EARTHQUAKE INSURANCE AND EARTHQUAKE RECONSTRUCTION: THE NEW ZEALAND CASE

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Introduction

> The most practical way to approach the questions of earthquake damage is by way of insurance against it. [Freeman, 1932, p. 1].

This view, expressed by an American engineer in 1932, was manifested in New Zealand society, commencing in 1944 and continuing up to the present. Since 1944, a national, compulsory program of earthquake insurance has operated in New Zealand.

The major problem that is thought to characterise New Zealand's national compulsory earthquake insurance program is that sufficient funds will not be available to bring about complete restoration after a serious earthquake in a major urban area. This paper, through analyzing the origins and the 37 years of functioning of the program, hypothesizes that a number of other problems as well as insufficient funds will be associated with earthquake insurance and earthquake restoration in the event of a serious earthquake in a major urban area.

Origins

Officially, the earthquake insurance program came into existence when the Earthquake and War Damage Act was passed by Parliament in 1944.[2] However, the program actually arose out of developments which had started as early as 1941. In that year, the War Damage Act was passed by the New Zealand Parliament.

The Act was modelled on the British example, which had been passed in the same year, but some differences existed. Both Acts established War Damage Commissions. In Britain, the Commission was empowered to levy a charge against the assessed value of all property in England and Wales, whereas in New Zealand the levy was on buildings only, excluding land and property such as fences and perimeter walls, and the levy was based on

the value of the buildings as assessed for fire insurance. In Britain, the rate of levy was 2s. in the pound for buildings and 6d. in the pound for all open and agricultural land, and in New Zealand, the rate of levy was 5s. per 100 pounds of fire insurance coverage ($ .25 per $100). The Commission funds in both societies were to be used for compensation for war damage. [O'Riordan, 1971, pp. 4-7].

A fairly strong case can be made that developments in New Zealand over war damage recompensation were at least initially a result of diffusion from Britain. But diffusion is not a complete explanation for New Zealand setting up a War Damage Commission. The British model did not diffuse to Australia, for example, suggesting that the situation was more conducive for its adoption in New Zealand.

From the very beginning, the War Damage Act was oriented toward general disaster coverage. The introduction of a national earthquake insurance program in New Zealand was foreshadowed in the Parliamentary debates in connection with the War Damage Act in October, 1941. In these debates, there was discussion about the use of surplus funds for covering other disasters. Coverage of earthquake disasters was specifically mentioned. "It was decided...that any surplus in the fund should be set aside to meet any disaster that might arise, such as an earthquake." [Prime Minister Nash, House of Representatives' Debates, Tuesday, 7 October 1974].

The possibility of refunding to premium payers any surplus in the fund at the end of the war was considered, but discarded in favor of making "grants to persons who have had damage done to their property as a result of earthquakes or other disasters..." [Wilson, Leader of Council, Legislative Council Debates, 9 October, 1941]. Thus, the War Damage Fund was always viewed as a general disaster fund.

The most important aspect of the origins of the earthquake insurance program is that the Earthquake and War Damage Commission arose during a period of international crisis. A situation of stress, which directly affected New Zealand society, was the setting in which the earthquake insurance program emerged.

The national earthquake insurance program was a war-time development for New Zealand. In a national emergency, sectional interests in a society are often downgraded in the national interest. In the early years, at least, of the war, there was considerable overall consensus, solidarity, and unity in New Zealand society. This was conducive to the emergence of a disaster fund that was based on equity of costs and benefits. Thus, the war situation initially produced and then led to the consolidation of the fund which became a means of reconstruction after earthquakes and other disasters.

The New Zealand earthquake insurance program was based on ideological commitment to equity. This was first manifested in the fact that recompensation for war damage to property was to be shared by all property owners. In the case of earthquake insurance, Freeman speaks of spreading the risk, and he is referring to geographically spreading the risk over as many communities as possible and also over a long term of years [Freeman, 1932, p. 23].

Spreading the risk is a collective strategy for achieving equity of costs and benefits. The operation of the program over a long period of time disperses the costs and permits the accumulation of funds. A pool of accumulated funds is then available to be disseminated on a widespread basis when an earthquake occurs. The compulsory nature of the programme achieves equity by assuring that the costs are spread over the entire population of the society.

