“Reducing Losses From Natural Disasters Through Insurance and Mitigation: A Cross-Cultural Comparison”

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This paper explores ways of integrating insurance with loss-reduction measures for the purpose of reducing future losses from earthquakes, cyclones (hurricanes) and floods. By examining institutional arrangements in Australia, New Zealand and the United States, it becomes clear that new directions for disaster policy are needed. Our interest in this paper is to stimulate discussion with respect to the development of alternative strategies to the current programmes in these countries. All dollar values are by country of origin and are not adjusted for inflation. (As of 14 September 1993, US$1 = A$1.5 and NZ$1 = A$0.84)

A. Illustrative Examples

A brief review of recent disasters in each of the three countries provides a perspective on the problem.

**Australia:** Generally, the country is viewed as seismically quiet. It does not lie on a major fault zone and until recently had not experienced any earthquake related fatalities. The Newcastle earthquake of 28 December 1989 changed this perception. Registering 5.6 on the Richter scale, the earthquake was located 14 km west to south-west of the city at a depth of 11 km. It lasted over 40 seconds, with intense shaking for less than 10 seconds. The city of 264,000 people suffered extensive damage and 13 people died. Fine weather helped the emergency response.

But severe earthquakes are by no means unusual in Australia, and some settlements have suffered extensive damage in the past, such as in Adelaide (magnitude 6.2 in 1954), Meckering, Western Australia (magnitude 6.9 in 1968) and Tennant Creek (magnitude 6.7 in 1988). A characteristic of these intra-plate earthquakes of significance to the insurance industry is the very large areas affected (Denham and Michael-Leiba, 1991). The damage area for Newcastle was around 9,000 square kms and the earthquake was felt over 200,000 square miles.

Over 50,000 buildings were damaged in Newcastle. In general, unreinforced masonry construction with shallow or no foundations on soft alluvial soils was the worst affected. This type of construction was mostly old, although the Workers Club, where nine people died after its upper walls and roof collapsed, was modern. Given that the business centre and oldest suburbs were located on these soils, damages were high for such a moderate earthquake, although the very large felt area was also a factor (Walker, 1991). Industry sources suggest that virtually all houses were insured for structural damage, but up to 70 percent were underinsured by up to 50 percent; and many people had no contents insurance. Nevertheless, as of July 1993 the insurance payout was $952 million, about two thirds of which was for households (July 1993 A$) (Les Lester, July 1993, pers. comm.). It could have been several times this total had insurance against business interruption been widely held in Newcastle.
Key issues relate to underinsurance, masonry construction pre-dating building regulations (related to this is the problem of severely damaged buildings of heritage value), and the standard, compliance, and enforcement of building regulations.

**New Zealand:** Cyclone Bola (6 March 1988) battered the top third of New Zealand with high winds and heavy rains that caused severe windthrow, flooding, and landslips in several regions. Direct losses were estimated to be around $112 million, but if indirect losses are added costs might have exceeded $200 million. Most of the direct damage cost was split between farming/forestry/fishing industries ($58 million) and local body/road infrastructure ($51 million). Damage to housing totalled just under $4 million, most of which was met by the insurance industry (Ministry for Civil Defence, 1989). It is believed that good compliance with relatively strong building codes prevented higher losses from wind occurring. Within two months of the event, some 11,500 claims had been lodged with the insurance industry with payouts exceeding $37 million (New Zealand Insurance Council, 1988).

Declaration of a regional civil defence emergency enabled central government to make available resources of its agencies for dealing with the clean-up. In addition, a relief package was provided by central government for the worst hit areas of the East Coast region. The size of disaster led government to request the Parliamentary Commissioner for the Environment to inquire into the effectiveness of existing flood mitigation measures and to recommend any new policies and practices (Parliamentary Commissioner for the Environment, 1988). She found, as had earlier research (Erickson, 1982; 1986), that existing policies and practices for avoidance and mitigation were not as specific, and responsibilities were not as clear, as they were for containment measures, such as flood control works, or for civil defence emergencies. It was recommended that this problem be rectified by improving existing use and enforcement of land use management and building codes. She also recommended that the goal of sustainable land use on all land should underpin future policies and practices.

**United States:** Hurricane Andrew (August 1992) hit the coast of Florida on August 24, 1992 with winds clocked as high as 145 miles per hour (mph) and gusts reaching 175 mph. Estimates of total damage vary between $20 and $25 billion (NOAA, 1993; State of Insurance, 1992); gross losses to the insurance industry is estimated to exceed $15 billion with approximately 2/3 covering homeowners losses (Florida Department of Insurance, 1993). Hurricane Andrew was by far the most costly disaster in United States history. Nearly $1.9 billion was provided by the Federal Emergency Management Agency’s (FEMA) disaster relief fund. The total cost to the Federal Government for repairing damage to public facilities is not, however, known.

Recent post-disaster studies showed that at least 25 percent of insured losses from the disaster were due to construction that did not meet local building codes. A study by the Southern Building Code Congress International concluded that inadequate code compliance and enforcement rather than standards written into the codes themselves contributed most significantly to wind damages to structures affected by the hurricane (Governmental Affairs, 1993).

**B. Questions for Consideration**

These three disasters raise the following set of questions that will be explored below as they relate to Insurance, Building Codes, Land Use Regulations, and Post-disaster Relief.

**Insurance:** What role has insurance played in protecting homeowners against losses from earthquakes, hurricanes/cyclones and floods? Are there significant differences in the type of coverage offered between the three countries and if so what is the basis for these differences? Is there a role for government to play in providing protection to insurers against catastrophic losses?
**Building Codes**: How can building codes be more effectively utilized to reduce potential losses from these disasters? Do building code standards differ across hazards? Does the level of compliance differ across hazards? What type of compliance and enforcement provisions appear to be appropriate? How can one link the compliance of codes to insurance premiums so as to encourage their adoption? Who should pay the cost of repairing damage to a structure where a code was not enforced?

**Land Use Regulations**: What role has land use regulations played in reducing losses from these three types of disasters? If land use regulations are present, what is the level of compliance and how well have these regulations been enforced? Is there a significant difference between the use of this policy tool between the three countries? What is the potential role of such regulations as part of a disaster management programme for these three hazards? More specifically, what role can land use regulations coupled with insurance and building codes play in mitigating future losses?

**Post-disaster Relief**: What role has relief payments played in reducing the adoption rates of insurance and mitigation measures? Can relief payments be linked to insurance and mitigation in ways that help reduce loss-potential?

**C. Outline of Paper**

The next section of the paper addresses the above questions by detailing the institutional arrangements associated with insurance, building codes and land use regulations for Australia, New Zealand and the United States. Our particular interest is in gaining insight into how well these policy tools have served to mitigate losses and compensate victims who would otherwise have had to rely on their own resources or disaster assistance for recovery.

