



*LAND USE PLANNING
FOR NATURAL HAZARDS*

STEWARDSHIP FOR THE FUTURE

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New Zealand Centre for Advanced Engineering
University of Canterbury Campus
Private Bag 4800
Christchurch 8140
New Zealand

*Front cover image: Kaikoura and Surrounds (stock)
Inside cover image: Earthquake Damage, Gisbourne,
December 2008 (D. Brunson)*



Land Use Planning For Natural Hazards – Stewardship for the Future is one of a series of CAENZ Comments on issues of topical importance to New Zealand.

Natural hazards impact significant numbers of households, businesses and farms annually in all parts of the country.

- Between 1984 and 2004 over \$100m was paid out in flood-related insurance claims in New Zealand (Insurance Council of New Zealand).
- The Ministry for the Environment projects that there could be a 2-4 fold increase in the frequency of flood events based on climate change models.
- EQC receives over 1000 landslip-related claims annually.
- In 2008 the value of consents issued for residential buildings alone was \$6.2 billion.

In order to lower our risk exposure in the future we need to better incorporate hazard planning in what we build today.

This commentary is derived principally from CAENZ papers on landuse and natural hazards. It is supplemented by comments from leaders in both research and practice. Many of these comments were acquired through interviews. Additional content was supplied by the editors and editorial support team.

foreword

Natural hazards are a dominant feature of the New Zealand landscape. Over our recent history, we have seen that increasing pressures from urbanisation, the increasing value of infrastructure and more intensive land use generally, can result in communities becoming even more vulnerable from exposure to these risks. Unless we act as a country to ensure that consideration of natural hazard risk becomes a commonplace part of all aspects of land use decision-making the likely outcome may well be an increased susceptibility to natural hazards and their impacts on our communities.

Land use management and risk management are unique disciplines that should ideally work together to improve the resilience of our communities. Research and practice in these areas is rapidly evolving as our understanding of the relationships between land use decisions and natural hazard risk improves.

This Commentary brings together the lessons and understandings that have arisen from the significant body of work undertaken by the New Zealand Centre for Advanced Engineering (CAENZ) which has had as its focus the processes by which natural hazard information is incorporated into land use planning and the institutional arrangements that support land use management in this country.

CAENZ seeks to play a catalysing role in discussion around issues of importance to New Zealand. Its position of independence provides CAENZ with the opportunity to take a detached and often wider view of issues. It does so with the intent of adding value though working with others.

In bringing our thinking together we have been fortunate not only in being able to draw upon our own work but also to compliment that with the insight and know-how of a wide group of expert contributors, spanning both discipline and institutional boundaries. From this collaboration we have learnt that this is the vital imperative of achieving a common understanding of what is required to make land use sustainable into the future.

This Commentary thus seeks to explore the issues that are important to achieving a consistent and cohesive approach for successful land use planning. The way forward will require that we adopt a comprehensive risk management approach that builds professional practise and underpins community understanding of the risks inherent to living in this country.



R J (George) Hooper

Executive Director



*Top: 1996 Ruapehu Eruption (GNS Science)
Middle: July 2008 Storm, New Brighton Beach Park area (Rodney Chambers, CCC)
Bottom: June 2006 Canterbury Snowstorm, (Electricity Ashburton)*

introduction

Land use planning is both a well established, and a powerful strategy for optimising sustainable development in the presence of natural hazards.

New Zealand's geology and hydrology are extremely dynamic and result in frequent changes to the landscape. When society's assets are affected adversely by landscape changes, natural hazards occur.

Sustainable development requires availability and affordability of resources, ecological sensitivity, and resilience to natural hazards. Development that is vulnerable to damage by flooding or landslide is not sustainable. Considered siting is a crucial aspect of sustainable development. Applying appropriate planning results in facilities that are situated so as to minimise their vulnerability to these hazards and increase their sustainability.

People have to live somewhere, so natural hazards are an endemic part of life in New Zealand; the level of risk that natural hazards present depends on the frequency of occurrence and the proximity to people and their activities – for example; floods, landslides, volcanic eruptions, earthquakes, and coastal erosion are only recognised as problems when they present safety issues or otherwise threaten human activity.

Since these risks only arise when society (the human system) is exposed to the hazards (the natural system), applying a 'systems' perspective to managing natural hazard risks presents crucial opportunities. This systems approach is holistic in that all parts of society and nature are considered. Because both systems are interlinked, an alteration to one part of one system has far-reaching and perhaps long-duration repercussions to both.

Although elegant at a strategic level, the systems approach does present challenges of knowledge and communication due to the complexity of the system interrelationships.

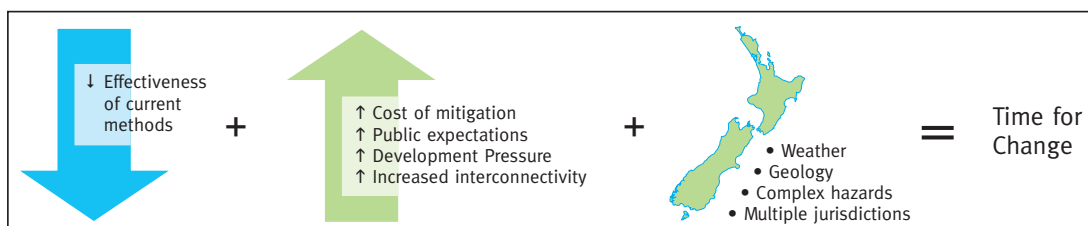
There is now overwhelming evidence that attempts to control nature usually cause damage costs to increase. Natural hazard events occur when the natural system's behaviour is unusually powerful – generally too powerful to be reliably altered or managed. This means that, in a dynamic environment like New Zealand's, managing natural hazard risks often means managing people rather than managing nature. Land-use policies and decisions must fit within the constraints set by nature; so knowledge of these constraints is vital.

SYSTEMS PERSPECTIVE

A systems perspective of a problem considers the way in which the problem interacts with the other parts of nature and society to which it is connected. Ultimately, we live in a system (Earth) in which everything is connected to everything else.

Unknown.

As our climate changes our risks are likely to increase, through a rise in both the frequency and intensity of climate events. Regardless of the quality of engineering measures, nature will ultimately prevail. Consequently, continued growth of population and development means that natural hazard risks increase even with a stable climate. The extent of damage is determined by what is at risk in the localities affected.



Because the timeframes that people can easily relate to are quite different to the timeframes of natural processes, the risks that arise from human interaction with nature are very difficult to analyse. From the time a decision or action is taken, decades may elapse before the consequential risk becomes apparent. Land use planning seeks to balance the needs and wants of today, with the legacy of risks that we leave to, and impose upon, future land users.

Some decades ago, management of natural hazard risks in New Zealand was led and funded by central government, but implemented locally. Now the whole system is almost entirely devolved and entrusted to local government. The management costs are shared across all levels of government, with expectations that in times of great need central government will assist.

A successful systems approach requires coordinated effort. Without coordination failures will occur, leading to increased demands on public agencies and a decreased public tolerance. Ultimately, the population becomes less resilient and risk acceptability is reduced to financial liability. With coordination, the tolerance for accepting a risk becomes a balance of economics, environmental impact and overall sustainability.

New Zealand has many examples of infrastructure and built environments located on sites exposed to natural hazards. Increasing pressures from urbanisation, the rising value of infrastructure and more intensive land use generally, can result in communities becoming even more vulnerable. New Zealand must manage its economic and social development accepting that natural hazards will always be part of the equation.

