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**The
NORTHRIDGE EARTHQUAKE,
USA
and its
ECONOMIC AND SOCIAL IMPACTS**

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1. INTRODUCTION AND GENERAL DESCRIPTION

1.1 General Description

The Northridge earthquake that struck at 4.31 a.m. on Monday, January 17, 1994 affected an area of 2,192 square miles in the San Fernando Valley, a densely populated residential area of northern Los Angeles, California.¹ Three counties, Los Angeles, Ventura and Orange were affected by the earthquake. The area has been repeatedly struck by moderate to large earthquakes, and Los Angeles County is one of the best-prepared regions of the United States. Yet in terms of financial losses, Northridge is one of the worst disasters in US history.

The earthquake was of moderate size, measuring 6.7 moment magnitude, on an unknown 'blind thrust' fault 20 miles northwest of Los Angeles. The depth of the earthquake was 11 miles (18 km), and near-record ground shaking was recorded. Peak horizontal ground accelerations approached or exceeded 1g in the region of the epicentre, and 11 of 100 monitoring instruments measured in excess of 0.25g. The peak vertical acceleration measured 0.48g. There were 14,000 reported aftershocks, many in the magnitude of 4.0-5.0 range. The duration of the earthquake was 15 seconds.

Human Impacts:

57 people were killed, and 72 deaths have been attributed to the earthquake.² 11,800 people received hospital treatment for injuries. 22,000 people were left homeless. The earthquake occurred in the early morning on a national holiday.³ Had it occurred at another time of day or date, building occupancies would have led to more extreme human losses. A number of bridges and multi-storey car parks collapsed, yet only one person died as a result.

Economic Impacts:

Preliminary total damage estimate were USD 15-17 billion,⁴ but these total direct loss estimates have been revised upwards over time.⁵ The Average Reported Estimated Direct Loss (AREDL) has been calculated to be USD 41.8 billion, using the estimates set out in section 2.1. The scale of the losses was unprecedented and indirect losses were high, exceeding all previous predictions. The earthquake alerted federal and state governments, as well as private insurers to the magnitude of potential losses from earthquakes in urban areas.

1.2 Detailed Description of Earthquake

The Northridge earthquake occurred on an unknown 'blind thrust', meaning that the rupture never spread to the earth's surface, but stopped some way below it. Several hidden fault zones have subsequently been identified which have changed the perception of earthquake risk in the greater Los Angeles area.⁶ The earthquake occurred in the densely populated San Fernando Valley, which has been repeatedly struck by moderate to large earthquakes. This is a predominantly residential area in one of the most well prepared regions of the United States.

¹ See http://www.fema.gov/NR/nr_0106.htm

² ibid

³ EQE (1994)

⁴ ibid

⁵ Scawthorn et al (1997), Eguchi et al (1998), Bolin and Stanford (1998), FEMA (2000)

⁶ Smolka (1995)

The size of the earthquake was moderate, yet some affected areas had ground motions more than twice those allowed for in the building code. Most of the structures in the affected area had been built within the last three decades and the relevant building standards had been considered to be reasonably earthquake resistant. As a result, the percentage of buildings destroyed by the ground motions was small, and the greatest damage occurred within about 16 km of the epicentre. Approximately 114,000 residential and commercial structures were damaged, including some 450 public buildings, sections of six freeways and 27 bridges, as well as power, water and sewer utilities.⁷ Liquefaction and landslides were not a major cause of structural damage.

Lifelines:

Lifelines⁸ were badly affected by the earthquake, particularly power, water and sewer utilities. Utility lifelines were restored within days, in most cases. The longest restoration period was 12 days for the gas supply.⁹ Damage to transportation lifelines was more severe. Traffic disruptions were a major problem after the earthquake, as the area is almost entirely dependent on automobiles. Portions of 11 major arteries into Los Angeles had to close and 9 bridges on major interchanges collapsed.¹⁰ Months afterwards there were still major traffic disruptions and sections of the Interstate (I) 5 and the Santa Monica Freeway were closed. These highways returned to normal service at varying rates, and transport-related effects included freight problems with raw materials and manufactured goods, as well as employee and consumer commuting problems.¹¹

1.3 Emergency Response

The California Governor's Office of Emergency Services (OES) co-ordinates overall state agency response. 104 emergency service stations were operational and traffic congestion was minor, in part due to the timing of the earthquake. Emergency operations appear to have been well co-ordinated. Immediately after the earthquake, local building and safety departments organised teams of inspectors to identify the extent of the damage. Buildings were inspected and tagged according to their structural safety. These coloured tags did not include damage to contents and damage that was not easily visible, and the full extent of earthquake damage was often unknown until wall surfaces had been exposed and the structure examined. 105,000 inspections were carried out in the building safety process.¹²

There were 110 fires. The Los Angeles County Fire Department lost its computer aided dispatch capability for a critical 7 hours, and subsequent fire fighting was hampered by the lack of water.¹³ Fortunately, there was little wind and the Northridge earthquake was 'linear', unlike Kobe, so the increased demand for manpower and material resources during and after the earthquake did not exceed the available supply.¹⁴

Prior to the earthquake, the OES had commissioned an Early Post Earthquake Damage Assessment Tool (EPEDAT)¹⁵ to serve both the emergency response and planning needs of the agency. Immediately after the earthquake, an estimated shaking-intensity map for the Los Angeles area with likely damage levels was compiled, reducing uncertainty and enabling emergency managers to locate and focus on the hardest hit areas. This Geographical Information Systems (GIS) system

⁷ EQE (1994)

⁸ A common definition for utility and transportation systems. See Eguchi (1997)

⁹ Eguchi (1997)

¹⁰ *ibid*

¹¹ Gordon et al (1996)

¹² Eguchi et al (1998). Refer to section 4.2 for a discussion on the social impacts

¹³ EQE (1994)

¹⁴ Eguchi (1997), p 117.

¹⁵ Goltz (1996).

improved the amount and timing of information available for the emergency response. The initial damage assessment was prepared for the California Office of Emergency Services (OES) immediately after the earthquake using GIS for the first time. This data were collated, analysed and distributed through a field office set up by the Federal Emergency Management Agency (FEMA) to co-ordinate activities. The United States Geological Survey (USGS) was entrusted with the communication of information. FEMA also introduced a teleregistration scheme to speed the federal disaster response.¹⁶

2. ESTIMATED LOSSES

2.1 Direct losses

The preliminary total damage estimate ranged between USD 15-17 billion,¹⁷ and was prepared for the California Office of Emergency Services (OES) the day after the earthquake. This was required for the disaster aid application to the President and Congress, and Governor Wilson, the Governor of California warned that the disaster could cost as much as USD 30 billion. A refined loss estimate of USD 13-22 billion was prepared for the OES by 25th January, eight days after the event.¹⁸ Later estimates of total direct losses totalled USD 25 billion,¹⁹ then upwards to figures of USD 39.6 billion²⁰ and USD 44 billion.²¹ The Average Reported Estimated Direct Loss (AREDL) has been calculated to be USD 41.8 billion,²² using the estimates set out in the table below.

