WELLINGTON AFTER THE 'QUAKE

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The Challenge of Rebuilding Cities

EQC
EARTHQUAKE COMMISSION

CAE

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Please Note:

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The Challenge of Rebuilding Cities

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View to the southwest over Wellington's central business district, built largely on reclaimed land which is susceptible to liquefaction during a major earthquake. The Wellington fault runs close to the base of the hills in the background. (Photo: Lloyd Homer, Institute of Geological & Nuclear Sciences).

Disclaimer
It will be noted that the authorship of this document and comments have been attributed to the many individuals and organisations involved. While all sections have been subject to review and final editing, the opinions expressed remain those of the persons responsible and do not necessarily reflect the views of the Earthquake Commission or the Centre for Advanced Engineering.

Foreword

The *Wellington after the Quake* conference sought to answer the questions faced by everyone in authority when cities commence recovery after a disaster: *What happens next? What do I do now?*

I proposed the conference within the Earthquake Commission (EQC), both to provide background for our own disaster management planning and to assist public and private planning for disaster recovery. All other government agencies or departments, local authority councils, businesses, or large organisations that face severe damage in a disaster need to plan their recovery. In order to do so, they, like EQC, need a basis for their planning.

The conference set out such a basis by identifying the problems sure to be faced and by indicating possible solutions based on world and New Zealand experience. Much of the planning in the public sector relating to disasters has focused on the response phase — people's needs immediately after a disaster. So, too, with businesses, disaster recovery planning has focused on ways of getting the business up and running immediately, somewhere, somehow. Neither has dealt to any extent with the longer-term recovery from a disaster, including reconstruction of facilities, rebuilding of communities, and rebuilding of organisations.

This conference brought together world and New Zealand authorities, with academic and technical expertise and with practical experience.

The conference concentrated on Wellington, but by bringing to bear the best knowledge from around the world, its results are applicable to many cities around the world. The insights from this conference should be of value in every city that faces a risk of natural disaster.

The conference was substantially supported by major sponsors, who are listed on page iii. The Earthquake Commission thanks the sponsors on its own behalf and on behalf of all those who attended the conference. Thanks are also due to the members of the organising committees for their invaluable help in making the conference a success.

Ian McLean

Chairperson, The Earthquake Commission

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• Pat Helm, Prime Minister's Department • Graham Miller, Wellington Regional Council

Contents

Wellington After the Quake: Introduction

The scenario: The great Wellington quake of 1995

The early morning flight from Christchurch had begun its leisurely descent to Wellington, still some 15 minutes away. The quiet of the cabin was broken by the voice of the aircraft captain from the flight deck:

> Ladies and Gentlemen, I am sorry to tell you that since we left Christchurch there has been drama elsewhere. At about the time we left Christchurch, the Wellington region was hit by what is believed to be a major earthquake. The situation is still very confused but it is believed that damage is severe and extensive. Air Traffic Control have advised that we are not to attempt to land at Wellington, but along with all other aircraft destined for the capital we are to return to the point of departure.

And later that morning on national television:

> We interrupt this programme to bring you a special news bulletin. Central New Zealand was this morning rocked by a major earthquake and there are fears that damage in the Wellington area is on a scale not seen before in this country. Communications links with Wellington are all down and this bulletin is coming to you from a newsroom in Auckland. The only information to hand has come from the captain of an Air New Zealand aircraft making an approach to Wellington Airport when the quake struck at approximately 8:15 am. All incoming aircraft have returned to the point of departure with the exception of one aircraft, which has carried out a low-level sweep over the city and the Hutt Valley.
>
> The pilot reports that a pall of dust and smoke hangs over the city, with several fires burning in the central business area. There are no obvious signs of traffic movement within the city.
>
> There is no traffic moving on the Hutt Motorway and it seems that the road is blocked by a number of rockfalls and landslips. There is no traffic movement on the Ngauranga Gorge. Closer to the city, the Thorndon area appears to have suffered badly. The motorway structures are damaged, and a commuter train lies close by on its side. The railway line has slumped into the sea.
>
> There are problems, too, in the harbour. A number of vessels appear to be damaged, indicating vertical movement of the harbour bed. That is the extent of the pilot's report so far.
>
> Reports of damage are now coming in from Masterton and Palmerston North and from Blenheim, but as yet there are no details.
>
> As further information comes to hand, we will bring it to you. I fear that this is the day we all hoped we would never see.

Four weeks later, an extract from the midday news bulletin:

> For the past four weeks, Wellington has been counting the cost of the recent earthquake. Priority is being accorded to the restoration of essential services and the provision of temporary accommodation for those whose homes have either been destroyed or that are for other reasons uninhabitable. Access to the city area is still limited. The airport is still not open to civilian aircraft, and only very limited access is possible via the two road routes north, the Ngauranga Gorge and the Hutt Road. No train services are operating.
>
> The expected rush of claims to insurance companies has not eventuated, no doubt due to the continued disruption of communications. Preliminary estimates of the likely cost are nevertheless starting to emerge. A spokesman for the Earthquake Commission has put the insured loss to residential property within the Wellington region at $1.9 billion, with a similar amount for damage to industrial and commercial premises. The Minister for Disaster Recovery has stated that damage to uninsured government property and to the infrastructure will exceed $1 billion.
>
> The Minister emphasised that even though Wellington, as the seat of government, had suffered violent disruption, there was no thought of moving essential elements of government, such as the Cabinet, out of the city.
>
> He also indicated that he had asked for a report on whether emergency legislation was required to facilitate the recovery and rebuilding of areas hit by the quake.

> Little progress has yet been made in clearing debris from the city streets. Authorities are having difficulty getting access to disposal sites.
>
> A spokesman for the building industry today said that contractors were already having difficulty determining priorities, and he spoke of likely shortages of both materials and skilled manpower.

Fiction? Of course. But prophetic? Time alone will tell.

New Zealand sits somewhat uncomfortably on the "Rim of Fire", a zone that encircles the Pacific Ocean, exposing land masses within it and adjacent to it to the consequences, both frightening and potentially devastating, of sudden movement in the land mass.

Each year, some 12,000 earth tremors are recorded, each a reminder that our position is not one of comfort. All but some 500 or so pass unnoticed by the "man in the street", but from time to time, the reminder is less gentle and the land form in many parts of the country bears witness to this.

Since organised European settlement of the colony began in the mid-nineteenth century, there have been a number of major events. The most severe originated on the Wairarapa fault in 1855 and is believed to have been of magnitude 8. There was vertical movement of up to 3 metres and possibly surface breakage over about 50 km.

In many of the succeeding years, there have been events that have resulted in changes to the land form and damage to the infrastructure, property and buildings. With the exception of the 1931 Hawkes Bay earthquake, which devastated the towns of Napier and Hastings and caused 256 deaths, damage in major urban areas has been relatively minor.

Such immunity will not continue, with the Wellington region in particular being susceptible to major damage and disruption from earthquakes.

It is against this background that this conference is directed at the challenge of rebuilding a city that has been the site of a major seismic event.

The context of the programme is set against the background of a large earthquake centred on the Wellington-Hutt Valley segment of the Wellington fault. Rupture of this fault segment is expected to be associated with a magnitude 7.5 earthquake at a depth less than 30 km. The average recurrence interval for such an event is about 600 years and the probability of it occurring in the next 50 years is estimated as 11 percent. This is seen as the "maximum credible event".

The damaging effects of such an earthquake would extend beyond the Wellington region, north into Manawatu and Wairarapa and south to Marlborough, Nelson, and possibly to North Canterbury and Westland. Whilst recognising this, this conference is concerned only with the effect on the Wellington region.

The description that follows sketches the challenge that will face those charged with the task of rebuilding a region after such a seismic event.

It happened one Tuesday morning...

In the conference scenario, the main shock occurred at 8:15 am on a Tuesday morning. After a very sharp initial jolt, violent shaking and rolling continued for some 30 seconds and was felt in varying degrees over much of the south of the North Island and throughout the north of the South Island. Aftershocks continued throughout the day, and those immediately following the main shock were felt over a wide area.

The MM IX isoseismal encompasses much of the land west of the harbour. More severe shaking — MM X — is apparent in parts of Karori, Ngaio and Johnsonville, along the length of the Wellington-Hutt motorway and within the central business district of the city. An MM XI isoseismal embraces the Thorndon area and harbour land to the south, Lyall Bay and portions of the Miramar Peninsula.

Movement has occurred along the line of the Wellington fault, with uplift generally of the order of 1 metre; horizontal displacement is generally 4 metres.

Liquefaction of soils has occurred at several locations around Wellington, including Evans Bay, State Highway 1 from Porirua to Paremata, and Seaview.

Rockslides and landslips are concentrated in the Ngauranga and Ngaio Gorges, along the Wellington fault scarp, the slopes above the Seaview area and State Highway 58 from Paremata to Pauatahanui.

Casualties

Known deaths total 1600, injured 10,000.

Building damage

In the outer areas such as Lower Hutt and Porirua, the majority of the old, unstrengthened brick and masonry buildings have been severely damaged; more than 40 buildings have completely collapsed and a further 100 buildings are in various stages of partial collapse and require demolition.

Near the Petone foreshore and at Seaview, liquefaction of the alluvium and reclaimed ground has occurred, resulting in considerable damage to buildings, many of which have either settled or have severe foundation damage.

Most streets in the Wellington central business district are blocked by debris. A significant proportion of old brick and masonry buildings, particularly those built before 1935, have been badly damaged and some have collapsed. At least five 1960s and 1970s multi-storey buildings have failed, with shearing of concrete columns leading to partial collapse of several storeys. Other multi-storey buildings have suffered damage, with access to some 100 buildings restricted due to jamming of lifts and, in some cases, damage to stairs.

Multi-storey buildings of recent construction are damaged to varying degrees, with loss of glazing and some outer building fabric such as precast panels.

Interiors of most buildings have been damaged, with the collapse of suspended ceilings and overturning of equipment. Approximately 500 buildings are no longer habitable due to internal damage and loss and/or damage to essential services.

Building damage has been greatest on the area of reclaimed land adjacent to the harbour foreshore. Ground subsidence has occurred, causing several buildings to tilt alarmingly, and many streets are completely blocked.

Housing stock throughout the area has suffered serious damage. Some houses have been destroyed and over 3000 are uninhabitable due either to damage or to lack of essential services. A further 40,000 properties have suffered damage to either the dwellings or the contents.

Infrastructure

Elements of the region's infrastructure have suffered severe damage and some services will be restricted for many months.

Utilities

Underground pipelines have generally suffered severe damage, and water, sewerage and gas services will be restricted over much of the area of the city for several weeks.

Electricity

A restricted service to all areas is likely to be available in two weeks.

Telecommunications

A restricted cell-phone network will be available within a day or so, otherwise only a restricted trunk line service will be available for some weeks.

Roading

Restricted vehicular access within the region will be available within about five days. Access into and from the region is likely to be severely restricted for a month or more.

Rail

Rail traffic north from Upper Hutt will resume within a day or so. No rail traffic in or out of Wellington is likely for two to three months.

Airport

Subject to availability of plant, the airport is likely to be open to restricted traffic within two to four days. Unrestricted movement of civilian aircraft is unlikely for some months.

Executive summary and recommendations

The theme of this conference was recovery — the challenge of rebuilding cities after a disaster.

Emergency management needs to look beyond the emergency response phase. It should examine the restoration of the affected region, including its services and facilities and the lives of its resident and working population.

After the big quake in Wellington, central government functions would be jeopardised, an economic crisis might arise, vital national transport exchanges would be severely hampered, business, industry and tourism would be severely disrupted and stress would extend far beyond the boundaries of the Wellington region.

Recovery is a very long process and needs to be considered and planned for in the pre-impact period, together with planning for the immediate response and mitigation. Knowledge of the mechanisms and procedures of recovery is a relatively new area of disaster research. However, recent attention to the vulnerability of physical utilities, although addressed to the response phase, has also been invaluable in increasing our awareness of what might be involved in reconstruction. There is increased understanding of the potential problems that must be considered and resolved before the disaster strikes a community or region. Only by using this in recovery planning will it be possible to act effectively to reduce human suffering, minimise economic loss and disruption in the private sector, and restore some normality to the affairs of the nation.

Government and responsibility

The preservation of the executive, legislative, and judicial arms of government is critical in order to preserve the sovereignty of the nation and demonstrate that the democratically elected government is continuing its function. The government should also be capable of responding to the extra demands occasioned by the earthquake.

The likelihood of damage on a scale that would render the majority of government buildings unusable is low, and the government's initial task would be to ensure that it continued to function effectively from the current parliamentary complex. Nevertheless, politicians have accepted that Wellington is sufficiently vulnerable to warrant a plan to remove key elements of the central executive from Wellington in order to ensure continuity of government.

There needs to be a sensible balance of responsibilities between those affected. The government expects individuals, businesses, and local authorities to play their part and take prime responsibility for disaster management. They must be encouraged and empowered to minimise, mitigate and manage disaster.

Government does not shirk its responsibilities, but wants the risk to be shared. Central government continues to cover a large proportion of infrastructural recovery costs. But in doing so, it transfers appropriate responsibility for the recovery as a whole on to those with a direct interest. Among local authorities and those directly affected, there is inevitably a far superior appreciation of local risks than in central government, and recovery is most likely to be successful when the local community has control over the speed and direction of the recovery effort.

Wellington city, with the Wellington region, has started its pre-impact planning process and is in a good position to be in control of its own destiny. The emergency management planning and preparation done have satisfied central government departments, whose role would be to support them rather than compete with or replace city initiatives. Although no recovery programme will ever be without problems, conflict and upheaval, a framework has been established and a dialogue started with all essential participants, including central government. This will ensure that the rebuilding of Wellington takes place in an environment of cooperation and coordination.

Plan in advance

Advance planning for urban relocation and reconstruction after future urban earthquake disasters should be an integral part of risk mitigation. In most places, there has been a marked neglect of disaster recovery plans compared with preparedness plans. However, it is becoming increasingly important to manage reconstruction as efficiently and effectively as possible. Apart from the general desire to reduce human suffering, there is a need to restore the

economy and business activity quickly, and there are many other pressures to expedite recovery.

From the standpoint of the victims, the period of reconstruction and general community recovery can never be short enough. People want to return to normal conditions quickly. They seldom want to relocate, even after experiencing the worst impacts of disaster. Damage is seldom extensive enough to make relocation a real option, and in any case the funds needed are not usually available. Existing procedures and organisational arrangements favour piecemeal decision-making, and few communities have the kind of pre-disaster plans needed to effectively influence post-earthquake reconstruction and relocation decisions. Past earthquake events have shown that the normal ways of doing business are not adequate to accommodate the needs, particularly in terms of the pressure for speed in approving projects and the volume of applications.

We can prepare for calamity by having sound, popular, well-understood urban design policies in place long before disaster strikes. However, the implementation of these proposals should not be deferred until then. Plans for a better city deserve to be actioned immediately. Although a major tremor will leave its mark, those who survive the catastrophe will still inhabit a familiar place.

We can also lower the vulnerability of the city to future events by having a reconstruction plan in place before the big earthquake occurs. The plan should include:

- designation of a lead agency to manage the reconstruction;
- detailed maps of the earthquake hazard and inventories of the local buildings and infrastructure;
- identification of areas where reconstruction should be limited to lower densities or relocated;
- identification of less hazardous areas that can serve as receiving areas for relocated development; and
- identification of financing mechanisms that will support reconstruction, particularly for affordable housing and other non-market uses.

Social impact

There is a need in New Zealand to look more closely at the social impact of earthquakes. Community recovery following disaster consists of three interdependent components — social, economic and physical. A major impact on any one component in the system will have dramatic effects on the other two. For community recovery to be effective, plans must include contingencies for all three elements. To date, New Zealand has not adequately planned for the long-term social and economic effects of disasters.

The impact on a city is far greater than the obvious costs of repairing damaged drains and cables. There are also hidden costs in the provision of long-term community support services. Accommodation, employment, health and general community wellbeing are all significantly affected after disasters. As one example of the extra burden on already overloaded support services, if 20 percent of the population in the Wellington region became homeless, there would need to be plans for sheltering or rehousing approximately 80,000 people, including the provision of food, water and medical care.

The social relationships and conditions that exist before any disaster will be carried forward into the relief and recovery periods. Those individuals without financial resources will find it even more difficult to meet daily needs. Those with compound problems — the poor elderly, poor single-parent families, poor families with disabled members — will not only find it difficult to find temporary assistance, but the organisational and social relationships that made it possible to function in normal times may be absent for an extended period after the earthquake.

It is also particularly important to be sensitive to the cultural perceptions of the Maori and their community structures, to establish linkages beforehand with the various marae, and to use Maori liaison officers in all dealings, especially during the rescue and recovery phases. Cultural awareness of other ethnic groups is also needed during recovery.

Many smaller businesses are vulnerable, particularly to short periods of disruption of essential services such as electricity and water — the so-called "lifelines". If one knows what businesses are dependent upon which lifeline systems, it allows emergency managers, in conjunction with lifeline service providers and the business communities, to engage in informed, strategic planning before and after a disaster for ways to reduce economic disruption.

Physical resources and logistics

Considerable physical resources will be required to reinstate Wellington after a major earthquake, and the success of the recovery effort will centre around the planning and preparation that has been done in anticipation of the disaster. Surveys of the resources required for reconstruction were presented in a way that allowed analysis of various recognised categories of materials, plant and labour. This assessment forms a valuable starting point for realistically gauging the time required for recovery and the likely availability of resources to complete the reinstatement within a particular period.

Assuming a reconstruction period of four years, there would be a manageable demand on available materials, plant, and labour from within New Zealand. The demand for labour could be satisfied by redeployment of existing resources from within New Zealand, but there would be a major problem with their accommodation requirements, e.g. the 15,000 extra workers required for construction work once demolition had been completed.

However, there is a major shortage of contractors skilled in the demolition of tall buildings and heavy structures. The immediate post-earthquake phase will also require large numbers of engineers with assessment skills and assessors for damaged structures. Contingency plans should be put in place to bring in US or other overseas expertise.

The work of the Wellington Earthquake Lifelines Group, which to date has focused primarily on pre-recovery phase activities, serves as a useful template for extending planning to the recovery phase. The key to success will be to involve the private sector in appropriate response planning exercises, as the majority of resources used for recovery will come from the private sector.

The recruitment and training of the necessary labour resources and the management of their deployment calls for the skills of organisations that have had experience with large-scale project management. These organisations, perhaps in a consortium, could provide the necessary interface between property owners and their insurers for managing the recovery phase.

By strategically involving offshore organisations and maximising the skills and resources they can provide, a more timely, economical and effective recovery could be achieved.

The logistics of the situation are daunting. Severe disruption of road and rail and their associated structures will occur because of land modification and landslips. This will prevent the movement of heavy equipment into and throughout the region. In turn, this will hinder demolition and the clearing of sites to enable any rebuilding to proceed. The feasibility of creating emergency beach landing facilities away from existing port areas, where facilities will be unusable, needs investigating. Strategic stockpiles of rebuilding and repair materials could be established on the Wellington side of the mountains and areas designated for tipping spoil. It could take more than four years to rebuild some of the damaged structures, and some will never be rebuilt because of owner and tenant flight.

The Civil Defence Act is written around disasters of short duration. Consideration should be given to establishing provisions for coordinated action, such as is possible in the Philippines and USA under their legislation.

Legislation

Existing legislation, which is not designed to cope with an emergency situation, may have to be suspended or a moratorium imposed for a term. It was a widely held view of people consulted that the consent procedures of the Resource Management Act and some aspects of the Building Act would not operate effectively under the conditions envisaged.

However, once there is sufficient political momentum, the fact that the existing rules do not work will not matter. They will be changed to meet the exigencies of the situation. This is not seen as fatal to the long-term prospects for the existing legislation — one should not expect standard rules to operate under emergency conditions. Some design criteria may be changed, and the performance-based code will almost certainly have to be reviewed in the light of actual performance. What may have been considered adequate before the quake may be considered quite inappropriate after it.

From a practical point of view, it may become necessary to set aside some problems to enable planners and building inspectors to focus on those priority areas of the city and environs that can be returned to normality first.

Recent events in the Philippines and Japan

Experience in the reconstruction efforts in the Philippines showed the wisdom of mobilising human and material resources in systematic phases. What might have been scientifically and technically rational solutions are not always politically and socially acceptable, and might have to be modified to secure the necessary cooperation and participation from the local community. Early-warning systems, as well as education of the public, were important to reduce loss of life and mitigate damage to physical infrastructure. Finally, good political leadership was vital at both national and local levels.

In Kobe, there were detailed plans for emergencies, but the authorities had not expected so much damage to transportation systems and lifelines, such extensive subsidence and liquefaction damage, or such loss of lives and homes of reconstruction workers. To respond better, they advise:

- having quake-proof water tanks at schools, hospitals and other major buildings;
- having back-up control systems, facilities and plant for all businesses;
- providing alternative connecting routes;
- having an underground tunnel for utilities; and
- securing communications by use of satellites, etc.

Insurance and reinsurance

Damage from the most recent earthquakes in Los Angeles, where the structural characteristics of most buildings are similar to Wellington's, was much more extensive than predicted by the insurance industry. Damage to some modern buildings, e.g. some steel-framed ones, as well as older ones, exceeded the worst expectations of structural engineers. A contributor to these results was the record-high ground motions experienced. The total direct loss of about US$20 billion and an insured loss exceeding US$12 billion (much of it to earthquake-resistant residential construction) constitute the largest insured losses in US and world earthquake history, excluding major fire following the shaking. Similar, pro-rated scenarios are expected for the Wellington earthquake, unless the lessons of very recent history are carefully studied and applied.

In major Australian disasters, the degree of non-insurance surprised not only the insurance industry, but also governments and welfare agencies. The 1994 bushfires in New South Wales revealed that 22 percent of the homes and 52 percent of the contents of homes totally destroyed by fire were not insured. People choosing not to insure their prime assets ranged across the socio-economic spectrum. Under-insurance was also a problem. The percentage by which homes were generally under-insured in these bushfires was 30 percent, and in some socio-economic groups it was as high as 50 percent.

There is a section of the community that does not believe in insurance and chooses to carry the risk themselves, believing that a disaster can never happen to them. However, it is this section that becomes the major beneficiary of appeal funds, which means that instead of transferring their risk to an insurance company, they have merely transferred their risk to the generosity of their fellow citizens. If adequate insurance is in place, a large element of disaster trauma can be eliminated.

The Earthquake Commission (EQC) will meet its responsibilities for the rebuilding of Wellington by planning meticulously for the event, leaving nothing to chance. If necessary, EQC can move its operations to an alternative site near Auckland. Its plan is to link into the insurance industry's emergency plan, obtain additional claims-assessing resources from overseas, and operate its office, expanded by temporary telephone and inputting staff. Constant review will be needed to maintain currency with available technology, increasing knowledge of seismic disasters and the circumstances of all the partner organisations involved. This plan is the first step in a four-part process of responding to a catastrophe, the whole of which involves planning, initialising the plan, sustaining the catastrophe response organisation during the emergency and, finally, shutting down the operation in an orderly manner.

Because of Wellington's high seismicity and insurance density, reinsurers have been carefully monitoring and analysing the earthquake risk for some time. Primary insurance companies in New Zealand and other interested parties have already been notified of the results of corresponding model calculations. On the whole, reinsurers should have no difficulty with the Wellington earthquake, although some allowance should be made for the ongoing privatisation of earthquake cover for commercial/industrial risks. There will be enough reinsurance capacity available provided that infor-

mation is explicit enough to quantify the risk precisely and the price of the cover is adequate for both insurer and reinsurer.

Economics and finance

There are a number of similarities between the coming Wellington quake and the recent Kobe disaster. Both cities are important ports and their economies contribute a significant proportion of their respective nation's gross domestic product (nearly 10 percent). However, the relative magnitude of loss, ability to rebuild and access to financial resources are all vastly different. The indirect loss model suggests that Wellington would suffer disproportionately greater indirect losses, bringing total losses to 300 to 500 percent of New Zealand's annual national savings. This is due to differences in the capacity and scale of the two economies.

There is a need to anticipate the major issues that would confront those responsible for the implementation of monetary and economic policy if a major earthquake occurred in Wellington. It would be valuable to run an occasional contingency planning exercise, involving Treasury, the Reserve Bank and other major participants in the financial system. It could well uncover potential weak spots in the financial system, which might threaten to destabilise it unless corrected. It could illuminate the issues that would confront the bank in sustaining price stability. It could provoke consideration of whether the rather fragmented arrangements for coordination of financial and economic policy now prevailing would be adequate to deal with such a crisis or require special machinery. It could also stimulate discussion on whether there might be "gaps" in the provision of certain types of finance to meet such an emergency, e.g. the availability of equity finance (or temporary substitutes for it) that would help carry worthwhile enterprises through their temporary difficulties without becoming excessively indebted. This might require collective action in addition to what individual financial enterprises would be able to provide.

What happens next? What do we do now?

- Planning for recovery from any disaster is about people as well as buildings. People come from a wide variety of ethnic and social backgrounds. They have diverse needs, and may be hungry and frightened and homeless, and English may be a second language to them. They will want to rebuild their lives while the politicians, engineers and planners will want to rebuild their city.
- The time to plan for rebuilding is before the disaster, not after it has happened. We need to know in advance what we want to restore, what we want to redesign and what we want to relocate, so that people already know what is to be done when the time comes and can move to implement the plans for recovery efficiently. We need to have had time to work through the consultation and decision processes with due deliberation and care, without the stresses of immediacy and the understandable desire of the affected population to restore some degree of normalcy to their lives as quickly as possible.
- In any disaster, the people who are affected will want to know who is in charge and who sets the priorities. Now is the time to determine with the utmost clarity what the arrangements will be. There is no time after the disaster for a committee to sit down to try and decide these things.
- Ownership of the rebuilding plans has to be shared by central government, regional councils, city and district councils, the insurance industry, private business, and the local communities. However, the question of who is to coordinate all of the activities is yet to be resolved.
- Any system that is devised needs to be applicable to any city in New Zealand. It needs to be widely understood and ready in advance. Moreover, it needs to be tested in advance.
- Despite efforts of civil defence organisations, there is still widespread lack of awareness of the recovery aspects of disasters. There needs to be a well-directed public education campaign to communicate existing plans and any future developments.
- A considerable amount of pain and destruction can be avoided by much greater mitigation efforts. Inducements need to be created to force urgent retrofitting of buildings and other structures.
- The logistics of the situation are formidable. We need to know who plans for the temporary facilities to be provided, for the transport in of heavy equipment, for the accommodation for the workforce and their supervisors, not to mention thousands of refugees — the regional or city councils, the Ministry of Civil Defence, or the Prime Minister's DESC organisation.

- Decisions have to be made about the provision of lifelines services to ensure that mitigation work is done and recovery plans are made. The strategic importance of alternative routes, such as Transmission Gully, and alternative sources of supply needs to be emphasised.
- Procedures for planning consent and the issue of building permits would need to be streamlined to enable things to happen. To do this, and otherwise expedite reconstruction, laws would need to be changed. It seems sensible to legislate now for the post-disaster situation, so that it can swing into effect immediately. Zones that the council would not want people to rebuild on could also be designated now.
- Cost implications of the Wellington quake, including costs of business interruption and indirect costs, would have drastic repercussions for the nation. These costs will impact directly on local businesses and local government, and the reduction in money supply will flow on to central government by the greatly reduced tax take from families and businesses struggling to survive through the recovery period. The challenge is for organisations to have thought about this in advance, to have contingency plans in place to enable them to continue to operate and to have identified sources of finance for recovery.
- There are several things you can do now to plan to recover your business operation. Firstly, make sure that you are in a safe, strong building, i.e. it is well-designed to code. Make sure the providers have a good lifelines restoration plan. Set up a management contract beforehand with a major construction firm to come in promptly to help get you up and running again.
- The role of the private sector becomes dominant in the reconstruction of devastated cities. Homeowners, the insurance industry, and owners of buildings and businesses will undertake their own reconstruction. Much can be done in advance to ensure that they can work effectively to restore normalcy to the city.
- It is costly and unnecessary for any country to ignore the knowledge of the many people who have a wealth of experience of disasters overseas, and it is costly and unnecessary for each local authority to invent its own recovery plan. Why reinvent the wheel in New Zealand, and why do so in each city? It is sensible for all organisations concerned to get together to share information and to outline the common principles that apply to all recovery undertakings.
- A strong lead from central government is required to promote planning for recovery and to communicate what is expected of all sectors of the community.

Organisation, Government and Legislation

The significance of Wellington being the capital in a disaster

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The premise is that a highly destructive earthquake centred on a major area of population would present severe problems of political management. Larger societies with greater economic resources can concentrate immediate rescue and relief from unaffected areas. A thinly populated, highly urbanised society like New Zealand would suffer the consequences of this paradox. This suggests that central government will be the prime mover and that existing emergency laws and strategies should be reviewed in the light of recent international discussion and experience.

Wellington represents a worst-case scenario and can be studied with profit in both the regional and national interest. It also draws attention to a major problem: the policy-makers operating under current arrangements in conditions of maximum stress have to respond to the emergency and, at the same time, maintain the economic and political stability of the whole polity. A wider review of the options might suggest a more appropriate location of political authority and the creation of institutions better equipped for the task.

Introduction

The process by which we come to understand the forces holding our habitat in precarious balance comprises a complex of observation, speculation and resolution. Generally speaking, the participants and their theories are largely unknown to the world outside their academic or other professional circles. Advances in knowledge are proposed, tested and confirmed by repeated enquiry, challenge and response. Progress is recorded in the professional journals, but the wider world of the intellect is minimally affected. Very occasionally, a great mind, operating at levels of hypothesis beyond the immediate grasp of his contemporaries, alters the way we think about fundamental forces. Once this new proposition is assimilated — often after prolonged debate — it is possible to go forward from the secure base of testable, explanatory theory. When this happens, the world of knowledge adjusts accordingly and, slowly but surely, a new orthodoxy prevails wherever disciplined intellectual exchanges govern outcomes.

A very few rewrite not only our assumptions about the universe but also the very techniques of thinking about its dynamics. In this way, they make us both more subject to its disciplines and more empowered to make them serve our ends. This operates at every level. Newton, in devising a universal theory to explain the movement of extraterrestrial bodies, opened the way to more sophisticated techniques of navigation. A government department — the Admiralty — in association with a body of enthusiasts for scientific knowledge — The Royal Society (of which Newton was a founding member) — gave immense impetus to the study of our terrestrial environment, including an accurate location and description of the land the Dutch had provisionally named New Zealand. Einstein, in his enquiries into the fundamental nature of energy, unlocked a conceptual door to unparalleled mass destruction.

No one questions the influence upon the future for humanity in these great moments of intellectual clarification and liberation from ignorance. There are two important points. First, the principles behind these great leaps were sufficiently general to engage lay interest and, secondly, the explanatory power inherent in the fundamental theory has grown with its application to phenomena.

While no one would argue that Alfred Wegener had an influence upon the world of the intellect comparable to that of Newton and Einstein, his theory of "continental drift" is a startling exercise in scientific intuition. Wegener, a German physicist of many interests (and one of those rare minds willing to think outwards from disciplinary constraints), offered an explanation for the uneven distribution of most earthquakes across the terrestrial sphere. Wegener's proposals have led to suggestions that earthquakes would be likely to occur more frequently at the interacting edges of vast, slowly moving plates, whose tensions are relieved by sudden rupture. This provides the energy that we experience as ground shaking and failure. Now that

these boundaries have been identified, it is possible to propose:

- with useful accuracy, where earthquakes are likely to happen;
- with less certainty, the energy they are likely to release; and
- with significant uncertainty, the moment at which the earthquake will occur.

Information is being collected with increasing volume and reliability as seismological records are accumulated by national and international agencies (Stevens, 1980).

One consequence of this research has been the hope that information could be interpreted to predict the moment when the earthquake might occur with sufficient accuracy to reduce damage to persons and property. After attending a number of meetings held to discuss this proposition, and after much consultation of the literature, I came to the conclusion that accurate prediction is nowhere in sight. If it did prove to be practicable, there is reason to believe that, in many respects, a prediction of an earthquake might be worse for the community than an earthquake itself. I see no useful purpose in committing public resources to the development of accurate prediction or in devising public policy for reaction to predictions.

Nonetheless, it is my belief that we have moved into a new era as a result of improvement in the relationship between responsible political authorities and the practitioners of earthquake science and technology. As records accumulate, analysis will identify the areas vulnerable to destructive shaking and land-use policies will be devised to minimise hazards to both persons and property. The programmes for these projects are under way throughout the world and must stand among the most encouraging examples of rational international cooperation. For example, let me cite the decision of the United Nations General Assembly to adopt the 1990s as the International Decade for Natural Disaster Reduction (UN General Assembly, 1989).

To explain this situation, we have to take into account not only the advances in earthquake science and technology, but also the peculiar political problems and strategies they generate.

The issue of control

One may argue that the least equivocal duty of the state, next to the maintenance of territorial integrity, is the protection of the citizen from the effects of natural disasters and the rescue and recovery of those injured or impoverished. This factor is always in dramatic evidence in the aftermath of a disaster, and it is reasonable to judge the prudence and foresight of any government by the way it prepares for and deals with the problem. Certainly, a state without comprehensive, widely advertised, regularly tested and constantly updated programmes of civil defence has failed one of the crucial tests of civilisation. Yet it would be bold to claim that, when an actual event occurs, the civil defence strategies of most states cope with uniform efficiency.

Any judgement on this issue is beset with variables in wealth, social cohesion, physical realities, the human and technical resources required, and the responsiveness of the chain of political command. It is important that uneven response should be reduced as far as possible, and international agencies at government and professional level have done much to draw the lessons from past events, subject them to evaluation and debate, and publish the results in widely distributed journals. Among other things, this promotes participation across international boundaries and the growth in expertise. Civil defence has become a major world issue of high political significance. It is worth recording that a Civil Defence Review Panel reporting to the Minister of Civil Defence stated that it was:

> *surprised by the volume and encouraged by the quality of written submissions (148) received, and by the level of participation at meetings that we held throughout New Zealand.*
>
> (Civil Defence Review Panel, 1992)

Despite this reinforcement of the political significance of civil defence, there are inherent problems in assigning action to particular authorities. The Review Panel discusses the problem of establishing a control process that provides authority appropriate to deal with the emergency without transgressing the principles of an open and responsible society.

The problem is simple in principle and its solution refers to a maxim of English constitutional practice, which requires that the "Queen's government must be carried on". This suggests that the appropriate executives must be left to exercise their powers until

they, or those to whom they are responsible, are replaced with procedural propriety. The clearest case occurs in the interregnum between defeat in a general election and the appointment of a new administration properly equipped with ministerial warrants. Despite the loss in the democratic process, the defeated executive retains the right and duty to make essential decisions and to accept responsibility, even where they have consulted incoming members of the new administration. The difficulties that may arise were most clearly demonstrated in the transition of power from National to Labour following the election in 1984 and the concurrent crisis in foreign exchange markets.

The discussion on this issue in the Civil Defence review touches on the principles at stake in this process. The Review Panel considered the case for appointing an elected politician as the "controller emergency forces" under the provisions of the Civil Defence Act. The proposition was rejected on a number of grounds, the most important being the constitutional proposition that emergency forces should be responsible to politicians but not commanded by them. The panel explored the analogy between civil and military defence structures and processes, and made the point that, for powerful constitutional reasons, the politicians should oversee, but not manage, the operations of military or civil institutions. Paramount among the reasons for this is the need to exercise constantly in the process of assembling resources and deploying them to counter hypothetical challenges. In the nature of things, elected representatives cannot be expected to acquire the professional skills appropriate to the task and should not seek direct involvement in the operational chain of command.

The civil and military defence authorities also have something in common in the manner in which their services are commissioned by the civilian authorities. A state of emergency exists when it is promulgated by a public authority invested with the appropriate statutory power. These range from the central government (in practice, the members of the Cabinet acting collectively) through regions and/or unitary authorities acting in combination according to the scope of the emergency. The authorities declaring the state of emergency are politically accountable for those members of the community whose lives are "restricted or affected by the declaration" (Civil Defence Review Panel, 1992, sec 10.009). Most events taken to be Civil Defence emergencies endanger the lives, social cohesion and economic performance of a geographically constrained section of the population. The assumption is that local organisations are in the best position to determine whether a declaration of a state of emergency should be made and the steps that should be taken to counter the emergency. Central agencies may indeed play a role in the response and recovery, but they will remain under the direction of the controller, whose knowledge of the various hazards will be honed by direct experience and by hypotheses worked out in training exercises.

There is, however, one official exception to this proposition. The motto of the capital of New Zealand is, in the fashion of these nineteenth century effusions, a Latin assertion that the city owes its preeminence to its geographical location (*supreme a situ*). Wellington was not the first capital and, if one takes the regions separately, never the favourite site for the centre of political power. It is essentially a compromise built, as it were, around the shores of a superb harbour more or less equidistant from the other major industrial and agricultural nodes. It is, by any reading of disaster information and analysis, the urban area most liable to violent events such as earthquakes, floods and storms. As a native son and having experienced two large earthquakes and a storm that destroyed our house, I feel the temptation to add a little anecdotal support for the "Close Down Wellington Movement". However, employing our rational faculties rather than our indignation, we can see Wellington as a geographical boon to all New Zealanders but compromised by exposure to highly active geological and meteorological forces.

That is why New Zealand governments have encouraged investigation of techniques to both mitigate the effects of earthquakes and incorporate the advances in public construction projects in the region. It also explains why a National Contingency Plan was approved by the Minister of Civil Defence on 7 September 1989 to mitigate the effects of what the document terms a "Major Earthquake in the Wellington Area" (Ministry of Civil Defence, 1989). The plan has now been modified by a document dealing with "Planning for Government Continuity" (Ministry of Civil Defence, 1994) to be read with the Civil Defence Act 1983.

The National Contingency Plan acknowledges a central truth about New Zealand government process. The capital of the country is located not only at the node of all major transport services but also the convergence of the principle fault systems

along which major earthquakes have occurred in the geological and historic past. The National Contingency Plan is no more than a prudent recognition of the need to deal with the strain that might distort the polity as a whole should a disastrous earthquake occur in the Wellington Region.

Clearly, the growing importance of civil defence in the complex of political responsibility stems largely from the outcome of energetic scientific and technological enquiries into earthquake and other natural phenomena and the means available to evade and counter their potential for disrupting social process. We need to examine the political process itself to see how it responds to the obligations imposed by these enquiries.

It seems reasonable to suggest that the structure of government should encourage rational and effective programmes. Reaction to the threat of earthquakes must be rooted in intelligent and sustained interaction between those acting with public authority and the ordinary citizen. With one important exception, most people seem to be generally convinced that politicians are motivated, for whatever reasons, by benevolent concern for the welfare of the citizen. (The exception may be found in irreconcilable positions taken up on the questions raised by the Treaty of Waitangi, but these do not seem to trench upon issues of public safety.) Despite robust conflict, there is effective communication between citizens and officials and every reason to expect willing cooperation.

This does not reflect some innate virtue in the citizen or society, although it is true that constitutional principles are elegantly spare. It might well be argued, indeed, that they are all too uncomplicated and deficient in clear rules to restrain the power of the political executive. Above all, there is no second tier of government capable of challenging the power flowing from the dual control of the central executive and the legislature. New Zealand is a unitary state of radical character and there is no jurisdiction extended to subordinate local authorities to challenge the centre at the ballot box and through the courts. In this respect, the New Zealand procedures differ from federal states such as India, Germany, Canada and the United States with their explicit assignment of constitutional powers and roles.

Moreover, unitary politics seems to match the uniform character of the society. There is an unsolved racial problem, of course, but in comparison with the violent antagonisms and historical injustices of other societies, there is, or has been, little reason to expect that central government action to deal with a common crisis would meet with obstruction. Until recently, New Zealand had a simple majority, first-past-the-post, single-member constituency process for the election of political representatives. Over the years, this proved to be extraordinarily stable. The leading parties commonly commanded a majority of seats in reasonably equal alternation and could form a stable government lasting at least until the next general election. Coalitions were rare.

The current Government will be the last constituted by this process, since New Zealand has adopted a proportional system of voting, which is likely to increase the number of successful factions in the legislature and lead to arrangements to sustain the majority acquired by coalition governments. At the same time, Maori are bringing pressure to bear on government to redress the effect of racial oppression. While Maori would not obstruct programmes to counter the devastation of earthquakes, they may very well be suspicious of radical constitutional departures with implications for administration of land.

On balance, it is probable that citizens accept the need for a detailed but flexible plan to allow public authority to deal with an earthquake disaster in Wellington, not only because statistics and earthquake science lead to this conclusion, but also because a large-magnitude earthquake in Wellington is likely to have a more devastating effect upon normal social and economic life than any other conceivable disaster. I have referred above to the National Contingency Plan. This indicates the direction in which official thought is moving.

Maintenance of government continuity

The studies undertaken conclude that a major earthquake in the Wellington region would cause many casualties, disrupt all reticulated services, damage all transport facilities and halt for varying times all services within the community infrastructure. From a national perspective, central government functions would be jeopardised, an international economic crisis might arise, vital national transport exchanges would be severely hampered, business and industry would be severely disrupted, tourism affected and stress would extend far beyond the boundaries of the Wellington region.

The question of government continuity is high in the order of priorities, given the unusual susceptibility of the central government infrastructure. The National Contingency Plan suggests that:

> *The preservation of the executive, legislative and judicial arms of government is critical in order to:*
>
> *1. preserve the sovereignty of the nation;*
>
> *2. demonstrate that the democratically elected government is continuing its function of governing the country; and*
>
> *3. respond at that level to the extra demands occasioned by the earthquake event.*
>
> (Ministry of Civil Defence, 1989, p. 8)

This an interesting development because it poses a question that may arise in relation to a number of capital cities as well as Wellington. To argue the propositions of the contingency plan a little further, we may accept, especially in these harsh days dominated by competitive market behaviour, that two factors will determine the speed of recovery. The first will be the ability to assess the cost arising from a major earthquake and the second to propose how this may be met by evolving a credible plan devoted to a process of recovery and, beyond recovery, expansion opportunities. It may well be sensible in a case such as Wellington's to plan for the permanent transfer of government to a new centre. The need for a temporary shift in the earthquake aftermath is raised in government planning documents in considering what is called "the severest situations" when:

> *... accommodation in Wellington will be uninhabitable for an extended period, communications will be unavailable, there will be the risk of physical danger to senior politicians and officials, and the task of responding to the event and recovering from it will be hindered rather than assisted by the continued presence of the Government.*
>
> (Ministry of Civil Defence, 1994, annex B-1, para 4)

This document proposes that the following agencies or elements of them should be required to shift to support government operations:

- Cabinet Office;
- Minister's Offices and Ministerial Services;
- Office of the Clerk of the House of Representatives;
- Parliamentary Service;
- Department of the Prime Minister and Cabinet; and
- Solicitor General.

The document makes it clear that, in the event of such a transfer, only essential activities would be contemplated while rescue operations continued. In the nature of things, however, activity would certainly expand with the exigencies of the recovery phase until the question of the permanent location of the capital arose. This, in turn, would raise the question of a rational policy response to the earthquake threat in the Wellington region.

There is no doubt that the country is lucky to have a natural meeting place near to the geographical centre of the country. It is also fortunate that a magnificent harbour supports the commercial, agricultural and manufacturing enterprise of the region and the country at large. No matter how pervasive the earthquake threat, these advantages will sustain a lively community on the shores of Cook Strait. Other commercial ventures and their employees will have to assess the risk of remaining in Wellington when the damage reports of the next large earthquake have been studied. So far as the public sector goes, the equation is different. There is no good argument for maintaining the capital in a place at risk of widespread destruction when there are viable and economically defensible alternatives. In the document "Planning for Government Continuity", it is suggested that:

> *Palmerston North or Auckland are the cities for the Government to relocate to, as they have good accommodation and communications.*
>
> (Ministry of Civil Defence, 1994, annex B-4, para 18)

Although this is intended to apply only for the duration of the emergency, it would represent an upheaval in the relationship between the government and the citizen and would only occur in extreme circumstances. At the lowest level, it might be regarded as desertion in the face of the enemy.

While it is true that the Civil Defence Plan transfers the emergency powers to officials rather than politicians, this makes less difference than appears at

first sight. Politicians rarely have executive control over the delivery of services. Their function is to determine what is to be done, provide the resources and delegate action to the responsible officials. Civil defence differs on two counts. First, it is expected to react immediately in accordance with an existing plan about which the central government will know little and understand less. The possibility of conflict between the two levels arises, where conflict would be undesirable, to put it mildly. A strong case for relocation fully argued as an option in certain cases would need to be heard through the parliamentary process and the principles incorporated in legislation. The present status of the relocation policy is not sufficiently authoritative in my opinion.

A more emphatic statement of what is needed to counter the effect of a large-scale disaster appears in the "National Contingency Plan (for a) Major Earthquake in the Wellington Area" approved on 7 September 1989 and referred to above. The line of reasoning and realistic assessment of the policy objectives provides a model for general argument about the government's obligation to the citizens and steady iteration of the doctrine through critical review along with progressive review of resources required to deal successfully with the phases of recovery. Wellington's seismic history and strategic significance might be employed as a credible "worst case" scenario. The contingency plan accepts this. This does not assume that relocation of the government is unavoidable, but, if the preservation of the government has become an issue, it seems that the destruction in Wellington would already have reached the point where that option would have to be seriously considered. The National Contingency Plan does not raise the issue of Wellington's long-term vulnerability, but this would have to be assessed as suggested above. The central location is now of marginal importance. As an administrative and commercial centre, Wellington has a substantial investment in a built environment, but the recovery phase would become a matter largely for private decision-making. A precautionary evacuation of Wellington would be impossible to argue politically or to justify economically. But one can look at shifting the government functions dispassionately as one rational solution to the exigencies of post-earthquake reconstruction. The logical centre would be Auckland, but it seems likely that the rest of the country would be uneasy at this expression of private and public oligopoly. The alternative, temporary and presumably seismically stable centre proposed by the official documents is Palmerston North, a thriving market town on a river plain with the advantage of a university and thus an eager band of potential consultants. A proposal to shift the capital to Palmerston North following a large earthquake would be an instructive and, possibly, a useful project for community planners. There is, of course, a nearby precedent complete, if not replete, with tertiary institutions and a growing reputation as a civilised place to be. Canberra has to work within a federal structure, but there seems no obvious reason why the precedent could not be adapted to a Westminster-style unitary state.

Conclusions

No doubt some of those who live outside Wellington are amused, some faintly irritated and some appalled by this cavalier shuffling of urban destinies. I dare not speak for those who own property in the city. I can only appeal to your forbearance and restate the point already made at the start.

The best information available to me suggests that Wellington is likely to experience severe earthquakes. My lay interpretation of the information appears to be confirmed by such of the scientific information as I have been able to comprehend. Sober bureaucrats charged with advising political leaders warn that extensive preparations are necessary to deal with the threat of earthquake destruction. The politicians have accepted that Wellington is sufficiently vulnerable to warrant a plan to remove key elements of the central executive from Wellington to ensure continuity of legitimate political authority following a destructive event in the Wellington region.

The contingency plans go almost, but not quite, to the point of permanent removal of the central government, depending upon the scale of destruction in Wellington. If that point were to be reached, it would be, in my opinion, irresponsible to restore the functions of government to Wellington without a penetrating analysis of the most recent information on the cost of recovery. In this process, the fearsome tragedy suffered by the people of Kobe may have much to teach the rest of the world.

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Organisation, government and legislation: Who coordinates recovery?

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A serious earthquake in Wellington will cause major and long-term damage to the city and its lifelines. There will have to be a coordinated effort to ensure that the city recovers as effectively and as efficiently as possible. There are national, regional and territorial jurisdictions and interests involved. Coordination of these interests will be a major concern of the recovery effort. Formal responsibilities for recovery coordination are defined in the Civil Defence Act 1983. Practice has evolved away from statutory procedures, and central recovery efforts predominate in current planning programmes. These are now generally coordinated through the Department of the Prime Minister and Cabinet, although their design is based on the country's recent history of rural-based, low-magnitude, low-scope impacts. At the same time, attention has focused on local government developments, such as the recovery planning process undertaken in Wellington city. Recovery should be the initial responsibility of the affected community. Central government should become involved certainly, but not as the lead actor.

Introduction

New Zealand has been spared the recent agonies that natural disaster has wrought on other countries, such as bushfires in Australia, floods in Europe, volcanic eruptions in Japan and the Philippines, or earthquakes and their consequent secondary impacts in India, USA and Japan. For the record, it should be noted that New Zealand is prone to all these natural hazard agents. That the country has not had a major natural disaster since 1931 is, to many knowledgeable observers, a surprise. Nevertheless, it is just as well. It has to be said that our current state of response and recovery planning is, in many areas, governed as much by good luck as by any deliberate intention. Central government's decision to review the coordination of disaster emergency services is the latest in a string of symptoms that points the way that the nation's counter-disaster structure requires a major overhaul. Certainly, the proficiency of New Zealand's disaster management system is not as good as it should — or could — be.

Nevertheless, our current state of preparedness reflects our relatively limited experience. Even if we include recent local events such as the earthquake in Gisborne (1993) or in the Southern Alps (1994), flooding in Kaikoura (1993) and Milford (1994), the flood-induced break of effluent mains in Kilbirnie, Wellington (1994), or the bushfires in Napier (1994) and Eastbourne, Wellington (1995), contemporary New Zealanders' experience with disaster is relatively confined in terms of three important criteria:

- the magnitude and scope of hazard impact;
- the location of impact (the majority have occurred in rural or semi-rural settings); and
- the degree of damage and disruption created by the impact agent.

What our recent past tends to hide, however, is that the effects witnessed in overseas events such as the Hanshin (Kobe) earthquake in January 1995, the Northridge earthquake in January 1994, the Guam earthquake in August 1993, the Hokkaido-nansseioki earthquake in July 1993, the Newcastle earthquake of December 1989 or the Loma Prieta earthquake in November 1989 can easily be replicated here. Six important commonalities warrant particular attention:

- they all impacted on urban settings;
- there were multiple impact sites;

- widespread property damage, injury and (in some cases) significant loss of human life resulted;
- utility lifelines were dislocated to the extent that ongoing social routines were severely disrupted;
- extensive disaster recovery operations were necessary; and
- different levels of government were involved in the recovery process.

There are two important variables in any disaster equation. Firstly, and most significantly, disaster is a local problem. On the whole, it is the local community that is impacted; hence, disaster impact and its consequences are major local issues. Secondly, disaster management requires a specific type of social crisis intervention process in which mitigation, preparedness, response and recovery are necessarily inter-jurisdictional in nature. The management of any large-scale disaster is not only an inter-organisational undertaking but, by its very nature, is also inter-governmental (Perry and Nigg, 1988). In particular, responding to and recovering from disaster requires a series of hierarchical and horizontal arrangements and responsibilities. To the extent that these different organisational and political units can agree on what needs to be done, what actions are important, who should be undertaking them, how it will be funded, what resources are to be committed to the process and who should be coordinating them, a system of disaster management can be developed. At the root of all this is coordination (Britton, 1990). While all three levels of New Zealand government — local, regional and central — are necessary for effective disaster response, the central/local connection will be the most significant in the context of a recovery process in post-earthquake Wellington city.

The reality of disaster

Disaster policy-making takes place in two political worlds. The first is that of "normal" politics, where disaster policies have low political salience and are relegated to the backwaters. The second is the "active" world of policy made after the event and that features high media interest and political desire to be seen to be doing something (May, 1988). However, the danger is that policy will be skewed towards the immediate and visible rather than perhaps the more important long-term issues. This is a distinct possibility for recovery programmes, which by their nature focus on the longer rather than the shorter term.

Recovery is a time for repair and reconstruction of the physical infrastructure following disaster. It is a process of healing for communities and their residents (LaPlante, 1988). There are, therefore, two components to recovery: the work that must be done and the process and organisation to ensure the work is done. The theme of this paper is the organisation and obligations for recovery, rather than the detail of what has to be done.

Recovery cannot be examined in isolation. Both the process and the quality of the recovery effort are likely to be affected by and respond to previous preparations for, and the response to, the emergency. The different facets of emergency management are interrelated, and the effectiveness of one affects and is affected by the others. The importance of understanding disaster pre-conditions is paramount (Britton, 1990). There is a common experience that disaster preparedness networks are complex and, as Gillespie et al. (1993) remind us, there is often a fragmented dispersion of responsibilities across a variety of agencies.

Recovery efforts must, therefore, concentrate on identifying the needs of the affected community and be informed by a vision of the ultimate size and shape of the community. This must be the primary task of the level of government responsible for the community. Local government is responsible for managing the disaster event and the recovery process. This is the interpretation most metropolitan locations have placed on the Civil Defence Act, although past practice in New Zealand has been for central government direction. As explained earlier, this divergence is partially explained by the low-magnitude, low-impact, rural-based character of recent hazard impacts in New Zealand. With this experience as a guide for developing recovery procedures, it is obvious that a major earthquake disaster in Wellington will be unprecedented and one in which past practices are unlikely to be of much assistance.

The fact that there will be more than one level of government with a legitimate interest in elements of the recovery does pose problems. Roberts (this conference), for instance, argues that in the New Zealand context, central government will be the prime mover in the recovery process. If this were to be so, different concerns from those regarded as

important by the local community are likely to be given priority. It may be that Roberts is basing his assumptions on past practices rather than current emergency management developments at local government level. When central government had a monopoly on major resources, it was more likely that it could play an influential role; this, however, is not the case in New Zealand today. Essential services, for example, are often no longer the preserve of public agencies. With this diminution, greater responsibility has fallen on local and regional governments to develop contracts with private agencies to ensure resource availability.

In Wellington's case, the problems of inter-governmental coordination may be exacerbated by its special position. As the capital city, the forum of political interests and the financial centre, it is inevitable that Wellington will attract the attention of a range of players and special interests that might not otherwise be concerned with the recovery process. It is possible that the special position will translate into special processes for recovery. That could be useful; it is more likely to be counter-productive.

Management of recovery may well involve an element of competition between levels of government for control of the process. Full local control over recovery seems likely if the local council can demonstrate that it either has the resources and processes in place or has a set of policies and procedures that have been agreed by relevant interest groups and that can be implemented without abnormal central assistance. Local government may not have full control over essential resources for the effective management of disaster recovery. However, it can, and should, have policy procedures and guidelines that can steer the recovery process through its various manifestations.

The recovery problem

The effects of a major earthquake will spread much wider than the immediate area of destruction. An earthquake in greater Wellington would directly affect:

- central government;
- regional government;
- three or four city and district governments;
- private agencies providing what many regard as essential services such as rail and telephone;
- other private businesses; and
- not least, individual citizens.

Indirect effects would spread much further. If the government decided that it needed to be relocated, albeit temporarily, at least one other city outside the immediate region would be affected (it is, however, not likely that central government would abandon the city and establish a permanent base elsewhere). If there was any evacuation or refugee problem, many other cities would be affected. Any international aid effort would involve central government as well as other cities. These issues are not central to the immediate recovery effort, but they may affect it.

The weight of informed opinion, supported by empirical evidence, seems to accept that recovery is best managed at the local level, but that there is a need for strong cooperation and coordination among and within levels of government (Hy and Waugh, 1990). It is local government that typically must finance much of the early response and relief as well as some portion of later recovery and reconstruction. The need to consider that local government's fiscal ability is underscored by research that:

> *disasters may have important long-term economic and fiscal impacts on selected communities as well as families and individuals ...*
>
> (LaPlante, 1988)

LaPlante (1988) shows that local government's response to disaster can play an important role in shaping the path of recovery at both the community and household levels. Yet local governments are often the forgotten partners in disaster recovery, a process that itself is very often neglected in favour of the apparently more "obvious" need to ensure effective impact response actions are in place.

A fully functioning emergency management system thus requires that governments possess the capability:

> *to understand (1) the total system, (2) the uses to which the products of the efforts of various professionals will be put, (3) the potential linkages between the activities of various professional specialists, and (4) the specifications for output and language which are compatible with the need and understanding of others within the total system.*
>
> (Petak, 1985, p.6)

Most states recognise these requirements, in theory at least, and have developed recovery policies to some. Most attempt to apportion responsibilities between local, regional (or state in the case of federal jurisdictions) and national levels of government so that appropriate decisions can be made by the appropriate level of government. The approach adopted depends to a large extent upon the political culture of the particular state, but the common theme is of local responsibility supported, as necessary, by higher levels of government.

US policy dealing with recovery requires all levels of government that receive federal disaster assistance to prepare a plan for averting recurrence of the loss (May and Williams, 1986). It is clear that in the US, state and local governments interpret and organise disaster policy. There is an intergovernmental bargaining model that best describes the interaction of national, state and local governments (Stratton, 1989). But state and local governments may not necessarily have the capacity to manage recovery effectively. Waugh (1990) observes that while it is clear that many states and localities do have the political, administrative and economic wherewithal to manage emergency programmes effectively, many others suffer from fiscal stress and a reluctance to become involved in wider policy activities.

Australia, in contrast, has had a tendency not to plan for disaster recovery at the national level. Recovery has been considered the preserve of state and local disaster management structures (Britton and Wettenhall, 1990). Australian authorities are now developing concepts that reject the "conventional" piecemeal approach to disaster management based on discrete and relatively independent political units acting in isolation. Instead, they are recognising the interdependence of those affected by disaster and are adopting more coordinated and internally cohesive strategies in which emergency functions are apportioned through inter-organisational consensus and cooperation between levels of government and the various emergency agencies (Britton, 1991).

These changes in practical emergency management reflect, and are reflected by, new theoretical insights into the nature of the problem. Nearly 20 years ago, Haas and others (1977) described recovery as "ordered, knowable and predictable". The central issues were, in their view, value choices that gave varying emphasis to the early return to normalcy, the reduction of future vulnerability, or to opportunities for improved efficiency, equity and amenity. If Haas is correct, then the problems are largely technocratic and solvable by the application of technocratic solutions.

But other researchers have determined that recovery is likely to be much more complex than this sanguine view. Rubin et al. (1985, cited in Bolin, 1994) found examples of confusing and simultaneous activity. Quarantelli (1989, cited in Bolin, 1994) expands this and argues that recovery is a heterogeneous and conflictual process. Recovery is a complex social process, dependent both on the material conditions rendered by the disaster and social forces existing in the community both before and after the disaster.

Recovery relies, it seems, on more than legislation and aid. Political and cultural conflicts over recovery plans and a lack of organisational capacity at the local level can severely inhibit the pace of reconstruction of earthquakes with regional impacts. Into this mix must be added the emergent local recovery effort: it should not be forgotten that recovery and reconstruction actions can be dominated by the volunteer effort if the victim population perceive a lack of organised response (Wenger, 1991).

Bolin (1994) described the different interests involved in recovery following an earthquake in Whittier, east of Los Angeles (population 75,000) and their sometimes conflicting objectives. The experience there was that many interests are involved in recovery. Individual victims were interested in rebuilding their homes and getting over the emotional disturbance of the earthquake. Business interests and the city government viewed the earthquake as an opportunity for the redevelopment and "revitalisation" of the uptown area, while other groups moved almost immediately to prevent the razing of buildings of significant historic interest.

A key feature of the recovery in Whittier was that the speed of physical recovery was subordinated to the time needed for comprehensive planning of the style, character and land use patterns of the uptown area. This trade-off of speed against planning was a specific result of the systems and requirements of government in Whittier and, not incidentally, of the level of pre-impact planning for disaster that had been undertaken by the local government. The pace of reconstruction in Whittier was affected by a number of factors. Key elements included:

- the lack of long-range planning prior to the earthquake;
- the time necessary to secure funding from government sources to pay for the reconstruction;
- the time required to develop a comprehensive, integrated master-plan for the city;
- a lengthy process to get building permits processed and approved;
- litigation by historic and preservation groups to prevent the demolition of buildings;
- shortage of staff in city government, which slowed building inspections and review of reconstruction plans;
- lawsuits against the city by businesses claiming that the city caused them losses; and
- a shortage of builders and materials.

By contrast, Geipel (1982) described the 1976 Friuli earthquake. It affected a population of some 500,000 over an area of 4800 km^2. The main concern for the residents was to begin reconstruction forthwith. They were not so interested in long-range planning by any government at any level because that could leave them in more or less permanent temporary accommodation. The Friuli case emphasised the importance of taking a regional — even an inter-regional — perspective. Earthquakes, especially, do not necessarily strike a single point. The Friuli earthquake affected a wide area. Decision makers had to solve problems of social policy with all the implications for equity.

Haas et al. (1977) discuss the basic public policy issues:

- Should normal as opposed to extraordinary decision making mechanisms be used?
- Should there be changes in land use?
- Should a concentrated effort be made to make the city more efficient and more attractive?
- Should there be compensation or special financial assistance for private property loss?
- How should personal or family problems be handled?
- How should increased local expenditure be financed?

It is not particularly difficult to recognise the issues. What is difficult is to get decisions made within a reasonable time-frame. For that reason, the more that recovery planning can be done in advance, even if only in principle, the more efficient the process is likely to be.

There are difficult questions for policy makers as they determine the appropriate roles for different levels of government and make decisions that will benefit some communities and individuals and act to the detriment of others. Petak (1985) describes a situation in which:

> *projects intended to provide an engineered reduction in the future magnitude of hazardous events may involve greater economic cost than calculable monetary benefits. They may extend benefits to one group but impose costs on still other groups. Regulatory policies targeted on reducing the vulnerability of buildings and community infrastructure ... may similarly result in amortized costs which exceed the economically calculable future streams of benefits resulting from the regulations.*

Mushkatel and Weschler (1985) show that recovery has both a technical and political dimension in which the public policy processes of formulating, adopting, implementing and evaluating policy are linked with the emergency management processes, in this case of recovery. They describe a matrix of inter-governmental processes in which a major task is to encourage governments at all levels to join in integrating the emergency management system into the overall inter-governmental system.

Extending this, Parker (1992) identifies three principal sets of influences: institutional arrangements and policies, the political economy and the technological environment. Institutional arrangements include legislation, organisational arrangements, attitudes and sub-cultures, financial arrangements and provision of the infrastructure behind the process (Parker, 1992). They both reflect and generate policies. They all determine how agencies respond to particular tasks. Institutions and policies are designed to make effective hazard management possible, but institutional inadequacies impede the process and may act in a negative or disintegrative manner. The basic intent of policies emphasising government assistance in the post-disaster period is to lift the excess burden of environmental risk from

the shoulders of the individuals and communities that have assumed it and spread the risk more or less evenly over the entire taxpaying population (Wright and Rossi, 1981; NZ Government, 1987).

The national system

As with most jurisdictions, New Zealand has defined its emergency management procedures in legislation and defined the relative roles and responsibilities of the different levels of government. The legislation has, however, been overtaken by practical developments to the extent that there is some scope for confusion as different actors work either from the authority of the legislation or from the practical policies developed over the last decade.

The Civil Defence Act 1983 defines civil defence (i.e. emergency management), in summary, as those measures "to prevent, reduce, or overcome the effects" of a range of natural and technological hazards. The Ministry of Civil Defence is established, and regional councils and territorial (i.e. local) authorities are required to plan for emergency management. A state of civil defence emergency may be declared by any of the three levels of government, depending on circumstances pertaining at the time. Such a declaration makes available a range of emergency powers to those authorities.

If a state of civil defence emergency is in force and the Minister of Civil Defence (normally the Minister of Internal Affairs) is satisfied that the appropriate level of regional or territorial government will not be able to coordinate the resources necessary to restore services, amenities and habitation, then a disaster recovery coordinator may be appointed using the authority of S69 of the Civil Defence Act. The coordinator has responsibility to the Civil Defence Commissioner (an employee of the Ministry of Civil Defence) for the direction and coordination of the use of all resources and services made available by a range of agencies, and he may exercise all the powers and duties of a regional or local (civil defence) controller.

It is necessary to note that there is no test of "satisfaction" described, but presumably it would include questions such as the degree of prior preparation exercised by the local authority, whether there was a viable emergency plan in place and whether the local authorities requested assistance. It is also probable that "satisfaction" could be determined by the amount, or source, of dissatisfaction from segments of the impacted community, especially if it was deemed that relief and/or recovery measures are not "progressing fast enough". This perceived problem is one of the most invidious to overcome and, ironically, is one of the most likely to occur. It is certainly the most difficult to plan around, mainly because popular judgment tends to go against the emergency response system once post-impact rescue and relief phases are over. There is a pervading view that disaster recovery should be achieved quickly. When it is found to be otherwise, public disquiet sets in. As dissatisfaction grows, so does the compulsion of higher levels of government to step in and "remedy" the situation.

Given a strict reading of the Act, a disaster recovery coordinator has a focus purely on restoring services or amenities, rather than on the wider recovery matters that would be necessary given our initial definition of recovery. A coordinator was appointed in 1987 following Cyclone Bola in the sparsely populated East Coast area of the North Island. His brief in that case was to coordinate all government activity and assistance not directly related to the immediate response to the emergency and to the preservation of life or property. In practice, there is a fine line between these functions and between questions of the immediate restoration of services and the longer-term size and shape of the community.

A commissioner for disaster recovery may be appointed under the authority of S692 of the Local Government Act 1974. This commissioner, too, has a focus on the immediate needs of the community rather than on wider recovery matters dealing with the long-term needs of the community.

The government has, since 1987, had a formal policy relating to recovery. This is the recovery plan for natural disasters and emergencies administered by the Department of the Prime Minister and Cabinet (DPMC, 1987). The recovery plan has been amended several times since 1987 and has been endorsed as the continuing basis of policy actions by successive governments since 1987. It has a wider scope for recovery than the legislation. It is concerned with longer-term issues rather than the day-to-day measures that may be needed to cope with the effects of the disaster, and it is primarily concerned with defining and limiting central government's liability to local communities in case of disaster.

The recovery plan gives direct responsibility for recovery matters to the affected community. In essence, then, its philosophy is that of an at-call backstop, designed to supplement local efforts but not to replace them. Hence, current practice is moving to disaster recovery being a local responsibility. However, should a local government not be able to follow through its post-impact obligations, then central government will do so.

The recovery plan also describes a process for appointing a disaster recovery coordinator, who in this case is a non-statutory authority reporting to the Department of the Prime Minister and Cabinet, and who acts as the Government's single point of contact in the affected area. Cooperation between this appointee and the community is not coerced through his statutory powers, but is achieved because, unless cooperation and coordination occur, central government assistance will be harder to get in a wide range of discretionary areas.

There are, thus, two central departments with emergency management responsibilities: the Department of Prime Minister and Cabinet, and the Ministry of Civil Defence. They have a clear understanding of their respective roles, of the ways that legislation and policy differ, and of the backstop role of central recovery assistance.

Within the context of comprehensive emergency management, however, the central agencies may not be central to the process. The city or district should attempt to solve its own problems and call in assistance when and only when that is required. Whether this will be the case in practice, though, is likely to be because of personal rather than systemic factors. That is, the outcomes rely on the individuals involved and the degree of interest they take rather than on formal policies and processes. Hence, some scope exists for conflict between central government players who wish to exercise the letter of the legislation and those who wish to apply "case law" in the form of policy as it is expressed in the recovery plan.

At the same time, Sections 69-72 of the current Civil Defence Act and Part 2 of the National Civil Defence Plan enable steps to be taken by a local government to assist community recovery. These steps include the appointment of a person to coordinate short- and long-term recovery activities, such as accommodation, building reconstruction and economic restoration. If local government chooses this option, the person appointed to undertake these tasks is known as a disaster recovery manager. Some local governments, and Wellington city is one, have used this opening to develop and implement disaster recovery procedures.

While the options are available to local government, the point to note is that, should the impact community not have sufficient pre-planning contingencies that provide an appropriate framework for recovery, central government will intervene. If central politicians are not convinced that a viable recovery management process exists, they will attempt to establish their own. If Wellington is to maintain control over its own destiny, it needs to demonstrate that it has a plan for recovery, one that takes account of the interests of national actors, that it is capable of managing the recovery process in partnership with the other units of government in the region, and that it does not have to demand an excessive level of assistance from central government.

The Wellington system

Wellington has gone a considerable way to achieving all of these requirements (see for instance, Scott, this conference). The recovery problem affects the different levels of government according to what is affected. Five major developments underscore these achievements. The Wellington Earthquake Lifelines Group (WELG), established in 1993, which operates under the auspices of the Wellington Regional Council, was set up to coordinate the efforts to reduce the vulnerability of the capital's lifelines (WELG, 1993, 1994). It comprises representatives of all local governments in the Wellington metropolitan area, all major utility and transportation companies and authorities, research organisations and consulting engineers.

The need for WELG becomes apparent when the relationship between ownership and infrastructure is made clear. The main road system is the responsibility of a national public agency. Other infrastructural utilities are privately owned. Central government will be concerned to ensure that all these parts of the infrastructure are restored as soon as practicable. Regional infrastructures are the responsibility of the regional council. The water system is an example. Wellington city is, in turn, responsible for its own amenities.

The complex of inter-relationships is well understood within the region and is represented by the

second major development. In 1994, the Wellington Basin Forum was established. Proposed and approved by the chief executives of Hutt City Council, Kapiti District Council, Porirua City Council, Upper Hutt City Council, Wellington City Council and Wellington Regional Council, the forum is an ad hoc policy- and decision-making group of senior managers and emergency management officers.

The reason for establishing the forum was to recognise that a large-scale disaster will affect several territorial authorities, and hence preparedness and response management actions need to be coordinated between them. One of its objectives is to achieve standardisation in essential emergency management activities. Through the forum, a set of memoranda of understanding (MOU) have been developed between members, predicated on "establishing a common agreement on comprehensive emergency management practices and procedures" for the territorial and regional authorities (MOU, 1994).

For the purposes of emergency management, the forum aims to transcend the political boundaries of local governments, creating instead a "supra-city" within which counter-disaster resources will be pooled rather than competed for. For recovery purposes, the regional council agrees to support and enhance territorial authorities in their post-impact needs and to allocate and prioritise resources not available to territorial authorities. For their part, territorial authorities have agreed to identify and develop a disaster recovery process for the local area and integrate and coordinate post-disaster recovery needs with each other (MOU, 1994).

The third development is the production of a draft recovery planning guide for Wellington city (WCC, 1994a). The guide describes the city's disaster recovery philosophy, its organisation for recovery and responsibilities for a number of disaster recovery functions. The important philosophical basis underlying the guide is the recognition that recovery occurs most effectively when the community is fully involved in its own recovery and when recovery issues have been debated and considered prior to impact (WCC, 1994a).

The fourth major initiative the city council has undertaken has been the development of a council emergency strategic plan to consider the critical issues related to disaster emergency planning (WCC, 1994b). For recovery, the planning guide discusses aspects of administrative continuity, the refocusing of the council's strategic direction and recovery liaison. These sections of the guide discuss the philosophy underlying the council's approach and establish responsibilities for action. The council emergency strategic plan also designates a senior council officer to be the disaster recovery manager.

The final significant initiative undertaken by Wellington city is the appointment of a full-time emergency management officer to the position of recovery support coordinator. In the New Zealand context, this is a unique post. No other local government, or indeed, no other level of government, has a permanent position directed solely to aspects of disaster recovery. The recovery support coordinator liaises with both regional and central government agencies, as well as coordinating a multiplicity of community support agencies through the disaster recovery planning guide.

The Wellington system of overall emergency management is described in Britton (1994) and shown diagrammatically in Figure 1. Clearly, Wellington has developed its own set of processes to ensure recovery and it has established institutional links inside its own organisation and external links with some of the other levels of government that have a legitimate interest in the city's recovery.

The question is, however, are these developments enough? Are they sufficient for central government to be relaxed, or "satisfied", that Wellington is able to manage its own earthquake-induced disaster recovery? Are these initiatives acceptable for Wellington city to demonstrate to central government that it has a set of policies that have been agreed by relevant interest groups and that can be implemented without abnormal central government assistance? Will these developments be enough to deter central government from wanting to be the "prime mover" in the recovery process? These are questions that only central government can answer, and that answer will probably only be forthcoming after the event.

If central government did assume the dominant leader role in the recovery process of a post-earthquake Wellington, especially if it decides to do so in a way that goes against the intentions of Wellington City Council or its ratepayers, it might wish to take heed of lessons learned by the Australian Federal Government following the disaster wrought on

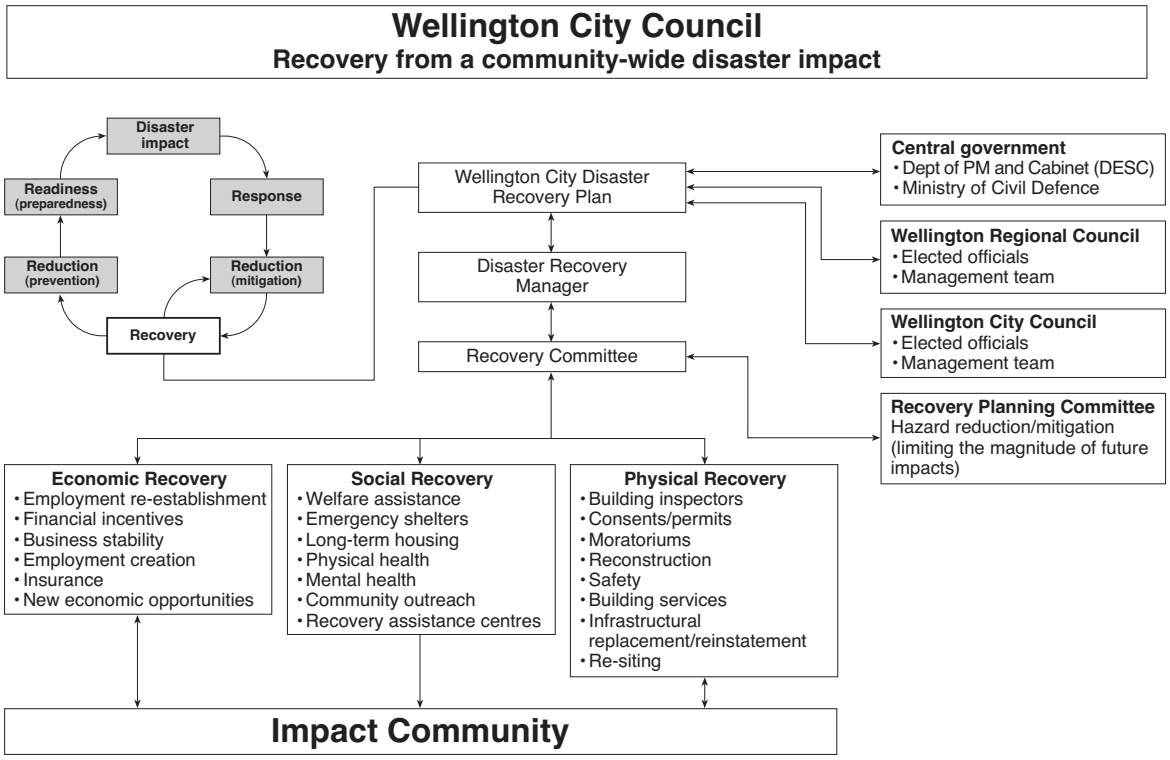

Figure 1: The Wellington system of emergency management (source: Britton, 1994). There is also two-way planning input from the Wellington Basin Forum.

Darwin by tropical Cyclone Tracy, in 1974 (see Britton, 1980; King, 1979).

Cyclone Tracy virtually obliterated Darwin on Christmas Eve 1974. Five days after the disaster, the Australian Prime Minister announced to the Darwin people that it would rebuild the city. A statutory authority, the Darwin Reconstruction Committee (DRC), was established by the Federal Government with a five-year term to plan, coordinate and undertake reconstruction of the city. An associated aim was to create a safer city from the perspective of the cyclone threat. Its area of authority was a 40 kilometre radius from the Darwin Post Office. While enabling legislation was being created, an interim Darwin reconstruction committee (IDRC) was formed.

The IDRC met on 6 January, 1975 and recommended that a new planning scheme be prepared to provide a basis for Darwin's rebuilding. The report contained, by implication rather than in detail, considerable potential for land-use change, and it appeared, at least to Darwin's residents, that the methods by which changes were to be implemented were quite definite. No public consultation took place in the design of the recovery plan. However, the desirability for public participation was stressed by the Cities Commission, and provisions for participation were incorporated in the Darwin Reconstruction Act 1975. By this time, however, public opposition to "outsiders" had set in and the DRC, when it came into being, encountered bitter opposition from residents, the Darwin City Council, and the Northern Territory Legislative Assembly.

While one of the aims of the DRC was to implement hazard mitigation measures as well as to rebuild the city, opposition to the committee was so great that few of the proposed land-use changes have been implemented and many had to be abandoned. Central government's intentions were well-meaning, but its capacity to act and its understanding of residents' desires were limited. That is not a necessary outcome of central intervention. It is a possible one.

Conclusions

Recovery is a link in a chain of events, which can be helped by carefully planned policy at each stage. At different points throughout the emergency management cycle, critical decisions are made, whether by design or default, that have important consequences

for the future of communities and the citizens who populate them. It seems that recovery is most likely to be successful when the local community has control over the speed and direction of the recovery effort.

There are specific processes in place within Wellington City Council and between the council and its neighbouring units of local government to ensure that resources for recovery can be made available and that a sensible set of policies for recovery can be developed.

The emergency management planning and preparation tasks undertaken by Wellington city have been sufficient to satisfy the responsible central government departments that their tasks in a post-impact "maximum credible earthquake" disaster will be those that support the programmes currently being set in train by the city, rather than tasks to compete with or replace city initiatives. While no recovery programme will ever be without problems, conflict, competition and upheaval, a framework has been established and a dialogue started with all essential players, including central government. This will enable the rebuilding of Wellington to take place in an environment of cooperation and coordination.

Recovery is a long-term process, all the more so because it is dependent upon pre-impact planning. The fact that Wellington city, with the Wellington region, has started this process implies that it is in a much better position to be in control of its own destiny.

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Panel discussion

Organisation, government and legislation

Chair: Fran Wilde, Mayor of Wellington
Panel: Neil Britton, Chief Advisor, Wellington City Council Emergency Management Office
Pat Helm, Policy Advisor, Department of the Prime Minister and Cabinet
Margaret Laird, Civil Defence Manager, Wellington Regional Council
Graham Miller, Civil Defence Controller, Wellington Regional Council
Paul Officer, Director, Ministry of Civil Defence
John Roberts, Emeritus Professor, Victoria University of Wellington
Jim Rolfe, Political Scientist, Victoria University of Wellington

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John Norton (Hutt City Council and Wellington Earthquake Lifelines Group) said that for recovery to be effective, it must be planned for. He noted that the Wellington Earthquake Lifelines Group was almost a voluntary group and that the Wellington Basin Forum had little in the way of physical resources or institutional commitment to support it. The support of both these initiatives is at present very nominal. He noted that the Wellington Earthquake Lifelines Group has had an impact nationally in bringing attention to the importance of lifelines, not just for earthquakes, but for other natural hazards as well. He said that it needs commitment to provide for the appropriate resources and expenditure to make these initiatives work. *Graham Miller* said that it was certainly recognised that companies and their staff had put a lot of time and effort into the Wellington Earthquake Lifelines Group and made a very important contribution to better understanding of lifelines. He agreed that more financial support was needed, backed up by political support. *Neil Britton* remarked that both those initiatives were relatively recent ones, but now that they had a "track record" in being effective, the next phase is to consolidate their credibility.

Ruth Norman (Auckland Regional Council) asked what planning had been done on a serious basis into the possible relocation of central government following a major earthquake. *Pat Helm* said that this had been under consideration for a long time and schemes were in operation specifying the roles of agencies and planning relocation. For example, following an earthquake disaster in Wellington, the Reserve Bank would immediately transfer its operations to Auckland and would have an emergency team fly in from Australia. This has all been rehearsed. He was not convinced that relocation involving entire government departments should happen automatically. Many of the buildings they occupy are on relatively stable ground that is not expected to experience liquefaction and severe ground shaking. The necessity for the government to move would have to be decided at the time and there would be negative aspects of a loss in confidence if a move took place. *Paul Officer* noted that the expression "continuity of government" was used deliberately rather than "relocation" and government politicians were extremely unlikely to want to walk away from Wellington. *Jim Rolfe* agreed, but thought it was necessary to have designated government officers who could go to Palmerston North to operate from there if necessary.

Ruth Norman asked whether the expertise of the Wellington Earthquake Lifelines Group included land-use planners. *Margaret Laird* passed the question to *David Brunsdon* (Project Manager) in the audience, who said that the group is made up of engineers and utility managers from the major providers of lifeline services. It included scientists, but no planners. However, they did liaise closely with planners. Their principal role was to promote awareness of issues related to security of lifelines and to encourage co-ordination. The group sees its role at the moment very much in the pre-earthquake context, but later could consider post-earthquake involvement.

Heather Smith (Waitakere City Council) said that her council has signed memoranda of understanding with adjacent councils to ensure that there is no competition for resources after a natural disaster. She asked if there were similar memoranda in Wellington, but on a larger scale. *Neil Britton* said that Wellington City Council had agreements with

three adjacent councils, including both the response and recovery phases. The agreements are for co-ordination and mutual assistance. He said that it had been a step-by-step process that required development of common understanding among the local authorities. Eventually, the Wellington Basin Forum may consider bringing in central government as well as other local authorities. A large earthquake would affect all of the cities in the Wellington Basin and a mutual problem warranted mutual co-operation. *Paul Officer* said that the present legislation, with all its limitations, does allow territorial local authorities to develop relationships with others and combine to do things for themselves. He said that it is a "playground for lateral thinking" and commended what had been done in Wellington. The worst thing that could happen is that people will expect those organisations to be able to do things after the disaster and then find out that they cannot deliver on the day.

David Greig (Auckland Regional Council) spoke of the integration of emergency planning that had recently appeared under the threat of a water crisis in Auckland, the magnitude of which could have been "horrendous". The Auckland Chamber of Commerce and many industries had started to develop disaster management plans. He asked about the role of the private sector in Wellington. *Neil Britton* agreed that the private sector must be involved. One of the strands in Wellington City is the development of a draft Wellington Recovery Programme and he has been in contact with 85 organisations about this. A member of his staff, *Rachel Scott*, added that it involved all sectors of society needing to understand both their own roles and those of others following a natural disaster. For example, Income Support Services will have to continue functioning.

George Walker (Alexander Howden Reinsurance) asked if there was a clearly defined delegation of powers following a major earthquake or were people going to sit down in committees when the disaster happened. *Pat Helm* replied that delegation depends entirely on the scale of the event, but it would not be a long process to resolve this at the time. The four levels of delegation are:

- those that can be handled by the territorial local authority;
- those that require the involvement of central government;
- the Governor General's power to become involved in a national disaster; and
- the Domestic and External Security Committee (DESC) system, involving all departments needed, which comes into operation in disasters, wars, terrorism, etc.

In the last few years, there have been 20 major flood events requiring approvals to be signed, and the response time was within an hour or so. Last year, of ten civil defence emergencies, two had co-ordinators appointed, one of them under the Civil Defence Act and the other under the DESC system.

John Lamb (Canterbury Regional Council and Christchurch Lifelines Group) said he was pleased at the publicity given at the conference so far to the Wellington Earthquake Lifelines Group. However, he said that what was needed was not political support, but resources. The Christchurch group had been called an engineering group to limit its scope. *Fran Wilde* replied that providing resources was a real problem because there was pressure on local authorities to spend less and disaster recovery is seen as being a long way into the future. She considered that awareness was more acute at local government level and there needed to be public education to create pressure on central government. *John Roberts* said that it was a test of a mature society to constantly test assumptions and "contemplate the uncontemplatable". The disposition is there, but what is required is a "galvanising spark" to carry it forward on the basis of the scientific certainty that this earthquake will eventually happen. What might be a reasonable response to this disaster required a rational, well-considered approach.

Ian McLean (Earthquake Commission) asserted that an answer still had not been given as to who would have responsibility for setting priorities following the earthquake disaster that is the scenario for this conference. *Paul Officer* said that on the scale of this scenario, it would have to be central government because no government could walk away from a disaster of this magnitude, but of course local government would also be involved. *Pat Helm* noted that he would not envisage central government cutting across local government responsibilities because they would not have a knowledge of local issues. Central government would simply want to ascertain that local authorities were handling the situation and were appointing people as recovery managers who were competent to do their jobs.

Margaret Laird pointed out that the existing Act was drafted over a decade ago, in 1983, and based on assumptions that no longer exist. She said that the fundamental issue of where responsibilities lie had still to be addressed. Ultimately, there is a need for sound legislative measures to work under. However, the issue was being reviewed and comments were welcome. *Paul Officer* agreed with Pat Helm about the relative responsibilities of central and local government. He said that the relationship between them is critically important, but it is not possible to predetermine all the actions taken because scenario A would be different from scenario B. Flexibility is needed, depending on the circumstances, and he noted the interesting lessons from the Kobe earthquake about the three levels of government there and their relationships in carrying out tasks. He said that because communications have been established between the various organisations involved in Wellington, they could now work through scenarios in advance of an earthquake.