The earthquake insurance program in New Zealand originated as a state initiated and controlled enterprise. Freeman, a major analyst of earthquake insurance, was not in favour of government earthquake insurance [Freeman, 1932, p. 691]. He thought it would remove the incentive for building earthquake resistant structures, it would be difficult to determine a premium rate for manifestly unsafe structures, and it would also be difficult to discriminate between the different degrees of risk in different localities. He did, however, feel that government, in this instance, state governments in the United States, could offer some sort of concurrent excess insurance.

New Zealand, with a documented history of considerable state involvement in social life, particularly in the area of national economic policies and developments, did not accept Freeman's views. Instead, the government established national, compulsory earthquake insurance, and furthermore, all earthquake insurance issued by the Commission is government guaranteed.

From its origins, the New Zealand earthquake insurance program has been coupled with fire insurance. New Zealand's decision to base earthquake insurance on property insured for fire is perhaps related to Freeman's claim that "it is easily possible to combine earthquake insurance with fire insurance in the same policy at an increase in cost which would be exceedingly small..." [Freeman, 1932, p. 3]. In any case, the main motive of combining fire and earthquake insurance is to reduce overhead costs such as office expenses, soliciting, inspection, and commission of agents.

Freeman's hypothesis that compulsory earthquake insurance would result in building construction being less earthquake resistant than it could be, has not eventuated in New Zealand. The argument that incentive to increase resistance would be lost because coverage would be available for the less as well as the more resistant structures at the same rate has not proved sound. After 37 years of compulsory insurance in New Zealand, there is no evidence that building standards have lowered or even remained static. On the contrary, research on earthquake resistant construction and implementation of building codes have been emphasised in New Zealand society.[3]

Functioning

By 1944, when the War Damage Act was repealed and replaced by the Earthquake and War Damage Act, the Commission fund had accumulated to $7,944,956. By 1980, the accumulated amount was $410,384,512. (See Appendix A.) Freeman in 1932 pointed out that the success of earthquake insurance depended upon "The building up of a reserve; recognising that earthquake insurance...meets its severe loss only once in a quarter-century or half-century, with many intervening years without noteworthy loss, and that funds well into the millions of dollars, must

at all times be kept in readiness to meet this rare emergency." [Freeman, 1932, p. 24]

In terms of this criterion, the New Zealand earthquake insurance program has not been successful. Up to the present time, sufficient funds have not accumulated to cope with a severe earthquake. The existing amount in the fund would constitute only a small fraction of the total liability if a serious earthquake affects a major urban area.

This weakness in the earthquake insurance program has been carefully analysed by Sherburd [1981, p. 4-6]. In his analysis, the following earthquake specifications were used.

Magnitude: 7.5 on the Richter Scale
Intensity: X on the Modified Mercalli Scale
Source Region: Close to Wellington, capital, population 350,000
Depth: Shallow, less than 40 kilometres
Aftershocks: One 6, one 5, numerous tremors
Time: 10:30 a.m. on a working and school day.

The Earthquake and War Damage Commission has estimated that such an earthquake would produce a claims cost of $2,000,000,000. This is based on a 20 per cent loss ratio on the total sum insured at risk in the greater Wellington area. This estimated claims cost greatly exceeds the existing reserves in the earthquake insurance fund, and also exceeds any previous claims cost, the highest being $2,513,321 in 1969 (see Appendix B). Since the earthquake insurance of the Commission is government guaranteed, the funds for meeting claims in excess of existing reserves will probably be obtained through substantial overseas borrowing.

However, dependency upon overseas resources, particularly for loan capital, may not be a straightforward matter. In 1968, after a major earthquake occurred in a sparsely populated part of New Zealand, it was claimed that "with the economy now strained to the limit of overseas resources and available investment, and likely to remain so, the possibility of sufficiently substantial loans to ensure quick recovery would be slight indeed." [Power, 1968, p. 26]

One proposed solution to the problem of insufficient accumulation of funds is to increase the rate of levy. When the earthquake insurance was officially made a component of the Commission's programme, the rate of levy was lowered from $.25 to $100 of fire cover to $.05 per $100 of cover. The rate has remained the same ever since.