CAENZ

Recent work by a variety of organisations has recognised the importance of bringing sustainability to the forefront of natural hazard risk management. Many of these projects have focused on generating increased information about our hazards and how to safely co-exist with them. CAENZ has been involved in several of these, including the “Managing Flood Risk” Standard, NZS 9401:2008.



Considerable work remains before we reach our potential in managing natural hazard risks. Increased effectiveness of risk management, shared understanding, collaboration and cooperation is required. Communication and knowledge sharing are the two areas that provide the greatest and most cost effective opportunity to advance land-use practice in the presence of natural hazards.

However, bringing this information into policy- and decision-making presents a number of obstacles: for example, there are multiple, inconsistent frameworks for the roles and responsibilities for land use and natural hazards.

There is also no consistent avenue for disseminating information to all of the relevant parties, ranging from ministries and government departments through to local authorities (and specialist engineers and advisors) and the affected communities themselves.



Top: 2007 Hawkes Bay Floods
Bottom: June 2006 Canterbury Snowstorm, Pleasant Point (Jeff Tollon)

There are seven key elements to establishing and maintaining resilient natural hazard management:

- Good information on the location and consequence of hazards;
- Clearly articulated targets for risk management;
- A fully integrated approach spanning reduction, readiness, response, and recovery;
- Well-established lines of responsibility at various levels within organisations;
- Excellent communication with and between agencies and civil society;
- Long-term strategic views; and
- Adequate resources to implement hazard management actions.

Stephen Swabey



The resulting low uptake of information means that New Zealand continues to allow land uses that result in net costs to the public purse. Landslip claims cost EQC tens of millions of dollars each year; environment court hearings are a burden on many local authorities; and major engineering works to mitigate hazards require substantive and continuing maintenance by both local and central government agencies.

All levels of government need to acknowledge that managing natural hazards is both normal and routine. What is lacking is the coordinated approach and leadership to make this happen. The New Zealand's public and public sector has yet to fully appreciate and take ownership of our exposure to natural processes. It is envisaged that eventually land use planning will incorporate natural process considerations in the same way that waste minimization has become an everyday, endemic consideration of normal business throughout the public sector.



Top right: Coastal Erosion (stock)

Bottom: October 2003 Flood Damage, Christchurch (G. Treadgold)

governance - taking responsibility

THE COST OF LIVING WITH HAZARDS

- EQC receives over 1000 landslip-related claims annually.
- The 2005 Bay of Plenty weather event that affected Matata resulted in nearly \$28m claims to EQC. Thirty-four hours of rain caused landslips and flooding that directly impacted over 800 properties and resulted in months of ongoing disruption to the affected communities; part of Matata remains devastated in 2009.
- Between 1984 and 2004 over \$100m was paid out in flood-related insurance claims in New Zealand (Insurance Council of New Zealand).
- The Ministry for the Environment projects that there could be a 2-4 fold increase in the frequency of flood events based on climate change models.
- New Zealand's most costly earthquake to date was the 1987 Edgecumbe shake at \$330m. The 2007 Gisborne earthquake cost an estimated \$35m. The expected Alpine fault earthquake in the South Island will cause costs orders of magnitude greater than these.

Natural hazard events at the lower end of the scale occur frequently in New Zealand. In recent decades we have been fortunate not to have suffered more damage and deaths as a result. The events have, however, come at considerable cost, cost that could have been substantially reduced by taking a more robust approach to land use management.



The Rakaia River and Southern Alps (GNS Science)

It is well-known that New Zealand will experience a devastating earthquake in the near future; but over a recent five-year period, society's use of flood plains and slip-vulnerable land has resulted in more damage and greater costs than earthquakes and volcanoes combined. This is most often the case; big events are rare on the human timescale. We take care to mitigate the effects of high impact, low time scale events, but do not take the same approach with more common lower impact events such as flooding and landslips.

Both flood plains and slip-vulnerable land are easy to identify and present avoidable risks. Reducing the risks from these 'everyday' natural hazards is far more achievable than dealing with the catastrophic events; but to do this requires the will to consistently embed policies that reflect a common understanding of acceptable levels of natural hazard risk into everyday thinking across all local and central government agencies.

Some people need to have it written down. Some need to talk. We need to communicate in different styles and forms as different people understand information differently.

We need to be able to listen carefully to the community. It's important to establish a context, to indicate an historical context and overlay that with trends and events.

Diane Turner

recognition by existing users of hazard prone land and providing information to future potential users to avoid risk. Existing users do not wish to have the information devalue their property. Furthermore future potential users are not represented when decision-making is made by individuals. It is required that active involvement of citizens become a central component of natural hazard management and land use planning, recognizing joint ownership of current and future risk exposure across the community.

A critical point in environmental policy and decision-making is the transfer of information

between scientific advisors and decision makers.

A significant component of environmental decision-making is arrived at through political processes in which elected representatives in public authorities must consider a wide range of opinions and values; natural hazard science is just one of many voices that potentially influence the choices made. However, science is not a value-based advisor. Natural hazard science is based on the physical context, the behaviour of the natural systems that are independent of policy. Scientific advice provides information on the non-negotiable constraints that determine the scope there is to undertake sustainable activity that reflects public values.

Each organisation, from ministries to local authorities, has taken a different approach to land use in the presence of natural hazards, according to their specific legislation and risk profiles. It is a difficult challenge to engage systematically and effectively across jurisdictions. A consistent national approach offers the ability to set minimum levels of acceptable risk that can be applied across all natural hazards and all the strands of natural-hazard-related legislation.

Central government expenditure on natural hazards is skewed toward response to and recovery from climatic events, through financial grants, social support and civil defence actions. The insurance sector likewise usually acts in

A resilient natural hazard management system is meaningless unless it is located in real communities and real places. Building such a system is fundamentally a 'governance' challenge – which refers to the complex array of formal and informal norms, networks and institutions through which communities (at various scales) make and implement decisions in the public interest.

Building resilience is therefore a 'governance' challenge and demands innovative and effective partnerships between key roleplayers – including Government, the private sector and civil society.

Bruce Glavovic



a response mode, although that is changing as they move to reduce their risk exposure. In contrast, local government expenditure is skewed toward warning systems, structural protection and maintenance of hazard defences.

In this current environment, the inter-relationships that govern hazard management and land use planning are too often overlooked. CAENZ has undertaken significant work over recent years to examine and comment on the processes by which natural hazard information is incorporated into planning decisions, and to better understand the institutional factors that influence decision-making. This work has demonstrated the importance of achieving a sector-wide common understanding and commitment to developing New Zealand best practice, in order to provide a comprehensive hazard risk management approach.

Managing risk within a complex system of



Top: The 1997 Abbotsford Landslide
(*Otago Daily Times*)

Bottom: The Boxing Day 2000 Malborough Fire
(*Malborough District Council*)

NATURAL HAZARDS LEGISLATION

Civil Defence Emergency Management Act (2002): Resilience to natural hazard (and other emergency) events requires a holistic approach. The CDEM Act outlines expectations placed on local authorities, emergency services, government departments and lifeline utilities to minimise exposure, prepare for, respond to and recover from these events.

Building Act (2004): Codes and standards that meet the Building Act determine the design performance of structures. Council bylaws can further define where buildings can be placed and expected performance criteria related to natural hazard exposure.

Resource Management Act (1991): How we manage the environment is governed by the RMA. This includes not exacerbating natural hazards.