David Hopkins (Kingston Morrison and Wellington Lifelines Group) said that one important issue not raised so far is the spectacular devolution of assets that used to be owned by central and local government over the last ten years. He wondered whether present planning was taking this into account.

Rebuild?
Where?

Urban relocation after earthquakes: Why do cities stay where they are no matter how many times they are damaged?

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This paper examines the concept of urban relocation after earthquakes by developing a typology of post-earthquake reconstruction and relocation that examines alternative forms of the phenomenon. The range of factors that have historically been shown to influence the outcome of reconstruction and relocation decisions after urban earthquakes are presented, and their effects on outcomes are addressed. These factors include cultural values, pre-event planning, knowledge of seismic risk and resources. The documented human impacts of relocation after disaster are discussed in an attempt to explore relocation consequences that extend beyond risk reduction. Finally, the conclusion is made that planning for urban relocation and reconstruction after future urban earthquake disasters is a key to the future effective use of these risk reduction mitigations.

Introduction

Ancient, medieval and contemporary history are filled with examples of major urban earthquakes. A repeated observation after these disasters is that damaged cities are almost always rebuilt on the same sites rather than relocated to safer territory. This choice has so often been selected throughout human history that it would be difficult to argue with the supposition that this response to earthquake disaster may be a universal element of the human character found in urban centres. It transcends all of recorded time, cuts across all of the physical places with an earthquake hazard that have ever been available for human habitation and has occurred despite the rich variation in the human cultures that have constructed urban centres and cities.

Urban areas do more than reconstruct themselves on the same sites after earthquake disasters. Urban reconstruction seems typically driven by human interests in resurrecting cultural patterns rather than physical urban elements. Cities typically reconstruct themselves in ways that are consistent with their image of their pre-earthquake cultural and social character. Even in modern times and in societies where strong external policies and regulations would redirect the character and priorities of local urban reconstruction, human settlements exert a strong preference for reconstruction that is in line with pre-quake cultural priorities, e.g. rebuilding city-centre fountains and churches fundamental to reinstating local culture and patterns of human interaction take on much higher priority than structures less central to the reinstatement of local culture and familiar patterns of human interaction. In this way, even the most casual observer of urban reconstruction after earthquakes would conclude that quakes do not tend to significantly alter the basic cultural character of cities.

The purpose of this paper is to examine the concept of urban relocation after earthquakes. To do so effectively, the paper also explores urban reconstruction as the most often selected relocation alternative. The paper explores three general issues. Firstly, a typology of post-earthquake reconstruction/relocation is developed that examines alternative forms of the phenomenon. Secondly, the range of factors that have historically been shown to influence the outcome of reconstruction/relocation decisions after urban earthquakes are presented, and their effects on outcomes are addressed. Thirdly, the documented human impacts of relocation after disaster are discussed in an attempt to explore relocation consequences that extend beyond risk reduction. Finally, a few general conclusions are drawn, based on the existing evidence, to inform planning for urban relocation and/or reconstruction after future urban earthquake disasters.

A reconstruction/relocation typology

The relocation of a city after an earthquake is not a simple concept. Relocation can be a varied phenomenon that ranges across very different activities, for example, moving the city to a new site and altering or moving different pre-quake activities to new locations within the city's boundaries, to recon-

structing the city as and where it was before the earthquake.

Relocation to a new site

History provides a few rare examples of cases in which a city impacted by an earthquake or its secondary associated hazards, e.g. a tsunami, has totally abandoned its pre-disaster location. Reconstruction of the city took place on a new and different site thought to be less vulnerable to future disasters.

One example is the city of Valdez, Alaska, and its relocation after the Good Friday, 27 March 1964 earthquake. That earthquake is now estimated to have been 9.3 in magnitude and the largest to have occurred in the United States in recorded history. The population of the coastal community of Valdez was around 1000 in 1964. The earthquake caused a massive underwater earthslide to occur on Valdez's coastline. The slide induced large waves that destroyed the city's commercial and port facilities.

Earth scientists were quick to conclude that Valdez occupied an extraordinarily hazardous site that was subject to future sliding, ground cracking and sea wave flooding. A reconstruction commission established by the federal government determined that the city should be relocated to a new site rather than reconstructed on its hazardous coastline. The commission was able to exercise great control over the sentiments of local residents, who were in favour of rebuilding their community on its existing site. The commission gave the citizens of Valdez a simple choice. They could relocate to the new site of Valdez with most of the associated cost borne by the federal government, or they could rebuild on the old site without any financial aid from government. The relocation of Valdez and its residents to its new site was completed a little over three years after the earthquake. The old site was cleared.

Intra-urban relocation

A much more frequently chosen relocation activity after major urban earthquakes is the partial reorganisation of an existing city to take variation in risk within the city's boundaries into account. For example, certain types of activities may be excluded from higher-risk districts that are designated for open space or low population density uses. Intra-urban relocation requires changes in pre-disaster land use, and in many ways it is not unlike any major urban development project.

Although intra-urban relocation is both more frequent after large disasters than full urban relocation to a new site, it is hardly free of controversy nor easily implemented. It is an option that has been chosen after more than earthquake disasters, e.g. floods are sometimes followed by significant changes in local land-use patterns. Two urban communities provide examples of the use of intra-urban relocation in response to the earthquake hazard.

The Spitak earthquake was in the 6.5 to 7.0 range and occurred on 7 December, 1988 in the Armenian Soviet Socialist Republic. The three largest cities to experience heavy damage during the earthquake and its aftershocks were Spitak, Kirovan and Leninakan. Leninakan had a population of about 250,000 people before the earthquake. Over half of the buildings in Leninakan either collapsed or had to be demolished. A central planning committee for reconstruction was established and staffed by members of central government agencies based in Moscow. It was determined that residences would not be reconstructed in the pre-earthquake city cell. Replacement housing was reconstructed on the rural fringe of the city in an area thought to be more seismically safe.

The city of San Bernardino, California, provides another example of intra-urban relocation because of the earthquake hazard. San Bernardino's example is particularly interesting because it adopted intra-urban relocation before, rather than after, an earthquake. It was determined in the 1970s that San Bernardino had a unique vulnerability to earthquakes. The city is located in southern California's inland desert. It had altered its water table to provide water for city services and growth, which made the southern half of the city particularly vulnerable to liquefaction in future earthquakes. One of the fastest growing parts of the state, the city chose to zone its southern section out of high-density use to limit its vulnerability in future earthquakes.

Reconstruction

The most frequent option to occur regarding post-earthquake relocation is no relocation at all. This includes the reconstruction of public and private buildings damaged in an earthquake on their original sites and the permanent repair of individual buildings. General reconstruction typically restores the identity of the city by reconstructing and replacing what was lost in the earthquake, but this need not always be the case.

The Whittier Narrows earthquake occurred on 1 October, 1987 in southern California. The quake and its aftershocks damaged some 10,500 residences and businesses in the Los Angeles metropolitan area, and some 12,000 persons were displaced from their housing as a consequence. In Whittier, as in most US disasters, individual victims were responsible for securing their own recovery aid, finding their own contractors or rebuilding their homes themselves, and managing their own recovery. Reconstruction was the order of the day as both businesses and homeowners sought to rebuild the dwellings damaged by the earthquake. But it went beyond simply restoring buildings. Land-use changes were made that did not alter future risk, but enabled some to gain financially. Apartment and multi-family buildings were allowed to encroach into pre-quake areas of single-family dwellings.

Factors that influence relocation and reconstruction

A major purpose of social scientific investigations of post-earthquake relocation has been to identify factors that play a significant role in determining relocations and reconstruction decisions. Relatively speaking, few studies exist on the topic. Nevertheless, existing research provides a compelling case for the conclusion that the following factors have and may continue to play major roles in directing post-earthquake urban relocation and reconstruction decisions. Unfortunately, it is difficult and perhaps impossible to suggest the likely relative weights of these factors on influencing relocation/reconstruction outcomes.

Cultural values

All human communities and societies have culture, that is beliefs, ideals and customs that all their members share and that make one society different from another. Values are the beliefs, attitudes and the expectations of conduct by which a society lives. Ideas of territory, land ownership, tenure, inheritance and many other cultural factors are ingrained in local societies. Cultural values have profound bearing on the ways that dwellings and human settlements are designed, built, used and passed on to subsequent generations. They also influence attitudes on land use, settlement and building, and they certainly influence relocation and reconstruction preferences after urban earthquakes.

Culture influences the acceptance of relocating earthquake-impacted communities in several different ways. Firstly, culture bonds people symbolically to their city, and this stands as a general all-encompassing constraint to relocation after earthquakes. Consequently, the level of quake-imposed destruction to the urban environment bears direct impact on the willingness of people to abandon the site of their pre-quake city. Willingness to leave is much lower when damage is low. The viability of wholesale relocation after earthquakes is typically low in much of the developed world, since rarely, if ever, is quake damage more than scattered and intermittent in a city.

Culture also impacts the acceptability of new cities at new sites when those sites offer opportunities consistent with pre-quake cultural patterns, for example, being close to roads, water resources, local markets and jobs, and when the new community conforms to the “organic” pattern of the settlement that is being abandoned. For example, new communities characterised by physical grid patterns find residents who are quick to build walls, plant trees and use other adaptations to alter the design of post-disaster settlements to resemble their pre-disaster communities.

Pre-event planning

Recent investigations provide a strong case for the influential role of pre-event planning in directing post-earthquake relocation and reconstruction. The post-earthquake environment is one in which many problems must be solved in a hurry, and the consequence is often that post-earthquake reconstruction and relocation practices are impacted by the need to move quickly. The priorities of disaster recovery to deal with the immediate needs for factors including safety, shelter, food and water often have long-term implications. For example, temporary housing located on the site of the disaster turns into permanent housing in poorer communities; in wealthier areas it most often results in the erection of supportive infrastructure that directly influences reconstruction patterns and constrains the option of relocation.

Information. Pre-earthquake planning for post-disaster relocation and reconstruction can dramatically reduce the unintended impacts of immediate disaster response actions on post-disaster decisions. But informed pre-event planning demands information including:

- the characteristics of the hazards and the geographic areas likely to be impacted;
- a demographic analysis of the population's size, composition and distribution;
- data on the local economy;
- the resources likely to be available in the post-earthquake environment;
- knowledge of the powers, programmes and responsibilities of local, state and central governments;
- existing land-use patterns and building stock characteristics and location; and
- an inventory of local infrastructure, for example, water, power, communication and transportation lifelines.

Organisation. Even when city governments have the authority needed to address post-earthquake relocation and reconstruction issues and strong leadership inclined to use those powers, the post-earthquake desire to return to normal as quickly as is possible often results in relaxing restrictions on reconstruction rather than increasing them. Pre-event planning must, therefore, provide for reconstruction and relocation organisations in anticipation of probable future disasters. An official rebuilding and restoration team in-place immediately after a major earthquake greatly enhances reconstruction and relocation decision making. Pre-event planning should provide the team with adequate staff and ability to hire them, a well-defined role, appropriate authority and power, and guidelines.

Procedures. The political processes that must be followed in making decisions about reconstruction after urban earthquakes tend to consume time and delay reconstruction decision making. A typical decision making sequence can include making a reconstruction proposal, discussion, public review, appeals, a public referendum and so on. Using existing non-earthquake related procedures in the post-earthquake environment does more than delay decisions. It also constrains the use of relocation as a reconstruction option, since it is typically based on a building-by-building decision making model. Existing procedures for construction decision making obviously should be streamlined after an earthquake. More importantly, pre-earthquake plans for changes in post-earthquake reconstruction decision making procedures could enhance the use of the relocation option if they incorporate a vision of risk reduction through altered land use patterns after earthquakes.

Damage evaluation. A major issue that impacts reconstruction and relocation decisions after major urban earthquakes comprises problems encountered in the evaluation of building damage. Many of the problems that characterise building safety evaluations plague the recovery phase after quakes rather than reconstruction/relocation. But the assessment of damaged buildings in the recovery period to determine resilience to aftershocks often has dramatic implications for the long-term disposition of a building. For example, there is often a link between quick damage evaluations and future public controversy, the objectives of damage evaluation are often not clear to those performing the evaluations, and evaluation decisions are not always supportable. A decision that a building is unsafe, as based on a short appraisal of the structure, is too often incorrectly interpreted as a demolition recommendation. Conversely, people want to reoccupy a damaged building as soon as possible. The result is often that damage is quickly hidden and improperly repaired without adequate professional inspections.

Post-earthquake risk reduction relocation and reconstruction decisions can be enhanced if pre-quake plans are in place to quickly and adequately mobilise and coordinate efforts to inspect building damage, set standards for the repair and reconstruction of earthquake damage as warranted, and make the relocation of urban areas an option in addition to the repair/demolition decision when individual buildings are inspected after earthquakes.

Knowledge of seismic risk

Particularly in the absence of wholesale destruction after an urban earthquake, the viability of relocation, intra-urban relocation and reconstruction decisions is severely impacted by the ability to delineate hazardous areas and evaluate the level of risk pertaining to alternative uses of different parcels of urban land. The level and location of damage experienced in a quake certainly influences perception of hazard in reconstruction. These perceptions are as applicable to influencing post-earthquake seismic design standards as they are to directing intra-urban relocation decisions.

Yet few areas of the world are informed with confidence about the seismic risk that they face. For example, the recent Hanshin earthquake near Kobe,

Japan, far exceeded the magnitude earthquake that some of the best seismologists in the world thought could occur in that region. Moreover, microzonation of seismic hazard is an expensive and elaborate endeavour that no community has been able to conduct in the aftermath of a major earthquake.

Additionally, a rigorous evaluation of seismic risk in the post-earthquake environment would very likely slow the pace and timing of decision making after an earthquake, at the very time that people are most anxious to restore their lives, homes and community. Because people like to reconstruct quickly, it is difficult for seismic risk to strongly influence reconstruction and relocation decision making in the absence of obvious wholesale destruction of particular areas if it is not clearly mapped, or at least understood, before the earthquake happens.

Finances

Post-earthquake relocation and reconstruction decisions and outcomes are dramatically influenced by the amount of money available for the post-disaster mitigation of future seismic risk. Relocation is extraordinarily expensive, and recent urban relocation cases typically occurred when the finances needed were provided by a national government. Intra-urban relocation is also expensive and, more often than not, it is most likely when paid for by programs from a national government. The quality and timing of reconstruction on site is also influenced by the availability of finances (for example, the public resources available for repair), the limitations imposed by available financing, the availability of government-sponsored loans and grants, and the extent to which damage is covered by insurance.

Relocation/reconstruction impacts

Few studies have been performed on the societal impacts of reconstruction and relocation after major urban earthquakes. The evidence that does exist suggests that impacts do exist and that they centre on the issues of equity and psychological effects.

Equity

Earthquakes impose unequal impacts on the population. Inequity in the distribution of impacts is largely the result of social and economic differentiation in the affected population. For example, losses tend to accumulate most among the poor, the elderly and members of a community's lower-income groups because groups such as these tend to occupy housing most vulnerable to quake damage, these groups lack the resources to readily recover from losses, and quakes and reconstruction tend to reduce the supply of affordable housing for low-income people.

Reconstruction and relocation after earthquakes also impose unequal impacts on the affected population. For example, the demolition of buildings typically results in the removal of affordable housing, and marginal businesses typically cannot survive the abandonment of storefronts even for a brief period of time. Impacts such as these are escalated as reconstruction and intra-urban relocation replace old building stock with structures built to current code and valued closer to the current market values. In this way, reconstruction creates a redistribution of resources that certainly creates winners and losers.

Few plan for reconstruction and relocation after earthquakes in ways that do more than rebuild structures but also provide for reducing the increased inequality and problems that are created for marginal social and economic groups.

Psychological effects

It is no surprise that earthquakes impose psychological impacts on the human populations that they affect. For example, research documents symptoms including depression, post-traumatic stress disorder, ulcers, attempted suicide, stroke, heart attack, admission to psychiatric hospitals and others. The subpopulations most likely to be affected include early emergency responders, the young, the old, those who were trapped, people who received a blow to their head or neck, those who experienced the disruption of important social ties and others. Population subgroups also react differently to relocation. Old people, lower-income people, long-term residents and those who had strong social ties to local individuals or institutions in their pre-quake city have the greatest difficulty adjusting to their post-relocation situation.

Conclusions

Based on historical experience, the alternatives available for seismic risk reduction after urban earthquakes seem limited, and there are several reasons why this may be the case. These include that people want to return to normal conditions quickly, damage is seldom extensive enough to make reloca-

tion a real option, existing procedures and organisational arrangements to deal with buildings favour decision making about individual structures, which places relocation somewhat out-of-mind, the funds needed for relocation are typically not available, and few communities have in place the kind of pre-disaster plans needed to effectively influence post-earthquake reconstruction and relocation decisions.

There is clear evidence for the conclusion that the use of reconstruction, intra-urban relocation and wholesale relocation of urban areas after earthquakes as techniques to reduce risk to future earthquakes is most likely a consequence of the failure of communities and societies to effectively plan for reconstruction before earthquakes occur.

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Planning for reconstruction: Opportunities and constraints facing Wellington

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Major reconstruction presents a logical opportunity to mitigate further hazard exposure. Avoiding well-defined areas of secondary hazards (e.g. areas prone to landslide or liquefaction) and replacing heavily damaged clusters of fragile structures (e.g. unreinforced masonry buildings) are obvious responses. The reconstruction period offers a unique opportunity to undertake such strategies if proper planning is in place.

This paper describes the reconstruction opportunities and constraints facing Wellington after a major earthquake. Planning for reconstruction must, however, anticipate the well-documented demands of the affected population to return as quickly as possible to the status quo ante. Past research shows that, to be effective, reconstruction plans must be developed and adopted well before the event. Effectiveness can be further enhanced by making key institutional arrangements, such as creating redevelopment authorities or identifying sources of reconstruction funding, prior to the earthquake.

Particular attention must be paid to the spatial distribution of damage. Experience from two recent earthquakes — 1989 Loma Prieta and 1987 Whittier Narrows — provides important lessons regarding the way in which damage is often scattered in a few concentrated clusters. Reconstruction planning must be tailored to address this phenomenon.

Introduction

Wellington is clearly a city that is situated in an extremely hazardous location. It sits atop the Wellington Fault, which has the potential for a 7.5 Richter magnitude earthquake. The scenario provided to conference participants suggested that an event of this magnitude would severely damage more than 3000 buildings, killing some 1600 residents and injuring another 10,000. Other studies suggest that death and casualty totals would be considerably lower, but in any event Wellington is clearly subject to serious earthquake damage. Perhaps if the earthquake hazard had been fully understood when the city was founded in 1840, another site would have been chosen. However, when one considers an alternative location, there are very few sites that offer sufficient level area for a city the size of Wellington. Complete relocation is not a viable alternative at this late date, given the investment in Wellington, including buildings, infrastructure and transportation facilities. The task now is to seek strategies that will make Wellington safer.

Kates and Pijawka (1977) define three phases of rebuilding after a natural disaster. The first is the emergency response phase, typically the first 72 hours after the event. This is followed by the restoration phase, during which essential services are brought back to normal operation. This phase generally occurs from 72 hours to several weeks after the event. The third phase, reconstruction, is divided into two parts. The first part focuses on rebuilding and bringing infrastructure systems to pre-event conditions. This usually begins within one week of the event and lasts for several years. A second part of reconstruction is focused on betterment and upgrading of the community. This last phase can extend as long as ten years after the event. This paper will focus on both parts of the reconstruction phase.

In reconstruction, the principal concerns are where the damaged elements of the city will be rebuilt on a permanent basis and to what standards. Many of the same standards used in land-use planning for earthquake-prone areas will apply to reconstruction planning (French and Isaacson, 1984; Bolton et al., 1986). This is not to suggest that planning for emergency response and short-term recovery is unimportant — it is. Our concern here, however, is with the longer-term rebuilding of the city of Wellington. In many cases, the data needs and

policies for reconstruction can support and reinforce emergency response planning.

As a first principle, those considering the rebuilding of Wellington should remember that an earthquake will not eradicate all existing development. Planning for reconstruction in an infill situation is much more difficult than planning for development of vacant land. The range of development options is severely limited by the remainder of the building stock and infrastructure systems that are left undamaged. Thus, an important concern when planning for reconstruction is how to integrate replacement construction into the existing urban fabric.

Reconstruction presents two major opportunities. The first and most important opportunity is to mitigate particularly hazardous situations. This can be done by relocating development out of particularly hazardous areas, such as liquefaction zones, or by replacing vulnerable structures with ones that are engineered to withstand higher levels of ground shaking and other earthquake-induced hazards. The other opportunity is to use the reconstruction period to make more general improvements in urban design and urban form.

Past research by William Spangle and Associates (1991) and others has shown that two countervailing forces operate during the reconstruction period. The first force is the desire of planners, engineers and public safety officials to use the opportunity afforded by the earthquake to mitigate the hazard by rebuilding in a safer manner and to avoid particularly hazardous locations altogether. The countervailing force is the intense desire of the affected population to return as quickly as possible to normal conditions. This is generally defined as restoring the types and patterns of development exactly as they existed before the disruption of the earthquake. This pressure to rebuild to the status quo ante is likely to preclude all but the most obvious reconstruction opportunities.

Reconstruction after a major earthquake presents an opportunity to mitigate the hazard through both locational and structural adjustments. The period after a damaging earthquake is a unique "window of opportunity" to make major adjustments to increase the ability of the city to withstand future events. Past research has shown that a well developed plan to guide the reconstruction is important if this opportunity is to be fully utilised. In the absence of a robust plan, reconstruction may replicate the mistakes of the past by reconstructing the same types of buildings in the same hazardous locations.

While New Zealand has experienced earthquakes of significant magnitude in the recent past (e.g. the 1987 Bay of Plenty earthquake), none have occurred in close proximity to a major urban area. As a result, lessons from four recent California earthquakes will be used to identify opportunities and constraints facing Wellington. Table 1 lists the four earthquakes that have damaged California urban areas in the past twelve years. These earthquakes can provide useful insights into the type of damage likely to occur in Wellington and the key issues to consider in planning for reconstruction.

Table 1: Recent California earthquakes

Earthquake	Year	Magnitude	Estimated property damage (in millions of dollars)	Deaths
Coalinga	1983	6.7	31	0
Whittier Narrows	1987	5.9	358	8
Loma Prieta	1989	7.1	5600	62
Northridge	1994	6.7	20,000	57

This paper will outline the opportunities and constraints facing Wellington in the reconstruction period following an earthquake of 7.5 magnitude. It will first describe the nature of the earthquake hazard facing Wellington. It will then consider important aspects of reconstruction planning and suggest strategies as to how each aspect might be approached in preparing a reconstruction plan.

The hazard facing Wellington

As described in a recent study by the Centre for Advanced Engineering (1991), there are a number of earthquake hazards that affect the Wellington region. A M7.5 earthquake on the Wellington fault is expected to produce ground accelerations of 0.9 *g* or greater under most of the urbanised parts of the region, including Wellington's central business district, Karori, Thorndon, the Hutt Valley and much of the Miramar Peninsula. This level of ground shaking can be expected to severely damage large numbers of unreinforced masonry buildings, as well as causing scattered damage to more modern structures. It will also cause significant damage to the region's urban infrastructure and transportation systems.

An event of this magnitude is expected to trigger a number of secondary hazards. Probably the most damaging of these is widespread soil liquefaction. In a M7.5 event, severe liquefaction can be expected in the reclaimed lands in the harbour areas of Wellington and Petone. Scattered liquefaction is also likely around the mouth of the Hutt River and in the central area of the Miramar Peninsula. Significant landsliding is also likely and will occur along the fault scarp and in other areas of extremely steep slope, such as those that characterise much of the region's shoreline in the Roseneath-Oriental Bay area.

While the Wellington fault is capable of producing a M7.5 earthquake, it is also capable of producing a damaging event of lesser magnitude. It should be noted that all of the recent California earthquakes were well below M7.5.

Planning for reconstruction

Reconstruction rarely happens without a plan, yet few cities prepare such a plan before an earthquake. Many are forced to develop a plan to guide their reconstruction after a damaging earthquake. In most cases, this is too late to institute effective changes. The pressures to get on with the rebuilding preclude collection of new data and a thoughtful consideration of all alternatives. In such a situation, it is difficult to take advantage of the opportunities presented by reconstruction.

There are good reasons for the lack of plan making before an earthquake occurs. The greatest difficulty lies in the fact that the exact nature of the damage is difficult to predict. Even with today's sophisticated mapping, modelling and risk analysis techniques, there is a large stochastic element in the damage pattern. The exact distribution of damage will vary depending on the size and the location of the specific earthquake. Unmapped geologic features and soil conditions can intensify damage at particular locations. Minor differences in construction quality can result in large differences in the level of damage. As a result, any plan developed before the event must be modified to account for the actual pattern of damage experienced. Even so, modification of an existing plan that sets out the general reconstruction strategy is likely to be much easier than creating an entirely new plan.

Analysis of the 1989 Loma Prieta earthquake indicates that damage to urban areas can be quite scattered (French, 1995). Figure 1 shows that damage to infrastructure and other public property from this earthquake was concentrated in several clusters in the San Francisco region. While it caused significant damage near the epicentre, the heaviest damage occurred more than 50 miles (80 km) away. Much of the area within 10 to 20 miles (15 to 30 km) of the epicentre was heavily developed, but, due to stable soil conditions and building types, sustained relatively little damage.

Those areas that experienced heavy damage were generally located on unstable soil or in areas of particularly vulnerable structures. Even at the neighbourhood level, it is not uncommon to find

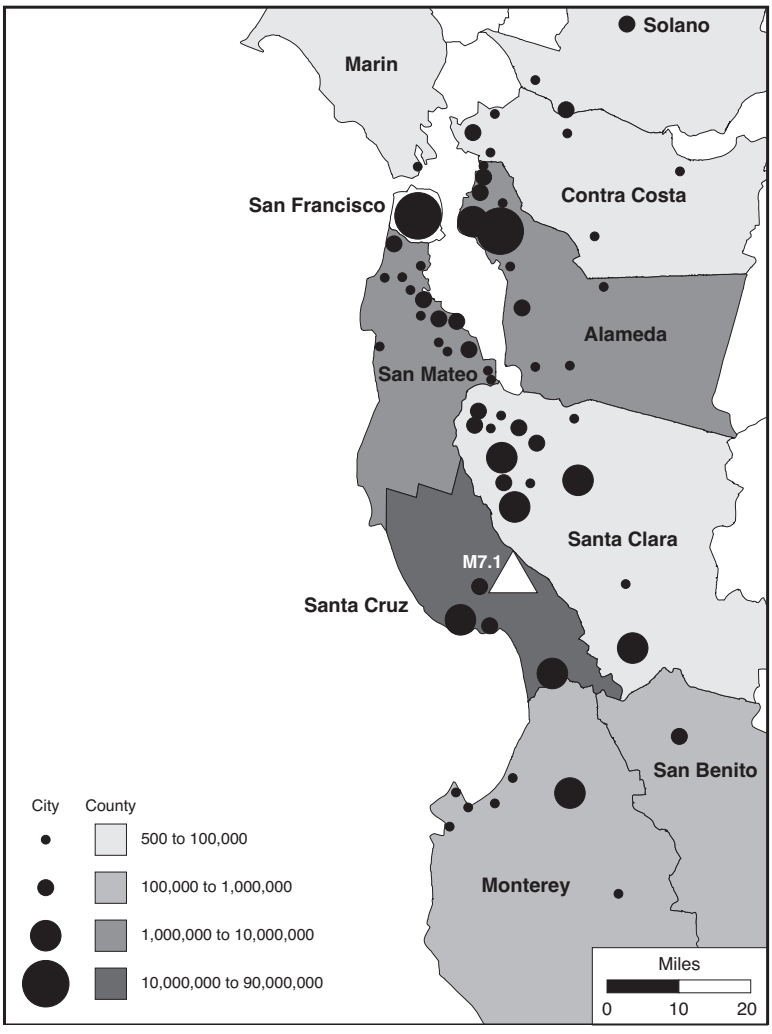

Figure 1: Public damage claims from the Loma Prieta earthquake

severely damaged structures juxtaposed with structures that have experienced little or no damage. Seemingly identical infrastructure components often behave very differently in response to the earthquake stress. Some of this variation can, of course, be explained by differences in underlying soil conditions or to differences in construction quality, yet even after taking these factors into account, a significant amount of variation in the damage pattern remains unexplained. As a result, our best models are unable to predict the exact pattern of damage, even if we know the precise location and magnitude of the earthquake for which to plan. Does this imply that it is impossible to plan for reconstruction before the event occurs? No, but planners must recognise that this uncertainty makes their task more difficult, and their plans must be designed to accommodate this uncertainty.

This level of uncertainty, coupled with the rapid pace of reconstruction, make traditional land-use regulation techniques, such as zoning and subdivision controls, less than ideal tools to guide earthquake reconstruction. These traditional tools can and should play an important role in limiting the amount, type and density of development in hazardous areas before the earthquake, but in the aftermath of an earthquake, there will be insufficient time to enact the necessary legislative changes to reshape urban development using them. Furthermore, the emotional period following a disastrous earthquake is unlikely to provide a political environment conducive to thoughtful consideration of reconstruction alternatives. Thus, the general framework for reconstruction planning must be in place before the earthquake occurs.

A reconstruction plan cannot be an exact blueprint for reconstruction; instead it must establish key guiding principles. A good plan must be more than a physical plan that specifies the location of damaged buildings and infrastructure to be reconstructed. It must also address the organisational and economic aspects of reconstruction.

Perhaps the best current example of an earthquake reconstruction plan developed prior to an event is the Los Angeles Recovery and Reconstruction Plan (1994). This plan includes recommendations to guide both emergency response and reconstruction activities. Wellington has made significant progress in preparing for emergency response. The city has created the Wellington Emergency Management Office and has been especially active in preparing to manage damage to lifelines (Britton, 1994). Through the Wellington Emergency Management Office, the city is developing a recovery plan that is modelled in part on the Los Angeles plan. However, to the best of my knowledge, Wellington has been less active in planning for reconstruction. While the Los Angeles plan had not been finally adopted at the time of the 1994 Northridge earthquake, it was largely complete. It was adopted just after the earthquake and was used to guide the reconstruction effort from the outset. The effectiveness of this plan in guiding this effort will provide important lessons on how we should plan for reconstruction.

Interestingly, the draft of the Los Angeles Recovery and Reconstruction Plan that was adopted in January 1994 dropped many of the policy statements that sought to take advantage of the earthquake to relocate development. For example, Policy Statement No. D.5 — Replanning Hazardous Areas states:

> *It is the city's policy to replan hazardous and devastated areas and recognized disaster generated constraints and opportunities.*
>
> (Los Angeles Emergency Operations Organization, 1994, p. 68.)

This policy, and its five implementation programmes, were dropped from the version of the plan adopted by the Los Angeles Emergency Operations Organization. Other strong statements dealing with relocating development outside hazardous areas and identifying areas with substantial numbers of unstrengthened buildings were also dropped. Nevertheless, I suggest that those components be made a part of Wellington's reconstruction plan.

Institutional organisation

Perhaps the single most important step in pre-earthquake preparation is to develop an effective organisational structure to manage the reconstruction process. Britton (1994) and others have highlighted the need for effective organisation of emergency management. This need extends to the reconstruction phase as well.

The case of Coalinga, California, provides an interesting lesson in organising for reconstruction (French, 1984; Tierney, 1985). In May 1983, the small town of Coalinga experienced a M6.9 magnitude earthquake that occurred on a previously unknown fault. The six-block downtown area that consisted of two-storey unreinforced masonry

structures was virtually destroyed. Within two years, the downtown was replaced by a modern low-rise downtown shopping area. Local residents concede that the rapid reconstruction and redesign of the area would not have been possible without Coalinga's Redevelopment Authority, which guided the reconstruction. The Redevelopment Authority had been created prior to the earthquake to revive the downtown area, which was economically depressed. After the earthquake struck, the city recognised the need for one agency to take the lead in the rebuilding process. Because the Redevelopment Authority was created with power to condemn land and issue bonds, it was the agency selected to manage the rebuilding. It was able to assemble the land and acquire funding to develop a more viable downtown.

The City of Los Angeles has created a Recovery and Reconstruction Division as a part of its Emergency Operations Organization. This division was created to coordinate the roles of multiple city agencies in the reconstruction process. The effectiveness of this approach is unclear at this point. The best organisational framework to guide redevelopment is unclear. It does seem clear that the plan must designate one organisation to plan for and manage the reconstruction process. This may or may not be the one that is charged with managing the emergency response phase.

It is also important to determine how the large number of building permits and inspections required for reconstruction will be handled. It may be necessary to develop a set of streamlined procedures and to determine specific areas where such expedited procedures will be applied.

Information needs

To begin the reconstruction process quickly, it is important to have adequate information about the city and the hazard. Much of this information can be developed before the earthquake. Capturing the information in a geographic information system (GIS) will allow it to be manipulated to model damage before the earthquake. This same information can be used for emergency services planning and to support reconstruction planning after the event. Wellington has already begun to develop important parts of this type of database.

Several types of information are needed to guide the reconstruction process. First is detailed mapping of the hazard. This would include not only the faults themselves, but also areas subject to landslide and liquefaction. Secondly, the region should develop a detailed inventory of the building stock. Such an inventory should classify each building by its structural type (e.g. wood frame, steel frame or unreinforced masonry). In addition, the size, value and current use of each structure should be catalogued. Finally, a similar database should be developed for the region's infrastructure, including water supply, sewerage, roads, telephone, electric power and natural gas systems. The database should include the age and capacity of each component of these systems. For network systems, such as the water distribution system, the material, diameter and length of each pipe segment should be incorporated in the database.

Wellington has undertaken an inventory of hazardous buildings. Roughly half of the 758 structures identified have been demolished or strengthened in the past 20 years (N R Britton, personal communication, 1995).

A geographic information system should be used to store and manipulate both the hazard and inventory information. This technology makes it possible to identify which buildings and infrastructure components are located in areas of unstable soil and other particularly hazardous areas. After an earthquake occurs, the damage to each structure and infrastructure system can be easily added to the database. Once actual damage data is added, the GIS becomes a powerful tool for reconstruction planning because it can combine information on the hazard, the building inventory and the infrastructure systems. Concentrations of heavy damage can be easily identified. As part of the planning process, alternative development patterns can be tested for exposure to the hazard and for compatibility with undamaged infrastructure systems. Such testing can assume that the best reconstruction alternative is selected.

Commercial and industrial areas

As a rule, pressure for reconstruction of commercial and industrial areas as quickly as possible is very strong. The costs associated with business interruption significantly increase the physical damage costs experienced by business. To provide more time to plan and execute significant reconstruction, temporary facilities can be created, particularly for retail shopping. For example, shortly after the Northridge earthquake, which virtually destroyed downtown Filmore, California, the local Chamber of Com-

merce and the city government created a shopping bazaar in a local park. Local merchants were able to relocate their downtown shops while the reconstruction of downtown was planned and implemented.

Physical damage, inventory losses and significant business interruption can be enough to eliminate marginally profitable businesses. These types of businesses are often located in older, more vulnerable buildings. Thus, the reconstruction process must take account of the fact that some businesses may not survive the earthquake. As a result, there may be fewer businesses and a different mix of commercial uses in the reconstructed city. While it is difficult to determine beforehand which businesses will fail, a rough estimate based on the experience of cities of similar size will help planners understand the likely changes in this type of land use. Reconstruction of commercial areas offers an important opportunity to improve urban design features that make the area attractive to shoppers. The case of Coalinga cited earlier and of the downtown Santa Cruz mall are examples of commercial areas that were significantly upgraded when they were rebuilt after suffering severe earthquake damage.

Hazardous materials are most likely to be found in industrial areas. The presence of these materials can complicate debris removal and may also cause significant contamination of soil and ground water in the case of serious spills. Reconstruction of these areas may have to account for these types of problems.

Residential housing

In the recent series of California earthquakes, damage to newer, single-family houses has been limited. This portion of the building stock is largely composed of wood frame structures that are able to withstand ground shaking better than most other types of structure. The principle exception was in the 1983 Coalinga earthquake, where large numbers of older houses were destroyed as their wood frames shifted off their concrete foundations. More modern building codes require that framing be securely bolted to the foundation to prevent this type of damage.

The largest proportion of damage to the housing stock in the other three California events was sustained by multi-storey apartment buildings. This damage was of two types — damage to older unreinforced masonry structures and collapse of structures with a soft first storey, usually parking garages. The Marina District of San Francisco experienced numerous failures of the latter type during the Loma Prieta earthquake.

Also in the 1989 Loma Prieta earthquake, damage to the older housing stock in Oakland was particularly problematic because it eliminated much of the housing available to low-income residents. Since these affordable apartments were only marginally profitable, if at all, landlords have been relatively slow to replace them. Thus, the earthquake significantly damaged the mix of housing available by eliminating many of the most affordable units. These types of units were disproportionately damaged because they were more likely to be in older, more vulnerable structures. To avoid negative impacts on the supply of affordable housing, the reconstruction plan may need to include explicit provisions to ensure the rebuilding of affordably priced rental units.

The Association of Bay Area Governments (1992) has developed a model to predict the number of uninhabitable dwelling units that are likely to result from various earthquake scenarios. The model is primarily used to estimate the demand for temporary housing, but its output could also be useful for reconstruction planning.

Two issues are important to recognise regarding residential reconstruction. Since many single-family homes are owner-occupied, the pace of reconstruction is likely to be tied to the availability of insurance payments or subsidised loans. Owners will rarely have the resources to finance rebuilding on their own. Secondly, there is a tendency in many cases for temporary housing to become permanent. This is particularly true of mobile homes. Low-income residents may find much of the affordable housing stock destroyed, with market forces unwilling to replace it.

Infrastructure systems

Components of most infrastructure systems exist as parts of larger networks. Because of the interdependent nature of these networks, damage to key components can affect the performance of the entire system. Thus, planning for infrastructure must take account of the connected nature of these systems. Studies of the 1989 Loma Prieta and 1987 Whittier Narrows earthquakes indicated that a relatively small percentage of the overall infrastructure system

is likely to be severely damaged (French, 1993). As a result, the existing pattern of infrastructure is likely to survive the earthquake. This pattern can be a major constraint to radical alteration of the city's current urban form. Past investments in infrastructure systems make it difficult to abandon most developed areas. Only in those areas where both the building stock and the infrastructure systems are severely damaged is it economical to undertake large-scale relocation.

It is, however, important to include mitigation as part of the reconstruction process. Damaged infrastructure components should be upgraded to make them more earthquake-resistant. Minor relocation of distribution lines around hazardous areas may be possible in some cases. Some consolidation of storage tanks and treatment plants may also be possible.

Land-use pattern

While wholesale relocation is unlikely, the reconstruction process does offer an opportunity to make useful adjustments in the existing land-use pattern. Opportunities will exist to lower residential densities, replace older shopping areas with more modern shopping districts and replace hazardous buildings with less vulnerable structures. There may also be opportunities to create open space in particularly hazardous areas, such as landslide, liquefaction and fault rupture zones. Neighbourhood parks and linear parks along rivers or shorelines can be created in areas of severe damage. These opportunities should be identified early in the process of preparing the data sets described earlier in this section. If major relocations or reductions in density are deemed desirable, receiving sites for the development to be relocated must be identified.

Conclusions

In the event of a damaging earthquake, Wellington will have an opportunity to rebuild in ways that lower the vulnerability of the city to future events and solve existing land use and urban design problems. To best take advantage of such an opportunity, the region should have a reconstruction plan in place before such an earthquake occurs. The plan should include the following items:

- designation of a lead agency to manage the reconstruction;
- detailed mapping on the earthquake hazard and the local building and infrastructure inventories, preferably in a GIS format;
- identification of areas where reconstruction should be limited to lower densities or relocated;
- identification of less hazardous areas that can serve as receiving areas for relocated development; and
- identification of financing mechanisms that will support reconstruction, particularly for affordable housing and other non-market uses.

Wellington has already started to plan its response to the likelihood of a future earthquake. Hopefully, this conference will encourage local officials, researchers and planners to extend those efforts further and to develop plans that can not only restore the city after an earthquake, but make it safer and better when it is rebuilt.

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Keeping catastrophic change in context

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Cities are resilient. Their capacity to survive results from great scale, massive infrastructure and a high degree of redundancy and autonomy among their parts. Permanence also expresses the human quest for eternity. For this reason, images of destroyed or abandoned cities are shocking to us. They portray complete loss, the threat that, individually and collectively, we will one day vanish without trace. A ruined city represents the end of history, the absence of destiny.

There is another urban image deeply embedded in most cultures. Confronting the eternal city is the ideal city — the future city, utopian, visionary, critical. As we plan for Wellington after the quake, the prospect of destruction is tempered by the promise of renewal. A calamity is an invitation to start again.

This paper examines the real opportunities that are found between these two contradictory impulses.

Reinventing Wellington: rival paradigms for an ideal city

What is a city? Here at this conference, each discipline and profession will answer the question differently. Urban designers have their own unique perspective on the subject. They employ a cluster of definitions to explain urban form and forecast change[1].

The city is a cosmological diagram

The very first cities may have been constructed as cosmological diagrams. Hierarchy, symmetry and precise division create a mandala, or a formal signature of universal order[2]. Boundaries are a prerequisite for settlement because a city's limits define a sacred precinct — a safe, stable place in which to dwell. Perfect geometry invokes divine favour and protects citizens from catastrophe. In this conceptualisation, a great earthquake might indicate a flaw in the pattern or a failure to observe the rituals that empower architectural relationships.

The city is a machine

The machine provides a more contemporary metaphor for urban form. The mechanical city has no meaning other than its overt function. The plan is configured to optimise production and public heath. Ideal layouts are either linear or orthogonal because these facilitate the commodification of land. Towns appear to be a logical expression of circulation, exchange, standardisation and an orderly separation of activities. They grow by replication and addition and there are no natural limits to their size. If the system is broken or damaged, components are simply replaced, connections are repaired and the processes will start over again. When we interpret the city as a collection of infrastructure, this paradigm is active.

The city is an organism

Our own biology invites us to regard the city as an organism. In this anthropocentric analogy, each town and every community are identities. Although we recognise the specialised physiology of different organs, the parts are interdependent and difficult to separate. The result can only be understood holistically. Organic growth is incremental and opportunistic, yet driven by "genetic" imperatives. So picturesque, vernacular forms are often favoured and urban designs refer explicitly to their contexts. Having reached maturity, the organic city establishes a stable equilibrium with its environment. It adjusts to external disturbances and responds to trauma by regenerating damaged urban tissue.

The city is a text

Cities may be read as historical texts. They provide a palimpsest on which each generation of inhabitants leaves its trace. Because the city grows by superimposition and accretion, urban fabric is layered and rich with meaning. The continuous, linear structure of the narrative projects forward in time, as well as backward. Permanent features of the city are a tangible link with the future and the past. The most

durable urban artifacts are the city's plan and its monuments, so it is these elements that "constitute" a city and comprise its "memory". Wars, fires, floods and other catastrophic events need to be recorded. They represent important chapters in the "biography" of the city. However, reconstruction should never completely erase the place's previous identity[3].

There are other concepts to choose from. View the city as an information system and our whole environment appears as a collection of signs. Examine the diversity of modern lifestyles and urban culture seems to occupy a "heterotopia" — a kind of giant theme park where a polyglot populace plays out its fantasies[4]. Leap into cyberspace and the city vanishes altogether. Software replaces hardware and the compelling prospect of virtual reality takes hold.

None of the conventions are static. Ideas mutate and sometimes become their opposites. Witness the wilderness and the park. Over a thousand years, the place of nature in the city has been reversed from a chaotic, menacing "outside" to a benign refuge for natural order. Consider the machine image. Once it represented dynamism, modernity and material welfare. Now, it has become a symbol of alienation and control. At the same time, the city of production has been replaced by the city of consumption, an entirely new suburban landscape that maximises accumulation of goods and expenditure of energy[5]. These transformations remind us that the city is constantly being reinterpreted.

Few cities conform exactly to any of these models. Try to understand Wellington's structure and identity as a "mandala" or a "mechanism", "tissue" or "text", and we would quickly find that none of these rival paradigms are mutually exclusive. All the metaphors are deficient. Yet, each benefits the analysis. The currency of all four models, even in the contemporary world, reveals the multiple purposes and modalities of the urban environment. A single explanation is bound to be deficient. If we treat the city exclusively as a system for production and exchange, we neglect its role as a mnemonic device and a repository for culture. If we assign value wholly in terms of aesthetic composition, individual sensory experience or personal identification with place, then the importance of property as a commodity may be overlooked. These competing paradigms jointly reveal the true complexity of the city and it is the composite picture that we must have in mind while we plan for Wellington after the quake.

Despite these concepts, the process of urban development is most often an empirical one. Expedient, fragmentary and incremental, city form frequently responds to circumstance rather than a single perfect idea. Yet natural disasters suggest a different kind of growth. Catastrophic change promises to deliver an urban tabula rasa — effectively a new civic foundation without context or compromise, a blank slate on which a contemporary vision of the ideal city can be mapped out. The seductive prospect is that, after the quake, Wellington might be reinvented.

If we could just start over again, a single comprehensive plan might produce an urban utopia: a bicultural city that truly expresses an emerging, indigenous South Pacific identity, a rational city that optimises late 20th century technology or an ecological city that achieves a stable, sustainable relationship with its environment. More equitable, more efficient, more comfortable, more beautiful, more coherent: in the past, these criteria have informed ambitious redevelopment proposals following wars, fires, floods and earthquakes[6].

Mountains and maps: immutable relationships resist comprehensive change

However, few of these grand schemes have been realised. Even if we could all agree what paradigm should be applied, the city's physical character would resist fundamental change. A thorough reinvention of the city is bound to be frustrated because the most significant determinants of urban form will survive a severe natural disaster: land form and the city plan. These two underlying and interdependent features imprint the urban environment with a permanent structure.

In fact, Wellington's first plan did represent a kind of ideal[7]. More utilitarian than utopian, the 1839 street map appears to us as a caricature of a city. Yet it captured the "Idea of Wellington" as the colony was conceived, in London, by Edward Gibbon Wakefield and the New Zealand Company. Occupying an artless rectilinear grid, the notional town displayed all the mechanical precision of a military camp. Indeed, the boundaries of the settlement were demarcated with forts and broad defensive terraces. Fifty-nine squares locate public institutions and places of commerce, everything from the "Presi-

dent's Palace" to a "Billingsgate Fish Market". In these names, we can read the company's determination to recreate the familiar, civilised landscape of the motherland. We can also identify bold aspirations for the city's future role as the capital of a nation that is both secular and republican. But the real focus of this settlement is commerce, for the plan gives greatest emphasis to docks, markets, exchanges and the kinds of public amenities that will ensure a healthy, industrious population.

For our purposes, the map's most instructive feature is that this ideal plan was never put into effect. In their careful enumeration of civic spaces, the colony's planners failed to account for the untamed, unforgiving character of the land itself. On paper, their ideal settlement occupies a flat, featureless plane and its streets are neatly bisected by a benign, navigable river. But this abstract setting bore little resemblance to the perilous marshes, braided channels and stormy foreshore of the Hutt Valley, where the New Zealand Company's ships first anchored.

Once these topographical imperatives became apparent, the official town site was abandoned in favour of Lambton Harbour and Te Aro Flat. Here, rugged terrain made a nonsense of the tidy orthogonal plan. In 1840, the first settlers were already pitching their tents on the beach as the colony's resident Surveyor General struggled to locate a sufficient number of private lots. Captain William Mein Smith handled this difficult and urgent task with great expediency. On his final plan, it appeared as though the original orderly grid had been shattered, then hurriedly reassembled. Apart from a neatly inserted shipping basin, only a handful of open spaces remained within the grid. An irregular elevated site was designated for government purpose, but this was the only sign of the settlement's pretensions to being the colony's new capital. The town squares have disappeared, as though the brute compressive strength of the terrain had squeezed all remaining voids out to the perimeter of the platted area. Here, on the steepest slopes surrounding the city, public open space coalesced as a broad greenbelt[8].

As we contemplate Wellington after the quake, the settlement's false start is significant. It reminds us that landform predetermines much of the character of our urban environment. This terrain is massive and enduring. Far from being threatened by earthquakes, our topography is the product of seismic forces. During the recent past, geological processes have raised beaches and helped to drain swamps. Yet, even the most catastrophic event will have an imperceptible influence on the contours that shape Wellington.

Mein Smith's final map of Wellington is little more than a "proto-grid", a crude framework for private speculation and civic enterprise. Undifferentiated one-acre parcels made no provision for the explicit functional specialisation that had characterised the earlier town plan. Whole elements of infrastructure appear to be missing: docks, railways, civic institutions. For 150 years, planners and property developers have attempted to correct the map's deficiencies by implementing piecemeal alterations and additions. Alleys and cul de sacs accessed the centres of large blocks. The original uniform matrix of streets was overlaid with a clearer hierarchy of major and minor routes. Reclamations erased the natural shoreline, extending broad ledges of new land far out into Lambton Harbour. However, Mein Smith's map remains persistently intact. It has provided the datum for one and a half centuries growth and it will be a reference for all future change.

So the city's plan introduces a second kind of permanence. The intricate patterns formed by property lines and public rights-of-way will escape destruction because they have an abstract existence. Yet these coordinates are potent generators of urban form, comparable in their effects to the natural features of a site. In a sense, cadastral surveys construct a phantom image of the city and, even though all physical boundaries may be destroyed, these legal descriptions will persist and will be reactivated following a disaster.

Mosaics, not master plans: informal order in an overgrown seaside town

So it is folly to anticipate a radical and systematic reorganisation of Wellington after the quake. Master plans will fail because immutable relationships control form and space. However, there is another constraint on sweeping innovation. Expansive urban designs, in the grand manner of Burnham or Olmsted[9], are doubly inappropriate here because Wellington is a complex product of idea and circumstance[10]. The casual mood of this city favours incremental change, improvisation and a picturesque aesthetic rather than a single dominant motif.

Everywhere, tight folds in the terrain separate places from one another or force unexpected encounters. All the city's natural parts are finite and the harbour provides the only common focus. Wellington's cultural and commercial life is concentrated at the margin where hills and water meet. A narrow ribbon of retail frontages and high-rise office blocks trace the original beach front, so the form of the city is both compact and attenuated. Activity is compressed into a linear structure, which defies the formation of a single unchallengeable centre. It is a city of edges and ridges, seams and corridors, viewshafts and villages. Its narrow streets are lined with miniature replicas of European and North American architecture. The result is hybrid and impure. The city has not been conceived as an elegant national capital, nor built as a diagram of power, nor constructed logically as an instrument for industry and commerce. Instead, Wellington resembles a rambling, overgrown seaside town.

This city is composed like a collage[11]. Fortuitous juxtapositions are the source of its charm. Precise order is always tightly circumscribed and the focus of attention often shifts to boundaries or fields of interference where one physical condition meets another. Because Wellington is already fragmented, the place tolerates further contrast and remains receptive to overlays and insertions.

This is exactly how redevelopment will occur following a major earthquake. Experience tells us that the damage will be severe but highly localised. Pockets of the city will be razed, although isolated structures will survive unscathed. Elsewhere, a single building may collapse while its neighbours all remain intact. Whole city blocks will be rebuilt and perhaps entire districts. But the threshold between new urban fabric and old will never be far away. "Great quake" neighbourhoods or "recovery-style" residences may appear distinctive, but they will join the existing mosaic of "Victorian" and "Edwardian", "pre-war" and "post-modern".

Remembering Wellington: architectural amnesia after the quake

So, grand plans disregard the mood of the city and the mode of recovery. From an urban designer's perspective, this means that the risks and opportunities associated with a major earthquake need to be well contained. In fact, the most vulnerable elements of urban identity are only revealed when Wellington is examined at an architectural scale.

Some buildings are indispensable. Not because they house vital services but because they help to define a sense of place. Parliament House, the Old Government Buildings, the Buckle Street Carillon, St Gerard's Monastery, perhaps the Railway Station and the Overseas Passenger Terminal: all these elements contribute to the essence of Wellington. Like natural landmarks and the street plan, they organise our experiences and influence our image of the city. As the capital's primary urban artifacts, these structures are identified by size and prominence or unique form. More importantly, their architecture exhibits exceptional integrity, richness or craft. These are the attributes that finally denote a singular presence within the general fabric of the city. Quality assigns these buildings their role as monuments.

One definition of "monument" is a written record. Applied to architecture, the word suggests an enduring object that commemorates an event or celebrates an ideal. Whether this is intended or not, symbolism always becomes the principal function of such a building. However, a monument seldom remains static as a register of history. Although they help us to remember, monumental buildings are constantly being reused and reinterpreted. Because of their permanence, they attract new uses and contemporary meanings. In this way, monuments have a special catalytic effect within the urban environment. They structure time, as well as space. They represent the past, but their certain presence in the future city also projects us forward[12].

If memories resided in a handful of grand public edifices, these could be secured against destruction or reinstated following a natural disaster. Continuity would be assured. However, the city counts several hundred items on its inventory of heritage buildings. All these structures possess uncommon qualities. Each has survived generations of change. Every heritage building acts as mnemonic device and a point of reference. Sometimes, their significance is known only to a small constituency of locals. Often, such an object triggers the private reminiscences of a single individual. These buildings do not qualify as civic landmarks or the instruments of state rhetoric. They are not "monumental" in the conventional sense of the word. Yet, each time a venerable structure is destroyed, the loss will provoke a personal sense of grief and introduce a kind of collective amnesia. In a small way, the memory and personality of the city is erased.

After the quake, those who rebuild Wellington will want to retain minor monuments as well as major ones. But they will need creative conservation strategies to do so. Some buildings will retain their authority as ruins. Others, partially demolished, may be incorporated as fragments into new construction. Elsewhere, it will be sufficient to carefully re-occupy a site so that the locus of an event or an idea is maintained. All these practices will help to preserve the identity of the city.

Rethinking the reclamations: scenarios for the city's soft sediments

Mountains, maps and monuments: the permanent features of Wellington's urban form are compelling. They structure growth, but they do not preclude change. Transformations will occur and, with a little imagination, it is possible to find promising opportunities for Wellington after the quake. As an example, designers might consider the soft sediments that surround the harbour. These include natural deposits and new land that has distanced the Capital's commercial spine from the water's edge. Some vigorous shaking here may provide us with a second chance to create an intricate, elegant interface between city and sea.

In this scenario, Museum of New Zealand becomes an island. Tall ships tie up on Lambton Quay at the Midland Park Marina. Liquefaction causes sections of the container terminal to slip into the harbour. Fortuitously, the awkward southern edge of the reclamation is reconfigured to follow a gentle curve. Planted with norfolk pines and pohutukawa, this becomes a popular esplanade and completes the chain of recreational spaces stretched around the inner harbour. Wellington's ancient stream beds reappear, first as trails of destruction, then as a series of leafy, linear parks or charming little canals that cut across Te Aro's street grid and stitch together the Town Belt, the Golden Mile and Lambton Harbour. The city's financial core, which has drifted from Featherston Street to the Terrace and lately towards Willis Street, returns to the nexus formed by Lambton Quay and Queens Wharf. As aging office blocks are demolished, developers match the most strategic sites with larger, more efficient buildings. These endow the Central Business District with a more romantic skyline and the silhouette of slender new towers provides a confident signature of the city's recovery. Official memorials are also built. Among them is Wellington's first city museum, where virtual reality recreates vanished streetscapes.

Catastrophic change in context: a single positive vision of a possible city

It is tempting to try and reinvent Wellington in this way. But we need to keep catastrophic change in context. A comprehensive blueprint for the city already exists. The strategic plan identifies broad goals and long range objectives. An urban design strategy focuses on potential amenity in public spaces. A heritage strategy protects features of cultural and historic importance and the district plan seeks to maximise the benefits of private property development.

Each document is the product of research, negotiation and review, which cannot be concluded until controversial policies have been challenged. For these reasons, the new district plan will be at least four years in gestation. The time and expense are justified because issues are complex, stakes are high and expectations are diverse. The city is a scarce resource and competing claims need to be resolved so that all citizens have confidence in the way it is managed.

Such careful deliberation will be impossible following a major earthquake. Choices will be expedient rather than visionary. Amid chaos and destruction, the first impulse will be to return the city to its former state, literally to recover what has been lost.

We can prepare for calamity by having sound, popular, well understood urban design policies in place long before disaster strikes. However, the implementation of these proposals should not be deferred until a "doomsday scenario" comes into effect. Plans for a better city deserve to be actioned immediately. Although a major tremor will leave its mark, those who survive the catastrophe will inhabit a familiar place. They will recognise many of the same constraints and opportunities that frame contemporary objectives for urban form. Because this continuity is assured, the same positive vision of our city's future needs to inform incremental change and recovery after the quake.

Notes and references

1. Three of these paradigms are based on Kevin Lynch's summary of normative theories for city form; see Kevin Lynch, *Good City Form* (Cambridge, Massachusetts, 1981) pp 71-98.
2. The literal definition of a mandala is a symbolic circular figure that serves as a religious symbol of the universe (*Concise Oxford Dictionary*).

3. Aldo Rossi refers to the city as the "collective memory of its people" and quotes Maurice Halbwachs' *La Memoire Collective* as the source of this idea; see Aldo Rossi, *The Architecture of the City* (Cambridge, Massachusetts, 1982) pp 130-131.
4. The term "heterotopia" was coined by Demetri Porphyrios. Charles Jenks uses a related term "heteropolis"; see Charles Jenks, *Heteropolis* (London, 1993).
5. Charles Leven characterises the metropolis of the twenty first century as a "new city ... determined spatially to maximise consumption"; see Richard Louv, *America II* (New York, 1985) pp 45-46.
6. Christopher Wren's plan for London after the Great Fire and Daniel Burnham's proposals for San Francisco are famous examples. Burnham prepared his design a year before the 1906 earthquake. But after the disaster, his scheme was promoted as a blueprint for reconstruction.
7. This plan was drawn by Samual Cobham at Newgate Street, London. The title of some editions refers to the town as "Britannia".
8. Daniel Burnham and Frederick Law Olmsted were both exponents of the "City Beautiful" planning movement in the United States at the turn of the century.
9. Ibid.
10. Donlyn Lyndon defines architecture as "a setting for the meeting of idea and circumstance"; see "The House of the Mind; Houses by MLTW" in Yukio Futagawa, *Houses by MLTW* (Tokyo, 1975).
11. "Collage city", as used by Colin Rowe and Fred Koetter, has a distinct meaning. It refers to a combination of traditional and modern forms in the contemporary city; see, Colin Rowe & Fred Koetter, *Collage City* (Cambridge, Massachusetts).
12. Aldo Rossi articulates many of these ideas in "Monuments and the Theory of Permanences"; see, Aldo Rossi, *The Architecture of the City* (Cambridge, Massachusetts, 1982) pp 57-61.

Discussion

Rebuild? Where?

John Blakeley (Centre for Advanced Engineering) asked whether there was a need for a single lead agency with the responsibility to co-ordinate reconstruction. He also asked whether it is possible to reconcile the need for a lead agency to co-ordinate reconstruction with a non-interventionist government philosophy in view of the devolution of government assets that had taken place in the last decade and the prevarication in the earlier panel discussion about where responsibilities will lie. *Steven French* replied that the Los Angeles Recovery and Reconstruction Plan (1994) included recommendations to guide both emergency response and reconstruction activities. While most recommendations for response had been adopted, many recommendations for reconstruction powers were deleted for the sake of expediency before the plan could be adopted because of the domination of market forces philosophy. Hence, although this plan is interesting, it is not necessarily a model to follow. However, it would be possible to have a redevelopment agency involving the private sector as a lead agency that is not completely incompatible with a free market response.

Chris Henri (Insurance Council of Australia) noted that the problem for Wellington is that a really large earthquake is needed before the layout of the city can be replanned. The Newcastle earthquake was too small to realise planning ideals. He said that opportunism in reconstruction could be an enemy or a friend. Regarding the issue of not putting people back in harm's way, he said that the Australian government had been quite inflexible when the case had been put to them for a joint project with the private sector. He wished to comment on Steven French's statement that insurance companies tend to put people back on the same site and that more flexibility is needed. In Australia, insurance companies do make some allowance for relocation, but they do it on an individual claim basis. Hence, to relocate people on a wholescale basis following a disaster would be extremely difficult. In any event, most people are under-insured, which militates against relocation. *Steven French* said that his comment that the insurance industry tends to put people back on the same site is not necessarily a criticism of the insurance industry. Land value will be an inhibiting factor against shifting people because insurance typically does not cover the landowner's investment in the land.

Ross Cuff (Robins NZ Ltd) asked whether, in view of the importance of insurance for financing reconstruction, the insurance industry in the US had been brought into the planning process. *Steven French* replied that federal government sponsored earthquake insurance contains mitigation as a component, and a local authority must have an earthquake response plan in use in order to participate.

David Hopkins (Kingston Morrison) commented that there appeared to be an issue of inflexibility in decision making after an earthquake disaster with the view being taken that people should not move and this transcended all agencies. He suggested that leadership was needed to either encourage people to stay or to relocate. *Dennis Mileti* said that the evidence in the USA suggests that no disaster has led to people moving into or out of that area, except temporarily. He observed that seeing people move out of the area will not necessarily motivate others to do the same. There is no case of hazard or disaster being a cause of migration, except for construction workers.

Stuart Macaskill (Wellington Regional Council) commented that individual people react differently to knowing the hazard zoning where they might live and asked how this should be handled by local government organisations. *Dennis Mileti* stated that hazard zoning seemed to have little effect on how people perceived risk or on their movement — people do not perceive that the hazard will happen while they are there. *Steven French* commented that every time local government makes a zoning decision, property values are affected, so local government is already involved in this issue. If a local authority knew of an area susceptible to liquefaction and approved an intensification of its use, he wondered who would be liable. *Trevor Roberts* (Earthquake Commission) considered that there was a trend to extend local authority liability (Hedley Byrne v. Heller 1964, Mount Albert Borough Council v. Johnson 1979). Local authorities were liable for mis-statements and could be expected to be liable for advice they gave, bearing in mind the information they had. Hence, the more that

local authorities record hazards, the more they expose themselves to potential liability claims. *Stuart Macaskill* commented that the legal position is clear for flood risks, but not so clear for earthquake risks.

Ruth Norman (Auckland Regional Council) commented that as communications technologies improved, businesses might take the opportunity to relocate away from vulnerable areas. She said that if jobs are moved, people would be expected to move as well and asked why this does not happen. *Chris McDonald* replied that this considered mechanical processes only. People tended to stay where they are, even if logic suggests they should move elsewhere. He said that Wellington had a symbolic role too, with many companies and other organisations wanting to be in the same place as central government.

Economic and Social Framework

The economic impact of earthquake disasters

Hal Cochrane

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with the assistance of Dennis Black and Jerry Steenson, Hazards Assessment Laboratory

Earthquakes conjure up images of physical destruction. There are, however, more subtle losses that spring from this destruction: loss of critical facilities, both private and public, produce economic dislocations that induce unemployment in sectors not directly damaged by the event. Most disasters cause some form of supply disturbance that ripples forward to demanders of critical products and backward to the suppliers of raw and semi-finished ingredients. A method for estimating these losses is discussed and applied to the 1995 Kobe and the coming Wellington earthquakes. The results suggest that when scaled for the size of the two economies, the Wellington earthquake would cause losses 10 to 20 times larger than what Japan will experience as a result of the Kobe earthquake.

Introduction

> *This perpetual consumption and reproduction of capital affords the explanation of what has so often excited wonder, the great rapidity with which countries recover from a state of devastation, the disappearance, in a short time, of all traces of the mischiefs done by earthquake, floods, hurricanes and the ravages of war.*
>
> (Mill 1909, p. 74)

When asked during his presidential campaign last summer whether Mexico wasn't relying too heavily on short-term investment that could flee the country at a press of a computer button, Mr Zedillo had replied that, as far as he was concerned, "Money is money" (*Wall Street Journal*, 3 January 1995).

If Mill and Zedillo are correct, there is little a macroeconomist can contribute to the subject of this conference; society will quickly rebuild (Mill) and the economic fallout from sudden shift in investor sentiment is unimportant (Zedillo). Clearly, modern economic systems are a far cry from the mid-19th century British economy Mill analyses in his *Principles*. It is puzzling why President Ernesto Zedillo, a Yale-trained economist, would discount the risks of borrowing "short" and investing "long". As Mexico has sadly discovered, investors are a capricious lot; confidence once lost is only regained through austere and costly fiscal and monetary restraint. Most alarming is the fact that Mexico's financial collapse was triggered by a series of political events, none of which engender the real economic dislocations that are anticipated after a Kobe-like earthquake.

These two points of view are not simply strawmen offered up to make interesting reading; they reflect a school of thought that holds that economic recovery from disaster is a foregone conclusion and, if anything, a disaster serves to revitalise economies. This paper is intended as the counterpoint to this perspective. I will show that disasters, rather than stimulating growth, induce costly economic dislocations that add to a nation's debt burden. The prospects for a rapid recovery from a truly catastrophic earthquake are illusory. If short-run regional gains exist at all, they are purchased at the expense of others, either our children who inherit additional federal debt, or those living elsewhere who suffer spending cuts or the burden of additional taxes.

This paper begins by critically reviewing the very limited body of literature linking disasters and the macroeconomic performance of small open economies. Several reasons are offered as to why empirical studies have failed to detect the effects of disaster on economic growth, trade balances and prices; counter evidence is provided. The anatomy of economic disruption, including the role of debt, is discussed; the resultant framework is used to evaluate the economic consequences of earthquakes in both Kobe and Wellington. Lastly, preliminary estimates of indirect damages from the two events are contrasted in order to gain a clearer perspective regarding the risks New Zealanders face.

A critical review of what others have found

I am aware of only two in-depth studies involving the macroeconomic effects of disaster in the context of open economies. They are the series of disaster reports produced by the United Nations Commission for Latin America (ECLAC) under the supervision of Roberto Jovel (1989) and a recently published book about the political economy of large natural disasters with special reference to developing countries by J M Albala-Bertrand (1993). Both consider macroeconomic issues, but neither provides a very rigorous method for sorting out the effects of disaster from the ongoing changes that may have happened if the disaster had not occurred.

According to Jovel's analysis of the social and economic impact of natural disaster, indirect effects include:

- a reduction in economic growth;
- an increase in the public sector deficit; and
- a deterioration in the balance of payments position due to a fall in exports and a rise in imports.

He goes on to point out that post-disaster reconstruction comes at a price. It results in a reassignment of existing resources and internal savings, a reorientation of existing bilateral or multilateral loans, and/or securing of additional external financing (Jovel, 1989, p. 144). Unfortunately, Jovel offers little empirical evidence as to how significant these growth impacts may be. Just as important, the evidence that such studies glean from past events fails to adequately isolate the effects of the disaster from underlying and ongoing trends.

In contrast, Albala-Bertrand (1993) attempts to isolate the effects of the disaster from the underlying problems small open economies routinely face. He correctly points out that a simple pre- and post-disaster analysis is likely to produce erroneous results. Most developing countries have sluggish economies that are plagued by debt problems and high unemployment. It would, in his view, be more useful to contrast the performance of disaster stricken countries with the performance of those spared damage. Albala-Bertrand analyses these two groups to see if they differ with respect to pre- and post-event changes in economic performance. The following summarises his findings:

- Gross domestic product — "natural disasters, especially sudden ones, do not lower the growth rates of GDP and that, if anything, they might improve them." (p. 67)
- Price level — "Thus, it can be concluded that as a rule there appears to be no important lasting effect on inflation caused by natural disasters." (p. 67)
- Gross fixed capital formation — "as a rule, the growth rate of gross fixed capital formation significantly increases in the impact year and regains pre-disaster levels afterwards." (p. 70)
- Manufacturing — "the growth of manufacturing remained rather unchanged..." (p. 72)
- Construction — " the growth rates of construction output are positively affected by natural disasters and even more so when they happen to be earthquakes." (p. 77)
- Public deficit (surplus) — "there may be no important increase in the public deficit on account of the disaster situation alone." (p. 79)
- Visible trade deficit (surplus) — "There is a clear and sudden rise in the trade deficit on account of the disaster situation." (p. 81)
- Reserves — "the worsening of the trade balance did not involve losses of reserves." (p. 83)
- Capital flows — "there is a clear positive change in capital flows when disasters strike and that helps to explain why increases in the trade deficit do not translate into a deficit in the balance of payments." (p. 84)
- Rate of exchange — "None of these cases here considered seems to have devalued because of the disaster situation alone." (p. 86)

Why indirect losses have been difficult to detect

On the surface, it would appear that the foregoing observations point to the conclusion that macroeconomic effects are minimal or nonexistent. This would be unfortunate for two reasons. Firstly, the tests Albala-Bertrand used were very crude. Secondly, he concludes that since the disaster and no-disaster economic paths appear similar, then damages must have been minimal. This too may be in error, in that a small change in the rate of economic growth could produce lasting and large impacts.

In any event, it would be very difficult to detect indirect damage by simply focusing macroeconomic performance indicators on the year of the event or the year after the event.

The pitfall of relying on a single myopic indicator of loss is revealed in Figure 1. Figure 1a shows the true measure of direct and indirect loss. Output in the economy ratchets downward after the event. However, as Figure 1b shows, credit-financed reconstruction tends to produce "bubble employment" for a relatively brief period. The region is, however, left with debt overhang that will eventually have to be repaid. It is this repayment that causes the economy to return to the lower growth path. In restricting the analysis to a brief period after the event (one to five years), analysts have produced a more optimistic assessment of damage than is warranted once the stimulative effects are stripped away.

The foregoing discussion helps explain why regional secondary losses are so difficult to detect; they may be displaced geographically and over time. This important point is underscored in Jovel's assessment of indirect damages:

> *Thus, depending on the size and degree of the diversification of the affected country's economy, the secondary effects of natural disasters include: a reduction in economic growth and the improvement of social conditions in general; an increase in the public sector deficit because of unforeseen emergency relief, rehabilitation and reconstruction expenditures and reductions in tax revenues; a deterioration in the balance-of-payments position due to the fall in exports and the increases in imports of equipment and materials for relief, rehabilitation and reconstruction ...*
>
> (Jovel, p. 144)

In summary, it is very dangerous to try to measure secondary loss without first separating the effects of the disaster from the effects of reconstruction. Losses can be spread over time and over regions. What is needed is a solid conceptual framework to account for losses; the anatomy of indirect loss follows.

Disaster: the anatomy of economic disruption

Natural disasters conjure up images of physical destruction — buildings that have either collapsed due to ground motion or have been swept/blown away by waves and wind. There are, however, more subtle losses that spring from this destruction: loss of critical facilities, both private and public, produce economic dislocations inducing unemployment in sectors not directly damaged by the event. Most disasters produce some form of supply disturbances that ripple forward to demanders of critical products and backward to the suppliers of raw and semi-finished ingredients. Input-output methods, the most commonly utilised tool for tracing inter-industry linkages, provide little guidance as to how an economy unbalanced by disaster will restabilise. The approach presented below addresses this critical point. It is based on a newly developed methodology embodied in the National Institute for Buildings Standards (NIBS) Standardized Earthquake Loss Estimation Procedure, hereafter referred to as the NIBS Indirect Loss Model.

Forward and backward linkages

Earthquakes may produce dislocations in economic sectors that do not sustain direct damage. Activities that are either forward-linked (rely on regional markets for their output) or backward-linked (rely on

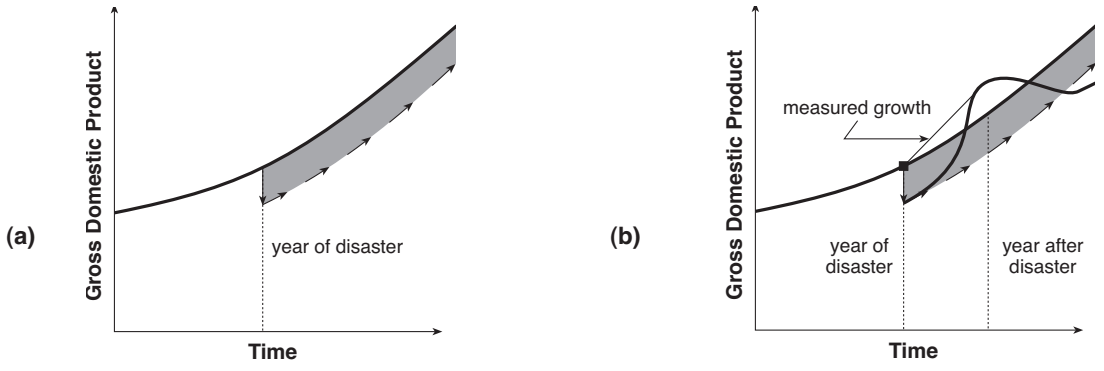

Figure 1: (a) Pure direct and indirect loss and (b) temporary effects of rebuilding

a regional source of supply) could experience interruptions in their operations. Such interruptions are called indirect damage. The extent of these losses depends upon such factors as the availability of alternative sources of supply and markets for products, the length of the production disturbance and deferability of production. Figure 2 provides a highly simplified depiction of how the direct damages induce indirect losses.

In this economy, A ships to B, and B to C. C supplies households with a final product and is also a supplier of inputs to A and B. There are two factories producing product B, one of which is destroyed in the earthquake. Indirect damages occur because:

- direct damage to production facilities and inventories causes supply shortages for firms needing these supplies (forward linkage indirect damage);
- damaged production facilities reduce their demand for inputs from other producers (backward linkage indirect damage); or
- reductions in government, investment or export demands for goods and services are caused by an earthquake.

Supply shortages and forward-linked losses

The supply shortages caused as a result of losing B could cripple C, provided that C is unable to locate alternative sources. Three options are possible:

- it might secure additional supplies from outside the region (imports);
- additional supplies might be obtained from the undamaged factory (excess capacity); and
- draw from B's inventories.

The net effect of diminished supplies referred to as forward-linked losses, the term forward implying that the impact of direct damages is shifted to the next stage of the production process.

Demand effects and backward-linked losses

Disasters can also produce indirect damages if consumer and producer demands for goods and services are reduced. If, in the example provided in Figure 2, firm B no longer requires inputs from A, then A may be forced to scale back operations. As in the case of forward-linked losses, the affected firms may be able to circumvent a weakened market by either finding alternative outlets (exports) or building to inventory.

The higher rate of unemployment caused by direct damages and subsequent indirect factory closures could cause normal household demands to erode. However, it is more likely that the receipt of disaster assistance, unemployment compensation or borrowing would buoy household spending throughout the reconstruction period. Evidence from recent events (Hurricanes Andrew and Hugo, the Loma Prieta earthquake and the Northridge earthquake) confirms that normal household demands are only slightly altered by disaster.

It is important to underscore the point that the disaster model(s) just discussed have the capacity to address both the contractions induced by the disaster and the expansion accompanying reconstruction. It may turn out that, in the short run, the latter outweighs the former, although in the long run, the reverse must hold. Disasters cannot be good for economies.

The role of international capital markets in propagating losses

Because New Zealand's economy is small and open, it is vulnerable to capital flight. The growth of liberalised trade has produced a free flow of capital, a significant amount of which is so-called hot money (speculative funds seeking high rates of return in emerging markets). The more speculative the investment climate, the more volatile exchange and borrowing rates. One need look no further than

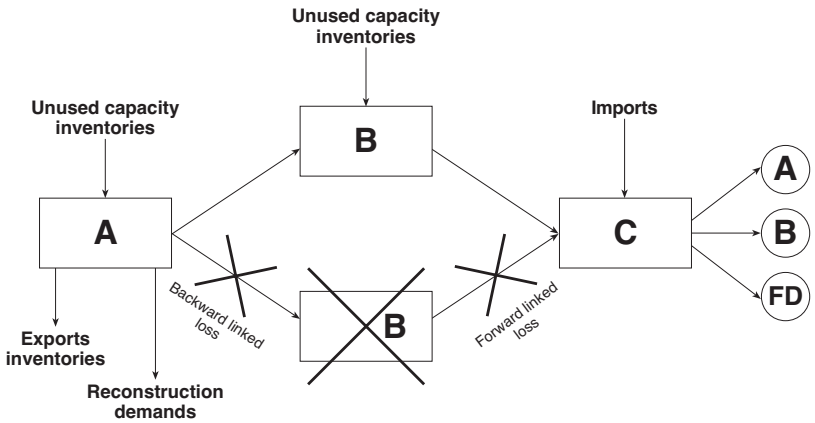

Figure 2: Indirect losses and adjustments to lessen them

Mexico's current debt crisis to observe hot money at work. Such exposure has the potential to produce two extremely important effects. Firstly, if an earthquake destroyed a significant proportion of the country's productive capacity, its GDP would decline, and with it, its ability to service debt. Secondly, cleanup and reconstruction would in all likelihood be financed through borrowing. Hence, debt would rise. These twin effects would produce a sudden increase in the ratio of debt to GDP, a change that could spell trouble, as it did in Mexico in the 1980s and now again in 1995. Figure 3 uses Brady bond data to illustrate how credit markets respond to debt. As shown, the greater a country's indebtedness, the greater the interest it must pay to secure additional debt. A large earthquake in a small, open economy such as New Zealand's could easily double the debt to GNP ratio and raise the real interest rate it must pay accordingly.

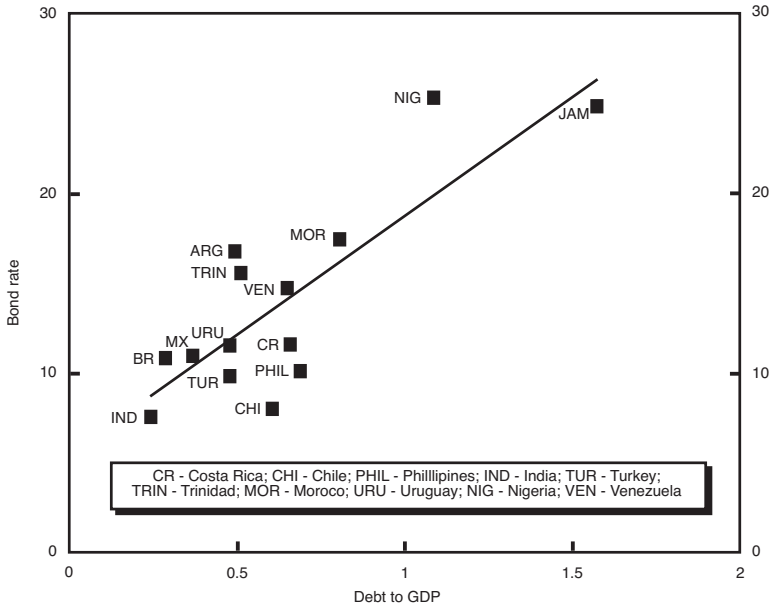

Figure 3: Yields and debt

Liberalised trade has also had a profound influence on central bank policies. The autonomy of monetary authorities has clearly eroded in direct proportion to the growth of these international capital markets. It is no longer possible for governments to pursue monetary and fiscal policies without reference to how these markets are likely to respond. So too, these markets are likely to react to a sudden change in the debt position of a country that has been rocked by disaster. Bond prices are likely to decline as investors attach a probability of default to the country's debt instruments. As the Mexican crisis clearly illustrates, the central government proved to be powerless in the face of rapid capital movements. Monetary policy would have been ineffective in countering the ensuing recession, since printing money would simply produce inflation, thereby driving nominal interest rates higher and further eroding the value of the local currency on foreign exchange markets. A stimulative fiscal policy would be equally ineffective; it would add to the country's indebtedness, thereby driving real interest rates even higher.

The effect of indebtedness on a country's real interest rates has been the subject of considerable speculation and empirical testing (see Sachs, 1985; Sachs, 1986; Sachs and Huizinga, 1987). The key point in much of this research is that a country's borrowing rate will reflect the risk international financiers perceive. Political instability and imprudent monetary and fiscal policies are often cited as causes of perceived riskiness. However, almost all agree that a country's credit-worthiness, or lack thereof, is of prime importance. The level of debt alone may be of little concern, particularly when normalised by the size of the economy (GDP), the stock of the country's resources (human and natural capital) or the size of the export sector (trade in products which earn foreign exchange). Until recently, it has been difficult to obtain a good measure of the risk premium financiers attach to these factors. However, with the advent of markets specialising in the trading of developing country debt instruments (e.g. Brady bonds, Moody's ratings) it is now possible to derive a risk function that reflects indebtedness.

Jeffrey Sachs' Brookings Papers on the subject of growth and debt underscores the importance of debt overhang in slowing the pace of growth:

> *Of all the causes of poor Latin American economic performance considered so far, the most significant seem to be trade and exchange rate policies. Put simply, the Latin debt became burdensome both because of its structure (short maturities, variable interest rate) and because of insufficient exports available to service it.... Capital flight, high inflation, and perhaps, larger public deficits*

> *have also contributed to Latin America's poor performance*.
>
> (Sachs, 1986, p. 548)

Sach's conclusions are clearly revealed in the capital movements in and out of Mexico (see Figure 4). Capital flight is a mirror image of the debt to GNP ratio.

An accurate loss accounting would include both direct damages to the capital stock plus direct and linked employment losses, plus the shadow costs stemming from additional indebtedness. Debt overhang not only slows rebuilding and capital accumulation, it produces employment effects as well. Either workers are paid a lower real wage during this transition or they will be out of work altogether. Since the wage bill or labour's contribution to production is typically a larger percentage than that of capital's, output reductions will exceed the direct loss. The extent of the reduction depends upon both the rise in real interest and labour's share of output.

The NIBS Indirect Loss Model

The NIBS Indirect Loss Model is a computational algorithm that accounts for earthquake-induced supply shortages (forward linkages) and demand reductions (backward linkages). The model is a version of a dynamic computable general equilibrium system designed to rebalance a region's interindustry trade flows based on discrepancies between sector supplies and demands. A complete description of the computational procedure for rebalancing the economy can be found in Cochrane and Steenson (1994).

A direct shock is introduced into the indirect loss model by adjusting the outputs and purchases in proportion to a sector's loss of function. Restrictions on shipments (forward linkages) and purchases (backward linkages) are computed and the resultant excess demands or supplies are derived. The first round effects are simply the direct loss of function times the inputs to that sector (backward links) and shipments from that sector (forward links). These first round effects produce excess demands and supplies, which trigger a search for markets and alternative supply sources.

In building the model, several critical choices had to be made regarding post-event household spending patterns, labour mobility, elasticity of supplies from the construction industry and the potential for product substitutions due to relative price changes. Evidence from previous disasters suggests that:

- normal spending patterns are not significantly altered;
- the workforce is highly mobile, particularly in the construction sector; and
- relative prices do not change appreciably.

Therefore, labour and construction sales are not constrained, and normal household spending is fixed and independent of current income. Given these conditions, the model assesses the net excess supplies (output less the sum of intermediate and final demands). A positive net value implies an excess supply; a negative indicates excess demand. It then attempts to resolve sectoral imbalances through a series of adjustments. If excess demand is detected, the algorithm checks to see if sufficient capacity exists in a sector. Excess capacities are a function of the user-defined level of unemployment.

Excess demands are met by first utilising surviving productive capacity (including plant and equipment found to be idle prior to the earthquake). If surplus capacity is insufficient, the model then explores the potential of importing and/or drawing down inventories. These options are also provided by the user and are expressed as a percent of pre-event capacities.

Disposal of excess supplies is logically similar. Three options are explored: inventory accumulation, exports and production to meet reconstruction demands. As in the case of the previous options,

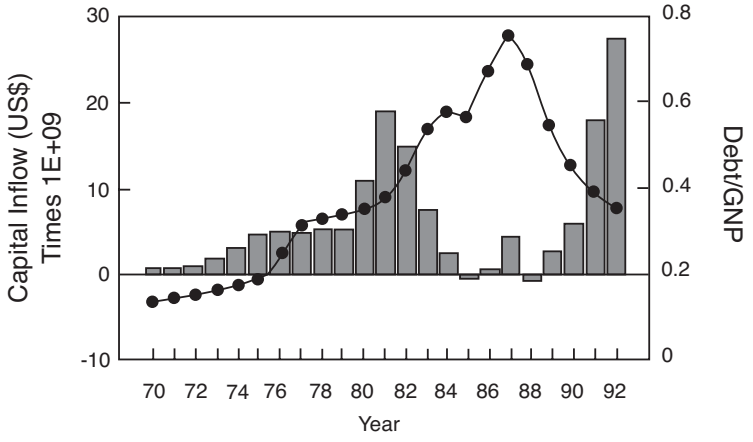

Figure 4: Capital inflow — debt to GNP (US$)

both are expressed as a percentage and are determined by the user. In most cases, excess supplies are not critical to the model's operation, particularly when reconstruction spending looms large. Much of the excess is drawn into the rebuilding process.