The premium rate is uniform throughout the society; there is no variation from one region to another. All parts of the society are treated as of equal risk. Critics make the case that low risk areas are subsidising areas of high risk since the program is uniformly compulsory with no variation in rate according to degree of risk.

However, field assessment of risk is a challenging task. It involves consideration of local ground conditions and an engineering knowledge of the expected performance of the existing building.

Very recently, on the basis of submissions from the Earthquake and War Damage Commission, a Commission of Inquiry recommended significant

changes in the premium levy system. (Report of the Commission of Inquiry into the Abbotsford Landslip Disaster, 1980: 162-163). The proposed changes are:

1. The premium should be collected by local authorities as part of the rating demand.

2. There should be an annual premium based on the unimproved value of each landowner's land.

3. The local authorities should account to the Earthquake and War Damage Commission for collected premiums.

4. An annual premium of $.02 for each $100 of unimproved value.

5. The level of the premium should be reviewed after three years.

6. The insurance should not cover rural land used for growing crops, standing timber, orchard trees, fences, gates, irrigation works, and other similar classes of rural improvement.

The liability and benefits of the earthquake insurance programme have developed into quite an unsatisfactory situation. The liability of the Commission is the lesser of (1) of the sum insured or (2) the indemnity value at the time of loss. Thus, most liability payments are on the basis of the assessed indemnity value at the time of loss. The Earthquake and War Damage Act does not define indemnity value and a legal definition of the concept is not readily available.

Especially in the 1970's, replacement insurance has become more available, and it is interesting to contrast liability for indemnity and replacement value. In the case of a 50 year old dwelling, the replacement value could be $60,000 whereas the indemnity value would be only $20,000 [Sherburd, 1981, p. 2]. The owner in the event of complete earthquake destruction of the building would receive an insurance benefit of $20,000 from the Commission and to accomplish complete restoration another $40,000 would have to be obtained privately.

It is simply the case that an insurance program which provides coverage on the basis of indemnity value of property is not going to provide sufficient funds to satisfactorily accomplish earthquake restoration. The indemnity value payments will not come close to meeting the actual costs of reconstruction.

When considering earthquake insurance as a strategy for accomplishing earthquake reconstruction, a number of other problems arise in the New Zealand context. Scale of activity is one of these problems. New Zealand is a small, island society of 3,000,000 residents. The over-all economy operates on a relatively small scale. Thus, a serious earthquake would disrupt the entire economy and set back development of the society for a decade. In contrast, a similarly strong earthquake would have only a minor effect on the over-all economy of Japan because of the difference of scale.

Another problem area centers on the relationship between the state and private sector in New Zealand society. Virtually all earthquake insurance is handled by the Earthquake and War Damage Commission which is

a state agency. When earthquake insurance is available only from the private sector, a number of difficulties arise. In areas of low risk, very little insurance coverage will be taken out. In high risk areas, insurance companies will be reluctant to issue much insurance and the amounts insurable will be relatively small. Also, premiums will be relatively high. The policies will be characterized by strict limitations, making them largely unacceptable to the insuree.

In New Zealand society, these difficulties have been circumvented by the state requiring compulsory earthquake coverage on fire insured property at a very modest uniform premium of $.05 per $100 of cover. However, involvement of the state in assuring the existence of earthquake insurance does not resolve all the problems in a capitalist society. In New Zealand there is a tension between the state and private sector when it comes to earthquake reconstruction, as the building industry is largely private enterprise. The tension manifests itself in a number of ways.

Competition can become extremely intense and stressful. Even though some financing may be available for earthquake reconstruction from insurance payments, in New Zealand society there will be strong, and at times invidious, competition for scarce building resources which will be largely controlled by the private sector. A scarcity of both material and labour resources will occur for the building industry in the area of impact. In fact, because of the small scale of the New Zealand economy, if the entire building industry largely diverted all of its resources to reconstruction there would be complete disruption of the over-all economy.

The last major earthquake affecting a built-up area occurred in 1968 when New Zealand society was experiencing a severe economic recession. One consequence of this was that the building industry in the earthquake area was quite run-down. There was a shortage of skilled tradesmen, equipment, building supplies, and other resources crucial for earthquake restoration. Coupled with this was the reluctance of the building industry to extend credit. The building industry claimed that it was not in a position to carry book debts [Gill, 1969, p. 117]. Thus, those who were able to pay cash were able to have their property restored immediately, if the building industry had the available resources. This means that socio-economic differences played a significant part in how earthquake restoration was actually accomplished. A program which is philosophically based on equity does not produce equity in practice when it comes to what actually happens during earthquake restoration.