To gain insight into the limitations of relying entirely on private market mechanisms for reducing future disaster losses, Section 3 focuses on the decision processes of consumers and insurers. We first examine why most homeowners have been unwilling to voluntarily adopt cost-effective mitigation measures or purchase insurance. We then turn to the reluctance of insurers to provide widespread protection against disasters where there is a potential for catastrophic losses.

Section 4 proposes a disaster management programme which links insurance and mitigation measures more closely together than they are currently to satisfy a set of pre-specified goals and objectives, such as assigning financial responsibility to those accountable for losses. In particular, it advocates the use of private market mechanisms to encourage adoption of protective measures, but takes into account the decision processes of both individuals and insurers in designing a programme. We then raise a set of open questions regarding the implementation of such a programme that may suggest areas for future research and discussion. In fact, the proposed programme should be viewed primarily as a means of stimulating discussion on ways that we can improve how society manages natural disasters.

**EXISTING INSTITUTIONAL ARRANGEMENTS**

In each of the three countries there has been an increased sensitivity to the importance of building codes and land use regulations in reducing losses from future disasters and a recognition that widespread insurance coverage would obviate the need for special disaster assistance. To date these measures have had only limited success in achieving these objectives. After detailing the current institutional arrangement in each of the three countries, we will
provide a summary table at the end of this section (see Table 1) to determine similarities and differences between them.

A. Australia

The Australian is continent is subject to a range of natural hazards, especially drought, cyclones, and floods (Heathcote and Thom, 1979). There is a long history of attempting to mitigate natural disasters through protective works and various approaches to land use and building management. This has run in parallel with the increasingly sophisticated arrangements for loss-sharing through government and private relief payments and insurance (Heathcote and Thom, 1979). But, as recent reports show, there has been little attempt to integrate these two areas of disaster management, although both have the same general aim: to reduce the impact of disaster (Australian Water Resources Council, 1992; Clark and Bodycott, 1989; Smith and Handmer, 1989).

Any moves to integrate mitigation and insurance in the foreseeable future will take place in an increasingly deregulated business environment. Government policy has deregulated the insurance industry as part of its general "free market" philosophy. Ideally, insurance premiums should send a message about the risk to the insured. In practice, vigorous competition is holding premiums at unrealistically low levels. This has reduced the value of insurance as a hazard management tool. This outcome demonstrates the difficulty in reconciling government's desire for deregulation with the requirement that market prices accurately reflect the value of the commodity for sale.

A related trend in Australian government is a move towards cooperative approaches and away from prescriptive or regulatory mechanisms in both intergovernmental and government-industry relations. This approach sits comfortably with the view that outcomes can be best achieved through information, persuasion, and an undirected market. (Cynics might observe that this leads to competence at developing policy documents and strategy statements, but little by way of applied outcomes.) Another related trend is that increased responsibilities are being given to local government. The state government is less inclined to take difficult decisions for local councils.

In earlier years, the federal government accepted its "contingent liability"; its ultimate liability for Australian disaster losses. In effect, this was an admission that the federal government saw itself as an insurer of last resort. Today, we hear little of this view.

Insurance. The Australian insurance industry is a mixture of private firms and government owned enterprises. Each state and the Northern Territory has one government owned insurance firm. Both government and private firms buy reinsurance—mostly from European based companies.

The industry is under the general oversight of the Insurance and Superannuation Commission responsible for ensuring fair competition. One aspect of this is to ensure that premiums are set at realistic levels. As already noted, there is a general view that premiums are unrealistically low. While increasing premiums would be more costly for consumers, in the longer run they would benefit as companies are more likely to remain solvent. The federal government does not reinsure the industry, because it is seen as an appropriate function for the private sector.

There are a number of important points which bear on the potential role of insurance in hazard mitigation in Australia.

The intensely competitive nature of the insurance industry and its sensitivity to public relations, reduces the likelihood that premiums will be raised for specific risks or that conditions would be attached to insurance policies. Neither is it likely that reductions in
Building codes. In Australia, building codes are developed at state and territory level, based on national standards. Enforcement is up to local councils, who may add local hazard related requirements. Where flooding is concerned, local regulations typically take the form of floor level requirements and these are found throughout the country. In the north, protection from cyclones is the main concern, and regulations emphasise protection from high winds (Reardon, 1989; Walker, 1989; 1992)

The insurance industry played a role in having building codes revised following some major disasters: most notably Cyclone Tracy in 1974 and the 1989 Newcastle earthquake. Insurance assessors who examine damaged buildings after such events are well aware of the limitations of building codes and in their enforcement. Older buildings that pre-date building regulations are problematic. In Newcastle, for example, some were found to have been built without any foundations and damages were high. Understandably, the insurance industry is, therefore, active in pushing for the upgrading and enforcement of building codes.

Compliance with building codes varies regionally. For example, compliance appears reasonable for wind loading codes in the cyclone prone north, but anecdotal evidence suggests that, nationally, enforcement is very patchy. Local governments are more concerned with avoiding legal liability than with rigorous enforcement of building codes. This may be achieved by notifying breaches of the code on the property title. The costs of taking breaches to court discourages active enforcement.

New buildings must be given a certificate of completion-- in effect, a notice that the building complies with codes. But practice often falls well short of this. There are many holes; government buildings are generally exempt from inspection and tradeoffs are often made by inspectors.

Councils have been very concerned about their potential legal liability for negligence by their building inspectors following some key legal cases. However, the recent House of Lords decision on Murphy v Brentwood District Council appears to have substantially reduced liability. It held that (except possibly in some unusual circumstances) a local authority was under no duty of care, and therefore could not be liable to those who might suffer loss because of building defects caused by (or not discovered by) the authority's negligence in undertaking its building control functions. In Australia, this decision could be changed by legislation, but that is most unlikely in the climate of "self regulation" and declining resources for enforcement. At present, the situation is uncertain.

In general, the system of building regulations is based on a "cooperative" approach, rather than one based on heavy handed and very expensive enforcement. There is an apparent reluctance by governments to enforce regulations which are unpopular with the building industry.

The existing building codes are reasonable. They can always be improved, but that is not the main problem. Energy needs to go into ensuring compliance with building codes with minimal enforcement costs. Any linkage of mitigation measures with insurance would need to have the support of the insurance industry. Considerable pressure could, however, be applied through the reinsurers.