After completing the first round of sectoral adjustments (changes in output to meet net excess demands), the algorithm recalculates the required shipments from and to each of the economy's sectors. Production, imports and exports are again adjusted to bring markets back into balance. The process of reapportioning production diminishes the excesses detected in the previous round of calculations, but introduces new, albeit smaller, imbalances. Each alteration of output signals a new set of forward- and backward-linked requirements. The adjustment process continues until the economy is rebalanced.

The model is made dynamic by tracking the amount of reconstruction occurring each period and then permitting each sector to expand production accordingly. It is resolved period by period until reconstruction is completed. Indirect losses are computed over the entire period and discounted accordingly.

Kobe

The Hanshin earthquake, centred near Kobe, of 17 January 1995 killed over 5000 people, injured nearly 25,000, left 330,000 homeless and will disrupt the region's factories, utilities and ports for up to a year (*Nikkei Weekly*, 23 January 1995, p. 1). Estimates of both direct and indirect losses remain highly speculative. Damages to structures have been assessed at anywhere between $30 billion and $100 billion. Estimates of the impact on the Kobe economy are even more wide-ranging, some placing the figure at 5 to 10 times the direct loss:

> *More sobering was the assessment by the Japanese Chamber of Commerce and Industry President Kosaku Inaba that, taking into account the losses wrought by the disruption of economic activity, the quake will end up costing 40 trillion yen ($400 billion).*
>
> (*Nikkei Weekly*, 30 January 1995, p. 4.)

Clearly, it is early to be projecting economic consequences for the Japanese economy, but even at this stage of the rebuilding process, a few observations seem warranted.

Indirect losses. The stimulus from rebuilding Kobe will far outweigh the economic dislocations stemming from the closure of its port or dislocations within Kobe's manufacturing sector. I say this because the $100 billion price tag to rebuild Kobe is equivalent to the sum of one year's gross fixed investment in all of Japan (public, private residential and private nonresidential). We have learned from experiments with the NIBS Indirect Loss Model that such a large stimulus would overwhelm the negative consequences stemming from disruptions of interindustry shipments (particularly given that the economy is mired in a recession and significant amounts of excess capacity exist). Some of the adjustments discussed earlier are emerging as important factors in dampening the earthquake's disruptive effects on interindustry shipments. Sealand, a major shipper utilising Kobe's port, has already taken steps to find alternatives, such as diverting vessels to berths in Tokyo, Yokohama, Nagoya, Naha and Okinawa, and chartering self-sustaining cargo ships that have their own cranes (*Nikkei Weekly*, 30 January 1995, p. 4). In other cases, demands are being met by drawing down inventories. Such was reported by the Kobe-based Sumitomo Rubber Industries Ltd (*Nikkei Weekly*, 30 January 1995, p. 17).

The NIBS Indirect Loss Model was utilised to provide a rough assessment of indirect losses that the Kobe earthquake might engender. Direct damages by economic sector along with estimated repair times, pre-event excess capacity and reconstruction financing were input to the algorithm. The results, shown in Table 1, indicate that the rebuilding stimulus will be substantial, so much so as to cancel the effects of direct and indirect damages. The net loss to the Japanese economy is projected to be a mere $1.05 billion. Indirect construction gains are $129 billion. Pure indirect damages, after eliminating construction gains, are $41 billion.

Table 1: Summary of projected Kobe losses/gains

Loss/gain category (- loss, + gain)	**Discounted amount during reconstruction** (US$ billion)
Direct loss	-89.44
Indirect loss/gain	88.39
Total loss	-1.05
Construction gains	129.64
Pure indirect	-41.25

Short-term financial losses. It appears that the financial markets in Japan have grossly overreacted to the event. The Nikkei lost 8 percent of its value over the course of a 10-day period. This is clearly a few orders of magnitude greater than the most liberal of damage estimates. One would expect financial markets to internalise the direct damages, but such a large adjustment seems unwarranted. The declines appear to be broad-based, indicating that investors gave little consideration to the nature of the losses. Kobe Steel lost 7 percent of its value, the same as Nippon Glass and the Bank of Tokyo. Auto manufacturing stock lost from 8 to 10 percent of their values. It stands to reason that stock traders would discount for the effects of damage, but a broad-based sell-off seems irrational. Traders must have reached the same conclusion, given that the market has since returned to pre-quake levels. However, after one month, analysts are still unsure of the financial toll on Kobe-based companies:

> *Most analysts are sitting on their hands 'since there's little concrete data available to base any judgments on' says ... Merrill Lynch, Japan, Inc*.
>
> (*Nikkei Weekly*, 30 January 1995, p. 17)

The market seemed to behave rationally in only one regard, that is in construction stocks, which rose dramatically the day after the earthquake.

Longer-term and broader financial losses. The longer-term financial effects may be more important, particularly for the world capital market. The Hanshin earthquake effectively removed Japan as an international creditor for a minimum of one to two years. Given the Mexican debt crisis and the numerous other financially troubled economies in Latin America (not to mention the fiscal problems Russia and Eastern Europe face), real world interest rates are likely to rise. This could forestall global economic recovery or, worse yet, produce an economic downturn. In contrast, the reconstruction of Kobe is likely to produce a mini economic boom in Japan, a conclusion supported by the NIBS Indirect Loss Model. This may be one of the most important by-products of the Kobe disaster — the impact of large urban earthquakes in highly developed export-based economies will be shifted abroad.

The coming Wellington earthquake: A contrast

There are a number of similarities between the coming Wellington quake and the 17 January Kobe disaster. Both cities are important ports; their economies contribute a significant proportion of their respective nation's gross domestic product (nearly 10 percent). Soft soils and liquefaction will accentuate damage, as it did in Kobe. Reconstruction times and the pattern of damage is likely to be similar. However, this is where the similarities end. As will be shown shortly, the relative magnitude of loss, ability to rebuild and access to financial resources are all vastly different. As a result, the coming Wellington quake could pose problems for New Zealand far surpassing what the Japanese government faced (and will continue to face) in the wake of Kobe.

The Kobe disaster was used as the model event that could strike Wellington. As in the analysis previously described for Kobe, the expected damage pattern and projected time to restore loss of function were fed to the NIBS model. Direct damages were assumed to be 35 percent of the capital stock, which is estimated to be US$29 billion (see Appendix A). The interest rate needed to attract international reconstruction financing was assumed to double because of the perceived default risks associated with a greater post-disaster debt to GNP ratio. The rationale for such an assumption follows from the previously described analysis of Brady bond yields. In essence, the Wellington quake would alter New Zealand's image as a credit-worthy borrower. The sudden deterioration of the country's fiscal position would produce a financial crisis paralleling what Mexico has faced recently.

The results of our assessment are shown in Figure 5. The total loss (over the five-year reconstruction period) is calculated to be approximately US$24 billion. It is interesting to note that direct damages amount to a relatively modest proportion of this total. More than half of the loss stems from income effects, i.e. employment lost directly as a result of the quake and linked unemployment. Figures 6 to 8 break down these income effects for more detailed study. The total income effect shown in Figure 5 reflects both the positive effects of reconstruction and the costs of forward- and backward-linked economic dislocations. After the first 12 months, the gains from reconstruction dominate; however, once reconstruction is complete, at 48 months, the effect of debt repayment depresses incomes. Figures 7 and 8 disaggregate the reconstruction effects from dislocation effects.

In contrast to Kobe, Wellington will suffer substantial indirect effects. This is due to a number of factors. One important difference lies in the way reconstruction would be financed in the two countries. Until recently, New Zealand has borrowed from the international credit markets to finance its investments, whereas Japan has been a creditor. New Zealand would be forced to pay a premium to add to its indebtedness; Japan would not. The economies are different and the excess capacity assumed in the Japanese system was greater. Hence, the effects of supply constraints would be more prevalent in New Zealand.

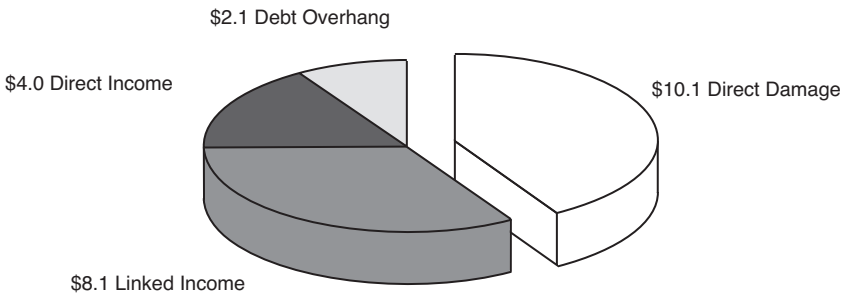

Figure 5: Composition of loss, Wellington quake (US$ billion)

What if Wellington were Kobe?: Implications for New Zealand's economy

What if Wellington were Kobe? Given the Kobe scenario, the same ground motion, liquefaction, design standards, etc., Wellington would sustain proportionately less direct loss. This result, of course, flows directly from the assumptions used. Our indirect estimate of capital at risk was tied to demographics; Kobe's population is three times that of Wellington, hence, the value damaged proved to be threefold as well. However, the indirect loss model suggests that Wellington would suffer disproportionately greater indirect losses. This is due in part to capacity considerations and differences in the two economies, particularly the amount of reconstruction assistance Kobe's residents could expect. Most startling, however, is the scale of loss (see Table 2).

Total losses are 300 to 500 percent of New Zealand's annual national savings; Kobe's loss scaled in proportion to Japan's annual savings is more than an order of magnitude lower (8 to 20 percent). When scaled according to the combined annual output of Japanese factories and service industries, the ratio shrinks to 3 to 6 percent. It is also interesting to note that the value of Japan's foreign assets far surpasses the combined cost of reconstructing Kobe and providing subsidies to all suffering indirect losses. The trade surplus for the period 1971-1991 permitted Japan to amass savings abroad of $638 billion. In contrast, the sum of New Zealand's trade deficits for the same period reveals a net foreign debt of $2.8 billion.

It is extremely important to keep these observations in mind when attempting to generalise from Japan's experience in rebuilding Kobe. It is highly unlikely that the macroeconomic consequences of the Wellington quake will be as muted as one might anticipate them to be for the Japanese economy.

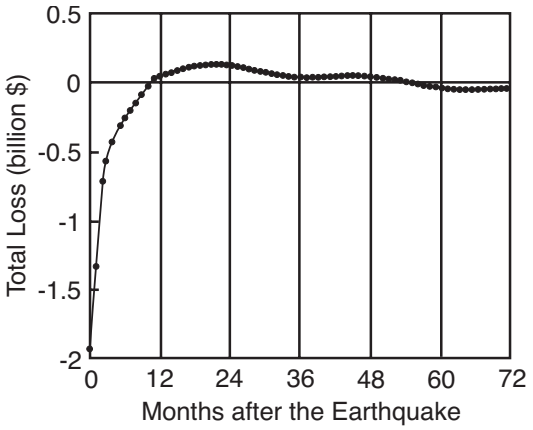

Figure 6: Total loss (US$)

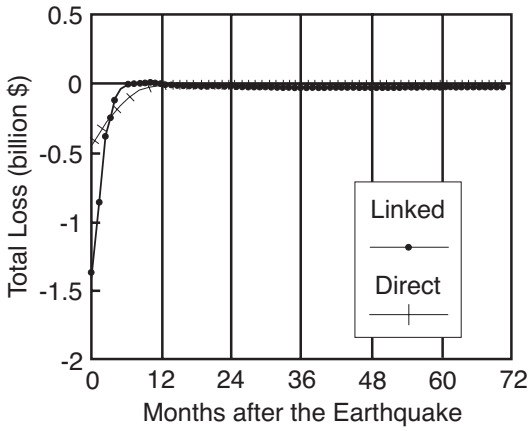

Figure 7: Direct and linked income losses (US$)

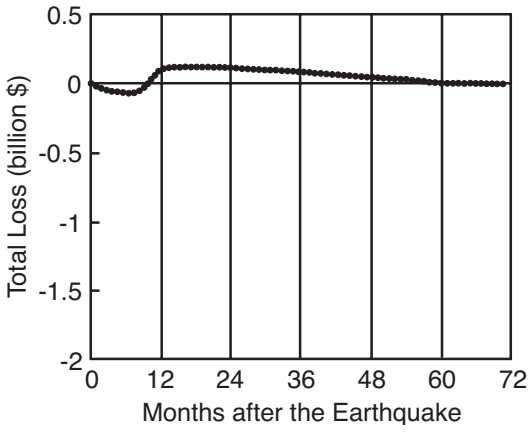

Figure 8: Reconstruction gains, Wellington quake (US$)

Rebuilding Wellington will be a much more daunting task. There will be no quick fixes, either from the central bank (printing money) or the federal government (expansionary fiscal policy). The international capital market, the primary source of reconstruction finance, will not permit it, any more than it would allow Mexico to rely on central bank money to escape the consequences of capital flight.

Based on this analysis, I can only conclude that if New Zealand's approach to preparedness and mitigation remains unaltered, a truly catastrophic Wellington quake will prove disastrous to the country's economy.

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Table 2: A comparison of economies and losses (all market values are in 1991 US$ billion)

	Kobe	Japan	Wellington	New Zealand
Population	1.4 million		350 thousand	
Economy	Manufacturing and service		Government and service	
Capital at risk	$117	$2-3 trillion	$29.1	$300
Gross Domestic Product	$402	$3349	$4	$39.5
Net factor income	$2.8	$23.7	($.2)	($1.9)
Net foreign assets*	76.5	$638	-0.3	-$2.8
Total losses		$100-$200		$20-30
Total loss (Percent of GDP)	25-50%	3-6%	500-800%	51-77%
Total loss (Percent of National Savings)		8-20%		300-500%

*Proxy measure derived by summing net exports over the period 1970 to 1991.

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Appendix A: Indirect method of estimating capital at risk

(Jones and Chang, 1993, p. 596)

There are a number of impediments to conducting a rapid damage assessment, not the least of which is obtaining an estimate of the value of capital at risk. Barclay Jones and his colleagues at Cornell University have developed an indirect method of estimating these values. By conducting an in depth survey of the built physical environment of a representative county in the United States (Sedgwick), he has been able to derive simple rules of thumb relating value to population for different classes of structures. The first two columns in the following table show the components of the classification scheme and the per capita values by component. The final two columns apply these values to the populations of Kobe and Wellington to arrive at the resultant value at risk.

	Per capita replacement cost US$ 1983	**Wellington 350,000 pop. US$ 1994**	**Kobe 1.4 million pop. US$ 1994**
INFRASTRUCTURE	12,426	6263	25,225
Subsurface	2877	1450	5840
Water	398	201	808
Sanitary sewer	425	214	863
Natural gas	919	463	1866
Interregional gas pipelines	470	237	954
Irrigation	29	15	59
Electric power distribution	636	321	1291
Surface	5326	2684	10,812
Highways	666	336	1352
Primary roads	2090	1053	4243
Secondary roads	2517	1269	5110
Alleys	53	27	108
Structures	1916	966	3889
Highway bridges	1100	554	2233
Primary road bridges	593	299	1204
Secondary road bridges	111	56	225
Railroad bridges	106	53	215
Pedestrian Overpasses	6	3	12
Vertical and complex elements	2307	1163	4683
Electricity	1098	553	2229
Generation	748	377	1518
Transmission	136	69	276
Distribution	215	108	436
Telecommunications	684	345	1389
Central offices	218	110	443
Cables, etc.	466	235	946
Cable television	52	26	106
Street lights	262	132	532
Traffic signals	40	20	81
Dam	126	64	256
Earthworks	45	23	91

ON-SITE IMPROVEMENTS	5584	2814	11,336
Surface	5501	2773	11,167
Athletic courts and fields	125	63	254
Golf courses	55	28	112
Landscaping	491	247	997
Paving	943	475	1914
Railroad track and runways	1615	814	3278
Agriculture	2272	1145	4612
Signs — on-site	71	36	144
Signs — off-site	12	6	24
TOTAL BUILDINGS	39,738	20,028	80,668
Residential	22,527	11,354	45,730
Single family and mobile homes	19,671	9914	39,932
Multiple family and group quarters	2856	1439	5798
Nonresidential	17,211	8674	34,938
Commercial	8380	4224	17,011
Industrial	3177	1601	6449
Agricultural	811	409	1646
Other	4843	2441	9831
Government	1226	618	2489
Institutional	1841	928	3737
Fratern., & charitable	166	84	337
Religious	908	458	1843
Hospital	767	387	1557
Education	1777	896	3607
School	1274	642	2586
College	503	254	1021
TOTAL BUILT ENVIRONMENT	57,748	29,105	117,228

Appendix B: The NIBS indirect loss model

The NIBS indirect loss model is a general equilibrium system which utilises the inter-industry coefficients found in input-output (I/O) tables. Supply shocks are introduced by curtailing outputs from sectors suffering damage and then recalculating the resulting excess supplies (backward links) and demands (forward links). Surviving production is reallocated iteratively until net inter-industry demands disappear. The model is not price-sensitive, but does permit import substitution and recognises that pre-disaster excess capacities could buffer the economy from the supply shock. Figure A1 provides a schematic of the model's design.

Essential computations

Direct income loss is original income times the percent output reduction due to direct damages.

Total income change is the income after the shock less the region's original income. This measures the combined effects of direct damages, pure indirect damages, and any stimulus resulting from reconstruction expenditures.

Pure indirect income loss is post-earthquake income (without reconstruction spending) less the post-event incomes (counting the effects of direct damages on regional incomes only).

Discounting for the effects of time

The recovery process is addressed by solving the model recursively, changing functional capacity as rebuilding occurs. The model is made dynamic by tracking the amount of reconstruction occurring each period and then permitting each sector to expand production accordingly. Payments for any debt that occurs are computed and

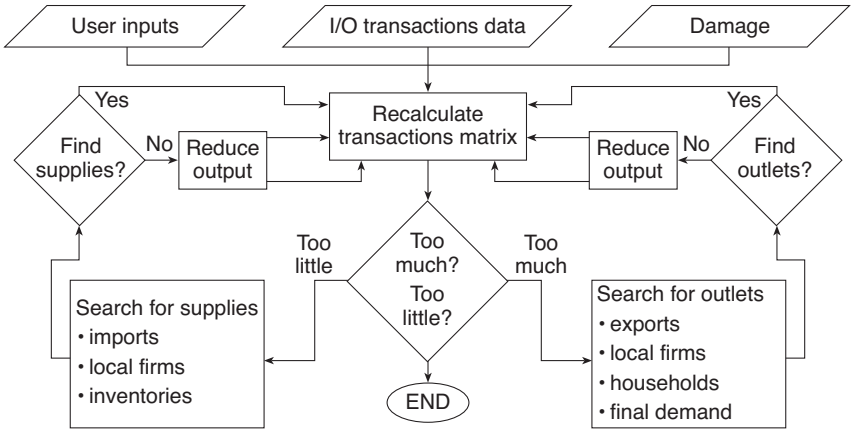

Figure A1: Indirect loss module schematic

subtracted from post-reconstruction final demands. The stream of losses are then discounted using a three percent real rate of interest. Figure A2 illustrates how function is recovered and reconstruction expenditures change.

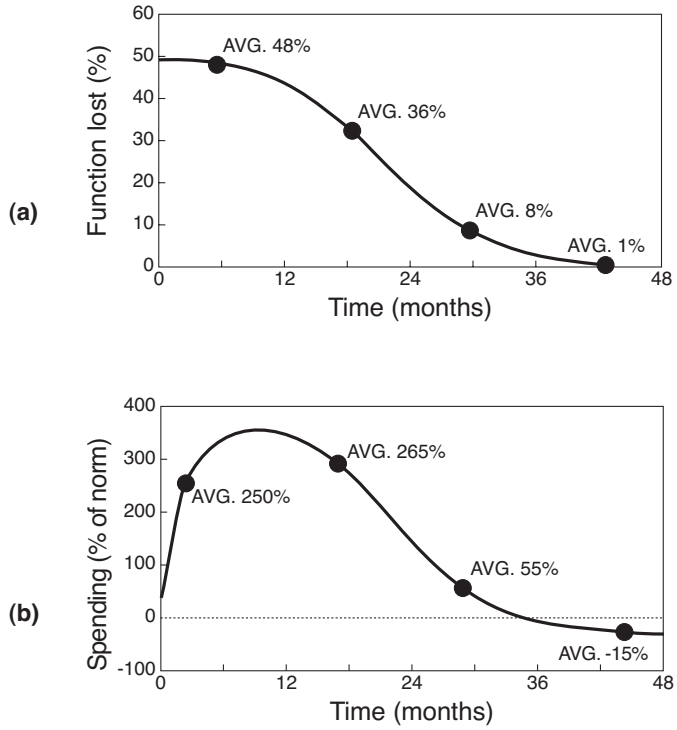

Figure A2: (a) Restoration of function with time. (b) Change in post-event spending.

Assumptions regarding pre-existing economic conditions

Tables A1 and A2 provide the values used to simulate the indirect losses for both Kobe and Wellington.

Table A1: Values used for the calculations for Kobe and Wellington

Variable	Value Wellington	Value Kobe	Rationale
Additional imports and exports	0% imp 0% exp	100% imp 0% exp	Japan can afford to liquidate financial assets in order to bring in additional construction and allied capacity.
Inventory adjustment	0%	0%	Inventories are not adjustable in either economy.
Unemployment	3%	3%	The earthquake is assumed to occur at a point of near full employment in New Zealand. Three percent unemployment was observed at the time of the Kobe event
Discount rate	3%	3%	Assumed.
Total construction	$10 billion	$80 billion	Observed.
Original capacity	$3 billion	$36 billion	Observed.
Outside assistance	$0 billion	$80 billion	Japan's central government would assist in rebuilding.

Table A2: Loss of function for different sectors

	Months after the event									
Economic sector	**1**	**2**	**3**	**6**	**9**	**12**	**24**	**36**	**48**	**60**
Agriculture	0.02	0.02	0.01	0.01	0	0	0	0	0	0
Mining	0.03	0.02	0.02	0.01	0.01	0	0	0	0	0
Construction	0.1	0.08	0.06	0.04	0.02	0	0	0	0	0
Manufacturing	0.3	0.26	0.22	0.18	0.14	0.1	0.06	0.02	0	0
Transportation	0.8	0.57	0.34	0.11	0	0	0	0	0	0
Trade	0.3	0.25	0.21	0.16	0.12	0.07	0.02	0	0	0
Finance, real estate and insurance	0.03	0.02	0.01	0	0	0	0	0	0	0
Services	0.1	0.08	0.06	0.04	0.02	0	0	0	0	0
Government	0.1	0.08	0.05	0.03	0	0	0	0	0	0
Construction spending	0.3	0.9	1.8	2.1	2.1	1.8	0.9	0.38	0.3	0

Disaster recovery as a social process

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This paper takes the perspective that recovery from disaster is not merely concerned with the re-establishment of the physical or built environment; that is, community recovery should not be conceptualised as an outcome, but rather as a social process that begins before a disaster occurs and encompasses decision-making concerning emergency response, restoration and reconstruction activities following the disaster. Put another way, reconstruction is less a technical problem than it is a social one. In order for successful post-disaster decisions to be made, however, there must be an awareness of the pre-disaster conditions that create situations of social and structural vulnerability, putting some segments of the society at greater risk in the event of an earthquake than others. From this perspective, what becomes important is how those decisions are made, who is involved in the decisionmaking, what consequences those decisions have on the social groups within the disaster-stricken communities, and who benefits from these decisions and who does not.

Introduction

When we think about the immediate consequences of a disaster, vivid images usually come to mind. In the case of earthquakes, the images are of twisted metal that was highways and bridges, blocks of crushed concrete and broken glass filling city streets, heaps of brick and mortar rubble that were once homes and pancaked or collapsed structures that had been places of employment.

While the Wellington region has not experienced the devastation of a catastrophic earthquake in modern history, similar to the one that struck Kobe earlier this year, projections of losses have been estimated. For example, Parr (1991) estimates that if a Modified Mercalli Intensity X earthquake occurs in the Wellington region, the minimal governmental liability (deriving from claims under the Earthquake and War Damage Act) would be close to NZ$10 billion. However, this figure may be understating the actual losses, since Falck (1989), using data from the 1987 Bay of Plenty earthquake, reports that 10 percent of the households had no earthquake coverage and another 10 percent were under-insured.

An emphasis on physical reconstruction

With an ominous earthquake scenario projecting catastrophic damage and disruption for the Wellington region, it would not be unrealistic to hear the term "recovery" used almost interchangeably with "reconstruction," "restoration," "rehabilitation" and "redevelopment." The emphasis is on putting the community back together again — on reconstructing the built environment so that people can again be housed, businesses can again serve customers and markets, and the infrastructure can facilitate the tasks and chores that must be undertaken in both peoples' and organisations' day-to-day lives.

In fact, this was the approach taken by Haas, Kates, and Bowden in the first study to specifically address this topic in 1977 in a book entitled *Reconstruction following Disaster*. In this influential first academic work to investigate this topic, they identified three phases of the post-impact period associated with recovery. The first they called restoration, which refers to attempts to "patch up" the damaged physical and social systems. These were "temporary measures" taken in the first days or weeks after the disaster event in order to make the community functional as quickly as possible. The next phase, replacement reconstruction, emphasised "restoring capital stocks to pre-disaster levels" and generally returning the appearance of the community to normal. This second phase could last from several months to a few years following the disaster event. The last phase was referred to as commemorative, betterment and developmental reconstruction and the emphasis was on promoting future economic growth and development within the community. This phase — which we now often refer to as "mitigation" and which has been associated with sustainable development — was expected to last until the onset of the next disaster.

This research was extremely useful in focusing the attention of those in the disaster research area on the different types of activities that take place during the recovery process and on the importance of damage

to building stocks and the infrastructure for the recovery process. The authors also incorporated a set of recommendations to planners and community decisionmakers about how to facilitate these processes — that is, how to make the reconstruction following disaster more efficient.

During the past 15 years, several researchers have used this approach, emphasising the physical or material aspects of collective life to investigate how disaster-stricken communities become rebuilt (Geipel, 1982; Oliver-Smith, 1993; Oliver-Smith and Goldman, 1988). They have conceptualised reconstruction in terms of replacement of what was lost or restoration of the original system. This approach has also been useful in cross-cultural comparisons of recovery from material losses sustained due to disaster events (Kreimer, 1978; Bates, 1982; Bates and Peacock, 1993).

Researchers using this perspective have discovered that communities strive to re-establish themselves in forms similar to pre-disaster patterns (Aysan and Oliver, 1987) and that this desire for continuity and familiarity in post-disaster reconstruction may actually enhance psychological recovery (Marris, 1986; Oliver-Smith, 1992). For example, in their explanation of the difficulties families confront in their attempts to recover, Trainer and Bolin (1976) identified three types of general constraints on families' ability to recover. The first, and most obvious, is the physical constraint brought about by the destruction of community facilities and other commercial amenities that were available in the pre-disaster community. With the loss of these physical, structural resources, there are many functions that the family can no longer fulfil in normal ways. Because of the loss of these physical resources, the family faces a temporal constraint. The time it takes family members to carry out their routine day-to-day activities (such as finding food and cooking fuel, preparing meals, bathing, etc.) requires much more time and effort. Because routine aspects of family life are consuming more energy, time is taken away from other activities (work, leisure, socialising), including rebuilding community structures. Because of these first two deviations from normal life, family members experience a third constraint — a subjective constraint. As the taken-for-granted nature of one's physical environment is shattered and as one's daily routines become radically altered, any comfort derived from integration into the social life of a community disappears.

A second group of researchers that have focused on reconstruction, using the model developed by Kates and his colleagues, have taken the view that disasters can be seen as opportunities to address long-term material problems in housing and infrastructural systems, recasting reconstruction into a developmental process of reducing vulnerability and enhancing future economic capabilities (Cuny, 1983; Anderson and Woodrow, 1991; Kreimer, 1979). Although this approach has most frequently been applied to developing countries, where disaster losses are extremely high, including capital investments in new major economic and governmental projects, recent disasters in the United States — such as Hurricane Andrew in southern Florida — have demonstrated the desire among some social groups to use such an event as an opportunity to replan and redevelop a poor, economically ailing community.

Recovery as a social process

But if one takes this perspective that community recovery can be equated with outcomes in the built environment solely, the sociological significance of what really transpires in the post-disaster community is missed. Recovery is not merely an outcome, but rather it is a social process that begins prior to disaster impact and encompasses decisionmaking concerning restoration and reconstruction activities. It must also be recognised that what takes place during the aftermath of a disaster had its roots in the pre-disaster phases of response and recovery planning as well as mitigation implementation.

Dynes and Quarantelli (1989), for example, have argued that:

> *... how recovery proceeds is rooted in the social structure and fabric of the impacted society. Put another way, reconstruction is less a technical issue than it is a social matter. Reconstruction only partly involves bricks and land use codes, it mostly concerns social values and group interests.*

From this perspective, what becomes important is how those decisions are made, who is involved in the decisionmaking, what consequences those decisions have on the social groups within the disaster-stricken communities, and who benefits from these decisions and who does not.

Implicit in the sociological notion of "community recovery" is the assumption that social groups will experience the recovery process differentially.

Communities are not monolithic entities, consisting of only one type of residential group. Although we do sometimes characterise cities by their major demographic and social trends, this tends to give the false impression that other social groups do not exist or, at least, are not significant. But all communities are made up of a variety of social groups — the elderly and the very young, the very wealthy and those on welfare, ideological conservatives and radicals, different racial and ethnic groups — to name only a few.

Because these social groups differentially experience the recovery process, the overall discussion of the community recovery process must include a consideration of pre-disaster intergroup dynamics and relationships, and their relative political influence. These groups will vary markedly in their ability to influence the decisionmaking process in their communities, depending on:

- their relative size in the community;
- their political linkages to those in decision-making positions;
- the informal as well as organisational contexts within which contacts take place; and
- the cultural history of intergroup relations that has preceded the current encounter.

It must be remembered that these relationships do not change substantially in post-disaster contexts (cf, Nigg and Tierney, 1993). Although there may be brief periods of time following the actual impact of the disaster agent on the community during which social group barriers are lowered and an altruistic, therapeutic community arises (Fritz, 1961; Barton, 1969), providing a context in which supportive and altruistic norms can emerge and enabling a collective response to victims of the immediate disaster event, these periods are usually very short-lived. As has been frequently evidenced, community conflict soon replaces altruism as communities move from the immediate impact period into the relief and long-term recovery phases of a disaster.

Family recovery

In all societies, the family is the basic unit of social organisation. To date, the majority of the research conducted on disaster recovery has focused on the family, asking the following types of questions: What types of families are most disrupted? What types of families are likely to recover most quickly? What accounts for differential rates of family recovery? In most cases, this research has also focused on natural disaster agents rather than on technological (or human-created) agents.

During times of disaster, the extent to which families are disrupted — their dwellings damaged or destroyed, their members injured or killed, their inability to carry on the necessary daily tasks of providing shelter and sustenance for members — is an indication of the extent to which the general community will also suffer disruption.

Bolin and Trainer (1978) offer the earliest processual definition of what family recovery entails. Family recovery is the outcome of a sequence of activities in which families utilise resources to overcome disaster-induced losses. This conceptualisation of recovery as process emphasises the action-orientation of the family as it tries to cope with the losses it sustained by actively using resources available to it to return to some desired or acceptable pre-disaster condition. Families not only use their own resources but may also seek assistance from their extended kin group as well as from extra-familial sources (such as governmental programmes and non-profit organisations).

Generalisations on family recovery

Several models of family recovery have been developed and tested by the research community using data from households interviewed at various intervals following the disaster to determine how well they recovered or how they attempted to do so (cf Bolin 1976, 1982; Bolton, 1979; Drabek and Key, 1984). Not only have the components of these models differed, but the passage of time between the event and when the data were collected varies from six months to ten years.

Despite these differences, generalisations can be drawn about how and what types of families are likely to recover. While the number of studies is relatively small, four topics have relatively consistent findings. In each of the following sections, these generalisations will be investigated for their application to the Wellington region.

Importance of the extended family. From Quarantelli's (1960) early comment on the protective functions of the family during crisis periods, researchers in the disaster area have generally found evidence debunking the notion that the nuclear

family is isolated from its extended kin group, whose importance has been increasingly diminished. Linkages to kin groups are strengthened immediately following the disaster event and continue into the recovery period as the victim family's extended kin group provides assistance to the victim family (Drabek and Key, 1976, 1984; Bolin, 1982). One of Bolin and Trainer's (1978) three models of the ways families recover is the "kinship" model, whereby victim families rely primarily on resources from their extended kin group. The importance of these enduring relationships has consequences for both emergency and temporary housing, and for the types of needs that special population groups (e.g. the elderly, the disabled and families with young children) who may become homeless will have.

Data from the 1991 Wellington census indicate that the Wellington region is rather stable with respect to population: 9 percent of the country's population live in this region and the population change rate is very low. Of the approximately 398,000 people living in the region, 22 percent are under 15 years of age while 14 percent are over 60. Of the approximately 142,000 households in the Wellington region, 75 percent are living in single-family dwellings and 71 percent either own or are buying their homes. Currently, 7 percent of the households in the area already consist of extended families and another 7 percent contain unmarried people who are residing together. Fifty percent of those who are 15 years of age or older are married, only 15 percent are separated, divorced or widowed. The remainder of the adult population (35 percent) have never been married, a third of whom may still be living at home with parents due to their ages (between 15 and 19). Following a world-wide trend, 21 percent of the households in the Wellington region are single-person households, characterising the region by a relatively low density rate of only 2.8 persons per household.

From this profile of residents of the Wellington region, what types of housing problems might we expect to result from the scenario earthquake and how would those problems affect recovery? The first problem concerns the need to project the number of households that would become dislocated and in need of both emergency shelter as well as temporary housing following a high-intensity earthquake. From the Northridge and Hanshin (Kobe) earthquakes, it was learned that housing losses can have devastating effects on the recovery effort. In Kobe, approximately 21 percent of the population of the city became homeless within seconds. While some larger apartment buildings were affected, single-family dwellings were the most vulnerable type of housing units and resulted in the largest number of dislocated families. If 20 percent of the population in the Wellington region became homeless, are there plans for sheltering (including the provision of food, water and medical care for a few weeks) or rehousing approximately 80,000 people? In Kobe, one of the most difficult problems the government is confronting with respect to the homeless victims is where to locate temporary housing units, given the scarcity of vacant land in the Kobe area. No recovery planning had taken place in Kobe prior to the quake to anticipate possible housing losses or to consider what types of programmes might be needed to rehouse homeless victims. Unlike many other disaster events, the Hanshin earthquake was unusual in that many of the homeless victims went to shelters, rather than to homes of relatives or friends in the same area. This was principally due to the widespread loss of homes, resulting in the inability of people to take refuge outside of government-operated shelters. In other words, extended families could offer some assistance, but it meant that victims had to leave the immediate area, disrupting neighbourhood patterns and friendship networks. Similar situations have been observed, to a much lesser extent, in Northridge (the so-called "ghost town" phenomenon), which resulted in some heavily damaged neighbourhoods being completely abandoned.

Following the Northridge earthquake, 22,000 people were made homeless in the city of Los Angeles alone, and moderate to severe structural damage affected 21,000 residential units. Unlike Kobe, however, only 2000 of the damaged residential structures were single-family homes (ad hoc Committee on Earthquake Recovery, 1995), and apartment complexes were found to be most vulnerable. However, also unlike Kobe, the vacancy rate in Los Angeles — even after the earthquake — was sufficiently high (in the most damaged areas) to allow people to be rehoused quickly through the provision of a variety of local, state and federal housing grant programmes. By leaving people close to their original neighbourhoods, employees were still able to get to work in usual ways and children did not have to be relocated from their schools, providing a minimum of broader social disruption.

Without knowing more about the condition of the housing stock in the Wellington area, we can predict

little regarding the magnitude of potentially homeless victims. Questions that need to be answered include: What seismic design requirements have been required for single-family dwellings — since those are the most frequent type of structure used by almost three-quarters of the population — in the Wellington region? For example:

- What proportion of single-family dwellings might not be anchored to foundations?
- What proportion might not have roofs and walls tied together?
- What proportion might have cripple wall foundations?
- What proportion may have masonry chimneys tied to roof or wall systems without adequate independent support?

In terms of recovery planning, attention must also be directed to areas where the building stock is undergoing deterioration, gentrification, redevelopment or changes in use. For example, in a report to the Wellington City Council on inner city housing needs (Housing and Community Development, 1993), an unmet need was identified for housing in the inner city, especially for students, young professionals and older people without children. The report identified a high vacancy rate in the central business district of Wellington, principally in commercial buildings that were 30 to 45 years old and could be converted to residential units by developers. However, the report cautioned that the conversion of these structures should be monitored since:

> *developers may not give adequate attention to the strengthening [for seismic resistance] of older buildings in this vulnerable area of the city...*
>
> (p. 6)

In this instance, earthquake hazard mitigation is directly related to recovery planning; being aware of the changed uses of these structures may directly change both response and recovery strategies for the inner city area.

Among the population groups that may need additional consideration are the elderly. One of every six people in the region are over 60 years of age, and many of them will have health and mobility problems. According to the *Quarterly Commentary for Wellington City* (October-December, 1993), one-half of Wellington's elderly live in properties rented by the city. What is the likelihood that a proportion of these properties could become damaged in the scenario earthquake and what types of alternative housing might be available? If a sufficient proportion of the elderly live alone, what types of special emergency response efforts (like search and rescue) as well as long-term services may be necessary to protect the health and welfare of these more fragile members of society, many of whom probably live on small fixed incomes and have medical needs that require professional monitoring? In the Northridge earthquake, several group-living facilities (including mobile-home parks and long-term nursing homes) for the elderly — those who required round the clock nursing as well as those who were relatively independent — were damaged severely, requiring the identification of group-like facilities in hotels farther from the impact areas. This was an unexpected problem that required extensive efforts to be undertaken in both the immediate and longer-term time frames, often resulting in a great deal of disruption for the residents of these facilities because they often had to be moved more than once.

The effects of low socioeconomic status. Poorer families are not only more vulnerable to disaster-induced losses (Miller and Nigg, 1993), but also have more difficulty recovering (Kilijanek and Drabek, 1979; Bolin, 1982; Bolin and Bolton, 1986). Due to their lack of economic resources during normal times, poorer families are often housed in substandard structures in hazard-prone areas, making them more vulnerable to natural disaster agents. Despite the fact that poor families often have the greatest needs following a disaster, they have the most trouble acquiring extra-familial aid.

According to the 1991 Wellington census, 6 percent of the region's residents 15 years of age and older are unemployed and another 30 percent do not consider themselves in the workforce for various reasons — retirement, homemaker, student or incapacity. For almost one-third of the region's adult residents, annual income is less than NZ$10,000. The *Quarterly Commentary for Wellington City* (March 1994) reported that the number of jobs in Wellington declined by about 15 percent between 1989 and 1993, and that the trend may continue.

Several questions must be answered about these poorer households before recovery planning can take place:

- Where are these households located in the region?
- Will some communities have more poor families with relatively few resources that they must prepare to shelter and rehouse?
- Are these poorer households located in more vulnerable structures, making them more likely to become homeless victims requiring a large variety of services?
- Are these households more likely to contain elderly on small, fixed incomes who may not be able to qualify for conventional loans to repair damaged homes?
- How many of these poorer households contain members who are physically handicapped who may require expensive medical assistance to live outside of their homes?
- What types of unemployment benefits are available to the poor, who may be functioning on the margins of solvency under normal conditions and who become unemployed due to earthquake damage or disruption of their employers' facilities?

It must be remembered that the social relationships and conditions that exist prior to any disaster will be carried forward into the relief and recovery periods. Those individuals without financial resources will find it even more difficult to meet daily needs. Those with compound problems — the poor elderly, poor single-parent families, poor families with disabled members — will not only find it difficult to find temporary assistance, but the organisational and social relationships that made it possible to function in normal times may be absent for an extended period of time following the earthquake, necessitating planning not only to provide immediate services but to replace the social supports that made it feasible for them to remain independent with augmented assistance programmes.

The effects of race or ethnicity. While there are some cultural differences, racial and ethnic minority families generally have the greatest difficulty recovering from disasters (Moore, 1958). They are least likely to have insurance to cover their losses (Bolin and Bolton, 1986), their extended kin groups have fewer resources to provide and they rely much more extensively on governmental aid for relief and recovery. However, they also have the greatest difficulty obtaining external aid (Dash, 1995). Even when they do receive external recovery assistance, however, they are more likely to evaluate it as inadequate and to recover economically more slowly. In most societies, socio-economic status and race are interrelated in complex and often different ways. Ethnic and racial minority groups are disproportionately poorer than the dominant racial/ethnic group in a society. Because they are poorer, they are also disproportionately more vulnerable, both to the disaster agent and to the negative impacts of long-term recovery.

All recovery planning must take into account the "natural" spatial and social ethnic or racial communities that make up the metropolitan region. These groups will have historical relationships with local and national governmental systems that may either facilitate or hinder their post-disaster access to disaster services. To the extent possible, community-based groups in each of these communities should be included in the pre-disaster response and recovery planning in order to assure that their cultural norms and values can be accommodated within the recovery plans. For example, it may be more practical to have the community-based organisation plan to set up shelters and feeding operations within their own neighbourhoods than to expect groups that typically have not had good social relations in the past to co-locate in the same facilities. Also, by bringing into the planning process members of these different communities before a disaster occurs, members of those groups are more likely to become familiar with the governmental structures that will lead the response and recovery process. So-called "system awareness" may, therefore, be higher, resulting in better outreach efforts within those communities following the disaster and a more equitable distribution of relief and recovery resources.

Urban-rural differences. A comment should also be made concerning urban-rural differences on family recovery. As crucial as this variable has been in explaining different patterns of family life, it has not received much systematic attention from disaster researchers. One reason for this omission is probably due to the single case-study method used in studying disaster events. However, Bolin (1982) was able to make some observations about the influences of residential location — that is, family residence in an urban or rural environment — in his comparative study of disaster events. Rural victims were found to use their kin group as a source of emergency shelter more often than did urban victim families. In rural areas, high-income victim families had fewer losses

than lower-income families. Rural families were also less likely to receive extra-familial assistance (that is, less aid and from fewer sources) than did urban victim families.

In recent work on disaster recovery completed by the Disaster Research Center (DRC), significant differences were found in the relationship between social context (that is, whether the community is basically in a rural or an urban area) and the recovery process (Miller and Simile, 1992; Simile, 1995). Due to the physical and social invisibility of the rural poor, they are often overlooked in terms of efforts to assess their needs and to provide resources for their recovery.

Business recovery

As significant as the economic sector obviously is in the recovery process for any community, it has received almost no attention from social scientists involved in disaster research. In his extensive review of disaster research findings, Drabek (1986) does not even mention the economic sector. After an exhaustive review of the literature on business recovery following a disaster, Dahlhamer (1992) found only three studies (Durkin, 1984; French et al., 1984; Nigg and Tierney, 1990) that addressed this issue.

However, sprinkled throughout the disaster literature are indications of the disruption of community life due to the disruption of the business community. For example, one of the first events that documented the impacts of disaster on business communities was the Xenia tornado of 3 April 1974. The entire downtown area, housing the city business district, was devastated. Approximately 155 commercial and four industrial businesses in 121 structures were destroyed, including eight supermarkets. One hundred other businesses suffered major or minor damage (DRC, 1976). More recently, the downtown business district of Santa Cruz, California, was devastated by the 17 October 1989 Loma Prieta earthquake. It was estimated that 60 percent (approximately 650) of the downtown businesses were destroyed or sufficiently damaged to require at least temporary closure (DRC, 1993).

There are two compelling reasons why communities should actively address the business recovery process. First, businesses as units of analysis have many of the same characteristics as households: they vary in size, they have incomes, they age, they have socioeconomic locations in the social structure, they are physically housed in structures that are more or less vulnerable, they may be embedded in a network of community organisations, and the types and amount of resources they have access to varies. On the basis of these characteristics, some businesses are obviously going to be less vulnerable to a disaster agent and more capable of recovering from disaster impacts. This raises questions about the adequacy of programmes available to businesses to assist them to recover and whether those programmes have similar problems of availability for certain classes of businesses (as was found for certain classes of families). Dahlhamer (1992) did find evidence that some types of businesses have greater success in obtaining governmental loans. In general, he found that businesses with older owners located in a building also owned by the business owner and whose owner had good credit could get a federal loan from the Small Business Administration following a disaster. He also found that some business owners got more favourable loan terms than others. Dahlhamer concluded that the federal disaster loan program was systematically not assisting those businesses that need the greatest amount of assistance to recover, but was aiding those businesses that could have obtained loans from commercial sources.

Secondly, businesses play vital roles in communities by providing goods and services to specific client groups, as well as providing employment opportunities for community residents. If businesses must close due to structural damage, inventory losses, losses of employees or losses of markets, what consequences are there for both family recovery and community recovery? Obviously, the longer businesses are closed, the greater the economic strain on families whose members were employed by those enterprises. Also, when businesses that provide basic goods and services (e.g. markets, clothing stores, gas stations, banks, utility companies) to community residents are not operational, the greater the temporal constraint — the length of time it takes household members to complete routine daily tasks — on family recovery (Trainer and Bolin, 1976).

Beyond these obvious implications for business recovery, community recovery can be affected in two important ways. Firstly, the longer commercial enterprises are non-operational, the greater will be the impact on revenues for the local government. Local governments receive a great deal of their operational income by collecting fees and taxes on commercial transactions or from property taxes.

Following a disaster, a community's revenues from these sources may drop dramatically until property owners can repair commercial buildings and businesses can recover sufficiently to put employees back to work, providing goods and services. While there is some compensation for the decline in these revenues to local government from the infusion of external aid, this intervention is short-lived. If the business sector does not sufficiently recover, community-based services (public works maintenance, social and health services, schools, cultural and recreational programs, and planned economic development initiatives) will be cut back, delayed, or eliminated.

Secondly, some businesses serve the needs of particular neighbourhoods and rely on local residents to use their establishments. When such businesses cannot recover from a disaster, what consequences does this have for the neighbourhood or the community that business serves? Some research has suggested that the character of the community may actually be changed if people have to leave their neighbourhoods to market, shop, bank and use recreational facilities, or if their children have to go to schools at a greater distance from their homes. Bondedness to the neighbourhood may decline and the businesses that remain may actually be hurt by the general decline in foot-traffic or normal transportation patterns that had supported them in pre-disaster times. In Los Angeles, following the Northridge earthquake, at least a dozen "ghost towns" have been identified, where the owners of both damaged businesses and residential properties have been unable to recover from the earthquake and, in effect, walked away from the destroyed properties, leaving abandoned, blighted neighbourhoods.

In considering the ways that community businesses can be harmed, communities must not just concentrate on the primary causes of losses; that is, on the effects of ground shaking on buildings and their inventories. While this is the most dramatic form of loss, it must be remembered that businesses can also sustain secondary losses from interruptions to lifeline systems (e.g. electrical systems, water and sewerage systems, telecommunications systems, transportation systems and natural gas systems). A project undertaken by the Centre for Advanced Engineering at the University of Canterbury (1991) reviewed the likely performance of the Wellington region's major lifeline systems to two different types of earthquake events. It was concluded that lifeline systems throughout the region were likely to sustain major disruption from groundshaking, liquefaction, landslides and land subsidence.

A question that has been recently addressed by the Disaster Research Center is the extent to which lifeline disruption affects business continuity; that is, how does the loss of specific lifelines effect the ability of a business to function if its physical facilities, equipment and inventory have not sustained sufficient damage to cause the building to close (Nigg and Tierney, 1994). This is an extremely important question, as the recent Hanshin earthquake illustrated, since the effects of lifeline failures go far beyond the immediate impact area and can affect the economic health of an entire metropolitan area, even to those businesses that could otherwise remain open and contribute to the region's general recovery, as was the case following the Northridge earthquake last year. In a study of businesses in Memphis, Tennessee — a metropolitan area that would be affected by an earthquake on the New Madrid fault system — a random sample of businesses was used to determine the importance of various lifelines to businesses in different economic sectors and the amount of time the business could remain open if that lifeline failed.

Table 1 presents the general importance of different systems for all of the businesses included in the study. Two clusters of services emerged: electricity and phone services were very important to business function, while the criticality of water, wastewater, and natural gas systems was modestly important. When asked how long the business could remain open without access to particular lifeline services, we see a similar pattern. Without electricity, the vast majority of firms would cease operating immediately and most could operate only half day at most without telecommunications (Table 2). Business could continue for approximately two days without either water or wastewater and natural gas customers could continue for almost a week without that service.

Further analysis of this data, however, indicated that the size of the business (i.e. the number of workers employed) and economic sector did matter for some lifelines. Table 3 presents the median numbers of hours that businesses, by size and sector, could continue to operate without water. It was found that 25 percent of all businesses would have to shut down immediately if their water system failed, but 12 percent reported that they could function indefi-

Table 1: Importance of lifeline service to business operations under normal conditions

Importance	Lifeline Services				
	Electricity (%)	**Water** (%)	**Natural Gas** (%)	**Wastewater Treatment** (%)	**Telephone** (%)
Very Important	82	27	18	23	78
Important	14	34	29	32	17
Not very important	3	31	39	33	3
Not important at all	1	8	13	13	2
TOTAL	**100**	**100**	**99[1]**	**101[1]**	**100**

[1]Does not total 100% due to rounding.

nitely without water. Although Table 3 indicates that there are some differences across sectors, these differences were insignificant. However, small businesses, regardless of economic sector, were found to be significantly less dependent on water availability than were larger businesses. Considering other lifeline systems' disruption, it was found that:

- For electrical systems, 59 percent of the area's businesses would have to shut down immediately, and this seemed to affect both large and small businesses, and businesses in all economic sectors equally.
- For telecommunications systems, 45 percent of all businesses, regardless of size, would close immediately, but wholesale and retail businesses could stay open significantly longer than other types of businesses.
- For wastewater (or sewerage) systems, 20 percent of businesses, regardless of size, would close immediately, and those businesses in the service sector would have to close significantly sooner than other businesses.
- For those companies that use natural gas, 18 percent would close immediately, regardless of size or economic sector.

While these statistics reflect assumptions that business owners have about their dependence on lifeline systems for their ability to remain open, these are some of the best indicators we have available upon which to make assessments about the secondary impacts of an earthquake on business operations. Getting an indication of the effects of lifeline interruption on the economic viability of an entire region following an earthquake allows for various types of planning to take place — preparedness planning for businesses with respect to the identification of back-up systems (e.g. electrical generators and cellular phones); the prioritisation of mitigation measures and restoration plans for lifeline providers, which would include the lesser damaged areas of the region if they contain sufficient economic enterprises. If one knows what businesses are dependent upon which lifeline systems, it allows emergency managers, in conjunction with lifeline service providers and the business communities, to engage in informed, strategic planning before and following a disaster for ways to reduce economic disruption.

Conclusion

When we talk about community recovery from disaster, our orienting concept is one of a system that is responding to stress. System stress takes place when demands on the social system exceed the system's ability to respond to demands being placed on it (Haas and Drabek, 1970; Mileti et al., 1975). The greater the impact of a disaster agent on a community's built and social environments, the greater the amount of stress on the system. How communities respond to long-term stress in the post-impact years will have consequences for families, businesses and the local government.

Table 2: Median number of hours businesses could operate with lifeline loss

Utility	Median Number of Hours
Electricity	0
Water	48
Natural Gas	120
Wastewater Treatment	48
Telephones	4

Table 3: Median number of hours businesses could operate with loss of water by type and size of business

Type and Size of Business	Median Number of Hours
Wholesale and Retail Trade	
Small[a] (N=124)	120.0
Large[b] (N=36)	24.0
Manufacturing and Construction	
Small (N=64)	72.0
Large (N=26)	48.0
Business and Professional Services	
Small (N=129)	24.0
Large (N=52)	23.5
Finance, Insurance, and Real Estate	
Small (N=71)	120.0
Large (N=23)	8.0
Other[c]	
Small (N=61)	168.0
Large (N=29)	72.0
All Businesses (N=627)	48.0

[a] Small businesses are those with 19 or less employees.

[b] Large businesses are those with 20 or more employees.

[c] "Other" consists of agricultural, fishing, forestry, mining, transportation, and public communications firms.

Our knowledge of recovery "lessons" is still in its infancy. This relatively new area of disaster research is still only minimally informed by theoretical approaches, has yet to develop consistent conceptual and operational definitions of key concepts, and is still in search of generalisable findings. One thing that is certain, however, is that we are beginning to know what potential problems must be considered and resolved before the disaster strikes a community or region in order to reduce human suffering, minimise economic loss and disruption in the private sector and maintain effective governmental action. We must remember that recovery is a very long process, having its roots in the pre-impact period when preparedness and mitigation are taking place — and where potential problems, risks and vulnerabilities can be identified — to a decade or two after a disaster has taken place, when the region and its people will be experiencing different kinds and rates of recovery.

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Discussion

Economic and social framework

Chris Henri (Insurance Council of Australia) remarked that there had been no mention of the language problem. Following the Newcastle earthquake, there were 67 languages to address and getting the message through was incredibly difficult. He related the example of a Chinese couple who would not move because their son had told them not to let anyone put them out of their home. *Joanne Nigg* said that after the Northridge earthquake, the authorities had made provision for speakers of Chinese, Korean, Cambodian, South American languages and others, but still had a problem with outreach (e.g. to the Armenian community, and with the numerous Chinese dialects).

David Brunsdon (Wellington Lifelines Group) remarked that Joanne Nigg's survey showed what his group suspected, that transportation was a key lifeline. *Joanne Nigg* said that the survey in Memphis did not ask about transportation because the last major events there were early last century and they did not want to get too hypothetical, but studies involving transportation are going on in Des Moines (Iowa) and Santa Monica.

Martin Hall (AMP Insurance Ltd) asked Hal Cochrane how sensitive his results were that interest rates would double and that total loss was so much greater than direct loss. *Hal Cochrane* replied that total loss had been developed from the ratio of debt to GNP and that rebuilding of Wellington was taken as given.

David Greig (Auckland Regional Council) asked Joanne Nigg whether there was much of an earthquake threat to New York. *Joanne Nigg* replied that there was enough risk to now include seismic design in building codes in New England, the State of New York, Washington and Oregon.

John Blakeley (Centre for Advanced Engineering) said that he understood that much of the problem in Kobe for businesses re-establishing after the earthquake was in matters over which they had little control, e.g. restoring connections to services. He asked if the survey showed whether businesses in the US had any idea about protecting themselves against this. *Joanne Nigg* stated that in Des Moines, most businesses did not own their properties, but she hoped that her work would interest landlords in maintaining emergency generators, etc. Landlords should be more involved because of their need to retain tenancies. Previously, there had been little attention to the importance of lifeline services for recovery as well as response. Local engineering managers of utilities should get together to plan mitigation measures and disaster response.

George Walker (Alexander Howden Reinsurance) commented that, in Hal Cochrane's figures for Kobe, a very low percentage of property and business interruption was insured. This is very different from New Zealand, where much of this risk is reinsured overseas. This changes the economics compared with the earthquakes in Kobe and Mexico. *Hal Cochrane* said it would not take much of an earthquake to bankrupt many insurance companies in the USA, and he did not know how much could be passed on to reinsurers. A situation where insurance was enough to cover all losses would be an extraordinary case. He did not know how much of a $24 billion loss in Wellington could be passed on to the insurance industry. He assumed that he was dealing with a situation where insurance was quite insufficient to meet the loss.

Physical Reconstruction 1

Physical reconstruction: Timescale for reconstruction

Claire B Rubin

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Experiences in the US have shown that recovery at the local level has many variations, because localities have different characteristics, needs, and means and because disasters come in many types and intensities. An understanding of the complexities of the recovery process is essential before one can engage in strategic thinking and planning for recovery. Among the essential elements are determining both the progression and timing of the major elements of the process.

While the efficiency of recovery is important, so is the quality. An effective recovery process should incorporate mitigation measures, such as seismic-resistant building codes, that would protect human health and safety in the case of another seismic event.

There are many forms of recovery, ranging from the minimal effort of simply replacing many structures and systems as they were prior to the major disaster to the carefully calculated development of seismically resistant structures that will withstand future earthquakes. A conceptual model of three forms of recovery, with varying degrees of mitigation measures incorporated are shown, in an attempt to illustrate the range of choices involved in the recovery process. There also are some confounding factors in recovery: the many simultaneous demands for assistance and resources, and the heavy demands on the intergovernmental relations process.

Finally, a Community Planning Matrix is provided in order to help local public officials assess local needs and determine priorities and timing for implementing reconstruction and recovery actions needed in all of the major domains of urban life.

Introduction

In the US, recovery from a major disaster at the local government level has many variations because localities have different characteristics, needs and means, and because disasters come in many types and intensities. Accordingly, there are many ways to approach the recovery process, from the standpoint of the key government, civic and private leaders in a disaster-impacted area and also many factors that may affect the timing and duration of recovery. Some impacted areas engage in strategic thinking and planning for recovery, while others engage in a patchwork of small plans that result in a free-form product. I am using the term strategic planning to refer to the process of building a vision and assembling the means to carry it out.

Strategic planning for recovery from a major earthquake in the Wellington area can provide the basis for setting priorities and for creating a timescale for the reconstruction and recovery process. Anticipating a major earthquake event, planning to mitigate its harmful impacts, and planning for community recovery can be done, should be done, but all too often are not done.

The US has had some recent experiences with major devastating earthquakes, as well as some major hurricanes, that may be helpful to emergency managers and planners in New Zealand. New Zealand, of course, has its own special risks, needs and resources. In fact, you even have some decided advantages over the US, such as the existence of nationwide, seismic-resistant building codes. Perhaps some of the US experience will be of use and will spare you from having to learn first-hand what does and does not contribute to an efficient and effective recovery.

I plan to briefly discuss what is needed for an efficient recovery at the local level, and then what is involved in an effective recovery — i.e. one that takes into consideration future seismic events and includes mitigation measures in the reconstruction process. I also plan to deal with some of the confounding factors in recovery, particularly the many simultaneous demands that can be expected to affect a relatively small number of public officials and a

finite amount of resources (public and private) available for reconstruction and recovery. Another major confounding factor is the intergovernmental relations process for restoring (a) the administrative capacity of each level of government to function, and (b) the restoration of government buildings and other essential structures in the nation's capital city. For example, it was reported in the newspapers that public emergency response in Kobe suffered from a lack of clearly differentiated powers and authority of each level of government.

The emergency management experiences in two recent major earthquakes — one in Kobe, Japan (1995) and the other in Northridge, California (1994) — can provide some useful insights about the difficulties of recovering from a major earthquake in a heavily populated urban area. Both quakes occurred in countries thought to be relatively well prepared, but both events revealed many unpleasant surprises to emergency management personnel, construction experts, and others.

In the aftermath of these two recent events, I am struck by the intense media coverage and intense public scrutiny of all aspects of the response and recovery processes. In the US, we refer to the immediate and intense television coverage of major disasters as the "CNN syndrome" (CNN is the Cable Network News station). My concern here is that as a result of almost immediate coverage of an unfolding disaster event, and the frequent replay of the most dramatic destruction, unrealistic expectations occur regarding what can be done in the way of response and recovery. The TV coverage dramatises the needs but does nothing to aid the response capability of the emergency responders. It can, however, spotlight inaction or inadequate action. In short, the CNN syndrome contributes to the general dissatisfaction with the ability of public officials to manage response and recovery quickly enough. From the standpoint of the victims, the timescale for reconstruction and general community recovery can never be short enough.

Aside from the general desire to reduce suffering among victims, there are many other pressures to expedite recovery. It is becoming increasingly important to manage reconstruction as efficiently and effectively as possible. In the past five years in the US, the political pressures on the federal government have been enormous and indeed have resulted in some improvements. Recent reviews and analyses of the Loma Prieta (California, 1989) and Northridge (1994) earthquakes have shown that in the less than five years that elapsed between the two events, the Federal Emergency Management Agency took many steps to improve the efficiency and effectiveness of its ability to manage the federal response and recovery assistance.

There is no such thing as an "acceptable timescale" for recovery from a large disaster. Expectations from citizens, media and business interests both in California and Japan have led to tremendous pressures on public sector decisionmakers and to efforts to reduce the lead time for governmental response and recovery actions. Without wanting to sound facetious, it seems that almost any timescale will be unacceptable to some sector or interest group that was impacted by the quake.

The fact that there has not been a major disaster in New Zealand in 60 years is very serious from this point of view. It highlights the need for large-scale simulation exercises and work on-site at overseas disasters.

In order to gain speed, without doing so at the expense of effectiveness or equity in providing assistance and services, a great deal of attention will have be given to streamlining decisionmaking in advance of a major earthquake. In fact, many aspects of intergovernmental decisionmaking can be negotiated in advance of a major disaster. Various forms of memoranda of understanding and mutual aid agreements can and should be put into place in advance of their being needed. Another possible consideration should be for major governmental agencies and businesses to consider alternative operating sites to avoid interruption of their key functions.

The disaster recovery process

Why do some places recover quickly and effectively and others do not? What are the characteristics of a successful recovery? In the 1980s, I headed a study of 14 communities recovering from a major natural disaster that had received national attention and federal assistance (Rubin et al., 1985). The size and location of the communities varied widely and the type of disaster event varied too. We tried to determine what are the characteristics of communities that recovered quickly and effectively from the disaster as compared with those that were slow and troubled in their recovery efforts.

We determined that there are three essential elements to the recovery process at the local level in the US:

1. personal leadership;
2. the ability to act (administrative capability); and
3. knowledge to act — knowing what do about a specific disaster event.

A graphic depiction of the many forces and factors that contribute to recovery and determine the relative efficiency and effectiveness of recovery at the local level is shown in Figure 1, which focuses on the various levels of government and the major determinants of an effective recovery. Figure 2 provides some additional detail about the three main determinants of an efficient recovery. It should be noted that, of the three main elements, no one was sufficient to ensure an effective recovery; but elements 1 and 2 together would allow a community to acquire the third element.

Recovery that includes commitment to mitigation

Subsequently, I was engaged in fieldwork in South Carolina, where heavy damage occurred from Hurricane Hugo in 1989. At that time, I was convinced that while the efficiency of recovery is important, so is the quality. In the case of a major earthquake, an effective recovery process should incorporate mitigation measures, such as seismic-resistant building codes, that would protect human health and safety in the case of another seismic event. These should be done, not just building by building, but to encompass entire segments of the community.

There are many forms of recovery, ranging from the minimal effort of simply replacing many structures and systems as they were prior to the major disaster to the carefully calculated development of seismically resistant structures that will withstand future earthquakes. A conceptual model of three forms of recovery, with varying degrees of mitigation measures incorporated is shown in Figure 3, which is an attempt to illustrate the range of choices involved in the recovery process. The key points here are the varying degrees of effort, levels of commitment, and time periods represented by these phases. This chart shows just three stages to make its points, but in fact there probably are many small peaks and troughs that will occur over years and decades.

Earthquakes are special

Unlike many other natural disasters, earthquakes usually involve a sequence of events (foreshocks, main shocks, aftershocks) and often are accompanied by related hazards, such as tsunamis, landslides, and liquefaction. Both the earthquake sequence and the related hazards may occur over a period of years. Usually there is no one discrete event (such as a cyclone) that is quickly over, so that recovery clearly can begin. Moreover, aftershocks not only can cause significant damage, but also are recurring reminders of risk and often cause earthquake victims to relive their fearful moments.

In my opinion, planning and managing recovery from a major damaging earthquake is the most complex and complicated recovery process from a natural disaster that exists. The aftermath of a major damaging earthquake poses special needs and problems — including not knowing just when the event is over; the inherently frightening experience

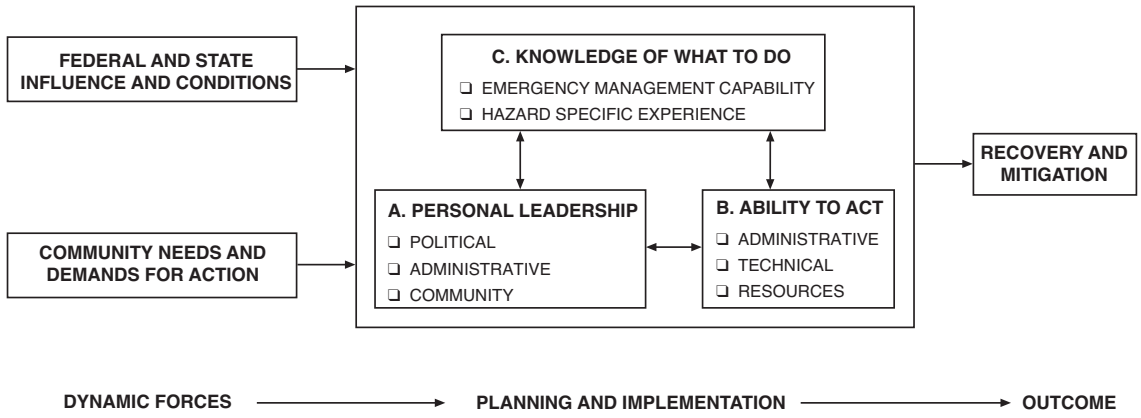

Figure 1: Elements of the recovery process (adapted from Rubin et al., 1985)

PERSONAL LEADERSHIP
- Local decision making
- Priority of intergovernmental relations
- Redevelopment of damaged area
- Long-range view of rebuilt community

ABILITY TO ACT
- Availability of state and federal resources
- Reliance on local rather than external resources
- Local administrative and technical capability
- Horizontal and vertical intergovernment relationships

KNOWING WHAT TO DO
- Familiar with requirements for state, federal assistance
- Identification of sources of assistance
- Realistic, flexible and current preparedness plans

Figure 2: Key elements of the recovery process (from Rubin, 1991)

of having aftershocks occur for months or years; and usually the need to review the adequacy of some fundamental governmental regulations, such as land-use controls and building code and construction standards. There is also a complex web of inter-organisational and intergovernmental complexities. Responding to and recovering from a major damaging earthquake may be longer and harder than recovering from any other natural disaster agent.

In the recent report by the US National Academy of Science, on *Practical Lessons from the Loma Prieta Earthquake*, the complexity of the intergovernmental negotiations regarding the restoration of major local public buildings was documented. Many recent earthquakes have revealed a great need for better inter-governmental coordination, and specifically for ways and means for public agencies to cut through restrictions, act flexibly, and try to facilitate the deployment of resources in areas where they can do the most good.

In the Rocky Mountain Model (Figure 3), the greatest competence in post-earthquake recovery and mitigation is the highest and most-difficult-to-achieve stage, Stage III. There are many reasons for the added difficulties, including the fact that the three elements of efficient recovery — personal leadership, ability to act, and knowing what to do — are all more difficult to acquire or perform after a major damaging earthquake. Some characteristics of that more difficult recovery are:

- Greater foresight, vision and persistence are needed by local public leaders when recovering

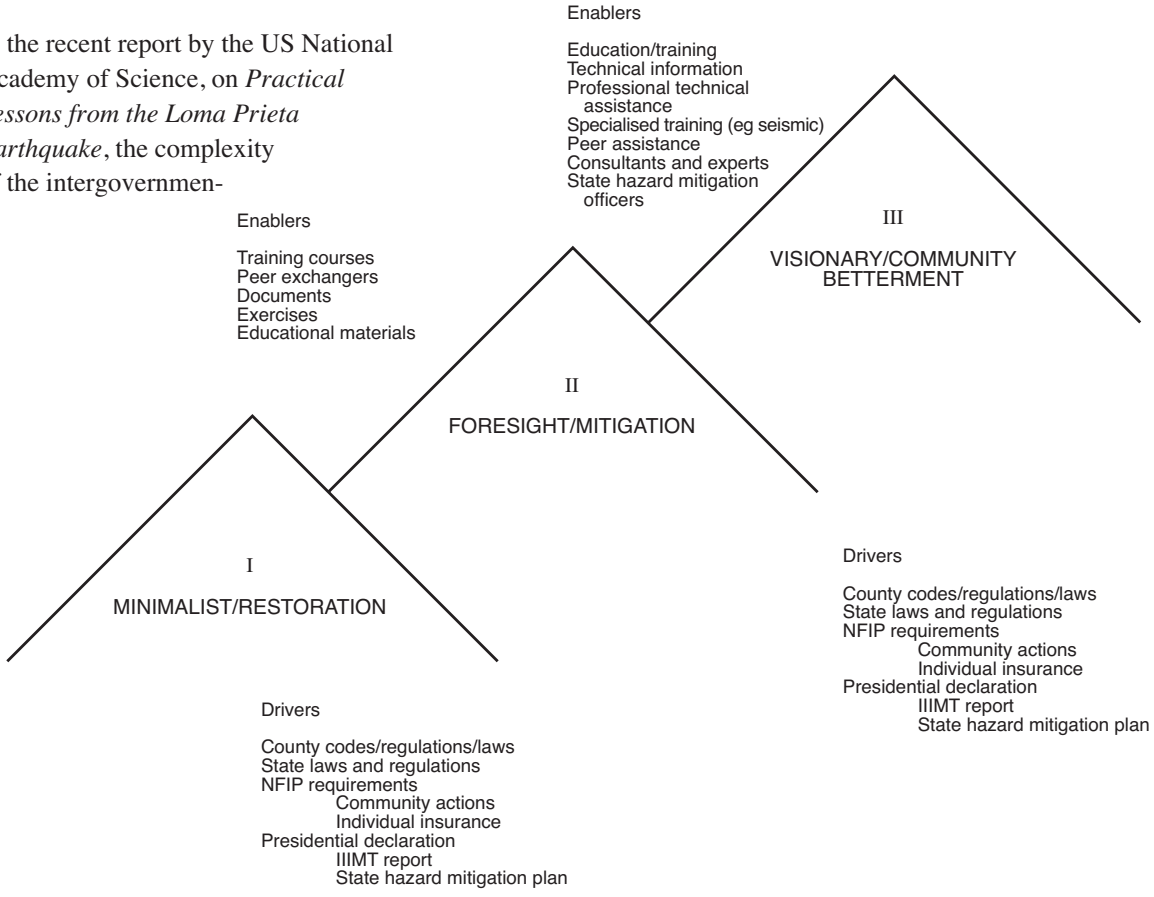

Figure 3: The Rocky Mountain Model of recovery following a disaster

from a major damaging earthquake (which is a low-probability high-impact event).

- Long-term interest, public will and local capacity will be needed to achieve and sustain the legislative changes necessary and then the implementation and enforcement of new laws and regulations, particularly those dealing with building standards and land-use regulations.
- Considerable local public capacity, skill and patience are needed in order to manage the recovery efficiently and effectively.
- A greater amount of damage and a longer-term recovery period can be expected. The duration of the recovery will depend on the amount of structural damage and on the number of personal injuries and deaths. Both are likely to be great after a major earthquake.

Implications

The snapshots of some local and state capacity levels, as depicted in the recovery model, reflect stages of mitigation capacity, suggesting a great deal of hard, time-consuming work is ahead for most communities in order to be able to effectively deal with and recover from a major, damaging earthquake. In the US, Peter May (May, 1991) has identified the basic dilemma underlying earthquake policy design and implementation:

> *On the one hand, federal officials have a strong stake in promoting earthquake risk reduction and preparedness, if only to lessen federal disaster relief outlays. On the other hand, local governments and individuals owning property in earthquake prone areas are reluctant implementors of risk reduction measures, both because of the costs involved and because earthquakes are low on their list of priorities. In overcoming this lack of momentum, federal policy must seek to building nonfederal commitment to risk reduction and to improve nonfederal capacity to carry out appropriate mitigating actions.*
>
> [p.269]

Timetable

In the past, some researchers have shown a straight line of recovery steps, but my research over the past decade or so has not revealed such a progression. There are many variables:

- whether or not an incident is one discrete disaster event, or multiple, cumulative events;
- the breadth of the event (the greater the number of jurisdictions or amount of inhabited territory, the greater will be the competition among them for resources);
- the organisational and personal capability of the recovery planners;
- the financial and other hard resources available to the impacted jurisdictions;
- time of year, weather and seasonal factors; and
- special populations impacted.

Recovery is community building in a telescoped timeframe — rebuilding major parts of the community in the highly compressed period of years, when the original construction took place over generations or centuries.

Priority setting and timing decisions

The need to attend to several major sectors of civic and economic life simultaneously is going to have a significant effect on any timescale that can be set for recovery in Wellington. I created a community planning matrix after spending time in the city of Homestead, Florida, after Hurricane Andrew in 1992. That small city (population about 28,000) was the most badly damaged community I have ever seen — about 80 to 90 percent of every sector, residential, commercial, governmental (civilian and military), was badly damaged or destroyed. In other words, the ratio of damage in all domains of municipal life was extremely high. While Wellington may not suffer such a high ratio of damage to all domains, nevertheless it is important to review all sectors of the community to determine priorities for reconstruction, ideally in advance of a major disaster. No sector can be let go — all need attention and will demand it, so priorities must be set.

The Community Recovery Matrix (Appendix 1) was created to help local public officials anticipate the many aspects of reconstruction and recovery. Although it was provided after the major disaster occurred, such a matrix could be used to consider the types and numbers of decisions that will have to made with respect to the rebuilt community. I have revised the original version of the matrix to include some of the special considerations pertinent to Wellington and to broaden some of the US-specific

references. Some aspects that I want to highlight include:

- many problems need attention at the same time and will be competing for the same resources;
- it highlights the need for tradeoffs and priority setting;
- the rebuilding plans of all sectors will be restricted by such practical matters as local debris removal capacity, the number of local construction companies and the amount of building material supplies available.

As can be seen in Appendix 1, the left column lists recovery needs or possible actions and the right side provides a time frame for planning and implementation. The items in the left column are provided to give a framework for thinking about recovery; there may be more or fewer categories of concern than the ones shown in the matrix and outlined in Figure 4. For those interested in a more detailed form of guidance, I recommend the recent, well-written handbook prepared by the State of California, called *Earthquake Recovery: A Survival Manual for Local Governments*.

The case of Wellington

Officials in Wellington (at each level of government) have a decided advantage regarding recovery planning, because they have begun early to plan their strategy(ies) to deal with the recovery process.

1. Overall Considerations
   A. Information needed (about impact, needs, etc.)
   B. Economic and job base assessment
   C. Recovery planning (urban master plans, documenting of expenses, mitigation efforts)
   D. Building and construction issues (changes in land use regulations, building codes and standards)
   E. Public and private finance (revenue and cost estimates)
2. Housing concerns (damage assessments and new requirements)
3. Business concerns (temporary relocation, recovery assistance)
4. Public sector, services and facilities
   A. Local government
   B. State/provincial/regional governments
   C. National government
5. Health, welfare, and other needs
6. Environmental and ecological problems/needs (air, water, soil quality issues)

Figure 4: Recovery needs/possible actions

All too few places have taken that early step. Some of the numerous variables that will affect Wellington's recovery, as a major city and as the nation's capital, include the nature of the community's economic base, the effectiveness of the civic leadership, the post-disaster condition of the natural environment and the political context — including the ability and willingness to act on the part of officials at each level of government.

What is important to the local community, particularly to its economic base, must be decided locally. Nevertheless, the local officials are likely to be dependent on the national government and private sector for funding and other assistance. What will make recovery difficult in Wellington after a major earthquake is that several major segments of the community base — government centre and associated organisations, industrial enterprises, transportation infrastructure and residential structures — are likely to be severely impacted. It will be essential that priorities are predetermined, so that scarce resources for debris removal, construction activities, financial support, etc. be marshalled to meet the predetermined priorities for restoration.

Some recovery decisions are driven by the private sector to accommodate economic needs. In disaster-impacted places that are heavily dependent on tourism, for example, one may see that expensive residential hotels are rebuilt substantially before residential rebuilding for citizens has occurred and shops featuring high-priced luxury goods may take priority over other retail stores. These actions represent a choice to attract income-producing tourist attractions as a priority. These decisions seem surprising at first, but may be appropriate given the local circumstances and priorities in the long run.

A special consideration in the case of Wellington is that as the national capital it has a high level of government presence and is home to not only national government buildings but also national associations and other organisations connected with the national government. What must be planned for is the restoration (or if need be the temporary relocation) of major government buildings and workers during the recovery period. For example, given the existing reliance on telephones and telecommunications, how

vulnerable will the existing communications among governmental organisations be? How readily can offices and organisations relocate and expect to function? The downside to a heavy dependence on electronic equipment is that outages of service can cause major, costly problems. Yet on the other hand, it may be that employees can operate from mobile centres or get their work done by telecommuting from home. After the Northridge earthquake in California, many alternative means of working outside the base workplace were tried.

Nevertheless, if there is major damage to important governmental buildings, one can anticipate that a large amount of time will have to be spent by public officials at all levels of government who are responsible for rebuilding and negotiating their redevelopment plans in order to restore key public services. Bear in mind that, at the same time as extraordinary demands for government services of all kinds are being made, some of the government agencies may themselves be disaster victims — that may mean loss of usual office space, equipment and records, temporary relocation and other unsettling work conditions. Although government buildings and workers may be victims of earthquake damage, they must still both perform their regular work and plan for moves and repairs the same as individual citizens and households must do. It also may be that a government worker may be a disaster victim both at home and at work. (This was true in Homestead, Florida, where about one-third of the staff in the city hall had been displaced from their homes.) The Mexico City earthquake of 1984 resulted in the destruction of a substantial number of federal offices; the accounts of that earthquake should be reviewed for useful lessons regarding recovery when significant damage has been done to the administrative capacity of the national government.

While I have not observed the recovery planning process in a city that is a major capital, one could anticipate that bureaucracies are not likely to move quickly in major decisions regarding major capital investments, or perhaps even relocation decisions, unless some pre-planning and various forms of agreement were in place in advance of the anticipated major disaster event.

I can cite two poor examples of intergovernment decision making post-disaster in the US: after the Loma Prieta earthquake (1989) caused major damage to the city hall buildings in San Francisco and Oakland, California, decisions about the appropriate means and costs of repairing the structural damage to those historic structures has entailed years of negotiations and ultimately lawsuits against the federal government. The Federal Emergency Management Agency (FEMA), which was going to pay most of the cost of repair, favoured a less costly repair process, while local officials in both cities favoured more substantial and more costly seismic-resistant retrofit. The resulting intergovernmental disagreements and litigation has meant not only years of delay in deciding what to do about those landmark structures but also less efficient functioning of local government agencies during the recovery period. Regarding the Loma Prieta earthquake, a major recommendation made afterwards was that what was needed was "judgment and flexibility specific to the conditions of each building as needed to foster recovery." (National Research Council, 1994, p.24)

Timing of recovery

Regarding setting a timetable for recovery, I suggest starting that process by using a planning matrix for assessing local needs and setting priorities for attention and resources. One cannot set a precise timetable for an endeavour that has countless decisions being made by many actors, but one can set priorities. Furthermore, the availability of certain resources will determine the sequence of recovery steps. In short, there can be no fixed schedule — recovery will occur sooner or later, but there are many things that can be done in advance to determine major interests, priorities for redevelopment and recovery efforts. To date, such planning is rarely done at the local level.

In the United States, when a disaster warrants national attention, the impacted (and overwhelmed) local and state governments request federal assistance. When the President declares the event a disaster, then federal agencies, resources and the Federal Response Plan (FRP) come into play. At this time, the US government does not have a recovery plan, although work is currently under way on creating such a plan and linking it with the FRP. It is interesting to note that the US government has been involved in response activities for more than 30 years, although the coordinated FRP is less than five years old. Moreover, after more than three decades of dealing with disasters, the federal government is just coming to grips with its involvement in the recovery process for its states and cities. FEMA is coordinating a federal interagency planning process

to deal with recovery assistance to states and local governments, and an outcome is probably a year away.

Conclusion

In various after-action reports and case studies of major disasters in the US, the points usually made include:

- recovery planning was sorely lacking;
- too many ad hoc decisions are made; and
- decisionmaking is characterised by linear thinking rather than systematic approaches.

Among the practical lessons learned from past earthquake events are that the normal ways of doing business are not adequate to accommodate the needs, particularly in terms of the pressure for speed in approving projects and the volume of applications, to name only two areas of special need. A final thought to ponder is: why is it that all levels of government fail to give as much attention to disaster recovery plans as they do to disaster preparedness plans?

Fortunately, there are knowledgeable and committed people in New Zealand; these are very important resources. If they can add experience with disasters, real or simulated, their abilities will be enhanced.

I leave you with the wry words of an American cartoon character named Pogo: "We are surrounded by insurmountable opportunities."

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Appendix 1

Community recovery matrix

prepared by Claire B Rubin

February 1995

10 = most important
1 = least important

	Year 1 (Months)												Year 2
RECOVERY NEEDS/POSSIBLE ACTIONS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1→12**
I. Overall Considerations													
A. Information Needed Regarding:													
1. demolition and debris													
• clearance													
• removal													
• disposal													
• external assistance (mutual aid, contractors, etc.)													
2. legal issues, e.g., ordering evacuation; resettling "illegal" occupants													
3. revise population data; determine relocation needs; gather new data, e.g., school children, residents, business establishments, etc.													
4. damage assessment and personal needs assessment													
5. means of informing the public													
6. documentation of expenditures, city personnel, etc.													
7. regulation (building permits) and control (out of town contractors; pets and animals; materials)													
8. managing disaster assistance from external (public and private) sources													
9. managing resources (donated goods and services, volunteers)													
B. Economic and Job Base Assessment													
1. analysis of major employers; likelihood of return, when, and at what ratio of former capacity?													
• major factories, military bases, government centers and other major employers													
• agricultural, botanical products													

10 = most important
1 = least important

RECOVERY NEEDS/POSSIBLE ACTIONS	Year 1 (Months) 1	2	3	4	5	6	7	8	9	10	11	12	Year 2 1→12
• commercial, retail establishments													
2. plan for economic base and job generation activities: e.g., economic development activities and organizations; participation in rebuilding efforts													
3. seek consultants and other specialists needed; get help with pursuing sources of public and private assistance to small businesses													
C. Recovery Planning													
1. use existing plans (master plan, economic development plan, etc.) to extent possible in creating redevelopment plans for badly damaged areas or for community as a whole													
2. assess local administrative capacity to deal with recovery:													
• review organizational mechanisms in place; determine new ones needed (e.g., housing authority, redevelopment authority)													
• augment capacity for intergovernmental relations, including countless meetings to be attended													
• determine consultants and other specialists needed to augment local staff to engage in aggressive pursuit of grant and assistance funds, other specialized functions													
3. determine mitigation measures that could be taken, or must be met by law during reconstruction, e.g., building codes and land use regulations													
4. manage special bookkeeping and accounting needed for potential reimbursement													
5. designate a coordinator of pro bono professional services offered to city by public management, engineering societies, architects, researchers, etc.													
6. coordinate with business and industry													

10 = most important
1 = least important

RECOVERY NEEDS/POSSIBLE ACTIONS	Year 1 (Months) 1	2	3	4	5	6	7	8	9	10	11	12	Year 2 1→12
D. Building and Constructing Issues													
1. create or revise building codes and standards to meet government requirements regarding seismic-resistant construction													
2. enact codes and standards for new residential and business units to be constructed													
3. explain and enforce new standards													
4. attend to non-conforming and exceptions needed													
5. identify and evaluate alternative (and innovative) types of construction, e.g., modular unit, special units													
6. decide how to license, monitor and otherwise control large numbers of building contractors, for both new construction and repairs													
7. decide how to manage the building permit process (including consideration of a moratorium)													
E. Public and Private Finance													
1. estimate remaining tax base													
2. revise estimates of revenues													
3. estimate costs of disaster-generated projects, activities													
4. identify likely sources of disaster funds													
5. project budget for coming year													
6. identify new sources of additional revenue (tax increase, bond issue, private funds)													
7. coordinate public and private services													
II. Housing Concerns													
A. Assessment of usable existing housing stock													
B. Determination of new types of housing and housing patterns to be used for new construction (e.g., planned unit development)													

10 = most important
1 = least important

	Year 1 (Months)												Year 2
RECOVERY NEEDS/POSSIBLE ACTIONS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1→12**
C. Determination of sources of temporary housing units													
D. Determination of sources of permanent housing													
E. Development of low and moderate income units													
F. Consideration of past social and neighborhood patterns: recognition of previous housing patterns, preferences of former residents regarding street and neighborhood patterns, priorities for former residents to return to reconstructed neighborhoods													
III. Business Concerns													
A. Assessment of usable business locations, establishments													
B. Identification of government assistance to aid impacted businesses													
C. Determination of new types of construction to be used in repairing and rebuilding damaged firms													
D. Building and construction issues: e.g., compliance with revised building codes and construction standards that must be used to ensure future disaster assistance from governmental sources													
E. Seek all sources of financial assistance to assist return of existing business and to attract new ones													
IV. Public Sector													
A. Local													
1. Public buildings and facilities (repair and restoration)													
2. Public policy regarding sighting of new facilities													
3. Communications, utilities, and other essential services (repair and restoration)													
B. State/provincial/regional/national government building and facilities													
1. Determination of repair, restoration and restructuring													

10 = most important
1 = least important

	Year 1 (Months)												Year 2
RECOVERY NEEDS/POSSIBLE ACTIONS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1→12**
2. Relocation decisions													
V. Health, Welfare and Other Needs													
A. Social services													
1. estimate need for													
2. determine providers, sources of funding													
B. Health services (physical and mental)													
1. estimate need for													
2. determine providers, sources of funding													
C. Public assistance													
1. estimate need for welfare, food assistance, unemployment benefits													
2. determine providers of care and services and also sources of funding													
VI. Environmental and Ecological Problems/Needs													
A. Air quality (open air burning)													
B. Water (quality and supply)													
C. Solid waste (landfills — temporary and permanent)													
D. Soil conditions (contamination)													
E. Hazardous materials (spills, accidents, disposal) incidents triggered by earthquakes													
F. Natural resources (wildlife, fish, plants)													

Assessment of resources required for reinstatement

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The process of restoring Wellington to normality after an earthquake will involve work on all elements of the built environment. This paper describes the assessment of the costs of repairing damaged buildings and infrastructure and then presents an analysis of the materials, plant and labour needed for reconstruction.