The existence of a state insurance program does not mean that the state will control priority over which tasks should be done first. In New Zealand, the mobilisation of material and labour resources will be largely controlled by the private sector. This mobilisation and deployment of resources will be largely influenced by monetary incentives rather than altruistic consideration of societal needs and goals. In other societies, with socialist economies, earthquake reconstruction could become a rallying point for intensified efforts for the good of the entire society. Resources would be allocated in the national interest. Moral and collective incentives would prevail.[4]

Another problem is whether insurance payments are used for earthquake reconstruction or are diverted to some other possibly quite

unrelated use. This was of minor significance, at least, following the 1968 Inangahua earthquake in New Zealand. According to the Secretary of the Earthquake and War Damage Commission, "in some cases it was found that all earthquake repair work was not being carried out, with the possibility that some, if not all of the settlement monies being used for other purposes." [Gill, 1969, p. 117]

This problem, of course, relates to whom the payments are made and when they are made. Perhaps the payments should be made directly to the parties who actually carry out the restoration and as progress payments once the reconstruction is underway. At the present time in New Zealand, in the case of encumbered property, a proportion of the insurance payment is made to the mortgagee.

Conclusion

As has already been noted, some changes have been recommended in the premium levy system for the New Zealand earthquake insurance programme, and at this point the possibility of other changes will be considered. The general question is: what is the future of this unique strategy for earthquake restoration?

What will happen ultimately to the New Zealand Earthquake and War Damage Commission if it has to respond to a severe earthquake in a major metropolitan area? The fund is government guaranteed and so coverage of insured properties is assured.

Once the earthquake crisis is looked after, will the Earthquake and War Damage Commission survive and continue to operate as it has in the past? Perhaps not. The New Zealand egalitarian ideology may no longer be sufficiently strong and viable to sustain a societal development which is based on sharing costs and benefits equitably. There will probably be a strong move to have the private sector assume complete responsibility for earthquake insurance. This would end national, compulsory coverage and bring about insurance on a user pay basis. In the event the Commission has to respond to a major earthquake in a built-up area, the end result may be that monetary incentives will supercede moral and collective incentives and the Commission will cease to operate as it now does.

A major conclusion of this paper is that the possible demise of the Earthquake and War Damage Commission and its program of national, compulsory insurance is a totally unacceptable option and should not be permitted to occur under any circumstances. A compulsory earthquake insurance programme, as a national policy for disaster response, is a fairly unique option for a society to pursue. In New Zealand's case, it has operated with considerable success, but should not be regarded as the utopian solution to earthquake restoration. On the other hand, even though national compulsory earthquake insurance is associated with certain problems, it is proposed that the program be modified rather than abandoned. In western capitalistic societies, there seem to be very few alternatives that could bring about earthquake restoration on a similar equitable basis.

The modifications to the program which have already been suggested in this paper are in the context of a national model of earthquake response. The major recommendation is that all property be levied as a source of capital for a disaster fund. The ultimate aim should be to accumulate sufficient funds within the society to be able to financially bring about satisfactory restoration after a serious earthquake. This approach is based on the strategy of self-reliance and progressive nationalism.

Another approach to modifyng the existing program uses an international model. The main recommendation is that overseas insurance be taken out for purposes of earthquake coverage. A case for the placement of insurance overseas is made by Power. "Although the premium rate may be high, there is no question of the ability of the insurance companies to pay out, and to pay from overseas fund sources - an important factor" [Power, 1968, p. 26].

Both the national and international model seem to be viable possibilities but with each having certain weaknesses. The national model has the weakness of requiring a widespread and prolonged period of commitment. To be successful in a small society such as New Zealand, the program would have to be comprehensively compulsory and operate for many years in order to bring about the accumulation of a reservoir of sufficient funds to handle major earthquakes as they occurred. For New Zealand, at least, the national model involves extremely long-term operation and very comprehensive support and participation from the entire society.