Relief and rehabilitation. Intergovernmental arrangements for relief are outlined in the Natural Disasters Relief Arrangements-- developed in the 1950s, formalised in 1971, and now under review. Historically, most government assistance has gone to local government for the repair of infrastructure. Relief for "personal hardship and distress" is generally met by state and federal governments according to a pre-set formula. Most states now have standing committees charged with the responsibility to ensure equitable distribution of all relief funds, both government and private. (Private appeals may be very important.) In general, emergency relief is progressively being seen as simply an extension of the normal social welfare systems of each state; and much greater attention is now being given to dealing with the intangible aspects of disaster, such as trauma and anxiety. Despite the formal arrangements, financial relief may still be driven by the scale of an event, media attention, and political opportunism. Concerns are occasionally expressed by government officials over repeated payments to some individuals, but so far there have been no
attempts to link relief with damage reduction. Liberal relief may impede the adoption of insurance and mitigation measures. However, if there was no government relief, private donations can be (and are often) very generous.

B. New Zealand

New Zealand experiences a range of natural hazards. Lying on the boundary of colliding tectonic plates means the country is prone to earthquakes and volcanic and hydrothermal eruptions. Being an elongated, mountainous, and oceanic country lying across the path of prevailing westerlies means that intensive, short-duration rainfalls that cause frequent riverine flooding and landslips are experienced. Periodically, cyclonic storms from the north reach New Zealand to cause extensive wind, flood, and landslide damage. Current practices for reducing losses from these natural hazards must be considered against a fundamental shift in political practice over the last 8 years away from social welfarism and into free-market capitalism. This has involved far-reaching reforms and restructuring. The thrust of change has been to dramatically reduce central government involvement in economic and social activities. The objective has been to leave responsibility for decision making, and the consequences of decisions, with communities that are likely to be affected. Some of the main activities of restructuring affecting natural hazard management include:

- reorganisation of central government agencies
- reorganisation of regional and local government
- removal or heavy reduction of subsidies
- reduction in provision of central government advisory services
- abolition of quasi-governmental organisations
- institution of user pays system for information and research.
- reform of resource management law
- reduction in government exposure to catastrophic events

**Insurance.** The responsibility for spreading the burden of loss in disasters is shared between the private insurance industry and various levels of government. The central government’s role in relieving losses and rehabilitating communities following disasters has, however, changed as a consequence of restructuring. Current policies place much greater responsibility for loss-sharing onto the private insurance industry and affected communities and individuals than hitherto. In the mid-1980s, Government proposed deregulating the insurance industry and withdrawing from, or at least substantially reducing, the range and level of natural hazards offered under its Earthquake and War Damage Commission. These proposals were originally opposed by the insurance industry on several grounds: 1) deregulation would increase competition and result in reduced profits; 2) an increased loading of natural hazards, especially from earthquake due to reductions in the role of the Earthquake and War Damage Commission, could affect the affordability of coverage for the public; and 3) reinsurance at affordable prices for the increased loading of risks could, at a time when the capacity for overseas reinsurance was decreasing, become less readily available (David Sargeant, New Zealand Insurance Council, 14 September 1993, pers. comm).

Prior to restructuring, a major source of assistance for losses from disasters came from a quasi-insurance fund administered by the government’s Earthquake and War Damage Commission. The fund was created by government in 1944 following a damaging earthquake north of Wellington, and was extended over the years so that by the mid-1980s it also included flood, storm, landslide, volcanic eruption, hydrothermal activity, tsunami, and fire caused by these events. The philosophy behind the Earthquake and Disaster Damage Fund was that natural events were unforeseen and where they were widespread and extraordinary citizens ought to be helped by recourse to a central fund. In effect, most disasters, especially flood, were not unforeseen and extraordinary, but public and political pressures resulted in a liberal interpretation of the Earthquake and War Damage Act 1944. The funds were obtained by a compulsory levy of 5 cents per $100 of property insured on all insurance contracts with fire content in them. The levy was collected by the private insurance industry on behalf of the Commission for which service a fee was
paid. Cover by the Earthquake and War Damage Commission was related to whether the building concerned had been erected in conformity with building bylaws. In addition, the Commission was empowered to establish conditions relating to natural hazard risk on its cover of property, but limited resources meant that the detailed risk assessments were never done on a nation-wide basis (Erickson, 1986, 190-191).

The private insurance industry has provided comprehensive policies to householders that included flood and storm cover, since the early 1940s. For an extra premium, fire policies for industrial and commercial properties could be extended to include flood and storm damage, as well as other perils. However, few extended policies were sold because company property owners could readily tap the much cheaper Earthquake and Disaster Damage Fund. Abuse of the fund by companies caused government to withdraw flood and storm cover for all property owners in 1985. By this time, however, over 95 percent of residential property was covered by comprehensive policies of the private insurance industry. For an extra premium, insurance companies also provided earthquake cover for the difference between the indemnity value provided for under the Earthquake and Disaster Damage Fund and replacement value. The cost of a comprehensive replacement policy on a modest house valued at $100,000 is around $245 and for contents of $30,000 about $220.

Where regional or localised hazards become noticeably worse, insurance companies may adjust premiums. Likewise, the adoption of significant mitigation measures, such as embankments or building elevation, may lead to a reduction in premiums (David Sargeant, New Zealand Insurance Council, 14 September 1993, pers. comm.) There is evidence that shows insurance companies having influenced the adoption of flood control works in several flood-prone communities by threatening to withdraw flood cover by not renewing existing policies or making new policies available (Erickson, 1986).

Consistent with policy to reduce its intervention in the market place, and to minimise its exposure to catastrophic losses, government has progressively restructured the Earthquake and War Damage Commission over the last 5 years. The recent Earthquake Commission Act 1993 has created a new Natural Disaster Fund which excludes all but residential property affected by earthquake, landslip, volcanic eruption, hydrothermal activity, tsunami, and fire associated with such events. Payouts will be capped at NZ$100,000 of the replacement value of houses and NZ$50,000 for contents (excluding motor vehicles and cycles, caravans, trailers, and boats). Thus, for more complete protection, residents will need to seek additional cover (for earthquake, and other specified hazards) from the private insurance industry. The Commission’s contracts with industrial and commercial property owners are to be phased out by 1996 (Earthquake Commission Act 1993).

Land use management. Historically, the mapping of natural hazards and the use of land use management as tools for natural hazard mitigation have been available to local government since passage of the Town and Country Planning Act 1953. Research shows that they were weakly adopted by local government because hazard disclosure and land use regulations were seen as impeding growth and development (Ericksen, 1971; 1986). Instead, councils opted for engineering controls which enjoyed generous subsidies from central government (Ericksen, 1971; 1986). In this, they were often encouraged by the insurance industry as a means of reducing the risk on its policies. By the end of the 1980s, central government support for the engineering option had closed as it set out to restructure central, regional and local administration and reform resource management policies and practices.