Earthquake Commission Act (1993): The Earthquake Commission is tasked with making provision with respect to the insurance of residential property against damage caused by certain, but not all, natural disasters.

institutions with different mandates, while at the same time seeking to incorporate private and community expectations, is highly challenging. There is potential for gaps, process breakdowns and inconsistencies. There is competition for expert resources to undertake the activities, and potential for 'silo' thinking within agencies and reinvention of solutions across agencies.

There is a real opportunity for developing and sharing best practice and for building capability across agencies, as well as for communicating how the parts of the hazard management system could link to deliver more resilient and thus more sustainable outcomes. The issue of how to address locally determined and locally inconsistent approaches has yet to be resolved.

Risk communication is not limited to event based risk management. Establishing relationships between authorities and communities builds a basis for community ownership of their natural

environment. This has been undertaken to varying degrees by several local authorities. Environment Bay of Plenty's River Scheme meetings and Opotiki District councils face to face interactions have laid the ground work for considered adoption of strategies to address flood risk exposure that include community ownership.

New and innovative solutions to hazard risk reduction are being developed all the time by local government. In order for others to learn from this, support at the technical and professional practice level as well as greater coordination across agencies is necessary. The work undertaken by CAENZ underlines the vital importance of both building on our past experiences and advancing current practice nationally.

Improving the practice of land-use management in the presence of natural hazards requires a framework that is shared across all the organisations involved. This shared approach is not about managing the risks but about integrated management in the presence of acknowledged risks. A significant aspect of managing with risk lies in understanding systems of governance and management, working in partnerships and through strategic alliances with organisations and the wider community. The Ministry for the environment captures this approach in their goal; "we work to achieve good environmental leadership and decision making at all levels so that we can deliver the environment that New Zealanders expect and deserve."

Even with robust governance arrangements, there are still obstacles to implementing land-use management in organisations and communities that have diverse personalities, interests and backgrounds. On-the-ground experience suggests that even in very difficult situations common actions can eventually be agreed, but the process of arriving at that agreement can be long and difficult.

CAENZ believes that the principles of integrated land use planning could be greatly advanced by adopting systems-based approaches to support consistent decision-making. There are enormous opportunities to lift the game in New Zealand but it will require bringing together many different specialisations.

natural hazard decisions: appreciation of the needs

Many natural hazard risk management decisions currently fall to local authorities. In Planning for Natural Hazard Risk in the Built Environment (CAENZ, June 2004) the observation was made that “significant advance has been made in planning and efficiency in the institutional processes now in place, but effectiveness from a natural hazard risk perspective is still a distant goal.”

HURDLES

- There is a nationally recognised lack of coordination across the players involved; leadership is required, with a clearly defined mandate. This will allow nation-wide changes in acceptable practice and increased coordination between national and local government.
- The national pool of public resources is insufficient – finance is required to provide appropriate numbers of skilled professionals with specific knowledge of natural hazard considerations. Finance is also required to defend decisions that refuse consents for use of land that is vulnerable to natural hazards.
- Mechanisms for providing better access to and uptake of natural hazard information are critical to improving hazard risk management in this country. Those tasked with implementation of land-use decisions require greater guidance on using information and feeding it into the process at the community interface. Access



Lake Sumner in Flood (K. Hoskin)

to expertise on natural hazards and on community vulnerability is critical.

- Maximum benefit from natural hazard knowledge can only be achieved in an environment where there is a common understanding of the concept of “acceptable risks” by all in the community. A two-way communication campaign is required to enhance both community and official understanding, so that hazard warnings are seen not as a ‘burden’ on a property (affecting value) but as an informed disclosure for the benefit of future occupants.

Established and coordinated networking, in conjunction with targeted communications by organizations, provides a powerful base for natural hazard risk communication to take place.

Resilience has to apply to all elements of the system – from the hazard source right through to the assets and people affected. With natural forces there are limits to what can be done to diminish or deflect the hazard when it is beyond a certain size or where the effects are complex. The law of diminishing returns applies when consequences cascade well beyond the source of the problem; the pathways between cause and effect can become so complex that mitigation efforts may have little impact. So, large, complex, or unusual hazards are best managed by building resilience in the communities that are likely to be affected. As a broad principle, there can be considerable value in trying to manage the small hazards (low floods, small landslides, gales, etc) but not much when they are infrequent or very large. In such situations it is better to concentrate the greatest part of resources on building resilience. Our definition of resilience in DPMC is:

“The ability at every relevant level, to anticipate and, if necessary, to handle and recover from disruptive challenges”.

Patrick Helm

- A cultural change is required within the public sector too. The relative priorities that shape land-use planning do not place sufficient emphasis on the role of natural hazards.

Natural hazard events are not the arbitrary 'acts of God' they were once thought to be. Thanks to significant work by geologists and engineers, natural hazard events can now be foreseen with a degree of certainty. We cannot know when they will occur, but they can be understood and appropriately planned for.

The role of Land Information Memoranda (LIMs) is a core link in consolidating council knowledge and in communicating natural hazard information to prospective



Waimakariri River (stock)

The greatest challenge (in general) is gaining recognition that hazard management programmes are valuable and have long term benefits to the community. There is scientific information out there that is not being used ... the value of having events is significant, as these provide an opportunity to build better programmes based on information. Communication between parties (scientists through to politicians) is an important issue. We need to show the cost-benefit of doing these things.

Peter Kingsbury

owners. Councils are obliged to make LIMs comprehensive, and are responsible for the accuracy of the information. This can be difficult and there have been numerous examples where councils struggled to consistently approach this issue. Councils' liability is not limited to providing accurate information to land owners: they are also responsible for what they allow land owners to do.

Even with a LIM that relates significant hazards, property owners may be prepared to undertake development - taking risks that councils would not. Should however, a consent be granted, other than under Section 36(2) of the Building Act, there is little means for the Council to transfer its liability.

FLOOD MANAGEMENT OF THE WAIMAKARIRI RIVER

Examples that illustrate an appreciation of the needs in making land use decisions for natural hazards can be found in a number of communities where potentially high impact risks have been identified.

One such example is the approach to flood management taken with the Waimakariri River north of Christchurch. Appreciating the needs generated by land use in the presence of natural hazards needs to become common practice and not be limited to high consequence events

The Christchurch/Kaiapoi area is considered to be the largest economic asset in New

Zealand at risk from flooding. Managing that risk is a significant issue for the sustainability of the city. Providing the adaptive capacity to manage the effects of a natural disaster on a socio-economic system is an issue of sustainability.

The traditional approach to flood management is to provide stopbank protection for a flood of a specified return period. In the case of Christchurch, stopbanks were designed for a 1-in-500 year flood flow of 4,730 cumecs. However the traditional approach does not consider the risk of stopbank failure below the design flow. Recent North Island

floods have experienced stopbank failure below design flow leading to flooding of “protected” areas and the inability of those floodwaters to return to the river because of stopbanks downstream. For the Waimakariri stopbanks there is considered to be a risk of breakouts from stopbank failure at 3,300 cumecs which is 70% of the design flow.

Furthermore the traditional approach does not provide adequate capacity for flood flows greater than the design flow. Climate change projections for the east coast of the South Island are indicating the occurrence of more extreme events. Also there is the potential for braided rivers like the Waimakariri to transport large volumes of shingle and sediment reducing the existing channel capacity. Thus a nominal design capacity is unlikely to be maintained in practice.