The international model has the weakness of creating an undue degree of dependency in New Zealand society. Once insurance is placed overseas, New Zealand loses some control of the situation. For example, control over how the insurance premium funds are invested would no longer be a New Zealand decision. In the case of Earthquake and War Damage Commission funds, at the present time most of the funds are invested internally in local body and government stocks.[5] Carrying overseas earthquake insurance would mean that New Zealand no longer controlled this investment capacity and would, in effect, put New Zealand in a very dependent position and subject to considerable foreign influence.

A further weakness of the international model, possibly of the national model too, is that attention is almost exclusively devoted to the purely financial aspects of earthquake restoration. It must be realised that the availability of adequate funds will not be sufficient on their own to bring about satisfactory earthquake restoration after a serious earthquake in a built-up area in New Zealand society. Adequate funds are a necessary but not a sufficient basis for earthquake restoration.

Adequate funds are a material resource. Social and organizational resources are also essential for earthquake restoration. The sociological aspects of disaster response are as important as the material and technological aspects. For example, perhaps one of the least recognised problems with New Zealand's earthquake insurance and reconstruction program is that the mixing of state and private sector activities can produce severe difficulties.[6] This is a problem area that will not be resolved by simply making available more funds.

In very general terms, the sociological aspects of earthquake response in New Zealand are generally analysed from only one perspective which can be narrow, confining and restrictive. Implicit in much of the discussion about the problems that would occur over earthquake insurance in the event of a severe earthquake is the view that New Zealand society usually operates as a finely-tuned and well-balanced entity, especially in the economic sphere. Power, for example, claims: "At the very best only a proportion of the building industry could be directed to the job of reconstruction without complete disruption of the economy, so that this burden would set the country back for possibly 10 years." [Power, 1968, p. 26] Thus, it is evident that much of the thinking about earthquake reconstruction in New Zealand is strongly influenced by the consensus, equilibrium model of social life.

The final conclusion of this paper is that sociologists and others concerned with disaster response need to consider alternatives to the consensus model, especially when dealing with the restoration phase of disaster response. Is it possible to view earthquake restoration as a creative, adaptive, and dynamic process for the entire society, rather than emphasising disruption and dislocation with a view to restoring the status quo as soon as possible?

FOOTNOTES

1. The research assistance of Mr. Gregory Seymour is gratefully acknowledged.

2. It should be noted that in 1949 the Earthquake and War Damage Act was extended to cover extraordinary disaster, storm and flood damage. The premium levy remained unchanged. A separate account, the Disaster Fund, was created by diverting one-tenth of the premium levy from the Earthquake Fund into the newly created Disaster Fund.

3. Seismic building regulations were introduced in New Zealand in 1932.

4. A capitalist and a socialist society, the United States and China are compared by Gimenez in her analysis of social response to earthquake prediction. She found that moral and collective incentives predominated over monetary incentives in the socialist society of China. [Gimenez, 1976]

5. In 1980, $372 million was invested internally and $40 million was invested overseas.

6. This situation is similar to "The Tragedy of the Commons" where severe problems arose because the grazing land was owned publicly while the cattle were owned privately. [Hardin, 1968]