The resource management law reform process (1988-1990) resulted in the integration of 16 major resource statutes, and numerous minor ones, into a single Act— the Resource Management Act 1991. This was accompanied by the restructuring of 280 regional and local authorities into 13 regional councils and 73 district and city councils (henceforth district councils) through amendments to the Local Government Act 1974.
The Resource Management Act 1991 provides an overarching framework for national, regional, and local level decisions affecting the environment. Its broad goal is to promote the sustainable management of natural and physical resources, thereby reflecting the Parliamentary Commissioner for the Environment's recommendation to government following Cyclone Bola. By implication, persistent natural hazards are seen as signals of unsustainable development. Primary responsibility for managing natural hazards (and resources) has been given to the newly created regional and district councils. The emphasis is on reducing loss-susceptibility through land use management and building codes, along with identification and monitoring of hazards and the provision of hazard information to the public. The process by which this is to be achieved is made clear in the Act. Regional councils must develop regional policy statements which provide an overview of resource management issues and policies for achieving integrated management of natural and physical resources. They may also develop regional plans for specific topics, such as natural hazards. District councils must develop district plans which must be consistent with the regional policy statement and plans. Both regional and district councils must include provisions for avoiding or mitigating natural hazards in their policies and plans. In plan preparation they must consider a range of policy alternatives (including the environmental outcomes of these policies) and justify the policies adopted (s.32). Further, councils must formally undertake policy analysis for plans and plan changes. Finally, they must monitor: compliance with conditions on resource consents (such as for land use, water, subdivision, and building permits); outcomes of policies; state of the environment; and baseline information, such as about natural hazards (s.35).

Clearly, the Resource Management Act 1991 emphasises an integrated planning approach to natural resources and natural hazards. This ought to help widen the earlier focus on catchment-wide floods and soil erosion to include more fully other natural events. Further, it emphasises an approach to natural hazards that seeks to reduce loss-susceptibility through land use management and building codes, rather than by engineering structures, such as embankments along rivers and coasts. The extent to which structural measures have been de-emphasised in the reform process is evidenced by the fact that subsidies from central government through the Ministry for the Environment to regional councils for reducing risks from natural hazards may not be used for new structural works or for repairing or maintaining old ones (Ministry for Environment, 1992). On the other hand, central government grants can now be given to regional and local authorities for developing policies and plans for avoiding or mitigating natural hazards.

At national level, the role of the Ministry for the Environment has been to encourage the district councils to use the process identified in the Resource Management Act 1991 for providing solutions to local problems. It does not see its role to be one of coercion or to monitor the performance of councils in plan production and implementation (S. Veart, Ministry for the Environment, July 1993, pers. comm.). Not evaluating the performance of councils in implementing the Act may well become the Achilles heel of the whole process. It is, however, too soon to appraise how effective the Act will be in moving communities towards avoiding and mitigating natural hazards.

Building codes. The destruction of Napier in 1931 led to the development of a national building code that covered many loading and other matters (New Zealand Standard [NZS] 95, Model building bylaw, 1935). Since then, experience has led to frequent improvements. NZS 4203 (1984)--General structural and design loadings for buildings--provides for wind, earthquake, and snow zones, and methods of estimating relevant loadings likely to be experienced on a particular site in such zones (Building Industry Authority, 1992a). Simplified provisions appear in codes of practice for buildings not requiring specific design, such as in NZS 3604 (1990) (B. Cashin, Building Industry Authority, August 1993, pers. comm.).

The recent Building Act 1991 introduced a uniform performance-based New Zealand Building Code (NZBC), and replaced the individual building by-laws of local governments, which were generally based on NZS 1900 (1985) and other standards. A new statutory body, the Building Industry Authority, has been established to administer the Building Act 1991. The new legislation is supported by a series of Approved Documents giving acceptable solutions to the NZBC performance requirements, but essentially drawing on previous New Zealand Standards and codes of practice.
(Cashin, 1983b). With respect to natural hazards, the codes have, however, been extended to include performance requirements for surface waters or floods for 10 percent and 2 percent storms respectively (Building Industry Authority, 1992b). Hitherto, codes aimed at flooding were developed through local government by-laws, under the Local Government Act 1974, usually at the behest of regional catchment boards.

The aim of the Building Act 1991 is to protect life, rather than property. In theory, the protection of property is the responsibility of the owner, not a dictate of the Crown. However, designing buildings to withstand forces that they are likely to experience in their lifetimes for the purpose of protecting life in effect results in a very substantial degree of protection for property. More specifically, the objectives of the Building Act 1991 are to protect health, safety, amenity (in terms of health) and other property-- and household units-- from injury or damage caused by structural failure and by surface water (The Building Regulations 1992, First Schedule, Clauses B1 and E1). Upgrading existing buildings cannot be required under the Building Act 1991 (or any other Act, section 7(2)), unless there is an alteration, change of use, a subdivision of a building, or the extension of life to a limited life building (section 8). However, as under earlier legislation, sections 64-67 of the Building Act 1991 give local governments powers to require dangerous buildings to be strengthened, such as against earthquake.

Under the Building Act 1991 local governments are responsible for issuing building consents (permits) and code compliance certificates designed to ensure that the safety standards are met and buildings comply with their original plans. Compliance involves field surveys by building inspectors from the relevant council at several stages in the development of a building. Costs of consents and certificates are defrayed by the applicant. Responsibility for damage includes inspections, should it be shown that a building has not met the code following disaster, lies jointly and severally with any parties who were negligent (Building Act 1991; Cashin, 1993a). The recent change in law in the United Kingdom (the Murphy case) has not affected New Zealand. Recent case law has maintained that local governments still have a duty of care function.

The integrated vertical system (local application of national standards) that has evolved in New Zealand ensures that there is a relatively high level of nation-wide compliance with quite rigorous building codes at relatively low-cost.

It is worth noting that under the Resource Management Amendment Act 1993, regional and district councils can make rules in their plans that are more restrictive than those provided for under the Building Act 1991.

