hazards and land use planning.

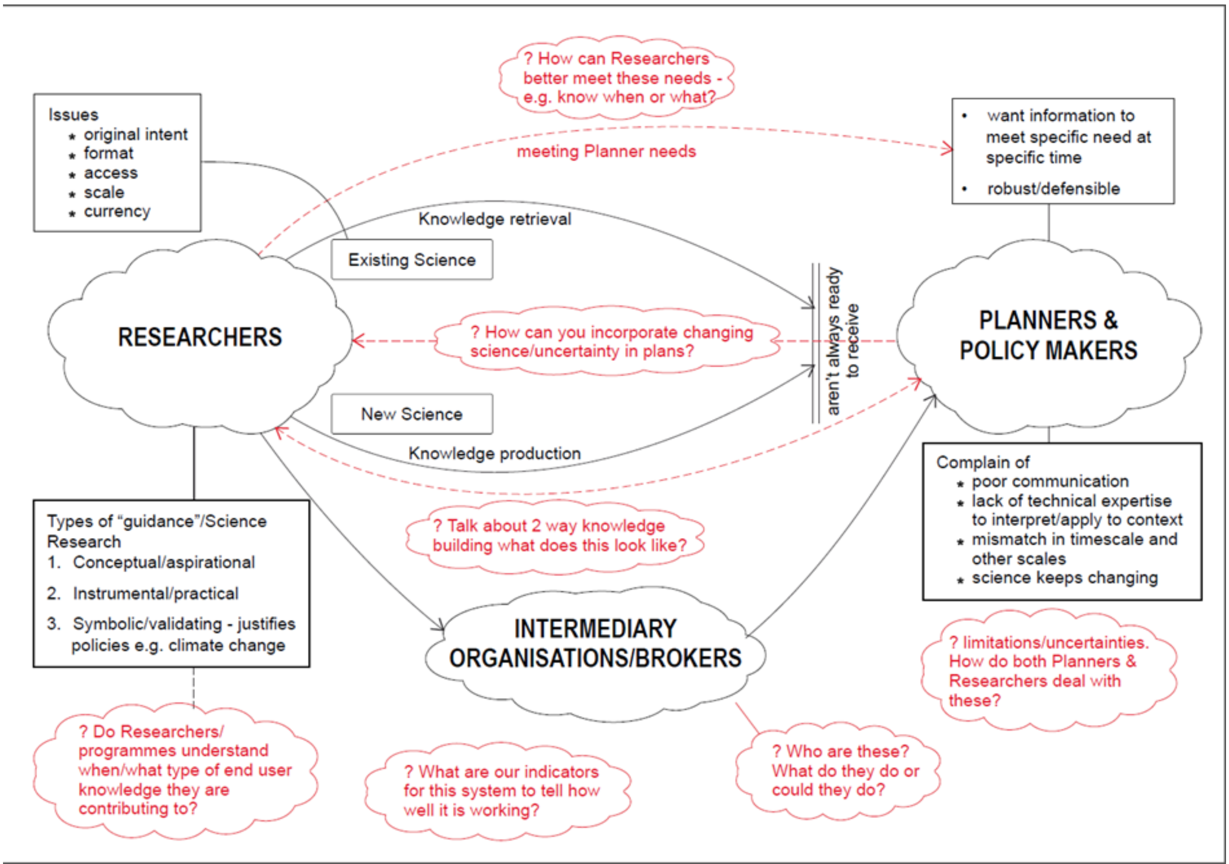

Figure 4.1 Initial mind map of ideas about the science-to-practice system for natural hazards and land use planning

Figure 4.1 conceptualises a broad relationship between science research information providers on one hand, and an undefined group of policy and planning stakeholders with an interest in natural hazard information on the other. The challenges and questions articulated in **Figure 4.1** centre around the themes explored in **Section 2.0**, and are primarily around how to improve delivery of existing science information, and increase the practical relevance of new science. Floating in the midst of this representation of science-to-practice is the notion of information brokers or intermediary organisations. Who are they and how do they operate? **Figure 4.1** also represents the awareness that current science-to-practice avenues are not meeting policy and planning stakeholder needs, and registers the concerns noted in **Section 2.0**, such as: lack of capacity to intersect with science; and a sense that science and local and regional planning scales do not easily mesh temporally or spatially. In this representation of the science-to-practice relationship, both science providers and policy and planning practitioners share the question of how to address uncertainty and change, particularly when science information is reappraised or updated.

This diagram was presented to a focus group of participants with differing relevant experiences relating to science and its role in land use planning. Their backgrounds included local and regional government, planning consultancy, natural hazards science research, and science communication (**Appendix A1.0**). The group discussed their experiences of the way natural hazards science was communicated, translated, and applied in land use planning. They reviewed **Figure 4.1** for what seemed accurate; what was missing; and what elements, in their view, had greater or lesser impact on how well science was integrated into land use planning practice in New Zealand.

Following the focus group, the mind map was further explored in interviews with natural hazards researchers, and those involved in local government planning. It was also presented to a mixed audience of natural hazards specialists, planners, policymakers, consultants and engineers, at a forum in Wellington (see **Appendix A1.0**), and central government agency staff from MFE, and EQC. **Figure 4.2** is a revised representation of the science-to-practice system for natural hazards and land use planning based on the feedback from the all these sources.