Buildings and infrastructure in the Wellington region are briefly described and their replacement values presented in various categories. Damage in dollar terms is assessed for each category, using existing knowledge of the likely effects of movement of the Wellington Fault, available damage ratio information and engineering judgment.

The assessment of the type and amount of resources needed is made by broadly analysing the work content of each element of the repair work and allocating the required expenditure to various categories of materials, plant and labour. These categories are chosen to match those normally used in resource assessment in the building industry.

The total resources likely to be needed for full reinstatement after a major earthquake in the capital are thus presented in a form suitable as a starting point for assessing the implications for timing, availability and supply/demand.

Introduction

Wellington's ability to recover from a major earthquake will depend on the nature and extent of damage, the overall costs involved, the resources required and their availability, the economic impacts, the time taken to reconstruct and repair damaged facilities and the logistics of applying resources to the task.

This paper presents an estimate of the resources required, based on the analysis of the estimates of the cost of restoration and the nature of the work involved. It makes no attempt to address issues of availability of resources or other issues affecting recovery and restoration.

Over the last decade, and particularly in recent years, increasing interest has been shown in estimates of earthquake damage losses in New Zealand. Changes in the insurance market and in the ownership and management of building and infrastructure assets have given this special impetus. As a result, a number of separate assessments of damage have been made for various groups of assets in the Wellington region. Not all assets have been covered and not all results are available in the public domain. However, sufficient information now exists to extend this information to make a broad assessment of damage to the total built environment.

But such an overall summary is only the first step in assessing the resources required for reconstruction, a task that has not been attempted to date, and to this extent this paper breaks new ground. However, the purpose is to quantify the resources required, not to present original work on damage assessments, except where these do not exist. The basic intention has been to take existing data on damage, extend it to ensure it covers the whole of the Wellington region affected by the Wellington fault earthquake and then to analyse the requirements for resources from the dollar amounts.

Assessment of damage has been made possible through the work of several researchers funded by the Earthquake Commission, the Wellington Regional Council and others. This has provided the geological, soils, seismicity and damage ratio data for much of what is presented.

Wellington's buildings and infrastructure

The Wellington region today comprises four main cities, Wellington, Lower Hutt, Upper Hutt and

Porirua, which account for the majority of the population in the whole region. The main areas of population are shown in Figure 1. The topography is generally steep with limited flat areas — most of the flat areas on the edge of the harbour are reclaimed land.

The early European settlers built in timber, matching familiar European styles and taking advantage of abundant natural timbers. After a damaging fire, emphasis turned to building in brick, which in time proved to be vulnerable to earthquake. After the devastating Hawkes Bay Earthquake of 1931, codes were introduced requiring design for earthquake loads. In 1965, 1976, 1984 and 1992, changes were made to code requirements, each bringing more complex and generally more stringent requirements to deal with the greater sophistication of buildings and to take advantage of the ever-increasing knowledge of their earthquake performance.

Houses in the Wellington region are generally built in timber and masonry, while most larger buildings are constructed in the indigenous material, concrete. Structural steel has not been used extensively except for industrial buildings, though more use is now being made of that material. Structural timber and concrete masonry are also commonly used for small- to medium-sized structures. The result is a wide range of building sizes and types, built to different codes.

Lifelines have not generally been subject to the same level of attention for seismic design, except bridges for road, rail, water supply and electricity generation and transmission facilities. Thus, vulnerability of lifelines in the region is highly variable. A major study of Wellington's lifelines, completed under the auspices of the Centre for Advanced Engineering (1991), provides a comprehensive overview of all the systems and their vulnerability to earthquake. Since that time, several studies of likely damage to selected lifelines have been carried out by the organisation responsible for them. In many cases, this has been followed up with mitigation measures, with the result that most Wellington lifelines have received or are receiving attention. Recent earthquakes in California have added to the impetus of this gratifying trend, and it seems likely that the experience in the Hanshin (Kobe) earthquake of January 1995 will have particular relevance to Wellington lifelines.

In summary, Wellington has a wide variety of buildings and infrastructure in various geological settings. An indication of the size of Wellington can be gleaned from Table 1, which summarises the buildings and infrastructure, showing the approximate value of facilities in replacement cost terms. This has been obtained in most cases directly from the authorities responsible for the assets; their ready cooperation is acknowledged.

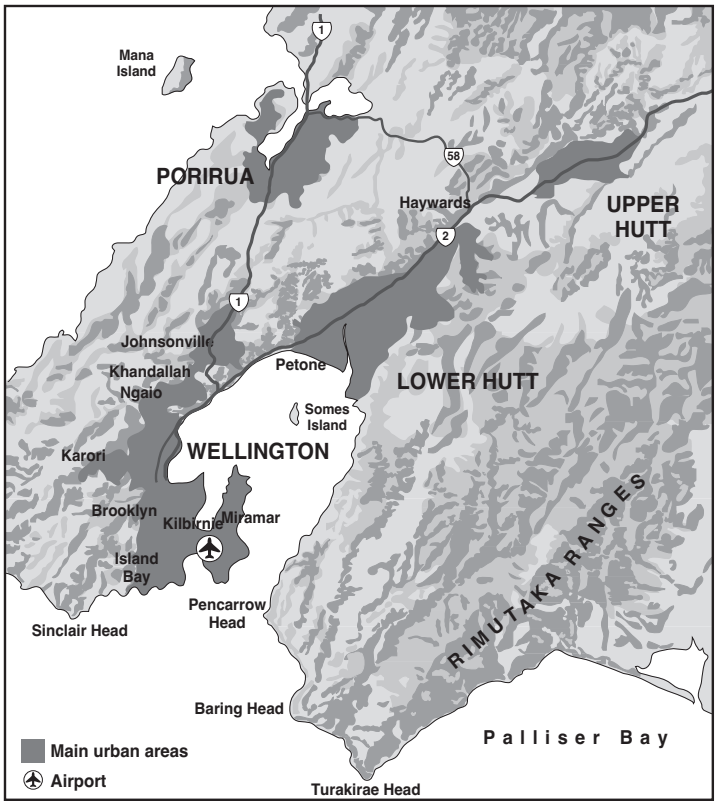

Figure 1: The Wellington region

Earthquake damage assessment

The seismicity of Wellington is relatively well known, and much research has been done in assessing damage of buildings for various possible earthquakes. It is beyond the scope of the paper to discuss this aspect, but one of the most damaging earthquakes is movement of the Wellington Fault. This event has been used in making the damage assessments. Isoseismals used for this event in previous reports to the EQC are shown in Figure 2 and may be taken as applying to the data presented.

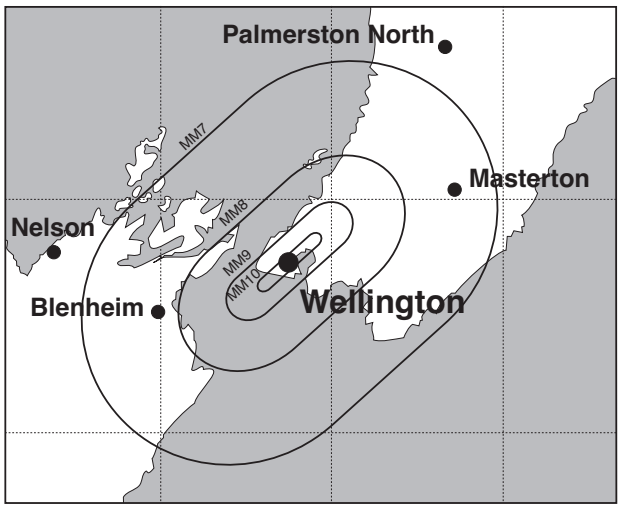

Figure 2: Isoseismals for Wellington fault event

The overall damage assessment made for the purpose of this paper was based on a mixture of data, including reports done for the EQC on buildings and infrastructure, and the work of the author on behalf of Kingston Morrison for various clients. The assessments have been made on a broad basis, assigning a single damage ratio to each main class of asset. The objective has been to obtain a reasonable assessment of overall damage without necessarily matching previously derived values exactly.

The assessments are made on the basis that Wellington would be put back the way it was. No attempt has been made to allow for obsolescence, current under-utilisation of facilities or any reduced demand for facilities in Wellington following the earthquake. These will all be significant factors, but for the sake of simplicity have not been factored in. If it is necessary to make such allowances, then these can be made on a global basis by increasing or decreasing the derived figures accordingly.

Table 1 shows the overall assessments of damage in dollar terms for the asset categories.

The categories chosen correspond to the way in which the data was received from the available sources, and, except for buildings, these correspond to categories of damage ratio. The values used are replacement values and were provided without an explicit contents value. The value of contents has been derived from data in reports to the EQC and have been taken as 21 percent of the building value in the case of commercial, industrial and rural buildings and 50 percent of the value for residential buildings and flats. The same damage ratio has been applied to the total of building value and to contents in each case.

Damage due to fire following earthquake was assessed to be 1 percent of replacement value for buildings and contents only, based on the report by Marsh and McLennan (1991). To highlight its inclusion in the figures, damage due to fire following earthquake has been shown separately.

Overall damage ratios (DR) are given for each group of assets. For buildings, these have been taken from the overall results and the damage ratio curves used by Dowrick (1992) and from values derived from the Applied Technology Council (ATC, 1985). General values derived for other assets from a report by Holmes Consulting Group and DSIR to EQC (1991), and from Andrews and others (1993). Values for airport and rail infrastructure were taken from reports by Kingston Morrison (1993,1994). Where no studies had been done, assessments were made based on ATC (1985) and on specific assessments of assets of that type in available reports. The values chosen represent reasonable estimates of likely damage, but even these should be interpreted in the light of the wide margin of uncertainty which exists in the derivation of damage ratios.

Assessment of resources required

The assessments of the resources required for reconstruction were obtained by a progressive splitting of the dollar amounts in each category of asset. Steps were:

Step 1 — Split into reconstruction sub-categories

Building damage was split into sub-categories according to the nature of the likely reconstruction or repair. This did not match exactly the sub-division used for the damage assessment, and the relationship between these two splits is given in Table 2. For each main building category, a distinction was made between complete replacement and repair, since the split of resources was seen to be different in each case. For commercial buildings, the repairable buildings were split into those with more than 30 percent damage and those with less. Those with the higher damage were assessed as requiring proportionately more work on the superstructure than those with the lower damage.

Although an assessment of the cost of damage to contents was made, no analysis for materials, plant and labour was made for contents damage.

Table 1: Replacement and damage values (all figures in NZ$M)

Item		Wellington			Hutt City			Upper Hutt		
		Replace	DR	Reinstatement	Replace	DR	Reinstatement	Replace	DR	Reinstatement
A	**Buildings**									
	1. Commercial and Industrial	15,058.8	0.18	2,710.6	3,668.0	0.15	550.2	739.2	0.15	110.9
	2. Residential	6,371.0	0.15	955.7	3,095.0	0.12	371.4	1,148.4	0.12	137.8
	3. Flats	1,809.9	0.13	235.3	917.1	0.10	91.7	277.2	0.10	27.7
	4. Other (Public)	386.1	0.18	69.5	179.6	0.15	26.9	72.6	0.15	10.9
	5. Rural	72.5	0.10	7.3	74.6	0.10	7.5	168.3	0.10	16.8
	6. Building Contents	7,349.1		1,359.1	2,829.7		427.4	918.6		147.6
	7. Consequential Fire Losses (1%)			39.8			10.5			3.0
	Total	**23,698.3**		**3,978.3**	**7,934.3**		**1,047.7**	**2,405.7**		**304.1**
B	**Roading**									
	1. Regional									
	2. District	476.0	0.08	38.1	66.0	0.08	5.3	94.6	0.08	7.6
	3. Suburban	in B2 above			220.9	0.15	33.1	in B2 above		
	Total	**476.0**		**38.1**	**286.9**		**38.4**	**94.6**		**7.6**
C	**Bridging**									
	1. Regional									
	2. District	3.0	0.30	0.9	43.0	0.30	12.9	15.7	0.30	4.7
	Total	**3.0**		**0.9**	**43.0**		**12.9**	**15.7**		**4.7**
D	**Rail Network**									
	1. Formation (incls track, tunnels bridges, etc)									
	2. Signals, communications, power									
	3. Ways and Works Mech Items									
	4. Locos, rolling stock, misc									
	Total									
E	**Airport Infrastructure**									
	1. Runways, Taxiways, Etc									
	2. Seawall and other Civil Works									
	Total									
F	**Port Infrastructure**									
	1. Wharves, Structures, Etc	306.0	0.20	61.2						
	2. Cranes/Equipment	36.0	0.20	7.2						
	3. Containers/Contents	60.0	0.10	6.0						
	Total	**402.0**		**74.4**						
G	**Water Supply**									
	1. Reticulation	283.4	0.08	22.7	81.5	0.08	6.5	35.3	0.08	2.8
	2. Distribution/Storage	56.1	0.10	5.6	10.3	0.10	1.0	6.2	0.10	0.6
	3. Pumping Stations	2.8	0.10	0.3	0.8	0.10	0.1	in G1 above		
	4. Plant and Misc Buildings	2.0	0.10	0.2	0.8	0.10	0.1		0.10	0.0
	Total	**344.2**		**28.8**	**93.4**		**7.7**	**41.5**		**3.4**
H	**Sewerage**									
	1. Reticulation Main	379.0	0.15	56.9	70.6	0.08	5.6	in Hutt City		
	2. Local Reticulation	in H2 above			95.2			53.3	0.08	4.3
	3. Treatment Stations	5.0	0.20	1.0	in H2 above			0.1	0.20	0.0
	Total	**384.0**		**57.9**	**165.8**		**5.6**	**53.4**		**4.3**
I	**Stormwater Reticulation**									
	1. Reticulation	250.0	0.12	30.0	95.0	0.08	7.6	46.3	0.08	3.7
	Total	**250.0**		**30.0**	**95.0**		**7.6**	**46.3**		**3.7**
J	**Gas Network**									
	1. Regional	330.0	0.04	13.2						
	2. Local	55.5	0.08	4.4	47.2	0.08	3.8	16.1	0.08	1.3`
	Total	**385.5**		**17.6**	**47.2**		**3.8**	**16.1**		**1.3**
K	**Electricity Network**									
	1. Regional Reticulation									
	2. Local Reticulation	447.0	0.12	53.6	139.0	0.10	13.9	51.0	0.10	5.1
	3. Nodes									
	Total	**447.0**		**53.6**	**139.0**		**13.9**	**51.0**		**5.1**
L	**Telecommunications**									
	1. Buildings and Plant	269.0	0.20	53.8	49.0	0.15	7.4	20.0	0.15	3.0
	2. Reticulation	100.0	0.08	8.0	66.0	0.08	5.3	30.0	0.08	2.4
	Total	**369.0**		**61.8**	**115.0**		**12.6**	**50.0**		**5.4**
M	**Broadcasting**									
	1. State owned									
	2. Private									
	Total	**0.0**		**0.0**	**0.0**		**0.0**	**0.0**		**0.0**
	GRAND TOTALS									
	Without Building Contents	**18,815.7**		**2,923.5**	**5,901.5**		**707.6**	**1,767.9**		**184.8**
	With Building Contents	**26,164.8**		**4,282.6**	**8,731.2**		**1,135.0**	**2,686.5**		**332.5**

Table 1 (continued)

Item		Porirua			Regional			Totals	
		Replace	DR	Reinstatement	Replace	DR	Reinstatement	Replace	Reinstatement
A	**Buildings**								
	1. Commercial and Industrial	770.0	0.15	115.5				20,236.0	3,487.2
	2. Residential	1,599.5	0.12	191.9				12,213.9	1,656.8
	3. Flats	177.8	0.10	17.8				3,182.0	372.5
	4. Other (Public)	66.6	0.07	4.7				704.9	112.0
	5. Rural	55.5	0.10	5.6				370.9	37.1
	6. Building Contents	1,075.9		148.2	0.0		0.0	12,173.4	2,082.3
	7. Consequential Fire Losses (1%)			3.4					56.7
	Total	**2,669.3**		**335.4**				**36,707.6**	**7,804.5**
B	**Roading**								
	1. Regional				670.0	0.08	53.6	670.0	53.6
	2. District	95.0	0.08	7.6				731.6	58.5
	3. Suburban							220.9	33.1
	Total	**95.0**		**7.6**	**670.0**		**53.6**	**1,622.5**	**145.3**
C	**Bridging**								
	1. Regional				360.0	0.30	108.0	360.0	108.0
	2. District	5.0	0.30	1.5				66.7	20.0
	Total	**5.0**		**1.5**	**360.0**		**108.0**	**426.7**	**128.0**
D	**Rail Network**								
	1. Formation (incls track, tunnels bridges, etc)				1,605.9	0.07	104.9	1,605.9	104.9
	2. Signals, communications, power				213.8	0.18	38.4	213.8	38.4
	3. Ways and Works Mech Items				55.1	0.20	11.0	55.1	11.0
	4. Locos, rolling stock, misc				795.5	0.03	23.9	795.5	23.9
	Total				**2,670.3**		**178.2**	**2,670.4**	**178.2**
E	**Airport Infrastructure**								
	1. Runways, Taxiways, Etc				42.1	0.08	3.5	42.1	3.5
	2. Seawall and other Civil Works				60.4	0.06	3.7	60.4	3.7
	Total				**102.5**		**7.3**	**102.5**	**7.3**
F	**Port Infrastructure**								
	1. Wharves, Structures, Etc							306.0	61.2
	2. Cranes/Equipment							36.0	7.2
	3. Containers/Contents							60.0	6.0
	Total							**402.0**	**74.4**
G	**Water Supply**								
	1. Reticulation	33.0	0.08	2.6	167.1	0.08	13.4	600.3	48.0
	2. Distribution/Storage	6.0	0.10	0.6	67.8	0.10	6.8	146.4	14.6
	3. Pumping Stations	0.7	0.10	0.1	20.6	0.10	2.1	24.8	2.5
	4. Plant and Misc Buildings	0.3	0.10	0.0	5.9	0.10	0.6	9.0	0.9
	Total	**39.9**		**3.3**	**261.4**		**22.8**	**780.4**	**66.0**
H	**Sewerage**								
	1. Reticulation Main	38.0	0.08	3.0				487.6	65.5
	2. Local Reticulation							148.5	4.3
	3. Treatment Stations	18.1	0.20	3.6				23.2	4.6
	Total	**56.1**		**6.7**				**659.3**	**74.4**
I	**Stormwater Reticulation**								
	1. Reticulation	15.1	0.08	1.2				406.4	42.5
	Total	**15.1**		**1.2**				**406.4**	**42.5**
J	**Gas Network**								
	1. Regional						0.2	330.0	13.4
	2. Local	18.4	0.08	1.5				137.2	11.0
	Total	**18.4**		**1.5**			0.2	**467.2**	**24.4**
K	**Electricity Network**								
	1. Regional Reticulation				807.1	0.10	80.7	807.1	80.7
	2. Local Reticulation	57.0	0.10	5.7				694.0	78.3
	3. Nodes							0.0	0.0
	Total	**57.0**		**5.7**	**807.1**		**80.7**	**1,501.1**	**159.1**
L	**Telecommunications**								
	1. Buildings and Plant	52.0	0.15	7.8				390.0	72.0
	2. Reticulation	36.0	0.08	2.9				232.0	18.6
	Total	**88.0**		**10.7**				**622.0**	**90.5**
M	**Broadcasting**								
	1. State owned				100.0	0.08	8.0	100.0	8.0
	2. Private				30.0	0.08	2.4	50.0	2.4
	Total	**0.0**		**0.0**	**130.0**		**10.4**	**150.0**	**10.4**
	GRAND TOTALS								
	Without Building Contents	**1,912.9**		**220.8**	**4,739.9**		**438.4**	**34,344.6**	**6,722.6**
	With Building Contents	**2,988.8**		**369.0**	**4,739.9**		**438.4**	**46,518.0**	**8,804.9**

Table 2: Summary of reinstatement and damage values for buildings (all figures in NZ$M)

Building Type	Damage Ratio Category				Total
	Commercial	Industrial	Residential	Other	(NZ$M)
Commercial and Industrial	2092.3	1394.9			3487.2
Residential			1656.8		1656.8
Flats	372.5				372.5
Other				112.0	112.0
Rural		37.1			37.1
Total (No Contents or Fire Loss)	2464.8	1432.0	1656.8	112.0	5665.6
Consequential Fire Losses	24.7	14.3	16.6	1.1	56.7
Total (Including Fire Losses)	2489.5	1446.3	1673.4	113.1	5722.3
Add building contents (non included in analysis of plant, materials and labour)					2082.3
					7804.5

Table 3: Summary of materials, plant and labour by asset category
(includes construction costs plus planning, design, etc. and demolition, all figures in NZ$M)

Category	Material	Plant	Labour	Total
Commercial Buildings — Complete Replacement	220.5	114.4	247.7	582.5
Commercial buildings — Repairs > 30% of Replacement	296.9	155.3	444.0	896.2
Commercial Buildings — Repairs < 30% of Replacement	430.4	178.0	823.1	1431.5
Industrial Buildings — Replacement	112.9	57.7	162.1	332.7
Industrial Buildings — Repairs	572.4	164.9	616.4	1353.7
Residential Buildings — Replacement	34.0	8.4	53.8	96.2
Residential Buildings — Repairs	343.3	212.7	1272.2	1828.2
Other Buildings — Total Repairs and Replacements	44.0	22.1	66.7	132.8
Roading	46.9	55.5	64.7	167.1
Bridging	45.9	31.4	82.7	160.0
Rail Network	52.9	68.9	79.6	201.4
Airport	2.1	2.6	3.7	8.4
Port Infrastructure	36.1	22.9	30.3	89.3
Water Supply	38.1	14.8	25.4	78.2
Sewerage System	33.6	17.9	30.4	81.8
Stormwater System	19.1	10.0	21.9	51.0
Gas Network	31.9	23.0	30.7	85.7
Telecommunications	52.9	18.6	37.2	108.6
Broadcasting Facilities	6.4	1.8	3.7	12.0
TOTALS	**2433.6**	**1186.1**	**4105.7**	**7725.3**

For all other assets, the splits used were the same as for the damage assessment. Table 3 lists the headings used.

Step 2 — Sub-division into activities or elements

Each asset category or sub-category derived from Step 1 was further split into activities or elements according to the nature of the work to be done. The total of these splits equated to 100 percent of the assessed damage. An important addition was made at this stage. The costs of planning, design, procurement and of demolition were considered to be additional to the damage value, so that the total of the percentages allocated was greater than 100 percent, typically 115 percent. The elemental split for buildings was chosen to match those in published handbooks on building costs, such as Rawlinson (1993).

Step 3 — Split into materials, plant and labour

Each activity or element was split between materials, plant and labour in proportions according to the

nature of the work involved. For instance, design activity was set to be 100 percent labour, and demolition was assessed to be mostly labour and plant, with little requirement for materials. Each element or activity was assessed separately, with the three splits adding up to 100 percent of the amount allocated to the element or activity.

Step 4 — Split into sub-categories of materials, plant and labour

Once the amount for materials was determined for a particular activity from Step 3, it was further split into sub-categories according to the nature and range of work required. The same was done with the amounts allocated to that same element for plant and for labour. The sub-categories used here were selected to correspond to those used in the industry. Categories of labour have been derived from those used by Statistics New Zealand in order to facilitate comparison with resources likely to be available. Categories of material have been determined to match those commonly used in New Zealand and the categories of plant have been taken from contractors' guides to machinery available in New Zealand.

A limited selection was made for each set in order to limit the work involved in analysis. The main categories are covered, but it is evident that a closer and more comprehensive analysis would be possible.

Step 5 — Calculation of resource quantities

Steps 1 to 4 resulted in a series of spreadsheets, one for each reconstruction sub-category selected in Step 1. These contained dollar amounts allocated to the various sub-categories of materials, plant and labour. Step 5 involved dividing these dollar amounts by a unit rate appropriate to the allocation in order to determine the contribution of that cell to the overall resource requirement. For example, in the case of concrete, the dollar amount was divided by the cost of a cubic metre of concrete to give the volume of concrete needed.

Table 4 is a sample of one spreadsheet, showing the detailed split of dollar amounts and resource allocations for commercial buildings with more than 30 percent damage. This provides an insight into the method used to assess the resources and into the range of sub-categories considered.

All other spreadsheets were compiled along similar lines.

Step 6 — Summation of resources required

This final step involved adding all the individual quantities and summarising them, a task made relatively simple by spreadsheet technology. Final totals are shown in Table 5.

Discussion

The values derived should be interpreted in the light of the wide possible variations in damage ratios. The application of damage ratios is valuable as an overall planning tool, but the temptation to interpret them as a prediction in a particular case should be strongly resisted.

The derivation of the resources required has taken no account of their availability or of the time likely to be taken to carry out the restoration work. The values derived are simply a total of resources that will need to be applied to complete the work. The intensity of input for any resource will depend on the overall timetable and the priorities assigned to various types of work.

It is beyond the scope of this paper to address these issues, but they are clearly crucial to the assessment of overall ability to recover and the resulting effect on the community.

It is, nevertheless, clear that very considerable resources will be required and that the mobilisation and effectiveness of these resources will depend significantly on the degree of preparation and preparedness of key asset owners and managers. Many asset owners and managers are addressing this aspect and this conference should provide greater impetus to such efforts and should promote awareness of the overall effect on the city of Wellington.

Comment will no doubt be made at this conference on the overall viability of Wellington after the quake. One point is worth making in relation to this. The overall damage value as a percentage of the total assets at risk, while significant, is unlikely to be sufficient to undermine overall confidence in the city's future. This is borne out by experience from past earthquakes overseas, which demonstrates that earthquake damage, while horrendous, has not led to significant relocation of people and assets.

It would be possible to refine the analysis of the split of resources considerably and go into more detail on many of the aspects. It is hoped that this initial broad

Table 4: Sample spreadsheet calculation of resources

Buildings			
Type	Commercial	Complete Replacement	
Damage =	20.0%	of	$2,489.5 M
		=	$497.9

	Planning, Design, Procurement			Demolition			Preliminary			Substructure		
	Percent	12.0%		Percent	5.0%		Percent	8.0%		Percent	17.0%	
	Value	$59.75		Value	$24.89		Value	$39.83		Value	$84.64	
Materials	Percent	Value	Quantity	Percent	Value	Quantity	Percent	Value	Quantity	Percent	Value	Quantity
concrete (m3)							3.0%	1.2	8,000	20.0%	16.9	112,900
timber (m3)							2.0%	0.8	800	10.0%	8.5	8,500
reinforcing steel (tonnes)							2.0%	0.8	500	10.0%	8.5	5,300
structural steel (tonnes)										5.0%	4.2	1,100
masonry, brickwork etc (m2)												
plaster board (m2)												
floor coverings (m2)												
windows/glazing (m2)												
painting (m2)												
plumbing and drainage($1000 units)							2.0%	0.8	800			
electrical ($1000 units)							2.0%	0.8	800			
mechanical ($1000 units)												
lifts and escalators per item												
fill (m3)												
basecourse/ballast (m3)												
paving (m2)												
Plant	Percent	Value	Hours	Percent	Value	Hours	Percent	Value	Hours	Percent	Value	Hours
bulldozers				5.0%	1.2	6,600				2.0%	1.7	8,900
cranes							19.0%	7.6	108,100	3.0%	2.5	36,300
trucks				25.0%	6.2	124,500				5.0%	4.2	84,600
graders												
excavators				20.0%	5.0	62,200				5.0%	4.2	52,900
rollers/pavers												
motor scrapers												
loaders				5.0%	1.2	11,300						
misc small tools				5.0%	1.2	124,500	15.0%	6.0	597,500	10.0%	8.5	846,400
Labour	Percent	Value	Hours	Percent	Value	Hours	Percent	Value	Hours	Percent	Value	Hours
A Management	10.0%	6.0	49,800	0.5%	0.1	1,000	1.0%	0.4	3,300	0.2%	0.2	1,400
B Design & Contract Admin	55.0%	32.9	365,100	4.5%	1.1	12,400	4.5%	1.8	19,900	4.5%	3.8	42,300
C Trades	15.0%	9.0	298,700	5.0%	1.2	41,500	15.0%	6.0	199,200	8.0%	6.8	225,700
D Service Workers	15.0%	9.0	358,500	5.0%	1.2	49,800	10.0%	4.0	159,300	5.0%	4.2	169,300
E Semi qualified & Plant Ops.	5.0%	3.0	119,500	20.0%	5.0	199,200	14.5%	5.8	231,000	7.3%	6.2	247,200
F Unqualified Labour	0.0%	0.0	0	5.0%	1.2	56,600	10.0%	4.0	181,100	5.0%	4.2	192,400
Total	100.0%	59.7		100.0%	24.9		100.0%	39.8		100.0%	84.6	

Notes
1) Contingencies allowed for by adding appropriate percentage (1 to 1.5%) from Rawlinsons to Preliminary
2) All costs in millions of dollars
3) Preliminary includes establishment, disestablishment, contingencies etc
4) 7% added to costs from main table to allow for consequential fire losses.
5) Rates

Labour	Rate ($/hr)
A Management	120
B Design & Contract Admin	90
C Trades	30
D Service Workers	25
E Semi qualified & Plant Ops.	25
F Unqualified Labour	22

Materials	Rate
concrete (m3)	150
timber (m3)	1,000
reinforcing steel (tonnes)	1,600
structural steel (tonnes)	3,800
masonry, brickwork etc (m2)	100
plaster board (m2)	20
floor coverings (m2)	60
windows/glazing (m2)	200
painting (m2)	10
plumbing and drainage($1000	1,000
electrical ($1000 units)	1,000
mechanical ($1000 units)	1,000
lifts and escalators per item	120,000
fill (m3)	25
basecourse/ballast (m3)	30
paving (m2)	200

Plant	Rate ($/hr)
bulldozers	190
cranes	70
trucks	50
graders	80
excavators	80
rollers/pavers	100
motor scrapers	220
loaders	110
misc small tools	10

attempt will encourage others to examine the issues in a more comprehensive and detailed fashion.

Other presentations cover issues of availability of resources, the time required for reconstruction, and the logistics of mobilising the required resources. Ideally, none of these issues should be considered in isolation, and it is hoped that the conference will stimulate discussion on these interrelationships and come to be recognised as a starting point for further, more integrated work.

Conclusion

The analysis presented indicates that very considerable resources will be required to reinstate Wellington after a major earthquake. The results are presented in a way that allows analysis of various recognised categories of materials, plant and labour. This assessment forms a valuable starting point for realistically assessing the time required for recovery and for assessing the likely availability of resources to carry out the reinstatement in a particular time frame. Because the quantities of most common building materials are assessed, it will provide separate sections of the building industry with their own perspectives on the likely impacts and opportunities.

Acknowledgements

This paper was written at the request of EQC, who made available much background material on damage assessments and provided encouragement. The cooperation of organisations responsible for buildings and infrastructure in the Wellington region was extraordinary and the overall assessment could not have been made without their readiness to provide information on the nature and value of their assets. It is a feature of Wellington that such coop-

Table 4 (continued)

Superstructure			Finishes and Fittings			Services (including external)			Totals		
Percent	30.0%		Percent	25.0%		Percent	20.0%				
Value	$149.37		Value	$124.47		Value	$99.58				
Percent	Value	Quantity	Percent	Value	Quantity	Percent	Value	Quantity	Dollars	Quantities	Materials
15.0%	22.4	149,400							40.5	270,000	concrete (m3)
10.0%	14.9	14,900							24.2	24,000	timber (m3)
5.0%	7.5	4,700							16.7	11,000	reinforcing steel (tonnes)
5.0%	7.5	2,000							11.7	3,000	structural steel (tonnes)
5.0%	7.5	74,700							7.5	75,000	masonry, brickwork etc (m2)
			15.0%	18.7	933,600				18.7	934,000	plaster board (m2)
			10.0%	12.4	207,500				12.4	208,000	floor coverings (m2)
			20.0%	24.9	124,500				24.9	125,000	windows/glazing (m2)
			10.0%	12.4	1,244,700				12.4	1,245,000	painting (m2)
						10.0%	10.0	10,000	10.8	11,000	plumbing and drainage($1000 units)
						5.0%	5.0	5,000	5.8	5,800	electrical ($1000 units)
						20.0%	19.9	19,900	19.9	19,900	mechanical ($1000 units)
						15.0%	14.9	120	14.9	120	lifts and escalators per item
									0.0	0	fill (m3)
									0.0	0	basecourse/ballast (m3)
									0.0	0	paving (m2)
Percent	Value	Hours	Percent	Value	Hours	Percent	Value	Hours		Hours	Plant
									2.9	16,000	bulldozers
									10.1	144,000	cranes
5.0%	7.5	149,400	2.0%	2.5	49,800	2.0%	2.0	39,800	22.4	448,000	trucks
									0.0	0	graders
									9.2	115,000	excavators
									0.0	0	rollers/pavers
									0.0	0	motor scrapers
									1.2	11,000	loaders
20.0%	29.9	2,987,400	8.0%	10.0	995,800	13.0%	12.9	1,294,500	68.5	6,846,000	misc small tools
Percent	Value	Hours	Percent	Value	Hours	Percent	Value	Hours		Hours	Labour
0.2%	0.3	2,500	0.2%	0.2	2,100	0.2%	0.2	1,700	7.4	62,000	A Management
4.5%	6.7	74,700	4.5%	5.6	62,200	4.5%	4.5	49,800	56.4	626,000	B Design & Contract Admin
5.0%	7.5	248,900	8.8%	11.0	365,100	20.3%	20.2	673,800	61.6	2,053,000	C Trades
3.8%	5.7	227,000	5.0%	6.2	248,900	5.0%	5.0	199,200	35.3	1,412,000	D Service Workers
16.5%	24.6	985,800	16.5%	20.5	821,500	5.0%	5.0	199,200	70.1	2,803,000	E Semi qualified & Plant Ops.
5.0%	7.5	339,500							16.9	770,000	F Unqualified Labour
100.0%	149.4		100.0%	124.5		100.0%	99.6		582.5		

Table 5: Summary of design, demolition and construction costs and quantities

(including construction costs plus planning, design, etc. and demolition)

	Dollars (millions)				Quantities	
Materials	Design	Demolition	Construction	Total		**Materials**
Concrete (m3)		1.1	283.0	284.1	1,895,000	Concrete (m3)
Timber (m3)		1.1	344.7	345.8	345,000	Timber (m3)
Reinforcing Steel (tonnes)		0.4	144.7	145.1	100,000	Reinforcing Steel (tonnes)
Structural Steel (tonnes)		1.1	131.2	132.3	41,000	Structural Steel (tonnes)
Masonary, Brickwork (m2)		0.0	69.3	69.3	694,000	Masonary, Brickwork (m2)
Plasterboard (m2)		0.0	194.7	194.7	9,734,000	Plasterboard (m2)
Floor Coverings (m2)		0.0	165.6	165.6	2,761,000	Floor Coverings (m2)
Windows/Glazing (m2)		0.0	199.6	199.6	998,000	Windows/Glazing (m2)
Painting (m2)		0.0	109.3	109.3	10,927,000	Painting (m2)
Plumbing & Drainage ($1000 Units)		0.0	248.2	248.2	256,000	Plumbing & Drainage ($1000 Units)
Electrical ($1000 Units)		0.0	157.0	157.0	164,800	Electrical ($1000 Units)
Mechanical ($1000 Units)		0.0	179.6	179.6	180,900	Mechanical ($1000 Units)
Lifts & Escalators Per Item		0.0	132.2	132.2	1,110	Lifts & Escalators Per Item
Fill (m3)		0.0	14.8	14.8	591,000	Fill (m3)
Basecourse/Ballast (m3)		0.0	24.6	24.6	820,000	Basecourse/Ballast (m3)
Paving (m2)		0.0	31.5	31.5	158,000	Paving (m2)
Plant						**Plant**
Bulldozers		7.9	4.5	12.4	67,000	Bulldozers
Cranes		4.3	131.8	136.1	1,925,000	Cranes
Trucks		86.1	268.3	354.4	7,090,000	Trucks
Graders		0.6	11.3	11.9	149,000	Graders
Excavators		37.4	71.1	108.5	1,441,000	Excavators
Rollers/Pavers			23.5	23.5	235,000	Rollers/Pavers
Motorscrapers		0.9	0.1	1.0	5,000	Motorscrapers
Loaders		3.1	0.6	3.7	34,000	Loaders
Misc Small Tools		53.2	481.4	534.6	53,459,000	Misc Small Tools
Labour						**Labour**
A Management	54.5	2.2	34.9	91.6	765,000	A Management
B Design & Contract Administration	298.9	26.2	361.4	686.5	7,631,000	B Design & Contract Administration
C Trades	112.8	52.5	1,017.3	1,182.6	39,423,000	C Trades
D Service Workers	88.5	24.5	334.5	447.5	17,900,000	D Service Workers
E Semi-qualified & Plant Operators	31.7	88.4	1,027.1	1,147.2	45,891,000	E Semi-qualified & Plant Operators
F Unqualified Labour	4.0	99.8	446.5	550.3	25,012,000	F Unqualified Labour
TOTALS	**590.4**	**490.7**	**6,644.3**	**7,725.3**		

eration is forthcoming and has enabled the region to progress its thinking and preparedness for earthquake. The support of each and every one of these organisations is gratefully acknowledged.

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Physical reconstruction: Availability of material, labour and plant from within New Zealand and the role of the private sector

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This paper compares the quantum of materials, plant and labour required for reconstruction after a major earthquake in Wellington, with known economic outputs of the construction industry and recent building industry statistics.

The availability of materials, labour and plant from within New Zealand and the involvement of the private sector in providing these resources for physical reconstruction is examined using an assumed reconstruction period of four years.

Some of the literature concerning notable recent earthquakes at Edgecumbe (1987) and Newcastle, Australia (1989) is reviewed and lessons concerning the involvement of private sector resources during the recovery (reconstruction) phase are noted.

It is concluded that the reconstruction would place a manageable demand on material, plant and labour resources from within New Zealand. It is recommended that the private sector takes a key role in planning for the disaster recovery phase of some future major earthquake event in Wellington.

Introduction

Estimates of the resources required for reinstatement of Wellington have been prepared by Hopkins (1995) and are the subject of another paper presented at this conference.

The Civil Defence Review Panel Report (1992) describes the emergency continuum as consisting of four phases:

- a mitigation phase, which involves attempts to prevent an emergency from arising or to reduce its effects if it does occur;
- a preparedness phase, in which plans are made to deal with an emergency;
- a response phase, during which measures are taken to deal with the immediate effects of the emergency itself; and
- a recovery phase, in which steps are taken to address the problems arising from an emergency.

The difficulty in treating these phases as a simple clockwise progression is the fact that they usually overlap. However, this paper confines itself primarily to the recovery phase.

An analysis is made of the current consumption of materials and use of plant based, where possible, on public domain information on sales and on the informed comment of key industry players. Availability of labour is based on latest census information.

Attempts to define latent capacity of materials and plant supply have met with mixed success, but they are presented here in an attempt to gain a more accurate view of availability. In most instances, the opinions of informed industry representatives have been relied upon.

The Edgecumbe earthquake and the Newcastle earthquake provide good opportunities for learning about the role of private sector organisations in reconstruction. The Newcastle event provides some clear insights into how the private and public sectors might cooperate efficiently to channel private sector resources into reconstruction.

Conclusions based on the research carried out during the preparation of this paper are formulated in the hope that the private sector might recognise the opportunities to become involved with public sector organisations in planning for a major recovery phase effort in a pre-impact environment.

Assessment of resources required

In a paper presented at this conference, Hopkins (1995) explained the methodology by which dollar estimates of earthquake damage for various classes of assets have been established. Broad-brush assessments of damage have been made on the basis that Wellington would be put back the way it was, i.e. there has been no attempt at this stage to take account of factors such as obsolescence, under-utilisation of facilities or the possible reduction in demand for facilities in Wellington following the earthquake.

The subsequent split of this damage into dollar values for materials, plant and labour resources required for reinstatement and repair are presented in Table 1 and form the basis for comparing and discussing various issues concerning availability of these resources. Quantities of each of the resources were established by dividing their dollar amounts by appropriate unit rates.

Reconstruction period

For the purposes of comparison of demand and supply, a reconstruction period of four years has been chosen. This period fits that used previously by Kingston Morrison Limited (1994) and is considered a reasonable choice based on recent evidence from overseas.

Availability of resources

General

This paper considers the availability of resources within the context of existing manufacturing and supply channels that operate within the building industry in New Zealand. There is no attempt to assess what new manufacturing and supply arrangements might be more appropriate after the earthquake. This paper does not specifically deal with how the existing or new supply chains might work following the earthquake. Logistical issues are the subject of another paper to be presented at the conference (Christianson, 1995).

In examining availability of resources, it has become obvious that not all the information required is in the public domain. It has been necessary, in some instances, to obtain information on a confidential basis from key personnel in companies and organisations that participate in the New Zealand building industry. It has not been possible in all cases to obtain facts and figures in a form that suits a consistent tabular form of presentation.

When discussing availability of specific materials and plant resources, it has been decided to present, where possible, the demand for each of the resources in a ratio form, which is calculated from demand over the National Annual Sales of that resource.

In cases where it has been possible to ascertain the latent production/supply capacity for a particular resource, a further ratio has been calculated, being the demand for each of the resources divided by the total of the national annual sales plus the latent supply capacity for the particular resource.

The overall demand for resources

An overall feel for the demand for resources following a major earthquake can be obtained in the following ways: firstly, to view the demand within the context of annual values of total buildings and dwellings put in place, and secondly, to view the total demand of $7,725 million within the context of the outputs of the national economy.

Annual building industry statistics

Figure 1 shows the annual value of work put in place for New Zealand and for Wellington for total buildings and total dwellings. All figures include alterations and additions. Superimposed on Figure 1 are three comparative graphs. It is assumed that cumulative expenditure on reconstruction follows a simple "S" curve throughout the four-year construction period:

- assumed total expenditure on reconstruction of infrastructure and buildings — the average annual demand over the four-year reconstruction period for infrastructure and all buildings represents about 40 percent of the annual spend on all buildings during the period 1988-1991;
- assumed expenditure on commercial and industrial reconstruction — the average annual demand over the four-year reconstruction period for commercial and industrial buildings represents about 25 percent of the annual spend on all buildings during the period 1988-1991;
- assumed expenditure on residential construction — it may be concluded that the average annual demand over the four-year period for residential reconstruction is about 30 percent greater than the annual spend on residential building activity

Table 1: Summary of design, demolition, and construction costs and quantities (including construction costs, planning, design, etc. and demolition)

	Dollars (millions)				Quantities	
	Design	Demolition	Construction	Total	Amounts	Units
Materials						
Concrete		1.1	283.0	284.1	12,895,000	cm
Timber		1.1	344.7	345.8	345,000	cm
Reinforcing Steel		0.4	144.7	145.1	100,000	tonnes
Structural Steel		1.1	131.2	132.3	41,000	tonnes
Masonary, Brickwork			69.3	69.3	694,000	sq.m
Plasterboard			194.7	194.7	9,734,000	sq.m
Floor Coverings			165.6	165.6	2,761,000	sq.m
Windows/Glazing			199.6	199.6	998,000	sq.m
Painting			109.3	109.3	10,927,000	sq.m
Plumbing & Drainage			248.2	248.2	248,200,000	lump sum
Electrical			157.0	157.0	157,000,000	lump sum
Mechanical			179.6	179.6	179,600,000	lump sum
Lifts & Escalators			132.2	132.2	132,200,000	lump sum
Fill			14.8	14.8	591,000	cm
Basecourse/Ballast			24.6	24.6	820,000	cm
Pavings			31.5	31.5	158,000	sq.m
Sub-total: Materials	0.0	3.6	2,430.0	2,433.6		
Plant						
Bulldozers		7.9	4.5	12.4	67,000	hours
Cranes		4.3	131.8	136.1	1,925,000	hours
Trucks		86.1	268.3	354.4	7,090,000	hours
Graders		0.6	11.3	11.9	149,000	hours
Excavators		37.4	71.1	108.5	1,441,000	hours
Rollers/Pavers			23.5	23.5	235,000	hours
Motorscrapers		0.9	0.1	1.0	5,000	hours
Loaders		3.1	0.6	3.7	34,000	hours
Misc Small Tools		53.2	481.4	534.6	53,459,000	hours
Sub-total: Plant	0.0	193.5	992.6	1,186.1		
Labour						
Management	54.5	2.2	34.9	91.6	765,000	hours
Design & Contract Admin.	298.9	26.2	361.4	686.5	7,631,000	hours
Trades	112.8	52.5	1,017.3	1,182.6	39,423,000	hours
Service Workers	88.5	24.5	334.5	447.5	17,900,000	hours
Semi-qualified & Plant Operators	31.7	88.4	1,027.1	1,147.2	45,891,000	hours
Unqualified Labour	4.0	99.8	446.5	550.3	25,012,000	hours
Sub-total: Labour	590.4	293.6	3,221.7	4,105.7		
GRAND TOTALS	**590.4**	**490.7**	**6,644.3**	**7,725.4**		

in Wellington and about 20 percent of the national spend on residential building activity, both for the period 1988-1991.

The National Economy

Table 2 has its origins in work carried out by Statistics New Zealand on the Inter-Industry Study of the New Zealand Economy for 1990-1991. For that period, the total "final use" or direct output of the New Zealand construction industry, including buildings and infrastructural works, was $10,927 million.

The table records the direct and indirect outputs of the industries that contribute to the construction industry. The total contribution of the construction industry itself to the final use or direct output of $10,927 million was $13,840 million, the difference being the amount contributed (i.e. the indirect output) to the other industries, in order for them to produce their contribution.

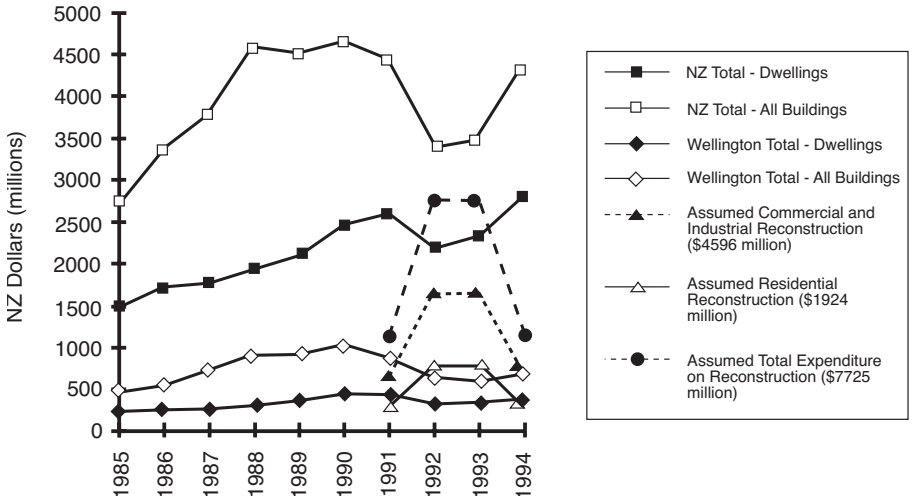

Figure 1: Annual value of total buildings and dwellings put in place NZ$ (millions) for New Zealand and Wellington, plus assumed total expenditure for commercial and industrial reconstruction, assumed residential reconstruction and assumed total expenditure on reconstruction

The average annual spend on earthquake reconstruction over the assumed four-year period ($1,931 million per annum) represents approximately 15 percent of the total output of the national construction industry for the 1990-1991 period.

Materials

Table 3 summarises the total and average demand over the four-year reconstruction period for several bulk building materials and key sub-contract areas. These demand figures are compared with the national annual sales and, where possible, the corresponding national potential supply capacity.

Concrete

In the case of concrete supply, there are several issues that need to be addressed — cement supply, aggregate supply, readymix production capacity and fleet distribution capacity. The ratios presented in Table 3 for national capacities are interesting in terms of understanding the over-capacity of the readymix industry, but are not so relevant to the Wellington region because of the perishable nature of the material.

The Wellington regional figures are more helpful. The current annual regional sales for readymix concrete are in the order of 175,000 cubic metres. It is estimated that the Wellington regional potential supply capacity is in the order of at least 700,000 cubic metres per annum. This would easily meet the demands created during reconstruction.Aggregate resources are dealt with later in this paper.

Cement supply is not seen as a difficulty. In the longer term, there are options for repair of storage silos in Wellington, should they be damaged. Supplies could be obtained through the ports of Taranaki and Napier. Alternatively, should wharves be unusable, it may be feasible to use ship storage or to unload tanker ships via temporary buoyed lines to on-shore storage facilities.

In terms of truck fleet resources, the current market in New Zealand is stretching resources — approximately 50 trucks are on the road in the Wellington region. In the event of the earthquake, it is likely that the current fleet could be relatively easily doubled by moving trucks from areas of low demand.

Precast/prestressed facilities in the Wellington region are estimated to have sufficient capacity for the likely demand of components needed for reconstruction.

Masonry/Brickwork

Table 3 indicates that there is ample national and regional capacity to satisfy the demand for masonry during the reconstruction process.

Timber

The 1994 figure for apparent consumption of sawn timber is 1,919,000 cubic metres; when exports are included, the 1994 production figure is 2,816,000 cubic metres.

Table 2: Inter-industry study of New Zealand economy 1990-1991 construction industry requirements (direct and indirect), NZ$ (millions)

Total Output for Construction Industry		$10,927
INDUSTRY GROUPS		Total Output Requirements Per Industry
PG1	Agriculture	$114
PG2	Fishing and Hunting	$7
PG3	Forestry & Logging	$165
PG4	Mining & Quarrying	$269
PG5	Food, Beverages & Tobacco	$135
PG6	Textiles, Apparel & Leather	$103
PG7	Wood & Wood Products	$930
PG8	Paper, Products & Printing	$464
PG9	Chemicals, Petrol, Rubber, etc	$879
PG10	Non-Metallic Mineral Products	$964
PG11	Basic Metals	$219
PG12	Fabricated Metal Products	$1,540
PG13	Other Manufacturing	$6
PG14	Electricity, Gas & Water	$327
PG15	Construction	$13,840
PG16	Trade Restaurants & Hotels	$1,644
PG17	Transport & Storage	$488
PG18	Communication	$307
PG19	Finance, Insurance, Real Estate and Business Services	$2,325
PG20	Ownership of - Owner Occupied Dwellings	$0
PG21	Community Social and Personal Services	$212
PG22	Central Government Services	$42
PG23	Local Government Services	$255
PG24	Private Non-Profit Services for Households	$11
PG25	Household Domestic Services	$0

Building and ancillary building services — Includes construction, alteration, renovation, repair and maintenance of buildings. Also included are ancillary building and construction services, such as brick and block laying, carpentry, painting, plastering, glazing, roofing, electrical and plumbing work, installation of heating, air conditioning, floor covering and insulation and other building and construction services.

Owner builders — Includes the construction of any building by a person (or enterprise) who undertakes construction work for their own use whether or not the owner physically does any building work. The main focus is on the building activity of households.

Other construction — Construction and project management for work other than building. Includes work on structures such as dams, roads, pipelines, tunnels, bridges, power transmission lines and flood and drainage facilities.

Approximately 700,000 cubic metres is used for structural grades. The industry has a reasonably high level of latent production capacity, which could be brought on stream to meet short-term demands created by the reconstruction effort.

Reinforcing steel

In 1994, total domestic sales of steel destined for reinforcing bar, mesh and fasteners amounted to 113,000 tonnes, of which approximately 15 percent was sold into the Wellington region.

The normal capacity for the manufacture of reinforcing bars in New Zealand is at least 250,000 tonnes per annum. The demand created by the earthquake reconstruction effort could be met with relative ease.

Industry sources indicate that there could be problems in providing fabricating facilities at short

Table 3: Total demand and average annual demand over assumed four-year reconstruction period for materials versus national annual sales and national potential supply capacity

Materials	Units	Total Earthquake Demand	Average Annual Demand Over 4 Year Construction Period	National Annual Sales (Consumption)	Latent Supply Capacity	National Potential Supply Capacity	RATIO = Total Demand / National Annual Sales	RATIO = Average Demand / National Annual Sales	RATIO = Total Demand / National Potential Supply Capacity	RATIO = Total Demand / National Potential Supply Capacity
Concrete	cm	1,895,000	473,750	1,730,400	4,269,600	6,000,000	110%	27%	32%	8%
Timber	cm	345,000	86,250	1,919,000	1,581,000	3,500,000	18%	4%	10%	2%
Reinforcing Steel	tonnes	100,000	25,000	113,000	137,000	250,000	88%	22%	40%	10%
Structural Steel	tonnes	41,000	10,250	25,000	25,000	50,000	164%	41%	82%	21%
Masonary Brickwork	sq.m	694,000	173,500	2,848,338	13,151,662	16,000,000	24%	6%	4%	1%
Plasterboard	sq.m	9,734,000	2,433,500							
Services										
Plumbing & Drainage	sum	476,000,000	119,000,000	245,000,000			194%	49%		
Electrical	sum	396,000,000	99,000,000	280,000,000			141%	35%		
Mechanical	sum	396,000,000	99,000,000	250,000,000			158%	40%		
Lifts & Escalators	sum	317,000,000	79,250,000	35,000,000			906%	226%		
Windows/Glazing	sum	199,600,000	49,900,000	177,700,000			112%	28%		
Fill	cm	591,000	147,750	2,271,000	2,729,000	5,000,000	26%	7%	12%	3%
Basecourse/ballast	cm	820,000	205,000	18,780,000	21,220,000	40,000,000	4%	1%	2%	1%
Paving (hot mix)	tonnes	300,000	75,000	580,000	4,420,000	5,000,000	52%	13%	6%	2%

notice. Investigations are under way to ascertain the viability of mobile fabrication plants to address the current range of projects in New Zealand. These could be redirected to the Wellington region in an emergency.

Structural steel

Structural steel is imported from Australia, Japan and Korea, where producers hold large volumes of standard sizes that can be readily accessed to meet urgent requirements. The required volume could be delivered to Wellington within a three to four month timeframe.

Plasterboard

The majority of plasterboard used in New Zealand is currently manufactured at sites in Auckland and Christchurch. A plant in Wellington has been mothballed.

In the event of an earthquake, the increased demand for plasterboard could be met by operating existing plants on a greater number of shifts. Industry sources confirm that short-term problems could be associated with the supply of skilled labour to fix and stop plasterboard. Current strong residential and commercial construction is fully utilising the capabilities of existing tradespeople throughout New Zealand. The Wellington earthquake scenario would call for importing of installation skills from offshore and the introduction of a rapid training programme for local labour.

Windows/Glazing

Current annual sales under the heading of windows/glazing have been calculated by applying the same trade breakdown percentages for residential and commercial construction as used by Hopkins (1995) to the annual work put in place statistics published by Statistics New Zealand. This calculation sets the current annual consumption for these materials at $177,700,000, which compares well with data provided from a key glass industry participant. Of total sales, approximately 10 percent goes into the Wellington region.

Since the closure of the Whangarei manufacturing facility some years ago, all building glass has been imported. It is estimated that basic replacement stock could be available in Wellington within four weeks of the disaster. The ability of overseas glass manufacturers to supply the amount of glass required is not considered a problem, although some of the high-performance glasses require lead times of up to 12 weeks. Supply from existing stocks elsewhere within New Zealand and from orders already in transit would be available in the short term.

Apart from specialised processing, such as toughening, laminating and double glazing, all of which can be done elsewhere within New Zealand (and Australia), the only facilities necessary could all be transferred relatively easily and quickly to Wellington from existing operations throughout New Zealand.

Industry sources estimate that there are approximately 120 glaziers and glass workers in the Wellington region. A further 50 or so operate within the immediate surrounding areas, with perhaps the same number again available from temporary transfers from further afield. There is very limited scope for the use of unskilled labour.

Building services

In Table 3, the items under the services heading have been presented in dollar terms and, for the purposes of comparison, the earthquake demand and annual consumption figures include materials, plant and labour.

Based on further analysis of the spreadsheets developed by Hopkins (1995), the total demand for services has been estimated to be $1,585,000. The percentages applied to this total to assess the demand for plumbing/drainage, electrical, mechanical, and lifts are 30, 25, 25 and 20 percent respectively. Based on advice from various industry sources and analysis of the annual statistics on work put in place published by Statistics New Zealand for dwellings and other buildings, the following market sizes have been established: plumbing/drainage, $245 million; electrical, $280 million; mechanical, $250 million; and lifts/escalators, $35 million.

Plumbing/drainage. The size of the current drainage market is estimated to be in the order of $95 million. This includes cast-iron streetware, valves and fittings, pipes manufactured from spiral welded steel, ductile iron, concrete and plastics. Industry sources indicate that current production facilities can supply a potential market size of $145 million, which implies that the demands for these products created by the reconstruction effort could be met fairly easily.

The current size of the plumbing market is estimated to be in the order of $150 million, of which piping makes up about $30 million. Industry sources indicate that the demand for plumbing componentry, including piping, can easily be met by ramping up current production, diverting products scheduled for export or by supplementing with imports.

Electrical. The size of the current electrical market is estimated to be in the order of $280 million. Building and power cables and external telephone cables have a market size of approximately $130 million. The majority of building and power cables are manufactured in New Zealand. Industry sources consider that the current production is working at 60 to 70 percent of full capacity. This excess capacity, coupled with existing import channels, could supply the resources needed for rebuilding after the earthquake.

The building industry related switchgear market is estimated to be in the $50 to $60 million range. The current production capability could be relatively easily doubled over a six-month period. The supply of imported componentry is not a significant issue.

Mechanical. This item covers fire services and HVAC. The size of the current mechanical market is estimated to be in the order of $250 million. Ramping up to meet the demands of rebuilding after the earthquake are considered to be well within the capabilities of the industry.

Lifts and escalators. The current size of this industry is approximately $35 million. Industry sources advise that the local industry is working at about 80 percent of capacity and that the demands resulting from the earthquake would cause a real shortage of skilled resources to cope with initial repairs and subsequently with rebuilding.

The view is that the larger international companies operating in New Zealand would have to call in experienced personnel from offshore, but that local and overseas manufacturers could keep up with the level of componentry required.

Hardfill

The ratios in Table 3 are not very helpful in understanding specifics related to supply of aggregates in the Wellington region.

The *NZ Annual Mining Review* indicates that, in 1992, the national total production of rock for harbour works and filling, etc. was 2,271,000 cubic metres, with 480,000 cubic metres being produced within the Palmerston North inspectorate — which includes the Wellington region. Almost 30 percent of the inspectorate's total aggregate production is

within the Wellington region, with approximately 140,000 cubic metres of hardfill produced.

Industry sources indicate that the output of existing plants could be easily doubled if there was sufficient demand. This would adequately meet the quantities required for earthquake reconstruction.

Basecourse/Ballast

The *NZ Annual Mining Review* indicates that the national total production of sand, rock and gravel for roads and ballast production was 18,780,000 cubic metres in 1992, with 3,152,000 cubic metres being produced within the Palmerston North inspectorate, which includes the Wellington region.

Using a similar calculation as for hardfill, the basecourse/ballast figure for Wellington region is estimated as 945,000 cubic metres. Industry sources indicate that the output of existing plants could be doubled if there was sufficient demand. This would adequately meet the quantities required for earthquake reconstruction.

Paving (hotmix)

As for readymix concrete, the ratios presented in Table 3 for national capacities of hotmix paving are interesting in terms of understanding the over-capacity of the hotmix industry, but are not so relevant to the Wellington region because of the perishable nature of the material.

The national annual sales of hotmix range from 580,000 to 600,000 tonnes. The Wellington region sales are in the order of 80,000 to 100,000 tonnes per annum. Current plants in the Wellington region are capable of producing up to 1 million tonnes per annum, which would easily meet the requirements for earthquake reconstruction. In the event that permanent plants are damaged, short-term supply could be supplemented by bringing in mobile plants. Currently, there are three that would be suitable for such purposes.

Conclusion

In general, it can be deduced that there is sufficient capacity within New Zealand to manufacture and supply the materials required for reconstruction over a period of four years.

Plant

Introduction

Table 4 summarises the total demand and the average demand over the four-year reconstruction period for key plant items. These demand figures are compared with the national listed capacity and, where possible, the corresponding national potential capacity.

Key resource documents have been the contracting industry's directory, *Contractor* (1994), and the Power Crane Association Crane Register (1994-1995). In calculating the listed capacity (in hours) of various plant items, it has been assumed that, on average, plant items work for 1500 hours per year.

The Contractors' Federation estimates that its plant register in *Contractor* (1994), excluding cranes, represents about 50 percent of the plant in New Zealand available for contracting purposes. The national potential capacity for all plant has been calculated by doubling the numbers of listed plant to allow for plant held by non-Federation members and multiplying by 1500 hours. This latter figure has then been increased by 20 percent to allow for increased working hours, from 1500 to 1800 hours per year.

In the case of cranes, the Power Crane Association estimates that its published figures for plant represent about 80 percent of the crane tonnage capacity available for work in New Zealand. The national potential capacity for cranes has been calculated by dividing the numbers of listed plant by 80 percent and multiplying by 1500 hours. This latter figure has then been increased by 20 percent to allow for increased working hours, from 1500 to 1800 hours per year.

Bulldozers, graders, excavators, rollers/pavers, motor scrapers, loaders

Table 4 indicates that the demand for these plant items is well within the capacity of the existing industry. There are no definitive figures published on availability of plant in the Wellington region, but industry sources indicate that approximately two-thirds of the listed plant capacity is based in the North Island and is relatively mobile.

Cranes

The total number of mobile cranes (truck-mounted, crawler and rough-terrain) registered by the Power

Table 4: Total demand and average demand over assumed four-year reconstruction period for plant versus national listed capacity and national potential capacity

Plant	Units	Total Earthquake Demand	Average Annual Demand Over 4 Year Construction Period	National Listed Capacity	Latent Capacity	National Potential Capacity	RATIO = Total Demand / National Listed Capacity	RATIO = Average Demand / National Listed Capacity	RATIO = Total Demand / National Potential Capacity	RATIO = Total Demand / National Potential Capacity
Bulldozers	hours	67,000	16,750	216,000	302,400	518,400	31%	8%	13%	3%
Cranes	hours	1,925,000	481,250	534,000	133,500	667,500	360%	90%	288%	72%
Trucks	hours	7,090,000	1,772,500	3,600,000	18,000,000	21,600,000	39%	10%	33%	8%
Graders	hours	149,000	376,250	109,500	109,500	219,000	136%	34%	68%	17%
Excavators	hours	1,441,000	360,250	628,500	628,500	1,257,000	229%	57%	115%	29%
Rollers/Pavers	hours	235,000	58,750	147,000	147,000	294,000	160%	40%	80%	20%
Motorscrapers	hours	5,000	1,250	87,000	87,000	174,000	6%	1%	3%	1%
Loaders	hours	34,000	8,500	483,000	483,000	966,000	7%	2%	4%	1%
Miscellanoeus plant	sum	534,600,000	133,650,000	100,000,000	25,000,000	125,000,000	535%	134%	428%	107%

Crane Association is in the order of 350, with approximately 246 located in the North Island and 70 operating in the Lower North Island.

An initial assessment indicates that mobile crane resources would be stretched, at least initially, but industry sources advise that there is a significant, but unknown, number of "truck-mounted/truck loading" hydraulic cranes (Hiab, Palfinger, etc.), which would be ideal for a lot of the work expected during the reconstruction period.

Trucks

The Road Transport Association advises that there are approximately 18,000 trucks in New Zealand available for "hire and reward". Of these, some 12,000 could be considered general-purpose vehicles. Approximately 8000 general-purpose trucks operate in the North Island.

Miscellaneous plant

This item is taken to include such items as compressors, compactors and the like. Sources within the construction equipment hire industry estimate that the size of the current market is in the order of $100 million per annum. Approximately 10 percent of the market is in the Wellington region.

It is difficult to assess the miscellaneous plant inventory held by contractors. An informed source estimates that nationwide this may be equivalent to an annual hireage figure of $25 million. One can conclude, therefore, that reconstruction would place severe demands on miscellaneous plant items. Hire industry experts consider that this shortage could be satisfied over a two to three month period.

Conclusion

It is fair to conclude that there is sufficient plant capacity within New Zealand to meet the requirements for reconstruction over a period of four years.

Labour

An overall view of labour resources available to assist with reconstruction was obtained from information provided by Statistics New Zealand from the 1991 Census of Population and Dwellings. The raw data was provided in the form of area of usual residence and occupation, by industry, for population resident in New Zealand aged 15 years and over, gainfully employed in the full-time and part-time labour force.

Tables 5 and 6 list the population and occupation for construction and allied industries for the whole of New Zealand and for the Wellington Regional Council area. Approximately 13 percent of the construction industry's labour resource is located in the Wellington region. An estimate of latent employment capacity was obtained by increasing the normal annual hours worked from 1500 to 1800 hours.

Additional resources could be obtained from the ranks of the unemployed. The household labour force survey for the September 1994 quarter (Statistics New Zealand) shows overall unemployment in New Zealand at 127,300 and at 16,200 for the Wellington region. Also, labour market statistics 1992 (Statistics New Zealand) shows that, of the numbers of people listed as being unemployed, approximately 9 percent had worked in the building and construction industries in their last job.

Table 5: Population and occupation by construction and allied industries for New Zealand and for population usually resident within the Wellington Regional Council Area

Construction Industries					
Occupation Grouping	Wellington Regional Council (WRC)	WRC total normal hours worked per year at 1500 each	NZ totals	NZ total normal hours worked per year at 1500 each	NZ total normal hours worked per year at 1800 each
Management	792	1,188,000	5283	7,924,500	9,509,400
Design & contract administration	468	702,000	2982	4,473,000	5,367,600
Trades	7188	10,782,000	50,568	75,852,000	91,022,400
Service workers	771	1,156,500	6225	9,337,000	11,205,000
Semi-qualified/ Plant operators	1023	1,534,500	10,890	16,335,000	19,602,000
Unqualified labour	699	1,048,500	6555	9,832,500	11,799,000
Totals	10,941	16,411,500	82,503	123,754,500	148,505,400

Construction industries include the following divisions:
51 Building Construction
52 Construction other than buildings
53 Ancillary construction services

Table 6: Population and occupation by allied industries for New Zealand and for population usually resident within the Wellington Regional Council area

Allied Industries					
Occupation Grouping	Wellington Regional Council (WRC)	WRC total normal hours worked per year at 1500 each	NZ totals	NZ total normal hours worked per year at 1500 each	NZ total normal hours worked per year at 1800 each
Management	1839	2,758,500	10,194	15,291,000	18,349,200
Design & contract administration	2136	3,204,000	12,987	19,480,500	23,376,600
Trades	534	801,000	4491	6,736,500	8,083,800
Service workers	3903	5,854,500	25,899	38,848,500	46,618,200
Semi-qualified/ Plant operators	2844	4,266,000	24,366	36,504,000	43,804,800
Unqualified labour	1314	1,971,000	9747	14,620,500	17,544,600
Totals	12,570	18,855,000	87,654	131,481,000	157,777,200

Allied industries include the following divisions:
41 Electricity, gas & steam production
42 Water works & supply
71 Transport & Storage
72 Communication

Table 7 summarises the total demand and the average demand over the four-year reconstruction period for key labour groupings. These demand figures are compared with the corresponding national employment levels and the national potential employment levels.

Conclusions

In a national sense, it would appear that there is sufficient labour to meet the demands of earthquake reconstruction. Adding the input of "experienced" unemployed people, i.e. a further (9% x 127,300 x 1800 =) 20,622,600 hours, plus recruits from allied industries, can only improve the situation.

Combining the various ratios given in Table 6 with feedback from various industry sources surveyed during the preparation of this paper confirms that there will be few problems in attracting the requisite labour force to Wellington. The major problem is likely to be associated with providing suitable accommodation.

Organisational issues affecting the private sector

Beyond the statistics on availability of materials, plant and labour lie the real issues of how the necessary resources will be deployed and managed.

In this paper, the emphasis has been on examining the availability of resources primarily for the recovery phase, but there is no intention of underplaying the role that the private sector must play in the other phases of the emergency continuum.

Hodge (1989) describes the on-site commitment of professional advisers such as engineers, loss adjusters, contractors, materials suppliers and the like that enabled rapid commencement of reconstruction work at the Bay of Plenty mill operated by Tasman Pulp and Paper following the 1987 Edgecumbe earthquake. The author also describes the flexible organisational structures and project management procedures (typical of large-scale industrial projects) that were put in place to manage operational and engineering support personnel from the mill, external specialist advisers, construction organisations, territorial authorities, insurance organisations, machinery suppliers, etc. Hodge also notes that:

> *... no effective plan can be formulated without dedication and commitment. The major difficulty in conceiving a disaster (recovery) plan is the acceptance of the fact that there is a probability of experiencing a significant disaster.*

Proceedings of a seminar held by the EQC for loss adjusters (EQC, 1987) describes the commitment and ability of the insurance industry to handle — on site — a high number of claims in a short space of time.

Robinson (1988) notes the experience of visiting householders whose frustration had reached breaking point following what appeared to be endless visits by inspection teams but no real action in repairing the physical damage. Builders also complained of wasting considerable time quoting on jobs rather than constructively working on repair and restoration and of the other real problem that they often had to quote on works without having a clear understanding of the works required.

The Newcastle earthquake (28 December 1989) has produced much reflection on the role of the private sector in the recovery phase. Rynn (1991) and Rynn et al. (1992) have provided extensive coverage of the events surrounding the earthquake and the lessons that can be learned.

There is a recurring theme that relates to the need to identify damage and/or defects correctly and determine the adequacy of the scope of works before repairs are commenced. There is also a need to have quality assurance procedures in place. Henri (1991) summarised some of the problems from an insurance perspective, but related to the building industry, as follows:

> *... the massive scale of damage in Newcastle produced the not unexpected problems of supply and demand of services and materials. In hindsight we can clearly see, that apart from temporary repairs which may have allowed occupation, permanent repairs ought not have been undertaken for at least three months. It would seem that much of the early repair work was a waste of time and money as much of this work had to be redone. However, there was great pressure being exerted by Local Authorities, the community in general and of course the building trade, to get on with the job. The earthquake damage represented a bonanza for the building trade in Newcastle and surrounding areas. Tradespeople of all disciplines and many others who promoted themselves as*

Table 7: Total demand and average demand over assumed four-year reconstruction period for labour versus national employment level and national potential employment level

Labour	Units	Total Earthquake Demand	Average Annual Demand Over 4 Year Construction Period	National Employment Level	Latent Employment Capacity	National Potential Employment Capacity	RATIO = Total Demand / National Employment Level	RATIO = Average Demand / National Employment Level	RATIO = Total Demand / National Potential Employment Level	RATIO = Total Demand / National Potential Employment Level
Management	hours	765,000	191,250	7,924,500	1,584,900	9,509,400	10%	2%	8%	2%
Design & Contract Administration	hours	7,631,000	1,907,750	4,473,000	894,600	5,367,600	171%	43%	142%	36%
Trades	hours	39,423,000	9,855,750	75,852,000	15,170,400	91,022,400	52%	13%	43%	11%
Service Workers	hours	17,900,000	4,475,000	9,337,500	1,867,500	11,205,000	192%	48%	160%	40%
Semi-qulaified & Plant Operators	hours	45,891,000	11,472,750	16,335,000	3,267,000	19,602,000	281%	70%	234%	59%
Unqualified Labour	hours	25,012,000	6,253,000	9,832,500	1,966,500	11,799,000	254%	64%	212%	53%
Overall Totals		136,622,000	34,155,500	123,754,500	24,750,900	148,505,400	110%	28%	92%	23%

qualified and experienced tradespeople, but were not, flooded into Newcastle in the days and weeks following the earthquake. Property owners, fearing they would find themselves last on the queue, scrambled to get tradespeople to quote and undertake repairs. The seeds of greed were sown at this time. The insurance industry staggered under the weight of quotes that were totally unrealistic, unprofessional and completely objectionable.

Fuller (1991) describes the central role established by the Master Builders Association in a wide range of activities — coordinating volunteer labour, setting of market rates to restrict opportunism, matching of client needs with builder's abilities, vetting of registered builders and sub-contractors, coordinating the region's building resources so they could be directed quickly and effectively to the massive rebuilding task and maintaining extensive liaison with emergency services, territorial authorities, labour organisations and professional bodies.

In the event of any large earthquake, decisions will be required on the standard of repair for damaged buildings. Should repair be to current codes, to a pre-existing level or something in between? The balance must hinge on the two questions of continuing safety and economic reality. Such questions will apply to all sections of the infrastructure as well. The processes for deciding on how such answers will be arrived at between the asset owners, insurers and territorial authorities should desirably be addressed in a pre-impact environment.

The proceedings of the Wellington Earthquake Lifelines Group (1994) attest to the commitment of various territorial authorities and organisations responsible for utilities to work together to ensure a coordinated approach to response planning for lifeline utilities and the impacts of interdependence of one lifeline on another on the response process. It is now commonplace for lifeline organisations to have in place registers of contractors, mutual aid agreements, registers of materials suppliers, registers of emergency stock levels for materials and registers of professional advisers.

In a broader sense, there is an awareness by businesses to devote resources to business interruption and continuity planning as evidenced by the number of seminars being promoted on the topic. There is a tendency, however, for such gatherings to concern themselves with information technology and related business systems issues rather than considering the physical viability or otherwise of continuing business in a particular locality.

The insurance industry has produced *The Insurance Emergency Plan* (1993), which relies on a national network of standing committees ready to respond and apply it should an emergency arise. The plan encourages a commitment to pre-emergency planning and requires at least annual liaison between civil defence, emergency services, territorial authorities, trade associations, etc. The aim is to inform these various bodies about the role of loss adjusters in an emergency and to gain information from the various bodies on important issues, such as what restrictions are likely to apply in differing types of disasters, the size and distribution of skilled labour

resources and the local availability, supply and sourcing of materials.

Britton (1994) provides a case study of emergency management and lifeline coordination for Wellington city. The author notes in regard to the recovery phase that Wellington City's Disaster Recovery Plan is currently being developed and that in consultation with relevant parties throughout the city, the plan establishes a coordinated framework within which mechanisms that are essential for prompt and appropriate physical reconstruction and social rehabilitation will take place. There has not been widespread involvement of the private sector with this planning initiative.

The Civil Defence Review Panel Report (1992) notes that the results of the State-Owned Enterprise Act 1986 and the Local Government Amendment Act (No. 2) 1989, which makes provision for Local Authority Trading Enterprises (LATEs), have made a considerable difference to the location, volume and, availability of equipment and services traditionally available to civil defence through central or local government organisations. Despite these changes, it is asserted by the Contractors Federation (Tritt, 1994) that there has never been a civil defence emergency in New Zealand when contractors' plant has not been readily and willingly made available.

The report also makes some interesting points about the planning requirements of an expanded private sector (including the SOEs and LATEs) within the civil defence context. It is noted that all organisations should plan for the civil defence needs of their employees or the people placed in their charge and secondly, in those industries that have been termed essential industries. Planning, while of benefit to the participants in the industry itself, is a matter of national concern. The following quote focuses the argument:

> *It is one thing to say that it is good business to plan as part of the national need, quite another to have it do so ... there is insufficient impetus for the private sector to perform.*

Conclusions

- Assuming a reconstruction period of four years following a major earthquake in Wellington, there would be a manageable demand on available materials, plant and labour from within New Zealand. The demand for labour will be satisfied by redeployment of existing resources from within New Zealand. The major associated problem will concern the accommodation requirements of the additional labour resources.
- The New Zealand construction industry has a proven track record in the management and supply of resources to satisfy the demands of major projects. The industry attracts personnel who have the necessary creativity, flexibility and mobility to meet the special demands that reconstruction after a major earthquake will create.
- There is a demonstrable commitment by professional groups, construction organisations and material suppliers to provide on-site resources from throughout New Zealand to deal with the response phase and to carry on to the recovery phase as may be required.
- There are significant inter- and intra-organisational issues that arise during the recovery phase. The organisations are diverse and include civil defence, emergency services, territorial authorities, asset owners, insurers, loss adjusters, engineers, architects, quantity surveyors, construction organisations, etc. Apparent reluctance by the private sector to become involved with planning for response and recovery may not be as widespread as earlier believed. Increasingly, private enterprise does take business interruption planning seriously.
- The work of the Wellington Earthquake Lifelines Group, which to date has focused primarily on pre-recovery phase activities, serves as a useful template for extending planning activities to the recovery phase. The key to success in this regard will be to involve key players from the private sector in appropriate response planning exercises, recognising that the majority of resources expended on recovery will come from and through the private sector. The development of workable processes and decision support systems linking the private and public sector in a pre-impact environment should be a valuable tool for utilisation by key players during the recovery phase.
- The response phase planning exercise should also identify appropriate organisational structures and define key roles and responsibilities to ensure the effective management of resources during reconstruction. Potential candidates to fill key roles should also be identified.

- Processes for determining demolition and/or the scope of rebuilding work, priorities for rebuilding and for agreeing on the technical standards for rebuilding should be addressed now. This would avoid much of the need for unnecessary rework that appears as a feature of both the Edgecumbe and Newcastle earthquakes.
- It is in the national interest that the recovery phase should be executed as efficiently and in as short a time as possible. The recruitment and training of the necessary labour resources and the management of deployment of these resources over a short period of time calls for the skills of organisations that have had experience with large-scale project management in New Zealand. These organisations, either acting alone or in a consortium, could provide the necessary interface between asset owners and/or their insurers to manage the recovery phase for a large grouping of assets. This would provide a level of certainty for material supply, plant supply and quality of performance, timing and cost. The pros and cons of this form of management contract ought to be explored as soon as practicable by large insurers, such as the EQC, and the larger construction and building organisations.
- It is hoped that this paper will serve as a prompt for the private sector to cooperate fully with the public sector in developing suitable mechanisms for expediting the recovery phase of the Wellington earthquake, when it occurs.

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Physical Reconstruction 2

The role of overseas organisations in disaster recovery efforts

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This paper attempts to define some of the key elements in disaster recovery and to illustrate how international organisations can assist communities devastated by natural disaster.

The Bechtel group of companies has had significant first-hand experience with earthquakes during recent years and has become very familiar with catastrophic events of other types and, consequently, with the methodology of recovery efforts requiring the procurement, traffic and logistics of mobilising, effectively organising and utilising global resources.

Using the hypothetical Wellington scenario, this paper attempts to discuss how this methodology is most effectively employed during the first four weeks after a quake and in the difficult period that follows. It also employs the example of Bechtel's experience in supporting the extinguishing of the Kuwait oil fires to illustrate how global resources can be utilised to mitigate disaster in a timely and cost-efficient manner.

Finally, the paper discusses the issues communities face in identifying overseas sources of supply and how international organisations can best supplement local resources in supporting major reconstruction efforts.

Introduction

The Wellington after the Quake Conference offers a significant opportunity for examining the challenges facing cities that have been devastated by a major earthquake.

The Bechtel Group of companies, headquartered in San Francisco, California, has had significant first-hand experience with earthquakes during recent years. In 1989, the San Francisco Bay area was hit hard by the Loma Prieta quake, and Bechtel engineers were active in emergency seismic evaluation efforts. Bechtel also provided the City and County of Los Angeles with emergency services after the Northridge quake of 1994. Furthermore, the company has become very familiar with catastrophic events of other types and, consequently, with the methodology of recovery efforts requiring the procurement, traffic and logistics of mobilising, effectively organising and utilising global resources.

This paper attempts to define some of the key elements in disaster recovery and to illustrate how international organisations can assist communities devastated by natural disaster.

The first four weeks

Four weeks after the quake, emergency response is complete and emergency life support systems and services have been restored (medical, water, food, shelter, power, sanitation, etc.). The damage to major infrastructure has been assessed, an overall reconstruction plan defined and the procurement process initiated; the general public is anxious to begin long-term reconstruction activities.

At this point, Wellington is in that uncomfortable stage between disaster and recovery. The sense of community that was so important in bringing people together immediately following the quake is beginning to fade, and a consensus on what to do next is noticeably absent. To ensure that recovery efforts continue in an orderly fashion after the emergency period is over, it is important to review the days immediately following the quake.

Within the first week after the quake, the Quake Recovery Plan (which has been prepared, approved and rehearsed well in advance) would be refined to address the specific emergency and reconstruction requirements. The plan would be reasonably comprehensive, but specifically focused on the realities of the situation. Immediate efforts would focus on

three elements of the plan: activation of the procurement pipeline, identification and contact of out-of-country labour sources and re-establishment of basic infrastructure.

A procurement pipeline for the early identification of equipment, materials and resources is crucial to any recovery and reconstruction programme. Knowing "where it is", "how to get it" and "how long it will take to get it" is of primary importance – regardless of what "it" is. This pipeline, which has been identified and periodically updated in preparation for an emergency, would be activated immediately.

In all probability, local labour sources would be fully utilised for emergency and other critical reconstruction and rehabilitation work. With local labour dedicated to these efforts, it would be necessary to have alternative sources identified for other important work. A current list (with pre-established agreements) of reliable and skilled out-of-country sources of construction labour would be verified and used for all major labour requirements. Having skilled, affordable labour identified and agreements in place would result in both timely response and considerable savings. Temporary housing, food and water, and support systems for foreign labourers also need to be in place (e.g. a chartered liner with emergency equipment and transport).

With the implementation of the recovery plan, materials, equipment and supplies would be en route from all over the world. Basic infrastructure would have to be operational to support the transport of materials, equipment and personnel. If the major air and sea ports were still not fully operational, airstrips, minimal port facilities and road networks would have to be opened. In addition, heavy equipment transport routes into Wellington would have to be cleared. Furthermore, receiving, warehousing, laydown and storage facilities would need to be established and communications networks (local), equipment and frequencies (multiple) would need to be in place.

If you don't have it where you need it, it won't solve the problem.

By addressing the preliminary steps in the recovery plan and effectively implementing them during the four-week emergency period, the potential of a successful post-quake reconstruction and recovery effort dramatically increases.

Keys to earthquake (disaster) recovery

For discussion purposes, assume that the above preliminary steps have been implemented during the first four weeks. Wellington now faces what could be a long and difficult road to recovery. Without the unified support of the entire community, the potential for further disaster is very real.

The keys to recovering from a major catastrophic event are:

- planning — essential for determining where the community is in the recovery process, where it is going and how it is going to get there;
- procurement, traffic, and logistics — "get it and get it to where it needs to be";
- management and teamwork (organisation) — maximise the participation and contribution of all resources; and
- communications — timely and focused resource utilisation.

The Kuwait oil fire disaster offers a prime example of how these key elements were used to accelerate and successfully complete the recovery effort. Furthermore, the project illustrates the value of foresight and planning in light of an impending disaster.

In anticipation of the havoc Saddam Hussein would wreak upon the Kuwait oil fields, a plan to control the damage was initiated in November 1990. After the Gulf War, which lasted from 15 January to 28 February 1991, the first Bechtel personnel arrived in Kuwait on 6 March. The main objectives of the Kuwait effort — the Al Awda phase — were to:

- extinguish the oil fires;
- restore oil production (crucial to infrastructure and economy);
- initiate oil recovery and processing (cleanup efforts vital to environment); and
- re-establish life support facilities and services.

During the war, 750 wells, representing 85 percent of Kuwait's oil producing capability, were dynamited or torched. Before the war, Kuwait had been producing approximately 1.5 million barrels/day of oil. The fires dealt a significant blow to the nation's economy, with losses of the order of $20 million per day.