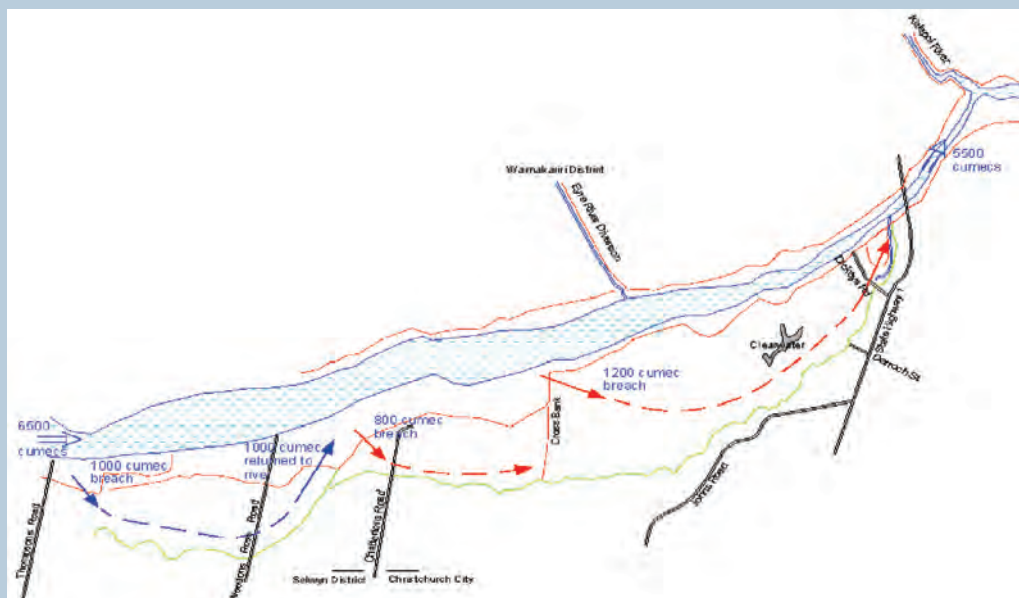
It has been estimated that in the next 30 years there is a 50% chance of stopbank failure and a 10% chance of urban area flooding. To address the issues of risk from a larger-than-design flood and containing breakouts from stopbank failure below a

design flood, the provision of a secondary stopbank along the alignment of a natural river terrace on the southern side to accommodate a 1-in-10,000 year flow (6,500 cumecs) has been designed.

The design concept is to contain and return breakout flow which involves flood storage between the primary and secondary stopbanks and returning that overflow to the main channel downstream. This also requires complementary work to strengthen and upgrade the stopbanks on the northern side of the river.

A number of mitigation measures have been incorporated in the design concept. These include:

- compensation for the potential damage from increased depth between the stopbanks
- rock lining in high velocity areas to reduce the risk of stopbank failure
- modifications to bridge embankments
- gravel removal from the channel to maintain channel capacity, and
- a flood warning and evacuation plan.



kaitiakitanga (stewardship)

There needs to be a shift in the central government incentives away from response and towards reduction of risk. Kaitiakitanga requires consideration of the interface between current usage desires and the legacy that is left to future generations.

Hazard management in New Zealand is dispersed over a number of agencies. Government departments, local councils, private business and professional associations share responsibility through a variety of functions for improving New Zealand's preparedness and response to natural hazard events. Each of these brings a different perspective, and this creates a complex and disjointed approach to land use in the presence of natural hazards. For example, the Ministry for the Environment holds ownership of the land-use policy-making process while local authorities are tasked with addressing the practical implications of applying it via specific decisions.

Social responsibility, economics and lifestyle preferences are the basic tenants that determine our individual approaches to land use in New Zealand. Interpretation of the implications of the use of land subsequently varies. As a result available information about



Mount Tasman (stock)

land is used in different ways and for different purposes. A developer has a strongly economic view to land use information as they are seeking to maximise return on investment, whereas a resident will interpret information in the context of lifestyle and implications to resell value. Government has the role of ensuring that social responsibility is considered by all and that in the long-term their decisions are not going to result in a legacy of ongoing problems.

KNOWLEDGE SHARING

The present system that links research through to practice is complex and has significant discontinuities that limit the development and implementation of best practice. A more carefully designed and coordinated approach is

... there is now better communication and understanding between all players in the natural hazards arena. Therefore, if it continues, it should get better and better. There will always be a grey area between the science and application of information, but this is improving. It has been a long time since we have been tested to the point that hard questions have been asked, we have a low population density, we have regular events but the impacts are still minor. A large event will be the test, and the opportunity, for natural hazard management programmes to be a bit more obvious - to have a higher priority than more fundamental issues such as wastewater.

Peter Kingsbury

We need to move beyond the constrictions of current assumptions about hazard management such as: that better information will inevitably lead to better management; that there is perfect information just around the corner; that more science is the answer; that cause and effect can always be unraveled; and that life is linear. That works mostly for simple risks. It frequently fails with the complex situations that emerge from large hazards or disasters.

Patrick Helm

required to ensure maximum benefit. Different styles and forms of communication need to be employed as different people understand the same information differently. Currently there is no mechanism to facilitate this process.

Organisations that are responsible for natural hazard risk need to listen carefully to the community and specialist advisors. In order to discern future risks it is important to establish the current context; to appreciate the

historical context and overlay that with trends and events. An advantage of past attempts to control natural hazards is that we now know the repercussions of interventions and can judge what might provide acceptable or unacceptable outcomes.

In order to bridge the knowledge gap between a LIM and a hazard map it would be useful to collate historical damage costs for areas and maintain it in a publicly accessible database.

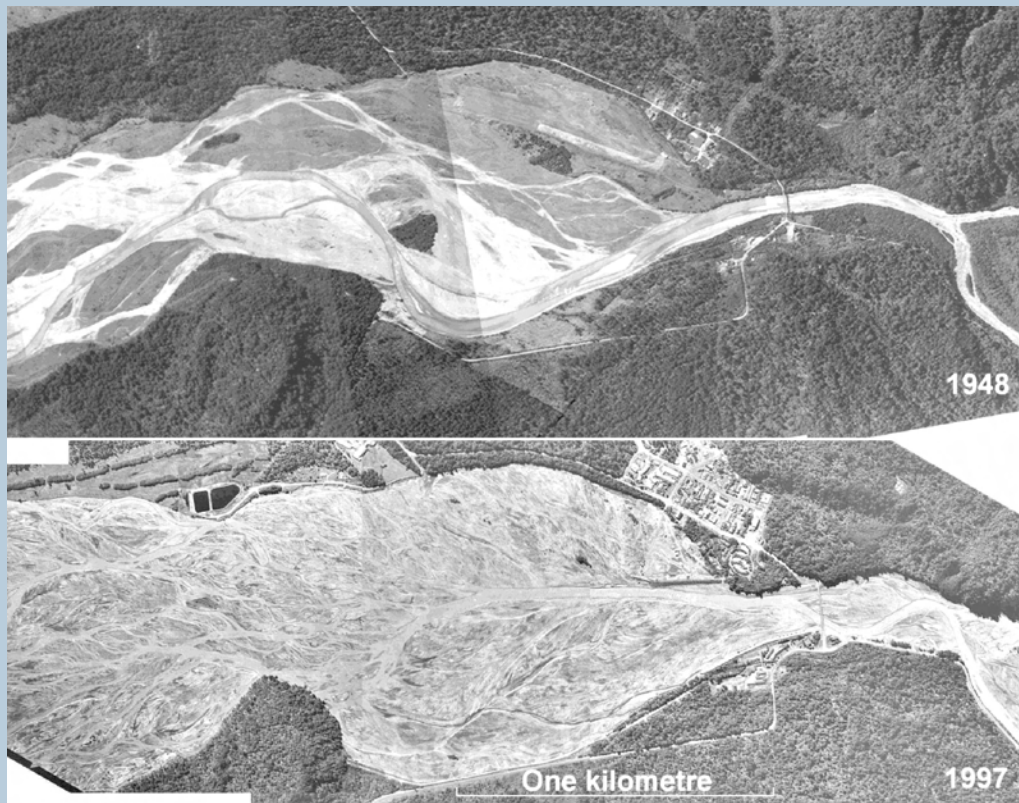
SMALL INTERVENTION, LARGE IMPACT

The change in the Waiho River planform between 1948 and 1997 is dramatic; but the change in bed level is even more dramatic.