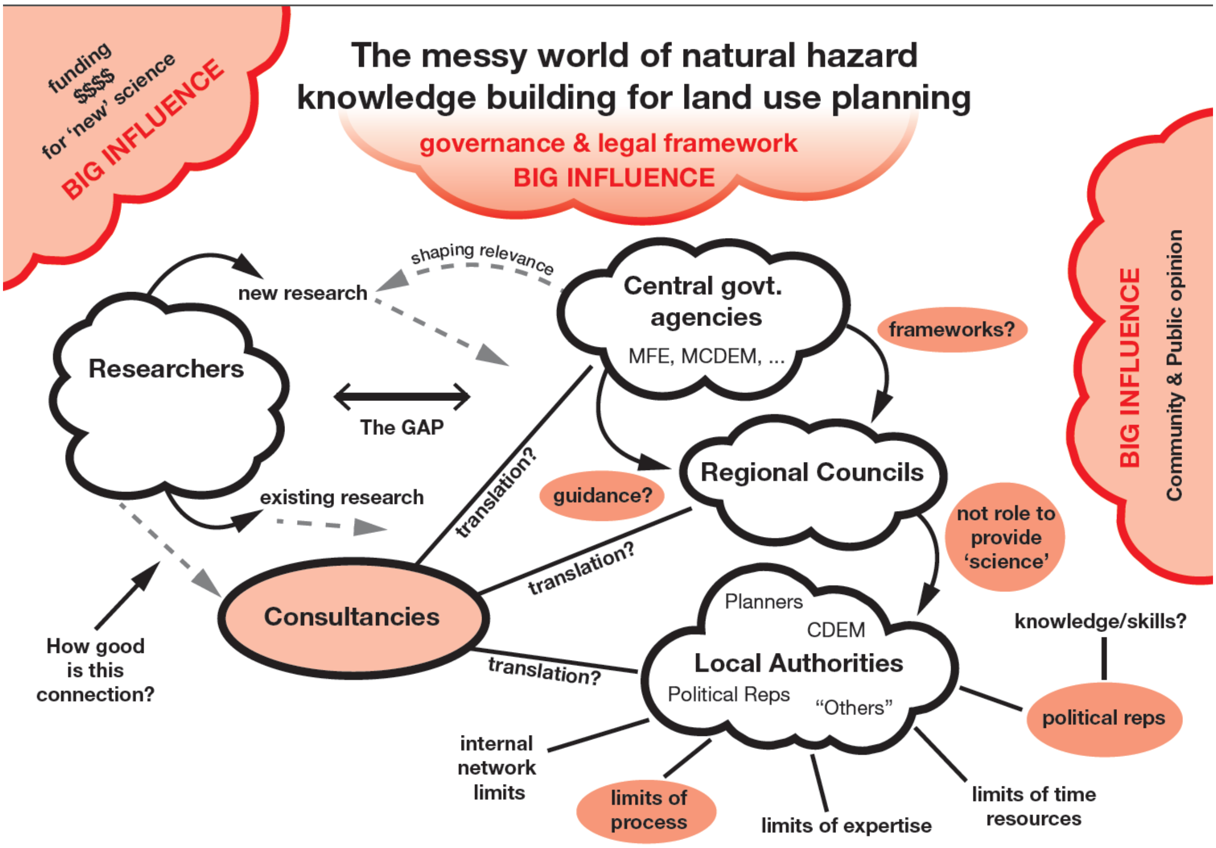

Figure 4.2 Revised mind map of ideas about the science-to-practice system for natural hazards and land use planning

Figure 4.2 identifies new drivers in shaping how natural hazard science is utilised in land use planning. These include the:

- influence of community and public opinion;
- importance of overarching frameworks, guidance and legislative mandate;
- lack of explicit intention to share science between national, regional and local agencies;
- absence of obvious knowledge brokers within the system;
- limits of capacity and process that shape how natural hazards science is utilised in land use planning decisions; and
- funding preference for 'new science', which influences how science providers are able to intersect with the land use planning world.

These influences and other aspects of building natural hazards knowledge for land use planning are further discussed below.

4.1.1 The Influence of Community and Public Opinion

Local government agencies are political entities where issues of local and regional importance are debated, and action is taken on behalf of various community determined agenda. While agencies have a responsibility to consider the needs of future generations, the present concerns and priorities of communities weighs heavily in decisions. As revealed in the case of PC29, natural hazards science information is not regarded as value neutral. Rather, it is associated with ideas that potentially place constraints on the amount and direction of growth. While it is unlikely that there would be pressure to disregard such information where it is legally required for any given decision, it may be subliminally side-lined where there is no strong advocacy for its inclusion. This political context consequently runs as an undercurrent influencing what information is privileged, and how resources are spent on its acquisition and utilisation.

4.1.2 The Importance of Overarching Guidance and Legislative Mandate

The strongest advocacy for the kinds of information that will be actively sought and included in any land use planning practice comes from governance level directives, best-practice guidelines and legislative mandate. For local government agencies, such directives come from regional frameworks provided by the regional council or via national level guidance documents such as those provided by MFE. Currently in New Zealand there is no national policy statement (NPS) or national environmental standard (NES)[7] for natural hazards. While impending reforms to the RMA 1991 are expected to strengthen provisions around natural hazards (Saunders & Beban 2012), these have yet to be realised. Policy and planning participants across the meetings conducted for this research commented on a perceived paucity in legislated or even best practice level guidance for natural hazard risk management. Scientists involved in the PC29 submission process expressed similar views, noting their surprise that there was not more definitive policy on the different kinds of information required to manage natural hazard risk at district and regional levels. However, planning practitioners also noted

[7] NPS and NES are prepared by government under the RMA1991. They state objectives and policies for matters of national significance (NPS) or prescribe technical standards, methods and requirements (NES). Local government agencies are required to give effect to NPS and NES in their policies and plans.

that NES's can be poorly written, inefficient and increase the burden and costs of administration.

4.1.3 Divergent Identity of National, Regional and Local Level Agencies

Science research agencies are increasingly sensitive to the different needs that various stakeholders have for science information. However, discussions with researchers throughout this project revealed there is a tendency to group policy and planning agencies together, or at least to assume that the relationship between national, regional and local environmental governance enables information to flow easily from one level to another, i.e. providing information at one level of the system is a means to providing it to the system as a whole. This is particularly assumed of regional and district agencies whose separate and autonomous role in natural hazard management is not always appreciated by researchers.