Utilising the procurement pipeline that had been initiated in November, Bechtel was able to identify and procure the equipment needed to fight the fires in an expeditious manner. At the peak of the effort, nearly 6000 vehicles and related equipment had been brought into the country to extinguish the fires. By September 1991, 10,000 workers were on hand to assist in the effort — most of them from other countries.

To house, feed and attend to a workforce of this magnitude, extensive temporary facilities had to be constructed. Again, the early identification of procurement sources was crucial to this effort, and 200,000 tonnes of supplies were brought in to support the daily needs of the workforce.

Throughout the Al Awda phase, communication was of paramount importance. After the first group of fires were capped and the workforce had increased to accommodate 27 firefighting teams, advance groups of workers prepared sites in anticipation of the firefighters. Water supply canals were dug and temporary housing installed just days ahead of the extinguishing and capping teams. Constant communication kept all parties informed of project progress and transitions from site to site were almost seamless. At the beginning of the phase, one fire was being extinguished every 10 days. By the end of the effort, the capping of two fires a day was not uncommon.

Experts had predicted that extinguishing the fires after the war could take anywhere from three to five years. The most optimistic estimates gauged the effort at two years. On 6 November 1991, the last of the oil fires was capped – only eight months after the first personnel arrived in Kuwait.

The lessons from the Al Awda phase of the Kuwait reconstruction programme are directly applicable to any major disaster. Success was achieved in record time due to an effective procurement system, the utilisation of out-of-country labour resources and a systematic plan for identifying and rehabilitating damaged facilities. Another critical factor in the Kuwait success was the maximisation of local involvement; no one has a more vested interest in returning infrastructure and other facilities to normal than local residents. In the aftermath of any disaster, offshore sources of materials, equipment and labour are always supplemental to local resources.

The role of overseas organisations

The Kuwait example is valuable in highlighting the skills and capabilities that can be provided by an international organisation. Kuwait was a unique situation that will, hopefully, never occur again. However, through that example it becomes easy to see how an overseas organisation can provide support to a country, or city, that has experienced a major disaster, whether natural or man-made.

In review, the most significant contributions an international organisation can provide are:

- programme management;
- planning and plan implementation;
- centralised support services;
- re-establishing the local economy and capabilities;
- community relations; and
- financial management.

Programme management. The primary characteristic of all disasters/catastrophic events is chaos. To minimise the impacts of confusion, disorganisation, disorientation and a general lack of focus, it is essential to immediately implement a management programme. This needs to include a detailed and coordinated plan, a well-defined structure and a competent, highly motivated and well-trained organisation. This can be accomplished in a variety of ways, but a professional, competent international organisation can be an invaluable asset and can make a significant contribution to an effective management programme, especially in the early stages of emergency and recovery.

Planning and plan implementation. The development of a detailed, well-defined emergency reaction and recovery plan is essential to ensure a timely and effective response to the quake and to minimise the adverse impacts on the community. Subsequently, the ability to coordinate and implement the plan is of paramount importance. International organisations, with experience in emergency reaction and recovery planning and implementation can make a significant contribution to a disaster response and recovery effort.

Centralised support services. Centralising support services (i.e. temporary housing, messing, water supply, communications, procurement, traffic and logistics, materials handling/storage and issuance,

transportation, etc.) will contribute significantly to maximising response, productivity and resource utilisation. Centralisation allows the various production entities/contractors to concentrate on the "things they do well" and, as a result, allows them to maximise their contributions while not having to worry about support requirements. Centralisation also allows the community to acquire the services of an organisation that has specific experience and expertise in providing support services under these extreme conditions, again resulting in channelling maximum productivity and contributions into emergency response and recovery efforts. International organisations can, again, provide this experience, expertise and capability.

Re-establishing (assisting) the local economy and capabilities. Any successful and effective recovery programme must take into consideration the local economy and skills and capabilities of the local workforce. It is essential that the local community reestablishes both its economic viability as well as its self-worth as soon as possible. This can only be accomplished through the revitalisation of the local business community. The selection of, and participation by, any overseas organisation needs to be sensitive to the needs and wishes of the local business community. The rebuilding of the community's economic viability is every bit as important to its recovery as is the rebuilding of its physical elements. An international organisation with proven experience in this area can be critical to a community's ability to recover from the disaster.

Community relations. The success of any disaster recovery programme is greatly enhanced when the general public is made aware of rebuilding priorities and kept informed of progress made. It is essential that the community relations effort communicates concern and a sense of positive, real movement to earthquake victims, as well as to the general public. Initial community outreach efforts should include:

- An information hotline such as "0800-RECOVER", which would provide constantly updated voice-mail information selections for callers, as well as live operations for specific questions.
- Establishment of on-line computer information networks through the Internet or commercial services such as CompuServe.
- Production of multi-language, question-and-answer handouts, fact sheets and mail pieces covering the most frequently asked questions concerning the recovery programme. These are pieces that can be distributed to the public by the mail at shelter locations, through national, state, and municipal agencies, utility companies, banks, and business organisations, etc.
- Brief weekly "news updates" to the outreach contacts, including those waiting for recovery assistance, to communicate a regular sense of movement and success of the recovery effort and to continually answer new questions.
- An overall media strategy to promote the rebuilding efforts and communicate a sense of accomplishment.
- Meetings, as required, with property owners to answer questions regarding rebuilding schedules and status related to specific properties.

Financial management. The emergency response and recovery programmes are going to be extremely expensive, under the best of conditions, and will require professional financial experience, expertise and competence. Financial and insurance programmes need to be established during the early phases of the planning, with the same level of attention given to their implementation and management as that given to the emergency response and recovery plans and programmes. Professional, experienced international organisations can provide invaluable services and make a significant contribution to a disaster-stricken community's financial well-being, recovery and reconstruction.

Conclusion

On 17 January of this year, Kobe and the surrounding areas were hit by a 6.9 quake (officially referred to as the Hanshin quake). Over 5000 people were killed and over 75,000 homes destroyed. The infrastructure damage was tremendous, and now, two months later, the rebuilding effort is still in the preliminary stages. As a result of that quake, the government of Japan is reevaluating their emergency response guidelines and considering establishing a government agency along the lines of the Federal Emergency Management Agency in the USA.

In hindsight, it is easy to say that emergency plans should have been more comprehensive and building standards more rigid. In reality, however, the magnitude of the Hanshin quake, the location of its epicentre and other factors make it impossible to

say, with any degree of confidence, that any of the damage could have been avoided.

There are, however, some important lessons that can be learned. In the first few weeks following the quake, there was a great deal of confusion as to how to handle offers of foreign aid. Granted, when any natural disaster occurs, the national government of the affected area should be first on the scene. However, having a detailed and comprehensive plan for utilising foreign sources of aid — whether financial, material, labour or a combination thereof — can be critical to a timely, effective and economical recovery effort.

One of the most pressing needs immediately following the Hanshin quake was for emergency temporary housing and life support — approximately 310,000 people were forced from their homes. The Kuwait example showed that an effective procurement pipeline in tandem with coordinated support efforts of overseas organisations can help establish temporary housing and life-support systems when local government resources are overwhelmed.

The Hanshin quake also revealed that cellular and satellite communications systems survived relatively intact, while hardwire telecommunications suffered significant damage. For the proposed Wellington scenario, it would appear that careful consideration of this information would be a key element in earthquake preparedness plans. As discussed earlier, open lines of communication are crucial to disaster recovery efforts, and the establishment of cellular and satellite systems dedicated to emergency relief would be an essential and integral part of any recovery plan.

Finally, the Hanshin quake revealed that in spite of some of the most stringent seismic building standards in the world, infrastructure can be decimated in a matter of seconds. Periodic review of the seismic standards used in the construction of major regional infrastructure should also be an integral part of any earthquake preparedness plan. The tragedy in Japan may lead to the mitigation of similar catastrophic damage, provided that the lessons learned are shared and disseminated in a timely manner and subsequently incorporated into the emergency planning and recovery process.

In the aftermath of a natural disaster, members of the affected community, quite naturally, band together to face the recovery effort as a cohesive unit and look to their local and national governments for assistance. There is often a sense that foreign aid constitutes charity and unwanted outside interference, thereby complicating the recovery and engendering a feeling of indebtedness on the part of the disaster-stricken community.

This paper has attempted to define the elements that are the key to any recovery plan and to illustrate their successful implementation through the Kuwait example. In Kuwait, the enlistment of non-Kuwaiti organisations to support the recovery effort was not a request for charity, but rather a shrewd tactical move in disaster mitigation. Ultimately, a community that has been ravaged by a major disaster such as this conference's hypothetical Wellington quake is primarily concerned with reclaiming normalcy in the lives of its residents. By strategically involving offshore organisations and maximising the skills and resources that they can provide a more timely, economical and effective recovery can be achieved.

Ultimately, however, the success of any recovery effort will centre around the planning and preparation that has been done in anticipation of the disaster. Assuredly, earthquakes will continue to rattle the earth — some causing significant damage. While we may not be able to anticipate the exact location and magnitude of these quakes, conferences such as Wellington after the Quake demonstrate the foresight that will ultimately lead to the saving of human lives.

The logistics of importing materials to the Wellington region, housing the workforce and construction bases

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On a normal day, Wellington consumes in the order of 200 million litres of water. Most of this is delivered to the consumer through a trunk main, which is adjacent to the main Wellington faults for much of its length and its branches cross the same faults in several locations.

A major motorway structure contains over 25,000 cubic metres of concrete. All of the cement for this comes from outside of the region. A large steel-frame building contains 150 tonnes of steel per floor. Much of this steel is imported from overseas. The demolition of a large reinforced concrete or steel structure will take several months from the initiation of drilling for charges to final removal of debris.

This paper examines the logistics of resourcing the labour, plant and materials to reconstruct Wellington's damaged infrastructure and to house the regular work force as well as the temporary emergency force. It draws on the author's first-hand experiences of the 1987 Bay of Plenty and 1990 Luzon earthquakes and a visit to USA to study the reports of the 1994 Northridge earthquake and other recent events in USA. Some reference is made to the nontechnical press reports of the 1995 Hanshin event near Kobe.

Recommendations are made for the creation of a resource register to enable the required resource to be located, mobilised and delivered to the Wellington region in spite of a severely damaged infrastructure. Recommendations are made for the establishment of a register of overseas supply sources where New Zealand sources are considered inadequate.

Introduction

The "Big One", the M_s 7.5 event, will be larger than any event in the memory of most people alive in New Zealand. There is a widespread belief among many people that they will cope, that there will be some disruption to their routine and that there will be localised shaking damage and some minor roading inconvenience will occur.

The reality of history and the anecdotal evidence from previous real events within the region shows otherwise:

- The 1855 Wairarapa Fault movement was reported to have been felt over an area of 900,000 km^2, caused severe damage as far away as Wanganui (200 km from Wellington) and was felt 240 km out to sea.
- The 1929 Murchison earthquake was accompanied by vertical ground movement in excess of 3.7 m (12 ft).
- The 1968 Inangahua earthquake caused substantial damage in Wellington, over 200 km away.
- The 1987 Bay of Plenty earthquake cased severe damage in Kawerau, over 40 km away.

These huge distances are typical of those experienced in the Philippines in the Baguio earthquake of 1990. This M_s 7.8 event caused severe damage over a very wide area of a country, which shares many of the geographical features of New Zealand and whose seismic code is closely based on the US Urban Building Code and SEAOC code. As in all earthquakes where seismic engineering has been practised, many structures survived, but it is the magnitude and distribution of land damage and deformation that should act as a stark warning to New Zealand, and Wellington in particular.

The Philippines sit on the edge of the collision zone between the Pacific and Indian Plates. Both strike/slip and subduction events occur. The geology of the islands includes large areas of soft sedimentary rocks of various ages, significant volcanic inclusions, deltaic rivers settled by urbanisation and large areas of soils that are liquifiable when subjected to large earthquakes. In this connection, the use of felt intensity values as some sort of finite scale is

misleading to the public and nontechnical professionals alike. Substantially greater damage will occur in an MM VIII event, which is caused by a larger earthquake than for the same intensity caused by a smaller event. The 1990 Philippines earthquake was characterised by:

- structural damage, particularly to rigid facades and eccentric or irregular buildings as far as 200 km from the epicentre;
- extreme liquefaction damage 70 km away from the epicentre;
- ridge acceleration, associated hillside erosion and river deviation over almost the whole length of rivers hundreds of kilometres long; and
- the total destruction of engineered mountain roads both across and parallel to the ranges.

This event is largely ignored by New Zealand seismic professionals, engineers and civil defence personnel alike. It serves as good model particularly for total disaster logistics.

Logistics

Logistics is considered to be the procurement and delivery of the right supplies, right quantities, in the right order, in good condition, at the right place and at the right time, all to the maximum benefit of the whole community. None of these logistics criteria can be satisfied without a contingency plan to cope with a modified infrastructure, since it is clear that all supplies depend on transport for their implementation (Figure 1).

In the Wellington Lifelines Study completed by the Centre for Advanced Engineering (CAE) in 1991, roading, or the lack of it, was identified as the most critical of all lifelines. This led to a further study carried being out on behalf of the Wellington Regional Council in 1994 to investigate the stability of hill slopes throughout the region. The prognosis that emerges from this study is that ridge damage in Wellington begins to occur at MM VII intensity events, is likely to be more serious when slope modification has occurred, such as in road cuttings, and will affect all roads through the region. Rail routes will be similarly affected.

STARLIFTER	40T CAP USAF 250 No.
LOCKHEED C5	250T (over short range) USAF 100 No.
ILYUSHIN IL76	30T+, Russian, Indian airforce
	All require long, > 1300m semi-prepared runway
HERCULES	12T payload. All Commonwealth air forces, USAF, Philippines and Indonesia. Very short runway. Can land on grass
BOENG 747	Major commercial freighter, needs long runway (SP version only, Wellington)
OCEAN BARGES	Hawaii, mainland USA
RO/RO SHIP	Australia
HEAVY LIFT HELICOPTERS	MIL 8 4T Capacity. West Coast South Island. Australia Backup

Figure 1: Air/sea freight backup and capacities

Control during the post-disaster period

The speedy and efficacious provision of the emergency response will not be possible without an overview authority/organisation being responsible for the prioritisation of restitution work once the civil defence emergency is considered to be over.

In the Wellington region, we have four separate city authorities on the south side of a line drawn from the Rimutaka Road summit to Waikanae, with several district councils north of the line. Each has its own civil defence controller with liaison links to those in the neighbouring areas. The regional controller has overall responsibility. The Wellington regional and city councils are totally dependent upon outlying areas for the restoration of infrastructure links to their areas of responsibility. The Civil Defence Act allows a council to declare an emergency, even if it is not affected, but is required to give assistance to another authority. The emergency can be declared for seven days and extended as required in seven-day periods by the controller. The Wellington repair period will extend into years rather than weeks and seven-day emergency powers are insufficient.

The Civil Defence Act allows for the appointment of disaster recovery coordinators and/or a commissioner for disaster recovery. Again, the duration of the powers for these persons seems to be woefully inadequate, at 28 days for a scenario that will last well beyond this period (Figure 2).

However, it does allow for an early independent assessment of priorities. There can be wasteful duplication of effort and, in some cases, competition for valuable resources causing resources to be spread thinly. After the Bay of Plenty earthquake in 1987, rapid action by consultants led to the

CD Act potentially ill-suited to multi-million Regional Disaster

Set up structure with permanebt budget, reporting during emergency direct to Cabinet, with planned administrative structure. Structure to have power to act when CD Act limitations affect ability to act effectively.

cf US FEMA and GoP PTFR

Figure 2: Repair coordination and administration

requisitioning of all available stainless steel to repair a gin/vodka alcohol production plant while milk and other dairy facilities remained out of action. By way of further example, there was no formal liaison between the emergency engineering teams employed on behalf of the insurance industry and those acting for the civilian authorities. The only contact the private engineers had with the civil defence authorities was to get passes for the restricted-access areas, which enabled them to enter the area and get food at the emergency feeding stations. US specialist earthquake engineers with extensive knowledge of disaster recovery scenarios received little or no official assistance with their work and were forced to leave at least one site.

My first logistical recommendation is that we look at the provisions of the Government of the Philippines Republic Act 6960 by which was convened a Presidential Task Force for Reconstruction (PTFR), charged with the "identification, prioritization, programming of projects and fund allocation within three months of a specified date". The PTFR reported directly to the Philippines' President and Cabinet and included works, social welfare, treasury and other key departmental secretaries. A multi-disciplinary support team assisted the group. Many of this team went on to become members of the reconstruction implementation teams. As well as scheduling the reconstruction programme, the PTFR was able to set design standards and set aside government tendering and contract rules for a short time. Normal procedures returned after six months.

Projects were categorised into three levels of urgency:

- Level I — Basic emergency repair merely for the purpose of getting the facility or infrastructure back into use, e.g. a temporary Bailey bridge. Projects are to be completed within two months.
- Level II — The reconstruction or restoration back to original condition of a facility or infrastructure to make it resistant to natural calamities, e.g. removal of slides, reconstruction of damaged embankment and pavement, reconstruction of schools, hospitals and government buildings, etc. These projects are to be completed within six months to two years.
- Level III — The reconstruction of damaged infrastructure and development of new facilities to minimise the disruption of infrastructure in case natural calamities such as earthquakes should occur in the future, e.g. new alternative routes, new towns, relocated production areas and reconfigured transport networks. These projects are to be completed within two to five years.

The approved projects were scheduled, costed, prioritised and allocated to various government agencies for implementation. The area affected by the earthquake was split into regions, most of which were controlled by the local regional office of the Department of Public Works and Highways (DPWH). Each region was allocated a Philippines consulting engineer who administered the design and construction of approved projects under the direction of the local DPWH Director. DPWH head office, assisted by ten international consulting engineers, provided technical direction and administered financial appropriation against the original PTFR schedule of approved projects. At this stage, it should be noted that these consultants were exempted from the normal immigration and work permit requirements, thus allowing their rapid deployment. The Kobe relief effort is reported to have faltered due to bureaucratic difficulties in such areas.

The PTFR only had jurisdiction over government-owned facilities since all the international aid agency funds are soft loans for such projects. Their reconstruction not only allows government to function but reassures the general populace that business is heading back to normal. The normalisation of life as soon as possible was a priority of the reconstruction targets of the PTFR. This carefully centralised and fully scheduled reconstruction programme achieved a considerable degree of success in three years. Some 3000 schools, 200 town halls, many police stations, several universities, many hospitals, hundreds of kilometres of highway, two large dams and a significant number of bridges were rebuilt or repaired. There was less success in the restoration of water supplies due to changes in aquifer levels, movement of well shafts, supply difficulties with adequate quality of pump components and difficulty in establishing the reconstruction of river catch-

ments' training levees due to the erratic behaviour of river beds seriously affected by the debris resulting from ridge erosion.

In the same period, almost no privately owned facilities were reconstructed.

Centralist and interventionist government is frowned upon in New Zealand, but it works well in the major disaster scenario. The probable post-event disruption of the Wellington region due to infrastructure damage lends itself to technically-led structure, as outlined above.

It is significant that the international aid agencies, such as the Asian Development Bank, which have more experience of disaster relief than anybody else, place great stress on the reconstruction of a country's logistic infrastructure system in disaster relief programmes.

Roading logistics for Wellington

Road vulnerability

The study that followed the CAE lifeline study (1991) gave the threshold of land damage as a seismic event exceeding MM VII in intensity. It predicted intensities in the IX to X range. At this level of shaking, it is predicted that no road or rail link out of the region is exempt from the probability of significant slipping and/or hillside modification. Some of these slips have the potential to be very large. One fairly recent (1855) seismically-induced slip can be clearly seen by today's travellers — the "gold slip" just to north of the BP station on the Hutt Road had a volume of approximately 500,000 m^3.

The study suggested that there is a significant to severe risk of major slipping — between 10,000 and 100,000 m^3 per slip — for over half of the slopes adjacent to the Hutt Road and SH 1, between Wellington, the Aotea Quay junction and Johnsonville, and SH 2 to Petone, with very major slipping at the BP station and the gold slip site. Within the city, the roads to Ngaio, Khandallah, Karori, Miramar, Hataitai and at Seatoun and Happy Valley are given the same risk category. The route along the hills between Ngaio and Johnsonville also has several risk points.

Many of the roads noted act as either critical intracity feeders or offer diversion routes if the state highways are blocked for any reason.

Similar scenarios are presented for the Hutt Valley, with almost continuous slumping along SH2 to Silverstream and high risk areas also at Point Howard and the Wainuiomata Hill Road. Continuous slipping is forecast for the Rimutaka Hill Road with the added complication of downhill slumping, which is more difficult to repair. SH 1 and SH 58 are in similar conditions, with severe risk between Plimmerton and Grays Road, at Paekakariki on both the state highway and the older hill road and slips on SH 58 at the Haywards end.

Multiple slipping produces separate problems other than causing severe local disruption at the time. The huge quantities of debris to be disposed of are often pushed over the side of the road without too much thought being given to where it goes. Loose debris will usually find its way into the nearest catchment and thence migrate downstream. Local authorities have the power to ignore the requirements of the Resource Management Act in emergency situations. However, the problem may not have been fully thought through. Again, using the Philippines example, consider the problems of the Dalton Pass in similar topography and geology to the Rimutaka Hill Road: immediately after the 1990 earthquake there were four significant slips per kilometre, and after one rainy season the slipping had become almost continuous and the river at the base of the hill slopes had risen by several metres because of the migrated debris.

There are not many well documented accounts generally available that quantify the clearance of seismically induced slips in New Zealand. In 1994, the clearance of the single large slip on SH 73 at Arthurs Pass took three weeks and costs were a significant proportion of the $1.7 million spent in Canterbury that year. In the same year, Transit New Zealand spent just over $4 million on other emergency work in Haast and Milford and a total of $6.33 million on unscheduled emergency work in the South Canterbury, Otago and Southland regions. This has been assessed to average out at approximately $600,000 per km. Individual highway component costs are high. Gabion retaining walls can cost $600/$m^3$ and State Highway bridges average out at $42,000/m. To repair/reinstate some 50 km of road with a dozen bridges and some gabion wall work could cost $100 to 150 million and require 1 million working hours (450 to 500 workers working for a year!).

Bridges

The CAE lifeline study (1991) also noted that the probability of bridges being put out of service due to fault movement through the bridge is very high at Silverstream, Normandale and Thorndon. These potential failures are critical to the Wellington region. Silverstream (Fergusson Drive bridge) carries over 50 percent of the region's water; on a normal day, Wellington consumes about 200 million litres of water. Over 30 percent of the region's dry foods comes from the supermarket distribution warehouse, which is on the wrong side of the same bridge to be of service to Wellington immediately after the quake.

Bridges consume large quantities of plant, labour and materials. Shell Gully motorway structures, which are not considered to be significantly at-risk structures, involved the movement of 200,000 m^3 of earth/soft rock, pouring 20,000 m^3 of concrete, drilling 2 km of piles, and placing over 2000 tonnes of reinforcing steel and 40 km of stressing cable. Up to 250 tradesmen were employed for up to four years. The contract value would be $40 to $50 million at today's rates. Thorndon Overbridge, which is an at-risk structure, employed up to 340 people, a peak that was maintained for two years. At today's rates, the construction cost would be in the order of $90 to $100 million. Demolition of the structure would probably take some 300,000 working hours (150 years!) Conventional high use of unskilled labour has been allowed for, since it is anticipated that hydraulic plant would be put on road work and reinstatement of buried pipelines. Control of this activity would be difficult. Enquiries within the trade suggest that there are only 20 skilled demolition managers able to work in engineered heavy demolition and only a handful of engineers with the requisite skills to advise. Clearly, there is a need to upgrade this bridge complex since, as discussed above, it would take some five years to rebuild it.

Other key road bridges in the region that are at risk from destruction by shaking or fault movement include Melling, Normandale and Petone bridges along SH 2, the Pipe Bridge at Seaview, and the SH1 bridge at Plimmerton. Some significant suburban bridges have suspect survivability, e.g. Kelburn Viaduct, and failure of these could isolate individual suburbs. To reinstate each of the bridges noted could take an extended period, a year or more to build, excluding design time. With a total deck length in excess of 600 metres, the repair programme is about two-thirds of the total of State Highway bridges built in the years 1992-1994 and has a probable construction value in excess of $25 million, excluding the costs of demolition.

Assuming major use of precast concrete, all beams would need to come from Otaki or Hastings along roads that I have already demonstrated are unlikely to be available. In the Philippines, the sensible alternative of casting on-site was adopted and full-scale mobile batching plant were used. I am not aware of such plant being available in New Zealand and none is shown in the Contractors Federation Blue Book (Figure 3).

Ignoring the traffic congestion issue, it is clear that the two most important bridges in the region are those at Silverstream and Seaview, since they are prime supports for Wellington's water, followed closely by Plimmerton. Although inconvenient, deviations do exist for all other bridges, and most can be temporarily reinstated using Bailey bridging. Transit New Zealand currently carries stocks outside the region, and componentry may be hard to provide due to highway disruption. Seismic "hardening" of Thorndon is now being planned and it is to be hoped that the retrofit is complete before any major earthquake. (Retrofitted bridges performed very well in Northridge in 1994.)

Some thought needs to be given to preparing riverbed crossing contingency plans and carrying out preparatory approach work now. For example, there are several locations along the Hutt River where a ford is easy to create and where land ownership does not present a problem. A good example is County

PROBLEM	SOLUTION
No local stocks	
a. Heavy Bridge Scaffold	Air freight ex Australia (3 bridges)
b. Bailey Bridge Units	Sea transfer ex Christchurch and Wanganui (barge or ship)
	Distribute by Mil 8 helicopter (4 tonne capacity, based on West Coast, South Island)
	NB: Bailey bridging flown into Anchorage 1964
c. Large Hydraulic "Nibbler"	Air freight if required ex Auckland, Australia and Japan. Barge/helicopter distribution

Figure 3: Bridge repair equipment — urgency

Lane at Silverstream. Preparatory work such as this can be timed to coincide with slack plant periods and also serves as a constant reminder to the public that earthquake preparation is one of the best forms of damage mitigation, other than getting the design right in the first place.

Roading is critical to the reconstruction of the whole Wellington infrastructure

All construction materials are either delivered to the region or distributed within it using the roading network. Even sands and road and concrete aggregates that are manufactured locally are sensitive to the stability of the hills and/or the availability of this network. For example, the coastal quarry at Owhiro Bay and the several quarries alongside SH2 in the Hutt Valley have threats to their production due to loss of production faces from seismically-induced slope modification, the same mechanism that puts so much of the region's roading at risk.

If all routes are affected to their maximum potential, then a decision needs to be made now as to priority for reconstruction in the future, since it will not be possible to tackle all routes simultaneously.

In the USA in the period following the Northridge earthquake in 1994, it took three months to reopen one of the critical freeway intersections, even given the huge resource base available. Dalton Pass in the Philippines was shifted to a completely new alignment in some areas and was able to take traffic — with difficulty — inside a month, but regular traffic conditions were still not available three years after the event in spite of an enormous effort involving the government and three aid agencies. No reliable all-weather road had been reopened over the central Luzon mountain range after three years, and detours of several hours were often necessary.

New Zealand's resource base is not large. It should be noted that the NZ Contractors *1994 Contracting Industry Directory* lists only 23 bulldozers and 62 wheeled loaders in the Wellington, Wairarapa and Manawatu regions. These are the key plant items required for large-scale debris clearance. The nearest significant motorscraper resource is in the Hawkes Bay (Figure 4).

It is clear that restoration of full roading capability to the region could be a protracted affair, even without considering the damage due to the effect of liquefaction on valley floor and coastal roads across silts and sands. The effect of highway damage and disruption on the reconstruction of damaged structures and utilities will be severe. It is important to consider what the reconstruction need will be.

Ports

Disruption will also occur due to liquefaction and shaking damage at the airport and in the port area. This will make plant replenishment difficult if stocks are topped up from South Island. Ports were damaged at Northridge, although they are located over 40 km from the epicentre. It is estimated that the port of Kobe will be out of action for four months due to liquefaction damage. The nature of construction plant is such that it is too large to arrive as container cargo and will need to be unloaded by cranes, which operate in the older and more vulnerable area of the docks. Damage such as that outlined above will affect the repair programme where sea delivery of materials and plant is necessary. A survey should be carried out now to determine which parts of the local coastline would be suitable for unloading heavy plant using tank-landing type vessels should no other route be available. Supply bases could be set up near these landing areas using council-owned sports grounds (Figure 5).

Since sea bed level change is a characteristic of large Wellington earthquakes, it is suggested these base areas be sought outside the main harbour, e.g. on the southern beaches and west coast in the vicinity of Porirua.

Buildings

Size of the problem

The extent of damage in unit and dollar terms is outlined in other papers presented at this conference or used as background material. These give cold figures but specifically exclude timetable and labour availability considerations. Firstly, it must be pointed out that there is as much range in the figures as there is in the prediction of damage. They are variously put between $3 to $17 billion for housing

PROBLEM	SOLUTION
Insufficient Regional Resource	
Motor Scraper and D8	Import from other NZ locations (by barge) landed on beaches if docks inoperable
Road priority to be incorporated in Regional CD Plan	
NB: Maximum payload Lockheed C5 125-250T depending on range (Ohakea)	

Figure 4: Road repair plant — urgency

PROBLEM	SOLUTION
Historically put out of action by land movement/shaking	1. Identify possible beach landing sites for first wave emergency plant
Small helicopter fleet	2. Ensure microwave link via Hawkins Hill to Christchurch has redundancy
	3. Investigate use of SH2 for STOL aircraft (700m unimpeded straight available). Trial flight
	4. Christchurch, Ohakea alternatives
	5. Inventory of crawler cranes required
	6. Limited helicopter fleet to be augmented (NZ and Australia)

Figure 5: Port, airport — urgency

only. The lower figure corresponds to 100,000 homes, which I consider too high. Forty thousand homes were destroyed in Kobe.

The figures need to be put in the context of normal building activity. In the year ending March 1994, the total value of building work in the Wellington statistical area was $352 million. In the same year, the value of building work in Auckland was $1049 million, South Auckland $423 million, Canterbury $398 million and the remainder of South Island $378 million. If we just take the lower figure, the predicted damage will equate to about 8.5 years of present workloads or be nearly equal to the total annual cost of New Zealand housing in the year ending March 1994. If the higher figure is correct, and it draws heavily on the Edgecumbe damage ratio, the ratio of the Wellington losses compared to the national construction total is very large whether we are considering time or cost to build. After the Loma Prieta earthquake, some 12,000 housing units were lost or severely damaged, and 30 to 35,000 were damaged to a lesser degree. By 1994, most of the single-family stock had been repaired, but less than half of the multi-unit homes had been repaired.

The possible value of commercial damage is not so easily defined. The Edgecumbe commercial figures do not readily translate to the Wellington scenario and there is greater variation in the size of loss anticipated. For commercial buildings, I have seen figures ranging from $100 million to $24 billion. It is my opinion that the lower figure is too low and the higher is unlikely. At the time of writing, there were still 140 or more notified earthquake-risk buildings in Wellington's central business district. There is a considerable number of pre-1935 concrete buildings and a large stock of reinforced concrete and riveted steel-frame buildings built prior to 1970 in the same area. Some of the concrete ones are not in very good condition. Most have stiff, rigid facades. There is no up-to-date seismic inventory for the Wellington region.

For the purposes of this study, the cost of damage reinstatement and repair has been assessed at $4 billion. This corresponds to the full reconstruction of two large buildings and 100 or more medium buildings, major repairs to six large buildings and substantial repairs to some 1800 medium-sized buildings following demolition of the damaged portions. These figures are entirely notional and must not be taken to indicate that Wellington's large buildings pose a significant risk. It is fair to say, however, that all major earthquakes bring their fair share of nasty surprises.

To gain some indication of the logistics of building, the Museum of New Zealand building will have consumed 22,000 m^3 of concrete and 39,000 m^2 of mesh and employed 250 people for long periods when completed in 1997. The Bank of New Zealand Centre used 10,000 m^3 of concrete, 37,000 m^2 of mesh and nearly 4500 tonnes of steel, and has 12,000 m^2 of precast concrete panels on the facade. It is 25 storeys from the ground to the roof. At its peak, some 250 people were employed on its construction (Figures 6 and 7).

Accommodating imported labour

It seems likely that 9000 to 10,000 additional tradespeople, at least, would be required to work on the commercial buildings and may be as many as 5000 on homes. There are approximately 65,000 employed in the industry nationwide in all trades, of which 30 percent are in the Auckland area. Therefore, the additional building load in Wellington approximately equals 75 percent of Auckland's normal work load. However, a fact to be considered is that commercial demand is dictated by normal financial and commercial conditions that impose a smoothing curve on demands. It is quite normal for very large projects to require assistance from overseas to top up our small labour force, particularly in the technical and supervisory areas. For example, up to 25 percent of the supervisors for Marsden Point Refinery were Australian, and the scheduling for the project was carried out in India.

MATERIALS	SOURCE
Cement, South Island	Stored in dockside silos
	May be inaccesible by ship
	Transfer from alternative silos at Hawkes Bay
	Critical material dependent upon roading
Aggregates, Local Manufacture	Production affected by hill face slipping
	Distribution dependent upon roading integrity
Structural/Reinforcing Steel	All manufactured outside of region
	Minimal stocks (2-4 months) held
	Not cost effective to fly. Barge delivery as plant. Requirement within national resource

Figure 6: Building materials — urgency

BUILDING MATERIALS	SOURCE
Plastic pipe	Continuous flow production in Auckland
	National resource able to cope with demand
	Distribution dependent upon roading
	Able to be locally transported by helicopter
Glass	No local manufacture. Stocks held are low
	Mass dictates distribution by rail/road infrastructure (refer roading). Joinery ex Auckland
Hardware, Electrical, M&E Plant	Substantial manufacture out of region (and overseas). Delivery dependent upon intact infrastructure

Figure 7: Building materials

It is not possible to accommodate these people in conventional short-term accommodation. Since some will be in the capital for several years, they are likely to buy a home. Many of the single, more mobile, workers will seek rental accommodation. It would be sensible to open a register now of home-owners who would be able, and prepared, to accommodate emergency workers. There are two valuable reasons behind this suggestion. Preparation is one of the best forms of mitigation. It will enable a wide cross-section of the community to become aware of the seriousness of the threat. Importantly, such a scheme would scatter tradespersons throughout the city (Figure 8).

Repair

The rebuilding programme can only start when the damaged buildings have been repaired or made safe. The demolition of a large building is not a common occurrence in New Zealand. There are no local contractors skilled in implosion techniques, the most effective way of demolishing large buildings. Just setting the charges for a seven-storey building can take a month. The demolition of large buildings takes almost as much detailed engineering as their erection. The time scale is long — Bullocks Department Store in Northridge was still being demolished six months after the earthquake. One of the significant constraints was the need to sift high-value contents from the debris as recovery to minimise the contents claim. This was also the case in the Hannahs fire in Wellington in 1980, where one of the tenants was a manufacturing jeweller. This conflict will arise in Wellington, particularly if separate loss adjusters, insurers and advisers are involved.

If the building is just damaged, the situation can be more complex. The repair costs for structural weld repairs in Northridge were often greater than the building value. Owners just walked away, leaving the city council with the problem. Tenants had probably left long before.

Inspection

The question of inspection to determine the next action following the earthquake is a major logistical bottleneck. There are only 350 insurance assessors in the country and not all can handle buildings. There might be only 200 to 250 able to work in this area. There will be a need to supplement these assessors with overseas personnel. About 18,000 buildings were destroyed in Kobe; 3000 buildings were "red tagged" after the earthquake in Northridge. Assessment is carried out by inspecting engineers in the immediate aftermath of the event. They will need to be serviced by engineers familiar

PROBLEM	SOLUTION
a. Most hotels in area of greatest dislocation	Establish resource inventory now of people prepared to offer accomodation
b. Distribution of labour	Zone city using postal codes for sector identification. Resource of accomodation to be evenly distributed in sectors

Figure 8: Accommodation

with New Zealand seismic design philosophies (or similar) if public safety is not to be compromised and confidence in the "authorities" is to be maintained (Figures 9 and 10).

It is extremely difficult to quantify the numbers of inspecting engineers required. It took two engineers three days to inspect, quantify and agree the principle of the repair of the NZ Distillery plant at Edgecumbe and many more days to implement current code compliance provisions that were part of the insurance cover. A team of 20 engineers from several consultants working together was assembled to inspect the damaged paper plant at Kawerau. Houses are easier to inspect. One engineer can report on three to four per day. Using the building numbers noted above, averaging commercial buildings at one per two days and four houses per day gives an initial assessment load of 8000 engineer days (100 engineers for 80 days).

A major logistic problem potentially exists in the issuing of building consents once designs have been completed. Some authorities are currently using all of the time allotted in the Building Act. The repair and restoration demand is a load on top of the normal load, which continues since most of the region's infrastructure will remain intact, although severely disrupted. A two-month moratorium was imposed on new construction after Kobe.

Forward planning

It is clear that we will have a huge struggle to meet both the building and the technical requirements imposed by the event being studied. In conversations with Federal Emergency Management Agency (FEMA) personnel in Chicago, it was made clear that FEMA only coped because liaison and manning difficulties exposed during civil emergencies 18 months beforehand and severe fires in 1993 had forced many changes in the coordinated management of an emergency. In spite of this, the city of Los Angeles had come close to being declared a federal emergency in 1994. The State of California has adopted a Standard Emergency Management System. For the last seven years, the Federal Government has been working on the development of a Federal Response Plan coordinating the activities of 27 emergency response agencies.

PROBLEM	SOLUTION
a. Technical assessment	IMMEDIATE NEED
250 engineers for 30 days	Internal source (NZ)
b. Loss Adjusters	IMMEDIATE AND ONGOING NEED
250 available NZ	Needs to be augmented from US. EERI best source for initial inventory. SOURCE NOW
c. Renewal/Repair Design (5 year programme)	600 engineers/draughting staff. NZ resource
d. Renewal/Repair Reconstruction (5 year programme) 3000/yr required	Unskilled — Using workforce unemployed because of earthquake. Skilled — NZ Resource. 200 supervisors required ex overseas

Figure 9: Labour — technical and trade

PROBLEM	SOLUTION
a. Demolition management Very small NZ resource	Resource inventory to be established now using UK and US as resource base
b. Large structure demolition Knowledge small	Loma Prieta, Northridge, Kobe demolition management to be researched now
NOTE: URGENT NEED — DEMOLITION IS A CRITICAL COMPONENT OF RECONSTRUCTION	
b. Disposal Management	Resource Management Act imposes constraint. Local Authorities need to establish emergency zones now and incorporate in DIstrict Schemes

Figure 10: Labour — technical trade

Conclusions

- The CAE 1991 lifeline study promoted a whole series of initiatives by the utility companies to upgrade their systems. The Wellington Regional Council's assessment of hill stability is a document that paints a disturbing picture of logistics chaos following a substantial earthquake such as that hypothesised for this conference. Wellington City Council's Emergency Management Office has achieved a high profile within the region.
- The above are government or quasi-government initiatives. In my research for this paper, it became clear that there are some enormous gaps in the communication between government and industry boards such as the Contractors Federation. Much work in the research and reporting of earthquakes and observing afterwards whether the lessons learned are being implemented is done on an ad hoc or voluntary basis. It was a very clearly expressed opinion during my questioning that the civil defence organisation at national and local level is seriously, and even dangerously, underfunded.
- The Civil Defence Act is written around relatively short-duration disasters. Some serious study should be given to establishing provisions for concerted action such as is possible in the Philippines and USA under their legislation.
- Severe disruption of the built road and rail formations due to land modification will occur. This will prevent the movement of repair materials into and throughout the region. An investigation should be carried out into the feasibility of creating emergency beach landing facilities clear of the most likely failed existing port areas.
- It is estimated that 15,000 extra workers could be required for construction work once demolition had been completed. These people will need to be accommodated. It is suggested that an accommodation register be kept.
- There is a shortage of major plant within the region. Meaningful discussions need to be held with the Contractors Federation to compile a register of available plant and to prepare a transport contingency plan to relocate it if land transport proves impossible.
- There is a major shortage of contractors skilled in the demolition of tall buildings and heavy structures. Contingency plans should be put in place to bring in US or other overseas expertise. It would be prudent to second some New Zealand personnel to such contractors as sponsored training.
- It is likely to take at least five years to rebuild most of the damaged structures. Some will never be rebuilt because of owner and tenant flight.
- The immediate post-earthquake phase will require large numbers of engineers and assessors with assessment skills for damaged structures. This pool probably does not exist. Meaningful discussions should be initiated with the relevant industry organisations and the major employers to prepare resource schedules and logistics arrangements now, so that people with the relevant skills can be mobilised without delay.
- The papers presented at this conference and the findings resulting from the plenary sessions should be used to initiate a disaster recovery manual as a companion to the book prepared by CAE in 1991. The manual should be properly funded by government as a necessary component of civil defence disaster planning.

Acknowledgements

This paper was written at the request of the Earthquake Commission, who have made much background material available and who funded a trip to USA to participate in the 1994 EERI Conference, which reviewed a wide range of studies, many of a non-engineering nature, of earthquakes in the last ten years. This encouragement is appreciated.

The contract for my services to the Government of the Philippines included approval to use information from the project for technical papers and presentations. I am grateful for the government's willingness to share the information in this way. I appreciate the willingness of the many people in other organisations who have been prepared to make information available for this paper.

The foresight of the Centre for Advanced Engineering together with the huge support from Wellington Regional Council in the production of the Wellington Lifelines book was a landmark for Wellington and heralded the widespread cooperation among professionals from differing industry groupings, which has had such a positive effect on earthquake disaster planning in Wellington.

I also thank my wife, Pat, for her forbearance and understanding while I was overseas in the Philippines experiencing that model earthquake that has so

focused my thoughts and awoken me from the apathy that seems to afflict most New Zealanders and successive governments when it comes to seriously thinking about earthquakes.

The opinions and findings presented in this paper are my own and do purport to represent those of any other person or organisation. They are based on a close personal involvement with nearly all of Wellington's major fires over the last 20 years, the Hutt Valley floods in 1976 and as a member of teams participating in post-earthquake recovery at Edgecumbe in 1987 and the Philippines following the large 1990 Baguio earthquake.

My old school and borough motto is "Respice, Prospice": Use the lessons from the past to prepare for the future. As far as earthquakes are concerned, there could not be a more apt exhortation.

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Discussion

Physical reconstruction

Chris Henri (Insurance Council of Australia) asked about priorities for flooding mitigation, using the example of a town in Australia where flooding is a non-insurable risk. The town had not maintained its levee very well, but it sandbagged its cemetery although the water went through the town. *Claire Rubin* noted similar examples from the 1993 flooding in the midwestern USA. In one case where caskets were displaced from the cemetery, it caused considerable distress, and in another, citizens worked all night to sandbag a historic monument. In Salt Lake City, the solution adopted for flood waters from a spring thaw was to sandbag the sides of the main street to channel the water through.

John Blakeley (Centre for Advanced Engineering) asked whether there should be a restriction on building projects in the rest of New Zealand following the earthquake in order to control prices because of the post-quake demand in Wellington. *Tony Lanigan* avowed himself a free marketeer, and pointed out that Australia was only a week away for building materials and labour. He believed the main restraint would be housing the labour force and that rebuilding Wellington would not adversely affect construction projects in the rest of the country. *George Walker* (Alexander Howden Reinsurance) supported Dr Lanigan's view because the reconstruction phase will be controlled by whoever controls the money. In the Darwin cyclone disaster, the Australian government owned the town and post-disaster inflation there was about 75 percent. The impact was felt as far away as Townsville. The Newcastle earthquake was different because the government only controlled building standards and post-disaster inflation was about 20 percent. The main cost influences at Newcastle were the differing views of clients' engineers and insurers on what remedial work was required. However, Hurricane Andrew had caused significant post-disaster inflation, not only in Florida — it had affected building prices over the whole of the USA. This was the big problem for insurers rather than underinsurance in that post-disaster inflation is not allowed for. He said that Darwin was not underinsured, but it was post-disaster inflation that caused the problem. He called for pre-disaster planning involving a group of asset managers and their insurers. *Tony Lanigan* said that although insurers claim that house insurance goes a long way towards relocating people, the land value is diminished and that affects owners of large assets. After the 1987 Edgecumbe earthquake, construction prices shot up for about three weeks, then fell back. *David Hopkins* added that information about post-disaster inflation was largely anecdotal, but his enquiries suggest that it would be less than that suggested by Dr Walker.

Hal Cochrane (Colorado State University) spoke of inflation being determined by the ratio of demand to capacity to supply. If the total supply is used in one place, it leads to postponement elsewhere. The inflation noted in Darwin was a natural market response. He also found it difficult to believe that New Zealand could rebuild without resources from Australia. *Tony Lanigan* replied that although he was not an economist, he disagreed. An efficient industry should not have spare capacity, but this sort of thing was difficult to determine when he approached them. The materials supply industry was sensitive to questions about excess capacity.

John Norton (Hutt City Council and Wellington Earthquake Lifelines Group) referred to John Christianson's belief in New Zealand's ability to cope despite his conclusions, which were rather more sober than those given earlier by David Hopkins and Tony Lanigan. Ability to handle response planning depends on being able to assess the likely earthquake damage in advance. In his work with the Wellington Earthquake Lifelines Group, he had intermittent optimism, and wondered whether Mr Christianson was also optimistic about recovery. *John Christianson* referred to the need for better information for a clear picture, because he had not realised the extent of the problem before working on his paper. For example, a seismic inventory is needed and should include all old buildings as well as lifelines. Susceptibility to landslips was also important and some work on utilities done by the Wellington Earthquake Lifelines Group is now being extended by the Wellington Regional Council's landslip project. Recovery planning needs to be holistic. If it is not possible to demolish, then rebuilding cannot proceed. Without a tip facility for materials from demolition and good road access, rebuilding cannot proceed. All major funding

agencies for disaster recovery stress the need for good roading access to restore the economy. *David Hopkins* said that he was a little more optimistic about what might happen because Mr Christianson had taken the worst that could happen and assumed it would apply everywhere throughout the Wellington region. However, a seismic inventory was an excellent idea. In a study he had done on bulk water supply, they walked the lines to see the situation and were able to put up proposals for mitigation over 20 years. They had also looked at the airport and found the restoration time was not as severe as it had at first appeared. Building insurers were forcing owners to take inventories and do more about their properties. *John Christianson* affirmed that an optimistic view should be taken that New Zealand would be able to cope with reconstruction following the earthquake. If taken over a five-year period, the construction activity would be no more than what happened during the mid-1980s building boom, but he was still conscious of what needed to be done. It would take months to get buildings repaired while getting lifelines re-established and somebody has to decide what activities get priority. Roading access is very definitely a priority as a large truck can carry in as much material as a plane. *Tony Lanigan* spoke of the need to establish a "first-help" system. Following the Edgecumbe earthquake, local people and those brought in from outside wanting to help were wandering around with nothing to do until materials were made available to them.

Ian McLean (Earthquake Commission) asked Bill Washburn how difficult it might be to get materials into Wellington compared with Kuwait. *Bill Washburn* replied that advance planning was the key. He said to plan for the worst in advance of the earthquake and hopefully it would not come to that. He suggested a staging centre somewhere near Auckland, then trans-shipping in the direction of Wellington, but it is necessary to get the paperwork in place now. He wrote no requisitions until the Iraq war was over. *Tony Lanigan* spoke of the possibility of using roll-on/roll-off ships for bringing in material supplies and equipment. He believed that the challenge would be taken up. *John Christianson* added that in the USA, the Federal Emergency Management Agency had managed to handle the Northridge earthquake effectively only because they had several stockpiles of materials handy. He suggested the need to establish a strategic store of materials on the Wellington side of the hills.

Dave Owens (NZ Fire Service) asked for comment on the proposed Transmission Gully highway route out of Wellington. In reply, *John Christianson* said that he believed this project justified itself entirely as a strategic civil defence route that would be invaluable after the earthquake. Transit New Zealand has other priorities, but it is a government matter. He fully endorsed the Transmission Gully project with no reservations.

Giles Lesser (Wellington City Council) commented that the Council's Roading Department is preparing emergency response plans. Like David Hopkins, they are walking the routes and looking at issues such as those mentioned. Work is progressing in this area, but it is not yet complete.

In closing the session, the Chairman, *Dr John Wood* (NZ National Society for Earthquake Engineering), thanked the Earthquake Commission for providing financial support for reconnaissance team efforts following major earthquakes overseas. He also thanked EQC for their funding of earthquake research in general in New Zealand with $600,000 being made available over the next two years, as well as their innovative step of initiating this conference.

Legislative Framework

Current planning and construction law: The practical consequences for rebuilding Wellington after the quake

John E Feast

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and Past President, NZ Contractors Federation Inc.

This paper explores the practical application of current legislation as it may affect the issue of consents, planning matters and the physical rebuilding of the capital city after a significant seismic shake has resulted in extensive property and personal damage in the Wellington region.

The manner in which Government, territorial authorities, professional planners, designers and advisers must work with the builders, developers and institutional investors to reconstruct services and structures will be considered, together with the practical problems of effectively meeting the requirements of the legislation for approvals, consents and title from the viewpoint of the rebuilder.

The paper draws on the views of local professional advisers, territorial authority officers and construction industry members who will together be required to rebuild a city devastated by earthquake. The effectiveness of the legislation to regulate the reconstruction process in the event of a natural disaster is assessed.

Introduction

In 1991, the New Zealand Parliament enacted the Resource Management Act and the Building Act, two quite radical statutes that will continue to have a significant effect in determining where, when and how any new development or construction will proceed in this country. Both statutes wiped a plethora of existing legislation, which had been developed over many years to regulate and control the planning and construction processes. The new Acts were intended to consolidate and simplify rules and regulations that had been, for many, an expensive nightmare prior to 1991.

The Resource Management Act 1991 (RMA)

Background to the RMA

The RMA sets out the rights, responsibilities, and legal obligations of individuals and both local and central government with the stated intention to ensure a balance between wide-ranging individual and commercial interests and community values. The Act is unusual in that S4 provides that the Crown itself is generally bound by the specific provisions of this legislation.

The Ministry for the Environment (1991a), in its brochure "Resource Management, Guide to the Act", states that the RMA:

> *is now the principal statute for the management of natural and physical resources and is the principal statute for the management of land, subdivision, water, soil resources, the coast, air and pollution control, including noise control.*

The RMA has been drafted to be consistent with an underlying philosophy that any use or development of resources and the environment centres on a concept of sustainable management. It requires territorial authorities to prepare a district plan and lists the matters that must be considered by the territorial authority when it prepares its plan. These district plans include district rules that prohibit, regulate and allow certain activities in the area.

The RMA was developed and enacted to ensure that the environment was managed in such a way that any development protected our clean air and water resources for our own use and for plants and wildlife; that noise levels were kept at an acceptable level; that there was adequate planning for parks and amenities; making sure our natural coastlines were preserved where possible; that mining developments had a minimum of effect on the natural surrounding environment; that the principles of the Treaty of Waitangi were recognised and observed, and that land-use practices were adopted that preserved soil

cover and avoided soil erosion (Ministry for the Environment, 1991b).

A practical assessment of the RMA

The view of a number of professional advisers to the construction industry, including the eminent local architect Ian Athfield, is that the RMA legislation was not specifically designed to meet the development and environmental requirements of the urban scene and is better suited to regulating land use in its wider definition in rural areas.

Many advisers, planners and developers believe the RMA is far more subjective in its approach than earlier planning legislation and, notwithstanding a stated wish to have the legislation uniform throughout New Zealand, the emphasis on "sustainable management" and "intended outcomes" (Ministry for the Environment, 1991c) has led to the view that much interpretive discretion is held by the officer of the territorial authority who considers a particular consent application.

There have been suggestions by some aggrieved applicants that the interpretation often being placed on the phrase "sustainable management" has the same meaning as "zero environmental effect" and that:

> *the time and dollar costs are running at three to five times greater for a resource consent than they were for an equivalent planning application.*
>
> (Barker, 1992)

Indeed, it is the view of one leading practitioner in planning law, Mr Jim Wiltshire of Simpson Grierson Butler White, that many developers who made representations at the time of the law review to support legislation to simplify and speed up the processing of planning and building approvals for projects that may have had innovative or radical elements find the problems they formerly faced for those "difficult" projects now apply to all applications for consents that have any non-standard element.

This may be because the legislation is new and significantly untested in the courts, but also because the RMA requires an extensive consultative approach. The applicant for a resource consent faces a heavy front-end loading of time and expense in making an application.

In simplistic terms, an application under the RMA or the Building Act 1991 imposes a burden of proof on anyone wishing to change the status of a property to show that the effects are acceptable.

Territorial authority discretion and the RMA

Because almost any construction is a "controlled activity", in terms of most proposed district plans produced to date and these provide only broad design guidelines, territorial authority planning officers have considerable discretionary powers to either approve or refuse a consent application. The applicant may be required to mitigate adverse effects, either real or perceived. Where public notification of the application is made in accordance with S93 of the RMA, S96 allows any person to make a submission on it. Any person who makes a submission may also appeal the decision under S120.

Benefits arising from the RMA

The RMA replaced some 20 major statutes, including the Town and Country Planning Act 1977, water and soil legislation and laws covering minerals, geothermal resources, air and noise pollution, and coastal development. Often there were conflicts within the existing legislation and complicated procedures that caused delay and added to costs for applicants for planning consents.

Territorial authority compliance with provisions of the RMA

A number of applicants for consents to be issued in terms of the RMA or Building Act 1991 have complained that the strict time frames for response envisaged by Parliament when it enacted this key legislation are being avoided by some territorial authorities (TAs). They have been accused of not recognising commencement of time for response until an inspector has been ready to process and consider the application, rather than from the date it was received. Alternatively, shortly before being required to respond in terms of the Act, some TAs have unreasonably requested additional information or explanation under S92 of the RMA to avoid the time limit constraints on allowing or rejecting the application.

Applicants have decided in most cases not to pursue any form of action to enforce the statutory obligations imposed on the TAs where this has occurred because it has been considered by them as likely to

be counterproductive — likely to further adversely affect the time for a response from the TAs concerned or the prospects for a successful application.

District plans

Some TAs are now operating under transitional provisions, having publicly notified the proposed district plans. The Wellington City Proposed District Plan was publicly notified on 27 July 1994 and it is significantly different from the existing Transitional District Plan (formerly the Wellington District Scheme), which it will eventually replace.

It is in terms of this plan that the city is likely to be rebuilt after the initial emergency. This district plan has been developed in accordance with the statutory requirements of the RMA.

While the Proposed District Plan has some immediate effect, the Transitional Plan will also continue to apply until the former becomes fully operative. It is less rigid and doctrinaire about what can go where than the Transitional Plan:

> *The City is divided into different 'areas'. The plan addresses these areas by providing objectives, policies and rules for the management of each.*
>
> (Simpson Grierson Butler White, 1994)

The Building Act 1991 (BA)

Background to the BA

Whereas the RMA applies to all aspects of the environment, the BA, on the other hand, specifically regulates all building work other than minor maintenance, low retaining walls and simple structures of less than 10 m^2 floor area (S32(b) and the Third Schedule to the Act). However, even these minor works must comply with the Building Code.

The BA replaced a multitude of former Acts, regulations and bylaws. It provides a performance-based control system that, although it does not regulate the appearance of structures or the standard of convenience, does have national application and is intended to be uniform. The BA takes account of environmental costs and benefits, protects other property from damage and provides safeguards for the health, safety and amenity and energy interests of the community.

> *The new building control system is designed to allow market forces to be combined with regulatory controls to ensure that the statutory purposes and principles of building control can be achieved, with minimal compliance costs.*
>
> (Cameron, 1992)

The BA, its regulations and the building code have been drafted:

> *primarily to codify basic standards of health and safety and to provide for a performance based building control system.*
>
> (Cameron, 1992)

The purpose of this new legislation was not only to simplify building control. The BA also provides procedures for dealing with buildings deemed dangerous or unsanitary (part IX), earthquake-prone buildings (S66), change of use of buildings (S46), building on land subject to erosion, inundation, or subsidence (S36). It clearly defines the functions, powers and duties of TAs (part IV).

The Building Industry Authority

In particular, the BA provided for the establishment of an industry controlling body, the Building Industry Authority, which in terms of S12 advises the Minister on matters relating to building controls, grant accreditation of building products and processes, reviews the operation of TAs, approves building certifiers and is responsible for education on building control matters. This body provides the means by which a uniformity for materials and systems approvals and codification can be ensured.

Obtaining a consent under the BA

The BA sets out the procedures for coordinating building control with other legislation, such as the RMA, through a process that begins with the TA providing a project information memorandum. Sections 30 and 31 of the BA regulate the application for and issuing of project information memoranda (PIMs). A PIM may be applied for prior to applying for a building consent. Any application for a building consent is deemed to include an application for a PIM. Details on the intended use of the site, location and proposed dimensions, vehicular access, disposal of wastes and other relevant development information are required from the applicant with the formal application, together with the fee payable to the TA.

The PIM, which will be issued by the TA after it has received the detail it requires, will include information known to the TA:

- identifying special features of the land concerned, such as potential erosion, subsidence of the site, the presence of hazardous material and the like (if it is likely to be relevant to the proposed works);
- details of stormwater or sewer utilities or network utilities; and
- an approval (subject to compliance with a building consent and necessary authorisations) or rejection of the proposed works.

Practical assessment of the BA

The chief executive of the NZ Master Builders Association has given qualified approval to recent outcomes achieved by his members under the provisions of the BA. The most frequent complaint from builders is that there is no commonality of interpretation, with individual officers of TAs imposing differing views on the requirements of the BA and its regulations. He reported that, where the proposed structures fully comply with the requirements, time frames have been shortened. Outside of approval documents, problems are frequently encountered. Many attempts at creative solutions to development or construction problems have led to considerable delay and cost.

The codification does not encourage innovation, although this had been mooted as an aim of the performance-based consent procedures under the BA. In reality, the lack of resources within TAs has meant that innovation has led to frustration. As a result, most developers have taken the easy way out and resorted to established and approved procedures and materials that have limited the development of new design.

However, the BA has clearly set out the programme and responsibilities for the construction industry and TAs in relation to any construction works.

The approval process for consents and the meeting of legislative requirements before, during and after physical construction are recorded in Figure 1.

Rebuilding: Management in the aftermath

The conference is concerned with the effect on the Wellington region, but damage following the subject earthquake will have had a significant effect through the Wairarapa, the Manawatu, and into Marlborough, Nelson and possibly as far south as Canterbury and Westland, and there will be a large number of TAs involved in restoration of services and amenities for the particular areas over which they exercise jurisdiction.

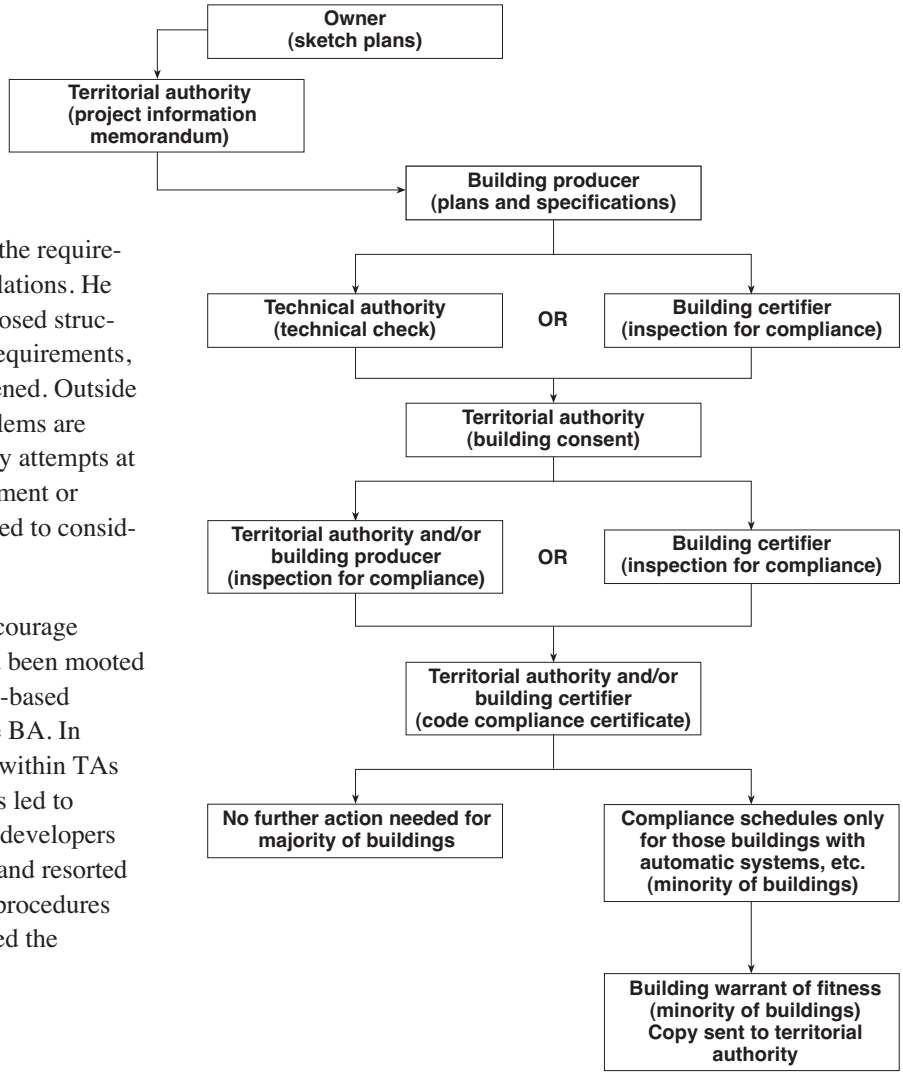

Figure 1: The approval process under the RMA (Department of Internal Affairs, 1991)

Management roles

In New Zealand, administrative roles in the case of emergency are split between central and local authority agencies and we still have to confirm who is going to call the shots and determine who directs what. Discussions with officers of the Wellington City Council's Emergency Management Office indicate that by mid-1995 the city will have a comprehensive Disaster Recovery Plan controlled by a disaster-recovery coordinator, the only pre-designated disaster manager in New Zealand. While the Wellington City Council may well be the best prepared TA in terms of emergency planning, it is not possible to ignore the facts that it *is* the capital city and that there are a large number of smaller TAs affected by the disaster. The scope and seriousness of the disaster will inevitably lead to the intervention of central government, in my view, and it may be impossible to look at Wellington in isolation from its neighbouring regions from a practical viewpoint. This is most likely to include the appointment of a disaster commissioner to manage resources and set priorities for recovery. Government is likely to pass legislation granting the commissioner or an emergency commission wide powers to deal with the emergency for a certain term.

This situation is similar to that in California, where we were advised the state governor was involved in the disaster recovery programme from a very early stage following the recent Los Angeles earthquake. This involvement would be no more than the equivalent of a response from the Prime Minister of New Zealand to a Wellington regional emergency. In fact, in the case of a major disaster in the USA, the state governor goes through the Federal Emergency Management Agency direct to the President through a streamlined chain of command.

Reconstruction

The early weeks following the earthquake will be absorbed in dealing with the overwhelming requirements of reinstating essential services, reopening roading, rail, sea and air links, and dealing with buildings and properties that present an imminent danger to health or the physical safety of citizens. It is against the background of the new legislation and other existing legislation, that the practical consequences of reconstructing the city following a serious earthquake will be assessed.

Priorities: Initial

The first priority for the TAs and the construction industry must be the allocation of construction resources to the "big picture", the re-establishment of road, rail and air links with the rest of the country and the removal of dangerous structures and debris from built up areas. It should be noted that the RMA uses the existing environment as a reference against which to study adverse effect or impact.

Environmental effect: the yardstick

In a city that has had much of its natural environment destroyed through widespread slips, debris, heavily damaged structures, liquefaction of soils and severely disrupted sewer, gas and water pipes, against what standards is reconstruction work to be tested?

The environmental impact at that time will be immense, with roads and services collapsing along Wellington's extensive waterfront and heavy contamination from silts and sewage present as a result of seismic movement. Significant areas of vegetation will have been brought down with slips, closing off roads and streets, which will also have suffered collapse due to the steep nature of the local terrain. Fire and flooding are also likely to have wrought havoc to the environment. The harbour and waterways will be heavily contaminated with detritus. The initial emergency response, too, will inevitably have caused a certain amount of unavoidable ancillary damage. People and machines will have been operating through the area affected to save lives and property and repair and reconstruct basic access and services.

The awesome and terrifying photographs from Kobe in mid-January showing the devastation following the massive Hanshin earthquake will remain with us for some considerable time as a sobering reminder of the havoc such an event can generate.

Priorities: rebuilding

The next priority must be the "small picture", making bearable the lives of individuals by reinstating normal services and providing the needs of shelter and the like. The medium- and longer-term picture, the rebuilding of damaged commercial property and general community amenities will be forgotten in the short- to intermediate-term.

When the time does come to focus on allocation of resources to the commercial rebuilding programme, the initial efforts should concentrate on those portions of the city and region that are still "sound"; areas where the TA does not have to initially determine whether there should be a future restriction on land use or structural designs and where immediate restorative progress can be made.

Problems for the consent process

A number of problems will later become more apparent as more consent applications for reconstruction are processed.

The horizontal movement along the fault will inevitably bring problems with land transfer survey and legal title to property, with some structures now partially on another legal title. Physical property may have been laterally and vertically displaced, but survey reference points and boundaries will remain constant. Along the fault line, this may cause considerable problems where there has been a movement of some four metres. This may involve the limiting of land transfer titles as to parcels while affected properties are resurveyed and boundaries positioned to take account of actual occupation and some compensation because government guarantees title to property in New Zealand by legislation.

The TA may also have to consider applications to rebuild on land that has shown a tendency to liquefaction or inundation or where the geomorphology has changed; some building materials and processes that have been approved under the building code may have failed under the stresses of the quake and require review; the city council may wish to limit certain land uses permitted under its district plan following the practical experiences and lessons arising from examination of the disaster areas.

Need to review district plans

In particular, it is probable that new earthquake fault lines may have emerged. It may become necessary for the local authority to review sections of the district plan and this will inevitably bring about disputes, hearings and appeals. Some properties may no longer be considered appropriate sites for certain replacement structures. Many of the "heritage" buildings and environments may have been destroyed or severely damaged. Most are constructed in materials or to seismic standards that do not fully conform with current code requirements or exist in areas that are likely to suffer from the effects of the earthquake.

Properties that had not previously been the subject of a heritage order may now become of considerable environmental or heritage significance because others, formerly more important, have been lost. There may be disputes about total loss or the reinstatement of damaged heritage sites.

Opportunities

The city council may well see the disaster as an opportunity in disguise to replan the city in a form more appropriate for the future and will be in a position to take more radical steps than had the earthquake not occurred.

There would be little argument that, during times of great stress, decisions or significant change which in normal times might be the subject of much public objection, appear to become less contentious. It would, for example, be difficult to see how successive governments could have implemented the radical tax changes and deregulated the New Zealand economy in the manner they did during the 1980s and early 1990s had there not been an environment of economic disaster facing the country at that time.

The risk of inaction

The practical risk is, of course, that in coming to terms with the disaster, the planning and consent system grinds to an effective halt for a long period of time while authorities assess the consequences of the earthquake and try to plan for and administer the future reconstruction phase. The real problems for the community in relation to the existing legislation are that it was not drafted to cope with an emergency situation and it has not been developed to operate under the conditions that will inevitably prevail in the aftermath of a severe seismic movement.

The current environmental legislation places a heavy emphasis on a consultative process, but the enormous problems of meeting the reconstruction requirements of a devastated city within a reasonable period will not allow us to enjoy consultative procedures.

One could imagine that everyone will be calling for immediate action: central and local government, private property owners and the community gener-

ally, but rapid action is considered by many commentators to be impossible under the RMA.

Recovery and rebuilding under current legislation

Background

It should be reiterated that while this paper is on the practical difficulties of rebuilding the city under the current legislation, the RMA has been of limited practical effect or consequence thus far for most TAs because none has a district plan actually in full effect, notwithstanding the fact that the legislation was enacted nearly four years ago. A district plan is defined as being an "operative plan" approved by the TA under the First Schedule to the BA.

Neither the BA nor the RMA appear to have provision for circumventing the procedures for the consent and consultation required to rapidly rebuild much of the capital city once the emergency itself has passed. The Civil Defence Act applies only to emergency situations and is really only appropriate in the immediate aftermath of the event. It is obvious that a broader power will be required to truncate administrative procedures and requirements over a longer period of time until the city returns to some semblance of "normality".

The 1931 Napier earthquake

Wellington and the Wairarapa suffered the consequences of two serious quakes, in 1848 and 1855, which seriously reduced citizens' confidence. Many early settlers left the area following the latter. These earthquakes were followed in 1894 and 1904 by two others that also caused considerable damage.

However, the best example of the recovery process from the consequences of a devastating earthquake in modern times was the Napier earthquake, which occurred on 3 February 1931 and caused significant loss of life and severe damage to a major metropolitan area.

The actions that followed that event will, in my opinion, be likely to be adopted in basic format should the subject Wellington earthquake actually take place.

On 28 April 1931, Parliament enacted the Hawkes Bay Earthquake Act 1931. The Act provided wide powers of regulation in relation to, among other things, in S66(1):

(d) validating the actions of public officers done in good faith;

(i) validating and authorising the erection of temporary buildings;

(q) the control of building operations, and in particular, authorising borough councils [now called "territorial authorities"] to issue building permits on such terms and conditions as they think fit; and

(w) modifying the provisions of the Town Planning Act 1926 [the planning and building control legislation then current].

Under this Act, a committee was appointed and authorised to act to administer the powers of the territorial authorities under Section 64. The Act also provided funding for rehabilitation, some protection for mortgagors and other borrowers, relief from taxes for a period and empowered the Governor-General:

> *...to make such regulations as he deems necessary, having regard to the exigencies of the Hawkes Bay earthquake and the conditions arising therefrom, for the purpose of validating, authorizing, or prohibiting any act (whether of commission or omission) thing, or proceeding.*
>
> (S66)

Current situation: Prospects for central government intervention

Today, the Governor-General has powers under the Local Government Act 1974 to appoint a "Commissioner for Disaster Recovery" (S692B of that Act) if there is a state of civil emergency or the local authority is unable to exercise its powers, functions and duties.

More generally, the Governor-General can appoint a Commissioner to exercise the powers of a local council where the council refuses to act or asks the Governor-General to do so (S721).

Notwithstanding an appointment under the Local Government Act 1974, it is my view that special legislation would still be needed to vary the processes under which the territorial authority grants resource and building consents.

Recent emergency: The Auckland water crisis

The only situation in New Zealand since the introduction of the RMA and the BA in 1991 which might give some indication of how central government might react in an event such as the Wellington region earthquake was the relatively minor emergency created by the recent water shortage in Auckland in 1994.

On 14 July 1994, the Watercare Services Ltd (Auckland Emergency Water Supply) Bill, a private members bill was introduced to Parliament on the basis of the urgency of the situation and the number of local authorities involved (Hon Simon Upton and Hon John Banks, 1994). The Legislative Analyst concluded from parliamentary debate (Ryan, 1994) that:

> *Normal processes for consents under various statutes and for negotiations ... could extend a start on the project from 2-3 months to 2 years.*

Central government was clearly prepared to enact emergency legislation to alleviate this community problem had the rains not come before Parliament completed its legislative process.

The prospect is special emergency legislation

For an event such as the subject earthquake, which will affect much of central New Zealand, it is almost inevitable that central government will play a major role and urgently pass empowering legislation to deal with the calamity. It is the view of most leading players in the wider construction and planning industry consulted for the preparation of this paper that in such an event it will become necessary to "make the rules work, or change them". Existing legislation, which is not designed to cope with an emergency situation, may have to be suspended or a moratorium imposed for a term.

It was a widely held view of people consulted that the consent procedures of the RMA and some aspects of the BA will not operate effectively under the conditions envisaged.

However, once there is sufficient political momentum, the fact that the existing rules do not work will not matter. They will be changed to meet the exigencies of the situation. This is not seen as being fatal to the long-term prospects for the existing legislation. While it cannot be disputed that there is criticism of the existing planning law particularly, one should not expect standard rules to operate under emergency conditions.

Review of material and process performance

It was a further view that some design elements and materials presently approved by the Building Industry Authority for use in construction may require specification review and that an urgent response suspending approval for the use of certain products and processes that may have shown a tendency to fail under seismic conditions will be required until that review has been completed.

> *The New Zealand Building Code states how a building must perform to ensure that health, safety and amenity needs of people, protection of other property from damage and energy efficiency requirements are satisfied.*
>
> (Building Industry Authority, 1991)

There will no doubt be concern expressed by construction consultants, especially architects and structural engineers, following the widespread damage to some modern structures after the earthquake. Some design criteria may be changed and designers may have to further review requirements to meet the performance-based code, which will almost certainly have to be reviewed with the hindsight of actual rather than design performance results. What may have been considered adequate prior to the quake may be considered quite inappropriate following it.

From the viewpoint of the TAs and their district plans then operative or under consideration, it will be necessary to review objectives and policies to reflect changes that may become necessary or desirable following the earthquake. From a practical viewpoint, it may become necessary to "ring fence" a problem that has become apparent to enable planners and building inspectors to focus on those priority areas of the city and environs that can be returned to normality first.

While there may in effect be a practical moratorium on work other than the restoration of basic services in the initial phases, it will be important to clear those parts of the affected areas for reconstruction at the earliest possible time. This may well require the appointment of additional TA officers, perhaps

seconded from other local authorities and the professions acting as agents for the TAs affected.

Conclusion

It is my view that the initial response to the disaster will be in terms of the Civil Defence Act 1983. Once the emergency phase has passed, it is likely that territorial authorities will wish to suspend all or parts of their district plans and many of the procedures under current planning legislation. A commissioner or committee will be appointed to oversee the early rebuilding of the city under the Local Government Act 1974 or will be empowered under specific enabling legislation enacted to meet the exigencies of the actual disaster. Because Wellington City's TA has gone some way to prepare for such an emergency and continues to develop a response plan, its qualified personnel will no doubt be co-opted to serve. However, because there will be many TAs affected and because of the seriousness of the disaster, central government will almost certainly intervene at an early stage.

It is considered by most people interviewed as background for this paper that the current planning and construction requirements will not operate effectively in such a situation. It was equally their view that if the current law cannot work, there will be the political focus and pressure to see that it will be changed for something more appropriate for the challenge of reconstruction following a natural disaster in New Zealand.

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During the preparation of this paper, the author interviewed or discussed matters contained herein with a number of people who have an interest in planning and construction. In particular, the author acknowledges the contributions of the following and all others who have assisted with opinions and comments:

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- Brent Player, Tse Group Ltd, Architects, Engineers and Surveyors
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- The Director and Staff, Wellington City Emergency Management Office
- Chief Building Inspector, Wellington City Council
- The Chief Executive, New Zealand Master Builders Federation
- The Director, New Zealand Contractors Federation Inc.
- Eric Sherburd, Charted Loss Adjuster

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Discussion

Legislation

Leicester Steven (Earthquake Commission) asked if any difficulty was envisaged with the Rating Act following a major earthquake. *John Feast* said that valuers he had spoken to believed that valuations would increase.

In reply to *Kevin O'Kane* (Ministry of Civil Defence), *John Feast* said that he saw the need for the Ministry of Civil Defence to have special powers during the reconstruction phase as well as the response phase.

Peter Milne (Power Direct) commented that the Health and Safety Act was producing some unanticipated problems. *John Feast* said that he had no expertise on this.

Tony Lanigan (A G Lanigan and Associates, Auckland) asked what specifically enactment of special legislation would achieve. In particular, he would not like to see standards for repair compromised. *John Feast* replied that the present legislation would not be adequate for a city in chaos. Special legislation would allow local authorities to give special permits and might only allow appeals from people with an interest in the property. He said that the problem to avoid is to hold up all building construction work while standards are reviewed for certain buildings that may not have performed well. Instead the problem could be put aside while other work can proceed. *Trevor Roberts* (Earthquake Commission) commented that businesses would need to get moving again after the disaster, but it would stop them if some legal requirements were rigidly enforced. The law was not designed to cope with the post-disaster phase and needed to be massaged to deal with the practicalities of the situation.

In response to a remark that there were no provisions for level of repair and that there had been a hiatus of several months while outline regulations for repair were defined, *John Feast* said that all buildings in Wellington have been assessed, and time frames have been laid down for bringing them up to the required structural standard for earthquake resistance.

Social Aspects of Recovery 1

Earthquakes: A Maori dimension

Wira Gardiner

Chief Executive, Te Puni Kokiri (Ministry of Maori Development), Wellington

Ruaumoko, the God of earthquakes, is no stranger to Maori. His appearance, manifested in the physical upheaval of the earth, has been part of the mythology and life of Maori. The strength of Maori society has traditionally been underpinned by the principle of collective responsibility. The whanau, or family unit, is the building block of Maori society, and the concepts of care for the extended family, charity, and help for others have been key strengths in the development of Maori. While decades of social change, including mass migration from rural areas to the cities, increasing levels of unemployment, and greater risk from economic restructuring, have seen Maori suffer from the rigours of modern Western society, they have retained a remarkable resilience to disaster.

There are approximately 42,000 Maori living in the greater Wellington area. They come from many different tribes, for example members of the Ngati Porou tribe, whose ancestral home is the East Coast of the North Island, number 10,000. Their personal response to disaster will inevitably spread to their relations in Wellington and further afield. The bonds of whakapapa (kinship) will sustain them in the period after the quake. Collectively, Maori response will centre on the marae in the Wellington area, with key points being the marae at Wainuiomata, Porirua, and Island Bay as well as elsewhere. These focal points could form the basis for catering for many hundreds of people. It is here that Maori in their largest numbers can be reached by the social services after the quake.

Introduction

E nga waka, to the many canoes that have borne you to this place; *nga mana*, to the many distinguished guests; *e nga reo*, to the many voices that have gathered here today; *o nga hau e wha*, from the four winds; *tena koutou*, greetings; *tena koutou*, greetings; *tena koutou katoa*; greetings to you all. *Mauria mai nga mate i runga i ou koutou pokohiwi*; transport with you to this place the recent bereavements that you carry. *Na koutou i tangi*; you have grieved for the loss of your loved ones; *na tatou katoa*, and we join with you in your sorrow. *Me ki penei*, let us now say; *kua ea*, we have completed our tribute to the dead. *Ka huri inaianei*, let us now turn, *kia tatou te hungaora*, to us the living.

Although it is now ten years since I left the job of national director of civil defence, I have not forgotten the challenges that faced us then and still remain with us now. I pay a tribute to the professional manner in which you continue to tackle the extraordinarily vexing area of public safety. I applaud particularly the initiative of the Earthquake Commission in bringing us together today to address these matters.

It is my privilege today to talk to you about one of the more troublesome of my ancestors — the god of earthquakes, Ruaumoko!

Ruaumoko, god of earthquakes

Ko Ruaumoko e ngunguru nei! Au, au, aue ha hei! — It is Ruaumoko that is rumbling. These are the opening lines of a famous haka. The haka, performed in a fierce and highly agitated manner, pays tribute to the god of earthquakes, Ruaumoko. It tells of rumbling, subterranean activity and the enormous pent-up energy of the god as he roams under the earth, seeking fissures to leap out into the open air, either by way of volcanic eruptions or by a crumpling of the earth.

Ruaumoko was one of the approximately 70 gods and demi-gods of the Maori world. Of the 70 that made up the pantheon of ancestral gods he was last in order of seniority. His lack of seniority had nothing to do with his lack of power. Rather it is to do with the fact that he was the last of the gods to be born.

In the beginning was darkness, a time of nothingness. *He Po. He Po. He Po.*

The earth mother, Papatuanuku, and the sky father, Rangi, lay entwined, and their offspring lay between them in the aeons of darkness. After aeons, the querulous offspring of Rangi and Papatuanuku got restless. Led by one of the senior brothers, Tane,

they decided to revolt and to separate their parents so that they could breathe air and see the light.

The Herculean struggles that ensued saw the brothers finally succeed in wrenching apart their mother and father. As the sky father, Rangi, was pushed screaming in anguish to his final resting place above, the earth mother, Papatuanuku, lay battered and exhausted.

Clinging to the breast of earth mother was her last baby. This was Ruaumoko. While his brothers went on to become the gods of forests, seas, winds, etc., he opted to remain with his mother and remained embedded in the earth.

As he grew, his abundant energies found expression in roaming underground, breaking out from time to time to remind his brothers that he was not to be forgotten. In many ways he was to become more powerful than they; striking at will and destroying everything in the path of his energies. He has become their nemesis, a constant reminder of what they had done to Rangi and Papa.

And last week, no doubt as part of the reminder notice for this conference, he gave us a relatively gentle nudge to let us know that he knew that we were going to be talking about him!

Scope of presentation

In this paper, I want to firstly share with you the earliest experiences of the first settlers in Aotearoa. Secondly, I will brief you on the characteristics of Maori society that make it distinct from the dominant cultural group — Pakeha society. Thirdly, I will brief you on the distribution of the Maori population in Wellington and identify the main cultural centres — the marae — in the region. Finally, I will attempt to sketch out a scenario response to a major earthquake here in Wellington.

Maori society

Arrival in Aotearoa

Over a thousand years ago, our ancestors drove out of the Pacific into uncharted waters and the challenges that lay far to the south in the southern oceans. They came upon Aotearoa, the land of the long white cloud.

As those first explorers beached their canoe on these virgin shores, they came upon a land, fished up by Maui, which had already been ravished by the exuberance of Ruaumoko. Volcanic cones were visible evidence of his work. The changing shapes of the landscape, particularly in the central region, were a less visible sign of his efforts to twist the earth into rumpled shapes.

The damage to those early settlers and the succeeding generations was relatively minimal. The scattered villages, the relatively sparse populations (estimated at 200,000 to 300,000 prior to the arrival of Cook) and the unsophisticated type of housing construction would suggest that our ancestors fared reasonably well and were able to live with the tantrums of Ruaumoko.

It might also suggest that perhaps the 1-in-1000 year type of earthquake might be nearer than we think.

Characteristics

To understand the potential behaviour patterns of modern Maori living in a city like Wellington, we need to look closely at the main characteristics of Maori society. Although in recent years the traditional behaviour patterns of Maori have been adapted and moulded by living in a complex urban environment, it is nonetheless true to say that significant traces still remain.

Whakapapa. The connecting root of Maori society is whakapapa or genealogy. In European society when people meet, the question most asked is: " What do you do?" This question is typical of a society which values the individual and places a premium on individual effort. In Maori society greetings are generally followed by, "Where are you from?" This is shorthand for what is your whakapapa? It is through this connective question that Maori derive a sense of belonging to a wider family group. The question reflects the collective nature of Maori society.

Whanau/hapu/iwi. The extended family played a crucial role in traditional Maori society. Multi-generational family units were the norm. Extended families grouped together from time to time into hapu and, where necessary for large-scale economic or war effort, the hapu banded together to form iwi. Although many families now live in a solo-parent relationship, there is still present the connection to the wider family.

The marae. The marae has always been the physical manifestation of the collective nature of Maori

society. Living quarters clustered around a central meeting place evolved over the centuries. Today we have approximately 1000 marae throughout the country. Typically, the marae consists of a tipuna whare, which represents a well-known ancestor; in front of the tipuna whare is a space called the marae atea (it is the place where the formal speeches of welcome take place); and not far from the tipuna whare is the whare kai (the dining hall). Marae operate on a voluntary system, and whenever a major function takes place it is the responsibility of the marae committee and the local people to look after the guests — feed them and ensure that they are accommodated overnight.

Maori in the Wellington region

Impact of post-World War II urban drift. After the Second World War many thousands of Maori moved from the rural areas to urban centres like Wellington. For tribes like Ngati Porou of the East Coast there are now approximately 6000 members, or more than double the numbers living in the home area. Maori who moved to urban areas like Wellington took up largely blue collar jobs in the railways, the post and telegraph departments, and local councils. The vast majority of Maori working in Wellington still tend to work in those areas.

The people. There are approximately 40,000 Maori living in the Wellington region. The majority of these people may be described as ra waho — people who have come to the region over the last few decades, and particularly during the 1950s and 1960s.

The local tangata whenua are Te Ati Awa, based around the Lower Hutt area, who have strong kinship links to Taranaki, and Ngati Toarangatira, based around the Porirua district.

It is likely that most of these people belong to social networks of kin, friends and neighbours. In the short term, and where the disaster is confined, these networks will be very useful in the rescue and recovery phase. However, if the disaster is extensive and the damage cataclysmic, then even these strong community networks could fracture.

Geographic location. The largest concentrations of Maori are based in the northern city of Porirua, the city of Lower Hutt, and suburbs like Wainuiomata. The majority live in state houses and, if they have work, it is in the lower level of the economic strata.