At the SH 6 bridge, the river bed in 1997 was about ten meters higher than in 1948, and was above the level of the riverside Holiday Park. This aggradation is not due to excess sediment supply from upstream; it is

because the presence of SH 6 on the south bank (bottom in the photos) meant that the river's natural tendency to alter its course to the south downstream of the bridge had to be prevented by a stopbank.

This constraint reduced the river's ability to transport sediment out of the reach, and it had to aggrade to increase its slope instead.



economic significance

The Building Act (2004), which governs the design performance of structures through its associated standards and codes, requires that residential structures be built to have less than a 10% probability of being damaged structurally (specifically by wind, earthquake or snow; but this criterion is likely to be legally applicable to all hazards) within 50 years. The event that would cause such damage has an annual occurrence probability of 0.2%, or a “return period” of 475 years, so it is a fairly major event. However, many natural hazards go unrecognised by council officials, and annual probabilities are very difficult to estimate even where a hazard has been recognised, so these rules are difficult to implement.

Communities have a right to expect that governments and even businesses provide the best possible approach to public risk.

Terry Day

It is acknowledged that events will occur that exceed the design standard and perhaps cause severe damage and/or death. This has to be accepted – it is impractical to design for the worst that the planet can throw at us, although this offers little consolation when lives are lost because a “permissible” event occurred.

In the aftermath of such events authorities need to demonstrate that the event exceeded the design level, in order to avoid criticism. In addition, the new Flood Risk Management Standard NZS 9401 (2008) makes the point that although super-design events will exceed built capability, there are other ways of reducing their impact – for instance by putting garages on the ground floor with living quarters above, where flood damage can occur. This is a concept that can equally be applied to other hazards.

Although not controllable, it should be stated that some natural hazards may be influenced by human activity. How we use land can affect the frequency and intensity of some natural hazard events. Conversion of land from forest to pasture can hasten erosion for a time; urbanisation on slopes can increase runoff

and in turn affect flood risks farther down the stream. For preventing landslips, competent engineering and stormwater management can be as important as geotechnical factors.

In considering the development of land for residential expansion and agricultural development, we need to consider several questions that have significant economic implications:

- In allowing increased expansion of housing developments into more hazard prone areas, is New Zealand appropriately managing its collective public risk exposure?
- Is a more proscriptive national approach required, or is sufficient guidance available for local authorities to provide consistent expectations of hazard consideration in consent approvals?
- Are there hazard resources that could be funded through central government so as to reduce the financial barriers to access by individuals and local government?
- Should natural hazard exposure be given greater priority as a consideration in setting land values?
- How can the uptake of natural hazard knowledge be better incorporated into existing land use practice without unduly raising the costs of development?
- What socio-economic incentives can be employed in order to raise the level of natural hazard consideration that is given to land use.

Not all leadership needs to come from professional sources. The relocation of Soldiers Grove Wisconsin, and Valmeyer, Illinois, were both voluntary efforts led by the citizens themselves. In both cases, there has been a related movement towards sustainable redevelopment. Our experience in the democratic setting is that the whole process is much more successful when citizens make decisions for themselves.

James Schwab

THE LIABILITY PICTURE

Local government devotes considerable resources to legal costs. Local Authorities have discretion to determine the extent of land affected by building work, and they have to consider the implications of liability and cost of protection measures. This results in inconsistencies between councils, that is sometimes reflective of the variations in the legal costs for defending decisions.

Increasing urbanisation increases the liability on Councils. People become less willing to accept individual risk, and place increased collective expectation on the public sector; for example, expecting their council to 'fix' an eroding sea-cliff. Individuals expect the government to wear the risk, they cease to accept responsibility for their own risk exposure. However, councils benefit from urbanization too. Increased populations generate greater revenue as rates and make provision of services more cost-effective.

STANDARDS

One of the key aspects to effectively managing natural hazard risks is having good decision-making processes that enable society to continue to function under sometimes unpredictable and extreme circumstances.

Standardisation in the areas of natural hazards and risk management aims, among other things, to promote good decision-making processes that lead to strengthening society's resilience to hazards, and a reduction in the overall costs of disruption caused by hazard events.

For example, New Zealand Standard NZS 9401:2008 Managing Flood Risk – A Process Standard was developed to guide decision-making on flood risk. It provides a framework to help decision-makers work through the range of issues that need to be considered in addressing flood risk. Another example is the joint Australian/New Zealand Standard on risk management (AS/NZS 4360:2004), which offers guidance on continuous improvement in decision-making and performance to manage risk.

A standardised, decision-making framework



Otira Viaduct, Arthurs Pass (K. Hoskin)

provides the methodological and technical tools needed to support and guide multi-professional, multi-jurisdictional actions and reinforces the strong relationship needed between emergency planning and urban and regional planning. It increases the likelihood of greater consistency within and across multiple interests, without supplanting the need for organisations to have their own operational plans and procedures, and to be familiar and compliant with their legislative obligations.

Standardisation contributes to improved governance structures and systems (i.e. institutions, their responsibilities and interactions, and the resources and infrastructures that support them) to ensure the capacity and capability exists to enable society to continue to effectively function whatever the nature and scale of the hazard.

The process of developing a New Zealand Standard ensures that:

- the appropriate level and range of expertise is involved;
- relevant interests are represented, and there is a balance of interests, during the development of the standard;
- decision-making is based on consensus; and
- the public have an opportunity to comment on the draft standard.

As well as providing a consistent framework for decision-making, standards also provide a means to carry out self-assessments, peer review, and performance audits of relevant organisations, systems, and processes.