While the RMA assigns distinct responsibilities to both regions and districts, there can be overlaps. Typically, the role of regional level agencies is to understand the natural hazard, to undertake environmental monitoring and to develop overall policy based on potential natural hazard effects. At the district level, agencies deal with land use and intersect with natural hazards in terms of the combined consequences of that land use and natural hazard. Often the roles and responsibilities for managing natural hazards are clarified within the regional policy statement.

Regional councils commonly have in house technical and science expertise to deal with their role in the environmental management system. Consequently, these agencies are more likely to have relationships with research providers. However, regional councils do not act as science brokers, interpreters or providers for district level agencies. Moreover, local and regional councils do not generally share resources, except in ad hoc circumstances such as when working within combined projects (often initiated by science providers). Tensions can also exist between these agencies, expressed at the local level as frustration that regional level agencies are naive about the practical challenges of implementing regional level policies; and at regional level as a similar frustration that councils are failing to take into account regional policies and implementation strategies. Both levels of local government expressed scepticism that science done at a national level had much value to them, unless the science has been used to provide baselines (preferably target figures) that can be readily incorporated into regulatory frameworks at local level (e.g. Gray et al. 2005).

4.1.4 Brokerage and The Role of Consultancy

The value of knowledge brokers (who have broad understanding of scientific and practitioner worlds, and can act as a translator between the two), is often espoused. It is a concept common to most if not all science-to-practice systems including health, agriculture and environmental management. Ferguson et al (2014, p.8) identify several characteristics of good science-to-practice knowledge brokers:

- Understand the management or policy context (e.g., objectives, legal constraints, timelines, spatial scales, and who makes what decisions);
- Have a solid grounding in the relevant scientific discipline;
- Place emerging research in the context of an existing body of knowledge, larger questions, management challenges, and management tools; and
- Brokers may be able to communicate sources of scientific uncertainty, and thus better contextualize available research.

From discussions with both researchers and practitioners in the natural hazards science-to-practice system, it was clear that no single agency assumes the role of knowledge brokerage. Rather, such brokerage as exists is spread across a number of agencies and individuals. Published material is the most common form of brokerage: the NZPI clearly provides valuable resources to planners, particularly through the Quality Planning website, focussed on good planning practice and guidelines. MFE provides some synthesis of research into overall policy directives (e.g. coastal change, MFE 2009; climate change impact on flood flow, MFE 2010; adapting to sea level rise, MFE 2014). Research agencies such as NIWA and GNS Science regularly produce scientific reports and interpreted guidance material. However, such material still requires considerable contextualisation to meaningfully aid land use planners in their work.

Other methods of brokerage are through specific funding programmes (such as Envirolink[8]), designed to support translation from research to practice in local government environmental management. Interviews with natural hazards science providers suggested that an expected outcome of including practitioners in the steering committees of research programmes is that these individuals will act as conduits, bringing information back to their respective organisations. Discussions throughout this project revealed that consultancies, individual consultants and the act of consultancy as a process are one of the most regular ways by which a bridge is provided between science knowledge, and policy and planning practice. Local and regional council practitioners interviewed cited the widespread use of consultants, primarily as technical input into current planning processes. Consultants thus regularly work across different agencies and at national, regional or local levels. Furthermore, consultants interviewed noted that, compared to peers within planning agencies, they had comparative freedom to attend conferences that stretched their disciplinary boundaries, and enabled them to interact with researchers and practitioners across not only the natural hazards arena but across other planning, engineering, and operational aspects of environmental management.

It is not just the consultancy organisation or the individual consultants that have the potential to perform this brokerage role, rather, the act of consultancy as a process is in effect brokerage, i.e. targeted response to defined policy and planning needs based on up to date scientific and technical knowledge. Research agencies themselves undertake consultancy work, which the scientists involved regard as vitally important in providing context and practical direction to their research work. Researchers interviewed in this project regarded consulting work as a good opportunity to do direct work relevant to end users, but noted that not all contracting experiences were equally productive. It could depend on where and when the consultant was brought into the project, and how much flexibility there was to work alongside end users in an iterative process. One participant observed:

> *The best outcomes [are where] local expert, local council and local community work together. Two out of three isn't as effective…. Not just bringing in at the end but right from the start.*

Concerns were also raised in discussions with land use planners, environmental policy practitioners, and central government agencies about the role of consultants in natural hazards and land use planning. One of these concerns was expertise creep, where there was an incentive for consultants to stretch the bounds of their proficiency to meet both a desire to secure contracts and the hopes of the contracting agency for a 'one stop shop' for their needs.

[8] http://www.envirolink.govt.nz

Good consultant input into planning processes is also reliant on a level of skill in-house to commission relevant work, and to provide the final step of incorporating this work into the planning process. The latter frequently depends on the time and opportunity for good dialogue with the consultant (Lunt & Davidson 2002).

4.1.5 Limits of Capacity and Process

Regional and district level policy and planning practitioners interviewed throughout this project corroborated the impact of limited capacity (discussed in **Section 2.0**) on the science-to-practice interface. Participants observed that capacity in different environmental management domains was heavily influenced by community and political priorities. For instance, one participant noted that their region had five full time staff available to work on science related to water management, in contrast to one half-time position given to work on air quality. Similarly, limits of process were also frequently mentioned as constraints on the science-to-practice interface. Participants cited tight time frames, particularly around investigative or scoping aspects of planning. As was illustrated in the case of PC29, this can amount to constraining the planning project to immediate needs at the expense of wider longer term implications.

4.2 Challenges for Researchers in the Science-to-Practice Relationship

Researchers spoken to in the course of this project had put a great deal of thought into how knowledge they generate could, and ideally would, be used by practitioners such as planners and policy makers at national and local levels. They were readily able to cite examples of good and productive science-to-practice relationships. However, they also emphasised the complexity of these cases, and that even in the best situations they would not regard them as wholly successful. Issues cited included:

- policy makers skirting the detail and context of findings in the hunt for a baseline number that could readily fit within planning frameworks;
- utilisation of generic findings at levels that are too specific and vice versa; and
- inappropriate correlation between mapping intended for geological purposes and its utilisation, without additional interrogation, in defining planning zones.