In a recent study (Wellington Regional Council-Hutt Valley Control Scheme Review 1990) of the Hutt Valley area, it was shown that Maori tended to live on the southern side of the Hutt river in the following localities: north Upper Hutt, Stokes Valley, Naenae, Waiwhetu, Moera and Petone. Only one community (Manor Park) on the northern side of the Hutt River had sizeable numbers of Maori.

The marae in the region. There are 11 marae in the region. They range from traditionally constructed carved marae like Ngati Toarangatira's marae at Takapuwahia to modern decorated marae at Island Bay. There two marae within the confines of Wellington city. One of these is the large multi-tribal marae of Pipitea and the other, Te Herenga Waka, is based at Victoria University. These marae have the capacity to sleep and feed hundreds of people, and with the addition of tarpaulins can sleep and feed thousands.

The Wellington earthquake

A scenario

When the major Wellington earthquake strikes there will be, as you know, considerable dislocation. One scenario has the central business district in ruins. It will be difficult to travel between suburbs because of the massive disruption to roads and rail. Many hundreds — perhaps thousands — have been killed. Many thousands of houses have been destroyed or are uninhabitable. It will take days and perhaps weeks to re-institute basic services.

In the days following the earthquake, there will be a need for communities to fall back on their own resilience and local resources to weather the initial period of rescue and recovery until a massive national and perhaps even international rescue mission can be mounted and sustained.

In the first few days, there will be a need to rescue survivors and stabilise the situation. In the following days and weeks, there will be a need to recover basic services and provide medium-term help for the homeless and needy. There is likely to be a longer-term need for redeployment of perhaps thousands of citizens outside of the area for periods of months while the city is re-established.

How Maori react to each of these scenarios will depend on their state of preparedness and their access to resources. Planners and rescuers should take a number of factors into consideration.

Planning

It would be useful for the planners in the Ministry of Civil Defence, Wellington regional and city councils in the greater Wellington region to study the impacts of the Edgecumbe earthquake on the Maori community.

It is important for planners to make provisions now to identify where Maori are concentrated, where they work and what their likely reactions are to disaster. Consultation via the marae and Maori organisations like the New Zealand Maori Council, the Maori Women's Welfare League, and the Maori Wardens Association is essential. When disaster strikes, it is better for Maori to deal with Maori. The introduction of task force teams from out of the area with no Maori members might also pose difficulties, and, therefore, planning should ensure that, should these be necessary, wherever possible local Maori liaison officers should accompany them.

Post-impact period

Because so many Maori live at the lower end of the economic scale, they are least likely to have stocks of food or the basic civil defence equipment in their homes. Moreover, if the quake strikes during work hours, there is a high likelihood that many will be at home, given the relatively large numbers of unemployed. Interestingly enough, it might be argued that, because they have been able to survive on the 'breadline' for long periods, they might be reasonably well prepared to stand the immediate deprivation of essential services and other quality-of-life items.

However, if major physical damage including large-scale loss of life and serious wounding occurs, there might be a need for rescue teams to focus on concentrations of Maori families, as there are not likely to be stocks or reserves of essential medicines or pharmaceutical drugs available in these households. Where damage to physical property is heavy and loss of life is minimal it is likely that Maori families will collect together and make the best efforts to survive the first few hours and days after the shock of the quake.

Medium-term arrangements

In the days and weeks following the quake, it is likely that Maori who need shelter will try to gather at their local marae. The marae facilities will need to be significantly enhanced, as facilities that in the normal course of events might be expected to cater for hundreds will possibly cater for thousands.

One of the consequences of living on a marae is that people become 'fixed' to the marae and are reluctant to leave. Should it be necessary for them to be evacuated to community halls or school facilities, then they will probably be able to fit reasonably well into the collective arrangements that such a move would entail.

A consideration for civil defence planners will be what to do with the dead. Since so many Maori who die in Wellington are returned to their home areas, where they may be mourned and grieved over by their relations, this could pose major problem, especially if the death toll is so high that mass burial arrangements might be necessary. Some degree of sensitivity will need to be accorded to this issue.

Longer-term arrangements

Should it be necessary to evacuate people out of the capital for periods of up to several months, then it will probably be a lot easier to move Maori, as they will have a turangawaewae elsewhere in the country. For example, the Ngati Porou people of the East Coast have available to them up to 48 habitable marae that could cater for their own people who might have to evacuate from Wellington.

Moreover, since it might be a considerable time before the capital can be re-established, the plight of those who have been evacuated might well be easier to manage for Maori than others. The majority of Maori living in Wellington occupy rented premises and, therefore, do not have a cultural tie to the house or its surrounds. It might be better for the government to provide incentives for these people not to return to Wellington.

Conclusions

The challenge for civil defence authorities is clear. In the time-honoured tradition, I wish to lay the following wero (challenges) at your feet. When dealing with Maori it is helpful to:

- accurately establish their demographics;
- understand their point of view, especially cultural;
- establish linkages before the earthquake, at marae, etc.;

- use Maori liaison officers as part of the rescue and recovery; and
- when dealing with Maori keep in the forefront of your minds this whakatauaki (proverb):

He aha te mea nui o te ao, maku e ki, he tangata, he tangata, he tangata,

If one asks what is the most important thing in the world, it is people, people, people.

Social Aspects of Recovery 2

Coordination and accessibility of post-disaster counselling and community support services

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In New Zealand's current social and economic climate, providers of counselling and community support services are faced with excessive demands on resources. Over the past few years, the use of these services has steadily grown while the funding available has diminished.

The post-disaster context places further demands on community support services that are likely to exhaust existing physical and human resources. The dynamic period in the community's recovery process requires prior planning that is comprehensive and flexible. Decisions need to be made quickly and actions that are to be effective cannot usually be taken without adequate preparation. Therefore, planning and coordination prior to impact are vital to ensure support services are provided to those most in need by making efficient use of existing community resources.

In Wellington city, a process to ensure that services will continue to be provided after a large-scale emergency has already begun. This paper discusses this process in the light of the population base of Wellington and the existing coordination and accessibility of counselling and community services within the city.

Introduction

New Zealand's experience with major disasters is limited at best. Since the 1931 Napier earthquake, there has not been a significant hazard impact in any large urban area. Yet the emergency response and recovery in that earlier event is still being used as a yardstick for our ability to cope in the nineties. It is no more appropriate to compare Wellington 1994 with Napier 1931 for disasters than it is to compare it for traffic, employment or any other social condition.

Disasters are social events and relate to the society affected, not just the location or the type of hazard impact. The time has come to reassess our performance measures and start learning from our mistakes. We need to take heed of the lessons learned, both here and overseas, and become more proactive in dealing with the effects of disasters — both short- and long-term.

Rebuilding the community is not just about the restoration of utilities and motorways. Recovery is about restoring the community's sense of normality. Thus, social support networks and services are an important factor in achieving this. Like the physical reconstruction following impact, social services will also need time to recover. Furthermore, as with physical reconstruction, there is a higher demand for social services while having limited resources and infrastructure.

Previous disasters, both here and overseas, have shown that effective recovery occurs when individuals and communities are able to exercise a high degree of self-determination, contribute to the management of the recovery process and participate in deciding what assistance measures are made available. This is best achieved by using, where possible, those agencies and personnel already established in the city. This helps the community to retain control and coordination of recovery activities and helps encourage the return of normal routines.

Community support agencies in Wellington

As with most New Zealand cities, Wellington has a large array of community-based organisations that provide services to targeted sections of the population. The services vary from counselling, information and advice, to more physical assistance such as accommodation, employment, financial aid and the provision of health services.

The services are provided, in part, by the dozens of umbrella organisations within the city. Many are government-based, such as the major health providers (i.e. Capital Coast Health, CCH), while others

have been established by specific interest groups to meet distinctive needs. These groups include support and advocacy networks for the elderly (Age Concern), for people with disabilities (Disabled Persons Assembly) and for specific ethnic minority groups (e.g. Pacific Island Resource Centre). In addition, a range of smaller agencies exist in supporting roles by supplementing services and addressing individual concerns (CCH and the Schizophrenia Fellowship, 1994; De Jouz, 1993; Wellington Consumer Health Forum, 1994; WCC, 1993a).

The social support system in New Zealand has grown out of the now outmoded welfare state model. However, much of the underlying philosophy of the welfare state is still evident in the range of services offered and in their delivery (Britton et al., 1992; Trlin, 1977). The services, generally speaking, cover six main areas of concern:

- health and welfare;
- accommodation;
- employment;
- financial assistance;
- education; and
- personal support.

Many of the services provided are required by law and are funded by central government. Many have developed out of larger government organisations to fill a certain niche in the community, while others have been established by the community itself to cater for unmet needs.

Although the need for community support services has increased and a broader range of services is now offered, the resources available to fund these services have generally remained static. Thus, the limited funding available has to be shared equitably among the agencies most in need and, as such, is often a source of contention among providers of community support services. Those without direct financial assistance from the government have to fund their services from the community via user-pays charges, grants, donations or appeals.

The lack of available funding has impacted dramatically on how various services have been provided. A large majority of community services are provided by volunteer groups and are dependent on community goodwill for resources and support. For many agencies, the introduction of a user-pays system is not a viable option. The people they serve are more often those who can not afford to pay for the services being offered.

By the nature of the work undertaken by community support agencies, these organisations generally have well established networks and routines with other service providers. However, there are a number of small and diverse agencies throughout the city that are not included under any major umbrella group and, therefore, do not have the same access to resources. These agencies often overlap with the type of services offered and frequently compete with each other for funding and support. Consequently, while many services are duplicated, there are other needs within the community that are not being adequately met.

The difficulties these agencies face will normally be exacerbated by a disaster. The disruption to routine and resources, especially to organisations reliant on volunteers, is likely to lower their level of service at a time when demand is peaking. The interdependency of these organisations, both on other community services and on the physical infrastructure (for example, public transport, telephones, power) make them particularly vulnerable to a hazard impact, again increasing the need while decreasing the resource.

One area of particular concern is counselling. Outpatient services, particularly in the mental health area, are already stretched to capacity. Major social service providers, such as Social Welfare, Health and Justice Departments, all have their own counselling services. Their funding is targeted to those most at risk and unable to pay for themselves. Following a disaster, additional funding is likely to be required to meet the public expectation for counselling services. Central government, through the Central Regional Health Authority, would need to fill the gap between post-impact demand for health services by purchasing from private counselling services.

Following a major hazard impact, limited resources are likely to be more in demand. It is important from an emergency management perspective that agencies work together in the pre-disaster phase so that community needs are addressed post-impact. This also extends to the integration of the physical recovery into the planning of social service provision. People often use a continuum of services following a disaster. Therefore, providers of community services should promote continuity of care

and a coordinated approach to care across the full range of counselling and community support services.

The Wellington situation

The cost of a major disaster in relative terms is much greater for those groups already dependent on government and community organisations for accommodation, social or financial assistance. These groups, often consisting of ethnic minorities, the unemployed, the elderly and people with disabilities, generally have less savings than the dominant population group, have little or no insurance and more often than not are in the lower income bracket, leaving them vulnerable to long-term financial difficulties following disasters.

Often these groups live in houses vulnerable to certain types of disasters, such as earthquakes or fire, frequently clustered in areas of high risk. Furthermore, these groups do not have the financial resources to increase their preparedness, either through storing emergency supplies or by taking preventative steps to reduce their exposure to known hazards (Britton and Lindsay, forthcoming; Rahimi, 1993; Tierney et al., 1987).

A growing proportion of Wellington city's population is vulnerable to the effects of disasters. There are currently about 150,300 people living in the city (Department of Statistics, 1992a). About 12 percent of the population is over 60 years of age, and the population is expected to age steadily over the next 25 years. With age comes decreased income, mobility and health, all of which contribute to higher vulnerability.

Between 1986 and 1991, the New Zealand-born population in Wellington rose by only 615, compared with a 4899 increase in the overseas-born. About 9 percent of Wellington city's 1991 population lived overseas in 1986, compared with a national average of only 5 percent. Wellington has a large percentage of Pacific Islanders and has twice the national proportions of ethnic Chinese and Indians, as well as a strong presence from smaller ethnic groups. For many of these people, English is a second language, making pre-event preparedness information difficult to access and hindering post-event information distribution (Kolarik, 1993).

Education

Compared with national figures, Wellington's population in 1991 was more educated than New Zealand as a whole. Only 23 percent of the city's population did not have any school qualification, compared with 38.1 percent for other urban centres and 40.7 percent nationally. Furthermore, 48.8 percent of city residents had at least one tertiary qualification. This percentage is much lower for other urban centres, at 37.1 percent, and nationally, at 35.7 percent. The differences in education levels are also apparent when comparing sections of the city, with lower education levels concentrated in areas of known risk from hazards.

Employment

At the 1991 census, 179,631 persons were in employment in the Wellington region, while 17,766 were unemployed and seeking work. Although unemployment in the city was low compared to the national average (9 percent compared with a national average of 13.7 percent), a significant number of jobs in the city were provided by a small number of organisations. It should also be realised that a large proportion of Wellington's workforce commutes into the city each workday.

The major employers in Wellington in 1991 were central government and some large corporate head offices, all with a national (or even international) focus. The government alone provided over 13,000 jobs in the city. Wellington City Council, Wellington Hospital and Victoria University of Wellington also provided large numbers of jobs, both permanent and contract positions. The major trading banks provided another 5000 jobs. Government and head offices also provided a significant number of jobs indirectly because a host of smaller business services have established themselves in Wellington to cater to these larger organisations (WCC, 1993b; WCC, 1994a).

Income

The median income for persons aged 15 years and over in Wellington city was $17,513 per year, the highest in New Zealand (Department of Statistics, 1992a). However, large numbers of people in the city were dependent on the Department of Social Welfare for financial assistance.

The number of social welfare benefits provided to people in Wellington city continued to fall over the

12 months to September 1994, but at a slower rate than nationally. The number of people receiving unemployment benefits in Wellington city fell by 7 percent (from 5848 to 5435) over the same period. This is well below the 12 percent fall recorded nationally. During the same year, the number of persons in the city receiving domestic purposes, sickness and invalids benefits increased by 8 percent, compared with a 5 percent increase nationally (WCC, 1994b).

Consistent with the drop in employment-related benefits, there was a reduction in the number of referrals for repeat applicants for budgeting advice and a fall in the demand for food parcels, down by 4 percent on the previous year.

Health

About 10.8 percent of Wellington's population have some form of disability, compared with 13.6 percent for New Zealand (WCC, 1993c). The elderly make up a large percentage of this group.

There has been a decline in visits to general practitioners since 1993, due in part to increased costs in medical care and prescription charges (Delahunty, 1994). Coupled with this was a growth of community health care services. Contracted to the regional health authority, these groups provided primary health care and health education and promotion activities to groups who traditionally missed out on services because of cost and accessibility.

Waiting lists at Wellington Hospital rose from 4380 to 5025 in the year to June 1994, up 14.7 percent for the year. The year also saw a rise in the demand for mental health services and community support services in the city, creating extra pressure for staff and patients (Delahunty, 1994).

Housing

At the 1991 census, 25.9 percent of private dwellings in the Wellington region were rented or leased, the highest proportion of rented dwellings in New Zealand.

Wellington also has large concentrations of older — often substandard — housing located in areas of known risk from landslides, ground shaking and liquefaction. Compounding this physical risk is a social vulnerability issue: many of the city's low-income groups are also clustered in these areas. The influence of location within urban areas on the vulnerability of lower socio-economic groups has been supported in overseas examples (Britton and Lindsay, forthcoming).

The social impact of disasters

Housing

Reading the recovery reports from many of New Zealand's recent disaster experiences, one can be forgiven for assuming that people had no major housing problems. Little information is available on the long-term rehousing of evacuees following New Zealand disasters, and what is available tends to be largely anecdotal.

Housing is perhaps the most significant element in recovery to the victim or household (Bolin, 1993) and is related to the social class of the victim, with wealthier victims more likely to establish new housing equivalent to, or better than, their pre-disaster residences in terms of size and amenities (Bolin and Bolton, 1986). The full impact of a disaster is unlikely to be felt in the immediate response to a disaster. Housing shortages are more likely to be felt after the declaration is terminated, as people slowly leave emergency accommodation and begin rebuilding their homes and seeking alternative long-term accommodation. This was apparent following the Southland floods in 1984 (Luketina, 1986).

Social class also affects the speed with which disaster-affected people will return to their homes. In both the Loma Prieta (1989) and Northridge (1994) earthquakes, renters tended to spend longer periods of time out of their homes. In Wellington, the high proportion of flats ("non-family households") and the large numbers of households in the lower income brackets will compound the existing housing problems in the city.

Wellington City Council is the second largest property owner in New Zealand and the major provider of low-cost accommodation in the city. However, as with many New Zealand cities, there is a shortage of affordable housing for low-income groups and this is likely to be exacerbated following any major disaster (French, this conference). This needs to be factored in to any long-term disaster housing policies, by including provisions to ensure the rebuilding of affordable rental units.

Following the 1994 Northridge earthquake in Los Angeles, emergency shelters were open for 34 days.

After Loma Prieta 1989, Red Cross emergency shelters had to be kept open for 66 days in Santa Cruz. Even when the facilities were eventually closed, 21 families were still staying in one shelter and had to be placed in motels. Following the 1984 Southland floods, 1200 houses were damaged, representing less than 6 percent of the housing stock. Over 3000 people had to be temporarily accommodated, many for six months or more. Damage in this event was estimated at $50 million.

Over short periods, disaster-affected persons can and will put up with minimal facilities. However, if they are expected to remain in emergency accommodation for some time, disaster-affected persons begin to demand increasingly greater levels of services — and understandably so. If the Wellington region is severely impacted, how much can evacuees in this region expect to receive and what will they be prepared to settle with?

Employment

Significant changes to the economic infrastructure following disaster, through service attrition, expansion or consolidation, will have a serious impact on the region's economic recovery. Previous disasters, for example, have shown an increase in trade for the building and hospitality industries, at least temporarily. Many Wellington organisations are acutely aware that the demand for their services is likely to exceed existing capabilities. Others in the city have plans in place to enable them to quickly relocate to other centres following a major impact.

The city's economy is highly dependent on its transport network, with a large daily commuter population and a reliance on limited access routes. Approximately 60,000 people enter the city from the greater Wellington region, mainly by private vehicle or rail. Approximately 25,000 residents leave Wellington city for work in the Hutt Valley or the Porirua Basin (WCC, 1994a). The disruption likely to the transport network within the region is likely to have longer-term effects on the city's economy. Furthermore, any additional stress on this system will intensify existing problems.

Wellington has a slightly greater proportion of jobs in communications than the national average. Local employment in the industry has been under severe pressure over the last six years due to restructuring and increased competition. High levels of investment are expected in the future, but the money is likely to be spent on technology rather than people (WCC, 1993a). Although this expenditure on technology has negative implications on employment, it has positive impacts for community recovery following disaster. Communications are a vital component in the restoration of essential services (CAE, 1991) and, as such, are important in the recovery of normal social systems and routines.

Counselling and community mental health

Social scientists have been unable to reach consensus regarding the psychological consequences of disasters (Quarantelli, 1985; Perry and Lindell, 1978). There is basic agreement, however, that disasters are themselves not directly equated with stress. Disasters cause changes in social systems, which in turn require system elements to adapt to different demands (Perry and Lindell, 1978; Luketina, 1986).

Quarantelli (1984) found that disasters do not generally result in severe mental health consequences, whether looked at in the short- or long-term. Services are sometimes required, however, because while the disaster agent may not generate psychological problems, the relief effort directed at victims may create a situation more damagingly stressful than the actual disaster experience itself (Ruscoe, 1988).

A study into social and psychological effects following the 1984 Southland floods revealed that any psychological problems that appeared following that event were more likely a consequence of the floods' aftermath rather than the flooding itself (Luketina, 1986). Following the floods, there were widespread claims about serious social and psychological problems, including a relatively high level of marital breakup, behavioural problems in children and increased anxiety and depression in adults. These claims were not supported by most of the relief workers. However, there is very little empirical evidence available to confirm or refute these claims.

That is not to say that there is no need for mental health services following a major hazard impact. Social research indicates that any dramatic change in the social structure of a community does have negative consequences on the population. These effects are particularly marked if the event causing change has been sudden and unexpected, for example, in areas where the loss of the major employer

has caused a sharp rise in unemployment levels, there has been a corresponding increase in many negative social, psychological and financial indicators (Peck, 1985). In towns where additional social support networks and initiatives have been encouraged, the long-term effects on the community have been far more positive (Boswell, 1994; Peck, 1985).

It is, therefore, appropriate for emergency managers to plan for the provision of increased social support services, including mental health, just as planning is undertaken for the possible loss of utilities, transport and communication links.

Making mental health an element in the disaster preparedness process will ensure better post-disaster coordination (Tierney, 1989). Any post-disaster mental health interventions should build upon community strengths, mobilising and incorporating latent community resources. Disaster mental health programmes should identify and attempt to coordinate with these supportive groupings, and they should facilitate the development of mutual-help networks where they do not already exist.

The Wellington city approach

Over the past two years, the Wellington City Council, through its Emergency Management Office has being developing a comprehensive disaster recovery programme. This programme is based on a programme undertaken in Los Angeles over the last six years, which resulted in the *Los Angeles Recovery and Reconstruction Plan* (Los Angeles Emergency Operations Organization, 1994).

In March 1994, the Wellington Emergency Management Office (WEMO) invited representatives from the lead disaster response and recovery agencies to meet together. The purpose of the meeting was for agencies to assess their ability to fulfil obligations under the Ministry of Civil Defence *National Civil Defence Plan*. Although most were willing to undertake these roles at the local level, concerns were raised regarding funding, staffing levels and the availability of resources.

Furthermore, little internal planning had been undertaken by the majority of agencies present. Many knew their requirements under the national plan but had little idea how to implement them post-impact or how their agency linked in with other agencies in the post-disaster phase. Nor did agencies appreciate that their obligations could not be indirectly transferred back to "Civil Defence", i.e. for transport, food and accommodation.

The draft *Wellington City Disaster Recovery Planning Guide* (WCC, 1994c) provides a framework for, and describes the responsibilities associated with, effective disaster recovery operations. It also sets out the basic principles for post-disaster actions. It has been produced to give assistance to those working in the area of disaster recovery and to ensure a coordinated approach to the restoration and provision of post-impact services. In this context, it is the vehicle that coordinates everyone involved in the disaster recovery process.

The guide, sent initially to about 80 agencies, has prompted them to look at their own internal planning and to address the need for strengthened external relationships. Without pre-planning, the time needed by organisations to respond is increased. Financially, the cost to develop and implement post-disaster programmes after impact is greater and often proves to be ineffective.

The guide is an ongoing project and the end product will become more and more sophisticated over the next few years. The aim is to have a final draft *Disaster Recovery Planning Guide* at the end of the current financial year (June 1995).

The guide provides guidelines for the major areas of concern present in the community following a major hazard impact. The main issues covered in the plan are accommodation, economic recovery, information and advice services, and the ongoing provision of mental and physical health services. It outlines the general activities required both pre- and post-disaster to ensure effective coordination of services and resources. WEMO is working with the agencies identified in the planning guide so that all aspects of community support are provided for, have appropriate networks established and are able to adapt to the stresses and conditions created following a major hazard impact. It is not meant to outstrip existing organisational objectives, responsibilities or structures, but to build on the skills, resources and networks already available in the community.

Conclusions and recommendations

Disasters are social events. The cost and time to rebuild a city is far greater than the obvious costs of repairing damaged drains and cables. The hidden costs to the community lie in the provision of long-

term community support services. Accommodation, employment, health and general community wellbeing are all significantly affected following disasters, just as they are following any other major disruption to the social infrastructure.

Community recovery following disaster consists of three interdependent components — social, economic and physical. A major impact on any one component in the system will have dramatic effects on the other two. For community recovery to be effective, plans must include contingencies for all three elements. To date, New Zealand has not adequately planned for the long-term social and economic effects of disasters.

The recent attention awarded to the restoration of physical utilities has been invaluable in increasing our knowledge of disaster reconstruction, but it has limited value when assessing the long-term social impacts on the community. Emergency management in this country needs to look beyond the emergency response phase and examine how the restoration of services and facilities affects the population.

Recovery is a long-term process and one that should not be taken lightly. Although Wellington has taken the steps to ensure this process is under way, there is still much more work to be done in this area. The fact that we have already started, however, ensures that we are in a much better position to control the rebuilding of the city, socially, physically and economically, when disaster does strike.

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Social aspects of recovery: The response of government agencies

Hon Bruce Cliffe

Associate Minister of Finance

Ladies, gentlemen, international guests; I am here today to represent the New Zealand Government at this conference. My task is to speak about the way this government envisages its role following a disaster — what our job would be "after the quake".

This is a theme close to my heart. Last week, my knees rattled as my Wellington residence, which according to the title deeds sits right on top of the Wellington fault, shuddered and shook for what seemed like several minutes, but was in fact only 20 seconds. That earthquake, at 5.9 on the Richter scale, illustrated graphically why those living in Wellington, living as they do on a major fault, need to be vigilant and prepared should disaster strike.

In my speech today, I propose discussing three main themes:

- how government sees its role;
- how government views the balance of responsibilities between central government and local government and private enterprise and individual owners of assets;

  — and last, but not least —

- the strong interest government has in fostering among all concerned a better approach to effective risk management.

Current recovery policies in New Zealand aim at dealing with a range of possible emergency situations. The Ministry of Civil Defence, for example, has prepared a national contingency plan for dealing with the immediate response issues resulting from a Wellington earthquake. A plan for ensuring the "continuity of government" was renewed at the end of last year.

The government's problem is that estimating risk in situations of low probability but potentially high consequence is extraordinarily difficult, therefore making it difficult to allocate appropriate levels of resources. Nonetheless, no government can afford to ignore the issue. Disaster strikes at any time — as evidenced by the earthquake near Kobe — which will have been referred to a number of times at this conference already.

I understand that this earthquake has revived debate in Japan on whether or not the Japanese capital should be relocated. This argument could well extend to New Zealand given that our capital straddles a major fault. But the truth is that there seems to be no place that is totally safe. Even if we were to move the government to my own electorate of the North Shore in Auckland, I am told that Kobe is as far from Tokyo as Auckland is from the Wellington/Wairarapa faults, and we have volcanos on the North Shore that may decide to blow at any time!

There are lessons that New Zealand can learn from Kobe, however. For example, New Zealand industry should study the commercial implications of the sudden loss of a major port for an unknown length of time. How many of our local companies have back-up plans for a situation of that sort?

Earthquakes are not the only natural disaster that government must consider, although they are potentially the most expensive type of disaster, given their ability to disrupt the economy and to damage property and infrastructure. The government also has to consider the potential impact of floods, storms, volcanic eruptions or bushfires. In fact, floods have accounted for more than half of the natural disasters which have occurred in New Zealand communities over the past 30 years. When we look back over the last 150 years, however, it could be claimed that more people have been killed as a result of volcanic action than by floods or earthquakes.

Last year we faced another kind of crisis when our largest urban area, Auckland, faced the prospect of an urban drought. Local authorities and central government had to work together to coordinate a possible response. A pipeline from the Waikato River was under consideration. Luckily the weather changed and the dams filled, but, had this not happened, we faced the prospect of a city of a million people going without water.

This country is prone to such natural hazards and this is why government policy reflects the need to be able to respond to a wide spectrum of possibilities.

When a major earthquake occurs in Wellington — what would government's main concerns be?

The government's initial task would be to ensure that government continued to function effectively from the current parliamentary complex. The first point to note is that the likelihood of damage on a scale that would render the majority of government buildings unusable is extraordinarily low. The parliamentary complex is on relatively stable ground compared to other buildings in Wellington. In addition, the unique circular Beehive, where the executive resides, is thought to be one of the safer buildings in town, while the older Parliament Building is currently undergoing work to strengthen its structure.

As you will all know, other government buildings like the State Services Building, the National Library, the National Archives and the High Court buildings have all been built with the intention of withstanding a major quake. We can only wait and see if such confidence is well founded.

Not only has the physical integrity been provided for, but roles and responsibilities have been carefully laid out as well. Among the statutory responsibilities to ensure safety and continuity of government, three sections of the Civil Defence Act 1983 are particularly relevant: sections 43, 44 and 45. The first of these in particular obliges departments and other central government organisations to maintain plans for the continuation to the *fullest possible extent* of their essential functions during and following a state of national emergency or civil defence emergency. To fulfil these obligations, many departments have back-up phone and computer systems in centres outside the capital.

The chances of the parliamentary complex collapsing are slender, but, as is only prudent, the government does have a back-up plan to shift to an alternative site outside Wellington should it be required. As soon as governance was assured — either in Wellington or out of it — the government would need to consider what assistance was needed by a city devastated by an earthquake.

In discussing recovery issues in particular, I want to impress on you that government does not shirk its responsibilities, but it does want the risk to be shared. Government continues to cover a large proportion of infrastructural recovery costs. But in doing so, it transfers appropriate responsibility for the recovery as a whole on to those with a direct interest. The issue is to strike a sensible balance of responsibilities between those affected — individuals, businesses, and local, regional and central governments.

Previously, we in central government were meant to pick up nearly all of the tab after disasters. But that arrangement was flawed. It provided no incentives for those affected to manage their assets effectively (for example, to construct them to good standards, maintain them appropriately and to mitigate the risks).

Having government cover the total cost of repair was unnecessarily costly for taxpayers generally and did not promote the right incentives. During the local body reforms of the late eighties, the Labour government at the time sought a better system. It sought to share the risk between central government and local authorities. Local authorities are now expected to undertake their own risk management; assuming responsibility for their assets.

Government does accept, however, that some major infrastructural assets such as sewage systems and water supply have very high value and are difficult or uneconomical to insure. Here the central government recognises that it needs to help and in essence it settled upon a 40:60 split of the cost of restoration of these major assets, with some specified conditions. This was based on the assumption that the requirement to meet 40 percent of the recovery cost would provide sufficient incentive for local authorities to be careful in the management and protection of their own assets.

The government defined some guiding principles and issued them in its recovery plan called *Natural Disasters and Emergencies within New Zealand*. The recovery plan sets out the framework, responsibilities, principles and policies for government assistance.

It can encompass many forms of event, from the catastrophic (such as earthquakes, floods and volcanoes), to medical emergencies, and to adverse events relating to agriculture.

Naturally one asks the question, Why should central government be involved at all? The answer is that central government's concern stems from the fact

that in each of these circumstances there will inevitably be some disruption of community and economic life and that becomes a national issue.

In the kind of situation that we are likely to be considering at this conference, it is very important that local authorities have a clear idea of government's purpose in offering aid, and the conditions under which it is given. The specific principles that shape the government's role in recovery, and which are set out in the official recovery plan, are as follows:

1) Initial and primary responsibility rests with those directly affected, with government providing supplementary assistance when required.
2) Individuals, businesses and local authorities must manage their risks properly to ensure that they have mitigation measures in place and have adequate financial resources to repair damage.
3) Government accepts that it has a role after *major* events.
4) Government helps restore the community capacity for self-help.
5) Government encourages proper risk management practices.

An important point — perhaps the most important point that I will make today — is the emphasis on risk management. The government's message is very clear. *The government expects comprehensive risk management practices on the part of all local and regional authorities, businesses, and individuals*.

The concept is simple.

Among local authorities and those directly affected there is inevitably a far superior appreciation of local risks than in central government.

The risks are neither unknown nor unknowable. They should be examined and assessed — just as the Earthquake Commission, our conference hosts, are holding this meeting to gather together ideas and information about how to manage earthquakes.

Sensible alleviation or mitigation measures can make an enormous difference. Lives can be saved, damage can be reduced and recovery costs can be reduced markedly.

But risk management has not been fully appreciated in our communities or among local authorities. A survey done in my own electorate, North Shore, in 1993 showed that only 37 percent of businesses were prepared should a major disaster occur, 40 percent were "not really prepared", 22 percent not at all prepared, and 1 percent "didn't know".

A number of our local and regional authorities have undertaken risk surveys for the purpose of setting insurance premiums. But more is required. There is a pressing need to improve risk analysis in this country and to develop practical risk management techniques to address the issues that have been identified. In saying that, I am fully conscious that some organisations and local authorities, including those represented at this conference today, already have effective mechanisms in place.

This need for organisations to better manage their own risks in the event of a major disaster, has become of even greater importance following the passage of the Earthquake Commission Act 1993. This act provided for EQC to cease renewing commercial property insurance completely from 1 January 1996. The government believes that EQC assistance is best targeted at ensuring that homeowners, above all, are able to regain a roof over their heads as quickly as possible following an earthquake. EQC is now constituted to achieve this end. The government, therefore, sees the role of the EQC as a social one. Businesses know best how to manage their risk and should be left to do so.

I would like to mention the work done by bodies like the Wellington Regional Council, the Canterbury Regional Council and the Taranaki Regional Council under the Resource Management Act to fulfil their duty to manage the risks facing their communities.

My message, to the extent that it is needed here, is to say that central government in New Zealand sees it as a local responsibility not just to repair damaged infrastructure, but to minimise, mitigate, and manage the risk. That is:

- to minimise the chance of an adverse event happening, where possible, and to reduce the likelihood of natural disasters triggering subsequent effects;
- to mitigate the consequences of an event, should it occur, through sound engineering and construction, and careful maintenance; and
- to manage the risk with appropriate financial and operational provisions.

For example, the Accident Rehabilitation and Compensation Insurance Corporation (ACC), one of my ministerial responsibilities, commissioned a report from Cambridge Architectural Research Limited and the Institute of Geological & Nuclear Sciences a year ago on the likely level of deaths and injuries following a major seismic event in a major populated area. Most available material related to experiences overseas, where construction methods and standards differed from those in New Zealand and where population densities were much higher. As a result of this, ACC believed it was paying too much in premiums for its international reinsurance, the system under which insurance companies spread the risks of a single organisation being caught by a rare event producing demands for payouts well outside the normal predictable level of payouts. In ACC's case, the premiums being paid for re-insurance were based on the established level of expectation of a major natural disaster occurring in this country, but with that expectation overlaid with casualty levels of overseas disaster patterns. The report was accepted as authoritative by ACC's international reinsurers, and the premium now being paid to buy an acceptable comprehensive level of reinsurance cover is substantially lower than before this study was done.

More New Zealand organisations could be doing this sort of research so that they better understand the nature of the risks faced and their relative magnitudes. This will provide a sound basis for sensible mitigation strategies.

By way of elaboration of the principles just outlined, let me mention briefly some important conditions that apply to the way government provides assistance. Assistance will normally only be provided where:

- there is a statutory requirement for action or a need to invoke a statute to achieve the desired ends; or
- recovery procedures cannot be carried on without government assistance; or
- central government help will aid the coordination of the process significantly; or
- there are economies of scale.

Although the programme for this conference identifies some specific forms of government assistance (Social Welfare, Department of Labour and ACC), these represent only a small part of the services potentially available in the event of a serious disaster. In practice, those responsible would be able (through the recovery coordinator) to call on a very wide range of assistance. Individuals would have access to the full range of help through ACC and social welfare that is available under normal conditions.

As an indication of the range of central government assistance that would be available to deal with a serious event in Wellington, I would flag the following:

- emergency feeding, housing and welfare;
- transport for evacuation;
- restoration of government services and facilities;
- assistance with some other services and facilities if uninsurable or if urgently needed (e.g. water supply, sewerage, bridges, and roads);
- expert advice and temporary labour to speed clean-up;
- coordination of responses from central government and appointment of a recovery coordinator.

There is one important qualification that I want to emphasise here. Government agencies or funding may be used to give assistance in the assessment and appropriate restoration of these services and facilities that are the responsibility of other agencies. But this applies only where commercially viable insurance cannot be obtained or where other agencies cannot do the job quickly enough.

In general, *if an asset is insurable then central government is unlikely to provide assistance*.

That is an important guideline to keep in mind.

And what of the future?

In late 1994, my colleague, Civil Defence Minister Warren Cooper, initiated a "green fields" examination of the way that emergency services in New Zealand are managed. The purpose is to develop options for better organisation of emergency services, and the review will be looking at trends developing overseas that may in time be applied here. A trend overseas that might occur here as a result of this review is the shift of emphasis away from response in the traditional sense to the more general idea of *emergency management*. Emergency management takes a more comprehensive approach to dealing with extreme events, placing greater

emphasis on anticipating and preparing for large-scale disruptions.

There is also a need in New Zealand to look more closely at the *social impact of earthquakes*. In the past, we have tended to approach earthquakes from an engineering perspective — that is to focus on technical solutions to the risk. This has led to some imbalance between the resources devoted to analysing the engineering consequences and those for the social consequences of earthquakes. By contrast with some other countries, not enough studies have been done on how New Zealanders might be expected to behave after a major quake. There is room for further work in this area.

Also worthy of further study are the opportunities presented by the recovery process after a major disaster. A plan for recovery can start with the question — if we were starting anew, what would we do?

I understand that Professor Dennis Mileti addressed the conference yesterday on why cities stay where they are, no matter how many times they are damaged. It may not, therefore, surprise you to know that, following disasters like Cyclone Bola or the 1983 Ash Wednesday fires in Melbourne, most people chose to recreate the environments that the disasters had swept away so efficiently. Surely the challenge that faces us is to design *new* environments aimed at mitigating the impact of such events.

In conclusion, I cannot stress highly enough the importance that this government places on individuals, businesses and local authorities playing their part and taking prime responsibility for disaster management. They must be encouraged and empowered to minimise, mitigate and manage disaster.

Over this century, New Zealanders, like many others in the western world, developed a welfare state mentality, believing that government would come to their aid in any circumstance. This past decade has seen a radical change in this attitude in many vital areas. Disaster management is yet another area where the role of central government should be put in perspective. Of course central government is there to play the role that only it can. It has the flexibility to respond in different ways to different situations. But it cannot be expected to carry the full burden of coping with disaster and nor is it best placed to do so.

Every New Zealander must play a part in managing the risk that a major earthquake may occur in their lifetime. This risk management works best for all when it is shared by all. This, and only this, is the route to a swift return to a normally functioning community after a disaster has occurred.

This in no way is a buck-passing strategy — it is reality. The individuals in local communities have more cause, more incentive and a greater ability to direct and implement a recovery "after the quake". It is government's job to encourage, coordinate and empower them.

Discussion

Social aspects of recovery

Mandy Wong (Reserve Bank of NZ) asked about work with different ethnic groups. *Rachel Scott* replied that Wellington City Council intends to work with many groups, but have mostly concentrated on Pacific Islanders and Maori at present.

Heather Smith (Waitakere City Council) said that different pictures of family outcomes had come from the Edgecumbe earthquake and Cyclone Bola — children were reported as having nightmares after the former, but not the latter. *Rachel Scott* said that she supposed it was dependent upon the type of event — with an earthquake there is no warning, but a cyclone is known about in advance.

The rest of this discussion was addressed to the *Hon Bruce Cliffe* (Associate Minister of Finance and the Minister responsible for EQC).

Graham Miller (Wellington Regional Council) remarked that, in the 12 years since the Civil Defence Act was passed, the structures of local and central government have changed and many authorities have divested themselves of control of their facilities. He asked when the review of the legislation that many people had recommended was going to happen. *Mr Cliffe* replied that the message had been received, loud and clear, and the process was under way and would take place when the Minister of Civil Defence wanted it to.

George Walker (Alexander Howden Reinsurance) asked how the government knew that overseas organisations would want to take on much of the reinsurance that it was wanting to share out. *Mr Cliffe* said that the government believed it would only happen if those overseas organisations felt that it was worth their while — which was also related to the national debt.

George Tyler (Auckland Regional Council), noting that an earthquake disaster was as different from a market situation as anything could be, asked if Mr Cliffe could give an opinion on what might be the source of last resort for funding for reconstruction. *Mr Cliffe* replied that it would probably be the government. However, people should look to their own resources first.

John Feast (Bradford Realty) asked how the government reconciled its desire to encourage risk management with housing the Minister on the fault line. *Mr Cliffe* replied that his "granny flat" in Tinakori Road was so small it would probably remain intact. Somebody remarked that the Prime Minister also resided on the fault line, in what was formerly a dental clinic.

Jenny Rowan asked what would happen to the chain of command in a disaster. *Mr Cliffe* replied that the chain "would fall like a pack of cards" and end up with the Wellington local government organisations. People should not sit back and wait for central government to decide.

In response to a question from *Jules Maher* (Telecom) about other ways of encouraging businesses to take on their own risk management, *Mr Cliffe* said that it was a shock to have taken away the "envelope" of EQC support, but businesses were taking on the challenge well. Perhaps the message that the first priority for EQC was to provide insurance cover for the community to restore its warmth and shelter had not been communicated well enough.

Dave Owens (Fire Service) asked at what stage it would become economic for the civil defence aspect of the Transmission Gully route out of Wellington to be supported by government. *Mr Cliffe* replied that both economic and strategic issues were being considered and that he would take the civil defence message at this conference back to his colleagues.

David Hopkins (Kingston Morrison) asked about the implications of government pushing risk management out to private organisations while at the same time being a source of last resort for funding. *Mr Cliffe* replied that the main thing was to ensure that the funds were there. If New Zealand had no debt, an earthquake would pose little problem financially.

Peter Yanev (EQE International) said that he was bothered that the excess applied to homeowners by EQC is only $200. With perhaps 100,000 claims following an earthquake, mostly minor, the excess becomes a major nuisance, he said. In California, they were moving to 10 to 15 percent excess in order to encourage people to have retrofitting work done

to reduce the risk. *Chris Henri* (Insurance Council of Australia) agreed that the Newcastle earthquake had shown that the excess of $200 that applied in Australia was too small and a real nuisance, and he thought it should be $5000 in Australia. *Mr Cliffe* replied that he had not been asked to consider that before, but it certainly should be looked at.

Recent Overseas Experience

Kobe presentation

Kiyoyuki Kanemitsu

Director, International Department, Kobe City, Japan

The people of Kobe thank you for your sympathy and prayers.

Before the earthquake, Kobe had become a very attractive place to live and work. Known as the "door to heaven", it was a prosperous harbour city nestling between the Rokko Mountains and the Inland Sea. Located in the centre of Honshu, Japan's main island, it combines easy accessibility to other major urban and commercial centres with delightful vistas of rural life. The city is only three hours travelling from Tokyo by bullet train, and Kansai international airport takes only 30 minutes to reach by jetfoil. Together with Osaka and Kyoto, it forms the focal point for the economy of western Japan.

Kobe has a population of 1.5 million in an area of 550 square kilometres. The city is divided into two sections by the Rokko Mountains running from east to west. The southern part, which faces the sea, forms the urban area, and the northern and western parts are rural, accommodating many newly developed large-scale housing complexes. The urbanised area, which was hit hard by the 17 January earthquake, stretches like a ribbon 30 km east to west and 2 to 4 km north to south. This narrow strip of land occupies less than 30 percent of the total area of Kobe but is home to 80 percent of the population. The population density is about 6800 persons per square kilometre, which is very high when compared with an average of 2700 for the city as a whole.

Kobe is well known as Japan's leading international port, handling 1700 million tonnes of cargo per year. After the opening of its port to the world in 1868, many foreign traders came to Kobe and helped to form a unique cosmopolitan community. The foreign influence can be found in the city's architectural styles as well as its variety of ethnic restaurants.

The city is known as an active, innovative developer. Two artificial islands (Port Island and Rokko Island) have been reclaimed, joined to the mainland by two bridges and are the site of the container wharves and many new multistorey buildings. These islands are considered symbolic of the forward-looking vision of the municipality.

In addition to being the largest port, Kobe is the centre of vital links in the nation's transportation system. Since Osaka Bay is surrounded by a largely mountainous region, many of the roads and railways are concentrated in the Kobe area. They include the Hanshin expressway between Osaka and Kobe, the Meishin expressway between Nagoya and Kobe, and the Sanyo Shinkansen (bullet train), which transports passengers between Tokyo and Osaka to the east and Okayama and Hiroshima to the west.

The great Hanshin-Awaji earthquake on 17 January 1995 occurred at 5:46 am. It is very significant that we suffered a direct hit at a shallow depth, which contributed to the high level of shaking. There were nearly 5500 dead and 15,000 injured. The number of damaged buildings and houses totalled 86,700 in Kobe. About 89 percent of victims were crushed to death, and most of the rest died in the fires that started in many places. Most died in ground floor rooms and most were elderly. About half of the victims were in their 60s or older, because they preferred to live downstairs.

The earthquake is the world's most costly disaster, with value loss estimated at 9.9 trillion yen (US$120 billion), excluding the loss of business opportunities.

We received a lot of criticism about our lack of preparedness in the aftermath of the quake. However, although experts had documented the presence of active fault lines in our region, nobody ever imagined such a destructive disaster would occur in our city. In Japan, only about 7 percent of residential fire policy holders had insurance against earthquakes. In Tokyo, which is the region of highest perceived risk of earthquakes, the figure is 16 percent, but in our prefecture, only 3 percent of the holders purchased the insurance.

The city had a detailed plan for emergencies, but it has to be admitted that there had been some reluctance to spend time and energy on 'low probability' and 'what if' scenarios. At the same time, the one that hit us was much bigger than anticipated. The intensity was rated at the maximum of 7 on the Japanese scale for the first time ever. The unusually

intense quake created many unexpected situations, which undermined our response seriously.

The intense quake damaged part of the emergency telecommunications system of our fire department, making it impossible to obtain information readily and swiftly about damage caused to lives and property. The Hyogo prefecture's sophisticated satellite circuit system was also damaged, which delayed the gathering and relaying to Tokyo of necessary information about the affected areas for the early stages of our response.

The extent of damage to transportation systems was a surprise. Because of the population density in and around Kobe, most of the expressways and local railways are constructed on elevated platforms, which were believed to be able to escape major damage even if hit by a big earthquake. However, the Hanshin earthquake brought serious damage, such as column failure, shifting of the superstructure platform on the column piers, division between sections of the structure, and sections of roadway dropping from the support columns. Surface roads also suffered significant damage, primarily from subsidence and liquefaction. Even the subway system, which was thought to be very resistant, was partly damaged and forced to suspend all of its rail service.

We never anticipated there would be such extensive subsidence and soil liquefaction. The port facilities along the waterfront as well as on the artificial islands became almost completely unusable, requiring shipping to be diverted to other ports. Only seven out of 239 berths remained operational. Large portions of the open areas on the waterfront and islands sank and became flooded. Dock facilities, including the huge cranes used for loading and unloading container cargo, suffered heavy damage. Many commercial structures around the docks as well as roads and railways providing dock access, including the bridges to the islands, were significantly damaged.

To our regrettable surprise, subsidence and liquefaction also caused heavy damage to underground water, gas and other utility pipes, suspending the supply of these necessary services. We had believed that underground structures would escape major damage, but in fact all these lifelines were cut.

We did not prepare for the situation where those who work in the various rescue and recovery fields would also suffer great damage. In Kobe, 15 city employees died, 950 people lost their homes, and about 40 percent of the total of 22,000 city workers were affected in some way.

Looking back over the turmoil right after the quake, lack of water was one of the main factors that defied our response efforts. The fire crews struggled with lack of water because they found many hydrants and some water tanks damaged. They used school swimming pools, rivers and the sea as alternative sources of water. Broken water mains also hindered medical activities. On the second artificial island, we installed a salt water distillation apparatus to assist the hospital. Hundreds of pump trucks were deployed to supply water for the people, in addition to provision of bottled and canned water at the evacuation centres.

For the past two months since the quake, we have had no time to criticise ourselves for our 'unpreparedness', as we have had to deal with many situations and have been busy just trying to recover from the devastation.

We have restored (by late April) 96 percent of the water supply throughout the city, except in areas where rubble has to be removed to restore service. Recovery of 70 percent of the gas supply has been completed. The electricity system was restored the soonest, with 50 percent of the power supply recovered on the day of the earthquake and the entire supply in six days.

Surface streets were more easily and quickly repaired. Within the first few days following the earthquake, construction crews achieved significant progress in clearing and repairing them. The collapse of a long expanse of the Hanshin expressway was one of the most striking results of the quake. There is a plan to complete this main link between Kobe and Osaka by the end of next year. More and more railway links are reopening. The most important rail system, Japan Railways, announced its intention to get all of its lines back in service by the end of April.

Recognising that the port is vital not only to our city but also to the country, every effort is being made to repair the port facilities. There was extensive evidence of liquefaction on the first artificial island, but less on the second because of the techniques used in construction. Almost all of the 239 berths, including 23 container berths, were damaged, and

the first artificial island was covered with several centimetres of a mixture of silt and sand that had come to the surface during the quake. Now, this material has been removed and the streets have been cleared by road graders. By late April, 104 berths have been restored and seven container berths will return to service. The bridges connecting the artificial islands to the mainland will be repaired by August. According to the recovery plan, half of the port facilities will be restored this year and full operation will begin in two years.

The provision of housing for homeless survivors in our city is another priority in our recovery efforts. Already 15,000 of a planned total of 30,000 temporary homes have been built. There is a plan to build 80,000 new homes over the next three years as part of the rehabilitation programme.

A ten-year redevelopment plan being developed in conjunction with the national and prefectural governments is expected to be completed by July.

The budget for the coming fiscal year beginning in April is the largest ever, at 2.78 trillion yen (US$33 billion), a 33 percent increase on last year's. The budget includes various projects to aid quake victims and promote the rehabilitation of our city.

The city will issue four times the amount of bonds from the previous year to cover the shortfall expected from the combination of the budget increase and an anticipated 30 percent drop in tax revenue. Many businesses were hit hard by the quake, and they will pay less tax because they will earn less this year. We took an aggressive stance in making the budget. Some people are worried about future fiscal difficulties, but we believe it is the only way to give expression to our firm determination to achieve a speedy recovery from the disaster.

Including the supplementary budget for fiscal year 1994 approved in February, the city's complete quake-related expenses will reach a total of 1.14 trillion yen (US$13.5 billion). The city allocated 55.8 billion yen (US$660 million) for the management of shelters, food and other supplies for evacuees, including temporary housing for the elderly and the disabled. We will spend 202 billion yen (US$2.4 billion) on the reconstruction of port facilities and 183 billion yen (US$2.2 billion) to remove debris and rubble produced by the quake. The city will also assist reconstruction of the Hanshin expressway and private railway lines. Moreover, 238 billion yen (US$2.8 billion) is earmarked for reconstruction projects, including urban rezoning and redevelopment programmes, housing construction and special assistance to small- and medium-sized companies.

In addition, the city and prefecture agreed to set up a joint 600 billion yen fund (US$7.1 billion) to support quake victims. Profits from this ten-year fund will be used to subsidise payments on housing and business loans, to promote employment, and to help private schools and cultural assets. Money for the fund will be raised through the issuance of local government bonds to be redeemed in ten years, with Hyogo prefecture shouldering 400 billion yen and our city the remainder. We are hoping that the fund may be further bolstered with income from a quake recovery lottery and a part of the donations that were collected for the quake-hit areas.

I would like to share with you some suggestions that experts and scholars have made on how to better respond to an earthquake disaster, based on our experience in the 17 January earthquake.

There is a definite need to secure multiple means of communication, for example satellites and radios to supplement national telephone lines, and they have to be quake-proof. It is also important to build an underground tunnel to house electricity and water lines, and to equip schools and other designated evacuation centres with quake-proof water tanks.

After an earthquake, it is important to quickly stop passenger cars and other ordinary vehicles from using major roads, so that rescue and relief supplies can proceed smoothly. It is necessary to have a secondary command centre, in case the main command centre is damaged or inaccessible. It is helpful to construct rail tracks that link different railways together so that alternative routes can be constructed even when sections of certain lines are damaged.

In general, it is important to have several back-up plans for every system and office, because in a disaster it is impossible to predict which areas will become inaccessible, which buildings will collapse, or who will be unable to get to their job posts. Once basic disaster and relief system plans are constructed, additional plans for how to deal with foreign offers of aid, as well as foreign news media, would also prove helpful.

In Japan there is an old saying: “National disaster comes when we forget”. We learned the truth of this in such a tragic way. The great Hanshin-Awaji earthquake should be taken as a wake-up call for cities with a relatively low level of earthquake risk, as Kobe had.

Recently, building technology and emergency preparedness techniques have made remarkable progress. However, advances in building methods and codes do not address the problem of an ageing inventory of existing buildings which fail to meet current building standards. Anti-disaster confidence is dangerous. Even a well prepared region may not really be ready for a “big one”.

Nature speaks, but are we always listening?

The great Hanshin earthquake

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At 5:46 am on Tuesday 17 January 1995 in south Kobe, Japan, a 6.9 Richter magnitude earthquake occurred with epicentre 30 km out to sea, off Awajishima Island, and its source 20 km deep. The strong ground shaking in Kobe lasted 20 seconds and the maximum horizontal ground accelerations recorded were 0.83*g*.

The result was over 5000 people dead, tens of thousands injured, and hundreds of thousands of people homeless. Thousands of buildings were badly damaged and many collapsed; major roadways and railways were cut due to collapses of bridges; fallen debris and ground surface movements distorted railway lines; port facilities were unusable; electricity, water, and gas supplies were cut, telephones out of order, and sewage disposal uncertain.

Some damage was particularly devastating. In a hospital building typical of many older major buildings the columns of the fifth storey collapsed, causing the floor above to drop, crushing to death 49 people.

Many residential houses were badly damaged; many collapsed and were followed by terrible fires in many areas. On the fourth day after the earthquake about 310,000 residents spent the night at 1077 halls and gymnasiums used as refugee centres.

There are many lessons to be learned regarding construction to resist earthquakes from observing the damage caused by a major earthquake. Within 6 days, a reconnaissance team arranged by the New Zealand National Society for Earthquake Engineering and sponsored by the NZNSEE and the Earthquake Commission, was sent to Kobe from New Zealand. The team, which I led, comprised ten New Zealanders, a Japanese, an Australian and a Canadian, and their expertise covered engineering geology and seismology; geotechnical engineering; building structures; industrial facilities; bridges and other lifelines; architecture, building services and housing; and fire and emergency response.

The objectives were to inspect damaged and undamaged areas and structures to assess possible causes of failure, so as to bring back lessons for New Zealand, and to assess the preparedness and emergency response. The team spent ten days in Japan, mostly in the Kobe area, inspecting damage and talking to engineers and scientists to obtain as much information as possible. A full report was published in the March 1995 issue of the *Journal of the New Zealand National Society for Earthquake Engineering*. As well as time spent in Kyoto on briefings, gleaning information from newspaper reports and videos of damage, and visiting the Disaster Prevention Research Institute of Kyoto University, the team visited Kobe for tours of damaged areas guided by staff from the Hanshin Expressway Public Corporation, construction companies, and universities. Kobe was approached by rail or bus or ferry and then on foot into the city. The team walked many kilometres.

Damage

The earthquake caused extensive damage in and around Kobe, mainly in a narrow strip of alluvial and colluvial flat land between the mountains and sea. The strip was 1 to 2 km wide and 30 to 40 km long and extended through Kobe and the adjacent communities of Ashiya and Nishinomiya.

Traditional Japanese houses performed badly. These houses were mainly one or two storeys, with timber or steel post columns. Roof tiles were laid on 50 or 75 mm thickness of clay (for insulation), resulting in a heavy roof; walls, which consisted of timber lath with clay infill between the posts reinforced by bamboo, had poor resistance to horizontal shaking. Many houses were destroyed by collapse of columns during lateral shaking under the weight of their heavy roofs. Modern housing, with lighter roofs and better bracing against lateral shaking, stood the earthquake well.

The strength of a structure may not be as great as the imposed seismic forces. For house structures to remain in the elastic range during a major earthquake would require huge seismic design forces, and seismic codes in Japan, New Zealand, and other countries use smaller seismic design forces. Typi-

cally a code as used in Kobe recommends a seismic design force of 0.2*g* applied horizontally and a design working stress with high allowable stresses. Hence, to survive the earthquake well, the structure must be able to deform in the post-elastic range without significant damage and certainly without collapse.

A new seismic code for buildings was introduced in Japan in 1981, and buildings in Kobe designed since then performed very well on the whole. In those modern buildings, the structure and the glass cladding had both been designed so that they could deform without fracturing, and there was little damage to either. This emphasises the need in New Zealand to enforce our current building design and construction codes strictly, and justifies the considerable upgrading of our seismic codes which has occurred since the mid-1970s, commencing with the general design and loadings code NZS 4203:1976. This upgrading involved the introduction of capacity design, in which structures are made capable of yielding in a ductile manner during a major earthquake and brittle collapses are avoided. For example, in the capacity design of building frames, the columns are deliberately made stronger than the beams so that, in the event of a major earthquake, yielding occurs mainly in the beams which are made adequately ductile, i.e. able to maintain their load-carrying capacity despite significant deformation.

Retrofitting

Many older buildings in Kobe did not fare so well — typically buildings of the 1950s and 1960s, which were designed to old (now sub-standard) codes. Many suffered failure of columns (both reinforced concrete and structural steel), which brought the buildings down. Most deaths in buildings in Kobe were due to the collapse of the columns of a storey, typically the bottom but also at times an upper storey, crushing people as the floor slabs above those columns pancaked. Engineers refer to this as a "soft storey failure". Those buildings had been designed according to the codes of the day and the designers could not be blamed. Our knowledge of how to design for earthquake resistance has increased a great deal since the 1960s. Nevertheless, it does illustrate that many of our older buildings need to be upgraded (strengthened), a task engineers call "retrofitting". Some older structures are inherently strong and have satisfactory earthquake resistance. Others are not strong and are not ductile and need to be retrofitted.

Ground liquefaction occurred extensively, and there was an example of one multistorey building which, though remaining intact structurally, simply toppled over during the main earthquake and a large aftershock.

Other structures

The same problems occurred for bridges as for older buildings. For example, a 600 m length of the Hanshin expressway overhead bridge toppled over due to failure of the columns. The columns lacked ductility and failed in a brittle manner, due mainly to inadequate circular hoop steel to prevent a shear failure, and also to brittle failure of butt welds in the longitudinal reinforcement. In the case of some other bridges, spans dropped off piers that had moved by about half a metre because of liquefaction.

Japan's top container port was put out of action due to ground movements (settlement and spreading) and crane collapses in the berth areas. The gravity caisson wall structures that retained the reclaimed islands rotated and moved laterally about 2 to 4 m, resulting in lateral spread of the ground extending often as far as 100 m behind the port breast works. Severe damage was inflicted on container cranes and adjacent buildings.

Lifelines

In Kobe, lifelines were severely damaged by the earthquake over a large area: 900,000 households were left without electricity; 850,000 households were left without gas; water supply cuts affected about 2.5 million people; 160,000 telephone lines out of 800,000 were out of order; all railway services stopped; major expressways were closed. An elevated expressway, which was a main artery for traffic movement between Osaka and Kobe, collapsed over many parts of its length, and many railway bridges collapsed.

The electricity was restored remarkably quickly, in a day or two. Water and gas took much longer, causing hotels and many other buildings to close although structurally sound. Fire followed the earthquake, but limited water was available to fight fires. More than 350 fires broke out, wiping out around 100 hectares of densely populated area. Many were caused by the overturning of stand-alone heaters (electricity and gas). It is obviously important that lifelines be capable of resisting earthquakes

without significant damage, so as to avoid serious disruptions to the life of a city.

The people

The people of Kobe were observed to be remarkably resilient, showing great determination to rebuild their lives. They got on with life. People walked unemotionally around the wreckage to work, carrying their day's water supply on their backs.

Impressions were that they are a very honest society. Piles of possessions on the footpaths outside houses were left untouched and bicycles were left unchained in the streets. There was a feeling of security when walking about. No looting was obvious.

The city was remarkably open, with access to the damaged areas. They were tolerant of visitors, many of whom were sightseers coming in from other parts of Japan.

The public were also reliant on quite a degree of government aid. Refuge centres were set up, and water trucks were in the suburbs.

Preparedness

The great Hanshin earthquake will have a profound effect on Japan's earthquake preparedness. In the past, Japan's disaster mitigation strategy has been heavily dependent on structural (building code) measures. Bitter criticism is being levelled at government in Japan for its slow response and inadequate preparedness, and in the future more emphasis will be given to these.

Kobe had not been considered a likely hit for a major earthquake before Tokyo, although it did have a Richter magnitude 7.5 earthquake in 1596 that flattened the city. The great Kanto earthquake of 1923 caused 140,000 deaths in Tokyo.

We are lucky in New Zealand that for more than 60 years since 1931 a major earthquake has not occurred in an urban area. However, a major earthquake could occur in Wellington or anywhere in New Zealand. According to data recorded since the 1840s, New Zealand can expect a Richter magnitude 7.0 earthquake about every seven years. There have been three earthquakes with Richter magnitude greater than 7.8 during that 150 year period: in 1855 the southwest Wairarapa had a Richter magnitude 8.1 earthquake, which also affected Wanganui and Wellington, resulting in five deaths; in 1929 Murchison had a 7.8 Richter magnitude quake with 17 deaths; and the 1931 Hawkes Bay 7.9 Richter magnitude quake caused 256 deaths.

New Zealand's Civil Defence, fire service and other emergency services need to be better coordinated to handle a major earthquake. Are they prepared? Some think not. Kobe was caught out by the magnitude of the event.

Structural engineers need to be prepared to classify damaged buildings, for example:

- dangerous — evacuate;
- further structural check needed — evacuate;
- satisfactory — need not evacuate.

Counselling services for trauma need to be organised. Lifting and digging equipment, tracker dogs, paramedics, need to be organised. Areas for dumping debris should be located.

Individual households need to be better prepared, because there may be several days after a major earthquake when we have to fend without water and electricity — torch, portable radio, food and water need to be available in every house.

Conclusions

The 20 seconds of strong ground shaking of the great Hanshin earthquake has provided many important lessons for New Zealand. Of these, four are paramount.

- Buildings designed to modern seismic codes survived the earthquake well. This justifies the design and construction provisions of current codes (which are very much more severe than older codes) and emphasises the need to enforce current codes strictly.
- Older structures are an earthquake risk. Many pre-1970s structures in New Zealand may need retrofitting.
- Lifelines of cities need to have adequate seismic resistance. The use of buildings after an earthquake will be severely hampered if, for example, the water supply is cut for weeks.
- Disaster preparedness and emergency response and recovery services are critically important. How well prepared are we for the effects of a major earthquake in an urban area of New Zealand?

The Philippines after the 1990 quake and the Pinatubo eruptions

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On 16 July 1990, the central and northern parts of Luzon, the biggest island group in the Philippines, were rocked by an earthquake with a magnitude of 7.7 on the Richter scale. After 45 seconds, nine cities and 39 municipalities in 15 provinces lay damaged, some of them almost totally devastated. Some 1200 people were killed and over 3000 were injured.

Barely a year later, another natural disaster struck — Mt. Pinatubo, a nearly forgotten volcano in Central Luzon, erupted ash clouds 20 to 40 kilometres high, covering almost the entire country in a blanket of white. Ashfalls and mudflows from Mt. Pinatubo killed or injured at least 800 people in three provinces and triggered massive evacuation by entire communities to safer ground.

These two disasters wreaked havoc on provinces that accounted for a major percentage of the Philippines gross national product. The destruction of industrial, agricultural and commercial establishments caused massive dislocation of the economy of affected areas as well as of the whole country.

The task of reconstruction was not easy. Despite the limitations, however, the task of rebuilding areas hit by the 1990 earthquake was finished in good time, and although there are continuing threats from Mt. Pinatubo, the social and economic life of affected provinces is basically back to normal.

Today, the regions most affected are designated critical growth areas: they are important in attracting international investors and their progress is expected to have downstream effects elsewhere. The success of the reconstruction effort brought to the fore important lessons in dealing with natural disasters, and these are summarised.

Introduction

The Philippines is a land blessed with natural beauty. Its sunsets and beaches and mountains have been widely talked about and written about. However, the country has also suffered natural calamities of such immense proportions they made world news.

Before the 1990 northern Luzon earthquake and the eruptions of Mt. Pinatubo in 1991, volcanic eruptions were more or less viewed as a tourism event. The world's most perfectly coned volcano is in the Philippines: Mayon volcano in the province of Albay, near the southernmost tip of the biggest island group, Luzon. Although its recent eruptions did cause damage to life and property, people still flocked to its basal slope to view the majestic display of fireworks emanating from its beautiful, sharp-crested summit.

The world's lowest volcano is also found in the Philippines. This is Taal volcano, considered a natural wonder because there is a tiny lake at its crater even as the volcano itself nestles in the midst of a bigger lake. When it erupts, tourists flock to nearby Tagaytay ridge, where there are excellent vantage points from which one can look down and safely view the fiery explosions of Taal, either with a telescope or with the naked eye.

The killer quake

Natural hazards in the Philippines, however, ceased to be postcard events after 1990. On 16 July of that year, at 4:26 in the afternoon, the central and northern parts of Luzon were rocked by a shallow magnitude 7.7 earthquake, which was felt near its epicentre at intensity 8. Locally, some areas were shaken at intensity 9, the maximum in our modified Rossi-Forel Earthquake Intensity Scale. The impact of that tremor approximated the explosion of some 10,000 atomic bombs similar to those dropped at Nagasaki and Hiroshima in 1945.

The damage

After 45 seconds, nine cities and 39 municipalities in 15 provinces lay damaged, some of them almost totally devastated. Some 1200 persons were killed and over 3000 were injured. It is interesting to

compare these numbers with those due to the magnitude 6.9 Hanshin earthquake at Kobe on 27 January 1995: over 5000 dead and 25,000 injured. Philippine government agencies estimated the actual property damage in the Philippines at about P15 billion, or roughly US$600 million.

The devastation affected major commercial centres and agricultural areas, which comprise the Philippines' breadbasket, as well as cultural and historical sites. This triggered what was perhaps the biggest reconstruction job in our country after the Second World War.

Government buildings in the country's National Capital Region also suffered heavy damage.

The affected major urban centres included:

- Dagupan City, which suffered the worst physical damage because of extensive liquefaction;
- Cabanatuan City, which saw a most tragic human drama when a school building collapsed;
- the internationally renowned city of Baguio, which was transformed within a few minutes from a tourist haven to a massive disaster area; and
- the nearby town of Agoo, La Union where centuries-old structures — virtual national monuments — came crumbling down due to the combined effects of liquefaction and severe ground-shaking.

In Cabanatuan City, which lies some 100 km northeast of Manila, students were in their classrooms when the entire three-storey building collapsed. Among those who were trapped under the rubble was a student who, although slightly hurt, managed to inch his way out. Amidst groans and cries for help from his schoolmates, he rushed back into the ruins to rescue the survivors who were trapped inside. Without regard for his personal safety he went back again and again to pull out the injured survivors. In his last attempt to rescue his classmates, a slab fell on him, pinning him to death. The Cabanatuan City crash claimed 221 victims: 125 injured and 96 dead, among them the young hero, Robin Garcia.

In Baguio City, the Philippines' summer capital, two major tourist landmarks were totally destroyed: the Hyatt Terraces Hotel and the Nevada Hotel, underneath whose rubble were buried many vacationers and convention delegates.

Within minutes after the earthquake struck, mining workers from the nearby Benguet Consolidated Mining Company and young cadets from the Baguio-based Philippine Military Academy rushed to the scene to begin what was to become days of rescue work. With nothing but picks and shovels, they hacked their way through the wreckage to rescue the survivors and pull out the dead from under the ruins. A few days later, they were joined by crack rescue teams from Switzerland, France, Japan and the US. The number of known casualties in Baguio, mostly from the Nevada and Hyatt Terraces hotels, numbered 1102 injured and 325 dead. Among the fatalities in the Nevada Hotel crash were participants in a conference of representatives of non-governmental organisations (NGOs) from all over the country. Just a few metres away, the Hyatt Terraces Hotel yielded a survivor on the 12th day of rescue operations. He managed to survive for that long under the rubble by the sheer strength of his will to live.

For a time after the tremor, travel from Manila northwards became difficult because major arteries in the national highway system were cut. These included two historic roads: Kennon Road and Dalton Pass. Luzon's longest span, Carmen Bridge in President Ramos' home province of Pangasinan, collapsed into the dry Agno river bed, looking like an ostrich with its head buried in the sand.

The physical damage wrought by the 1990 quake, however, was nothing compared to the emotional toll it exacted on those who lost their livelihood, property and, most especially, loved ones.

The Pinutabo eruption

We had barely finished rebuilding from the devastation of the 1990 quake when Mt. Pinatubo, dormant for the past five centuries, erupted and spewed ash clouds 20 to 40 km high, covering nearly half of the Philippine archipelago in a blanket of whitish volcanic ash and depositing ash as far as Cambodia.

Our geoscientists have reason to suspect that the 1991 eruptions of Mt. Pinatubo might have been hastened by the 1990 earthquake. Ground shaking was reportedly severe in the Pinatubo area during the earthquake. Three weeks after the tremor, the social workers and local peoples living in the northwest flank of the volcano reported audible rumbling sounds, cracks and increased steaming from pre-existing thermal areas. These were earlier

thought to be just continuing aftershocks of a strong tectonic earthquake and heavy rains in the area and that they were without volcanic significance.

With the benefit of hindsight, our scientists now surmise that the 1990 northern Luzon earthquake could have hastened the maturation of the Pinatubo volcano.

Effects of the eruption

Meanwhile, international savants say the eruption of Mt. Pinatubo is the worst natural disaster worldwide in 100 years. They added that its eruptions registered perceptible cooling effects on global temperatures, offering a welcome relief from the irreversible trend of global warming.

Ashfall and mudflows from Mt. Pinatubo have killed or injured at least 800 persons and directly affected the lives of 1.5 million people in four central Luzon provinces. These include:

- Pampanga, the economic centre of the region and where Angeles City, the former site of the US Clark Airbase, is located;
- Tarlac, the home province of former President Corazon Aquino;
- Zambales, where the city of Olongapo, former site of the biggest US naval base, is located; and
- the historic province of Bataan.

Had it not been for the timely alert bulletins issued by the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the early evacuation of those living near Mt. Pinatubo, many more would have been killed by the eruptions.

Continuing lahar flow

The Pinatubo eruptions triggered one of the most massive human evacuations in our history, as entire communities had to be brought to safer ground. The recurring voluminous flows of lahar altered in a rather bizarre way the physical landscape of the central Luzon region and caused extensive damage to infrastructure, agriculture and commerce.

The ashfalls and the deadly flow of rain-mobilised pyroclastic material have buried farmlands and populated areas by as much as 30 feet (9 metres). Our local scientists predict that alteration in the hydraulic regime of rivers and streams is also inevitable due to the filling up of river channels by volcanic debris.

And because large volumes of loosely consolidated pyroclastic materials still remain in the upper and middle slopes of the Pinatubo volcano, we will have to contend with the continuing threat of lahar flows for at least the next five to ten years.

These two major natural disasters wreaked havoc on the Philippine provinces that accounted for a major percentage of our country's gross national product. The destruction of industrial, agricultural and business establishments caused massive displacement in the economy of the affected areas, as well as that of the entire country.

The task of reconstruction

It was imperative that the affected areas be rebuilt as soon as possible and their productivity restored.

The task of reconstruction, however, was not an easy one for us. We had to face two serious limitations: one, in terms of experience in dealing with natural calamities of such nature and magnitude; and two, in terms of funding the logistics, considering that the 1990 earthquake and the 1991 eruptions of Pinatubo took place just when our country was on the verge of an economic take-off.

Dealing with different disasters

In the Philippine reconstruction experience, therefore, the primary issue was how to determine our priorities in the utilisation of scarce funding and logistical resources.

That was a less difficult task for the post-earthquake reconstruction efforts, since the tremor was a one-time event, so to speak. It was relatively easy to mount a good estimate of what needed to be done and how much it would cost to do it.

The Pinatubo event, on the other hand, remains an open-ended hazard. The seriousness of the annual ritual of destruction depends on the vagaries of weather conditions. Despite the fact that we expect no primary eruption for the next few centuries, secondary hydrothermal explosions still occur. We expect the landscape of central Luzon to continue to be altered by the annual downhill surge of mud from the lahar deposits, which usually occurs during the rainy season in the second half of the year.

I was privileged to have served in the Presidential Task Force formed to oversee the rehabilitation efforts after the two disasters struck. I was named Chairman of the Presidential Task Force for the Rehabilitation of the Earthquake-damaged Areas by former President Corazon Aquino. Later, as Secretary of Public Works and Highways, I was part of the Mt. Pinatubo Task Force, which evolved into the Mt. Pinatubo Commission.

Learning from natural disasters

Our experience in the reconstruction efforts brought to the fore several important lessons in dealing with disasters of major proportions and varying nature.

The first is the wisdom of mobilising human and material resources in systematic phases.

Secondly, the experience showed that what may be scientifically and technically rational solutions may not necessarily be politically and socially acceptable.

Thirdly, and a consequence of the second lesson, local community cooperation and participation, from evacuation to reconstruction, is needed.

Fourthly, early-warning systems, as well as education of the public on how to deal scientifically with natural disasters, are important to mitigate losses in terms of physical infrastructure and human lives.

Finally, the role of the political leadership is vital, both at the national and the local levels.

Government response

Our first lesson was on the wisdom of mobilising human and material resources in systematic phases.

With the creation of the Presidential Task Force for the Rehabilitation of Earthquake-damaged Areas came instructions from then-President Corazon Aquino to have a clear differentiation between rescue and relief work overseen by our National Disaster Coordinating Council and the next phase of work, which was purely rehabilitation, and finally long-term reconstruction and development.

As a result, we outlined three stages of government response following the quake: the first was rescue and relief; the second was rehabilitation; and the third was the longer-term reconstruction and development work.

While all three were necessarily interrelated, the differentiation augured well for better management and public accountability. Most important, the approach helped us deal with the issue of priorities in the allocation of funding and logistical resources. The phases of work served as a framework for determining what must be done first and to what extent.

Our work was subdivided into five areas:

- roads and bridges formed one major area of concern;
- other vital infrastructure, which included telecommunications, power and water;
- livelihood and emergency employment;
- social services, which included psychological rehabilitation and health services; and
- peace and order.

Funding requirements

To undertake the reconstruction work on the earthquake-damaged areas, we estimated that we needed at least P10 billion, or roughly US$ 400 million (at P25 to US$1).

Our national coffers were not ready to contend with such an emergency. It is in view of this that we appreciated a second important lesson: that international support, in terms of funding and technology-sharing, was indispensable.

To help us raise the needed amount, the international community held a pledging session from which US$ 500 million in grants and soft loans was raised.

With this amount and the local counterpart funding, we undertook a total of some 9030 public works projects and directly assisted 146,769 individuals who suffered from the aftermath of the quake.

Support from various sources

The efficient utilisation of international and local funding support for the rehabilitation of the quake-damaged areas depended much on the support of the national and local leadership.

Former President Corazon Aquino was nominally in charge of the rehabilitation programme, with the Task Force reporting directly to her. The Philippine Congress established a committee that convened regularly to monitor the progress of the rehabilita-

tion work and to ensure that the funds were properly applied.

The private sector also had a critical role to play. NGOs, currently a major social force in the Philippine countryside, helped our government in the identification of priority rehabilitation projects, particularly those in the areas of livelihood and social services.

Critical role of communities

The participation of local communities, however, became even more important in the Pinatubo experience. This was because evacuation of entire communities had to be undertaken actually in the wake of deadly lahar flows, which rendered whole neighbourhoods uninhabitable.

Moreover, it was in the Pinatubo experience that we realised the all-important fact that there could be situations where scientifically and technically rational solutions may not always be politically and socially acceptable.

Consequently, consensus-generation at the local community level became critical to the decision-making process on the engineering interventions pertaining to the downward sea-bound flow of volcanic and pyroclastic materials. For example, one of the questions that confronted the managers of the Mt. Pinatubo rehabilitation programme was how to deal with the lahar flow. Some advocated continuing engineering interventions such as dikes and canals. Others, including international experts, underscored the need to allow the lahar flow to take its natural course. Both courses of action, however, would always put some communities at a disadvantage. There was, therefore, the inevitable clash of preservation instincts among affected communities, thus putting to test the consensus-generation mettle of our rehabilitation managers.

After a long series of difficult negotiations among representatives of the affected communities, the local officials and the rehabilitation managers, during which the various alternative measures and their potential consequences were painstakingly explained, a general agreement was reached whereby necessary protective dikes would be constructed to save the areas still free from lahar inundation in order to minimise the damage and contain it within already affected areas.

Science education

Another important lesson we have had is the need to upgrade the local residents' scientific understanding of natural hazards. To a significant extent, superstitious beliefs have stood in the way of disaster-preparedness because some residents of Pinatubo, for example, have chosen to ignore scientific warnings in favour of folk beliefs. We remember that, despite the intense warnings of the forthcoming eruption, some local peoples refused to leave Pinatubo because of their spiritual belief that their god, who resided within the volcano, was "merely angry".

Early on, it became quite clear that it was necessary to educate the local residents on both the short-term and long-term effects of the Pinatubo eruption and the further potential risks that the recurring lahar flows continued to pose to the nearby towns and communities. Constant briefings were also given for members of the media to keep them updated on the hazard situation.

Recovery and growth

These calamities have not dampened the spirit of our people in these areas, a fact evidenced by the rise of new infrastructure and renewed business activity.

Today, Baguio City is back on its feet and has resumed its role as a popular international tourism destination. Dagupan, a sea of mud after the liquefaction experience, is practically a new city, with roads, drainage systems and public buildings better constructed than those before the quake. All the damaged bridges have been restored. There are hardly any traces left of the killer tremor except people's memory of those who perished in the disaster.

In the face of the continuing and difficult consensus-seeking process that accompanies the ongoing mitigation and rehabilitation efforts, the major regions affected by the two natural disasters have been designated as critical growth areas. Northern and central Luzon are important entry points for international investors and their progress is expected to bring downstream effects to the other parts of the country.

Three specific development sites are worth mentioning. The first is Subic. Located in the Pinatubo-affected province of Zambales, this was the former home of the largest US naval base outside of the

American mainland. Subic today is being developed in a pattern similar to that of Hong Kong. Its developers envisage an area dedicated to light- and medium-scale industries, as well as a portion similar to Hong Kong's central business district. The state-of-the-art facilities left behind by the Americans, who restored these base areas back to the Philippines in 1991, are making it easier for international investors to establish their business inside Subic. Designated as a special economic zone that offers tax incentives to investors, Subic also boasts of world-class tourism facilities, duty-free shops and excellent maritime port facilities.

Meanwhile, in the neighbouring city of Angeles, development frenzy is taking place in another former US facility, Clark Airbase. Its runway, once clothed with thick ashes that were spewed out by Pinatubo, has been restored, together with the other vital aviation facilities once used by the US Air Force. Clark has been designated as the site of the Philippines' future premiere international airport, a development that has attracted a lot of foreign investors to establish business there. When the Philippines celebrates its 100th year of independence in 1998, Clark will be the site of the major festivities.

A third major development area lies in the City of Baguio. Called the Summer Capital of the Philippines because of its year-long cool climate, Baguio was one of the cities most seriously damaged by the 1990 earthquake. Days after the major tremor, its dazed residents camped out of their homes, fearing consequences of the aftershocks.

Baguio is the site of Camp John Hay, the erstwhile rest and recreation area of Asia-based US servicemen. This place is now being transformed into a world-class family vacation resort, a move that has attracted large Asian conglomerates to put in their money and generate employment for the victims of the 1990 quake.

The people in the areas affected by the two major calamities have learned to accept the reality that there is a constant threat of natural disasters similar in nature and magnitude to the 1990 earthquake and the 1991 eruption of Pinatubo. This acceptance, however, has been tempered and made wise by the realisation of the imperatives of proper disaster management and mitigation.

These two world-class natural disasters have inspired our policy- and decision-makers, scientists, engineers and development planners, as well as a hitherto complacent citizenry, to devise appropriate measures to live safely with natural hazards. The lessons gained from the reconstruction efforts have in fact bolstered our confidence and equipped us to deal with similar disaster-causing phenomena in the future. Volcanic eruptions and other natural hazards may no longer be mere postcard events after the 1990 northern Luzon earthquake and the 1991 eruptions of Mt. Pinatubo. In addition to their photogenic attractions, they serve as a reminder that Planet Earth is very much alive and still challenges scientists, engineers, mitigation planners and the public in general to find ways to confront natural hazards and mitigate their effects.

Conclusions

Following the northern Luzon earthquake of 1990 and the eruptions of Pinatubo volcano in central Luzon in 1991, the Philippine Government faced the difficult task of determining priorities in the utilisation of its scarce funding and logistical resources for the reconstruction of the damaged areas.

The task was less difficult in the case of the earthquake aftermath since that was a one-off event. It is more difficult with the aftermath of the Pinatubo eruptions because it is a continuing threat, the nature and magnitude of which are dependent on the vagaries of weather conditions during each year after the initial eruptions.

Both disasters brought to the fore the wisdom of adopting well-defined phases in the reconstruction work, generating strong support from the affected communities and having good political leadership. The latter becomes even more important in cases where solutions that are scientifically and technically sound are not necessarily socially acceptable.

Both experiences also underscored the need in the Philippines for well-established early warning systems, and the education of residents in disaster-prone areas in order to adopt a non-superstitious and more scientific view of hazards.

These disasters have inspired policy- and decision-makers, scientists, engineers and development planners to devise appropriate measures to live safely with natural hazards.

Insurance and Financial Markets 1

Handling risk and claims after a catastrophe — An engineer's perspective

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Strategies for handling risk assessment and the resultant claims from an earthquake in the heart of the Wellington region are presented. These are discussed from experience with several major events of the past few years — the Richter magnitude (M7.1) San Francisco earthquake of 1989, the M8.1 Guam earthquake of 1993, the M6.7 Northridge earthquake of 1994, and the M6.9 Hanshin earthquake of 1995. The strategies are based on extensive and direct involvement with risk assessment and damage predication before and after the Northridge earthquake and direct involvement with claims after the other disasters.

The Northridge earthquake is the event most similar in recent history to a large earthquake in the Wellington region. Except for major (high-rise) commercial structures, the structural characteristics of Wellington's buildings are very similar to those of Los Angeles. The high-rises can be compared to those of Guam, where seismically designed reinforced-concrete frames were the predominant construction.

Damage in Los Angeles, and more recently in Kobe, was much more extensive than expected or predicted by the insurance industry, and damage to selected classes of modern buildings exceeded the worst expectations of structural engineers. A contributor to these results was the record high ground motions experienced. In Los Angeles, the total direct loss of about US$20 billion and an insured loss exceeding US$12 billion (much of it to earthquake-resistant residential construction) constitute the largest insured losses in US and world earthquake history, excluding major fire following the shaking. Similar, pro-rated scenarios are expected for the Wellington earthquake, unless the lessons of very recent history are carefully studied and applied.

Introduction

The staggering magnitudes of losses from recent natural catastrophes have caused the insurance industry worldwide to re-examine its practices of assessing risks. The unprecedented insured losses caused by these disasters have also prompted the industry to reassess its practices, from underwriting to reinsurance, loss control, claims handling and pricing of products.

During the last 24 years, I have participated in the investigation of, and sent engineering teams to, 60 damaging earthquakes and several large windstorms and floods throughout the world, including most significant earthquakes to affect modern industrialised areas. Just in the last two and a half years, that includes the three largest economic losses due to natural phenomena in modern history (Table 1).

The Wellington earthquake scenario

My comments will reflect some of the key lessons learned from a technical and an insurance perspective in the context of the scenario specified for this conference. Because of experiences in the Northridge and Kobe areas, which are directly applicable to Wellington in specific and New Zealand in general, I shall take the liberty to extend some of the key details of the assumed scenario, which was written long before the Hanshin earthquake, and shortly after the Northridge event but before its lessons were fully developed.

The scenario specified for the Wellington region is based on a Richter magnitude event of 7.5, centred on the city of Wellington. The severely affected area roughly encompasses the North Island south of Palmerston North through the South Island, roughly north of Nelson. This is the approximate region affected by assumed or calculated Modified Mercalli

Table 1: The three largest economic losses from natural hazards

Event	Date	Direct damage (US$ billion)	Insured loss (US$ billion)
Hurricane Andrew, Florida	Oct. 1992	30	15.5
Northridge earthquake, Los Angeles	Jan. 1994	20+	12+
Hanshin earthquake, Kobe	Jan. 1995	100-200	3-6

Intensities of 7 (MM VII). Typically, minor damage will occur over a much larger region, but pockets of moderate and even severe damage will occur in this area due to specific local characteristics such as poor soils, concentrations of value, such as older industrial facilities, etc.