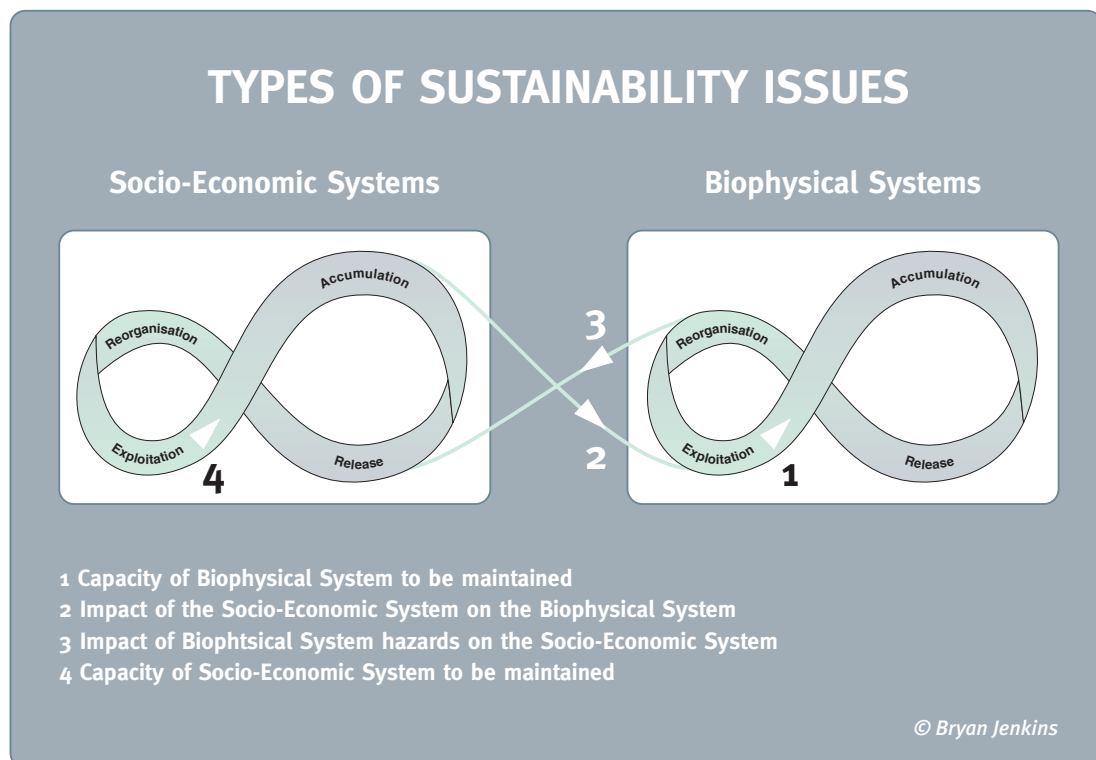
Standards also encourage better stakeholder engagement, communication, sharing of information, and public awareness about natural hazards.

COMMON LAW

Regional councils and territorial authorities have separate but complementary functions and powers under the Resource Management Act 1991 (sections 30 and 31) relating to the management of land and the mitigation of natural hazards through planning and other methods.

The Local Government Official Information and Meetings Act 1987 (section 44A) enables any person to apply to a territorial authority for information (a land information memorandum or 'LIM') on matters affecting any land in the district. This includes information on natural hazard characteristics of a particular area of

land that is known to the territorial authority. Territorial authorities also have discretion about other information to include on a LIM that they consider relevant. This is proving to be controversial with coastal property owners in some districts where councils have proposed to amend LIMs on coastal properties to include the risk of inundation from sea level rise due to climate change. (See Local Government Official Information and Meetings Act 1987 s 44 (A) and *Altmarloch Joint Ventures Limited v Moorehouse*, 3/7/08, Wild J, HC Blenheim, CIV 2005-406-91: although please note this case may later be restricted on its facts). However Councils may meet with resistance to amending LIMs to recording potential natural hazards on LIMs. In the longer term, this controversial issue could be resolved through the preparation of a National Policy Statement (Part 5 of the Resource Management Act 1991).



The four types of sustainability issues can be depicted as a pair of Lissajous: one Lissajous figure representing biophysical systems and the second representing socio-economic systems. The four types of sustainability issues are shown numerically as:

1. capacity of the biophysical system to be maintained;
2. impact of the socio-economic system on the biophysical system;
3. impact of biophysical system hazards on the socio-economic system; and
4. capacity of the socio-economic system to be maintained.

Rodney District Council met with considerable resistance and was threatened with legal action when it recently proposed to amend LIMs on coastal properties to include the risk of inundation from sea levels rise due to climate change. If Councils are to satisfy their legal duty of providing information as to future risk, whilst facing property owners concerns as to devaluation, central government guidance and assistance may be required.

Ceri Warnock

INSURANCE AND RESILIENCE

The value of planning for hazards and managing risk needs to be appreciated. The reality and inevitability of hazards needs to become ingrained in New Zealand culture. Changes need to be effected culturally and strategically, not under duress as a result, for example, of not insuring.

Increasing community resilience reduces Crown liabilities. Shifting focus from the hazard to the way the community lives with (i.e. adapts to) the hazard presents considerable potential benefits. Enhancing resilience improves the overall national management of a range of different natural hazards.

In contrast, reliance on insurance tends to have a negative effect. When individuals cannot afford insurance the Crown invariably bears the cost when damage occurs. When professional liability insurance costs increase, professionals either cease to practice or construction costs increase, housing becomes unaffordable and, once again, the Crown invariably takes on a greater risk portfolio.

SUSTAINABLE MANAGEMENT

The concept of sustainable management of adaptive cycles was originally developed for natural resource management, and is now being used widely for management of transformations in human and natural systems.

This approach seeks to balance environmental, social and economic considerations in order to appreciate the dynamics of natural hazard risks.

It recognises three types of sustainability issues:

- The capacity of a natural system to adapt to demands made upon it, independent of human activity
- The capacity of a natural system to be maintained where there is an impact from human activity
- The capacity of human systems to adapt to the effects of natural hazards.

Conceptually there is a fourth type of sustainability issue:

- The capacity of a human system to be evolve to meet demands independent of changes to the natural system.

Consideration of these four issues determine the environmental, social and economic viability of undertaking and/or continuing land use in the presence of natural hazards.

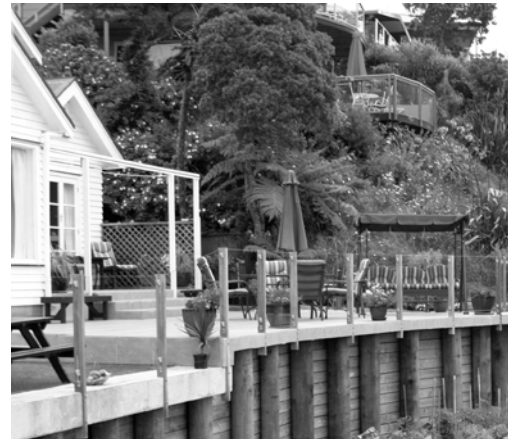
Resilience is the ability of a system (land management, community or governance etc) to withstand a shock, using a variety of responses and actions before and after an adverse event. Resilience includes being able to identify hazards and adjust behaviours over the long term to an acceptable level of risk.

Trecia Smith

building understanding

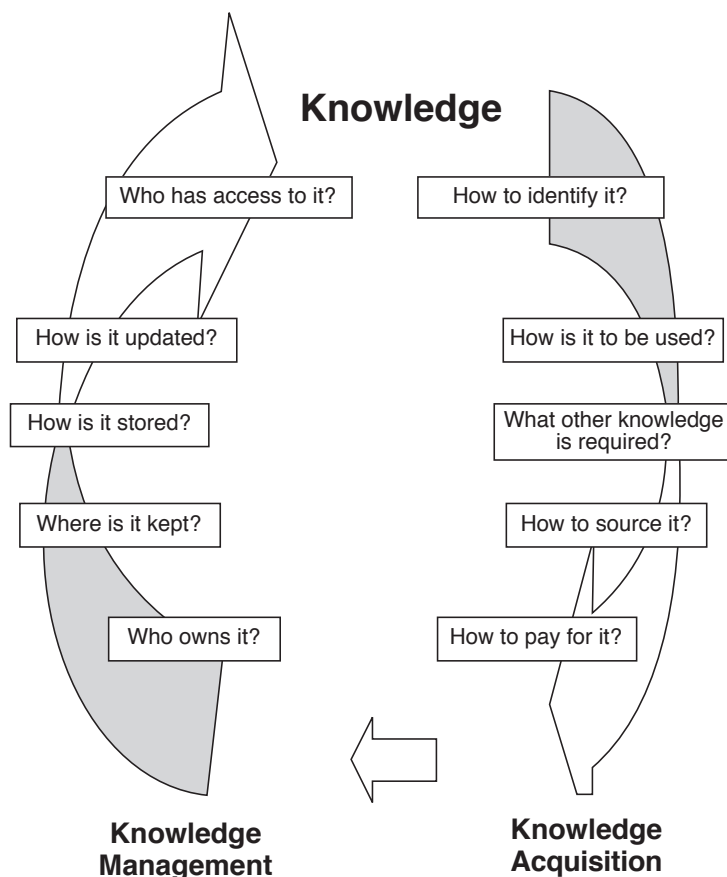
Many professions, universities and CRIs have recognised that understanding natural systems behaviour relevant to natural hazard risk management is extremely beneficial. Their ever developing knowledge is for the most part recorded in publicly-accessible theses and scientific publications; however it can be difficult for non-specialists to fully appreciate or source these resources. Additionally, specific hazard-related investigations undertaken for clients on a commercial basis may not be widely available.