Researchers expressed the view that planners and policy makers did not always appear to know what they needed, or could identify a need but lacked the in-house capability to work with researchers to meet this. However, they sympathetically acknowledged that both sides faced time and resource constraints that limited their ability to develop work iteratively. As one participant observed

> *It is very hard to do a circle another time around – [i.e.] we have learnt this and we are going to do this differently.*

Despite their frustrations, all those interviewed saw intersection with the practical world in which their knowledge could be applied to be a fundamental part of their work. Discussions with those interviewed added several important elements to the understanding of the science-to-practice system for natural hazards and land use planning. This includes:

- the way in which individual researchers perceive their role in the science-to-practice system;
- the cost and scale of doing outreach; and
- the impact of funding and programme administration structures.

4.2.1 Roles of Individual Researchers in The Science-to-Practice System

In contrast to the high rotation amongst staff in local government agencies (Saunders et al. 2014), staff turnover in research agencies is comparatively low. Consequently, researchers have often worked in their field for many years and have amassed considerable experience not only in technical matters, but in the overall field where this science has relevance. For example, a researcher may have more institutional knowledge of an organisation than staff at that organisation, due to staff turnover (ibid). Contrary to the sometimes expressed assumption that scientists can be detached from the applied world, over the length of their working careers they are typically involved in many aspects of the science-to-practice system. Participants in our interviews regularly provide input into hearings, and plans, take part in training, and participate in workshops and seminars with a focus on end user needs. Similarly, many of those interviewed were involved as consultants to local and national level agencies. Researchers also valued the personal relationships they built with individuals in many agencies citing these as an important conduit for building understanding for both parties.

Many researchers, with this long term and broad oversight of the system, regard it as part of their role to promote innovation. One example given was the promotion of more integrated use of coastal hazard information, which was done through active submission to the national coastal policy statement. Researchers who are interested in contributing to improved natural hazards management are consequently frustrated when their work is used to simply input data into an under-examined existing state of practice.

Researchers' comments suggested that they regarded local government agencies as having the most influence on how their science, and they themselves, gained entry into the policy and planning arena. They often felt frustrated by the tendency to bring in a technical expert at select and constrained moments, rather than creating opportunities to work alongside the public planning process. Those interviewed commented on the experience of being rolled out at public events to solve problems, but also acknowledged that they were treated with respect and that these situations were an opportunity to have two-way discussion that helped both sides collectively build their knowledge about a particular problem.

Ultimately, researchers believed they were limited in how proactive a contribution they could make to the land use planning practice. In particular, how could they transform knowledge they generated into useable and used material by regional and local government agencies where the agencies themselves did not perceive a need for it? In the absence of some interrogation mechanism for their science, they were limited to reacting to a situation defined by current planning and policy development ideas.

Also of significance was that most researchers interviewed noted that they had most contact with regional level or national level agencies – and far more limited connections with the numerous district level agencies. This is made more significant by the observations noted in **Section 4.2.3** – i.e. that national and regional level agencies were not necessarily a conduit for information to local level agencies.

4.2.2 Challenge of Doing Outreach

There is a general expectation that science done within a publicly funded system should be freely available. However, the cost and time for communicating findings and providing interpreted material based on these can be considerable. Researchers interviewed in this project expressed their awareness of their own limitations and the sheer scale of the task. As one participant noted:

> *We ran a series of workshops that reached over 220 people, but the planning community is much bigger than that.*

Researchers also noted that creating guidance is a messy business, a substantial amount of time goes into translation beyond producing the report and findings, and they were constantly learning new ways of how to approach things. As one participant noted:

> *Putting guidance out there is part of the system – you learn how it is used, how it works – what else needs doing…always evolving.*

Participants commented on two factors they believed influenced what guidance was most successful:

1. where the agency has a clear need and an ability to work with providers; and
2. when the guidance is properly targeted to different sectors and based on a relevant scale e.g. large infrastructure projects, regional policy statement, local planning. Guidance that is too generic is too difficult to tailor to any particular situation.

A recurring challenge for researchers is how to address uncertainty; how to incorporate it in the research itself, and in the information they provide to local government. Participants interviewed commented that the common practice is to present averages or central tendencies without deliberately incorporating uncertainty.

4.2.3 The Impact of Science Organisational Structures on Science-to-Practice

Like their counterpart professionals in planning and policy agencies, the role that researchers can play in the science-to-practice system for natural hazards and land use planning is shaped by the pressures and levers of their own science organisation structures. Key influences researchers interviewed identified were:

- the practice of frequently renewing funding goals and research programme arrangements;
- funding emphasis on new science; and
- lack of recognition for day-to-day interactions that build relationships.

It is inevitable that science funding goals and programmes are regularly renewed in the face of updated awareness of public priorities. However, funding emphasis on new research often leaves researchers and practitioners with a practical problem of how to resource the continued use and access to historic data. Furthermore, researchers interviewed in this project argued that such activity was often framed as starting afresh and consequently cut across existing research-knowledge user relationships. Emphasis is commonly placed on high level stakeholder input at initial planning stages for research focused on identifying needs and can be at the expense of ongoing and more ordinary interactions that steadily build capacity for good knowledge exchange – i.e. the ordinary interactions that push things along. Researchers interviewed believed it was important to give greater recognition for these activities and to adequately resource them. Such ordinary activities can include consultancy, which is often treated as a separate and self-funding activity, rather than an important part of the science-to-practice interface. The interview with staff at EQC echoed this reflection on what was termed artificial ideas about science and stakeholder engagement, and the perception that these occur at discrete moments in the research process as opposed to being integral to how research is done and knowledge is developed.