The estimates of damage for the scenario are based almost entirely on data originating prior to the Northridge event, and rely heavily on data from the 1987 Edgecumbe earthquake (M6.2). Sparse and highly unreliable data exist for New Zealand from previous earthquakes, but some of these data are also applicable. In California, we faced a similar situation prior to the Northridge earthquake. The data used for various scenarios, including those of insurance companies, were primarily from earthquakes centred outside of metropolitan areas. Several recent California events were centred near or in metropolitan areas; however, they were either too far (e.g. Loma Prieta earthquake of 1989 (M7.1) and Landers-Big Bear earthquakes of 1992 (M7.6 and M6.7)) or were too small and, therefore, did not produce reasonably strong or long ground motion (Whittier Narrows earthquake of 1987 (M5.9)). Numerous other earthquakes throughout the world produced valuable data but it was not known how well such data could be applied to scenarios for large metropolitan areas. The Coalinga earthquake of 1983 (M6.7) and the Edgecumbe earthquake of 1987 (M6.2) are two such events. Both caused severe damage within very small and remote areas, and affected industrial and housing stock that is typical of both countries. In both cases, a limited number of structures were located right on top of the causative fault and experienced extremely strong ground motion, but only for a few seconds — typically less than 10 seconds.

The Northridge earthquake dramatically altered and extended our database on the performance of the building stock of a metropolitan area. For the first time, we were able to capture valuable engineering data from a well instrumented event within a major metropolitan area. Those data, particularly in terms of damage ratios, are particularly applicable to Wellington and New Zealand because of the great similarities in buildings and their design across the entire spectrum, from wood-frame residential construction to commercial building construction, to industrial and infrastructure construction. Hundreds of thousands of structures were affected and tens of thousands of structures suffered damage — from total to minor. The earthquake lasted between 10 and 15 seconds, affected a relatively new region of Los Angeles, built-up in the last three decades, and caused the largest insured loss in modern earthquake history.

The recent Hanshin earthquake was even more dramatic. Kobe, a modern Japanese city, generally and erroneously believed to be highly earthquake-resistant and built to the latest standards of earthquake-resistant design, suffered a staggering loss. The damage data are still being processed, but our observations, as well as several preliminary technical reports, indicate that about 100,000 buildings were severely damaged and about 30 to 40 percent of the central business district of Kobe was destroyed. Hundreds of commercial structures, some of them new and built to the latest codes, collapsed. Many, of course, survived with negligible damage. The earthquake lasted between 15 and 20 seconds.

The technical and insurance data gathered in Kobe and Northridge, and in all other events discussed above, are extremely valuable for use in scenarios such as the present one for Wellington. However, the data are inadequate in that they require technical extrapolation for larger events. At this time we simply do not have experience with a Richter magnitude 7.5 earthquake in the middle of a modern metropolitan area. Our experience extends only up to magnitude 6.9 (the Richter magnitude of the Hanshin earthquake) and up to about a maximum of 20 seconds of strong shaking under such an area. An earthquake with a magnitude of 7.5 will affect a much bigger area than the ones with which we have experience, and the strong ground motion may last well over 30 seconds — almost twice as long as the motions that affected the Los Angeles and Kobe regions. Earthquake damage increases with the duration of shaking. The relationship is not linear

but increases in an exponential manner with increased duration.

I have made the above comments in order to place the Wellington scenario in the context of our current knowledge of what happens to the building stock of a city in a strong earthquake. When we make a specific set of assumptions, based, of course, on the best available current knowledge, we arrive at a specific, deterministic scenario. The assumed scenario, I believe, is a reasonable one. However, it is one of many different possible scenarios, and we must recognise it as such. The earthquake may be larger, the duration of shaking may be longer, the damage may be much worse, or perhaps, with some luck, much less. In other words, we are faced with a set of probabilities and, ultimately, only probabilistic analyses will give us a better understanding of what we may experience in the future. At this point, I do not believe that we understand adequately the probability of when the assumed earthquake may happen, but we are beginning to understand what may happen, given actual scenarios such as those in Los Angeles and Kobe.

The insurance industry and earthquake risk

Since the financial disaster that befell the insurance industry following Florida's Hurricane Andrew of 1992, the industry has been in a frenzy to quantify its existing risks — from hurricanes, floods, earthquakes and other natural phenomena. That hurricane, as well as the results of the Northridge earthquake, showed that industry risk models were totally inadequate. The results of individual insurance company models were off by more than an order of magnitude. As a result, there has been a rush, often frantic and misguided, to create appropriate software in order to quantify the risk. Unfortunately, it is a lot easier to develop authoritative-looking computer models, based on the latest geographic information systems (GIS), than to develop technically adequate and accurate software models for use by nontechnical people from the insurance industry. I shall try to place the Wellington earthquake scenario in the context of an insurance industry in a state of dramatic change.

I do not believe that at this time adequate software models for the determination of earthquake risk of insurance and reinsurance portfolios for New Zealand exist, either in New Zealand or elsewhere. That applies to personal lines insurance portfolios, to commercial lines portfolios, and to other specialised portfolios, such as highly protected risks or specific industry risks. Any reasonable model of a Wellington portfolio needs to have, at the very least, the following:

- accurate maps of soils and other appropriate geology (these are available);
- accurate and adequate property location information (the data are available, but have they been collected and put into a GIS in an electronic, or other appropriate format?);
- accurate and adequate data on the critical structural characteristics of all types of buildings and other critical characteristics of industrial or other facilities (again, the data are available, but have they been collected and put in an electronic, or other appropriate format?);
- adequate and reasonable damage functions for each category of structure important to the portfolio (such damage functions have been assembled for some types of typical structures for New Zealand, i.e. single family residences, but, as discussed in the text above, the curves do not currently represent data from the most important data sources such as the Northridge earthquake, nor do they represent damage from magnitude 7.5 earthquakes from actual and statistically adequate experience).

Several portfolio analyses have been performed in and for New Zealand. These have been done on the basis of engineering analysis and judgment, or other similar methods, as discussed elsewhere in the proceedings, but without the benefit of the attributes discussed in the four points above. They represent a start, but do not yet define in any technically complete manner the risk situation in New Zealand and in Wellington.

Therefore, it is my impression that the typical New Zealand insurance and reinsurance company is in about the same state of comprehending its earthquake risk as was the typical company in the USA and elsewhere before the industry debacle in the Northridge earthquake. Based on what happened in Northridge, it is safe to assume that whatever happens in the scenario earthquake in Wellington will dramatically surprise the insurance carriers involved, unless, of course, they take the necessary steps to adequately determine their risks before the earthquake occurs.

Insurance industry losses and performance in the Northridge earthquake

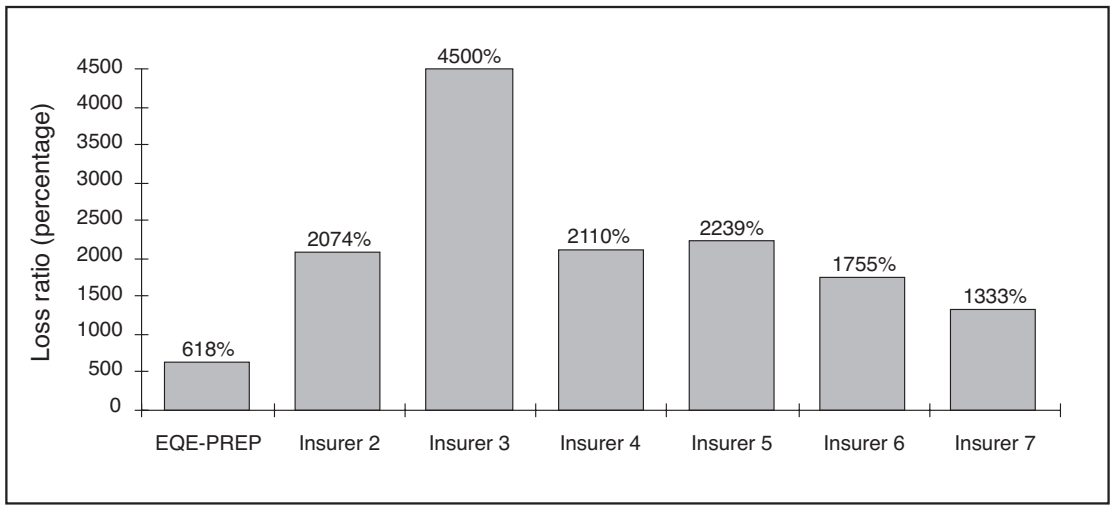
As mentioned above, the lessons flowing from the January 1994 Northridge earthquake in the Los Angeles metropolitan area are numerous, are still emerging, and have serious implications for those preparing for a similar catastrophe. While only a Richter magnitude 6.7 event, the fact that it was a "direct hit" centred in a densely populated, wealthy residential and business community, produced extensive damage to a wide variety of structures and caused a loss in excess of US$20 billion, with an insured loss currently of more than US$11.2 billion (Property Claim Services, Rahway, New Jersey, 15 March 1995). This earthquake is the event most similar to a large earthquake in the Wellington region. Except for certain major commercial structures, such as very tall highrises, the structural characteristics of Wellington's buildings are very similar to those of Los Angeles.

With Northridge proposed as the living laboratory, I would like to confess that my "engineer's perspective" has been broadened, if painfully so, by this destructive event. In 1989, my consulting engineering and management consulting firm decided to test its ideas on risk assessment and management by entering the insurance business as a residential earthquake risk underwriter in a program entitled Preferred Residential Earthquake Protection, or PREP. In the face of many frustrations in the California marketplace, we managed to have some 20,000 homes insured throughout California at the time of the Northridge event. Prior to that event, California experienced several destructive earthquakes: in San Francisco in 1989 (M7.1), Los Angeles in 1990 (M5.5) and 1991 (M5.8), near Palm Springs in 1992 (M6.1), near Eureka in 1992 (M7.0) and east of Los Angeles near Landers and Big Bear in 1992 (M7.6 and 6.7). In all of these events our software predicted levels of damage, immediately after the events and before any claims had come in, consistent with our later experience. Northridge, however, was very different. While we sustained a heavy loss of about US$21 million with our tiny market share of about 0.7 percent, we did very well relative to the other major insurers in the marketplace. As the loss ratio comparison (gross loss to annual premium) of Figure 1 shows, the EQE-PREP program loss ratio is about one-third of the industry average. The numbers are further skewed because we estimate that the EQE-PREP premiums are about 60 percent of the market average, which in itself contributes to a higher ratio. We believe that this very favourable result stems from three areas that we consciously attempted to manage during our four startup years: risk selection, portfolio management and coverage design.

I will explore very briefly each of these elements of overall earthquake risk management, emphasising aspects that should be relevant to developing strategies for better avoiding, insuring, and managing a similar Wellington event.

Risk selection. As discussed earlier, in order to understand the risk, we need to know the risk location exactly so as to determine the soil beneath it and the distance of the risk from known and suspected faults. The latter distance is necessary in order to determine the severity of the shaking, which is a function of distance from the source, the fault, and of the soil, or geology, on which the risk is located. Our criteria stipulate that locations above a certain intensity of shaking are unacceptable risks, given the premium structure. Risk selection also involves the age of the property. Our criteria stipulate that properties older than a certain age are unacceptable, unless the property has been strengthened to more recent building code criteria. For example, a wood-frame home constructed in 1890 is unacceptable, unless it was recently strengthened. We have found that even in a mandatory insurance environment, it is necessary to price according to risk in order to create an individual and societal incentive for risk avoidance (do not build here, etc.) and risk improvement (retrofit the older home, etc.).

Portfolio management. Through the use of our software, we continuously review the geographical spread of risk of the portfolio. The highest loss ratio in the Northridge earthquake, as illustrated in Figure 1, was experienced by Insurer No. 3, whose portfolio was very heavily concentrated in the strongly shaken area of the earthquake. Even though we were unaware of the existence of the Northridge Blind Thrust Fault, our portfolio management would have precluded a heavy concentration of risk such as that experienced by Insurer No. 3. That would have been done through the specific management of offers in specific areas where concentrations begin to develop. However, in a mandatory insurance environment, the value of portfolio assessment may be in buying excess reinsurance, planning post-disaster support, etc.



EQ MARKET SHARE	0.70%	23.40%	3.80%	11.80%	12.90%	1.80%	3.40%
LOSSES (millions)	21.0	2530.0	900.0	1300.0	1500.0	165.0	240.0
EQ PREMIUM (millions)	3.4	122.0	20.0	61.6	67.0	9.4	18.0

Notes:
1. Commercial premiums and losses included.
2. Some premiums do not include automobile lines (i.e. “20th Century”)

Figure 1: Northridge earthquake loss ratios as of 27 January, 1995

Coverage design. The relative success of the EQE-PREP program is partly due to careful design of the offered coverage — including such features as a stand-alone policy, no frills coverage (such as various minor appurtenant structures or specific types of contents), and a high deductible, also called “excess” in New Zealand. The policy, in effect, is designed to be a disaster policy, and to come into effect only if serious damage occurs.

Even with a loss ratio one-third of the industry average, our losses dramatically exceeded our expectations. Based on experience with 60 earthquakes, I expect that the same factors will come into play after the scenario earthquake for Wellington.

The epicentre of the Northridge earthquake was beneath the San Fernando Valley of Los Angeles, radiating seismic energy almost directly at the buildings and structures on the ground surface. The result was unusually high ground-motions, with peak ground accelerations approaching near record levels for sustained ground-motions in a populated area. Accelerations approached 1*g* at several locations in the valley. Comparable accelerations would be expected in and around Wellington in the event of a magnitude 7.5 earthquake. The acceleration in Kobe was about 20 percent lower.

The California Governor’s Office of Emergency Services (OES) retained EQE immediately following the earthquake to estimate the total monetary value of property damage from the earthquake. We estimated, within 36 hours of the event, that value to be somewhere between US$15 and $20 billion. That estimate agrees very well with the current estimated direct loss of a little more than US$20 billion.

Insured loss in Northridge: estimated versus reported

While loss-estimation technology provided an accurate estimate of total property damage, the picture is different regarding estimates of the insured loss. Table 1 presents some of the best available information regarding some of the larger reported industry losses.

For Northridge, these losses are clearly very large and represent a significantly larger fraction of the total damage than industry experts expected. That is, since earthquake coverage is typically only accepted by a minority of insureds, with substantial deductibles, the common wisdom is that an earthquake’s insured losses would normally be a modest fraction of total losses, compared with other hazards like hurricane or conflagration (where insurance coverage is often almost total). That insured losses are

about 50 percent of the total loss in the Northridge event has come as something of a shock and has very dire implications for the industry should a truly great earthquake occur in California or other regions of the world where coverage is high.

In the confusion of the days following the Northridge earthquake, there was a natural desire to understand the event's financial implications for the insurance industry. Several estimates were published by various consulting organisations, ranging from a low of US$0.6 billion, to a high of US$2.3 billion. As time went on, not only did the reported claims increase, but so did the estimates. EQE's 18 January estimate was based on the statewide average percentage of personal and commercial properties with earthquake coverage (about 25 percent). Shortly thereafter, when EQE employed the Los Angeles regional average of 35 percent and made minor technical corrections (e.g. earthquake magnitude increased from the initial M6.6 to M6.7), the estimate was increased to ranging between US$2.5 billion and US$3 billion. In April, A M Best issued an estimate of US$4.7 billion (US$5.3 billion, including loss adjustment expenses), based on a 96 percent response rate survey of 148 companies, and estimated that this could grow to as much as US$6 billion, including loss adjustment expenses. Also in April, Property Claim Services (PCS) estimated US$4.5 billion, 70 percent of which was from personal lines and 28 percent from commercial lines. Finally, the California Department of Insurance reported on 18 April that its March Data Call had indicated an industry loss of US$4.7 billion. Losses, now about a year later, have grown to more than US$11.2 billion and will be larger.

While the initial estimates were substantially less than the current reported insured losses, several observations are relevant and applicable to the Wellington scenario. Firstly, loss-estimation technology and the traditional method of extrapolating initial reported claims produced about the same results (and both were substantially less than the actual losses). Secondly, loss-estimation technology was very responsive, providing insured loss estimates (as well as the damage estimate for the California Governor, which was used immediately to support a request to the US Congress for relief funds) within one or two days after the event, while the traditional method took much longer. Traditional methods based on extrapolating early claims naturally involve a time lag and, therefore, potentially substantial error. Loss-estimation technology seeks to overcome these shortcomings through direct estimation of damage and insured loss. Nevertheless, loss-estimation technology fell short for this event because of several factors.

Factors in underestimating insured loss in the Northridge earthquake

Loss-estimation technology involves analysis of hazard (seismology and geology, in the case of earthquakes), vulnerability and value at risk, all of which are uncertain to varying degrees. Within these three aspects, there were a number of factors contributing to the low initial estimates of insured loss. Unless carefully studied and well understood, the same factors will contribute to underestimating predicted or actual losses, should the Wellington scenario earthquake occur. These factors and their relative impact on the overall estimates included the following:

Inaccurate initial seismologic data. The event was initially estimated at M6.6, which was corrected several weeks later to M6.7, and the epicentre location was initially placed somewhat farther north than it actually was. These are typical changes in earthquake parameters following a strong earthquake. The effect of the magnitude change was minor. However, the location correction placed the earthquake more directly under the populated area and closer to central Los Angeles, and had a significant impact on estimates.

Ground motion estimation. In simple terms, earthquake faults can be grouped as (a) moving sideways to each other (strike-slip), (b) moving toward each other (thrust or reverse), (c) moving away from each other (normal) or (d) combinations thereof. Most faults in California, as well as the Wellington fault, are predominantly strike-slip, and initial loss estimates were based on ground motions calculated assuming strike-slip faulting. Thrust faulting such as in the Northridge event, however, has been observed only recently to produce earthquake motions significantly greater than in strike-slip events of comparable-magnitude. The Northridge earthquake produced the highest ensemble of ground motions ever recorded in a large urban area. The result was a major underestimation of ground motions in the initial estimates. Estimates were low because neither the thrust versus strike-slip nature of the event nor the fact that this particular thrust event was anomalously high was recognised. This underestimation of ground motion led to significantly low estimates of

the initial losses. Up to this time, we do not have good strong-motion data from the Wellington area portion of the Wellington fault. Since the fault appears to have thrust motions associated with it, it remains to be seen what types of ground motions will be generated in the scenario event.

Underinsurance. Underinsurance (which effectively lowers the deductible) is a common problem in all kinds of insurance, often resulting in underestimating losses. This was a significant problem in the 1991 Oakland hills, California, fire, as well as in the Northridge earthquake. Besides the usual problems of the insured value not keeping up with inflation, a significant problem in Northridge (and in the 1991 fires) was the cost associated with hillside construction. Because, as in the Wellington area, the San Fernando Valley is ringed with steep slopes, a substantial number of affected homes had above-average repair costs. High repair costs resulted from the difficulties of working on steep slopes as well as slope failures causing above-average damage, particularly to foundations, which would have had little or no damage had they been on level ground.

Adjusting practices. Adjusting practices such as paying for entire new interior finishes when there is relatively minor cracking, or paying for a chimney to be rebuilt as structurally reinforced, as mandated by the building department, when the unreinforced chimney is only cracked (i.e. costs to comply with increased code requirements) may have played a significant role in insurance claims being larger than estimated. That is, a deficiency was found in most current loss-estimation technology algorithms in that they estimate actual damage rather than insured payment. The overall impact of this aspect is difficult to assess, but ranges from moderate (in commercial lines) to perhaps major (in personal lines).

Deductibles. Not only did adverse selection exist to a greater than recognised degree, but a number of homes had a less than 10 percent deductible on their earthquake coverage. For decades, earthquake cover was offered in California with a 5 percent deductible. Beginning about a decade ago and accelerating with the 1989 Loma Prieta earthquake, industry practice tended to shift away from a 5 percent to a 10 percent deductible. Data on the percentage of homes with a less than 10 percent earthquake deductible were not widely available or used in the initial loss estimates, which appear to have been all based on a universal 10 percent deductible. We now know that more than a few homes had a less than 10 percent earthquake deductible. The effect of this is difficult to assess, but is probably minor to moderate. This problem is discussed further later on because of the special problems due to the very low deductibles for homes covered exclusively under the policies of the EQC of New Zealand.

New damage data. Most of the loss estimates were based in part on a compilation of expert opinion about earthquake vulnerability of various kinds of construction (based on a study by the Applied Technology Council of California in 1985, ATC-13), with little empirical verification. Even when significant effort had been expended on collecting real data on building seismic vulnerability, such as by EQE in its numerous post-earthquake damage surveys, the relevant events that had occurred paled in comparison to the sheer number of buildings affected in the Northridge event. While many of the kinds of damage came as no surprise, certain types of steel buildings were revealed for the first time to have significant earthquake vulnerabilities, which had been previously unsuspected. A great number of the taller buildings in Wellington employ a framing system called ductile-concrete-frame. The system has not yet been tested adequately under very strong ground motions, and it remains to be seen how this type of new construction performs under real, strong and long ground motions. We could have another surprise.

Another aspect that had not been previously appreciated was the hidden nature of earthquake damage. That is, while fire, flood or wind damage is essentially surface-acting and thus readily apparent on inspection, earthquakes affect mass. The result is that interior and initially hidden parts of structures may be damaged, even though the exterior is undamaged. Insurance adjusters are less experienced with this type of phenomenon. Examples of hidden damage were in residential homes (cracked wall studs behind gypsum board, broken concrete slabs beneath carpeting) as well as major commercial buildings, where steel columns were badly cracked. In these commercial structures, the building generally looked fine, and the damage could not be observed until interior finishes and fireproofing had been removed. Fifteen months after the Northridge event, in March of 1995, claims are still being filed because of leaking roofs that may or may not have been damaged by the earthquake of January 1994.

While the hidden nature of the damage does not explain the total insured loss, it does explain why estimates have continued to increase with time. The overall impact on total insured losses is difficult to determine, but is probably moderate to major. More importantly, the Northridge event offers an excellent opportunity to collect damage and vulnerability data, which the insurance industry, including that of New Zealand, should not miss.

Short-term inflation. In April 1994, A M Best reported that two-thirds of all claims had already been settled (however, perhaps not two-thirds of the dollar amount). Pressures to settle claims inflate costs because of short-term labour and materials shortages, whereas most loss estimates may be based on more typical labour and materials costs. Early reports indicated that this effect may have increased repair costs by as much as 25 percent for personal lines, but this effect should not have impacted all claims, so that the overall impact is probably less. The impact is estimated as minor to moderate. What the impact will be to an area such as Wellington under a very large earthquake remains to be seen. The ongoing scenario in Kobe may provide valuable information. However, that scenario is also different, as Kobe is only a small part of the much larger Osaka metropolitan area.

The text above attempts to identify factors that might have played a role in the initial estimates of insured loss, based on loss-estimation technology, being substantially less than what was actually sustained. A precise understanding of which of these factors was most crucial to the underestimation requires a detailed analysis (currently under way). However, some insight as to which factors are most important has been gained through our work for individual companies.

Figure 2 shows, for example, a comparison, by zip code, of losses incurred by a large insurer ("Company X") in the Northridge event, with EQE's estimate of losses using loss-estimation technology. These estimates are after-the-fact, and are based on the actual ground motions experienced in Northridge, and Company X's actual portfolio. As such, they filter out three of the factors identified above: (a) inaccurate initial seismologic data, (b) ground motions, and (c) adverse selection.

While there is some uncertainty about the line of perfect agreement, the overall agreement is excellent, with the total estimated losses being within 10 percent of those incurred.

Based on this comparison, we can identify (on a preliminary basis) that the primary factors causing the initial estimates of insured losses to be much lower than those incurred were (a) the very intense ground motions observed in the Northridge event; and (b) the poor understanding, at the time, of the concentration of values at risk (i.e. not recognising existing adverse selection).

David McCormick, one of the senior structural engineers in our San Francisco office, recently wrote a brief article for an in-house publication, concerning his experiences in adjusting losses after the Northridge earthquake. Many of the ideas expressed above reflect experiences such as his, so this article is attached as Appendix 1.

Deductibles (Excesses)

The various problems of deductibles that we have experienced in earthquakes in California can be applied to the Wellington scenario. As discussed above, deductibles in the USA for single-family residences are now typically in the 10 percent range. In the aftermath of the Northridge earthquake, higher deductibles are being offered at a reduced premium. It took an industry disaster to convince the individual companies that earthquake insurance should, in effect, be disaster insurance and not a conveyance for trading dollars to pay for minor

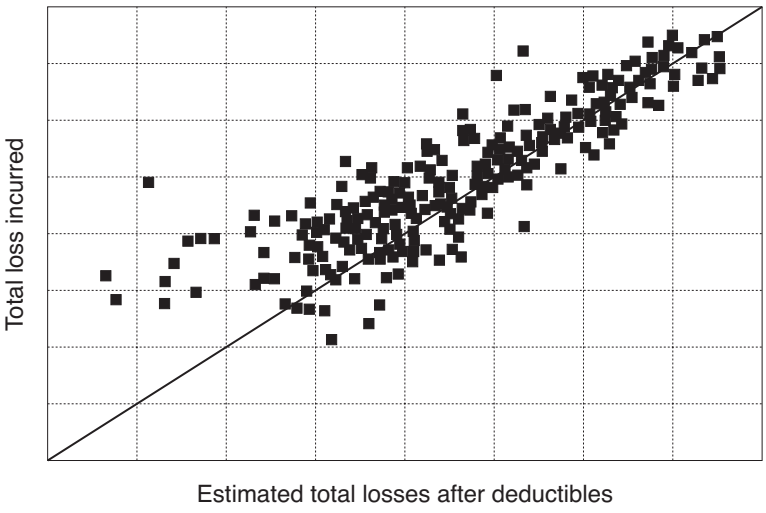


Figure 2: Actual versus loss estimation technology-based estimated losses for Company X, Northridge Earthquake

damage and/or home remodelling in the midst of a disaster area.

The NZ$200 deductible applied by the EQC is ridiculously low and is an invitation for problems in the midst of a disaster. Our experience in California indicates that at this level of deductible almost all affected property owners will submit claims. The current estimates for claims in the event of the Wellington scenario earthquake are low. The scenario states that over 43,000 houses, which is about one-third of the total number of houses in the Wellington area, have damage. EQC expects a further 25,000 claims from outside the Wellington region, on the basis of the total of about 235,000 homes outside the Wellington region that will be affected in some manner by the earthquake. Furthermore, EQC's planning is based on a similar earthquake being the maximum credible event of about 100,000 claims (Middleton, 1995). Our data suggest that, given the very low deductible, there may be more than 125,000 claims in the Wellington area, plus 25,000 to 75,000 from outside the area, resulting in 150,000 to 200,000 claims. Most of these claims will, in effect, be nuisance claims, resulting in high adjusting costs and wastes of valuable resources in the midst of the disaster, when these resources are stretched thin or may be unavailable.

In the Northridge event, our claim and adjusting costs ran at about 5.5 percent of the total sum claimed. The cost was increased somewhat by the attempts of homeowners to pad the damage to get it over the high deductible of 10 percent in order to receive at least some compensation. With a NZ$200 deductible, that problem will not exist. Instead, a large percentage of the claims, probably much more than half, will be minor but will consume about half of the attention of the EQC and its contractors.

I believe that higher deductibles for New Zealand, say 10 percent, will actually be very beneficial for all involved. Low deductibles discourage homeowners from doing anything to reduce their risks. The recent higher deductibles and the lowered availability of earthquake insurance in California have spurred quite a lot of retrofitting (strengthening) of weaker properties — primarily the older housing stock that lacks some of the basic but simple features of earthquake resistance. Many small contractors in California now specialise in strengthening houses, and the costs are quite reasonable. A more recent development is the involvement of financial institutions. Some are offering more favourable loans in order to promote the strengthening of older and/or weaker homes. Lenders are also beginning to require inspection of homes for earthquake hazards when transferring title. All of this is difficult and perhaps impossible with trivial deductibles. I also believe that full insurance is counterproductive and discourages safety awareness. To me, the Armenia earthquake of 1988 (M6.9) is the best example. In effect, all building stock in the town of Spitak was insured under the old Soviet system of state ownership, yet almost all of it collapsed, with very high life losses. The concept of risk was not understood; it was not even considered — in a known earthquake area — because someone else would rebuild.

If ever there is an insurance cover situation needing a meaningful deductible (10 to 15 percent or more of the home rebuilding cost), it is earthquake insurance.

Loss control

Loss control is practised extensively in the area of fire protection. Its application, while obvious, is much less prevalent in the area of loss control for earthquakes. Fortunately, Wellington and New Zealand are among the leading forces in earthquake hazard mitigation and, therefore, loss control. Numerous buildings in Wellington, and now some of the infrastructure, have been and are being strengthened to make them more resistant for future earthquakes.

Loss control for earthquakes needs to become, for the insurance industry, as common as loss control for fires. The principles are the same — but the earthquake issues are much more complex. Our experience in California is that loss control works. Numerous older residential, commercial, and industrial structures and key equipment systems and contents had been strengthened to newer seismic criteria and were subjected to very strong ground motions in the San Francisco area in 1989 and particularly in the Los Angeles area in 1994. In just one example in the Northridge area, a roughly US$10 million investment in the evaluation and strengthening of a large brewery (worth roughly US$1.3 billion) led to a probable avoided loss of more than US$0.5 billion and a trivial business interruption of just four days.

The risk reduction, or loss control, programme that led to this success story was triggered by the lack of capacity for earthquake insurance in the late 1980s. The resultant loss control work dramatically reduced

the company's needs for earthquake insurance and, therefore, its long-term expenditures on insurance. Resources can now be diverted to more loss control. We have witnessed this process now for about 15 years in California. The huge losses from the Northridge event have now spurred many more companies to increase their loss-control activities, particularly for industrial facilities and commercial buildings. An industry is growing in the field of earthquake loss control.

The lack of adequate loss control was painfully obvious in the Kobe area. Little loss control was practised in the area. Very few, if any, older buildings and other structures had been strengthened, despite the lessons from California. The results were devastating, particularly for buildings and other structures constructed in the 1950s to 1970s. The worst performers were low- and mid-rise reinforced-concrete buildings, and particularly those on soft soils. These, too, will be the worst performers in Wellington. Under the stronger ground motions of a M7.5 earthquake, the damage will be worse than in Kobe, unless the practice of loss control is expanded dramatically in the private sector. In this area, the brokerage community can and should play a major role.

Major claims

Through EQE's hundreds of post-earthquake projects, we have gained some interesting experience with major claims — particularly for large reinforced-concrete buildings, large and overly flexible steel-framed buildings, and industrial buildings.

Following a major earthquake in a modern metropolitan area, the claim-adjusting community is overwhelmed by the magnitude of the task at hand. There are two reasons: (a) most adjusters do not have experience with sophisticated structural damage, and (b) most engineers also do not have adequate experience with real earthquake damage.

We have now seen this problem in four recent major events — the 1989 Loma Prieta (M7.1), the 1993 Guam (M8.1), the 1994 Northridge (M6.7) and the 1995 Hanshin (M6.9) earthquakes. Major buildings in each earthquake were judged to be irreparably damaged and were scheduled to be demolished. Some were demolished when, in fact, they could have been repaired at a fraction of the cost of new construction. For example, in just one hotel in Guam, the structure was repaired for about US$2.5 million, and was actually upgraded to the current code requirements for seismic loads after it had been condemned and scheduled for demolition — it would have been an insured loss of more than US$20 million. The owner's engineers and the adjuster's engineers had agreed that the property was a total loss. None of them was from an earthquake region and none had any reasonable experience with earthquakes — it took foresight on behalf of the insurance carriers, with whom we had worked before, to bring in specialists (structural and earthquake engineers) who had designed similar buildings (in California), had repaired similar damage before, and had upgraded similar buildings.

Adjusters and their insurance clients need specialised training to recognise when they need assistance with earthquake damage. The sophistication of the problem is beyond the normal qualifications of the practitioners and that results in additional and unnecessary losses.

Conclusion

The effects of the future great Wellington earthquake can be dramatically reduced if the insurance industry takes an active part in future loss control and in assessing and controlling its own risks. Large earthquakes in California and hurricanes in Florida and Europe and the resulting huge losses have forced the issues already in the USA and Europe.

The New Zealand insurance industry still has the opportunity to learn the easy way from the problems and mistakes of others, before the Wellington fault or a myriad of other faults let loose their stored energy. Loss control and intelligent risk management and underwriting can do that.

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Appendix 1: Article from an insurance company in-house newsletter

Kemper Insurance recruits SF E&D for the long term

Dave McCormick

EQE International, San Francisco

Soon after the Northridge earthquake, EQE received a telephone call from Kemper Insurance asking if we would agree to provide the company with an engineer to help its adjusters for two weeks. I was volunteered, and jumped on a plane to Burbank. Upon arrival, I was greeted by about 30 adjusters from all over the country who had taken over the Best Western in Glendale. They gave me a T-shirt, a jacket and a cellular phone and made me an official member of the CAT(astrophe) Team. Nearly one year and more than 20 flights later, I am still assisting adjusters with claims, although the initial emphasis has shifted from commercial (warehouses and malls) to residential properties.

My primary charges were to verify that the observed damage was indeed caused by the earthquake and to propose conceptual fixes for the structural damage. It did not take long before my belief that wood-frame buildings generally perform well in earthquakes was changed. None of my previous earthquake reconnaissance trips prepared me for what I saw, including virtually brand new houses that were total losses. Many houses I saw that were 20 or 30 miles from the epicentre had substantial damage.

Upon my return, I immediately changed the deductible on the policy for my home from 10 percent to 5 percent. I also sought code coverage, so that any work required by post-earthquake changes in ordinances would be covered. Many insureds did not understand their policies, nor did they understand that optional coverages were available. The introduction of several ordinances by the City of Los Angeles made house repair work very challenging in a number of cases. Prior to the earthquake, I had not given much thought to how a crack in a stucco or lath and plaster wall can be "structurally" repaired.

The aftershock activity resulted in the need for repeated surveys of the same losses. Cracks kept growing in length and width. Some of my most memorable experiences were during aftershocks. In one case, I was standing next to a two-storey building trying to determine whether the damage was serious enough to warrant substantial repairs. During the aftershock, the building swayed horizontally about 6 inches, with all of the deformation occurring at the bottom floor where the damage was concentrated. Upon removing some stucco, I saw that many of the studs had split.

In another case, I was in the crawl space under a house when an aftershock hit. The house had been sliding down the hillside before the earthquake, and I watched as the crack in the ground under the house actually got wider and wider. Still another time, I was on top of a tilt-up getting some photographs of the partially collapsed roof when the aftershock hit. Fortunately, the plumbing in the building was still working.

Understanding the damage I saw was not always immediately possible. For instance, several slab-on-grade houses were observed to have horizontal cracks on the side of the foundation around the entire perimeter. It was only once repair work was begun that we determined the cause. The contractor had poured the footing, and then applied the plastic vapour barrier for the floor slab, and had extended it over the footing, thereby creating a plane of weakness. Poor construction quality was often the source of major damage in the houses that I visited.

Some of the sadder cases of damage were those instances where individuals had reacted to the recent fires in the Los Angeles area by replacing their wood shake roof with heavy clay tile roofs. While their neighbours' houses were virtually undamaged by the earthquake, some of these houses, where the owner had tried to do the right thing, had heavy and sometimes total losses.

In general, the work with Kemper was very instructive. I learned that chimney damage is not always possible to detect by visual inspection. In virtually every case where we ordered a smoke test or video survey, cracks were observed in the liner.

I was left with the impression that the insurance industry needs to change the way it does work. The industry is trying to be fair, which is more than can be said for many of the insureds. Minor cracks in plaster led to totally new paint jobs for entire rooms. If it is difficult to determine whether a crack is new or old, it is typically assumed to be new. An amazing number of new driveways were poured after the earthquake. Is this really how insurance dollars should be spent?

Role of insurance companies in disaster recovery

Christopher Henri, AAII

Insurance Council of Australia Ltd, Sydney

This paper draws from recent experience which the insurance industry gained from the Newcastle earthquake of 1989 and the Cessnock earthquake of 1994, but also focuses on some of the major difficulties which confronted the industry with other disasters like the March 1990 hailstorm, the January 1991 thunderstorm down blast (both in Sydney), and the extensive bushfires in New South Wales in January 1994. All of these involved tens of thousands of individual claims and hundreds of millions of dollars in settling them.

The Insurance Emergency Service (IES) Australia is perhaps best known for its response to tropical Cyclone Tracy's destruction of Darwin in 1974 and the Ash Wednesday wildfires in South Australia and Victoria in 1983, although it actually traces its origins to several natural disasters in 1961.

Its contribution to the affected community is to ensure that domestic and small business claims resulting from designated disasters are speedily and capably assessed and ultimately settled with the utmost convenience to all concerned. This is done by establishing an industry-coordinated response organisation that also establishes contact with government at all levels and represents the industry on any relevant external emergency committee. The IES also ensures accurate information flows to the media, insurers, governments and government agencies, and other interested parties, and maintains disaster statistics for use by insurers and other professionals.

Its experience, including problems associated with conveyancing of property, is related to the insurance implications of a devastating earthquake in Wellington.

The Insurance Emergency Service (IES) in Australia

The Insurance Emergency Service (IES) is a disaster response scheme organised and managed by the Insurance Council of Australia (ICA) under a tripartite agreement; the two other partners are the Chartered Institute of Loss Adjusters and the Australian Institute of Loss Adjusters. It has been mainly developed to assist householders, farmers and small commercial insureds, as a service to attend to claims that may arise in an insured disaster situation. Larger commercial insureds are usually well looked after by the major loss adjusting firms. A disaster situation may arise that does not involve an insurance industry response, for example the effects of drought or pestilence, and, in most instances, flood waters.

The administration of the IES consists of a national coordinator and national chief adjuster, together with their deputies, and is supported by a national IES committee. In each of the states and territories of Australia, there is a regional coordinator, a regional chief adjuster and a regional IES committee headed by ICA's regional manager. When the IES is activated by ICA's chief executive to respond to a designated disaster, it is the role of the state coordinator to bring together teams of experienced claims managers to cope with the high number of claims that are lodged within the first few days or weeks after the event. Similarly, the state chief adjuster organises the loss adjusters and arranges for work to be allocated to them.

The IES has four phases of implementation, each building on the previous phase:

- Phase A establishes the IES Community Assistance Program, which communicates with disaster victims by way of the media and community meetings and establishes lines of communication with government agencies and relief centres.
- Phase B establishes claims reporting centres which receive initial advice of claims and transmits these on to the relevant insurers.
- Phase C progresses to the point where work is allocated to loss adjusters. However, having been assigned a job, the loss adjuster then negotiates direct with the insurance company to effect settlement of the claim.

- Phase D is the full operation of the IES and involves the establishment of a central claims bureau, where loss adjuster's reports are checked and recommendations made to the insurers.

A little known fact about the IES is that it was first established in Western Australia in 1961 due to two events occurring at the same time. A large bushfire devastated the southwestern portion of the state and a cyclone struck at Onslow to the north of Perth and created floods at Carnarvon. It was natural for loss adjusters to opt for work in the southwest region, close to Perth and in far more pleasant climatic conditions than farther north. To overcome the potential problem, a meeting of insurers and loss adjusters was called and agreement reached to mobilise the loss adjusters and allocate them to the two devastated areas.

It is a remarkable achievement that the man who conceived of the idea of the Insurance Emergency Service in 1961, at that time the Western Australian state manager of a large insurance company is still involved with the IES today. Mr Les Lester is the national coordinator and at 80 years of age has accumulated a vast experience in dealing with disasters; the most notable being tropical Cyclone Tracy in Darwin in 1974, the Ash Wednesday bushfires in South Australia and Victoria in 1983 and the Newcastle earthquake in 1989.

While the first Insurance Emergency Service can be traced to Western Australian in 1961, there was a significant period of time, in fact some 12 years, before another major disaster occurred and, with no opportunity for the IES to be activated in those intervening years, the concept faded. When Cyclone Tracy struck Darwin in 1974 there was no formal national agreement in place to deal with that emergency, but an ad hoc agreement was put together quickly and worked extremely well under difficult circumstances. For several years afterwards, interested groups analysed how the insurance industry could respond to cyclone damage in a large coastal city or town, and there was some preparatory thinking towards the formation of a formal ongoing insurance emergency service. When disastrous fires ravaged a large part of the western districts of Victoria in 1977 and another ad hoc arrangement was worked out to coordinate the insurance industry and loss adjusters, the Board of Directors of the Insurance Council of Australia decided to establish a formalised Insurance Emergency Service. The first truly national agreement was drawn up early in 1979.

Three disaster studies

In the Australian experience over the past 20 years, three natural disaster events have had a major impact on the general insurance industry because of their unique circumstances. They were the 1974 tropical Cyclone Tracy at Darwin, the Ash Wednesday bushfires of 1983 in Victoria and South Australia, and the 1989 earthquake at Newcastle. Although there have been many other events which have been quite important from the disaster response point of view, such as the tropical cyclones Althea, Winifred and Aivu in Queensland, and severe storms such as those which struck Brisbane in January 1985 and in Sydney in March 1990 and January 1991, these three produced the greatest challenge for the insurance industry and it is best to examine these events for their problems and for the solutions found.

Tropical Cyclone Tracy 1974 — Darwin, Northern Territory

Tropical Cyclone Tracy was a small but very intense cyclone with a recorded surface wind speed of 217 km/h. It moved over Darwin at a slow speed of 8 km/h for about five hours, commencing at around 1:30 am on Christmas Day 1974. It prescribed a zigzag path over the main city area and in its wake left a city almost totally destroyed. Some 23,000 people, or about 75 percent of the population, had to be evacuated to southern cities. Ten thousand dwellings were destroyed or substantially damaged, as well 10,000 cars and some 750 caravans. Altogether, including commercial loss of profits and marine and aviation claims, the insured loss came to AUS$217 million in 1974 dollar terms. This amount would approximate AUS$760 million in 1995 dollars.

Notwithstanding the large insurance payout for this event, it is important to recognise the impact that the appalling degree of under-insurance had on the overall insured loss. The average sum insured on dwellings in 1974 was AUS$20,500 and this amount tied in closely with the average indemnity value of about AUS$20,000. However, the severe effects of inflation induced by having nearly all labour and materials flown in or transported overland or by sea to Darwin, and new building standards, caused the replacement costs of dwellings to rise sharply, to some AUS$45,000.

The insurance industry's maximum probable loss (MPL) assessment for cyclone damage to a northern city prior to December 1974 had been around 20 percent. Tropical Cyclone Tracy reversed that view; in fact, the insured destruction and damage revealed the MPL was of the order of 80 percent.

The remoteness of Darwin, the extent of destruction, and the climate produced a very difficult set of circumstances with which the insurance industry had to deal to make the claims settlement process effective.

Access to Darwin after the cyclone. In the days immediately following Tracy's destruction of Darwin, complete Government control was essential. It was a stage when firm control was required, but tempered with understanding and consideration. It must be remembered that most people who remained in Darwin were there to do a job, but they represented no more than about 25 percent of the normal population of the city.

Gaining access to Darwin was very difficult. The lack of federal government cooperation forced the original assessment party consisting of three chief executives to hire a plane to get into Darwin. A few days later, the insurance industry's disaster response coordinating team found themselves in the same position with no priorities from the Royal Australian Air Force and no assistance from government departments. This lack of cooperation was compounded when the RAAF Control at Darwin refused the party a permit to land, and it was necessary to land near Katherine, 300 km south of Darwin.

Once in Darwin city, however, attitudes were entirely different. The federal government had appointed an emergency committee, which was well organised and used its authority with efficiency and consideration. Its members gave the insurance industry's coordinating team complete cooperation, and it is worthwhile noting the benefit of having people in authority who are able to make decisions on the spot.

Assessment of cyclone destruction and damage. Tropical Cyclone Tracy probably embraced all of the difficulties an insurance industry could ever expect to face — all in one event. The damage was by far the worst that has been experienced in Australia and the assessment process was aggravated by Darwin's isolation and subsequent long wet season. Because the majority of the population had been evacuated to various state capital cities in southern Australia, it was often difficult to track evacuees to their temporary homes. Nevertheless, over a period of months all claimants were located and the claims settled by the insurers.

Loss adjusters from around Australia were brought to Darwin in teams of some 20 at a time. They were replaced on a regular basis after periods of service of three to four weeks. Many retired loss adjusters offered their support and handled paperwork for those in the field. As well, they helped organise replacements. Specialist adjusters were also brought in to handle the commercial, marine and aviation claims.

The assessment of cyclone damage requires experience beyond that obtained in normal claims settlements. For example, a dwelling may have obvious damage, such as having had its roof destroyed, but may otherwise appear to be intact and, therefore, considered only to be a partial loss. But, on closer inspection by a building consultant the whole dwelling could well be a total loss due to the frame being twisted beyond repair.

Assessors were organised into groups on a geographical basis and it was agreed to dispose of as many total loss claims as possible in the worst hit areas. Total losses, either in fact or due to underinsurance were relatively easy to handle, provided that all relevant information was supplied by the insurer and the lot could be identified.

Proper identification of the site was of paramount importance. It was the assessor's responsibility to ensure the lot number was correctly identified and usually a double check was made to ensure the description of the dwelling agreed with the description of the wreckage.

Homes that were damaged by the cyclone produced their own difficulties, mainly due to:

- delay in producing the new building code;
- temporary repairs only being allowed;
- shortage of materials even to carry out the smallest of temporary repairs; and
- dwellings being declared unfit for habitation or restoration by the NT Administration's Engineers' Department, contrary to the loss assessor's opinion that the building could be repaired.

Motor vehicle and caravan claims. Special consideration had to be given to motor vehicle and mobile caravan claims. In Darwin, there were only five motor body repairers active to some extent but in no way capable of coping with some 10,000 motor vehicles and 750 caravans that were either destroyed or extensively damaged.

Consideration was given to transporting damaged vehicles south, but the cost by road and rail was very high and in any case the wet season precluded the use of this method for several months. Shipping out of Darwin was limited to one ship per month and the most that could be sent south by this method was 120 vehicles per month. It was necessary to assess all damaged vehicles as quickly as possible, because the whole of Darwin was covered in salt water spray during the cyclone and vehicles were deteriorating rapidly. A separate team of motor vehicle assessors was appointed and a compound set up to accept damaged but movable vehicles. They cooperated with the police, who had taken many destroyed and badly damaged vehicles to their own compound.

Many motorists continued to drive their vehicles in a damaged condition, when under normal circumstances they would not have been allowed on the road. Fortunately, a large number of vehicles that were roadworthy had been driven south in the evacuation and many of the motor vehicle claims were settled in other places.

While total losses presented no real problem, partially damaged vehicles certainly did. There was no great difficulty in obtaining repair quotes, but it would have been many months before the vehicles could have been repaired. The effects of inflation meant that a repair quote bore no resemblance to the actual costs of repairs many months later. The majority of claims for damage to vehicles remaining in Darwin were settled for cash, according to the body repairer's quote, and the owners subsequently ran their vehicles into the ground.

Caravans required specialised repairs and it was necessary to bring to Darwin experienced body builders to cope with the number of caravans whose owners opted for repairs.

Federal government action. Immediately after the cyclone, the government-appointed emergency committee requisitioned all building materials, generators and other items necessary to maintain as much of the city as possible. They also requisitioned food and turned a blind eye to people helping themselves.

Requisitioning continued until 3 January 1975 without records being properly maintained, but from that date, the emergency committee limited the authority to requisition and agreed on proper records being kept. Up to this time it had been impossible to tell what had been requisitioned and what had been pilfered or otherwise lost, and insurers had little choice but to accept the loss as part of claims.

Building materials were also commandeered by the administration, including all new materials that came into Darwin after the cyclone. By 6 January, agreement had been reached between the insurance industry's central claims office and the emergency committee, which allowed for applications to be submitted to import materials for temporary repairs to minimise insurance losses.

The Darwin Reconstruction Commission. On 30 December 1974, the federal government established a statutory authority to plan, coordinate and carry out the reconstruction of Darwin city; the authority was to have an initial life of five years. To avoid delay, an interim commission was appointed, pending the drafting and passage of the necessary legislation. By 6 January 1975, the interim commission had agreed to establish a citizens advisory council to keep it informed of community requirements and reactions. It also arranged for the production of a new building code for the city. Because of the lack of legislation, the interim commission had no powers but depended on cooperation of other government bodies, and with this collaboration was able to start its planning. On 28 February 1975, the Darwin Reconstruction Act 1975 received assent and the Darwin Reconstruction Commission was formally established.

The Commission based its assessment of the requirements of the reconstruction programme on a number of assumptions, of which the most important to the insurance industry were:

- that by 1980 the expected population of Darwin would be in the vicinity of 56,000;
- that the revised building code would apply to all new structures and restored houses; and
- that the private homeowner would have limited ability to finance the cost of rebuilding the house and the private sector would be unable or unwilling to enter into financial commitments

because of high costs and uncertainty as to the future of the city.

The second and third assumptions in particular were of interest to insurers. The new building code was established after tropical Cyclone Tracy, and its application with respect to extra cost provisions was of concern to insurers as they considered any extra cost flowing from the new building code was not part of the normal domestic claim. The third assumption, of course, highlighted the problem of under-insurance.

The cost of rebuilding was aggravated by the delay in revising the building code, lack of readily available labour and materials, and the steady rise in costs during the period until buildings were completed.

The commission decided that its planning should take the form of policies rather than the town plan used prior to tropical Cyclone Tracy. It was believed that town plans were inflexible and, in the case of Darwin, rapid growth would make such a plan ineffective for the future. Included in its policies was a new element — the definition of coastal tidal surge zones being those areas liable to inundation by the sea during a cyclone. The commission did not prohibit residents from rebuilding in these areas, but rather discouraged development. It did not provide any resources to assist repairs or restoration in the two designated tidal surge zones. However, it did give consideration to additional assistance to private homeowners to relocate elsewhere.

By May 1975, building contracts for some 1300 houses had been let, divided between four contractors. The average cost of each house was estimated at AUS$44,600, subject to rise and fall clauses — a figure that was more than double the average amount of insurance cover on houses at the time of the cyclone. By June 1976, the population of Darwin was only 4000 short of its pre-cyclone figure of 49,500. By June 1977, 2355 new houses and flats had been completed and the commission had approved a further 500. A number of houses, not so seriously damaged, were upgraded by a system of over-battening of their roofs that involved minimal work to the interior.

Salvage. In any other location, insurance losses might have been mitigated to a large extent by recovery from salvage, but due to the isolation and lack of transport facilities a great deal of salvage was dumped as worthless. There were differences of opinion between insurers and representatives of overseas reinsurers with respect to salvage of dwellings. In most cases, the extent of under-insurance was such that the problem was purely academic.

However, it is interesting to note that many thousands of concrete posts on which dwellings had been constructed remained standing after the cyclone. Insurers and loss adjusters felt that unless they could be used in the restoration of the dwelling, they had no value, and as the new building code required dwellings to be built on concrete rafts on the ground, the value of concrete posts were not taken into account in the settlement of claims. The reinsurers' representatives initially took the view that they had a salvage value even though they had to be collected and sent somewhere where they could be used. This was not a practical solution, and eventually the reinsurers' representatives agreed not to take the value of this salvage into account.

Trade risks. Although it was apparent some trade risks were abandoned by their owners, it was difficult to prove in view of the wholesale evacuation of the city. However, in one particular instance there was no doubt the premises had been abandoned to the insurers, who because of doubts as to the legal position did take over the salvage in a endeavour to minimise the loss.

The attitude of management and staff of large department stores presented an interesting comparison. In one instance, the management and staff abandoned their store leaving it completely open to looting. In the other instance, the management and staff stayed to secure their store, locking all entrances.

Another aspect of under-insurance is also noteworthy. The retail and wholesale stores had stocked up for Christmas and the wet season. In most cases, insurances on stock had not been adjusted to reflect the increased values. In one case, the build up in stock had reached a value of AUS$70,000, whereas stock normally held had been AUS$15,000 to AUS$20,000; insurance cover at the time of tropical Cyclone Tracy was only for AUS$15,000.

Flying debris. An interesting phenomenon of cyclones is that items found in a house may not necessarily belong to that house. This was particularly the case with jewellery, but even included

heavy items like refrigerators. The Darwin Travel Lodge Motel had a Volkswagon Beetle embedded in its third floor wall plus three other vehicles in its pool.

The Ash Wednesday 1983 bushfires in South Australia and Victoria

The bushfires commenced on 16 February and by 17 February were largely out or contained, although in a few areas the fires kept burning in bushland and forests until about 22 February. Temperatures were well into the 40˚C+ and humidity was almost at zero percent. Strong winds in many areas carried the fires very quickly. In some areas, it was estimated that the across-the-ground speed of the bushfires exceeded 100 km per hour.

Because of the long drought in both South Australia and Victoria, there was a large amount of dry fuel on the ground to feed the fires. Probably the most severe fire was in the area of the Cockatoo township in the Dandenong Ranges, which caused an immense amount of damage in a comparatively short period. It was estimated that the heat generated from that fire was not far short of the heat generated by the Hiroshima atom bomb blast. The loss of 76 lives, with more than 2000 people suffering extensive burn and smoke inhalation injuries, added an horrific dimension to the extensive property and livestock losses.

The fires raged over some 1400 km, from the Clare Valley north of Adelaide to Mount Gambier in the south and across coastal areas and southern Victoria to the Dandenong Ranges east of Melbourne. Some 46 villages and towns and urban areas of Adelaide were affected by the bushfires; 2179 houses were destroyed and over 2000 other houses were damaged. Many historic buildings were destroyed. Livestock losses were enormous, with some 264,000 sheep perishing and nearly 19,000 cattle. In addition, several hundred thousand sheep and cattle were left without feed. Three hundred and ninety three thousand hectares of bushland and state forests and 19,000 km of fencing were burnt.

Using 1995 dollar values, the insured loss totalled AUS$231 million for Victoria and AUS$63 million for South Australia. By late afternoon on 16 February, it was evident that there would be an extraordinary amount of destruction of property spread across the two states and, to meet the large number of insurance claims anticipated, the chief executive of ICA declared a state of insurance emergency for both Victoria and South Australia.

A central claims bureau (CCB) was established at ICA's head office in Melbourne and in the Royal Insurance Company's building in Adelaide. In addition, claims reporting centres (CRCs) were established in four townships in Victoria and four townships in South Australia; in most cases, they were situated near to evacuation centres, but two of the CRCs were later relocated as they were found to be too far removed from the affected area. By the afternoon of 17 February, loss adjusters were making their way into the devastated areas.

No disaster event is going to produce a set of circumstances that enables the IES to operate with absolute efficiency and convenience. In the case of the 1983 Ash Wednesday bushfires, many lessons were learned that were either acted upon immediately or were recorded for future reference when the IES was reviewed to further refine the claims response programme.

Member insurance companies made claims staff available for the CRCs and the CCBs, but the constant turnover of staff mitigated against the efficiency and continuity of effort. In consequence of this, some consideration has been given to the employment of claims staff who could be made available for the whole of the expected period of any future disaster.

Although management by improvisation will always be a major feature in a disaster situation, one important lesson learned from the 1983 bushfires was that every effort must be made to get adequate premises for CRCs to ensure that the administration of loss adjusters is segregated from the reporting of claims by disaster victims. In this respect, it is essential that although the CRC may be under the control of an insurance officer for the purpose of receiving and recording claims, there must also be a loss adjuster in charge of the adjusting team and that team must be small enough to be properly managed. Where possible each loss adjuster should be allocated claims in a defined area to obviate unnecessary travel and to allow them to get a better understanding of the area in which they are working.

The paperwork associated with a disaster of the 1983 Ash Wednesday bushfires type is enormous and adequate lines of communication between CRCs

and the CCB are essential, even to the extent of employing a courier service on a daily basis.

The South Australian Health Commission conducted a survey of the 12 months following the Ash Wednesday bushfires to ascertain the health and social impact on the communities. This survey clearly showed that many people suffered post-traumatic stress disorders, characterised by reduced involvement in normal activities, with many sufferers being reluctant to consult with any professional person about their condition. Typically, alcoholism and drug problems were evident, as were cases of mental illness, hypertension and sleep disturbance.

The important issue for loss adjusters and insurance claims staff is to recognise that when they are negotiating and consulting with disaster victims they may be dealing with people who have acquired health problems as a direct consequence of physical or mental deterioration occasioned by the event.

Very often it may only be the loss of a loved pet that causes a distress disorder, which interferes with a person thinking clearly and responding effectively to requests from the loss adjuster or claims staff for information vital to the claim's progress. Many complaints about the insensitive and inadequate behaviour of insurance personnel can be eliminated by recognising potential or actual stress disorders. Unfortunately, good work in this field is counteracted when the opportunistic element in the community commences fraudulent activity against insurance companies; the natural response is to harden one's attitude.

In its report, the South Australian Health Commission found that the psychological and physical health of the bushfire-affected population was significantly impaired by the experience of the disaster. Although some of the problems arose soon after the bushfire and were recognised and dealt with at the time, the majority continued for 12 months and many were identified or acknowledged for the first time only months after the bushfire took place. While the study indicates some deficiencies in the recognition and management of the problems, it must be remembered that this was the first comprehensive study of a total population affected by a major disaster, and at the time only a limited knowledge existed of the nature, extent and duration of the health and psychosocial problems that would arise in later months.

The Newcastle earthquake, 28 December 1989

While earthquakes and earth tremors occur in Australia on a regular basis, it is infrequently that they affect populated areas. Insurance claims were submitted following earthquakes in Adelaide in 1954 and in the Western Australian towns of Meckering in October 1968 and Cadoux in June 1979, and more recently at Tennant Creek in the Northern Territory in January 1988. The Adelaide earthquake of 1954 was largely forgotten from memory and only scant details were available to draw upon for the insurance industry's response to the Newcastle earthquake. Although traumatic for the communities involved the earthquakes at Meckering, Cadoux and Tennant Creek were relatively small events from the aspect of servicing claims and the insurance payout.

The 1989 Newcastle earthquake presented the insurance industry in Australia with the largest aggregate loss on record. Some 64,000 domestic and 6000 commercial claims were lodged with insurance companies for suspected earthquake damage to about 35,000 properties. The total insurance payout in 1995 dollar terms came to AUS$1.02 billion.

Apart from the spectacular collapse of the Newcastle Workers Club, with the tragic loss of nine lives, and substantial collapse of a few other buildings in the commercial district, the full extent of damage was not immediately apparent. In fact many insurance claims were lodged months after the event and in some cases several years later. For about a year after the earthquake, new claims kept coming in, at a rate of between 300 and 400 each week.

From the outset, ICA's assistant chief executive did not declare a state of insurance emergency, but the IES was activated to the level of Phase 1, which established lines of communication with Newcastle City Council, the Police Service, welfare agencies and the media.

The decision by ICA not to activate the full operation of IES, namely Phase 4, was based on a number of premises. Firstly, the initial indications were that the earthquake damage was moderate; although disrupted for a time, public infrastructure and services were largely unaffected. Secondly, Newcastle is Australia's sixth largest city, with a population of some 400,000 people and extensive resources; it is situated some 160 km north of Sydney and is easily accessible by road, rail and air. Thirdly, on the

initial run of claims, most insurance companies believed they could service their claims from either their Newcastle or Sydney offices.

The IES state coordinator, Mr Philip Reed, went to Newcastle on the day following the earthquake, made contact with the state emergency service and was taken on a conducted tour of the worst areas. For the first few days, he operated out of a motel, but later secured office accommodation for the IES Phase 1 operation at his own company's branch office after it was agreed that the building could be reoccupied. Having been recalled from annual leave, ICA's NSW regional manager joined him a few days later and commenced the process of holding industry debriefing meetings and attending the series of business and community meetings organised by Newcastle City Council and Hamilton Chamber of Commerce.

Access to area and damage assessment. Damage assessment got under way immediately, with leading loss adjusting firms commencing operations for their principals in the evening of the earthquake. NRMA Insurance, the largest insurer of home buildings and contents, with approximately one-quarter of the market in NSW, had their "in house" senior adjusters assessing domestic damage in the afternoon.

The initial assessing activity was not undertaken without difficulty, as large sections of the earthquake-affected areas had been cordoned off by the Police to prevent further injury from falling masonry, awnings, and parapets. In fact, the central business district remained cordoned off for a period of eight days. Permission to enter damaged areas had to be obtained from the Police and, apart from the authorities themselves, this was limited to loss adjusters and IES personnel.

Loss adjusting. In a disaster situation where Phase 4 of the IES has not been activated, it is normal practice for loss adjusting firms to send in teams of adjusters, numbering about 15, on the basis of two weeks on and two weeks off until the job is complete. In the case of the Newcastle earthquake, organised relief of loss adjusters became practically impossible. After the initial surge of claims, new claims kept coming in at the rate of up to 400 a week for over 12 months. A number of very experienced loss adjusters were still hard at their task two and a half years after the earthquake and their stress levels had long since gone through the roof.

Following an earthquake, seismologists, geologists, the authorities and the affected community ready themselves for aftershocks. In the case of the Newcastle earthquake loss-adjusting programme, there were aftershocks of a different kind. Firstly, there was the effect of the record rainfall in early February, which complicated the adjustment of earthquake claims and caused the reopening of claims that had already been assessed. Secondly, on 18 March 1990, a hailstorm that would ultimately cost AUS$300 million struck large areas of Sydney; 28,911 household claims and 8541 motor vehicle claims were lodged. Insurance companies and loss-adjusting firms had no alternative other than to pull back their troops from Newcastle to undertake the assessment and servicing of the Sydney hailstorm claims. With the continuing inflow of new claims and reopening of old claims, the strain on the loss-adjusting fraternity that remained in Newcastle became enormous. The final aftershock came in the form of a very severe thunderstorm that struck the northern suburbs of Sydney on 21 January 1991. Giant trees fell across houses, cutting them open as easily as a knife cuts through butter. This event produced 28,206 household claims and 3692 motor vehicle claims for an insured loss of AUS$160 million.

When one considers the normal assessment period for substantial earthquake damage of about 12 months and adds a factor for the continuing run of new claims, it can be seen that the three events all occurred within the earthquake assessment time frame. In all, the loss-adjusting firms and the insurance companies serviced 144,000 claims, a not inconsiderable feat given the complexity and special circumstances of each event.

A number of factors caused stress and strained relationships in the loss-adjustment programme for Newcastle. Some companies chose to operate their claims settlement programme from their Sydney office, either because they had no Newcastle branch or it was seen as a more efficient method. In some of these companies a number of claims managers and their staff abrogated their responsibilities to the loss adjusters. As they were some distance from the action, they could not, or did not, want to grasp the emerging problems. Lack of interest became apparent and played havoc with dispute resolution. Ongoing trauma had a lot to do with bloody-minded attitudes. Property owners fell out with builders, builders fell out with property owners and subcontractors; loss adjusters were criticised for being

insensitive and uncaring. On-site dispute resolution meetings involving all parties became the order of the day, and many overheated situations were resolved by this method.

Insurance issues. There has been a good deal of scientific examination of the Newcastle earthquake, commencing with a conference organised by the Australian Institution of Engineers in Newcastle in the middle of February 1990 and culminating in October 1991 with a special conference on the lessons learned, which was organised jointly by the Newcastle City Council and the Centre for Earthquake Research in Australia.

There were many important implications for the insurance industry, some of which were immediately apparent and others that became issues of concern in the months following the earthquake. Newcastle's earthquake did not present, as some might suggest, a unique set of circumstances. Similar circumstances could be replicated in many other cities and towns in Australia that might in future be subjected to earthquake.

Earthquake risk in Australia. From the insurance underwriting perspective of natural hazards, the risk of earthquake had not been highly regarded. Insurers knew far more about tropical cyclones, severe storms, flooding and bushfires. Even in scientific and academic circles, the study of earthquakes at best only received marginal government financial support. In consequence there was a low state of preparedness by the insurance industry for dealing with the earthquake in Newcastle. That situation changed dramatically in the intervening years, and the insurance industry was much better prepared technically to deal with the Ellalong (Cessnock) earthquake of August 1994, a much smaller event in terms of the number of claims and cost.

Notification of claims. There is no statutory time limit for lodging claims in Australia as there is in New Zealand and elsewhere overseas. Consequently, Australian insurers only have a defence against late notification where they can show successfully that they have been prejudiced.

Generally speaking, insurers had no previous experience of claims lodgement patterns for an earthquake event to draw on. As an example, one insurance company tracked the lodgement of claims on a monthly basis for three years and recorded a 14 percent increase in claims lodged from the end of 1990 through to the end of 1993. A number of the major home insurers placed advertisements in regional newspapers calling the attention of their policyholders to the necessity to lodge their claim without further delay. In October 1990, after an industry meeting called to discuss a cut-off date, the Insurance Council of Australia advertised in the *Newcastle Herald* pointing out to domestic property owners they may be prejudicing their claims by late notification. In addition to the lingering tail in the lodgement of claims, a considerable number of claims needed adjustments to their quoted costs because further damage was discovered during repairs or even after the repairs had been completed.

There were many reasons why property owners were slow in lodging their claims:

- believing they only had superficial damage, many domestic property owners decided to wait or were encouraged to hold back, letting more urgent major damage receive assessment and be quoted on for repair;
- many property owners believed they would have trouble getting builders and tradespeople to quote for repairs and therefore decided to wait until the initial rush had died down; and
- Newcastle received record rainfall early in February 1990 and rainfall continued well into the second half of the year.

Until the storms of early February, most loss adjusters believed they had full control over the earthquake damage claims and also in the question of quantum. However, the rainstorms changed that and virtually every claimant contacted their insurer or the loss adjuster to advise of additional damage caused by water which was able to penetrate buildings through openings created by the earthquake. In many cases, property owners were not even aware that damage had been caused to their roofs.

The contentious issue of earthquake damage versus reactive clay soil. In the period following the earthquake, the Newcastle region experienced very heavy rain. This wet period continued into the third quarter of 1990. It was then followed by an extended period of drought, which continues even to this time. The effect of these climatic conditions became noticeable towards the end of 1990 and very noticeable through 1991.

The insurance industry became increasingly concerned at the continuing run of late reported claims

and while there was genuine earthquake damage among some of these claims, by far the majority were for damage not related to the effects of the 1989 earthquake. In their reports to insurers, loss adjusters and consulting engineers were advising that in their opinion the damage was due to reactive clay soils, slope instability or other non-earthquake causes.

Homeowners who were seeing their buildings opening up could not believe that the damage had not been caused by the earthquake and many disputes between insurance companies and property owners took place. Proof of damage and causation of damage are very difficult areas for property owners and insurers and these disputes became very costly affairs as each side resorted to engineer's reports to prove their case.

In order to try and help the people of Newcastle understand what was happening to their land through climatic extremes and the effect on their buildings, the ICA and GIO Australia commissioned a structural and geotechnical engineering report, *Factors influencing structural behaviour of residential buildings in Newcastle*. This report was widely distributed. Several copies were lodged with the Newcastle Regional Library for general reference purposes in the hope that it would help overcome the misunderstandings and communication problems that bedevilled the insurance industry and the victims of the earthquake.

A lesson learned from this is that it could have been commissioned early in 1990 and released to all concerned at the time. This would have greatly reduced the problems experienced by builders, structural engineers and loss adjusters with the claims they were servicing. It is appropriate to mention that much of what was written in that report was known prior to the earthquake and was readily available for reference in publications issued by Standards Australia and the CSIRO. Engineers and builders had always had those references available to them. However, the problem they and insurers had to deal with was that so many of the buildings in Newcastle were quite old and had been built at a time when building ordinance and regulations were not as stringent as they are today; in other words, at the time the buildings were constructed, they were regarded as satisfactory.

One of the co-authors of the report, a geotechnical engineer, noted in another paper, quite correctly, that caution should be exercised in attributing all damage to reactive clay soil since this has no more credence than the rationale that all damage after the earthquake was due to ongoing earthquake or induced ground movement. He insisted that each site should be treated as an individual site unless specific data was known on particular areas such that informed comment could be made rather than sweeping statements that were often wrong.

Pre-existing building defects. The essentially automatic nature of home insurance leads to the necessary acceptance by insurance companies of the inadequacies of buildings that may make them susceptible to damage from an insured event.

Following an inspection of nearly 4000 residential properties that involved sub-floor, roof cavity, externals and internals, one expert building consultant stated that approximately 70 percent of the structures inspected had defects sufficient to impair their ability to withstand a minor earthquake. Not only was there erosion of wall ties, lack of collar ties, eroded brickwork or aged settlement pattern, but also there was a lack of support by piers and general foundations.

A high proportion of damaged buildings were constructed of unreinforced brick masonry with little resistance to lateral loading. Particularly vulnerable were gable ends, parapets, facades and chimneys. Damage was caused to older two storey houses, and those with double leaf cavity construction suffered heavily from the lack of adequate ties, with the outer leaf collapsing as a result of the lack of restraint.

In this respect, it is important to view damage to buildings in Newcastle and surrounding areas in the correct perspective. A structural engineer observed that the vast majority of buildings did not collapse, despite the fact that none had been designed against earthquake forces, and the high damage bill for structural repairs was due, to a large extent, to the poor quality of many buildings and houses caused by poor initial construction and long-term structural deterioration.

Local councils and the building ordinance regulations. Newcastle City Council advised that it would require property owners and builders to submit a building application for any structural repair over AUS$1000. This presented a problem because "structural" was not clearly defined and AUS$1000 was a relatively small sum. This issue was aggra-

vated by the fact that Newcastle City Council did not have enough building inspectors to maintain an efficient and speedy process and, even with the help of seconded building inspectors from other cities, a backlog in building approvals developed.

The term "betterment" became the centrepoint of many arguments between property owners and their insurers and building regulators. Ordinance 70 requires buildings to be repaired to the latest standards. It is generally understood that elements such as electrical systems and plumbing may need to be replaced because they no longer meet current standards. However, in the case of the earthquake damage, many domestic properties were found to have either very shallow footings or no footings at all. For buildings with noticeable inherent structural weaknesses, earthquake repairs should only have been carried out after the pre-existing problems had been remedied by the owners. With regard to the servicing of an insurance claim, communication with and education of the property owner as to the significance of any structural problems identified was essential prior to insurance repairs being carried out. However, this led to disputes as many property owners saw the earthquake as a tremendous opportunity to repair all the old cracks and problems with their properties. In the second half of 1990, insurers noted an increasing number of non-earthquake related claims being submitted. It was obvious that property owners were hoping that their insurance would cover repairs or rectification even though the cause may not have been earthquake. In many instances, the builder was asked to include additional work in his quote for earthquake damage.

The poor construction, by modern standards, of many of Newcastle's older commercial and industrial buildings and their inability to resist lateral forces has resulted in the reinforcement of building codes and, following the occurrence of sometimes quite minor damage, building owners have had to conform with those new standards. Many did not have the financial resources to do so, and in some instances authorities had to take a practical approach and water down some of their requirements, but usually only upon the owner giving an undertaking that improvements would be made over a reasonably short period. However, there was no leniency for insurers. Given sufficient cover, building approvals were not given unless repair plans incorporated all the improvements required. Some building owners took advantage of this situation.

A good example is that of a three-storey solid brick building that had formerly been used as a factory but had been abandoned some years prior to the 1989 earthquake in favour of a more modern and capacious outer suburban location. This building sustained a moderate degree of damage. The owner and his building consultants seized the opportunity to build into the repair specifications not only the requirements for strengthening the building for earthquake resistance but also for fire risk. Fortunately, in a conference that included Council building officers, it was revealed that although the Council did require all the improvements specified, those not relevant to earthquake risk would not have been insisted upon until such time as the owner wished to re-occupy the building or until Council, in working its way methodically through the code of building design, arrived at the particular building concerned. In consequence, the claim on the insurer was greatly modified but it was this type of activity which made life very difficult for the insurer.

Fraud. Regrettably, a fraudulent element emerged. This was particularly noticeable in quotes being made by some sectors of the building trades. Insurance companies had to resort to professional building consultants to check for fraud. Examination by one consultant revealed quotes of AUS$160,000 for a true damage factor of AUS$30,000, AUS$140,000 for a true damage factor of AUS$28,000 and AUS$86,000 for a true damage factor of AUS$2800.

It subsequently became necessary for the Master Builders Association to remove a number of contractors from their membership. The Police Service established a special insurance fraud unit in Newcastle that investigated all levels of fraud, from minor to major, perpetrated by builders, tradespeople, property owners and even to the extent of examining the way claims were being administered by loss adjusters and claims managers. Ultimately, a number of builders were charged with fraud.

Conveyancing of earthquake-repaired property and other real estate issues. The Australian Insurance Contracts Act 1984 contains specific provision for the sale of insured property. Section 50(1) allows for a purchaser to become party to the vendor's insurance during the process of the sale of the property. The protection of the vendor's insurance commences the day on which the risk is passed to the purchaser and ends at the time when the sale or assignment is completed, or when the purchaser enters into possession of the building, or when the purchaser

effects his or her own insurance, or when the sale or assignment is terminated, whichever first occurs. The problem of conveyancing would appear to be peculiar to earthquake, as it is unlikely to occur in any other type of claim, because only earthquakes are likely to cause further damage at a later period. The exception, of course, would be faulty workmanship. In most cases, the new claims made by the purchaser against the vendor's policy were beyond the circumstances outlined in Section 50 of the Insurance Contracts Act and no benefit could accrue to the purchaser. In any event, most purchasers had effected their own building insurance.

To assist insurers, ICA obtained legal opinion from two eminent lawyers who held that if the agreement for sale or assignment was not made prior to the earthquake then the purchaser could gain no benefit pursuant to Section 50(1) of the Insurance Contracts Act. Their statement was qualified by other possibilities such as oral agreements and rights to occupy. Once it was agreed that the purchase was outside the scope of Section 50, the rights of any purchaser to an insurance claim depended on documentation of the sale. If the agreement was not made before the earthquake, the insurer for the vendor was entitled to simply deny the claim. If the purchaser effected insurance after the event, the insurer would have no liability to meet the claim.

An interesting phenomenon that manifested in the real estate arena was the effect that earthquake repairs and reinstatement had on the real estate values of properties that were fully insured, under insured or not insured at all. Actually, some 1200 homes were found to be uninsured, of which over 20 were declared to be constructive total losses. For social and community reasons, the authorities decided to replace these homes with low-cost, brick-veneer, slab-on-the-ground homes financed by loans from the Newcastle Lord Mayor's Earthquake Appeal Fund. Arrangements were made for the capital amount of the loan to be repaid at a future date when the owner-occupier ceased to have a need for the home. Consider the hypothetical streetscape of five timber homes prior to the earthquake, all of similar age and condition and all occupied by elderly people on pensions or fixed income, some of whom have family members living with them. The first house is not insured and is declared a constructive total loss. The second house is not insured but only sustains partial earthquake damage and can be repaired. The third house is grossly under-insured and is declared a constructive total loss. The fourth house is also grossly under-insured but sustains only partial damage. The fifth house is fully insured and sustains partial damage. The end result of this hypothetical streetscape is that one parcel of land now sports a brand new brick veneer home; another property through being fully insured has been repaired and now looks like new with new paint, etc. It is also possible that the underinsured constructive total loss home has been replaced with a new brick veneer house through a combination of insurance money and loans made available from the appeal funds. The other two houses have been patch-repaired and manifestly show their age and condition.

It is easy to see how some dissatisfaction arose in the respective real estate values of neighbouring properties.

Historic buildings. Many of the older buildings in Newcastle contributed significantly to the character of the city. Many of them were also close to the end of their economic life. Where major damage had been sustained, the best policy on economic grounds was demolition and replacement with more modern structures better fitted for modern living. In some cases, the cost of repair may well have exceeded the cost of replacement. This created considerable tension in Newcastle between the owners and the heritage-minded members of the community.

Heated debate raged for a considerable period as groups such as the Heritage Council fought for the preservation of certain buildings, or features of buildings, which some engineers and others felt were unsafe. In the suburb of Hamilton, one building had scaffolding around it for 12 months at a weekly cost to the owner of AUS$1200 because heritage-minded people were arguing over the proposed demolition. In the end, builders and their employees refused to work on it because it was considered too dangerous, and ultimately the building was demolished.

This type of tension was no doubt greatest where buildings were only insured for indemnity, as such insurance would not have paid for restoration, and owners really had no choice but to demolish to make way for new economic buildings.

In the main, insurers do not have a negative attitude to heritage buildings; they do not universally or automatically apply premium loadings simply because a building is listed. The underwriting

approach is determined by their experience of some of the more obvious and recurring features that are usually manifest in listed properties:

- there are often problems of replacement or reinstatement where materials and finishes are expensive to reproduce;
- there are often hazards associated with fire safety (electrical wiring, etc.), security and maintenance;
- property owners are frequently under-insured; and
- pressure to reinstate a property to a particular condition often comes from the owner or the community quite regardless of any requirement associated with heritage listing.

Against this background, it is difficult to avoid the conclusion that most considerations that the owners of heritage buildings might encounter when arranging insurance protection flow from the nature of their own particular property or location. Heritage listing does not raise automatic barriers or impediments to obtaining competitively-priced insurance cover. But it does alert insurers to the need for careful assessment to ensure that an adequate and appropriate contract is arranged and that the basis of any possible future loss settlement is clearly established and understood by both parties.

Architecturally significant buildings. Buildings of monumental proportions, such as many of the older churches in Newcastle, presented particular problems. One very large church was described by one engineer as being no more than a multi-storey garden wall! The roof was far above the floor with none of the cross-bracing provided by intermediate floors in commercial buildings; the building was long and narrow; there were no major trusses and the copper-clad, barrel-vault, lightly-built roof was the only means of holding the side walls together; the wonder was that it did not all fall in a heap. There are many church buildings like that in Newcastle, their imposing appearances belying their fragility in earthquake terms.

The issue was how to deal with such buildings, especially when they had significant sentimental or heritage value and when feelings ran high if there was any suggestion of their not being restored in a manner identical to that which existed prior to the damage.

Given the resources available through insurance, the question was posed as to how owners should go about restoring badly damaged buildings of high, noncommercial value. For example, should new finials, gargoyles and the like be manufactured out of modern materials so that they look just like the ones destroyed but are in fact not the same ones? If these features were reproduced, would they not just be building a "theme park" that could never have the same historical significance as the old?

Again, should insurers prop up the old portions by boring holes through them, inserting stainless steel rods and the owners and community then pretend that they are the same as formerly? Would Stonehenge or the Coliseum of Rome or other less well known but equally historic structures ever be regarded again with the same awe if they were fixed in this way?

Perhaps Coventry got it right after its famous Cathedral was bombed, burnt and reduced to a ruin in the second world war. Coventry resolved to build a new modern Cathedral right beside the ruin and separate the old from the new with a glass wall. In that way the worshippers of Coventry had a practical and magnificent church in which to follow their faith and preserve what remained of the old.

The modern insurance policy issued to cover commercial premises and major noncommercial buildings such as churches, contains three main elements. Firstly, it promises to indemnify the insured against loss. Secondly, it promises that indemnity on a new-for-old basis. Thirdly, it promises to meet the extra costs incurred because of regulations issued by the appropriate authorities. It is in this area of "extra costs" that the real problem arises for the insurer. The insurer can readily determine the financial liability inherent in indemnifying the insured on a new-for-old basis. But it is more difficult to determine what extra costs are likely to be demanded. In an attempt to place some limit on such items, the underwriter inserts the stipulation that the extra costs are limited to the restoration of the actual damage caused by the peril insured against unless the damage exceeds 50 percent of the full value of the building.

However, recent legal opinion seems to be that if the building owner is prevented from restoring the damage, however minor, unless he brings the entire structure up to current standards, then he cannot be indemnified unless all the work is put in hand, and

that at the expense of the insurer. Never mind the 50 percent proviso specifically brought into the clause wording! The difference can be millions of dollars.

Asbestos problems. There were many warehouses, commercial buildings and private homes in Newcastle roofed with asbestos. There was also asbestos used in the form of lagging around pipes and for insulation concealed in ceilings. The effect of the earthquake on this material had a dramatic impact on the cost of repairs to buildings. In fact, most buildings in Newcastle with asbestos roofs were the subject of earthquake damage claims; in many cases, the earthquake caused movement in the fixing screws and sheet joints that allowed the entry of water.

In quite a number of cases, asbestos was incorrectly handled and there were examples of contractors removing asbestos without notifying the authorities. One contractor was charged by the authorities for dumping asbestos material in nearby bushland. It was often the case that quotations for removal of debris had to be substantially escalated to comply with the statutory requirements for removing this dangerous material. One quotation for AUS$5200 for debris removal increased to AUS$72,000 when the contractors calculated the cost of compliance.

Commercial insurance claims for business interruption. This proved to be a very difficult and costly aspect of the earthquake for the business community of Newcastle. Small business was found to be almost totally without insurance protection for business interruption and small- to medium-sized businesses that did have insurance cover generally found the cover to be inadequate or ineffective.

There are normally three factors for a business interruption claim. Firstly, there has to be an insured peril, such as an earthquake. Secondly, the actual property of the insured at the premises of the insured has to be damaged by the insured peril, and thirdly, there has to be an interruption to the business resulting from that damage. It is normal practice to nominate an indemnity period and this is usually stated as 12 months.

The problem for those businesses that had interruption cover was that many of them did not suffer actual damage and, although they experienced either the total elimination of their trade or a very significant downtown for many months and in some cases several years, those businesses were not able to recover their loss from their business interruption insurance.

However, in those cases where there had been damage to the insured's property and a business interruption claim was successful under the policy there was an element of cover which did benefit many businesses. This was known as the "adjustments clause", which allows adjustment of a claim to take account of circumstances that would have affected the client's business had it not been for the damage. In one example, there was a large hardware chain whose property was closed down for many months after the earthquake and who could not participate in the resulting increase in trade as a consequence of the earthquake. They were, in fact, fully compensated.

The Cessnock earthquake, 6 August 1994. The city of Cessnock is situated about 45 km due west of Newcastle. The epicentre of the August 1994 earthquake was near the small village of Ellalong, 10 km south of Cessnock. The earthquake measured 5.3 on the Richter scale, slightly less than that of the Newcastle earthquake. While it is still too early to provide final data on insurance claims, the aggregate loss is expected to be about 10,000 house claims and 400 commercial claims for an estimated payout of AUS$34 million. For the most part, houses sustained only minor damage.

This earthquake was not declared a disaster by government or the ICA, and the processes of loss adjusting and claims settlement were left entirely to individual insurers. This time, however, loss adjusters were much better prepared to point out to property owners the non-earthquake pre-existing building defects and maintenance problems.

A number of property owners in the Newcastle area who had received cash settlements for their Newcastle earthquake claims and who had not carried out the repairs came forward with new claims for the same damage, alleging the Cessnock earthquake as the cause. In some cases, these people tried to claim through the same insurer and in other cases they had changed to another insurer in the intervening years. It was quite foolish for these people to attempt to pursue their false claims because the insurance industry holds a Newcastle earthquake reference database of some 48,000 entries. The media took up the issue and the practice soon faded away.

Conclusion

The spate of natural disasters in Australia over the past five years has brought into focus a number of important considerations for the insurance industry and the community in general.

Natural disasters deliver up tens of thousands of domestic claims and hundreds of commercial claims, which provide a significant database for analysis. When combined with data available from disaster welfare agencies and community relief agencies, a very exact picture of the degree of non-insurance and under insurance emerges.

The degree of non-insurance has surprised not only the insurance industry, but governments and welfare agencies. The January 1994 bushfires in NSW revealed that 22 percent of the homes totally destroyed by fire were not insured. An even more alarming statistic was the discovery that 52 percent of the contents of homes totally destroyed in the bushfires were not insured. People choosing not to insure their prime asset ranged across the socio-economic spectrum.

Under-insurance is a disaster that can be avoided; it is only a matter of effecting adequate insurance. The percentage by which homes were generally under-insured in these bushfires was 30 percent, that is the sum insured to the real cost of reinstatement. However, in some socio-economic groups this percentage rose to as high as 50 percent. In many cases, the sum insured did nothing more than meet the liability of the homeowner to the mortgage; in consequence, the homeowner's own equity in the property was unprotected.

Insurance of contents of homes generally falls short of the real cost of replacement by an average of 30 percent and rises to 60 percent.

When disaster victims are interviewed by welfare agencies, the opportunity is taken to find out why they are either not insured at all or are grossly under-insured. There is a section of the community that just does not believe in insurance and chooses to carry the risk themselves, believing that a disaster can never happen to them. However, it is this section that becomes the major beneficiary of appeal funds, which means that instead of transferring their risk to an insurance company they have merely transferred their risk to the generosity of their fellow citizens.

Insurance over home and contents is essential and property owners must be made aware that disasters do happen and sooner or later a disaster will befall their community. If adequate insurance is in place, a large element of disaster trauma can be eliminated.

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The Earthquake Commission's preparations for disaster

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The Earthquake Commission (EQC), now restructured as a separate corporate entity, has a tremendous challenge: how to handle the 70,000 or more claims from the Wellington scenario earthquake with a dozen staff, all of whom have been personally affected by the disaster.