In order to increase information sharing and raise understanding by all parties there is an urgent need for relevant science to be made more widely available and understandable to the non-scientists involved in land-use decision- and policy-making. With the expanse in knowledge that is being produced this may even require that policy- and decision-makers be made aware of and kept abreast of the existence of relevant science. There are not yet mechanisms by which this can take place



Slope Stability, Opua (K. Hoskin)

or a way to measure how effective knowledge sharing is. Currently information often reaches those who need it at the initiative of concerned scientists who send it unsolicited – with no assurance it will be read. Central government is in a position to address this issue by requiring CRIs and universities to communicate their hazard-related findings to councils; and setting expectations for councils to consider it.





Top: July 2006, Haumoana Coastal Erosion (Ecan)
Bottom: Severe Weather, Porters Pass (G. Treadgold)

Another issue not addressed in this commentary is the issue of scientific uncertainty and ways of managing peoples expectations with regards to certainty of outcome. The projection of size and risk is highly uncertain. When climate change projections are introduced then the issue of how to resolve scientific uncertainty becomes a major policy development issue. The way forward is not to manage the risk, but to manage with the risk. A critical component of this, is the risk communication process and community engagement in relation to building resilience in the presence natural processes.

In this context, the Earthquake Commission consistently encourages the development and promulgation of relevant hazard-related science. Its investment in GeoNet, in particular, has had a marked effect, providing a vital part of New Zealand's Hazard information infrastructure. There is considerable merit for increased liaison between councils and EQC

Opportunities exist to improve the way we manage land and waterways to reduce risk, the way we use land, land in hazardous areas, the way we manage this type of land. Currently we don't do a very good job – we still build on flood plains and unstable land.

Michele Daly

in order to improve the communication of research needs to the scientific community, and of science to the councils.

At a central government level the Department for Prime Minister and Cabinet, Ministry for Civil Defence and Emergency Management and the Ministry for the Environment and Ministry for Agriculture and Forestry all have key roles in managing natural hazard risks. As large land owners the New Zealand Transport Agency and the Department of Conservation also have a role to play in setting the standard for building shared understanding of natural hazard risks between land users and policy makers. However in order to reduce natural hazard risk, these agencies need to work more closely with each other, with local government, with the private sector, and with communities that are willing to take a fresh approach to addressing their risks.

It is the communities who ultimately have the greatest potential to contribute the greatest amount of future of hazard management in New Zealand. Through engagement with these communities there is substantial opportunity to determine the solutions that will best meet their needs and for the communities to take ownership of the hazards that affect them. This is a goal for achieving improved resilience - that communities should be encouraged to get involved in addressing the risks they live with.

Roles and responsibilities for local government are not well defined. There is variability in the degree to which natural hazards are considered in landuse decisions. Evidence demonstrates an absence of a consistent framework.

Local Government collectively needs to take a more proactive stance, insuring consistency and dissemination of best practice across the sector. The Ministry for the Environment has no clear mandate to pursue this ideal, and

as a consequence is unable to provide the level of guidance that is needed for consistent application of natural hazard information to land use decisions.

In the absence of specific commissioned research there is also generally a knowledge base available and readily applicable to planning applications. In this respect, EQC claims provide a significant learning resource. Investigation of files reveals the worrying frequency of inadequate site investigation and inappropriate house siting in relation to hazards that originate both within and outside of affected properties.

The Ministry of Civil Defence and Emergency Management, while tasked primarily with response, has an important role in the governance of natural hazard risk management, potentially serving as a catalyst in bringing together agencies and individuals to advance understanding of the strengths and knowledge that reside with the various organisations that are engaged in natural hazards.

Other government departments also have important roles which have not generally been exploited to advance knowledge sharing and mutual understanding. For example; the Department of Conservation controls large tracts of largely undeveloped country, but significant assets are sited within its estate (e.g. Aoraki/Mt Cook village). Such developments fall under the jurisdiction of district councils for land-use planning purposes. Much DoC land is ideally suited to acquiring increased understanding of natural processes, and DoC is very amenable to this use.

the future: prioritising effort

New Zealand has the policy and legal frameworks in place to build more sustainable, hazard-resilient communities. However there is considerable opportunity to streamline and coordinate knowledge transfer, legislation and policies. Aligning the RMA, LGA, BA and CDEMA, particularly in the context of hazard 'reduction', is an important policy imperative.

For many years hazards experts have urged communities to pay as much attention to undertaking measures prior to disasters as to responding to disasters after they happen. There is a need to raise visibility of hazards issues and to include public safety as part of the overall vision of community development. Hazard management has to be included in comprehensive planning, with hazard plans integrated into general land use planning and with effective linkages to other elements and plans.

James Schwab

There is a legacy of response-oriented and compartmentalized thinking within much current hazard management practice; this needs to be stripped away and replaced with a systemized and integrated approach built upon the concept of developing resilient communities. Rather than government being seen as the sole owner of natural hazard risks, communities need to be encouraged to take a proactive and holistic approach to hazards, bringing them into everyday thinking and lifestyle considerations.



1987/88 Canterbury Drought (The Christchurch Press)

Change will need to be driven by local government with support from agencies such as Ministry for the Environment, Ministry for Civil Defence & Emergency Management and others. Relationships within and between Government, society, the private sector and communities need to be strengthened and focused around the concept of shared risk ownership.

As has been previously mentioned in this document, the most powerful form of interaction is that which informs and supplements voluntary action by communities. Uninformed perceptions, based loosely on facts, can dominate the planning process, limiting capacity and willingness to accept and adapt to natural hazards.

The principles of integrated land use planning need to be better systemised and incorporated into planning documents. Having planners more overtly illustrate the relationships of natural hazard management to other areas of endeavour may present opportunities for organisations and communities to better consider how natural hazard management can be better incorporated into everyday life.

Part of the challenge is to integrate 'cutting edge' thinking and practice about reducing hazard risks into what are perceived to be 'non-hazards' related planning and decision-making processes e.g., District Plans, etc. In other words to 'mainstream' hazards into what are viewed as 'non-hazards' functions and activities. Central to achieving such 'mainstreaming' is improved dialogue and awareness raising about the real hazards risks that NZ communities and regions face.

Are we managing hazards? I think it is more constructive to view hazard risks as a function of community vulnerability and the hazard per se. We need to focus more attention on addressing the root causes, drivers and manifestations of vulnerability. Putting measures in places is fundamentally a governance challenge.