Furthermore, many programmes (for example 'It's Our Fault'[9], DEVORA[10]) have governance arrangements made up of representatives from agencies with an interest in natural hazards at national, regional and local levels. There is an assumption that these representatives will not only provide input on research relevancy, but act as conduits to draw information back into their constituent groups. Examples of successful science—to-practice as a result of these arrangements do exist (such as 'It's Our Fault' information contributing to initiatives within the Wellington City Plan). However, because these are anecdotal they are difficult to learn from and to use as a basis for future arrangements. In particular, the way in which representatives pass on information to others is generally not reviewed or prescribed. Planners interviewed as part of the PC29 case commented that they would not necessarily expect to receive updates from senior staff involved in governance groups for research programmes.

4.3 VIEWS OF NATIONAL AGENCIES ON SCIENCE-TO-PRACTICE

In this project, interviews were conducted with staff from MFE and EQC (see **Appendix A1.0)** as two national level agencies with an interest in how natural hazards science contributes to outcomes in natural hazards management and land use planning. Those interviewed were able to offer oversight of practices across the environmental and natural hazards management field, which added comparative understanding of the science-to-practice system for natural hazards and land use planning. In particular, they commented on: the role of agencies; the specific challenge to utilising natural hazards science in land use planning; and possible expertise gaps in the natural hazards and land use planning system.

4.3.1 Role of Agencies

MFE has a significant - but possibly poorly understood - role in the natural hazards science-to-practice interface. While MFE does not regard itself as a research funder, it makes an active contribution to MBIE (Ministry of Business Innovation and Employment) funded science in terms of ensuring that programmes are addressing relevant issues. It provides input into legislation and non-statutory guidance which in turn guide the way regional and local government agencies perform their roles. MFE also contributes to local government reform that addresses resourcing and capacity. As such, they act to influence the scope of science available to local government agencies, the guiding frameworks and imperatives for the use of science at regional and local level, and the capacity within agencies to apply science.

Staff members interviewed at MFE were aware of the need for more governance-level material addressing natural hazards. They noted, for instance, that guidance on coastal hazards and climate change had not been updated since 2008 (a revised version is due in 2016/17). They further observed the growing recognition of the need for guidance that addressed the method and structure of decision-making. This would include clarity on what one participant described as where the decision lies. One example given is when consultants are asked to provide information on what risk is acceptable (a judgement that should ideally also involve communities and political representatives), as opposed to limiting their contribution to providing

[9] https://www.gns.cri.nz/Home/IOF/It-s-Our-Fault
[10] http://www.devora.org.nz/

information on hazard risk scenarios and impact. A second example is the need for clarity around uncertainty, where it affects either the information used in a decision, or the decision itself. In such circumstances it is not always apparent who has the mandate to communicate with communities, or make choices around this uncertainty, and the default position is often to leave this to the consultant.

MFE staff also commented on the need for better articulation around terms used in managing natural hazards. For instance: what does acceptable risk mean; what is a risk process; and what are legitimate ways of determining probability? They commented that central government has a role to support the use of common definitions and frameworks. However, they recognised there would always be an ongoing challenge to address the language differences between those who do science, and those who apply it, to meet specific planning needs within local government agencies.

EQC, in contrast to MFE, has a more constrained and targeted strategic intent to improve management of natural hazards across New Zealand. EQC funds research as well as the application, translation and the capability to take up research. They invest in:

- people through research fellowships (research capability);
- new knowledge through project funding (fundamental through to applied);
- science-to-practice (e.g. guidance and policy notes); and
- sector education for professionals who apply information and make decisions about risk.

As a funding agency, they balance a mix of initiatives with long and short term returns, work with direct application and highly innovative ideas, and try to address gaps and support the retention of capability.

Both EQC and MFE staff recognised a role for central government in improving the quality of information available to local government. This could be through such avenues as providing standard templates for analysis and guidance on tests and information that should be included for professional consistency amongst consultants performing similar tasks.

4.3.2 Specific Challenges of Getting Natural Hazards Science into Land Use Planning

Staff at EQC and MFE made several observations about specific conditions that made the science-to-practice interface with land use planning particularly challenging. They observed that the socio-political context which governed the priorities for local government agencies were particularly problematic for natural hazards. Planners always face a professional tension between preparing and signalling issues that are going to be of increasing importance (but around which there is some uncertainty), and responding to issues that have an obvious immediate imperative. Natural hazard risk is inherently future focussed and making decisions in favour of more conservative management of natural hazard risk appears to have few, if any, immediate gains, but may have significant impacts on development and growth.

The opportunity to incorporate new understanding about natural hazard risk in land use planning is also constrained by abilities to change the management of land under existing use, as opposed to greenfield (or undeveloped) sites. Restricting existing use can be very contentious. Furthermore, interviewees observed that community and public opinion seemed to be more ready to accept science relating to environmental issues such as air quality and water quality, citing contention around natural hazards science, particularly climate change and coastal issues.

Those interviewed commented on an apparent difference in levels of uptake of available natural hazards science in infrastructure planning versus land use planning. One example discussed was the technical information available on liquefaction impacts in Canterbury prior to the 2010 earthquakes. The asset management organisation Orion NZ (responsible for electricity networks in Canterbury), used this information to strengthen the resilience of their infrastructure. In contrast, little uptake of this information was evident in land use planning provisions and decisions made by local government agencies (St Clair & McMahon 2011).

Possible reasons for the difference is the single goal focus of asset management organisations (to maintain the ability to operate), as opposed to: the multiple and conflicting priorities of local government agencies who face pressures from developers to ensure land is available; to provide opportunities for affordable housing; and to maintain a sustainable rating base. Another possible reason for the different responses from infrastructure versus land use planning is where it is possible to lay both responsibility and blame in the event of negative outcomes. In the management of assets, this is more obvious and is supported by clear guidelines in the Building Act and Civil Defence Emergency Management Act. For natural hazards and their multiple impacts on land use, the risk is less widely understood, and responsibility is more diffuse and largely divested to individual property owners.