TABLE 1:

ESTIMATES OF LOSSES in billion USD				
Source	Time after disaster	Direct or total	Primary or Secondary	Amount of Estimate (USD)
OES (EQE, 1994)	1 day	direct	secondary	USD 15-17 billion
OES (in Goltz, 1996)	8 days	direct	secondary	USD 13-22 billion
RMS. (1999)	15 months	total	secondary	USD 25-30 billion
Smolka (1995)	18 months	total	secondary	USD 40 billion
<i>Scawthorne et al (1997)*</i>	<i>20 months</i>	<i>direct</i>	<i>Primary</i>	<i>USD 39.6 billion</i>
Collins (1998)		total	secondary	USD 30-40 billion
<i>OES* (in Eguchi et al, 1998)*</i>	<i>3+ years</i>	<i>direct</i>	<i>Primary</i>	<i>USD 44 billion</i>
Bolin and Stanford (1998)*	4 years	direct	secondary	USD 44 billion
AREDL				USD 41.8 billion

**(Estimates used for calculation of AREDL)*

The increase in the losses over time was due to the initial damage estimates being prepared by building inspectors checking for safety, rather than losses. 105,000 initial safety checks were made. 333,000 insurance claim inspections were made later by loss adjusters, with increased estimates.²³ Many buildings did not pose an immediate safety concern, but required repair. Structural damage was found in many modern structures, hidden by finishes and fireproofing. Damage to contents,

¹⁶ See <http://www.fema.gov/rt/10442-e2.html>

¹⁷ EQE (1994). See <http://www.eqe.com/publications.northridge/execside.htm>

¹⁸ Goltz (1996)

¹⁹ RMS (1999)

²⁰ Scawthorn et al (1997)

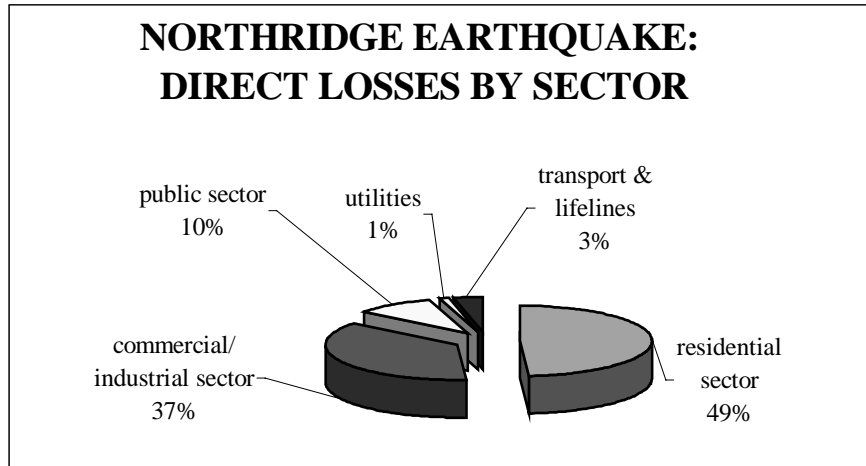
²¹ Eguchi et al (1998), Bolin and Stanford (1998)

²² There is always a wide range of reported loss estimates. The Average Reported Estimated Direct Loss (AREDL) meets the following criteria: only estimates of direct losses, only estimates made at least four months after the disaster, only primary estimates or those based on original data.

²³ Refer to Eguchi et al (1998) for a detailed discussion

water damage due to broken pipework, the exposure of asbestos-related materials, as well as retroactive building code requirements for replacement work all increased the direct economic losses even further.

FIGURE 1: Direct losses by sector



Most damage was incurred in the residential and commercial sectors, as shown in figure 1 and table 2. Although the Northridge earthquake occurred in a residential area, commercial and industrial losses were proportionately very high. Damage to agriculture was comparatively minimal. Public sector losses were relatively small, but Los Angeles is a car-bound society dependent on motor vehicles for urban transportation, and damage to infrastructure affected indirect losses. These indirect losses have been estimated to be over USD 7.5 billion,²⁴ of which more than 80% were from business interruptions. Most of these losses were uninsured and have had major social and economic impact on the affected area. Tax revenue losses are estimated to be USD 0.86 billion. Almost 1% of the USD 4.1 billion Small Business Administration loans has currently defaulted. The San Fernando Valley had been subjected to a recession for three years prior to the earthquake, and this exacerbated the effects of the earthquake.²⁵

TABLE 2: ESTIMATED DIRECT ECONOMIC LOSSES IN USD BILLIONS

Sector	Estimated direct losses in USD billions	Percentage share of direct losses	Amount insured, in USD billions	Amount uninsured, in USD billions
Residential	20.6	49.3%	9.88	10.72
Commercial/Industrial	15.2	36.4%	4.02	11.18
Public infrastructure	6.0	14.3%	No mention	6.0
Agricultural	No mention	na	0.004	na
DIRECT LOSSES	41.8	100%	13.9	27.9

²⁴ Refer to table 3

²⁵ Alesch & Holly (1996), Bolin & Stanford (1999)

Public Sector Losses

Losses resulting from damage to infrastructure (power, gas, water) and direct damage to production centres were initially estimated at USD 6 billion, equivalent to 15 -30% of actual property losses. Lifeline damage was estimated at USD 2 billion.²⁶ Some 450 public buildings, sections of six freeways and 27 bridges, as well as power, water and sewer utilities were damaged.²⁷

Transportation: Traffic disruptions were a major problem after the earthquake, as the area is almost entirely dependent on automobiles for urban transportation. Portions of 11 major arteries into Los Angeles had to close and 9 bridges on major interchanges collapsed. All of these structures had already been scheduled for retrofitting after the 1989 Loma Prieta earthquake, when 860 structures were identified in need of retrofit. None of the 122 structures, which had already been strengthened, failed in the Northridge earthquake.²⁸ A report prepared for the California Department of Transportation concluded that had the bridges been retrofitted, they would have survived the earthquake with little damage.²⁹ There was no significant damage to any of the airports in the vicinity.

Lifelines: Various lifelines were affected by the earthquake, and losses varied considerably as set out: LADWP (Power) - USD 136m, SoCal Edison - USD 0.5m, LADWP (Water) - USD 44m, MWD - USD 5m, LA City (Sewer) USD 36m, SoCal Gas - USD 60m, PacBell - USD 26m, GTE USD 3.5m, Caltrans - USD 1450m. Almost 95% of the damage to lifelines were eligible for federal assistance. Under the terms of the Stafford Act, FEMA was liable for 90% of these costs, while the utilities had to cover the 10% shortfall, USD 0.3 billion.³⁰

Schools: Almost half of Los Angeles schools were damaged and costs exceeded USD 100 million.³¹

Hospitals: 31 Los Angeles area hospitals were damaged, and 9 were forced to evacuate.

Corporate/Business Losses

Corporate damage has been estimated at approximately USD 15.2 billion.³² The area's largest shopping centre, the Northridge Fashion Centre, was virtually destroyed and did not open for more than a year and a half. Several multi-storey reinforced concrete parking structures collapsed, and many were severely damaged, causing indirect retail losses.³³ 57% of Los Angeles businesses in the affected area reported experiencing some type of direct physical damage due to the earthquake, of which the most common type was non-structural (68% of those with reported damage) damage to furnishings (56%) damage to equipment (52%) damage to inventory or stock (50%) structural damage to building (39%) and buildings declared unsafe (15%).³⁴

In some buildings the structural damage exposed asbestos (insulation and fireproofing), which delayed reconstruction due to the specialist removal requirements. In addition, the structural damage caused large-scale failure of sprinkler and utility pipes in inadequately braced ceilings and equipment. These failures of air conditioning units, ducting and sprinkler systems caused serious interior damage to many business premises, flooding the contents below. This in turn affected the ability of some stores to reopen, exacerbating the indirect business interruption losses.³⁵

²⁶ Eguchi (1997)

²⁷ EQE (1994)

²⁸ EQE (1994) Scawthorn et al (1997)

²⁹ Eguchi (1997), p 121.

³⁰ Eguchi (1997), Eguchi et al (1998)

³¹ EQE (1994)

³² Updated from Scawthorn et al (1997). The original figure was based on total losses of USD 39.6 billion, and has been amended by the same percentage.

³³ EQE (1994)

³⁴ Tierney (1997)

³⁵ EQE (1994), Smolka (1995)

Residential Losses

Total damage from residential exposure has been estimated as USD 20.6 billion, 49% of the total losses.³⁶ Building inspectors with the task of estimating initial damage estimated that 82% of all structures rendered uninhabitable by the earthquake were residential.³⁷ This percentage totalled 14,600 dwelling units, of which 77% were apartments and 23% were single family dwellings. Soil conditions played a major role in damages.³⁸ Many structures failed due to inadequate bracing or lack of connection to foundations. Mobile homes were found to be more vulnerable to fires, and 100-150 mobile homes were destroyed by conflagrations from gas and propane lines.³⁹

Agriculture Losses

There is no data readily available, although some insured losses have been reported.