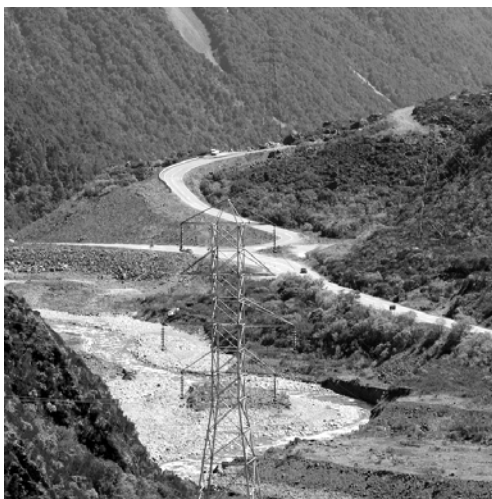
Bruce Glavovic

towards a vision of landuse in the future

New Zealand has too many examples of infrastructure and built environments located on sites vulnerable to natural hazards, and communities unaware of the implications of these risks. On the other hand New Zealand is fortunate, by comparison with other developed economies, that we are still relatively sparsely populated. This means that as development continues, alternative sites or design solutions are available for proposed facilities and infrastructure.

The question however, still remains on how best to incorporate these factors into land use decision-making and the criteria that should be applied to land use planning and management. This Commentary has explored the requirements for framing these issues and the desirability of a standardised decision-making framework to support and guide multi-professional and multi-jurisdictional actions. We argue that an integrated risk management approach is required; with hazard planning fully integrated into general land use management approaches.

The obstacles to adoption of such an approach are largely institutional; in particular the lack of an agreed framework within which all involved in land use decision-making can communicate, exchange knowledge and work towards decisions acceptable to all.



Arthurs Pass (K. Hoskin)



Lake Brunner (stock)

This Commentary also stresses the vital importance of an adaptive cycle framework that emphasises the concepts of resilience and the capacity of human systems to evolve to maintain existing socio-economic systems and the demands of sustainable future land use.

The complexity of natural systems and human systems means that quantifying natural hazard risk is difficult; but a comprehensive systems approach is essential to increasing understanding and thereby reinforcing community resilience. Too often the interrelationships that govern hazard management and land use planning are overlooked. Acknowledging these interactions and interdependencies is essential if we, as a nation, are to fully appreciate the impact that land use decisions may have on system continuance and sustainability.

Such an approach requires that all involved have confidence that their concerns are being fairly addressed. Again, CAENZ's analysis suggests that the way forward requires these decisions be rendered within a standardised framework that provides for a greater constancy within and across institutions and jurisdictional boundaries.

Crucial to this process is community acceptance of the public knowledge of the risk on their individual property. At present the public or individual landowners are not incentivised to take ownership of the risks that

arise from ill-informed decisions. Furthermore, future potential users are not represented when citizens themselves make decisions. CAENZ suggest that standardisation and alignment of professional practise will do much to accommodate these complex relationships and foster improved collaboration, which better meets the needs of future generations.

A strategy to meet these challenges will require multidisciplinary approaches that encourage engagement and addresses the different values and balance of interests that currently challenge conventional practise.

It will also require innovative thinking with respect to incentivising change. Examples that have been successful in other countries may hold the key. Successful approaches in the USA have seen the linking of natural hazard management with increasing greenspace; linking sustainability for natural hazards to adoption of both engineering solutions and community solutions that decreases natural hazard risk whilst at the same time improving standards of living.

There are significant barriers to the uptake and transfer of technical information and understanding of hazard risk, and there is currently a high level of dependence on individual expertise, professionalism, vision and commitment to achieving an objective and holistic approach to land use decisions. Addressing the complex range of issues systematically, through promoting good practice and solving weaknesses, will improve the impact of natural hazard information, and hence provide more confidence for the community in decisions that are taken.

CAENZ

To capture this vision the various related professions must work together to identify barriers to best practise and develop appropriate approaches to reducing these barriers. The way forward requires a shared vision that incorporates:

- Greater public, professional and official understanding of natural hazards.
- Better communication of information about natural system behaviour at all levels; government, councils, planners, public, scientists, and engineers.
- Action that addresses the issue of locally derived and locally inconsistent approaches.
- Increased use of broad-scale systems thinking.
- Establishment of key principles regarding avoidance and mitigation of natural hazard risks.
- Genuine involvement of communities in developing their land management processes.
- Increased focus on resilience, adaptability and individual ownership of risks.
- Greater debate of options for resettlement and relocation to avoid known hazards.
- Collective ownership of the problem and alignment of legislation and policies with this ideal.
- Standardisation and the adoption of best practise to promote good decision making

CAENZ, as a non-partisan, collaborative body, is committed to playing its part in this process. We continue to advance our various programmes in this field and updating our knowledge and information on the emerging global trends and related gaps. We urge others also to pick up this challenge.

CAENZ PUBLICATIONS RELATING TO LANDUSE AND NATURAL HAZARDS

- *Risks & Realities*
- *Risk Communication for Natural Hazard Events: Review of the 2004 Eastern Bay of Plenty Floods*
- *Managing Landslip Risk: Improving Practice*
- *Managing Flood Risk: The Case for Change*
- *Planning For Natural Hazard Risk in the Built Environment*
- *Natural Hazards management Forum May 2001*
- *Risk Assessments of Industrial & Natural Hazards*
- *Lifelines in Earthquakes*
- *Infrastructure Vulnerability to Natural Hazards*
- *Landuse of Landslip-prone Land*

CAENZ PUBLICATIONS RELATING TO THE MANAGEMENT OF RISK

- *Owning the Future: Integrated Risk Management in Practice*
- *Sharing the Future: Risk Communication in Practice*
- *Challenging the Future: Connecting the words in Risk Communication*
- *Current Imperatives for Risk Management in New Zealand*
- *US/NZ Workshop on Civil Infrastructure Systems*
- *Resilient Infrastructure*
- *Integrated Risk Management*
- *Risk Communication*
- *Modern Approaches to Infrastructure Resilience*
- *Risk Management Seminars*
- *Risk Communication Workshops*

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As a matter of editorial style, it was decided not to reference the many quotations and extracts to the specific source documents. Quotations and extracts are taken from internal and published reports as well as interviews. A bibliography is provided instead. We also acknowledge the authorship of Bryan Jenkins for the figure provided on page 16; “Types of sustainability Issues.”

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feedback

CAENZ welcomes comments on this paper. You are invited to write to:

CAENZ
University of Canterbury Campus
39 Creyke Road
Private Bag 4800
Christchurch 8140
New Zealand

telephone: +64 3 364 2478
fax: +64 3 364 2069
e-mail: comments@caenz.com
website: www.caenz.com

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To advance New Zealand's economic growth and social progress through broadening national understanding of emerging technologies and facilitating early adoption of advanced technology solutions.

CAENZ'S ROLE

CAENZ is helping transform New Zealand's technical infrastructure to advance economic growth and social progress:

- ▶ **As pioneer** CAENZ is applying engineering knowledge and insight to technology-related economic and social issues so as to facilitate the development of new perspectives and solutions.
- ▶ **As integrator** CAENZ is bringing together knowledge, money and resources to create opportunity.
- ▶ **As knowledge broker** CAENZ is facilitating the cross-pollination of knowledge across disciplines and institutional boundaries to advance engineering knowledge and practice.
- ▶ **As awareness raiser** CAENZ is helping to inform and educate New Zealand communities about technology matters to enable more informed community participation in decision-making.

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