Relief and rehabilitation. In the past, a civil defence emergency declaration by local government resulted in the release of substantial state resources for community relief and rehabilitation. Some communities deferred adopting mitigation measures as a consequence. Research suggests that about 80 percent of direct property losses in flooded communities are externalised (Erickson, 1986, 87). Recently, central government streamlined its role in providing direct relief and rehabilitation following disasters (Ministry of Civil Defence, 1992). First, it will no longer provide a matching grant for monies raised by public appeal following a disaster. Rather, it will consider each case on its merits and target funds accordingly. Second, it will continue to encourage regional and district councils to adopt a pro-active stance towards disaster planning through their civil defence organisations (Civil Defence Act 1963/1983). Third, it will reduce its assistance to regional and district councils for rehabilitating infrastructure. This will be facilitated by the New Zealand Local Government Insurance Corporation Ltd which is currently establishing The New Zealand Local Authority Protection Programme-Natural Disaster and Emergency Fund. Incorporated under the Charitable Trusts Act 1957, its purpose is to provide cash accumulation to assist local authorities in meeting responsibilities with respect to restoration of infrastructural assets following disasters. Entry to the programme is voluntary, the incentive being to obtain support from unaffected councils following a disaster.
cause of the damage from a cyclone. If, for example, the cyclone blew off the roof of the house so that water came pouring in from above, then the cause of the damage would be wind and damage (minus the deductible) would be covered by the homeowners policy. If the roof remained intact and the damage was caused by rising water, then the homeowner would file a claim under his or her flood insurance policy.

The need to determine the cause of damage can be both time consuming and inequitable if the structure is insured only against wind damage. For many structures it is difficult to specify what proportion of the losses are due to each of these elements, particularly if the structure is severely damaged. It is not unusual to find a situation where a well-constructed structure owned by Family A is classified as having suffered water damage because the roof remained intact while a home owned by Family B did not meet building codes, lost its roof from the storm and hence had its damage classified as "wind losses" (Dacey and Kunreuther, 1969). If both Families did not have flood insurance, it does not seem very fair to reward A by covering its losses and not paying any of B’s damage.

Building codes. In regions of the United States subject to possible earthquake activity, seismic building codes have been developed on the basis of scientific studies on ground shaking and engineering motion. The United States Geological Survey (USGS) is the principal federal agency conducting this basic research and the results of their studies are disseminated to professional organisations as well as local and state governments for planning purposes (Schulze, et al., 1987).

A study undertaken for FEMA by Dames and Moore (1990) identified a set of cost-effective loss reduction measures that could be incorporated into state and local government earthquake ordinances. A more recent study on the economic impact of earthquake mitigation measures by Litan, et al. (1992), provides a justification for more stringent building codes on new construction in Shelby County including the city of Memphis, Tennessee, a part of the country that has not suffered any severe damage from earthquake, but which is considered by seismologists to be in a high-hazard zone.

With respect to flood damage, the NFIP imposes minimum building codes and standards for communities where flood maps have been developed. For example, all new or substantially improved regulated structures must have their lowest floor, including the basement, elevated to or above the level of the 100 year flood (Kunreuther, et al., 1978). Many states and localities have adopted more stringent regulations than the minimum required by the NFIP, but as with most mitigation programmes, there is little information about how effective they are in reducing flood damages. It should be added that, in order to impose these structural requirements, there is a need to have accurate maps of the floodplain. Even though nearly $900 million has been expended for federal mapping of floodplains, only half of the country’s floodplains have been mapped. In addition, much of the mapped floodplain only has a general outline of flood risks rather than calculated flood elevations; hence communities are not able to impose these NFIP regulations on new development (Kusler and Larson, 1993).

With respect to cyclones, there are hundreds of variation with respect to the building codes in hazard-prone communities along the Gulf and Atlantic states despite the development of several model codes. One reason for differences between towns is that many communities do not update the standards as they are revised in new editions of the model code. Furthermore, in some states such as Texas, unincorporated areas may not be governed by any code because only municipalities are permitted to adopt a code (All Industry Advisory Council, 1989).

We have already noted that enforcement of codes was somewhat limited for structures affected by Hurricane Andrew. Due to inadequate inspection staff and incorrect assumptions or inadequate knowledge about cyclone resistant construction on the part of inspectors and builders, code enforcement in coastal areas in the United States ranges from only fair to nonexistent (All Industry Advisory Council, 1989).
flood coverage as a condition for a loan. A similar programme for farmers is operated by the Farmers Home Administration. Victims can claim uninsured losses as a deduction on their federal income tax.

In addition, FEMA provides immediate relief to victims by distributing food supplies and medical facilities, providing temporary housing assistance, relocation assistance, and family and individual counseling for mental stress (Petak and Atkinson 1982). Private relief organizations, such as the Red Cross, provide supplemental assistance to disaster victims.

D. Summary

In Table 1, the institutional arrangements associated with loss-sharing (insurance and relief) and mitigation of natural hazards (building codes and land-use regulations) are summarized. For the three countries and the three hazards considered in this paper the message is mixed. Although insurance is available in all three countries (with the exception of flood coverage in Australia), the purchase of coverage varies considerably. In New Zealand, there is widespread protection through "compulsory" government and private schemes, while in the United States there is limited interest except for wind damage, which is on a homeowner's policy normally required as a condition for a mortgage. Australia falls somewhere between the other two countries with respect to earthquake and cyclone protection. In all three countries, post-disaster relief packages are liberal, but New Zealand has taken steps recently to push much greater responsibility onto local communities and the insurance industry.

Turning to mitigation measures, Table 1 summarizes whether the government has developed building codes and land-use regulations for the three different hazards. Building codes are well-developed in New Zealand, and local governments are now required in law to comply with and enforce them, and they do so. These policy tools have been utilized to a lesser extent in Australia and the United States. There is empirical evidence that building codes in both countries could be strengthened considerably and that enforcement is lax. Land use controls present a different picture. There is an open question as to the actual use of land use controls for avoiding and mitigating natural hazards even when provided for in legislation. There is limited data in all three countries on the ways these measures have been utilized by the appropriate governmental units. New resource management legislation in New Zealand eschews regulating activities through zoning ordinances, focusing instead on environmental effects or outcomes. It is too soon to tell whether this will result in reduced levels of hazard.
Table 1. Role of insurance, building codes and land use regulations for natural disasters in Australia, New Zealand and the U.S

<table>
<thead>
<tr>
<th></th>
<th>AUSTRALIA</th>
<th>NEW ZEALAND</th>
<th>UNITED STATES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSURANCE PURCHASE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td>widespread</td>
<td>widespread</td>
<td>limited</td>
</tr>
<tr>
<td>Flood</td>
<td>limited/none</td>
<td>widespread</td>
<td>limited</td>
</tr>
<tr>
<td>Cyclone</td>
<td>land-wide, none</td>
<td>widespread</td>
<td>wind-wide, water-limited</td>
</tr>
<tr>
<td><strong>POST-DISASTER RELIEF</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td>widespread</td>
<td>widespread</td>
<td>widespread</td>
</tr>
<tr>
<td>Flood</td>
<td>widespread</td>
<td>widespread</td>
<td>widespread</td>
</tr>
<tr>
<td>Cyclone</td>
<td>widespread</td>
<td>widespread</td>
<td>widespread</td>
</tr>
<tr>
<td><strong>BUILDING CODES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td>limited</td>
<td>nation-wide</td>
<td>widespread</td>
</tr>
<tr>
<td>Flood</td>
<td>moderate</td>
<td>nation-wide</td>
<td>moderate</td>
</tr>
<tr>
<td>Cyclone</td>
<td>moderate to widespread</td>
<td>nation-wide</td>
<td>limited/uneven</td>
</tr>
<tr>
<td><strong>LAND USE REGS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td>none</td>
<td>limited</td>
<td>none</td>
</tr>
<tr>
<td>Flood</td>
<td>moderate</td>
<td>moderate</td>
<td>widespread</td>
</tr>
<tr>
<td>Cyclone</td>
<td>none</td>
<td>limited</td>
<td>limited</td>
</tr>
</tbody>
</table>