2.2 Indirect Losses

A number of studies assessing the indirect losses have been undertaken, usually with a focus on the restoration of lifelines. Indirect impacts associated with the failure of lifeline systems may far outweigh the direct costs of repairing the system.⁴⁰ Several studies have surveyed businesses in the impacted area,⁴¹ and one such study modelled the economic impacts using their Southern California Planning Model, estimating business interruption losses to total USD 6.5 billion in terms of lost output.⁴²

TABLE 3:

ESTIMATED INDIRECT LOSSES in billion USD		
Commercial	Business interruption	6.402
Unemployment	69,014 person-years of employment	
Residential	Vacated housing	0.098
Other federal agencies	Default on SBA loans	0.376
Federal and state losses	Tax revenue losses	0.86
TOTAL		7.736

Source: Gordon et al (1996), FEMA (1999), SBA (1999)

³⁶ Updated from Scawthorn et al (1997). The original figure of USD 19.5 was based on total losses of USD 39.6 billion, and has been amended by the same percentage.

³⁷ EQE (1994)

³⁸ ISO (1994)

³⁹ EQE (1994) This vulnerability is due to the likelihood of detachment of the structure from its foundation and the effect of this failure on utility lines such as gas and propane.

⁴⁰ Eguchi (1997)

⁴¹ Alesch & Holly (1996), Tierney (1997)

⁴² Gordon et al (1996)

Public Sector Losses

Lifelines have been shown to be extremely vulnerable to earthquakes, and their failure can result in substantial direct and indirect losses.⁴³ Transportation lifelines proved to be problematical, and months after the earthquake there were still major traffic disruptions and sections of the Interstate (I) 5 and the Santa Monica Freeway were closed. These highways returned to normal service at varying rates, and transport-related effects included freight problems with raw materials and manufactured goods, as well as employee and consumer commuting problems.⁴⁴

Corporate/Business Losses

Aggregate business losses have been estimated at USD 6.4 billion, of which 48% were direct business interruptions.⁴⁵ Losses of \$1 billion were suffered outside the region. Studies indicate that 15-30% of businesses damaged closed down permanently.⁴⁶ Some business losses were alleviated by the quick restoration of utilities, but damage to transportation routes, car-parking garages and retail areas affected losses. Residents who remained in Northridge changed their shopping habits. Businesses were also hampered by the slow response of public agencies, and their inability to obtain Small Business Administration loans.

Only about 20% of businesses carried earthquake insurance for damage or business interruption and only slightly more than 25% of those filed claims.⁴⁷ The highest job losses were in the retail (24%) and health service (18%) sectors. Half of the Northridge job losses, equivalent to 69,014 person-years of employment, occurred in the fault zone. Tax revenue losses associated with business interruption amounted to a total of USD 0.86 billion, of which USD 530 million was at federal level, USD 163 million at State level, and USD 164.4 million at local level.⁴⁸

Indirect losses have major economic and social impacts on society. Many individuals change their spending patterns and draw on savings, current earnings and credit for essential rebuilding after a major disaster. Discretionary income is drastically reduced, which in turn affects many small businesses. Damage was not found to be a reliable predictor of business failure, while entrepreneurial skills were a critical factor in the ability of a business to survive. Some small businesses were failing as a result of the Northridge earthquake two years after the event.⁴⁹

Residential

There were 9 billion unit-days of vacated housing. 25% of damaged multi-dwellings and 80% of damaged single dwellings were vacated for more than 3 months. This amounted to USD 98 million, approximately 1.5% of the total cost of business interruption.⁵⁰

⁴³ Eguchi (1997)

⁴⁴ Gordon et al (1996)

⁴⁵ Gordon et al (1996)

⁴⁶ *ibid.*

⁴⁷ Tierney (1997)

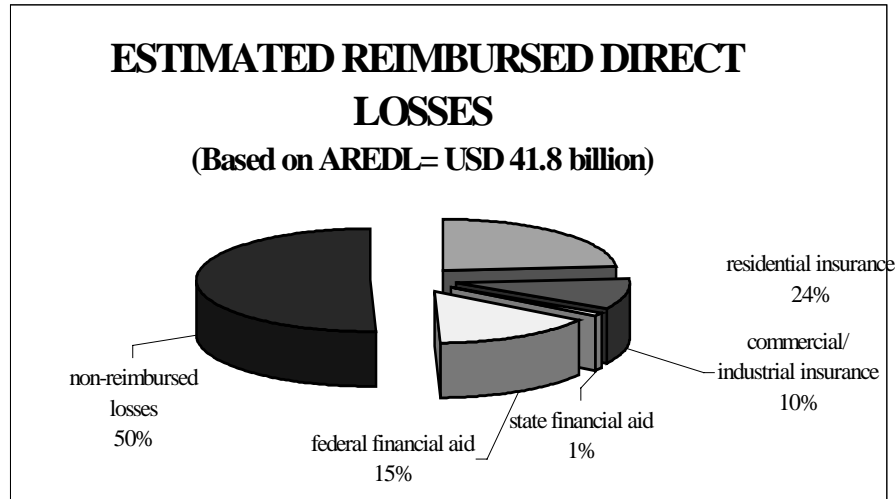
⁴⁸ Gordon et al (1996)

⁴⁹ Alesch & Holly (1996)

⁵⁰ Gordon et al (1996)

3. REIMBURSED LOSSES

FIGURE 2:



Source: FEMA (2000) HUD (2000), Eguchi et al (1998) Scawthorne (1997), IBHS (1999)

TABLE 4:

REIMBURSED LOSSES in USD billions					
		Insured	Uninsured	TOTAL	<i>Direct reimbursed losses</i>
FEMA	Public Assistance program		4.578	6.197	<i>4.0*</i>
	Individual Assistance program		1.424		<i>1.193</i>
	Administrative costs		0.195		
Other federal agencies	HUD		0.837	1.962	<i>0.837</i>
	Dept of Interior		0.005		<i>0.005</i>
	Department of Education		0.256		<i>0.256</i>
	Federal costs unaccounted for (this includes mission assignments to other agencies)		0.864		
California State*	Public Assistance program		0.45	0.606	<i>0.45</i>
	Individual Assistance program		0.06		<i>0.06</i>
	State Employment Dept		0.041		
	State Board of Control		0.055		
Voluntary aid	Red Cross, Salvation Army		0.037	0.037	
Insurance payments	Residential insurance	9.88		13.9	9.88
	Commercial insurance	4.02			4.02
TOTAL REIMBURSED LOSSES		13.9	8.8	22.7	20.7

Source: FEMA (2000) HUD (2000), Eguchi et al (1998) Scawthorne (1997), IBHS (1999)

* *Estimated portion of direct loss reimbursements for public assistance programme.*
Estimates of total losses include structural damage, individual and family grants, as well as rental assistance, relocation costs, debris removal, mission assignments, medical and funeral costs. (Items italicised have not been included in the direct loss estimate.)

3.1 Government

Federal aid

A Major Disaster Declaration must be requested by the governor, and declared by the president. It includes an agreement to commit state funds and resources to the long-term recovery.⁵¹ On February 12th 1994, President Clinton signed the bill for the President's Disaster Relief Fund that authorised USD 8.6 billion in aid for the earthquake victims.⁵² The Federal Emergency Management Agency (FEMA) co-ordinates federal assistance when disasters and emergencies are declared and so administers this fund. The proportions for Northridge were 90% federal and 10% state.

Total federal expenditure amounted to USD 13 billion,⁵³ of which USD 8.16 billion were reimbursed federal losses by the Federal Emergency Management Agency (FEMA) and other federal agencies. Federal assistance was generous, perhaps due to the political importance of California. The earthquake occurred in a congressional election year.⁵⁴ Although FEMA plays a key role in disaster assistance, other agencies such as the Small Business Administration (SBA) U.S. Department of Agriculture (USDA), Department of Housing and Urban Development (HUD), U.S. Department of Transportation (DOT) U.S. Department of Interior (DOI) are also involved.