Planning is the only solution. EQC's current plan covers six areas:

- *staffing, including temporary staff;*
- *operations — configuring the office to cope with the influx of claims;*
- *claims-assessing resources;*
- *activation of the insurance industry's emergency plan (the IEP);*
- *activation of the alternative site at Manukau, near Auckland; and*
- *accounting and financial aspects.*

However, EQC wants to ensure its catastrophe response planning is as comprehensive as possible. Having sought out and learned from the best practitioners in the world, EQC has commenced a revision of its own plan. This will document the coordinated involvement of all the outside specialists identified as having a part to play. Full benefits of the latest technology will have to be gained in order to maintain communications links, register triage claims, process claims and monitor progress. Regular training, testing and review will not only promote readiness, but will also encourage all participants to take a proprietary interest in the plan.

Introduction

The Earthquake Commission (EQC) is a Crown Entity (government agency) set up under the Earthquake Commission Act (1993) to administer an insurance scheme that protects participants' property against damage or destruction resulting from certain types of natural disaster, the most significant being earthquakes. Membership of the scheme follows automatically from the purchase of fire insurance from an insurance company. That company collects the premium on EQC's behalf and passes it in bulk to the Commission monthly.

Due to the splendid foresight of the previous generation in setting up such a scheme immediately following the second world war, and to nature's sending a "quiet period" for earthquakes since then, EQC's capital and reserves have been built up to NZ$2.4 billion. This is still not enough, but currently with the commercial reinsurance arrangements EQC has been able to make, the Commission should be able to fund its maximum foreseeable loss. This, caused by movement along the Wellington fault line under the city, would result from more than 100,000 claims on the Fund, amounting to $3 to $3.5 billion when a prudent insurer's margin is added (Dowrick et al., 1991, 1992).

Nevertheless, a Government guarantee is written into the Act. Very advanced corporate modelling (Ansley 1994, Ansley and Kreps 1994) carried out on behalf of the Commission has established that the probability of calling on this guarantee in the medium term (i.e. EQC's "Probability of Ruin") is very high, so long as current arrangements of EQC's payments to the government are in force.

Recently, the scheme was changed to include only domestic property (houses and their contents), and a four year phase-out from nonresidential property is currently under way. The new residential scheme has been called "EQCover".

The main objective of EQC is:

> *to pay all lawful claims on the Commission promptly and fairly and still remain solvent without calling on the Crown guarantee*
>
> (EQC Statement of Intent 1994-1996)

Funding is critical to the recovery process. Mader (1994) states, "Financial resources are the fuels that drive the rebuilding engines after an earthquake". The experience of areas of Los Angeles after the Northridge earthquake illustrates the point in a negative way: without funding, what little happens, happens slowly.

With its dozen salaried staff, EQC handles about 3000 claims per year as a matter of routine. These involve the employment of external assessors, engineers, valuers and other specialists. The greatest single-event workload came from the 1987 Edgecumbe earthquake, which resulted in 6000 claims. EQC estimates that the number of claims arising from its worst scenario could exceed 100,000. With the uncertainties of the past few years now settled and EQC's future as a purely domestic insurer established, EQC must develop and maintain its own catastrophe response plan. In the past, the State Insurance Office stood behind the Earthquake and War Damage Commission's obligations with all its resources of a national branch structure, claims personnel and expertise. This facility disappeared upon the decision to sell State to the private sector and subsequent restructuring of EQC into a separate corporate entity. The link is now broken — EQC is on its own.

The Commission has developed its own disaster plan since that time. It is divided into six sections:

- staffing, including temporary staff;
- operations;
- claims-assessing resources;
- activation of the insurance industry's emergency plan (the IEP);
- activation of the alternative site at Manukau, near Auckland; and
- accounting and financial aspects.

EQC's response will depend greatly on the IEP (NZ Insurance Council, 1993), which will take over other sections of EQC's own plan (e.g. the allocation of assessors) if the IEP is activated. This is a decision largely left to the local emergency committee. While the IEP would provide an adequate response to moderate disasters, its viability is less certain when faced with the extent and dislocation of this major earthquake. This is not to say that EQC's current plan would necessarily fare any better.

EQC has investigated insurance companies' catastrophe response plans that have had to be implemented. Commissioners and staff visited companies in the UK that had experienced the devastating storms of a few years ago and in Australia to learn about the Newcastle earthquake and subsequent bushfires and hailstorms. EQC representatives went to Los Angeles to see US companies still engaged in the aftermath of the Northridge earthquake. Other offices, like the American Red Cross, Los Angeles City Department of Building and Safety, California State Government Office of Emergency Services and the Office of the Insurance Commissioner of California were also called upon. All were very generous with their time and their information, holding nothing back. State Farm Insurance even invited EQC representatives to spend three days with their Disaster Response Team in Bloomington, Illinois, an experience that proved seminal in the revision of EQC's own catastrophe response plan, which is now under way.

The scenario set for the conference states that over 43,000 houses in the Wellington area have damage. This is about one-third of the number of houses in the area. On top of these (say) 45,000 claims there are those from the wider area affected — north into the Manawatu and Wairarapa, south to Marlborough and Nelson and even as far as Westland and North Canterbury (according to the scenario). There is a total of 235,000 homes in these regions, housing about 20 percent of the entire population of New Zealand. EQC could expect a further 25,000 claims from outside the Wellington region. Obviously these will be smaller claims, many involving only contents. EQC must pay all claims over $200, a minuscule excess by world standards.

The total number of claims arising from this earthquake is, therefore, likely to be at least 70,000. EQC's planning is based on a similar earthquake being the maximum credible event of about 100,000 claims.

The civil emergency

An earthquake of this magnitude and resulting in such casualties will, of course, lead to the declaration of a state of Civil Defence Emergency under the Civil Defence Act (1983), which would give definite priority to personal safety and welfare — not areas of professional concern to EQC — during the response phase. EQC must also expect restrictions on access to its own office in the area of reclaimed

land in downtown Wellington, west of the harbour. This is within the MMIX isoseismal.

No doubt, access to many claims sites will also be denied for some time. While this may not cause any difficulty initially, EQC should be ready to commence the inspections necessary within two weeks of the earthquake and claims in "off limits" areas will then become a concern. In the meantime, settlement of lesser claims — those out in the MMVI areas and below — will be progressing.

It is prudent for us at EQC to try to ensure by prior arrangement that our staff can get to our office, if safe, and that that office has a priority for the restoration of necessary services. Equally important is a plan for alternative siting of the office, either within Wellington or away from the city. EQC has an alternative site near Auckland, which is described later.

Civil Defence is in the hands of local authorities and each Civil Defence Controller may accord priority treatment for EQC at their discretion. Obviously a critical contact for EQC is the Wellington City Council Emergency Management Office, but a comprehensive approach to all 78 controllers is necessary to obtain coverage of all possible claims sites in New Zealand.

A rapid inspection and tagging system has been prepared by the Ministry of Civil Defence and disseminated to all local authorities. Again, different local practices will complicate planning, but a link with this system could be of benefit to EQC in that it provides an initial indication of the extent of the damage. Coordination and multiple use of surveys is important. There are reports (for example, Robinson, 1988) following both local and overseas events, of victims losing patience with the seemingly constant stream of inspectors traipsing through their properties on behalf of one authority or another. Furthermore, for reasons of efficiency, EQC could avail itself of reports obtained for other purposes (e.g. chimney safety, integrity of foundations, etc.) to assist the claims process.

With thoughtful planning and the cooperation of the authorities, EQC will seek to utilise the period of the Civil Defence emergency constructively instead of resigning itself to a situation of restriction and disruption. It could marshall, brief and equip its response team for its duties within the most severely affected areas while settling smaller claims from outlying districts, using, to the fullest extent possible, methods that do not involve a visit by an insurance claims assessor.

Human needs

The human resources required by EQC to accomplish its work will exhaust local supply. Along with the tradesmen and professional people brought in by other organisations, EQC and the insurance companies will have to "import" assessors, engineers and other claims-handling personnel. Whether they come from other parts of New Zealand or from abroad, these people will be worked for long hours while they are on site and will have a finite tour of duty. Obtaining assessing resources from off-shore, through the international firms in New Zealand and independently of them, is a part of EQC's current plan.

The people EQC sends out to the public will be dealing with claimants who have just suffered great personal loss or tragedy. They may still be in shock or ignorance about the fate of loved ones or their own future. An insurance claims executive with experience of the Newcastle earthquake of 1989 recently told the author that the most difficult aspect of all was the interface between traumatised claimants and overstressed insurance personnel.

The first need is for adequate pre-disaster training, preparation and briefing. This, of course, presupposes that individuals have been identified well in advance. Welfare, medical and counselling resources should be part of the on-site catastrophe response team but, more than that, peer contact, partnering, socialising and opportunities to interact with each other must be part of the response plan.

EQC staff availability

In the conference scenario, the earthquake has struck at the homes of every staff member of the Commission, including potential temporary staff to be taken on in Wellington because of the emergency. These people will at least be under some personal stress and have priorities ahead of trying to report for work. Matters like missing pets, nervous children, chaotic homes or disrupted transport will militate against their coming in. These priorities may not be what we would prefer, but they must temper EQC's dependence upon Wellington-based staff to turn out on its behalf.

This means our planning must not be dependent upon the availability of individuals. Dual staffing of critical positions will assist, but of more use is the meticulous detailing in writing of all necessary duties and functions. EQC has a Disaster Action Plan of which every Commissioner and senior staff member has several copies for home, briefcase and office. It is intended to be clear and very detailed, containing pro forma forms and statements, names and contact numbers, location of equipment and supplies, and procedures for setting things in motion.

Staff who may be willing to continue working from Wellington may be reluctant to go up to Auckland to the alternative site. It could be several days at least before any regular EQC staff manage to report to the Auckland office. The alternative site may well be operated by alternative staff, brought together through the efforts of a non-Wellington domiciled Commissioner, utilising their Disaster Action Plan.

The government factor

As the government can shift its attention away from matters of initial response, EQC must be prepared to be regarded as a prime implementer of any policy devised to deal with recovery. Prior consultation will clarify for each side the requirements and expectations of the other.

Matters to be talked through include:

- The manner in which government would expect EQC to settle claims. The simplest method of quantifying the amount of loss or damage and then paying out by cheque may well be unhelpful if banking facilities are disrupted or rebuilding resources are unavailable. Due priority will need to be given to the recovery of the community. Desertification of earthquake-hit areas through lack of funding for domestic renewal has been shown to be a problem in other countries, e.g. USA (Colvin and Gordon, 1994). In New Zealand, although the funding for domestic renewal will come predominantly from EQC, a government agency, EQC claims payouts may be spent in other ways than on repairs and reinstatements. There is still, for example, the possibility of widespread expenditure of claims proceeds on means to enable victims of the disaster to leave behind their shattered dwellings and restart life elsewhere. Also thwarting the purpose of domestic recovery and renewal is the practice of paying the proceeds of claims to mortgagees if they then use the cash to liquidate their debt on a badly damaged house, leaving the occupiers debt free but homeless. EQC will have to consider methods of settling claims that, while avoiding the insurer's nightmare of becoming the guarantor of every tradesman's work, ensure that claims proceeds are used for the purpose intended. A system of payment on completion of repairs to the satisfaction of the claimant is not difficult to set up or administer.
- According to a Government discussion paper (Hon Doug Kidd, 1991), the Government will wish to see essential community facilities reestablished first, followed by domestic housing and then commerce. Market forces alone will not ensure this order of priorities. EQC, as virtually the sole funder of housing reinstatement, could be seen as an agency through which Government policy could be implemented by direction of scarce building resources, both human and material. This is an area that several papers at this conference touch upon, with an indication that follow up work is necessary.
- EQCover follows automatically from the purchase of a homeowner's policy from a regular insurance company. The corollary is that, if there is no homeowner's policy (or any policy of fire insurance), there is no cover from the Commission. EQC's scheme does not relieve New Zealand authorities from the problem of uninsured homeowners. For this particular "earthquake", we can predict that 1500 damaged houses and 8000 owners of damaged personal possessions will not be insured. These will form a sizeable pressure group that will no doubt catch public attention.

Disruption of lifelines and infrastructure

The Centre for Advanced Engineering's study of Wellington's lifelines in earthquakes (Centre for Advanced Engineering 1991) contained some preliminary assessments of the time it would take before a general service could be expected to be restored. The scenario reflects these assessments:

- up to two weeks for water;
- 12 weeks minimum for sewerage;
- two weeks for electricity supply;
- three to six weeks for telecommunications services, although a restricted cell phone service should be available within a day or two;

- several weeks for reasonable road access and months for rail;
- six weeks for the airport.

In most cases, a basic manageable service for priority use could be in operation within days or even hours. EQC could make a good case for being registered as a priority user. Although there is no doubt that an earthquake of the magnitude postulated for this conference will dictate a removal of EQC's headquarters to the Auckland alternative site, EQC will need to return to its Wellington headquarters as quickly as a resumption of services can allow.

However, a substantial presence in the disaster area will have to be maintained for the access of the public and for control and coordination of the claims inspection operation, which will involve several hundred personnel. This is a major part of the Insurance Emergency Plan in which EQC is a partner. This plan deals with the setting up of temporary information/claims centres by pooling the resources of all insurance companies. The IEP provides for all claims handling to be effected through an on-site coordinating adjuster (OSCA) and his team. The OSCA's role is pivotal to the purpose and operation of both the IEP and the centres set up under its provisions. These centres will have to be outside the areas of severest disruption, but close enough to promote maximum operational efficiency.

Communications and operations

After the Northridge earthquake, an insurance company in California said it received 15,000 claims (about half its eventual total) in the first five days. Primary requirements for handling this level of activity are adequate communications systems and claims handling operations. EQC's normal resources will have to be multiplied several-fold to be able to cope. Traditional insurance company claims processing methods will have to be re-examined by lateral thinkers during a process re-engineering exercise. Technological solutions, such as expert systems, document imaging, estimating software and geographical information systems, must be investigated. The attributes of the country's telecommunications system must also be utilised to the full; for example, an 0800 number's ability to recognise the area code of a caller could be used to direct calls from areas where minor damage has occurred (say MMVI and below — the outlying perimeter of the affected area) to separate call centres equipped especially to deal with small claims, possibly even settling them there and then, over the telephone. In this scenario, calls from Palmerston North, the top of the South Island and any from further afield could be directed to the special small claims call centre.

EQC must be prepared to operate without access to its primary computer systems. Normal business prudence is followed by making tape backups and storing them off-site. EQC has an alternative site from which to operate, in the Manukau City centre, close to Auckland airport. An agreement with a supplier has been concluded by which these alternative offices will be equipped and set up within 72 hours of notice being given by an EQC Commissioner or senior staff member. There are sufficient space and support facilities to enable EQC to double its current staff numbers with temporary telephonists and data input personnel. This site is tested annually and its adequacy reviewed. Following the 1994 test and review, arrangements at the site and for its use were substantially upgraded.

Disruption of the insurance industry

As already stated, EQC currently relies on the IEP of cooperation among insurance companies and a pooling of resources to enable an adequate industry-wide response to a disaster. The disaster preparedness of individual companies within the industry is, therefore, of interest to the Commission. It is a subject on which we have sought little information to date.

Because EQC extends coverage only to those who have a valid policy of insurance with a commercial insurance company, it must at some stage (at present it is the initial stage) obtain confirmation from the company that a policy is in force. Currently, this is achieved by an exchange of correspondence, an unwieldy enough procedure when a 3000-claim event occurs. Clearly, arrangements will have to be made for the electronic interrogation of the databases of at least the market leaders if this one necessary step is not to reduce EQC's handling of the 70,000 claims to a snail's pace. EQC is currently seeking assurances from external auditors that company records will still be available in spite of a disaster.

Shortage of resources

The papers in the physical reconstruction section of this conference address issues surrounding the

provision of sufficient building resources to allow reconstruction to be completed. EQC must also consider how to cope with the shortage of claims-handling resources — assessors, engineers, tradespeople and insurance staff.

The change in cover given by the new residential scheme alters the relationship between EQC and insurance companies. Whereas previously each party was involved in a replacement basis claim from the start, now insurance companies will be activated only when a claim exceeds the limits to which EQCover insures — $100,000 for a dwelling plus $20,000 for its contents. These are very high excesses from the insurance company point of view and they will be concerned with only a small minority of domestic claims. (They will be called upon for motor vehicle claims and other items covered by them but excluded under EQCover.) It seems to follow that insurance companies with predominantly domestic portfolios will be net resource providers under the IEP, with EQC being a major user. I should add a note here that, until the end of 1996, when EQC relinquishes its last nonresidential risk, it remains the first loss insurer up to a limit of this class of property also, but this scheme is on an indemnity basis.

The telemarketing industry already has most of the resources needed for setting up and operating claims calling centres. Training and software — normal requirements for a telemarketing company's client — are the only additional elements to add to the premises, communications systems and staff already employed in that industry. EQC is investigating the possibility of telemarketing specialists having a role in the catastrophe response.

There are about 350 insurance assessors in New Zealand who could handle earthquake damage claims. With each assessor capable of handling about 100 open claims at once, and being in demand from insurance companies as well as EQC, there is obviously going to be a shortage. The two approaches to deal with this shortage (not mutually exclusive) are to use assessors sparingly and to contract with overseas suppliers. Some of the technology mentioned under "Communications and operations" and use of other specialisations like quantity surveyors, property managers, engineers and architects (supervised by a senior assessor) will achieve the former. As for obtaining overseas staff, the difficulty is not in the numbers but in the training, orientation, logistical support and local acceptance of them. EQC has developed introductory material for assessors arriving from overseas to work during a disaster.

Financial markets

The short-term reaction of currency markets to the disaster is uncertain. Perhaps the stronger likelihood is that the kiwi dollar will fall with a preponderance of players anxious to sell out of it. This will, of course, create import inflation to exacerbate the shock inflation following from the post-earthquake shortages of consumables.

This is the background against which EQC will be seeking to liquidate its assets to provide the funding for claims settlements. At present, about 40 percent of those assets are denominated in five foreign currencies and a partial natural hedge will be in operation. As the kiwi falls, EQC's foreign assets will rise in value, while EQC's claims payment currency remains kiwi dollars. However, import inflation will cause claims costs to rise, subject to the caps on EQCover of $100,000 per home and $20,000 per contents policy.

Apart from working capital, the rest of the Natural Disaster Fund is invested at government direction in its own bonds. The government would have to borrow to replace the EQC money now required to pay for the disaster. The orderly liquidation of investments is a matter that would involve Treasury, the Reserve Bank and EQC. For EQC's part, its reinsurance programme cuts in before the Fund is exhausted, so it can be used to buffer investment liquidation.

Reinsurance

EQC buys one of the world's biggest catastrophe reinsurance programmes, by which the international market would commence reimbursing EQC for the cost of claims after they exceed NZ$1 billion, to the tune of a further $1 billion. The total claims cost to EQC, to which reinsurers will be contributing, will be $2.5 billion to $3.0 billion.

Our brokers will need accurate reports of EQC's claims payments to effect the timely collection of proceeds from our reinsurers. Other insurance companies will also be making demands on their reinsurers. The currency in which these claims will be paid is New Zealand dollars. Reinsurers' demand for the several billion New Zealand dollars required

to meet their obligations is one factor arguing against a spectacular fall in the value of the kiwi — there will still be significant demand for the currency.

Media

The news media are a legitimate part of any disaster situation: our challenge is to enable them to be informative, accurate and constructive.

It is as vital to prepare and plan for media activity as it is for any other part of the catastrophe response. Much can be done beforehand in the forms of ensuring systems can produce the timely statistics that interest the press, pre-production of announcements to the public for television, radio and newspapers, and finding the contacts with whom to open up channels of communication with each organ of the media.

EQC has deposited with radio stations and newspapers a copy of its "What to do if you have a claim" statement in the hope that it will be used after a disaster. Perhaps the hope could be turned into something more formal and certain.

We can also prepare generally for the stories that are bound to break — the uninsured houseowner who has lost everything, unusable community structures that could not afford insurance, aspersions that EQC has insufficient money to meet claims, the price and availability of rebuilding resources, delays in repairs, etc.

The international press will take an interest in a disaster of the magnitude of the scenario and any releases for this media will need more general background for overseas readers with little idea of the New Zealand situation.

The scientific community

Whenever an earthquake of interest to New Zealand occurs, the National Society of Earthquake Engineering sends a reconnaissance team. This is usually made welcome and all possible access and courtesies are extended by the hosts. EQC has itself benefited from the tremendous goodwill of American friends in sharing their experiences and information after earthquakes they have had. It would be only civil of us to receive overseas visitors in the aftermath of our own disaster with the same hospitality and openness. The hosting of international delegations should be part of our catastrophe response plan.

Conclusions

EQC has scanned the world in search of the best practices for handling a large and sudden influx of claims after an insured disaster, when the providers of the cover are themselves affected by the disaster. Although we have found several companies that do it well, we have to recognise our own unique situation: Our organisation of 12 permanent staff must be turned into one of perhaps 1000 in a very short time. Our claims system handles about 3000 claims per year — it must suddenly be made to handle over 100,000. It is not enough just to import the people and the equipment within days of the event. We have to have an organisational structure waiting to be activated to manage the new staff, the new sites, the new equipment and all the other necessary features.

Unlike other disaster sites we have been told about, we would not be an island of destruction in a sea of resources (Newcastle 1989, Loma Prieta 1989, Northridge 1994) — Wellington would be an island of destruction in a sea, full stop. The transport links between Wellington and the rest of New Zealand and the world are the most vulnerable feature of the city.

EQC's current plan is to link into the insurance industry's IEP, obtain additional claims-assessing resources from overseas and operate its office, expanded by temporary telephone and inputting staff, from an alternative site near Auckland, if necessary. Meetings with organisations that have experienced disasters like the worst that EQC could face have convinced EQC that more comprehensive preparations are needed for the "mega-catastrophe".

EQC will meet its responsibilities for the rebuilding of Wellington by planning meticulously for the event, leaving nothing to chance. Such planning will become an integral part of EQC's routine operations, as constant review will be needed to maintain currency with available technology, increasing knowledge of seismic disasters and the circumstances of all the partner organisations we have involved. This plan is the first step in a four-part process of responding to a catastrophe, the whole of which involves planning, initialising the plan, sustaining the catastrophe response organisation during the emergency, and finally — very importantly — shutting down the operation in an orderly manner.

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Insurance and Financial Markets 2

Reinsurance — Its contribution to risk assessment and disaster management

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The way that reinsurers would handle the aftermath of a Wellington earthquake, and what they could do to help deal with the losses is discussed.

We compare the Wellington scenario with the latest worldwide loss experience. Recent years have seen an unprecedented increase in the loss burden from natural catastrophes. Since 1987, seven events have occurred, each costing the insurance industry more than the NZ$4 billion postulated for the Wellington earthquake. It is, therefore, safe to assume that reinsurers would have no difficulty bearing their share of the Wellington loss.

Because of the city's high seismicity and insurance density, reinsurers have been carefully monitoring and analysing the earthquake risk of Wellington for quite some time. Primary insurance companies in New Zealand and other interested parties have already been notified of the results of corresponding model calculations. Swiss Re will not be caught off guard by the extent of a possible loss; on the contrary, our own capacity studies make provision for even higher potential losses.

On the whole, reinsurers should have no difficulty with the Wellington earthquake, although some allowance should be made for the ongoing privatisation of earthquake cover for commercial/industrial risks. There will be enough reinsurance capacity available provided information is explicit enough to enable a precise quantification of the risk and provided the price of the cover is adequate for both insurer and reinsurer.

Introduction

There should be no doubt whatsoever that Wellington will be hit by a big earthquake one day. But for an international reinsurer like Swiss Re Group, will it be just another loss among many? Or at least a not quite everyday event with an impact on our profit and loss account? Or will it perhaps amount to a disaster of totally unexpected proportions, pushing us and other reinsurers to the very limit?

The scenario specified for this conference is an event of magnitude 7, claiming 1600 lives and damaging about 40,000 properties in the Wellington region with total insured property damage somewhere around NZ$4 billion (approximately US$2.5 billion).

Although Wellington is not one of the world's largest cities with a population of millions, it is a highly interesting location for an international catastrophe reinsurer. I can hardly think of another place of similar size that has such a high earthquake exposure as Wellington. It is literally perched on top of an active fault with an earthquake potential of up to magnitude 8, which is close to the strongest events imaginable. Furthermore, a large part of private property (buildings and contents) and of possible business and production interruption in Wellington will presumably be insured against earthquake. This is not the case in other earthquake-prone cities like Los Angeles or Tokyo, where the insured portion of property is considerably smaller.

It, therefore, goes without saying that the insurance industry, i.e. New Zealand insurers and international reinsurers, will play a decisive role in coping with the consequences of a major earthquake in the Wellington area.

Reinsurance in general

Reinsurance is simply insurance one step removed from the "man in the street". Insurance companies need to stabilise in time and space the fluctuations in their losses and results, a need that is met by reinsurance. Reinsurance exists for all the lines of business for which there is direct insurance, although its extent varies with the susceptibility of the business to fluctuations.

To give some indication of the dimensions involved, the 1992 worldwide premium volume of private non-life insurance totalled around US$700 billion, of which about US$150 billion, or around 20 percent, was passed on in the form of reinsurance (Swiss Re, 1994a). New Zealand's non-life premium volume was NZ$2.89 billion in 1992. We do not have figures as to exactly how much of this was re-insured, but it is likely to be in line with the world average of around 20 percent. The proportion of reinsurance payments for major losses (e.g. natural catastrophes) is, however, much higher.

Reinsurance is especially needed for those lines of business that are prone to major fluctuations. The insurance of natural hazards is a classic example. Natural catastrophes, such as earthquake or storm, rarely occur in a specific area. But they affect entire regions and insurance portfolios at a time, simultaneously causing untold amounts of bodily injury, property damage and consequential losses. It is, therefore, impossible, over a reasonable period of time at least, to achieve any form of balance between premiums and losses in the affected area alone. These risks are only bearable to some extent if they can be spread throughout the worldwide reinsurance system.

Past and future catastrophe losses

Loss experience

A glance at the losses over the past 20 years shows that the insured losses from catastrophe events are quite clearly rising (Figure 1). There are several reasons for this development. Key aspects include the general increase in insured values, the greater concentration of values in coastal areas (which are more exposed to natural hazards) and the increasing comprehensive cover of such risks by insurance.

If we look at the principal natural hazards of storm, earthquake and flood separately, there are a few essential differences (Table 1). Insurance against storm hazard is fairly comprehensive, as in most countries it is automatically added on to fire coverage. Normally, therefore, the greater part of the overall damage to the economy is insured. Earthquakes and floods cause high fatalities (especially in developing countries) and can result in extensive damage to the economy. The insured portion, however, is usually small, in particular because the covers are not (yet) so widespread or are subject to limits or deductibles. What is more, these perils largely affect the infrastructure (transportation, lifelines, etc.), which is normally uninsured.

It is important to note that although these losses place a great burden on the insurance industry, financial obligations have by and large been met. None of these events has, for example, exceeded the loss potential assumptions we use to determine our capacity allocation.

Loss potentials

One thing is certain: matters can get worse. Table 2 shows estimates of the possible extent of future insured losses from natural catastrophes.

Although our conference scenario only states a figure of US$2.5 billion for Wellington, we have put it in the category of events from US$5 billion. The reasons are listed below. It should be borne in mind that the probability of the scenarios given here varies greatly. Certain earthquake scenarios (e.g. London

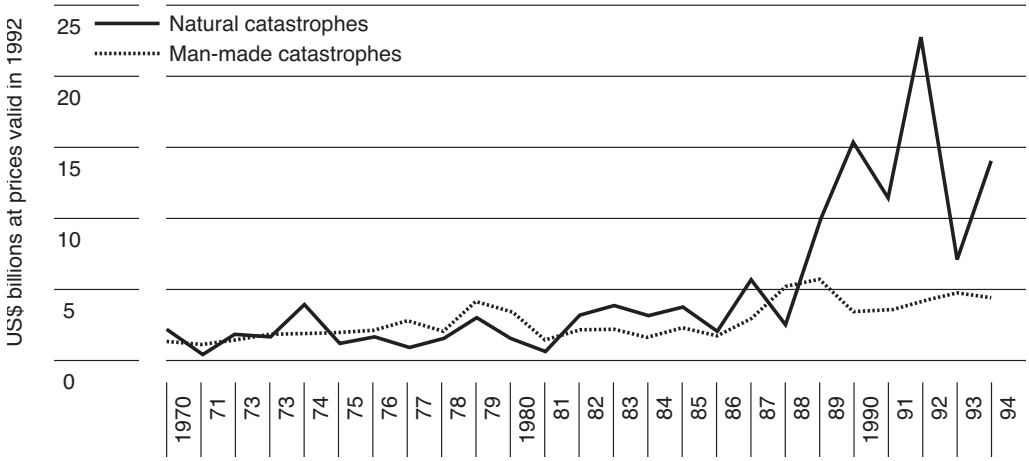

Figure 1: World total of insured catastrophe losses 1970-1994 (Swiss Re, 1995b)

Table 1: Major natural catastrophes 1985-94

Peril	Event/Location/Country	Date	Deaths	Loss total billion US$	Loss insured billion US$	Loss insured % reins.
Storm	Andrew, Florida	08/92	15	30.0	15.5	40
	Mireille, Japan	10/91	51	5.2	5.2	25
	Vivian, Europe	02/90	64		3.2	70
	Daria, Europe	01/90	95		4.6	70
	Hugo, Carib./USA	09/89	61		4.3	50
	Gilbert, Jamaica	09/88	350	1.1	0.8	50
	Oct. Storm, Europe	10/87	13	2.9	2.7	50
EQ	Northridge, Ca.	01/94	64	30.0	10.0	40
	Latur, India	09/93	9500	0.3		
	Gilan, Iran	06/90	50000	8.0	0.1	
	Newcastle, Austr.	12/89	10	0.8	0.5	
	San Francisco, Ca.	10/89	63	7.0	1.0	30
	Armenia	12/88	25000			
	Mexico City	10/85	10000	4.0	0.2	90
Flood	Mississippi/USA	06/93	45	0.8	12.0	20
	Pakistan	09/92	3800	0.7		
	China	06/91	1700			
	Bangladesh	04/91	140000		0.1	

or Sydney) are mainly determined by the fact that, although these cities are in low-seismicity areas, earthquake insurance covers almost everything, so even a medium-sized event would cause vast insured losses. The corresponding return periods for these scenarios are, however, well over 1000 years, whereas for seismically active regions (California, Japan) or for storm scenarios, time horizons of about 100 years are more realistic.

The Wellington scenario in detail

Insured values

The Wellington scenario is shown in Figure 2.

We do not have any comprehensive data on the insured values concentrated in the affected area as we do not know how the insurance density of commercial/industrial risks will look once privatisation has been completed (from 1996). However, data is available for property, on indemnity value basis, in 1990. Table 3 shows the values for the main affected CRESTA (Catastrophe Risk Evaluating and Standardising Target Accumulations) zones.

These values have to be increased by about 15 percent to allow for inflation from 1990 to 1995. We estimate the changeover from indemnity value to replacement value to be an additional 40 percent. This leads to property values of about NZ$39 billion (of which about NZ$12 billion commercial/industrial) in zone 10 alone and approximately NZ$73 billion (of which about NZ$22 billion commercial/industrial) in all five zones together. Not included are business interruption values, which we estimate to be a further NZ$3 to 5 billion in this area.

Losses: direct insurance and reinsurance

Figure 2 shows the approximate extent of the area affected by the event outlined in the given scenario, with insured values (taking the above mentioned NZ$73 billion and including business interruption covers) of about NZ$80 billion. The scenario loss of NZ$4 billion corresponds therefore to a damage ratio of about five percent of the affected replacement value.

According to the scenario, the loss for the residential risks covered by the EQC should be about NZ$2 billion. With the current reinsurance programme of the EQC, NZ$1.2 billion would remain with the EQC and NZ$0.8 billion be assumed by reinsurance.

How the remaining NZ$2 billion from the commercial/industrial sector is distributed between insurance

Table 2: Estimated extent of possible insured damage from natural catastrophes (* including claims payments from state insurance covers)

Ins. loss billion US$	Earthquake	Storm	Flood
> 40	San Francisco/USA Los Angeles/USA	USA east + Caribbean	
20-40	Tokyo/Jap.*	Japan NW Europe (F/UK/B/NL/D)	
10-20	Midwest USA		
5-10	Mexico Israel Sydney/Australia Lisbon/Portugal Vancouver/Canada London/UK Wellington/NZ	Australia Hawaii	London/UK France*+Germany

and reinsurance depends on the individual reinsurance programmes of the various companies, which we do not know in detail. Let us assume that 20 percent remains within the insurer's deductible and 80 percent is paid by reinsurance, then the insured loss remaining for reinsurance totals NZ$2.4 billion (approximately US$1.5 billion).

As mentioned above, comparison with the reinsurance loss of recent years would suggest that this event could easily be absorbed by the international reinsurance market, although it is, of course, not possible to state anything on the proficiency of the individual market players. As far as Swiss Re Group is concerned, our own PML estimates assume a market loss significantly higher than NZ$4 billion. Our share thereof, however, will clearly be less than our exposure from other major earthquake and storm scenarios.

Our models even go one step further. We calculate the possible maximum loss burden arising from the occurrence of several catastrophe events throughout the world in the same year and their corresponding probabilities so as to have sufficient funds for such events.

Reservations

It is by no means certain that the insured loss will not exceed these NZ$4 billion. After events such as Northridge 1994 or Newcastle 1989, the insured loss amounts continued to rise for months. This phenomenon is attributable to the widespread impact a natural catastrophe can have. As tens of thousands of losses occur simultaneously, it is practically impossible for insurance companies to adjust losses strictly and settle them accordingly. The great demand for repair material and services causes prices to explode — at the insurers' expense. The cost for anti-seismic improvement of buildings — often on the basis of corresponding state provisions — is, likewise, passed on to insurers.

The impact of these aspects is all the greater the more isolated the area affected and the higher the insurance density. Wellington would, therefore, be an obvious candidate for a massive increase in insured damage in the long run. It cannot be ruled

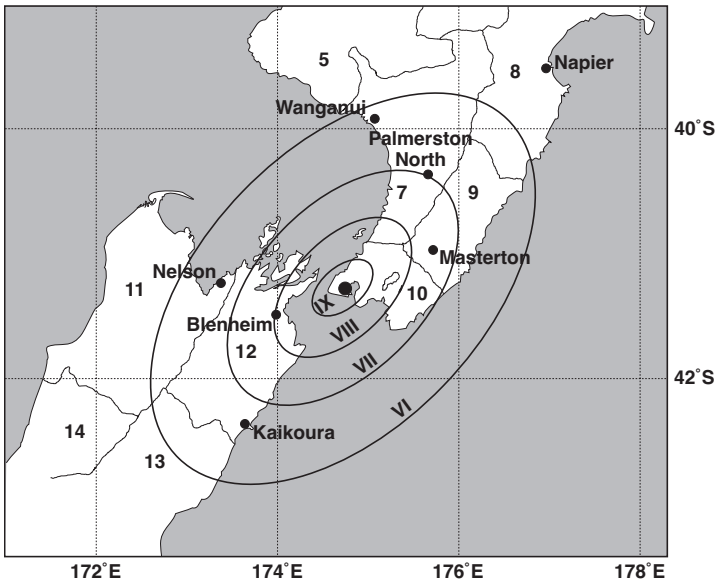

Figure 2: Wellington scenario earthquake M 7.5: Accumulation zones and estimated Modified Mercalli intensities

Table 3: Property values 1990 (indemnity value) per CRESTA zone in NZ$ billion (EQC renewal info)

CRESTA zone	Resid./Flats/Rural/Urban		Comm./Ind.		Total
	build	cont	build	cont	
7 Manawatu	4.43	3.02	0.89	2.40	10.74
9 Wairarapa	1.38	1.03	0.20	0.70	3.31
10 Wellington	11.22	5.60	4.47	3.11	24.40
11 Nelson	1.79	1.11	0.37	0.89	4.16
12 Marlborough	1.03	0.77	0.19	0.54	2.53
Total 7 + 9 - 12	**19.85**	**11.53**	**6.12**	**7.64**	**45.14**

out that in time, the NZ$4 billion — estimated one month after the event — might even double in size.

Risk assessment methods

Method applied

In reality we are still talking about an impending event and nobody really knows how many casualties and damaged buildings it will cause and what the insured loss will be.

For reinsurers — as well as for direct insurers — it is crucial to be able to assess the extent of loss in advance and as accurately as possible. This enables us to calculate the premium level we need, and at the same time gives us confidence that when the event occurs, we are able to meet the obligations we have entered into.

For earthquake risk assessment, there are basically four factors that have to be quantified and then combined in an appropriate manner, namely:

- the seismic hazard, i.e. the frequency and magnitude or extent of earthquakes, which can be quantified quite well from past earthquakes with the additional aid of tectonic studies;
- the vulnerability of insured objects, which can be determined from loss statistics;
- the amount and geographic distribution of insured values; and
- the effect of cover conditions.

Scenarios

The easiest way to combine these factors is to model scenarios. The extent of a major event, for example as shown in Figure 2, is matched with the current portfolio distribution. The loss amount for this specific event can be calculated by determining the damage ratios with regard to the earthquake intensity — depending on the quality of the insured objects and on the cover conditions.

Loss frequency relationship

A slightly improved risk picture results if, instead of merely looking at a scenario in isolation, an entire area is analysed by a simulation. As an example, Figure 3 shows a loss frequency curve for all of New Zealand. This was obtained by combining frequency and loss effect of all possible earthquakes across the entire country. At Swiss Re, our earthquake underwriting policy has for about 15 years been essentially based on such analyses.

This marketwide consideration provides a more comprehensive picture of the earthquake risk and one that is of greater value to a company conducting

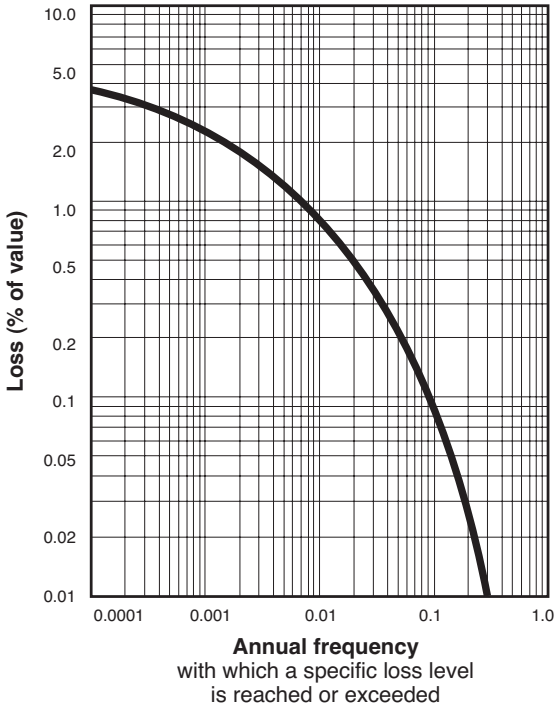

Figure 3: Loss frequency curve for buildings alone, all of New Zealand

business throughout the country. The integration of frequency and extent of loss over the entire area (in the diagram the area under the curve) provides the necessary earthquake premium rate. Moreover, all possible losses, i.e. other significant scenarios, are included. This is important because it is not clear from the beginning whether Wellington can be assumed to represent the worst case potential. A major event could, for example, also occur in Auckland, where the seismicity is lower but the insured values are much higher.

Risk analysis software

The development of natural hazard models has made great progress in recent years. The calculation of loss scenarios, earthquake premiums or loss frequencies using risk analysis software offered by specialised consulting firms is now an established part of insurance industry activities.

Generally, these assessment tools enable a far better quantification of the risk. This increases the insurance industry's readiness and ability to cover these risks, as the better a risk can be assessed, the more capacity can generally be made available to cover it.

Uncertainties

Despite the positive developments in the field of natural hazard analyses, the uncertainties surrounding all model calculations cannot simply be overlooked. I already mentioned the events at Northridge and Newcastle with the uncontrollable rise in damage. Northridge is also notorious in that initial estimates of damage immediately after the event were far too low (by a factor of five). This illustrates that the uncertainties of the various model parameters do not always balance out — in reality, unfavourable influences can accumulate, leading to drastic discrepancies between calculated and real loss amounts.

Problem of consequential damage

A particular problem, in both its analysis and dealing with it, is that of indirect losses and consequential damage, such as business interruption resulting from property damage, power failure or lack of access, etc. Construction technology in highly developed, seismically active countries has been refined to a point where, with more recent buildings at least, the extent of property damage can be kept quite low. In contrast, processes and operations are becoming increasingly complex and as a result more susceptible. Insurance coverage of business interruption is extensive in New Zealand. It is hardly possible to assess reliably the corresponding damage potential. The covers often comprise so-called reciprocal and suppliers extension losses, as a result of which, for example, plants in Auckland could also claim earthquake damage if their production comes to a standstill as a result of lost suppliers or clients in Wellington. It goes without saying that, under such circumstances, a scenario calculation restricted to the area with pure physical damage serves no purpose.

Problem of branch accumulation

A further important aspect is the possibility of accumulation from various branches of insurance. Apart from damage in actual property insurance as such (building and contents), other non-life branches (e.g. engineering, marine, aviation) as well as liability, accident and life insurance will be affected. It is hardly possible to devise a model that accounts for this damage realistically.

Reinsurance contributions and their prerequisites

To what extent will reinsurance be affected by this Wellington event? There can be no denying the anxiety this event will cause. The extent of the insured damage will be considerable. US$2□ billion insured losses would be the second largest amount of earthquake damage paid out so far. But comparison with other catastrophe losses leads to the conclusion that reinsurance will have no difficulty coping with this event. This remark should, however, be qualified with regard to New Zealand: the reinsurance capacity available for one market or catastrophe scenario depends on a series of factors, the most important of which are business volume, risk information, price and cover conditions.

Volume

A decisive criterion for the reinsurance business policy in a particular market is the ratio between possible catastrophe damage and business volume overall. The more the reinsurer participates in the entire insurance business of a market, especially the profitable branches, the more catastrophe capacity will be available.

Information

The importance of adequate risk information has already been mentioned. Specifically, this means that the insured portfolios per risk category and per region have to be accounted for separately and notified to the reinsurer. This is equally important for insurer and reinsurer to determine the need and the optimal use of reinsurance. The better and more transparent this information is, the more it is possible to optimise the use of the capacity.

Price

It is equally important that the reinsurer obtains the proper price for his capacity. This means that the direct insurer must also charge an adequate premium rate graded according to hazard zone and risk quality. A standard premium rate only makes sense in the case of compulsory earthquake coverage (e.g. with the EQC). The earthquake premium itself should not only contain the loss burden but also a price for the available risk capital and a margin to cover uncertainty.

Cover conditions

Earthquake insurance has to be technically sound beyond the mere question of premium. In view of the high overall loss burden, it is, for example, essential that policyholders bear a certain substantial part of the loss themselves, ideally by means of a deductible equal to at least two percent of the sum insured. The cover conditions should — in accordance with the severity of the earthquake risk — be carefully formulated, e.g. excluding reciprocal and suppliers' extension losses.

Conclusion

Wellington is for us one of the world's most fascinating places in view of its position and high insurance density. Fortunately, risk awareness is highly pronounced and New Zealand engineers are among the world's leading exponents of earthquake resistant construction. We, therefore, have no doubt that the New Zealand insurance market will be able to cope with the demands of providing an adequate cover of the earthquake risk, so that insurers and international reinsurers can contribute their utmost to handling this catastrophe when it comes.

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The role of the finance industry

Sir Frank Holmes

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and Emeritus Professor, Victoria University of Wellington

This paper examines the implications of the Wellington disaster for the financial system, e.g. through its effects on means of payment for retail transactions locally and nationally (which would in turn be affected by the quality of disaster recovery arrangements of institutions) and through its effects on the domestic money and foreign exchange markets.

Special attention is given to what the Reserve Bank and the government might do to stabilise and resuscitate the system (which, of course, requires some assessment of their own disaster recovery capacity) and to deal with any loss of confidence in the solvency of individual institutions.

The paper also considers how the need to fund reconstruction is likely to impact on the various actors in the financial system and analyses the critical issues likely to be involved. Particular attention is given to the response of central and local government to the additional demands having to be made on them and how they might best be financed.

Introduction

The big quake damaged the providers of financial services in Wellington, along with other members of the Wellington community. The head offices of several major financial institutions suffered serious damage. Officers of financial institutions were among the 1600 people who died and the 10,000 who were injured. Like many of their customers, they had their personal property and equipment destroyed or damaged. Many found it difficult or impossible to get to work or found their places of work unable to function for some time, especially in the central business district. They were among the queues of people seeking to make claims from the Earthquake Commission, their insurance company and the ACC, seeking assistance from the health system or social welfare or the employment services, and needing credit from the system to cover unexpected deterioration in their financial position.

The big quake brought home to their customers how important financial enterprises are in enabling a modern economy to function. We depend on the industry to provide an effective means of payment and to enable people to place their savings safely. We borrow funds and buy and sell assets through financial institutions on terms and conditions that suit our purposes in the prevailing circumstances. They provide opportunities for us to insure against risks.

The big quake also brought home to both staff and customers how dependent they had become on computer systems, which were seriously affected. Some customers became anxious about the safety of their savings during the period when the financial institutions were bringing their disaster recovery plans into effect. Both the financial institutions and the Reserve Bank hastened to assure customers that there was no need to rush for cash as a precaution. Those whose incomes were disrupted, particularly those who were not eligible for social welfare assistance, were naturally concerned about their capacity to draw on their savings and obtain credit.

The authorities did their best to allay fears, here and overseas, about what was going to happen to interest rates and share prices as people sought to turn their shareholdings and security holdings into cash and as the government and local bodies began to consider how they might finance the increased demands for public expenditure. The operations of the finance industry have become increasingly global and subject to overseas influences. These can be cruel if investors lose confidence in the way in which the New Zealand economy and financial systems are being managed. Many overseas investors were worried about what the overall effect of the quake would be. Interest rates, share prices and the exchange rate reflected the fluctuations in their concern. It was fortunate that they could be assured that government and important New Zealand

enterprises were much better placed than in the past to cope with their short-term problems and to fund reconstruction. The episode emphasised how important it was that our financial enterprises were capable of gearing themselves to continue business despite the damage to their Wellington operations and to play their part in funding the recovery.

The financial risk and who carries it

The role of the finance industry in the event of a large earthquake is much greater now than it was in the past because of changes in the attitude of central government towards its responsibilities for bearing the financial risk of major disasters. Successive governments since 1984 have been reducing some very large contingent liabilities that their predecessors had assumed. These included responsibilities for insurance against earthquakes.

In a discussion paper preceding recent changes to the legislation, the Minister then responsible said that the prime concern of government in the event of a major earthquake would be humanitarian — to reduce stress as effectively and efficiently as possible, to provide basic adequate housing and other amenities and to re-establish basic infrastructure such as roads, bridges and water mains. So far as insurance against disaster was concerned, policy would aim to complement, not replace, private arrangements. The government, he said, had no special competence or social responsibility to provide insurance for nonresidential property. Accordingly, EQC cover of such property is being phased out and will end in December 1996. It was decided to continue to make it compulsory for people who insure their residences against fire to take out disaster insurance. However, "to encourage residential property owners to make their own arrangements beyond the level where the state has a necessary contingent liability", it was decided that EQC cover on both house and contents should be "capped", eventually at $100,000 and $20,000 respectively.

The Labour Party had proposed to make it compulsory for everyone to take out disaster insurance. National opted against this, leaving those who do not insure against fire unprotected against other disasters. The government paper recognised that the potential "free-riders" would include some who were least able to look after themselves and who were likely to look for support from government if a quake ruined their property. For humanitarian reasons, government would have to grant such support in some measure. But those not insured were warned that they would probably wait longer for assistance in rebuilding than those who had insured and that they should not expect too much.

The commercial community will be expected to take responsibility for looking after itself in future disasters. Businesses can be very seriously affected by loss of income and key staff as well as loss of property. A quake can disrupt a business, not just by adverse affects on its own premises, equipment and staff, but by interfering with the flow of its inputs and outputs through the adverse effects on clients and suppliers. Reduced sales, turnover and cashflow threaten the financial viability and creditworthiness of enterprises. The longer the down time, the greater the danger they will not recover. Many enterprises would have found it difficult recently to obtain insurance against loss of profits, although the situation has improved in the last year by comparison with that of two or three years ago, when reinsurance overseas was so difficult to place. Some may find that their insurance is inadequate to cover replacement or to pay for strengthening or upgrading their property, which the authorities consider necessary. A guide published by the Ministry of Civil Defence indicates that planning and training that will limit damage to property and equipment, sustain post-quake activity and keep staff safe both at home and at work can be a very worthwhile investment, especially in disaster-prone areas. Better preparedness would certainly alleviate the problems with commercial customers that the finance industry would otherwise have to deal with.

The Government still provides a safety net, over and above EQC arrangements, for individuals and families who suffer through loss of breadwinners, through injury or ill health, or through loss of income and employment. Such people can have recourse to one or more of the ACC, the public health system, unemployment or other welfare benefits and emergency assistance. But again, the trend of policy has been towards making individuals carry more responsibility to provide against such hazards than was previously the case. Not everyone has been willing or able to react adequately to this policy change. The finance industry's role in providing effective and secure arrangements to promote and manage savings, to extend credit, and to insure against risk for both individuals and enterprises has assumed greater significance, even in "normal" times, and more so in the event of a major

disaster. It behoves individuals and enterprises both to save more and to take care in choosing the financial institutions to which they entrust their savings and insurance arrangements.

Central government has also reduced its past commitment to take responsibility for all the costs involved in reinstating water, sewage and other essential community services after a large earthquake or other major disasters. Under the government's Disaster Recovery Plan, local and regional authorities now have to cover 40 percent of such costs beyond a threshold level. In other words, the ratepayer rather than the taxpayer must now assume that responsibility. The disaster recovery plan also stipulates that, if local bodies cannot demonstrate that they can meet their 40 percent obligation, through proper maintenance, provision of reserve funds, effective insurance or participation in a mutual insurance scheme with other local authorities, then central government's 60 percent of the costs will not be available to them.

Local authorities have created a mutual protection programme called the LAPP Disaster Fund, open to all local bodies to cover tangible, infrastructural assets which are generally uninsurable, e.g. water reticulation/treatment/storage, sewage reticulation and treatment, stormwater drainage, dams, flood protection schemes, seawalls and harbour risks. Government offered local bodies who joined the scheme a dispensation from meeting the full 40 percent obligation, which would phase in over three years from 20 percent in 1993. I am informed that about 50 percent of New Zealand's local authorities have joined the scheme. These include all local authorities in the Wellington region other than the Wellington Regional Council, which has elected to use other means of meeting its obligations.

An estimate by Kingston Morrison last year put the costs of replacing buildings, contents and infrastructure after a major Wellington quake at $8.4 billion. Of this, the EQC's maximum probable loss was put at $2.5 billion. Replacement of industrial and commercial buildings (which will not be covered by EQC after 1996) was estimated to cost $3.8 billion. The restoration of infrastructure would cost over $1 billion. It is evident that enterprises particularly, and to a lesser extent local bodies, will be expected to carry a high proportion of the costs of reconstruction after a quake, with the assistance of their banks, insurance companies and other financial institutions.

Central government would face a considerable direct increase in expenditure, both for the replacement of public assets and for various "welfare" schemes. Some of the capital expenditure would be spread over a period of years, but a large quake would cause a significant detrimental effect on the annual balance of government revenues and expenditure. Government would also face a considerable demand for redemption of government securities maturing during the reconstruction period. The disposal of securities before maturity would also tend to have an adverse effect on government-security prices and interest rates and, therefore, the terms on which the government could borrow new money.

The EQC funds have been almost completely invested in non-tradeable New Zealand government securities. The government would have to redeem these as required to meet EQC obligations. The means that the government can and will adopt to meet its financial obligations will have a considerable effect on financial markets, especially as there will be extra demands for funds from the private sector and other levels of government as well.

The government has not granted the request by the EQC to keep most of its funds overseas. At present the EQC's fund totals about $2.4 billion. Since December 1993 $1.0 billion formerly held by EQC in New Zealand government securities was invested in deposits at the Reserve Bank. Returns on these are linked to those of foreign currency bonds. Therefore, they are called Foreign Bond Linked Notes. It will be noted that the funds are not invested directly in foreign currency bonds but in an official New Zealand security linked to the returns on the foreign currency bonds. Thus, these EQC funds are protected against the adverse effect of a depreciation of the New Zealand dollar. However, they do suffer a reduction in value if the New Zealand dollar appreciates, as it has recently.

In essence, the government has not been prepared to see the EQC as a self-contained SOE, managing its funds in the best interests of the enterprise and its customers. Rather it sees itself as the real risk taker, through its guarantee of the EQC. Thus it has elected to compel the EQC to hold its investments in official securities in New Zealand and has retained responsibility for meeting its guarantee to the EQC from overseas funds, if required, as an outcome of its own management of the Crown's foreign currency assets and liabilities.

The government has relied on its capacity to draw on its own overseas reserves, or to draw on lines of credit abroad to the extent necessary to avoid too much domestic borrowing or tax increase to cope with demands for extra government funds after a major disaster. The government would have been running a very big risk of being unable to deliver on its undertakings if the disaster had occurred a decade ago. Our reserves then were almost depleted and we were having great difficulty in meeting our overseas liabilities. The restructuring of the past ten years has greatly improved the position of the government and the nation as a whole. However, our net external debt remains relatively high and its further reduction must remain a high priority as part of prudent preparations to meet a disaster, as well as for more general economic reasons.

The quality of disaster recovery planning

No systematic review has been done of the present state of disaster recovery planning in the finance industry. The general insurance industry, along with the EQC, seems to be prepared both collectively and (at least for the larger firms), individually, to act quickly and decisively to meet commitments in the event of a disaster.

The Insurance Emergency Plan prepared by the Insurance Council, the EQC, and the Institute of Loss Adjusters provides for coordination of the efforts of members of these organisations to provide effective assistance to those who have suffered loss or damage to their property. Individual companies have done a great deal of disaster recovery planning, For example, the company of which I was recently Chairman made the preparation, testing and implementation of a comprehensive disaster recovery plan the responsibility of a very senior manager. I was satisfied before I left late last year that he and his team had made very good progress at Wellington head office and branch level.

The banking industry has had little collective discussion through the Bankers' Association on the issues involved in a major disaster. I am also advised that the Life Offices have not seen fit to involve the Life Offices Association in addressing the issues of either disaster recovery or funding the reconstruction. Individual enterprises seem to be at various stages of development of disaster recovery planning. All major banks have in place some provision to restore normal facilities for customers as rapidly as possible, especially to ensure adequate back-up of the critical information systems upon which their domestic payments and foreign currency transactions depend. Databank's major processing centre is in Auckland and it has other processing facilities in centres outside Wellington which should function well in the event of a Wellington disaster.

A 1992 survey by Coopers & Lybrand of corporate security and contingency planning by 367 respondents in Australia, New Zealand, and Singapore (73 from the finance sector and 80 from New Zealand) indicated that financial sector companies were on average convincing leaders over other enterprises for contingency planning, especially for their computer systems. However, a significant percentage had not completed a recent threat assessment, established tolerable outage limits, or tested their plans within the last year. There has been no specific survey of financial enterprises based in Wellington. However, I believe recognition of the need for contingency planning has been growing, and that at least the larger enterprises are aiming to expand their existing contingency planning, concentrated on their computer systems, into an overall strategy for business continuity. However, the industry is not immune from the tendency to give low priority to expenditure of management time and resources on what are perceived to be less pressing, longer-term eventualities, which may not occur during the tenure of the existing top management. This conference, along with unfortunate events, like the earthquakes at Los Angeles and Kobe, and warnings, like the recent force 7 earthquake concentrated off the East Cape in New Zealand, may help to give disaster recovery a higher ranking in the planning process and accelerate the progress that has already been made.

Likely strains on the industry in the short-term

The Reserve Bank has special responsibility to promote "the maintenance of a sound and efficient financial system" and to avoid "significant damage to the financial system that could result from the failure of a registered bank".

It has been tightening up its own system of crisis management. Its plan, which it expects to implement fully by mid-1995, envisages the appointment of a manager designate in Auckland who could take over its functions if management in Wellington could not operate for a time. The Auckland branch has been physically stocked with computer facilities (with the

bank's systems backed-up there daily). This would enable continuation of inter-bank settlements, the provision of liquidity to facilitate settlements, and the implementation of monetary policy. The Auckland office might also have to manage foreign reserves, including any authorised intervention deemed necessary to help preserve an orderly foreign exchange market.

The Reserve Bank has particular responsibility to preserve the integrity of the payments system. A large earthquake could lead to an unusually large demand for cash if other systems of payment, e.g. direct credit, ATMs, EFTPOS were temporarily disrupted in some Wellington locations. The bank could be expected to ensure that there was no shortage of currency to prevent financial institutions from satisfying legitimate demands for cash.

A more important problem would be the uncertainty created by the quake in the money and foreign exchange markets and on the stock exchange. It would take time to get an overall assessment of the scope of the disaster and its likely effects on production and trade, interest rates, and exchange rates. Overseas investors, in particular, may overestimate the severity and duration of the adverse effects. Through large precautionary movements of funds they could cause interest rates to rise and the New Zealand dollar to depreciate to an extent which was unjustified by the real situation. (Reports of a force 7 quake off the East Cape recently, though it caused no appreciable damage, were enough to provoke some overseas precautionary action.) The Reserve Bank would be expected to play a vital role in allaying concern, using its powers judiciously to stabilise the financial markets, gathering and disseminating information on how the financial system was coping with the crisis, and reassuring participants in the market that appropriate responses were being developed through an informed consensus on the issues to be confronted.

The bank would need to monitor closely the capacity of banks and other financial institutions to cope with the effects of the increased demands of customers to withdraw funds and/or to obtain additional credit. The security for some loans would obviously be adversely affected: bad debts would increase and the value of some of the assets on balance sheets would fall. There would be a danger of loss of confidence in the safety and solvency of some institutions. This is unlikely to be the case for major banks, especially those who have strong overseas parents. But it is a major responsibility of the central bank to ensure that liquidity is available, either directly or through the stronger institutions, in a manner which will prevent loss of confidence in a particular institution from threatening the integrity of the payments system as a whole.

Official policy in the last few years has been based on the philosophy that neither the government nor the Reserve Bank should guarantee the safety of investments made by private citizens or the continued solvency of particular financial enterprises. It does, however, insist that customers of the institutions should be well-informed and not subjected to false or misleading information. In banking and insurance, regimes of prudential surveillance are being put in place which require enterprises to obtain and publish credit ratings from an approved agency and to disclose that rating to customers. The major aim is to ensure that the boards of directors and managements of institutions take full responsibility for the strength and solvency of their own enterprises. Moreover, while the Reserve Bank does not guarantee the solvency of particular institutions, and will not tell us in advance what it will do in the event of a crisis, it does accept an overall responsibility to keep the payments system as a whole functioning, through use of its capacity to be a provider of liquidity and lender of last resort.

If the potential failure of a financial institution appeared to be a threat to the integrity of the system, either the government or the Reserve Bank could use powers to appoint statutory managers to that failing institution. The bank has proved reluctant to do so, but a statutory manager was used for the Development Finance Corporation and again for the Public Service Investment Society many years ago.

Overall, *caveat emptor* (let the buyer beware) is the general rule confronting New Zealanders who deal with financial institutions in New Zealand. When you contemplate the implications of a major quake for your capacity to obtain repayment of your funds or to collect your insurance, you must ensure that you are dealing with an institution that is capable of dealing with a crisis. There has been some justifiable concern that the past loose regulatory regime governing general insurance institutions would allow the entry of "fly-by-night enterprises" which could collect premiums against earthquake but would be most unlikely to be able to honour their commitments if there were a major disaster. The new regime should give more protection against such

institutions. As an elementary precaution, you should regularly review the strength of the institutions to which you are entrusting your funds.

Our banking system seems to be well placed to ride out a crisis. The general insurance industry is also very much better placed to deal with such an eventuality than it would have been three years ago. At that time, many were not able to make underwriting profits and the average solvency level was lower than usual. Since then, there has been considerable restructuring in the industry, and the average profitability and solvency ratios of participants have improved considerably.

The EQC, State Insurance and NZI have some of the highest individual catastrophe programmes in the world. New Zealand is particularly subject to the vagaries of the world reinsurance market including its reactions to other people's catastrophes. The increase in the difficulties and costs of obtaining reinsurance in the early 1990s and the extra responsibilities thrust on domestic insurance companies because retentions were increased and event limits to insurers were introduced by the reinsurers, inevitably led to increases in premiums in New Zealand. Moreover, a more conservative approach was taken to the insurance of older, risk-prone buildings and to loss of profits cover. Recently the entry of new players in the market has made it somewhat easier for domestic insurers to obtain reinsurance. Because New Zealand's overall reinsurance programmes and likely demand for reinsurance are small relatively to the capacity of the world market, and because we have not made large claims in recent years, most New Zealand insurance companies have been able to limit to manageable levels their own direct exposures to a major quake in Wellington. For example, State Insurance has provided cover of $6.5 billion to customers in the region of which Wellington is the centre. It has reinsured its maximum probably liability of $745 million for this region under catastrophe and surplus treaty arrangements, and would have to find a maximum of $30-35 million through excesses and co-insurance provisions in its catastrophe programmes.

Overall then, the general insurance industry seems well placed to cope with its responsibilities to customers in the event of a major disaster. The reinsurance arrangements which it has made, along with the $1.2 billion placed by EQC, and the commercial insurance privately placed overseas, would together make a significant contribution to the foreign exchange available to the New Zealand economy in the process of recovery and reconstruction. This would help to alleviate any tendencies for the exchange rate to depreciate as imports were brought in to supplement domestic supplies.

Of course, should New Zealand have to draw heavily on this reinsurance, it is likely to have some adverse effects on the terms on which future reinsurance would be available to the country. This consideration lends emphasis to the importance of continued improvement to the financial strength of all elements of the New Zealand economy. New Zealand's growing external debt in the 1970s and 1980s was a reflection of serious overspending and weaker balance sheets of New Zealand government, businesses, and households, facilitated by lax control over domestic money and credit. As a result, we undermined our capacity to cope with a crisis. There are much stronger grounds now for confidence in the capacity of private enterprises, financial institutions, and central and local governments to deal with the effects of a major quake in Wellington. Continuation of the sorts of policies which have contributed to the improvement, by sustaining that confidence, would help to limit adverse effects of the disaster on the continuity of business and on interest rates, share prices, and the exchange rate. Averting instability in financial markets would greatly ease the problems of funding recovery and reconstruction.

Funding of reconstruction

Some people have unkindly suggested that a disaster in Wellington would have little impact on New Zealand's export trade and gross domestic product. Only a relatively small proportion of New Zealand's output of primary products and manufactures comes from Wellington, so that the direct effects of an interruption to production here on merchandise exports would not be great. However, the indirect effects on the inputs and outputs through the country of disruption of Wellington's important contribution to the transport of goods by sea and rail would be significant. So too would be both the direct and indirect effects of disruption of its financial, administrative, communication, information and marketing services, for example. It would be important for New Zealand as well as for Wellington that its productive capacity should be restored as quickly as possible.

For an eventuality like that which we are assuming here, contingency planning should rate more highly

in all sectors of the economy. This should certainly extend to the finance industry. Its institutions should not only step up the quality of their individual recovery plans, but also plan collectively through a process in which the Reserve Bank, Treasury, and the Debt Management Office should be playing a central role.

The total bill of $8.4 billion to replace housing, commercial buildings, contents, and infrastructure may be compared with the total annual gross fixed capital investment in New Zealand. This averaged between $12 and 15 billion per annum from 1989-1993, and has probably increased to about $18 billion in 1994-95. Wellington's share of GDP is about 13 percent and so capital formation here has probably been fluctuating around $2 billion recently. The demands on the building industry in a crisis would be particularly strong. Kingston Morrison put the replacement cost of buildings at around $5.6 billion. This compares with annual expenditure on new buildings in New Zealand at about $5 billion. The reconstruction programme required in Wellington might be diminished to some extent through decisions by some enterprises and others to relocate outside the Wellington region. Unless they closed down or found under-utilised capacity, however, this would not diminish what would potentially be severe pressure on available supplies of equipment, materials, and labour. The path of wisdom would be to phase reconstruction over a period of four or five years if possible.

The finance industry would have to play a very important part in funding the process of recovery and reconstruction. Shortages of supply, aggravated by any depreciation of the exchange rate in response to the crisis, would pose a severe challenge to the Reserve Bank in carrying out its primary function of preserving price stability. The bank would require nice judgement to decide how far it should relax monetary policy in order to accommodate the "supply shock" without unnecessary adverse effects on output and exports, while preventing the one-off increase in prices from initiating an inflationary spiral.

The government and the bank should recognise that the preservation of economic stability could not be left to monetary policy alone. There would probably be no great support now for a reversion to rationing of some supplies and direct controls over prices and wages in any substantial way. However, the community would rightly expect government leadership in coordinating recovery and reconstruction and in minimising destabilising bottlenecks.

Coordinating and contingency planning

Recent developments in government, which I regard as generally most desirable, have reduced its direct participation in economic activity and exposed domestic producers to greater competition to serve customers well. These developments mean that old approaches to dealing with a crisis would no longer work. A new and more market-oriented approach to coordinating policy would be required.

In the absence of the old Ministry of Works, the government would need to give leadership in planning or implementing priorities in the crucial programme of reconstruction of the infrastructure and other public facilities in consultation with regional and local authorities and those now responsible for power and communication. The key here, as with the preservation of financial stability and the funding of reconstruction, is for government and its official agencies to provoke and assist participants in the markets concerned to anticipate potential problems and to devise appropriate mechanisms and policies through which appropriate responses will be made. These problems include shortages of labour, materials, and equipment. Success on this front, including readiness by government to gear its employment service, training programmes, and immigration policies to ease potential shortages of labour, would greatly ease the task of preserving reasonable stability of prices.

Government has recently shown some interest in devising strategies for development over the medium term. However, the central agencies of the Crown in the financial sector, other than the EQC, seem reluctant to go beyond disaster recovery planning to sustain their own activities. We are dealing with an eventuality whose scale and timing is unpredictable. Agencies like Treasury and the Reserve Bank do not seem to see much merit in starting from a scenario like that given in this conference as a basis for trying to anticipate critical issues with which they might have to deal in the financial system as a result of a major Wellington quake.

The Reserve Bank recognised that it must play a key role in sustaining confidence and safeguarding the payments system. However, for reasons of 'moral hazard' among others, it was reluctant to be too

precise about how it would do this. The new systems of prudential surveillance would, it was contended, put more pressure on directors and management of financial institutions to strengthen their capacity to meet such a crisis. This would make intervention by the central bank less necessary.

I see value in an occasional contingency planning exercise, starting immediately after this conference, and involving Treasury, the Reserve Bank and other major participants in the financial system. Such an exercise would seek to anticipate the major issues which would confront the participants, and those responsible for the implementation of monetary and economic policy, if a major earthquake occurred in Wellington tomorrow. It could well uncover potential weak spots in the financial system which might threaten to destabilise it unless corrected. It could illuminate the issues which would confront the bank in sustaining price stability. It could provoke consideration of whether the rather fragmented arrangements for coordination of financial and economic policy now prevailing would be adequate to deal with such a crisis or require special machinery; and it could stimulate discussion on whether there might be "gaps" in the provision of certain types of finance to meet such an emergency, e.g. the availability of equity finance (or temporary substitutes for it) which would help carry worthwhile enterprises through their temporary difficulties without becoming excessively indebted. This might require collective action in addition to what individual financial enterprises would be able to provide.

The Treasury (and the Debt Management Office) prefer to rely primarily on the operation of market forces, backed by a continuation of strong and responsible macro-economic and constructual reform policies, as the best preparation for New Zealand to cope with a major national disaster, wherever located. I agree with that view, but the case for it would be strengthened through occasional contingency planning exercises for disaster, of the type which I propose.

The EQC appears to have had difficulty in persuading the Treasury to take seriously the modelling exercise which it has done to try to assess the "probability of ruin" for EQC because of the exhaustion of its reserves, and to establish a case for holding a much higher proportion of its reserves overseas, including overseas equities. The debate has had a rather narrow focus. It has concentrated on the solvency of the EQC and on whether the EQC or the government (which the Treasury regards as the real risk taker) should take the decisions on whether or not funds collected for earthquake insurance should be invested overseas. I see merit in extending work of the kind which the EQC has commissioned on these issues to cover a broader front as background for a contingency planning process.

One can legitimately query the validity of some of the assumptions which the Kingston Morrison team made in the EQC exercise, especially the large depreciation of the New Zealand dollar which it would expect. This analysis seems to have too little regard for the supplies of foreign exchange which would be available from reinsurance, private insurance overseas, government borrowing, infusion of capital by overseas owners of enterprises, and other foreign assistance with reconstruction. Moreover, given a continuation of good domestic policies, the "shock inflation" expected in New Zealand as a result of depreciation and shortage of supplies also seems excessive. We need discussion among both official and private members of the finance industry on what the demand for and supply of funds for reconstruction overall (not just for the EQC) are likely to be in the event of disaster, with some particular reference to the availability of overseas exchange.

The EQC was right to emphasise that whoever assumes responsibility for ensuring that New Zealand can cope with a major national disaster should pay special attention to building up adequate reserves and accessible lines of credit overseas to meet likely requirements during the crisis. New Zealand has shown the dangers that can arise if a country has a government that ostensibly collects funds to provide for such a disaster, but in fact treats them as just another source to finance current domestic expenditures and follow overall policies that exhaust overseas assets and increase overseas liabilities. Happily, current policy settings are making it possible for us, if we persist, to reverse those trends quite rapidly. I see value in extending the "probability of ruin" approach to the assessment of contingent liabilities and prudent net reserves in the public sector as part of a wider contingency planning exercise for the finance industry as a whole.

Discussion

Insurance and financial markets

Steve Gentry (Kingston Morrison Ltd) stated that at the time of the Inangahua earthquake (1968), he had arrived there as an insurance claims assessor at the end of the rescue phase and before the recovery phase. His company's contract was with the Earthquake and War Damage Commission, but the civil defence controller had total control. As a result, he spent his first three to four days there looking after civil defence matters and asked if there was a similar arrangement now. *David Middleton* replied that a protocol has still to be arranged with the Ministry of Civil Defence and this is one of several significant agreements yet to be sorted out.

Colin Packham (Mercantile and General) asked Peter Yanev about the main determinants of the unexpected increase in insured losses. *Peter Yanev* replied that those were listed in his paper. However, fraud was quite a major factor in escalating payments by insurance companies after the Northridge earthquake. Probably twice as much was paid out as should have been. Underinsurance was another important factor.

Peter Leslie (Wellington Regional Council) said that utility insurance was a major concern for his council. He asked what is likely to happen to insurance premiums in the aftermath of the Kobe earthquake. *Chris Henri* replied that premiums are likely to rise as a result of Kobe, but disaster events are happening at regular intervals all around the world. How much premiums will rise for the homeowner whose policies and premiums were meant to cover all contingencies will depend on how much reinsurers want to claw back from insurers by raising their premiums. The increase in premiums will only become noticeable if the drawdown as a result of Kobe and other recent disaster events becomes significant. *Peter Yanev* said that worldwide, insurance premiums are very low for earthquake compared with what they should be as a purely business decision. In the USA, the total premiums for earthquake insurance for the last 30 years were used up by the Northridge earthquake. Most insurance companies have lost more than they expected and, as a result, premiums have increased dramatically (from 50 percent up to 150 percent).

Bill Ferris (Public Trust) asked what EQC was doing to ensure that with the new limit of EQC insurance on domestic properties, underinsurance does not become a major problem. *David Middleton* replied that individual homeowners now have the responsibility for topping up their earthquake insurance. EQC will cover $100,000 (plus GST) for the house and $20,000 (plus GST) for the contents. This is sufficient for most people and few houses will need more than that. The responsibility of EQC is to put a roof back over people's heads, but a homeowner wanting a fancy roof will now have to pay extra for it.

Dick Carter (Port of Wellington) asked if, as a result of experiences following the Newcastle earthquake, insurance companies might be more flexible in future as to how claims should be handled. *Chris Henri* replied that with insurance companies competing for business, there were wide differences in what damage they covered and in premiums, sometimes between close neighbours. This caused considerable problems. However, insurance companies did co-operate with each other to some extent. Following the Newcastle earthquake, arrangements were made to call insurance companies together during the reconstruction period to resolve problems and to help maintain the image of the insurance industry. However, in the end it comes down to the individual contract between a homeowner and an insurance company.

Colin Packham (Mercantile and General) asked how the map of Modified Mercalli intensities for an earthquake in the Wellington region used in Werner Schaad's paper (Figure 2) had been derived. *Werner Schaad* replied that microzoning information was used as well as elliptical intensity curves.

David Hopkins (Kingston Morrison Ltd) said his paper at this conference was a follow-up to a report by Kingston Morrison last year, which was referred to by Sir Frank Holmes in his presentation on estimating replacement costs of buildings following an earthquake in Wellington. Dr Hopkins said that zonation had to be considered. All buildings might be at high risk, but some would be more so because the single most important determinant was the building itself. The wide range of uncertainty of

replacement costs is something that will have to continue to be lived with. The tools used, such as damage ratios, all had uncertainties, although they provided insights. He said that Kingston Morrison are trying to match their work against estimates for replacement cost that EQC has already obtained and this is regarded as a suitable basis for estimating the cost of physical reconstruction. *Sir Frank Holmes* agreed that although subject to uncertainties, the exercise was still very useful because it did at least give an order of cost.

John Blakeley (Centre for Advanced Engineering) asked Sir Frank Holmes who in central government should provide leadership in the contingency planning exercise suggested in his paper in the absence of the old Ministry of Works. *Sir Frank Holmes* replied that Treasury should be central, in particular, the Debt Management Office. However, he would also hope that organisations such as the Earthquake Commission, the Insurance Council, the Bankers Association and the Life Offices Association would also see merit in pressing for such an exercise to be carried out, or take an initiative themselves.

Dieter Losse (Greig Fester, London) asked Werner Schaad about the stability of construction prices before and after the earthquake scenario. *Werner Schaad* replied that construction prices were subject to cycles according to supply and demand. Given that the Wellington event could be coped with, he did not think there would be any great effect on construction prices.

Conclusions

Looking forward from the conference: Where to now?

Ian McLean

Chairperson, Earthquake Commission, Wellington

Arising from this conference, many people will have ideas about the future direction of earthquake recovery planning in general and the Earthquake Commission in particular. Participants are invited to send their comments and ideas to the EQC, because this feedback is one of the outcomes we wanted from the conference.

A great many proposals have been made and discussed — some of them conflicting. A great many perspectives have been glimpsed, and a great many questions have been asked. However, there has also been a good degree of unanimity about several of the issues raised. Above the mists a few mountaintops have emerged as clear and distinct. In answer to the questions after a disaster — *What happens next? What do we do now?* — the conference has provided these answers.

First and foremost, planning for recovery from any disaster is not just about bricks and mortar — it is about people as well as buildings. And the people are not all middle-aged men of European extraction well versed in insurance practice — they come in all shapes and sizes, children and old people, men and women from a wide variety of ethnic and social backgrounds. They have diverse needs, some will be hungry and frightened and homeless, and English may be a second language to them. They will want to rebuild their lives while the politicians and engineers and planners will want to rebuild their city.

The time to plan for rebuilding is before the disaster, not after it has happened. That is another clear message that has emerged from many of the papers presented here. The time to decide what city we want to recreate is when the sun is shining and when society is stable and settled, not amid the chaos and destruction of an emergency when funerals are being arranged and when priorities have to be assigned on the spot and quick actions have to be taken. We need to know in advance what we want to restore, what we want to redesign, and what we want to relocate, so that people already know what is to be done when the time comes and can move to implement the plans for recovery efficiently. We need time to work through the consultation and decision processes with due deliberation and care, without the stresses of the immediate response to disaster or the huge pressures from the affected population to restore some normality to their lives right away.

Thirdly, in any disaster the people who are affected will want to know — *Who is in charge here?* The second session described the relations between those responsible for emergency management in central and local government. The precise sharing of responsibility for the organisation of disaster recovery, to the extent that it has been determined, is not widely known. Things have changed with the passing of the Ministry of Works and Development. There is now no public works department. No arrangements have been made to replace its key national role in disaster recovery. Organisations have been restructured, and it is not always clear any longer who does what. This is a real issue, and it needs to be addressed urgently. Now is the time to determine with the utmost clarity what the arrangements will be. There is no time after the disaster for a committee to sit down to try and decide who is in charge and how responsibilities will be shared.

Next, the ownership of the rebuilding plans has to be shared by many different groups: government, the regional councils, city and district councils, the insurance industry, private business, and local communities. It is not the same as the immediate response phase, when the local and central government play the dominant roles. The private sector needs to play a part.

Any system that is devised needs to be applicable to any city in New Zealand. It needs to be widely understood and ready in advance. Moreover it needs to be tested in advance.

Who sets the priorities? It would not be acceptable, I am sure, if prominent and wealthy people were able to repair their swimming pools while hospitals await repair. At the other extreme, it would be equally unacceptable for people to have to form long queues to get papers stamped by bureaucrats before they could get their toilets fixed.

The logistics of the situation are formidable, as we have heard and seen from several speakers with first-hand experience of overseas disasters. Who plans for the temporary facilities to be provided? For the transport in of heavy equipment on roll-on roll-off barges? How is the accommodation for the 500 to 10 000 workforce and their supervisors to be organised, not to mention thousands of refugees? Are they to be billeted? Are ocean liners to be used as floating hotels? Who plans all of this — the regional or city councils, the Ministry of Civil Defence, or the DESC organisation in the Prime Minister's Department?

We have heard how the lifelines studies have progressed, the roads, power lines, water supplies, and so on. Until they are fixed, nothing else can be repaired. The decisions cannot be left solely to the providers of the lifelines services. Consumers as well as the lifelines providers have a stake in ensuring that mitigation work is done and recovery plans are made. For Wellington we have heard about the Transmission Gully proposal, an alternative route which, unlike the present state highways in and out of the cities, could be relatively immune to damage from a major earthquake. After the disaster, if there is not a road up there it will have to be built, so it makes sense to factor in now the strategic advantage this would have for Wellington.

Another important aspect we have heard about is the planning legislation. Laws which in normal times are arguably a procedure for obtaining the best decisions from all perspectives would cause unworkable delays to efficient rebuilding. The whole raft of legislation — the Resource Management Act, the Building Act, the Occupational Safety and Health Act, district plans — would need to be modified or overridden just to enable things to happen. There will be some zones that the council would not want people to rebuild on. Perhaps those zones should be designated now as places to be used differently in future. Why not legislate now for the post-disaster situation, so that it can swing into effect immediately following a disaster?

Several estimates have been made of the cost implications of the Wellington quake for the local and national economy. The differences between them appear to result from different estimates of damage ratios, and inclusion or exclusion of costs of business interruption and indirect costs. However the figures are derived, everyone would agree that the sort of costs incurred by Kobe city would frighten Wellington city and have drastic repercussions for the nation. The different sectors will have varying capabilities to absorb the costs that will arise. As well as in the insurance and reinsurance industries, whose business is to provide for these types of situation, these costs will impact directly on local businesses and local government. The reduction in incomes will flow on to central government by the greatly reduced tax take from families and businesses hard hit by the disaster. The challenge again is for organisations to have thought about this in advance. Have you assessed what your costs might be? Have you contingency plans in place to enable you to continue to operate? Have you identified your sources of finance for recovery?

We have heard of the probable timescale for rebuilding, and best estimates seem to put it at four or more years. The restoration of lifelines — communications, transport systems, power supply — as well as hospitals and schools would come first. Then attention could turn to restoring homes, factories, and offices, and so on. Where will you be in that timescale? How will you survive — or will the cost of business interruption be too great for your business to survive? There are several things you can do now to plan to recover your business operation. Firstly, make sure that you are in a safe, strong building, i.e. one that is well designed to code. In addition, you should be talking to the utility providers to make sure they have a good lifelines restoration plan. Another safeguard for larger organisations is to have a management contract set up beforehand with a major construction firm to come in promptly to help to get you up and running again, for example a full set of the plans of your buildings could be held by the construction company. The cost would be relatively small compared with the cost of delays in rebuilding.

A final important conclusion to come from this conference is that it is foolish to try to reinvent the wheel — it is costly and unnecessary for any country to ignore the knowledge of those with a wealth of experience of disasters overseas; it is costly and unnecessary for each local authority to invent its own recovery plan. Most places in New Zealand have some sort of hazard to worry about. It is sensible for all organisations concerned to get together to share information and to outline the common principles that apply to all recovery undertakings.

Finally, while the role of the private sector is important in the response phase after disaster, it becomes dominant in the reconstruction of devastated cities. Homeowners, the insurance industry, and owners of buildings and businesses will effect their own reconstruction. Much can be done in advance to ensure that they can work effectively to restore normality to the city.

The questions which we each will face as we seek to recover from a disaster can be put in advance: What happens next? What do I do now? And the answers can be ready in advance.

This conference has shown that there is available a great deal of experience and knowledge about disaster recovery. I hope that the conference has opened the door to fruitful use of that knowledge in establishment of sound recovery plans for the future. The conference is over. The work is now to be done.

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EARTHQUAKE COMMISSION

The Earthquake Commission (EQC) was established in 1945 and provides natural disaster insurance to residential property owners.

EQC is a Crown Entity, wholly owned by the Government of New Zealand, with a seven person Board of Commissioners, a General Manager, a staff of 12 and one office in the capital, Wellington. Crown Entities are organisations that are not government departments or state-owned enterprises but nevertheless belong to the Government and are subject to public sector finance and reporting rules.

EQC is the primary provider in New Zealand of certain natural disaster insurance to residential property owners. It also offers limited cover to non-residential property owners until 1996. EQC administers the Natural Disaster Fund, comprising capital and reserves. The Government guarantees that this fund will meet all its obligations.

EQC's role is to help New Zealanders recover from the effects of natural disasters. It does this by securing New Zealand residential property owners against the cost of natural disasters and by helping organise repair and replacement after the event. The main mechanism for this is the provision of natural disaster insurance to property owners who insure against fire.

In a time of disaster, EQC works through the insurance industry's co-operative emergency plan and a network of private assessors who evaluate and help process claims. EQC's Disaster Plan also provides for an alternative operations site and provision of additional staff and equipment.

EQC also encourages and funds research about matters relevant to natural disaster damage and it educates and otherwise informs people about what can be done to prevent and mitigate damage caused by natural disasters.

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Chairperson: Ian McLean (to 30 June 1995)
General Manager: David A Middleton

CENTRE FOR ADVANCED ENGINEERING

The Centre for Advanced Engineering was founded in May 1987 to mark the centenary of the School of Engineering at the University of Canterbury.

The objective of the Centre is to enhance engineering knowledge within New Zealand in identified areas judged to be of national importance and to engage in technology transfer of the latest research information available from overseas. The Centre is not concerned with basic engineering research, but with the application of research findings to engineering problems.

The Centre undertakes major projects, bringing together a selected group of practising and research engineers and experts in the particular field from both New Zealand and overseas to:

- consolidate existing knowledge
- study advanced techniques
- develop approaches to particular problems in engineering and technology
- promote excellence in engineering
- disseminate findings through documentation and public seminars.

The Centre also facilitates joint publications with other organisations, carries out smaller projects on engineering subjects of current concern, and arranges lectures and seminars on appropriate topics as the occasion arises.

For further information on the Centre's activities and publications, contact:

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Wellington After the 'Quake

The Challenge of Rebuilding Cities

Proceedings of an International Conference

The Wellington after the 'Quake conference, held in Wellington in March 1995, sought to answer the questions faced by everyone in authority when cities commence recovery after a disaster: What happens next? What do I do now? Although the conference focused on Wellington, the issues discussed are relevant to anyone who will be involved in the reconstruction of a major city following a natural disaster, in New Zealand or overseas.

All government agencies or departments, local authority councils, businesses, or large organisations that face severe damage in a disaster need to plan their recovery. The conference outlined the basis for planning recovery by identifying the problems sure to be faced and by indicating possible solutions based on New Zealand and world experience. There were a total of 24 invited speakers from New Zealand and other countries, including the USA, Japan, Australia, Switzerland and the Philippines. The conference included sessions on:

- Organisation, Government and Legislation
- Rebuild? Where?
- Economic and Social Framework
- Physical Reconstruction
- Legislative Framework
- Social Aspects of Recovery
- Recent Overseas Experience
- Insurance and Financial Markets

Wellington After the 'Quake is jointly published by EQC and the Centre for Advanced Engineering. The conference proceedings include the papers presented at the conference, summaries of seminar discussions and an overview of the conference highlights.

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EARTHQUAKE COMMISSION

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