4.3.3 Missing Expertise in Natural Hazards & Land Use Planning

Interviews with staff at both MFE and EQC elicited some observations on deficits in professional capability within the natural hazards and land use planning field. This goes beyond the general capacity and capability limits that affect science-to-practice, and are caused by lack of staff time and resources across regional and local government. Rather, it refers to the specific ability to understand and manage risk.

Comments included that risk analysis, or other specialist expertise, was being inappropriately added to consultancy contracts for related areas (such as engineering) which are more accurately categorised as natural hazards science. One interviewee attributed this to a lack of understanding about the subtleties of expertise, but also suggested that local government agencies have many incentives for wanting a simple relationship with a single consultant rather than bringing together multiple disciplines. An example given was the confounding of geo-hazard understanding with geotechnical understanding.

Also discussed was the lack of peer review undertaken for social and planning components of natural hazard risk management, as opposed to the technical component. It is possible that consultants may not be knowledgeable in social science methodologies, and internal peer review may not be able to offer any review of the specific method. This suggests a lack of available expertise as well as lack of recognition of the professionalism of this area. What is needed is recognition that good methodology in this area is not a matter of opinion, and a greater ability to recognise this with confidence.

4.4 SUMMARY

Interviews were conducted with planning and policy practitioners at regional, local and national level; and researchers involved in applied research into natural hazards science and management. Feedback from these interviews considerably enriched initial ideas (**Figure 4.1**) about the science-to-practice system for natural hazards and land use planning. A revised view of the science-to-practice system for land use planning is offered in **Figure 4.2**.

Regional and local planners and policy makers highlighted four elements missing from the initial ideas about the system that significantly impact on the social context within which land use planners are able to learn about, and incorporate, new knowledge into their practice:

1. The influence of community and public opinion;
2. The importance of overarching guidance and legislative mandate;
3. The divergent identity of policy and planning agencies operating at national, regional and local level; and
4. The ill-defined nature of knowledge brokerage and the potential importance of consultancy.

Researchers spoken to in the course of this project had clearly put a great deal of thought into how knowledge they generate could be used by practitioners. In interviews they highlighted several areas of influence on the science-to-practice interface for natural hazards and land use planning:

1. The way in which individual researchers perceive their role in the science-to-practice system;
2. Funding emphasis on new science and frequent reworking of programme administration structures;
3. Scale and cost of doing outreach; and
4. Lack of recognition of the importance of iterative, long term relationships and knowledge exchange through consultancy.

Interviews with staff at EQC and MFE offered oversight of practices across the environmental and natural hazards management field which added comparative understanding of the science-to-practice system for natural hazards and land use planning. In particular, they commented on:

1. The role of national agencies in creating direction, frameworks and consistency in natural hazard management;
2. The specific challenge of utilising natural hazards science in land use planning; and
3. Possible expertise gaps in the natural hazards and land use planning system.

5.0 WAYS TO IMPROVE SCIENCE-TO PRACTICE IN LAND USE PLANNING

In this section we offer key areas for improvement of the science-to-practice system for natural hazards and land use planning, based on the feedback from researchers and practitioners and emergent ideas in the literature.

In making these suggestions, we are aware that all systems are imperfect and that the situation for inclusion of natural hazards science in land use planning shares many common complaints of science-to-practice systems in many fields. For instance, we found that concerns about information dissemination and a desire for more readily accessible, centralised sources of information about hazards is a concern that could be applied to any number of environmental management domains. Similarly, lack of science capability and capacity within local government agencies is also a common concern. The science-to-practice interface for environmental management in general could certainly benefit from attention to these issues of information access and technical capacity. However, the points we have chosen to highlight in this section are more specific to the context of natural hazards and land use planning.

It is also important to note that we are aware that there has been significant achievement in science-to-practice in natural hazards in New Zealand. The points we raise here are intended to help support these efforts. They are grouped under five areas:

1. Supporting the socialisation of science;
2. Greater mandate for natural hazards in land use planning;
3. Recognising and supporting knowledge brokerage;
4. Greater capacity and capability for addressing risk; and
5. Science as a concerned citizen

We also add some reflections on the experience of researchers directly contributing to a planning process as a submitter.

5.1 SUPPORTING THE SOCIALISATION OF SCIENCE

> *It's recognising that there are many parts to the system; if you want system wide improvement you can't just focus on one thing; it requires consideration of all parts of the system and you don't want to gold plate one and underdo another bit, it's got to be with an understanding of how all the parts connect (Central government interviewee).*
>
> *As science agencies we can have this naive view ...if we provide knowledge people will act (Research interviewee).*

The two quotes above are comments made by a central government interviewee and researcher respectively. What they both signal is the importance of understanding that any contribution to science-to-practice by an individual or an agency is more likely to be successful when the system itself is better understood. They also highlight that effort aimed at concentrating primarily on improving ways of presenting science, and making local government agencies aware of it and of its implications, can lead to frustration as the barriers to uptake are not solely within this part of the system. A wider understanding of …the social context in which people learn about new knowledge (Reed et. al. 2014, p. 337), illustrates that continued effort to improve science communication alone will not necessarily lead to greater presence of natural hazards science in land use planning decisions. Research institutions (and funders) could benefit from a wider appreciation for the context within which science information fits i.e. how it is mediated through multiple levels of government and used in what is essentially a values driven decision system. This could moderate some expectations of how science information alone ought to lead to any particular outcome on the ground.

In our examination of the natural hazards science and land use planning interface, we consider several important features are under appreciated for their influence in science-to-practice. We group these into levers and networks. Key levers include:

1. The local government political and social context. This influences how natural hazards science is regarded and prioritised, and at times set in opposition to other values (such as growth and development).
2. The funding imperatives of agencies such as MBIE, which prioritise new science and also influence science management structures, and stakeholder engagement.
3. Governance guidance and legal frameworks. These create both a hierarchy of importance for natural hazards management, and standards of practice for how regional and local government agencies respond to natural hazards management.