TABLE 5:

FEMA FUNDING in USD billions		
Individual Assistance:		
Temporary housing, emergency home repairs, mortgage assistance	1.193	1.424
<i>Personal property replacement, permanent repairs, transportation, medical and funeral expenses</i>	<i>0.167</i>	
<i>Disaster unemployment assistance</i>	<i>0.009</i>	
<i>Housing inspection services</i>	<i>0.023</i>	
<i>Crisis counselling</i>	<i>0.032</i>	
Public Assistance		
Payments to state and local governments for repair and replacement of damaged infrastructure, emergency services and debris removal		4.578*
<i>Mission assignments to other federal agencies</i>		<i>0.020</i>
<i>Administrative costs</i>		<i>0.194</i>
<i>Hazard mitigation measures</i>		<i>0.741</i>
Total FEMA relief costs		6.957

Source: FEMA (2000)

Note that items italicised have not been included in the direct loss estimate.

*Estimated portion of direct loss reimbursements for public assistance programme = USD 4 billion. This excludes indirect loss reimbursements, such as debris removal and emergency services.

Table 5 sets out the current details of reimbursements from FEMA, dated January 31, 2000, totalling USD 6.957 billion. Other federal expenditure amounted to USD 6.043 billion, of which some costs relate to the Small Business Administration loans and hazard mitigation projects. Direct reimbursements from FEMA have been estimated at USD 5.193 billion and those from other

⁵¹ See <http://www.fema.gov/about/4-sect1.htm>

⁵² ISO (1994)

⁵³ FEMA (2000)

⁵⁴ Bolin & Stanford (1998)

agencies USD 1.098 billion, totalling 6.291 billion for direct federal reimbursements.⁵⁵ By the close of 1994, FEMA reported that some 667,801 Southern Californians had applied for federal aid, three times as many as following Hurricane Andrew in 1992.⁵⁶

Other federal agencies disaster aid

Although FEMA plays a key role in disaster assistance, other agencies such as the Small Business Administration (SBA) U.S. Department of Agriculture (USDA), Department of Housing and Urban Development (HUD), U.S. Department of Transportation (DOT) U.S. Department of Interior (DOI) are among those that also play a role. The details available of aid from these agencies are set out below.

Department of Housing and Urban Development (HUD)	USD 0.837 billion ⁵⁷
Department of Interior - historic preservation work	USD 0.005 billion ⁵⁸
Department of Education	USD 255.6 million ⁵⁹
Federal costs unaccounted for	USD 0.864 billion ⁶⁰ .
TOTAL	USD 1.098 billion

Federal Disaster Loans

The federal government provides assistance to victims in the private sector through the Small Business Administration (SBA), who make low-interest long-term loans (generally 4%, up to 30 years). SBA loans are available to restore structures to their pre-disaster condition, and may be increased up to 20% to include mitigation measures. Loans to a limit of USD 200,000 are available to residential homeowners, renters and non-farm businesses. Similar loans, to a maximum of USD 1.5 million, are available to businesses and private, non-profit organisations. In some cases, the SBA will refinance existing mortgages on homes and business properties.

39,129 commercial and 193,867 residential SBA applications were made (as of 24.3.1995), an unprecedented number.⁶¹ Of a sample population, 11% had applied for SBA loan assistance for their business losses. Of this number, half had received loan amounts requested, 30% had their applications turned down and 10% of the loans were still pending. For the businesses that had received SBA loan assistance, the median percentage of business losses covered was about 50%.⁶² 124,245 SBA loans, amounting to USD 4.1 billion⁶³ were approved. The SBA announced that 9,144 loans totalling USD 286 million were in default, and have estimated that a further USD 90 million of Northridge borrowers are likely to default on their loans.⁶⁴

⁵⁵ Refer to table 5 for details. Direct reimbursements exclude rental assistance, relocation costs, debris removal, medical and funeral costs, mission assignments and administration costs.

⁵⁶ See http://www.fema.gov/NW294/94_015.htm

⁵⁷ HUD (2000)

⁵⁸ See http://www.fema.gov/NW295/95_129.txt

⁵⁹ See : <http://nces.ed.gov/pubs/d96/D96T356.html>, item 96.

⁶⁰ This figure is the unknown element of the federal disaster relief programme, and includes the FEMA USD 0.20 billion assigned to other federal agencies.

⁶¹ Gordon et al (1996)

⁶² Tierney (1997)

⁶³ See http://www.fema.gov/library/df_4htm

⁶⁴ See <http://www.sba.gov/IG/sar3-99.pdf>

3.2 State Sector

The Governor's Office of Emergency Services (OES) co-ordinates overall state agency response to major disasters. Under the Stafford Act, the state was liable for 10% of the costs of the federal assistance programme and contributed USD 0.6 billion in reimbursements. California voters rejected a proposed USD 2-billion bond issue earmarked for earthquake relief, and so only some of the repair and rebuilding needs could be met. A plea was made to President Clinton, who agreed to redistribute USD 225 million from infrastructure budgets to enable the affected cities to make 30-year no-interest deferred loans to owners of damaged buildings.⁶⁵

State Board of control	USD 0.055 billion
California Employment Development Department	USD 0.041 billion
Individual/Family Grant programmes	USD 0.06 billion
Public Assistance	USD 0.45 billion
Total California State share	USD 0.6 billion⁶⁶

3.3 Private Insurance Sector

There are two estimates of insured losses. The Property Claim Services (PCS) estimated the final losses to be USD 12.5 billion, after adjusting them upwards eight times from an initial USD 2.5 billion to a final figure of USD 12.5 billion, 20 months later. The Institute of Building and Home Safety (IBHS) reached a final estimate of USD 15.3 billion. The National Research Council (NRC) recommends the use of both the PCS and IBHS figures, the advantage of the IBHS figures being that they provide disaggregated catastrophe claims information.⁶⁷ The average has been calculated to be USD 13.9 billion, as set out in table 6 below.

TABLE 6:

ESTIMATES OF INSURED LOSSES			
	PCS estimate⁶⁸	IBHS estimate⁶⁹	Average
Residential	USD 8.4 billion	USD 11.35 billion	USD 9.88 billion
Commercial	USD 4.1 billion	USD 3.95 billion	USD 4.02 billion
TOTAL	USD 12.5 billion	USD 15.3 billion	USD 13.9 billion

Source: IBHS (1999), Kerney (2000), Scawthorne et al (1997), Eguchi et al (1998)

Both the PCS and the IBHS adjusted their estimates of insured losses upward over time. Several factors have contributed to the large increases. The seismological data on which initial estimates were based was incorrect, and estimates were prepared assuming a smaller earthquake with an epicentre further from central Los Angeles.⁷⁰ Adjustment (such as replacement of new for old) and retroactive building codes contributed to the underestimation of these losses.⁷¹ Reopened claims with additional discovered damage, higher living expenses resulting from longer repair periods, and a large number of claims initially thought to be below the level of the deductible all increased estimates. Underinsurance was a major issue that was not reflected in most of the settlements, due

⁶⁵ See <http://www.huduser.org/publications/destech/bigone/sect1.html>

⁶⁶ Eguchi et al (1998)

⁶⁷ NRC (1999)

⁶⁸ Kerney (2000), Scawthorne et al (1997), Eguchi et al (1998)

⁶⁹ IBHS (1999)

⁷⁰ Scawthorne (1995)

⁷¹ Eguchi et al (1998), Scawthorne (1995)

to its political sensitivity.⁷² It has also been suggested that insurers were generous in their claims settlement to influence moves to repeal the mandatory offer requirement.⁷³

Legal issues regarding Northridge claims have centred on the interpretation of the statute of limitations in residential property claims, delayed discovery of loss, waiver and estoppel, and the obligations of the insurer. The California Department of Insurance (CDI) instigated a mediation program to resolve disputes over earthquake claims without costly litigation. This program has investigated more than 3,300 complaints about insurance-related claims and recovered over USD 71 million from insurers.⁷⁴ Allstate opened 9,000 of its 46,000 homeowner's claims for reevaluation, as part of a settlement of two civil suits that charged Allstate with deliberately underreporting estimates by loss adjusters during inspections. Allstate put aside USD 60 million to deal with these claims, and have earmarked USD 5 million to set up a charitable foundation.⁷⁵

3.4 Aid from other sources

Volunteer assistance was received from volunteer organisations including the American Red Cross (ARC) and Salvation Army. The ARC sheltered 22,000 people, served 1.7 million meals and operated various other programmes. The ARC spent USD 36 million on their programme. The Salvation Army spent more than \$1 million for displaced persons' housing and mass feeding.⁷⁶

4. ECONOMIC AND SOCIAL IMPACTS

4.1 Economic Impacts

Almost 67% of all estimated direct losses were uninsured. Federal financial aid met over 15% of these losses, while 1% were covered by state financial aid.⁷⁷ Over 56% of the federal aid programme went to meet the public losses through the Public Assistance programme, while approximately 28% of private losses were met by the FEMA and other federal aid programmes. Despite generous federal, state and insurance reimbursements half of the direct losses were borne by the disaster victims.⁷⁸ "*Many homeowners, renters and businesses paid thousands of dollars out of their own pockets to rebuild their own lives*",⁷⁹ said James Witt, director of FEMA.