Appendix A

Earthquake and War Damage Fund Statistics

Year	Amount Insured ($ Millions)	% Increase Over Prev Year	EQWD & Disaster Premiums	Amount of EQWD Fund	% Increase Over Prev Year	Ratio % Of Fund to Amount Ins'd
1944	1,139		2,846,610	7,944,956		.70
5	1,281	12.5	640,548	8,762,426	10.3	.68
6	1,463	12.4	731,722	9,678,456	10.5	.66
7	1,640	12.0	820,130	10,656,162	10.1	.65
8	1,980	20.7	989,876	11,858,626	7.3	.60
9	2,163	9.2	1,081,408	12,458,652	5.0	.58
50	2,349	8.6	1,174,334	13,904,584	11.6	.59
1	2,810	19.6	1,405,220	15,476,740	11.3	.55
2	3,351	19.3	1,675,360	17,372,012	12.2	.52
3	3,823	14.0	1,911,278	19,546,538	12.5	.51
4	4,174	9.2	2,086,794	21,948,278	12.3	.53
5	4,732	13.4	2,365,784	24,708,788	12.6	.52
6	5,209	10.0	2,604,392	27,784,912	12.4	.53
7	5,761	10.6	2,880,414	31,186,314	12.2	.54
8	6,143	6.6	3,071,512	34,918,842	12.0	.57
9	6,703	9.1	3,351,266	39,071,780	11.9	.58
60	7,031	4.9	3,515,306	43,483,966	11.3	.62
1	7,643	8.7	3,821,736	48,424,026	11.4	.63
2.	8,296	8.5	4,147,970	53,982,904	11.5	.65
3	8,764	5.6	4,381,868	59,956,578	11.0	.68
4	9,426	7.6	4,713,000	66,590,374	11.1	.71
5	10,229	8.5	5,114,288	73,904,248	11.0	.72
6	10,827	5.8	5,413,660	81,702,826	10.6	.76
7	11,716	8.2	5,857,886	90,333,840	10.6	.77
8	12,630	7.8	6,314,856	101,137,652	12.0	.80
9	13,711	8.6	6,855,681	109,449,876	8.2	.80
70	14,233	3.8	7,116,523	121,211,258	10.7	.85
1	16,242	14.1	8,121,212	134,928,640	11.3	.83
2	17,567	8.2	8,783,464	150,306,030	11.4	.86
3	21,384	21.7	10,692,037	164,886,127	9.7	.77
4	23,892	11.7	11,946,006	181,969,232	10.4	.76
5	30,275	26.7	15,137,399	208,269,594	14.5	.69
6	38,327	26.6	19,163,416	239,967,920	15.2	.63
7	45,202	17.9	22,601,021	267,773,163	11.6	.59
8	51,500	13.9	25.749,996	310.535.210	16.0	.60
9	59,526	15.6	29,763,175	360,157,057	16.0	.60

(From: Abbotsford Landslip Commission of Inquiry: Phase 4: Submissions on Behalf of Earthquake and War Damage Commission, 1980)

Appendix B

Earthquake and War Damage Claims

Year	Number of Claims	Amount($)
1942	Nil	
1943	29	1,912*
1944	16	110*
1945	2	164
1946	82	1,014
1947	134	3,558
1948	401	15,834
1949	343	25,752
1950	306	4,322
1951	544	38,682
1952	232	8,088
1953	69	1,786
1954	457	24,392
1955	86	4,186
1956	125	9,108
1957	318	17,150
1958	308	17,394
1959	140	10,426
1960	624	73,542
1961	228	31,036
1962	357	16,658
1963	2,381	248,224
1964	221	10,184
1965	86	4,742
1966	1,945	242,574
1967	1,749	193,018
1968	300	19,850
1969	13,005	2,573,321
1970	288	120,373
1971	240	35,048
1972	1,848	210,897
1973	3,700	272,747
1974	567	91,515
1975	4,274	419,988
1976	1,728	181,757
1977	2,113	337,236
1978	856	80,198
1979	270	21,021
1980	639	122,965

*War Damage

(From: Abbotsford Landslip Commission of Inquiry: Phase 4: Submissions on Behalf of Earthquake and War Damage Commission, 1980)

Appendix C

Claim Statistics for Larger Natural Disaster Occurrences (Earthquakes from which more than 200 Claims have Resulted)

DATE	GENERAL EPICENTRAL AREA	MAGNITUDE	CLAIMS RECORDED	APPROX COST OF CLAIMS ($000)
23.5.1948	North Canterbury	(5.0+) Force VII	239	25
11.1.1951	North Canterbury	(6.0) Force VII-VIII	380	30
29.9.1953	Opotiki & South	(5.0) Force VI	365	20
22.5.1959	Picton	5.0	461	50
10.5.1962	Westport	5.9	2,243	225
5.3.1966	Gisborne	6.2	1,900	225
23.4.1966	Seddon	6.0	1,575	180
24.5.1968	Inangahua	7.0	10,500	2,430
25.9.1968	Puysegur (Southland)	5.5	250	3
1.11.1968	Wellington	5.5	2,200	136
9.1.1972	Te Aroha	5.1	1,300	150
6.1.1973	Hawkes Bay	6.7	2,300)	200
22.3.1973	Hawkes Bay	5.7	800)	
26.3.1973	Wellington	5.5	350	25
19.4.1974	Dunedin	5.0	2,767	300
21.3.1976	Wairoa	5.5	829	130
5.5.1976	Milford Sound	7.0	450	50
18.1.1977	Cape Campbell	6.0	980	150
1.6.1977	Edgecombe	5.25	360	50