Key networks that influence science-to-practice in natural hazards and land use planning are:

1. National – regional – local. National bodies involved in environmental and natural hazards management (e.g. MFE, EQC, MBIE); regional and local government have a hierarchy and connection that relates to their relative responsibilities under the legislation, but does not equate to a ‘trickle-down’ system for knowledge sharing.
2. Consultancies. Consultancies play a critical role in supporting local government capability and capacity in land use planning, but are insufficiently embraced as stakeholders in knowledge sharing with research institutions.
3. Scientists and land use planners. Researchers have a more regular relationship with both national level and regional level agencies, but fewer direct connections with those at local level.

Improving information dissemination practices is clearly a responsibility and task that researchers and research institutions already assume. However, responsibility for improving the socialisation of science requires cooperative effort between both science information producers and practitioners at all levels. Ferguson et al. (2014) in their work on linking environmental research and practice, stress the need for both researchers and practitioners to make efforts to reduce the gap – it is not just the responsibility of one side. They note that this is an incremental process, and best based on long term and continuous activity, rather than disjointed information dissemination exercises.

Following are four recommendations to support the socialisation of science knowledge.

Actively Learn About Each Other’s World

Comments from researchers interviewed in this project often highlighted the difficulties they faced in understanding how their work intersects with the world of planning and policy development, e.g.

…. really struggled to understand how my work is being used…to understand the hierarchy of plans

Similarly, practitioners cited difficulties with the range of methodologies that seemed to be employed by scientists dealing with, on the face of it, the same issue. For example:

…would be good to have nationally consistent methodologies, e.g. for flood modelling.

Mutual education is a responsibility that could be shared between both researchers and practitioners. This can include providing scientists and policy planners with a chance to instruct one another in the basics of planning, processes and hierarchies (i.e. planning 101), and how science is and could be used to support these processes.

Create 'Meaning-Making' Opportunities

Ferguson et al. (2014, p. 5) advocate that researchers and practitioners create opportunities to work on commonly identifying the problem. Without this, parallel thinking can occur, where the science done by researchers and the research result needed by practitioners are not necessarily compatible.

This echoes comments from both researchers and policy and planning practitioners interviewed in this project about the value of opportunities for mutual interrogation, particularly when reviewing technical input into policy or planning projects. This goes beyond the idea of translating technical information into policy and planning language. Rather, it gives both sides the chance to check assumptions and meaning. This is best achieved in a face-to face setting where learning - and not simply information dissemination - is the focus, and it can be built into workshops and seminars with the support of adequate facilitation.

Provide Good Examples

Throughout this project we regularly asked those interviewed for good examples of science-to-practice. Most struggled to do this although they could describe good instances of productive relationships between researchers and practitioners. Examples that were offered were often at a high level such as the use of science to transform public thinking and ultimately public policy on major issues, such as atmospheric ozone depletion.

Breaking down component parts of science-to-practice into smaller level components, such as well organised workshops, valued contributions to policy development, or succinct renditions of complex topics, and highlighting these as examples, will help to create ideals of good practice which can be more readily emulated. These examples should include real understanding about the ingredients that made these useful and realistic reflections on the costs, resources and skills needed to achieve them so they can be replicated.

Plan for Science-to-Practice

Planning, reflection and evaluation are important to system improvement. They ensure that steps to better knowledge integration are not treated as recipes that can be applied without understanding of the specific research and policy context. This can include:

- review of current activities for strengths and gaps – particularly checking whether existing practices are achieving what it is assumed they will;

- wider recognition and resourcing of ordinary, everyday mechanisms for connecting researchers and stakeholders – including consultancy and submissions on plans/hearings/expert witnesses – fully embracing this as part of science-to-practice system; and
- Recognition of the different purposes and intentions for science knowledge and differentiating where these are mainly instrumental (e.g. providing baselines for policy or guidance), or aiming to influence some more fundamental aspects of practice. Different types of information require different science-to-practice approaches.

5.2 Greater Mandate for Natural Hazards Science in Land Use Planning

This project highlighted that natural hazards science can be regarded as being in conflict with growth and development goals causing it to be down-played or even side-lined in land use decisions. Natural hazards science needs stronger advocacy in the planning process. This can be achieved through increased community consciousness of the need for greater risk management; or national level guidance that increases the imperative for decision makers to actively consider natural hazards.

There was general agreement amongst those interviewed at both local and national level, that stronger governance frameworks than are currently available for natural hazards are desirable. Methods and process guidance that focus on the structure of decisions, the types of technical input required, and that clarify the boundaries between hazard assessment and judgements about acceptable risk, would provide a foundational context for how natural hazards science and hazards risk are weighted in local planning.

Other interviewees commented on the difficulty for local government agencies in adapting their practice to a risk based approach, noting their challenges included an inability to assess risk, and the lack of adequate frameworks and tools to have conversations with their council and communities.

> *…the single most useful thing for planning in New Zealand would be good practice guidance on risk assessment – both assessment and comparing options for addressing these*

National guidance would assist councils in overcoming this challenge.

5.3 Recognise and Support Knowledge Brokerage

A key role in any science-to-practice system is that of knowledge brokerage. In this project it was apparent that no single agency or group were recognised as having responsibility for acting as a broker for natural hazards science knowledge. However, while this is not a definitive role for anyone in particular, it is still incidentally or even surreptitiously performed by individuals within the science-to-practice system. This was referred to by one central government interviewee as a ’black economy’, adding that:

> *Often comes down to individuals working beyond their mandate to get stuff done. Hard to get any particular agency to put their hand up to do this.*

Interviews in this project suggested that consultants, and the act of consultancy itself (whether performed by an independent group or a science institution), is one of the most active forms of science brokerage available to local government agencies. Participants in the study observed that consultants are often supported and encouraged to attend non-core discipline conferences, which is another way in which consultants facilitate links between science and land use planning.