Northridge earthquake demonstrated the success of a modern building code in reducing deaths and injuries to a very small fraction of the affected population. Most of the buildings were built within the last three decades, and were considered to be reasonably earthquake resistant.⁸⁰ However, there was considerable economic loss and social disruption, raising the issue of how much protection should be provided economically. This debate should not be the sole responsibility of the engineers and code developers; society must participate in the process of weighing the costs and benefits of more protection.

⁷² Collins (1998)

⁷³ Eguchi et al (1998)

⁷⁴ See <http://www.insurance.ca.gov/PRS/PRS1997/Pr032-97.htm>

⁷⁵ See http://www.claimsmag.com/Issues/November/feature_allstate.asp

⁷⁶ See http://www.fema.gov/NR/nr_0106.htm

⁷⁷ Refer to figure 2, and table 4 for details

⁷⁸ Based on AREDL=USD 41.8 billion. Refer to section 2.1 for details

⁷⁹ See <http://www.fema.gov/library/wittspch5.htm>

⁸⁰ EQE (1994)

The scale of losses inflicted by the Northridge earthquake has forced both federal and state governments to reassess the levels of disaster aid, particularly in the current climate of shrinking budgets and federal cutbacks. The focus of government has increasingly shifted from post-disaster relief operations to pre-disaster mitigation measures,⁸¹ and the stated mitigation goal of FEMA is to reduce natural disaster losses by half by the year 2010. Northridge earthquake illustrated graphically the value of the seismic strengthening and risk reduction programmes, which can avoid substantial losses. None of the failed transportation structures had been strengthened, yet all 122 strengthened structures were undamaged.⁸² Examples of other retrofitting successes, such as department stores, hospitals etc. have been highlighted and used by FEMA as justification for their shift of policy to mitigation.⁸³

Small businesses are often hardest hit by natural disasters, as they seldom carry insurance or possess the resources to make a meaningful recovery. Small businesses are also rarely diversified in terms of products or services, and their customers are often victims of the same disaster. They have less mobility than other members of the community, and generally suffer both personal and business losses. Damage is not a reliable predictor of business failure. Small businesses were still failing as a result of the Northridge earthquake two years after the event. Entrepreneurial skills were a critical factor in the ability of a business to survive. When these businesses fail, there are costs to the individual and to the community. A significant effect can be the downward spiral of a neighbourhood. In contrast, large businesses are able to relocate their operations temporarily, and offset losses against other locations.⁸⁴

Business interruption effects have been estimated to be USD 6.5 billion, of which USD 5.5 billion were in the Northridge region.⁸⁵ Most businesses had earthquake insurance for their homes, but only 13% of small businesses were insured. This led to large uninsured losses, and many business failures. The rate of business failure varied among sectors. Manufacturing was the least affected, due to customers outside the region, while retail and service firms were most badly affected.⁸⁶ Tax revenue losses associated with business interruption amounted to a total of USD 0.86 billion, of which USD 530 million was at federal level, USD 163 million at State level, and USD 164.4 million at local level.⁸⁷

Northridge earthquake was a direct hit on an urban area and the scale of losses caused by the earthquake far exceeded expectations. The threat of the 'Big One' has occupied much forethought and research at local and national level.⁸⁸ The US has a large concentration of localised industries, such as the entertainment and aerospace industries in southern California, the electronics industry in San Francisco, the aerospace industry in the Pacific Northwest and the financial sector in New York. These industries could be seriously affected in the case of a major earthquake.⁸⁹

4.2 Social Impacts

Disasters are often accompanied by a desire for a recovery to reproduce a return to normalcy, and achieve the status quo of the socio-economic and built environment prior to the earthquake. This is

⁸¹ See <http://www.fema.gov/library/wittspch5.htm>

⁸² EQE (1994), Eguchi (1997)

⁸³ See <http://www.fema.gov/library/wittspch5.htm> and <http://www.fema.gov/impact/impact00.htm>

⁸⁴ Alesch & Holly (1996)

⁸⁵ Gordon et al (1996)

⁸⁶ Alesch & Holly (1996)

⁸⁷ Gordon et al (1996)

⁸⁸ See <http://www.huduser.org/publications/destech/bigone/sect1.html>

⁸⁹ Scawthorne et al (1997). The risks are greater in areas where earthquake preparedness is less established, rather than California.

almost impossible to achieve. There are many federal, state and local participants each with their own political, economic, social or environmental agenda, and at best recovery takes the form of restructuring, rather than the desired reversion to the previous status quo.

There are certain groups less likely to achieve any semblance of their prior socio-economic level, and these groups are often the most vulnerable members of society - the low income, immigrant, unemployed and elderly groups. They also have the least access to resources to manage their losses.⁹⁰ Social, economic and political processes structure the lives of different groups of people in different ways and affect their ability to react to a natural hazard. Their level of vulnerability only becomes apparent in the face of disaster.⁹¹

The earthquake affected a large area of the San Fernando Valley, which supports half of the city of Los Angeles' population. Approximately 48% of the population were homeowners - middle class and therefore not obviously insecure- yet many proved to be vulnerable to the hazard. This vulnerability had been increased by the declining market value of housing in the area (which followed a boom of the 80s), job redundancies due to corporate restructuring, defence spending cuts, increasing liabilities due to underemployment, as well as the high insurance deductibles, which are based on the value of the property rather than the level of damage.⁹²

Northridge earthquake provided a generous system of federal social protection by international standards, yet victims received at most partial compensation for their losses and had to find means to cover their losses. Many individuals changed their spending patterns and drew on savings, current earnings and credit for essential rebuilding after the disaster. Discretionary income is drastically reduced, which in turn impacts many small businesses.⁹³

Despite substantial financial aid, people and businesses moved out of damaged downtown areas and did not return. An estimated 60,000 people migrated and only 20,000 moved into the area. Many of these newcomers were Hispanic and Korean, and were younger and poorer than their predecessors. These migrants had different retail habits, which changed the social structure of the area.⁹⁴ The downtown areas of Whittier, Santa Cruz and Northridge were slow to recover.⁹⁵

Disasters also offer an opportunity to improve safety measures. The moves initiated by Northridge earthquake were an increase in the level of geological hazard mapping, the development of new building code standards, seismic retrofitting of older structures to meet revised seismic codes, as well as improved emergency preparedness. This preparedness involved emergency training for households and residents and the creation of Disaster Assistance Response Teams, (DART). A non-profit corporation, the Emergency Network Los Angeles (ENLA) was established to act as an umbrella organisation for the NGOs (non-governmental organisations) and approximately 300 CBOs (community based organisations) that provided a second tier protection for the vulnerable members of society, whose needs were not met through conventional channels. The other aim of the ENLA is to provide a network for future disasters.⁹⁶ Both government and non-governmental organisations have benefited from a history of collaboration over a number of Californian earthquakes.