Adoption Rates:  
- Limited: Less than 35 percent  
- Moderate: 35 to 65 percent  
- Widespread: Over 65 percent
DECISION PROCESSES OF HOMEOWNERS AND INSURERS

In developing a programme which relies on insurance and mitigation to reduce future losses, it is important to gain insight into how the different interested parties deal with low probability-high consequence events. This section focuses on the decision processes of two of the key stakeholders, homeowners and insurers. Our specific interest in studying their behaviour is to provide evidence as to why one needs to consider supplementing private market mechanisms with regulations and government reinsurance.

A. Homeowner’s Decision Processes

Insurance can aid the financial recovery of homeowners suffering property damage from a severe disaster, while at the same time reducing losses from future disasters. In theory, insurance should be ideally suited to play both of these roles. A homeowner who has purchased coverage is protected against a severe loss through the payment of a small premium. If premiums are based on risk, then insurance should encourage individuals to adopt cost-effective loss-reduction measures on their homes. In practice, insurance has only been partially successful in achieving either of these roles for residential structures.

In the United States, unless coverage is required as a condition for a mortgage, few homeowners have voluntarily purchased insurance against damages from earthquake, cyclone, or flood. Few homeowners have voluntarily undertaken measures to reduce damage to their homes even when the benefits are high and the costs are relatively low. A 1974 survey of more than 1,000 California homeowners in earthquake-prone areas revealed that only 12 percent of the respondents had adopted any protective measures. A similar survey undertaken in flood-prone areas of the United States revealed that 27% of the 2,055 homeowners interviewed had taken preventive action. Fifteen years later there was little change in the situation in earthquake areas in the United States despite the increased awareness by the public of the earthquake hazard. A 1989 survey of 3,500 homeowners in four California counties subject to earthquake damage found only 5 to 9 percent of respondents in these counties reported adopting any loss reduction measures (Palm et. al., 1990). A follow-up survey of residents affected by the October 1989 Loma Prieta earthquake by Palm and her colleagues, revealed that few residents invested in any type of loss-reduction measures.

In Australia and New Zealand the situation is somewhat different to that in USA. In both the private insurance industry provides comprehensive householder policies which include most natural hazards. In Australia, the package excludes flooding, while in New Zealand the exception is, for the most part, earthquake. In neither country is the hazard for each property actuarially assessed. Because the policy contains a package of risks, natural hazards may be quite incidental to a homeowner’s decision to take out insurance. Although in both countries insurance coverage is very high, there is a serious problem of properties being under-insured. For example, data from Newcastle following the 1988 earthquake show that insurance coverage was over 99 percent, but 70 percent of policy holders were 50 percent under-insured (L. Lester, 29 July 1993, pers. comm.). After the flood that struck Paeroa, New Zealand, in 1981, it was found that 30 percent of property holders were underinsured. A subsequent survey found that 60 percent of respondents had increased their household insurance cover following the disaster (Erickson, 1986). Household insurance is high in both countries because banks require a comprehensive policy as a condition of providing a mortgage.

In Australia, anecdotal data suggest that the adoption of cyclone measures for old housing has been very patchy, with the exception of Darwin following Cyclone Tracy, but there the destruction was so extensive that most houses were rebuilt. In many country towns, adoption of individual measures against flooding is widespread, ranging from emergency planning and
earthquake without reinsurance responded to the survey; all of them would still be insolvent, even if the reinsurers paid all their claims.

Based on the amount of insurance in force in Australia and New Zealand, it seems likely that catastrophic natural disasters could produce an effect similar to that described for the US.

Currently, the Australian Insurance Council is undertaking a study of the industry’s ability to withstand a major catastrophe. The local industry has total assets of some 19 billion A$, but after liabilities, its net worth is $9-10 billion, plus reinsurance. Unlike the US, Australia has not had an insolvent insurance company for 15 years. The reason for this may be the result of pressures from the Insurance and Superannuation Commission, the Federal Treasury, and the reinsurance industry for the insurance industry to keep premiums at levels that will minimise the risk of insolvency. Thus, while the Commission’s role is to ensure fair competition, the long-term interests of consumers has been protected by keeping companies solvent.

In recent years, the New Zealand government has sought ways of reducing its exposure to catastrophic natural hazards. This has resulted in a reduction in the range of events covered by its Natural Disaster Fund and a consequent expansion in the coverage of wind and flood under the insurance industry. The Earthquake Commission (which administers the Natural Disaster Fund) has been put on a commercial footing and must seek reinsurance with overseas companies. Apart from government requiring a modest start-up deposit, the 40 or so insurance companies in New Zealand are not regulated. Because of limits within the New Zealand market, it is common practice for insurers to seek reinsurance offshore, especially in London and European markets. As noted earlier, the insurance industry opposed deregulation and was fearful of becoming overexposed if government withdrew its Natural Disaster Fund. Strong competition and concerns over reinsurance have caused the industry to act conservatively so as to reduce the risk of insolvency.

A PROPOSED PROGRAMME FOR REDUCING FUTURE DISASTER LOSSES

The evidence presented in the previous section strongly suggests that relying solely on voluntary market mechanisms is not likely to reduce the losses from future disasters significantly. Homeowners are reluctant to protect themselves of the consequences of natural disasters because they feel it will not happen to me and/or are myopic with respect to time horizons and/or trade off different problems with long-time horizons (employment and natural hazard) in order to deal with those judged to be of most immediate importance. Insurers focus on the consequences of a catastrophe and have limited interest in marketing coverage to all residents in hazard-prone areas, except where the risk is spread through comprehensive, multi-hazard policies. Below, we propose a programme which supplements market mechanisms with government enforcement and catastrophic loss protection. The proposed approach utilizes the best features of current programmes in Australia, New Zealand and the United States.