Ferguson et al. (2010) note that while many agencies or organizations do not have the resources for a dedicated information broker, identifying a person within an organization who tends to think broadly and creatively across the science-to-practice spectrum often serves this function. They can also be helpful in motivating science and practitioner relationships.

Greater recognition of the importance of science brokerage and greater support would improve the science-to-practice system for natural hazards and land use planning. This can be achieved through:

- More active inclusion of consultants in science-to-practice engagement;
- Recognition of the act of consultancy within research institutions for the opportunity to build science-to-practice relationships; and
- Recognition and better resourcing of individuals who perform this role.

5.4 GREATER CAPACITY AND CAPABILITY FOR ADDRESSING RISK

Insufficient capacity and capability in any system is a common complaint, particularly where a subtle and diverse range of expertise is needed to address relatively local scale issues. This project revealed some confusion about the distinction between hazard science and risk analysis, whether this could be sourced from the same individual or even the same organisation.

Risk analysis and management is a specific expertise. It cannot be assumed that regional or local level policy and planning staff can easily add this to their repertoire without adequate support. Similarly, interviewees - particularly at central government level - were aware of the need for clarity around expertise boundaries for technical hazard science and hazard risk. A report by Local Government New Zealand (2014) further highlights a tension at local government level between managing resilience and managing risk.

Local government agencies are particularly unsupported in managing risk. This project highlighted a lack of technical resource sharing between regional and local government, and that researchers were less likely to have direct links with local agencies than with regional and national level agencies.

Actions that support greater clarity and expertise on risk include:

- Greater recognition of the specific expertise involved in risk analysis and management; and
- Cross institutional sharing of risk expertise.

5.5 SCIENCE AS A ‘CONCERNED CITIZEN’

The example of GNS Science making a submission to Petone Plan Change 29 is a step beyond the usual actions of a research agency – i.e. to become so actively and overtly involved in shaping the outcomes of a land use planning decision. While this may be an unusual action for a research agency as a whole, our interviews revealed that individual scientists often contribute to different aspects of the planning process. Moreover, this ‘engaged science’ can be very rewarding. PC29 still went ahead but was substantially modified, on the basis of GNS science input with the inclusion of an objective, policies and rules pertaining to natural hazards. Advocacy for the responsible inclusion of natural hazards information in decisions affected by natural hazard risk is a value that needs support from qualified experts within the planning process. While wholesale participation in planning processes across New Zealand is beyond the resources of science providers, considered involvement in select cases can greatly advance best-practice for how natural hazards science is included in land use planning decisions.

6.0 CONCLUSIONS

The way in which natural hazards science is incorporated in decisions affecting land use at a local level is a complex process influenced by numerous social levers and networks. There are many actors who have a role to play. Both research providers and policy and planning practitioners are aware of many of the challenges associated with enabling science-to-practice. However, efforts to improve the situation are sometimes misplaced and are often dominated by ideas about improved delivery and science communication that can place undue burden and expectations on only one component of a complex system.

In this review of the use of natural hazards science in land use planning, and in the specific case of Hutt City Plan Change 29, we found that the availability of technical information alone is not enough to ensure that natural hazards science is able to contribute to any planning decision. Rather, a mix of factors act to facilitate and constrain this. These include the time limits of existing planning processes; the skills and resources of planners and policy makers; the availability of consultants or knowledge brokers who can interpret technical information into compelling and plausible planning options; and importantly, social and political pressure which shapes the decision context and directs it towards a specific planning outcome that may not have natural hazard risk as a high priority.

Any contribution to improving the science-to-practice interface for natural hazards and land use planning, by an individual or an agency, is more likely to be successful when the system itself is better understood. This review showed numerous opportunities to support better capacity within planning and policy development to address natural hazards risk. This includes actions to support more long term, ongoing interactions between researchers and practitioners (particularly at the local level), and acknowledgment of the importance of knowledge brokerage. It also recognises the role for national agencies in providing stronger directives for the inclusion of natural hazards science in land use planning; and for national, regional and local agencies to become better at sharing the specific expertise associated with understanding and managing risk.

PC29 illustrates that there is also value in research agencies acting as ‘concerned citizens’. Advocacy for the responsible inclusion of natural hazards information in decisions affected by natural hazard risk is a value that needs support from qualified experts within the planning process. While wholesale participation in planning processes across New Zealand is beyond the resources of science providers; considered involvement in select cases can greatly advance best-practice for how natural hazards science is included in land use planning decisions.

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APPENDICES

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A1.0 PARTICIPANTS IN WORKSHOPS, GROUP AND INDIVIDUAL INTERVIEWS

WORKSHOP	PARTICIPANTS
Scoping the science-to-practice system workshop (Massey University)	Senior resource management planner, Cuttriss Consulting; Senior policy advisor Greater Wellington Regional Council; Earthquake geologist, GNS Science; Natural hazards planner, GNS Science; Researcher, Massey/GNS Science Joint Centre for Disaster Research.
Hutt City Council Plan Change 29 Review	Policy Planner, HCC; Consents Planner, HCC; two Consultant Planners, Boffa Miskell.
NIWA	Group Manager - Coastal and Estuarine Processes; Manager Pacific; Programme Leader - Risk Impacts of Weather Related Hazards
Environment Bay of Plenty	Policy Analyst (Natural Resource Policy); Regional Planner
GNS Science, It’s Our Fault programme members (GNS Science)	Senior geophysicist; Earthquake geologist; Engineering geologist; Engineering seismologist.
MFE	Senior Policy Analyst resource management national direction (land and air); Senior Analyst, Climate Change Analysis and IPCC National Focal Point
EQC	Research Manager Science & Education
Ideas in natural hazards science, policy and planning Forum: July 31st 2015	Participants from range of agencies across Wellington region including: local, regional and central government, consultancies, and research agencies

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