⁹⁰ Bolin & Stanford (1998)

⁹¹ Blaikie et al (1994)

⁹² Bolin & Stanford (1998)

⁹³ Alesch & Holly (1996)

⁹⁴ Alesch & Holly (1996)

⁹⁵ CDI (1997/8)

⁹⁶ Bolin & Stanford (1998)

Due to the localised impact of the earthquake, damage was concentrated in particular areas. 15 of such areas (later increased to 17) with red-tagged⁹⁷ damage levels averaging 60% of the housing stock, were designated 'ghost towns' by the Los Angeles Housing Department (LAHD). All but 4 of these areas were heterogeneous, middle-income neighbourhoods. The high number of abandoned structures soon made these areas a target for looters, and they were rapidly blighted by squatters and street gangs. This degeneration had serious social effects on the remaining housing, businesses and neighbourhoods. The federal Department of Housing and Urban Development (HUD) and its state counterpart, the LAHD targeted assistance towards these areas, but it was not always economically viable to reconstruct this housing stock in a weak housing market. As a consequence, there is less available low-income housing provision in Los Angeles. In many cases non-structural damage, damage to parking facilities and outbuildings was not repaired. This has led to neighbourhood decline and a negative spiral of property values.⁹⁸

5. INSTITUTIONAL ASPECTS

5.1 Regulatory/legal framework

The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 is the core legislation under which federal emergency relief is managed. In order to qualify as a major disaster the event must be clearly more than state or local governments can handle alone. A Major Disaster Declaration must be requested by the governor, and declared by the president. This declaration is based on the damage assessment, and an agreement to commit state funds and resources to the long-term recovery.⁹⁹ There are two main categories of disaster aid, namely:

- Individual Assistance (IA), for damage to residences, businesses and personal property losses. This aid includes Disaster Housing, Disaster Grants and other Disaster Aid Programmes, such as legal aid, unemployment assistance, crisis counselling. Applications are made through a Disaster Application Centre or by tele-registration, normally to a 60-day deadline. Low-Interest Disaster Loans are also available through the Small Business Association.
- Public Assistance (PA), is aid to the state or local government to pay part of the costs of rebuilding the community's damaged infrastructure and public facilities. This may include debris removal, emergency protective measures, loans for essential government functions and grants for public schools.

Under the Stafford Act the financial burden of emergency assistance is placed on the taxpayers, and the federal government provides funds to state, local governments and private non-profit organisations to cover at least 75% of the costs of the repair, restoration or replacement of public facilities. At the time of Northridge, the percentage (the Volkmer percentage) provided by the federal government met 90%¹⁰⁰ of the replacement costs. Generally, public assistance programs pay 75% of the approved project costs, but this can be increased at the discretion of the President.

⁹⁷ Tagging of buildings is set out in the California State Post-Disaster Safety Assessment Plan. Inspectors affix tags to inspected buildings. Green tags indicate that no hazards have been discovered, yellow tags allow only limited entry, and presuppose a potential danger, while red tags indicate immediate danger and non-admittance. (Eguchi et al, 1998)

⁹⁸ Comerio (1996), in Bolin & Stanford (1999)

⁹⁹ See <http://www.fema.gov/about/4-sect1.htm>

¹⁰⁰ According to the Insurance Services Office, the federal government has reduced its share of disaster assistance programmes from 100% for Hurricane Andrew, 90% for the Midwest floods, to 75% for the Northridge earthquake. ISO (1994) Other authors, such as Kunreuther (1998), Bolin & Stanford (1998) maintain that the percentage for Northridge was 90%.

5.2 Mitigation measures

Current policy, as set out in the Stafford Disaster Relief and Emergency Assistance Act of 1988, places the financial burden of emergency assistance on the taxpayer. This policy has meant that local communities have had little interest in investing in mitigation measures.¹⁰¹ FEMA breakdown of costs indicate that USD 0.741 billion was spent on hazard mitigation directly as a result of Northridge.¹⁰² As a result of the increasing losses from natural hazards, FEMA adopted a National Mitigation Strategy, aimed at reducing loss of life and property damage by increasing mitigation. There are five main elements:

- Public Awareness and Training for architects, engineers, building and local officials.
- Leadership and Co-ordination: all twenty nine affected federal agencies have issued regulations to incorporate seismic safety measures in all new buildings owned or leased by the Federal Government and to reduce the earthquake risk to existing federally owned or leased buildings.
- Hazard Identification and Risk Assessment: FEMA has commissioned the National Institute of Building Sciences to develop a nationally applicable standardised method for estimating potential earthquake losses.
- Applied Research and Technology Transfer: Reports, recommending the NEHRP provisions for new buildings and a comprehensive set of nationally applicable consensus-backed guidelines has been distributed.
- Incentives and Resources: The 1993 Volkmer Amendment to the Stafford Act following the Midwest floods incorporated a new formula for post-disaster mitigation funding. This increased the Northridge mitigation funds to nearly USD 1 billion instead of the USD 200 million under the old formula.¹⁰³

Under the terms of the Stafford Act the state must prepare a disaster mitigation plan for future events. For each major disaster declared by the President, FEMA will fund up to 75% of the eligible costs of each mitigation project, provided the additional 25% is raised by the state or local sources, in cash, in-kind services or donated materials. Small Business Administration (SBA) applicants can request up to 20% increase in their loan for appropriate hazard mitigation.¹⁰⁴ The Hazard Mitigation Grant Program (HMGP) can provide up to 15% of the federal share of Public and Individual Assistance programmes, minus administrative expenses.

FEMA also created a Seismic Hazard Mitigation Program for Hospitals (SHMPH), which provided grants totalling USD 1.7 billion to participating hospitals, almost 25% of the costs incurred. The program was initiated after disagreement with the California OES about the state requirements, under PIN3, that hospitals meet the 1992 California Building Code.¹⁰⁵ FEMA has established a community based disaster mitigation programme, 'Project Impact', which has absorbed USD 80 million of funding.¹⁰⁶ Other mitigation measures have been undertaken, which include:

Research into design criteria for steel moment-resisting construction	USD 8.7 million ¹⁰⁷
FEMA Preparedness, Training and Exercises Directorate	USD 144 million ¹⁰⁸
US Fire Administration	USD 29 million
Risk Assessment of natural hazards	USD 128 million

¹⁰¹ See Kunreuther & Roth (1998) introduction.

¹⁰² FEMA (2000)

¹⁰³ Moore (1997)

¹⁰⁴ See <http://www.huduser.org/publications/destech/bigone/sect1.html>

¹⁰⁵ See http://www.fema.gov/IG/shmp_bk.htm

¹⁰⁶ See <http://www.fema.gov/nwz98/98017.htm> and <http://www.fema.gov/impact/impact00.htm>

¹⁰⁷ See http://www.fema.gov/NWZ95/95_129.txt This was done as a direct result of the poor performance of the steel construction method, which is widely used, and was believed to be seismically resistant.

¹⁰⁸ See <http://www.fema.gov/nwz98/98017.htm>

Emergency Food and Shelter Program	USD 100 million
LA Unified School District (securing of overhead lights in schools)	USD 120 million ¹⁰⁹

The pressures of the immediate needs of constituents ensure that mitigation measures are often short-term recovery plans rather than long-term mitigation measures. California State offered USD 250 million for financing of seismic retrofitting and another USD 50 million to match funds to help localities retrofit public buildings¹¹⁰. The California Department of Insurance (CDI) initiated two earthquake retrofit programmes in 1997, providing grants or low interest loans for low- to moderate-income households so reducing the risk of earthquake damage. The CDI also organised home inspections and mitigation measures using CDI approved seismic retrofit contractors.¹¹¹ The California Earthquake Authority launched a retrofit programme, SAFER, in October 1999.¹¹²

Mitigation measures could include better structural design, tougher enforcement of building codes or improved land-use planning. In view of the low frequency of catastrophic events, individual homeowners and small businesses are often unwilling to commit their funds to mitigation measures.¹¹³ Such measures could reduce some of the potential losses from an earthquake, but there appears to be reluctance by the insurance industry to provide incentives such as premium reductions to encourage their adoption. Regulatory restrictions constrain realistic setting of rates and incentives would encourage residents in high-risk areas to purchase coverage, thus increasing insurers risks.¹¹⁴ Suggestion has been made for a seal of approval for structures complying with building codes, similar to current termite and radon inspections, as a mandatory condition for use when financing a property.¹¹⁵

Building Codes:

Building Design Codes:

Los Angeles building codes specify buildings to resist a horizontal acceleration of 0.4g. The model codes only require consideration of vertical acceleration in special design cases such as the design of cantilevered elements, and in areas of high seismicity. Los Angeles City adopted an Unreinforced Masonry Retrofit code in 1981, but this was not adopted in other areas affected by the earthquake such as Fillmore, Whittier, Santa Cruz and Coalinga, due to the high costs associated with the strengthening procedures.¹¹⁶

When designed to conform to the lateral force requirements of the code the structure should:

- Resist minor earthquake motions without damage
- Resist moderate earthquake ground motions without structural damage, but may experience some non-structural damage
- Resist major earthquake ground motion having an intensity equal to the strongest forecast for the building site, without collapse, but with possible structural damage.