(From: Abbotsford Landslip Commission of Inquiry: Phase 4: Submissions on Behalf of Earthquake and War Damage Commission, 1980)

Appendix D

Seismicity of New Zealand: Shallow Earthquakes of Richter Magnitude 6 or Greater

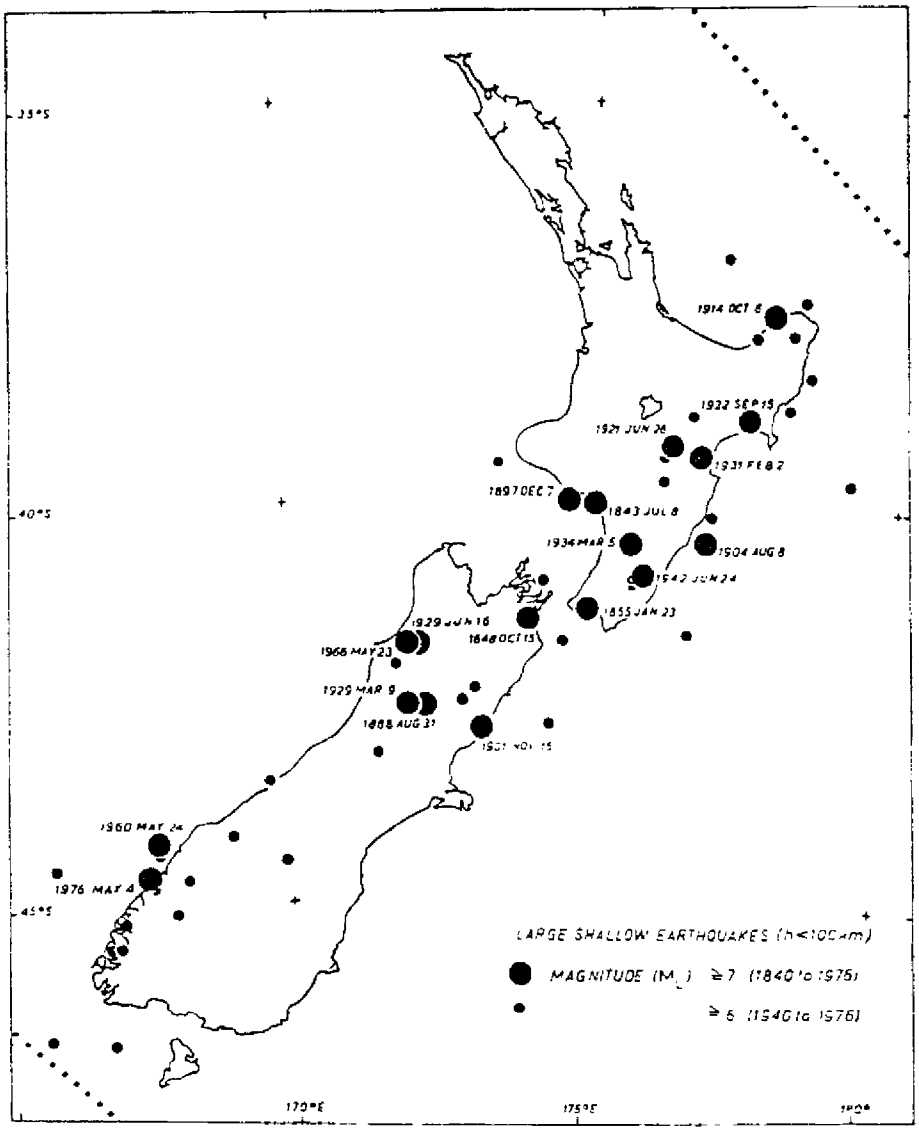

FIGURE 1: LARGE SHALLOW EARTHQUAKES IN NEW ZEALAND
(Supplied by the Seismological Observatory, Department of Scientific and Industrial Research, Wellington)

(From A.V. Hatrick, "Dams and Earthquakes in New Zealand", Bulletin of the New Zealand National Society for Earthquake Engineering, 11 (June, 1978) 100.)

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