A. Goals and Objectives

In developing a hazard management programme (HMP) aimed at reducing the magnitude of disasters when major events occur, it is useful to specify a set of goals and objectives which can be used as a basis for determining how well the HMP performs. Below is listed a set of criteria which can be used to judge the effectiveness of a particular hazard management programme. There may be other measures which need to be considered, so this list should be viewed as a starting point for future discussion.
Objective 1: The HMP should reduce expected tangible losses from future disasters by at least 10 percent over the current programme life of 10 years. This will require improved risk assessment techniques and hazard mapping for planning purposes.

Objective 2: Cost-effective mitigation measures should be utilized in structures and be linked more closely to other policy tools, such as insurance and land use regulations.

Objective 3: The HMP should assign financial responsibility for recovery to those accountable for losses.

Objective 4: The HMP should reduce the possibility of insolvencies of different stakeholders affected by natural disasters (e.g., potential victims, insurers, banks) to as low as practicable.

Objective 5: The HMP should provide assistance to low income families who cannot afford mitigation measures or who require disaster assistance.

B. Elements of the Programme

Undertake risk assessments for structures. Unless there is a detailed analysis of the risks associated with different structures in hazard-prone areas it is difficult to analyse what mitigation measures are cost-effective. Funds for these risk assessments should be provided by the appropriate levels of government that currently bear the costs of disaster relief, and by other agencies deriving benefit from the risk assessments, such as local communities and the insurance industry. This is an important first step in meeting Objectives 1-3.

Institute more stringent building codes on new homes. To meet Objectives 1 and 2, relevant government agencies should develop stringent building codes which incorporate cost-effective mitigation measures on new structures, and ensure compliance with, and enforcement of, the codes. The limited voluntary adoption of these measures on existing homes in USA, and to a lesser extent Australia, suggests that innovative ways need to be found to encourage homeowners and the building industry into modifying structures to meet appropriate standards. This means discovering what modifications are critical and for what costs and benefits. It also means ensuring that key players, like the building industry and home owners, are behind the programme. The New Zealand approach, whereby a building consent and certificate of compliance are not given by the local authority unless the national building codes have been met or exceeded, might provide an appropriate model to consider.

Building codes can serve an important function in reducing future property damage. Cohen and Noll (1981) provide an additional rationale for building codes. When a building collapses it may create economic dislocations and other social costs that are beyond the economic loss suffered by the owners. These may not be taken into account when the owners evaluate the importance of adopting a specific mitigation measure.

Utilize land use regulations to reduce damage. Land use regulations have a place in a HMP if the general taxpayer pays for a substantial portion of disaster losses to the public sector. In the United States, the federal government through FEMA pays 75 percent of infrastructure (e.g., sewers, electricity and other services) and repair of road damage as well as repair of public buildings. In major disasters, such as Hurricane Andrew, the federal government's share may exceed 90 percent. Likewise in Australia and New Zealand, post-disaster relief for infrastructure has been liberal, although the latter is moving to push greater responsibility onto local councils via its insurance company.

To meet Objective 3 there may be a need for more effective land use management for earthquake, floods and cyclones. In theory, the NFIP could serve as a guide for the implementation of such a programme; in practice, there are several states and communities that
have implemented land use regulations that might serve as a model. (For more details see Kusler and Larson, 1993.) Rather different approaches are offered by New Zealand's Resource Management Act and the New South Wales merits-based approach to floods.

**Utilize seals of approval on structures meeting codes.** Each building that meets or exceeds the specific building code would be given a seal of approval (similar to the code compliance certificate in New Zealand). This would provide homeowners with the knowledge that the building has been safely designed and built in accordance with a federal or national code. Local governments would be held liable for all damage from a disaster to a structure that was given a seal of approval and shown to not meet the code (as is the case in New Zealand). This provision would address Objective 3.

**Utilize insurance to encourage building code enforcement.** To reduce their losses from disasters, insurers are likely to limit coverage to structures that are given a seal of approval. If banks require insurance as a condition for a mortgage, then financial institutions together with the insurer can help enforce building code regulations, thus addressing Objective 1. The experience in New Zealand suggests that compliance with building codes is not generally reflected in adjusted insurance premiums. However, government's partial withdrawal from earthquake cover could alter that behaviour. It is likely that mechanisms for forging the link would be needed for this element of the programme to succeed.

**Utilize insurance to reflect reduced losses.** The cost of insurance should reflect the reduction in potential losses from the adoption of building codes. To reflect Objective 4, these expected benefits to policyholders could be provided in the form of reduced premiums, lower deductibles and/or higher coverage limits.

**Develop all-natural hazards insurance.** The insurance industry should be encouraged to market homeowners insurance which includes protection against earthquake, flood and cyclone damage. To address Objective 3, rates would be based on risk with the potential losses diversified throughout the country. This type of insurance policy would also eliminate having to determine the causes of a loss as insurers in the United States currently have to do for cyclone damage. With their comprehensive householders policies, Australia and New Zealand already go someway towards all-natural hazards insurance, but with important omissions (flood and earthquake, respectively). However, as in the United States, the cost of rating individual properties on the basis of risk seem prohibitive in a highly competitive market. Nevertheless, the industry as a whole may find rating areas, rather than individual properties, according to multi-natural hazard risk worth serious consideration.

**Institute government reinsurance.** To address Objective 4, the Federal or Crown government should provide reinsurance protection against catastrophic losses from all disasters on the newly designed homeowners policy. Private insurance firms would build up the fund by being assessed premium charges in the same manner that a private reinsurance company levies a fee for protection.

The need for such a government fund arises from the apparent inability of the private reinsurance market, due to limited financial capacity, to provide sufficient protection against large-scale disasters that might occur in the United States. It is an open question as to whether the private reinsurance industry could offer sufficient coverage to insurers against the consequences of a catastrophic disaster in Australia or New Zealand.

The advantage of a Federal reinsurance programme is that it reduces uncertainty about probability and consequences of a catastrophic disaster and should enable insurers to reduce their premiums for disaster coverage.

**Subsidize low income families.** Many of the poorly constructed homes are owned by low-income families so that they cannot afford the costs of mitigation measures on their existing
structure nor the costs of reconstruction should their house suffer damage from a disaster. To satisfy Objective 5 two measures should be undertaken:

- low interest loans and grants should be provided for them to adopt cost effective mitigation measures, or to relocate—it could be better to demolish and build anew elsewhere.
- special disaster assistance should be given to them to aid their recovery process.

C. Open Questions

A number of open questions need to be addressed before one can design a specific programme which refines, modifies, and eventually operationalizes the different elements described above. We now raise some of these questions, but encourage you as a reader to reflect on other issues you feel need to be taken into account. The questions are grouped under the different elements of the programme proposed above.

Risk assessments.