Current building codes focus on saving lives, and not property loss. *"The purpose of the Uniform Building Code is to provide minimum standards to safeguard life or limb, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures."* Prescriptive building codes,

¹⁰⁹ See <http://www.fema.gov/library/wittspch5.htm>

¹¹⁰ See <http://www.huduser.org/publications/destech/bigone/sect1.html>

¹¹¹ See <http://www.insurance.ca.gov/EXECUTIVE/CatSeries/Earthquake/Earthquake.3.htm> and <http://www.insurance.ca.gov/PRSarchive/PRS1999/Pr149-99.htm>

¹¹² See <http://www.earthquakeauthority.com/data/about/about.html>

¹¹³ Petak (1998). The CEA provides an incentive of 5% premium discount for retrofitted houses.

¹¹⁴ Roth (1997)

¹¹⁵ Kunreuther (1996)

¹¹⁶ Bolin & Stanford (1999)

based on proven performance standards, are perceived to be a way of addressing the economic consequences of earthquakes.¹¹⁷

Building codes form the primary form of protection against losses from earthquakes, but adoption of a code will not necessarily ensure that building practice meets the standards set out in the code without competent enforcement. Building codes are often not enforced in hazard-prone areas, and varying levels of enforcement lead to different standards.¹¹⁸

The state of California requires all cities to adopt the most current version of the Uniform Building Code (UBC) as the minimum code for the city/county.¹¹⁹ A city/county may choose to adopt a more restrictive code; so the requirements and regulations could differ between San Francisco and Los Angeles. The City of Los Angeles introduced retroactive building codes to improve the seismic standards of buildings, and replacement work had to comply with these codes in order to obtain building permits.

The UBC code contains seismic design provisions and it existed long before the National Earthquake Hazards Reduction Program (NEHRP) provisions were developed. The NEHRP standards were drafted by the Building Seismic Safety Council (BSSC), a council under the National Institute of Building Sciences (NIBS). The NEHRP provisions have enabled the Federal Emergency Management Agency (FEMA) to provide a uniform guide for seismic risks, but states are not obliged to adopt these measures.

FEMA has issued a set of guideline provisions that all three code bodies in the US have adopted, which set out design criteria based on the seismic risk of the area. Federal policies have encouraged a uniform set of codes. The advantages are that of legal liability (the uniform code would be widely accepted as up to date practice) as well as the increased efficiency of a uniform standard for compliance and enforcement.¹²⁰

The International Code Council¹²¹ (ICC) is a non-profit organisation created in order to develop a single set of national codes, and the final draft of the International Building Code¹²² for the United States has been completed. This code provides a comprehensive set of construction codes without regional limitations, but it will require adoption and enforcement by state, county and municipal authorities. FEMA has signed an agreement with the ICC to work together on Project Impact, a series of mitigation measures, and has committed funding to encourage adoption and enforcement of the new International Code.¹²³ There is a competitive effort led by the National Fire Protection Association, but it does not look likely to succeed.¹²⁴

Land-Use Planning:

The Alquist-Priolo Act of 1972 is the principal form of land use planning for earthquakes in California, and is designed to prevent development along active fault lines. The legislation requires evaluation of the site by an engineering geologist who can make recommendations for 'safe' construction, and it also requires real estate agents or sellers to disclose risks if the property lies

¹¹⁷ Moore, FEMA representative (1997); Petak (1998)

¹¹⁸ Kunreuther (1996)

¹¹⁹ Petak (2000)

¹²⁰ Wright (2000)

¹²¹ The ICC was founded in 1994 as an umbrella organisation by the Building Officials and Code Administrators (BOCA), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI).

¹²² See <http://www.intlcode.org>

¹²³ See <http://www.intlcode.org/newsrel/nr100899.html>

¹²⁴ See <http://www.nfpa.org>.

within 1/8 mile of a trace of an active earthquake fault. Studies indicate that this legislation has not been implemented.¹²⁵

6. EARTHQUAKE INSURANCE

6.1 Earthquake insurance in the US

The insured losses of Northridge cost more than three times the total earthquake premiums California insurers collected in the 25-year period prior to the disaster. Prior to Hurricane Hugo in 1989, with insured losses of \$4 billion, the insurance industry had never suffered losses in excess of \$1 billion. Since then, over 10 disasters have exceeded that amount.¹²⁶

These recent losses have made it more difficult and expensive to find insurance for natural disasters. The increased risks posed by natural disasters are also due to the increasing number of Americans living in high risk areas, increasing capital investment - sometimes in new technologies, a large number of unsafe buildings, vulnerable lifelines, as well as the increasing interdependence of people. Some insurers and reinsurers consider the earthquake premiums inadequate at present and believe that the potential losses far exceed their capacity, encouraging them to withdraw from the market completely.¹²⁷

Earthquakes pose a significant risk in at least 39 states. Unlike California, these states are not well prepared for these events, and as a consequence are potentially likely to face higher human and physical losses than a comparable earthquake in California. Although the potential for US earthquake insurance appears great, each state has a different regulatory body and system, which makes the potential risk difficult and expensive for the insurer to determine. The eastern United States has experienced a number of damaging earthquakes, such as the 1755 Boston, 1811 New Madrid, and 1884 New York earthquakes. There are longer recurrence periods, and therefore less information and greater uncertainty about these risks. There is a credible risk of a magnitude 5-6 earthquake affecting cities such as Philadelphia, Boston or New York, yet no planning has been made for this risk.¹²⁸ Although there are some current moves to make lifelines more resilient to earthquakes, and for new construction to meet seismic building codes, the overall lack of preparedness, ageing buildings and infrastructure leave society exposed.

Earthquake insurance can be purchased as a supplement to standard coverage, but the take-up is low except in high-risk areas. California, and subsequently Washington, the Midwest and Oregon have all seen increased pricing plans, based on more detailed information of the seismic risks. Insurers are now departing from their past practice of basing earthquake premiums on historical data and using scientific research and computer simulation models to predict earthquake risks.¹²⁹ Earthquake insurance policies are usually for replacement coverage, replacing old for new, which increases the liability of the insurance company.¹³⁰

6.2 Earthquake insurance in California

¹²⁵ Palm (1998)

¹²⁶ Kunreuther (1998)

¹²⁷ CDI (1997/8), Roth (1997)

¹²⁸ Jacob (1995)

¹²⁹ Risk Management Solutions, in New York Times (1999)

¹³⁰ Roth (1997)

Demand for both residential and commercial earthquake insurance has increased over the past 15 years, due to earthquakes, media publicity and rising property values. At the time of the Northridge earthquake, 40% of homes in Los Angeles County had earthquake insurance. This earthquake insurance tends to be purchased by higher-value homeowners, and similarly larger commercial businesses. Mortgage lenders do not normally require earthquake insurance. The reasons given for this are that most loans are on post-1940 properties (built according to some earthquake code) therefore the probability of default is unlikely if there is still positive net equity in the property. Lenders also spread their risks geographically and often pass the risks on to others, and may not discriminate on mortgage loans, because of state and federal anti-redlining legislation.¹³¹

In general, it is large multistate companies with multiple lines of insurance business that have the financial resources to provide insurance against natural catastrophes. The Northridge earthquake demonstrated that the losses were subsidised by other lines of business and business written in other states.¹³² Over the last decade, the number of insurers writing homeowners policies in California has dropped by 23%, resulting in a higher concentration of policies, an increased market share and therefore, a disproportionately larger exposure for the three largest homeowners insurers.¹³³ Seismologists from the United States Geological Survey (USGS) have predicted an increase in seismic tremors and major magnitude 8 earthquakes, and the occurrence of earthquakes of a magnitude of 6.0+ is expected every 1.6 years for the next 30 years, which has increased insurers concerns about their exposure.¹³⁴

Residential earthquake insurance.

In 1985 California State introduced the 'mandatory offer law', which required insurers selling homeowners policies on one- to four-family units to offer earthquake coverage for these structures.¹³⁵ This law requires any insurer writing residential property insurance to offer its prospective and existing clients coverage for loss due to earthquake. The offer must be in writing, subject to minimum coverages. The client has 30 days to accept the offer, but if it is not accepted, the insurer must renew the offer every 2 years.¹³⁶

The mandatory earthquake offer requirement took away from insurers the ability to manage their total risk exposure as they were required to insure old structures in poor condition as well as newer structures, leading to adverse selection problems. After the Northridge earthquake, homeowners decided to avail themselves of this insurance policy, but the high level of losses and seismologists' predictions of further earthquakes caused most insurers to stop writing residential policies, the only legal recourse open to them due to the mandatory offer law. This caused an insurance availability crisis.

The California Earthquake Authority (CEA) was created by the Legislature in 1996 to address the crisis in insurance availability. It is a state-run company funded by the private sector offering earthquake insurance as an endorsement of homeowners' insurance policies. The funds to pay insured loss claims come from premiums, participating insurance companies and reinsurance purchased by the CEA. No public money, including the State General Fund, is pledged to cover losses. The CEA has a total claims-paying capacity of \$7.2 billion.

¹³¹ Palm (1998)

¹³² Roth (1998)

¹³³ ISO (1996)

¹³⁴ This information stems from "Seismic Hazards in Southern California: Probable Earthquakes 1994-2024", and is discussed in CDI (1997/8), Macilwain (1994), NYT (1999).

¹³⁵ Roth (1997), CDI (1997/8)

¹³⁶ CDI (1999)

The CEA commissioned earthquake risk analyses for the entire state, dividing the state into 19 separate rate territories. Rates are dependent on earthquake risk, as well as the age and construction of the home, soil type and proximity to faults. These rates subsequently doubled to actuarially based premiums, but due to political pressure the rates in northern California were reduced despite the results of the risk modelling.¹³⁷ The rating structure of the CEA has been controversial since its inception.¹³⁸ The average cost for a basic policy is now \$2.79 per \$1,000 coverage, but can be as high as \$8 per \$1000.¹³⁹

Deductibles were increased from 5-10% to a standard 15%, the value of contents was lowered to \$5000 and additional living costs was limited to \$1500. The standard coverage offered by the CEA does not cover out buildings and structures, for example detached garages, garden walls, swimming pools, patios, fences or driveways. Some participating companies have introduced a reduced 10% deductible, and higher coverage limits for personal property and additional living expenses. Depending on its date and type of construction, a retrofitted house may be eligible for a 5% premium discount.

It is important to note that the deductible is 15% of the replacement cost of the structure itself. This ensures that the CEA will not pay any claims for structure damage or contents damage unless the damage to the structure exceeds 15%. Should any residents be forced out of their home, the policy will, however, still pay the additional living expenses allowance, up to its \$1500 limit, even if there is minimal structural damage. Many homeowners have chosen not to insure due to the increased premium rates, reduction in coverage offered by the CEA and the low chance that the loss will exceed the 15% deductible. These factors have caused the average level of residential earthquake coverage in California to drop by half to 17%.

Commercial earthquake insurance

There is no mandatory offer requirement for commercial earthquake insurance. Commercial rates are low and appear to be readily available. Approximately 80% of earthquake exposure are on commercial property, yet it is the owners of commercial properties, rather than the small businesses renting the space that purchase this earthquake insurance. Most commercial buildings are only partially insured for earthquake damage, and many older buildings are not covered at all. Small businesses do not buy insurance due to the high cost of cover, their short time horizon, the low number of assets at risk, and the perceived availability of loans and grants. There is generally little coverage for loss of use or business interruption losses.¹⁴⁰

7. CONCLUSIONS

Northridge earthquake was relatively small in terms of seismic intensity, yet its financial impact made it one of the worst disasters in US history. The economic losses were extreme, exceeding all previous predictions. The earthquake provided a graphic illustration of the magnitude of potential losses, alerting federal and state governments, as well as private insurers, to the large risk exposure from earthquakes and the need for greater loss control to reverse the trend. Research has shown that potential direct losses from natural disasters are only likely to increase over time as more Americans live in 'high risk' areas, yet often fail to take the commensurate structural steps to safeguard their property. Indirect losses have also escalated due to the increased interdependence of people and businesses on all forms of communication and other infrastructure.

¹³⁷ Petak (2000)

¹³⁸ Consumer Watchdog (1999)

¹³⁹ III (2000)

¹⁴⁰ CDI, 1997/98

Although the earthquake occurred in one of the best-prepared regions of the world, the extent of the financial losses was extreme. The levels of reimbursement were high; yet non-reimbursed losses still amounted to 50% of the total losses. These losses of approximately USD 21 billion were met by the victims of the disaster and have had major social impacts on the communities affected.

The federal and state governments provided the primary source of relief and economic recovery. FEMA estimates of total federal expenditure on Northridge are more than USD 13 billion, making it the most expensive natural disaster in US history for the federal government. However, federal disaster relief programmes have been reduced over time from 100% assistance for Hurricane Hugo, 90% for Northridge to a current lower level of 75%. This level could be reduced further, particularly in the light of federal cutbacks. This is likely to mean that future disasters will not be covered by government aid to the same extent.

The future role of private insurance in the protection of financial losses from catastrophic events is uncertain, and will depend on the extent of future federal relief programmes for natural disasters. Should these federal programmes be reduced, the demand for private insurance will increase. However, the increasing scale of these losses has made it more difficult and expensive to find insurance for natural disasters. The insured losses inflicted by the Northridge earthquake were so extreme they amounted to three times the total earthquake premiums collected by California insurers in the 25-year period prior to the disaster. As more research becomes available regarding the risk of potential losses posed by earthquakes, insurers increase their premiums, increase the levels of the deductible or reduce the level of coverage. This in turn lowers the level of insurance penetration and leaves more of society vulnerable should a disaster occur.

Northridge earthquake highlighted the value of two preventive measures. First, it showed that good data collection and the use of Geographical Information Systems (GIS) could reduce delay and minimise losses. The proactive steps taken by the California Office of Emergency Services (OES) in the commission of a GIS system appeared to serve the emergency response and planning needs of the agency admirably. It enabled data to be collated, analysed and distributed which in turn improved the ability of the authorities to co-ordinate the response and to focus on the hardest hit areas.

In addition, the earthquake proved the value of seismic strengthening and mitigation measures in reducing deaths and injuries to a very small fraction of the affected population. Current building codes focus on saving lives, but this does not reduce the economic and social costs to a community. The economic costs of better seismic protection are high, and the issue of how much building codes should address the economic consequences of earthquakes has led to considerable debate. The public is not always willing to invest in costly mitigation measures that are essentially long-term, when the likelihood of residential occupation is short-term. This risk debate cannot be restricted to the engineers and code developers, and society at large must participate in assessing the costs and benefits of better seismic protection. In addition, the earthquake demonstrated the vulnerability of some of these building types. Most of the structures affected by the earthquake were constructed in the last three decades and were considered to be earthquake resistant, but not all buildings proved resistant. This has led to improved seismic building codes and highlighted the need for a modern standardised building code.

The probability of another Northridge earthquake, with a similar or greater scale of losses, appears to be high. Yet federal and state governments are keen to shift the responsibility for disaster relief, and funding is unlikely to be equally generous next time. Insurers have grown wary - as the increased premium rates and reduced coverage offered by the California Earthquake Authority indicate - and earthquake insurance is no longer as widely carried by the public as before. Who will

bear the costs of the next Northridge earthquake? Will it be the federal government? The state government? The private insurers? Or the disaster victims? The likelihood is that it will be the latter, but this will result in clear political, economic and social costs. The situation becomes more complex as the percentage of society vulnerable to natural disaster increases. There is no simple solution to this problem, and the result will probably be a trade-off between political, economic and social factors. The issue this trade-off raises is one that only society at large can make.

*"With few exceptions, the country's catastrophe strategy has been to stay lucky. It has worked, in an era of infrequent catastrophes, smaller populations and exposures. But it cannot work forever and, will not work where increased populations and exposures are a fact of life."*¹⁴¹

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