- What risk assessment techniques are currently available for determining the potential losses to structures in different hazard-prone areas?
- How costly is it to undertake these risk assessments?
- Is it appropriate for the government to bear the costs of risk assessments or should this be borne by the residents in the hazard-prone community?

Stringent building codes

- What are the challenges in having Federal and State governments develop more stringent building codes and a low-cost system of compliance and enforcement at local authority level?
- Are adequate data available to specify cost-effective mitigation measures for different hazards?

Land use regulations

- Under what physical conditions is it appropriate to develop land use regulations?
- Are there effective ways of overcoming opposition from specific groups (e.g., real estate developers) so that one can implement land use management approaches?
- What lessons can be learned from existing programmes in all three countries that have successfully implemented integrated land use management approaches (e.g., the NFIP in the United States; the cooperative flood policy in New South Wales; and the environmental outcomes approach in New Zealand)?

Seals of approvals

- How easy is it to determine whether a particular structure meets a specific code or standard so as to be able to give it a seal of approval (e.g., building consents and code compliance permits in New Zealand)?
Can one easily determine whether a damaged building has not met the building code following a disaster?

Who would determine whether a structure meets code (e.g., scientific experts; local government building inspectors)?

Is it appropriate to require the local government to pay for the full damage from a disaster should the code not be met?

Will the threat of such a penalty induce local governments to inspect buildings carefully before a disaster to see that the building code is met?

**Linking insurance with seals of approval**

What type of competitive pressures may lead insurers to provide coverage for structures that do not have seals of approval?

Under what circumstances are banks likely to require insurance as a condition for a mortgage?

**Utilize insurance to reflect loss reduction**

What are the most effective ways for insurers to reflect the loss reduction so that homeowners perceive the benefits of mitigation (e.g., lower deductibles, lower premiums, higher coverage or some combination of these)?

Are there analogies from other types of coverage (e.g., fire insurance) that can be assist the industry in answering the above question?

**Develop all-natural hazards insurance programme**

Are there legal impediments in developing all-natural hazards insurance? (E.g., is it possible to include flood damage in such a programme in the United States given the existing NFIP? In New Zealand and Australia there is no legal impediment.

How feasible will it be to charge rates based on risk if they vary considerably from one region of the country to another?

How difficult will it be to identify areas of risk on a multi-hazard basis?

Should the insurance industry share the responsibility for, and cost of, identifying natural hazards on a region-wide basis?

**Government reinsurance**

How can a government reinsurance programme be structured so it is not perceived to be a bailout for the insurance industry, and so that companies would not be inclined to buy less commercial reinsurance?

What data are available to show that there is not enough private reinsurance capacity available to cover a catastrophic loss?

How large a reduction in premiums and/or increase in coverage at the same premium will be possible under a government reinsurance programme?

Is there capacity for reducing premiums in a highly competitive market?
Subsidize low income families

- What are the appropriate measures of income to determine whether homeowners qualify for loans or grants to undertake mitigation measures?
- What types of disaster assistance are most appropriate to aid the recovery of low income families?

D. Concluding Comments

The relevant interested parties in Australia, New Zealand and the United States may answer some or most of these questions differently. The current institutional arrangements, including the political and legal structures, will play an important role in the development of any hazard management plan. We look forward to a continuing dialogue on these issues in the hopes that new approaches will be developed and implemented in each of these countries which utilize insurance and mitigation measures as tools for reducing losses from future natural disasters.
NOTES

1. Prior to the completion of a flood risk assessment study (called a flood insurance study) the maximum limits of coverage for a single residential family house is $35,000.

2. The 100 year flood plain is defined as areas where there is a one percent annual chance of a flood occurring that will cause damage to property located there.

3. The deductible on a homeowner's policy varies from $100 to $500.

4. It would be extremely unusual for a homeowner to be protected against water and not wind damage as indicated above.

5. The most severe earthquake to ever strike the United States occurred in 1811 near the town of New Madrid, Missouri, approximately 100 miles from Memphis, Tennessee. It was felt over about 1 million square miles---half of the continental United States. Since there were few structures located in the area at the time of the earthquake the damage was minimal.

6. One of the opportunities for reducing future flood losses is with structures that have had repetitive losses. Recent data indicates that in the 1980s 30,000 structures filed 2 or more claims of over $1,000 or more accounting for about 30 percent of the claims paid in the NFIP. Either elevating these structures or relocating them has the potential for tremendous reduction in future flood losses (Kusler and Larson, 1993).

7. The two model codes used most heavily in cyclone-prone areas in the United States are the standard building code and the basic building code (All-Industry Advisory Council, 1989).

8. The one area where we do have some knowledge of their limited use is in flood plain management in the United States. (See Burby and French, 1985; Kusler and Larson, 1993 for more detailed evidence and a list of relevant references.)


10. See Camerer and Kunreuther (1989) for a more detailed discussion of the decision processes of individuals with respect to low probability high consequence events.

11. The cost estimate for such a measure on a one story house built prior to 1940 is between $1000 and $2000; the estimated reduction in damage would be between $25,000 and $30,000 should a disaster of the magnitude of the 1989 loma prieta earthquake occur (Gallagher Associates, 1990).

12. This calculation assumes that if a quake occurs during the time horizon the mitigation measure would be intact, so that the $1500 cost would not have to be incurred again.

13. This statement was made by Robert Sheets, a meteorologist at the national hurricane center at the annual naturals hazards workshop in Boulder, Colorado, July 11-14, 1993.
ACKNOWLEDGEMENTS

We are very grateful to people in various private and public agencies who provided information for this paper. In particular, we would like to thank Mary Fran Myers and Eve Passerini (Natural Hazards Research and Applications Information Centre, University of Colorado) for the helpful information they provided on the United States; Brian Cashin (Building Industry Authority), David Sargeant (New Zealand Insurance Council), and Jennifer Dixon (Department of Geography, University of Waikato) who respectively answered a series of questions about insurance, building codes, and land use regulations in New Zealand; and Les Lester (Consultant, Insurance Council of Australia) who kindly provided information on insurance in Australia.


New Zealand


Insurance Council of New Zealand, Insurance Council Bulletin (various issues).


New Zealand Statutory Acts and Regulations:
1991: Building Act 1991 (No. 150)
1992: Building Amendment Act 1992 (No. 126)
1992: Building Regulations 1992 (No. 150)
1987: Charitable Trusts Act
1992: Earthquake Commission Bill (No. 210-1)
1944: Earthquake and War Damage Act (1944 No. 15)
1974: Local Government Act 1974 (No.66)
1989: Local Government Amendment 1989 Act (No. 2)
1953: Town and Country Planning Act (No. 91)


United States of America


