CATDAT

Integrated Historical Global Catastrophe Database

A review of Australian Damaging Earthquakes

EGU 2011-4934

abstract

Problem Definition

With the increasing number of earthquake effect databases and reports worldwide, the number of erroneous and contradicting figures is increasing. It has been seen that the number of recorded damaging earthquakes in major databases generally consists of very few entries for Australia despite the large number of damaging earthquakes. In addition, due to the short recorded history of Australia, existing earthquake risk is difficult to quantify.

Why study Australian Earthquakes?

By using the newly formed CATDAT Damaging Earthquakes database, the socio-economic damage data collected for historic Australian earthquakes and at least rockbursts are presented. Although the total Australian statistics, just over $5 billion USD (2011 HNDECI adjusted dollars) and 16 earthquake deaths and 5 rockburst deaths, are dominated by the 1989 Newcastle Earthquake, many other historic earthquakes have recorded significant losses to regional finance and infrastructure and a repeat earthquake could cause significant damage with the now increased exposure. Most Australian buildings are built of URM with a reasonably low seismic code by world standards.

The effects of over 90 damaging earthquakes have been recorded in Australia since the beginning of its European history. Given the small return period of European Australian history (approx. 220 years), there exists a large gap in the historical damaging earthquake record compared to some other parts of the world, with increased uncertainty of the effects of large earthquakes expected along major faults through urban centres (particularly Adelaide and Perth – both cities of over 1 million people).

This complete list of Australian damaging earthquake socio-economic losses in CATDAT, sourced from many locations, includes estimates, trends and figures of these earthquakes based on historical Australian building type, economy and social data. Details as to damaging earthquake secondary effects are also presented. In addition, a normalisation procedure has been used to look at potential economic losses from a reoccurrence of these earthquakes.

How does this help the community?

This work furthers the need for systematic risk assessments for all urban centres in Australia. This data should help to standardise the differences seen in literature and historic earthquake databases in values of historic Australian damaging earthquakes and will also aid earthquake loss estimation damage-loss conversion ratios.

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Data Collection and Losses in Australia

What is the criteria used?

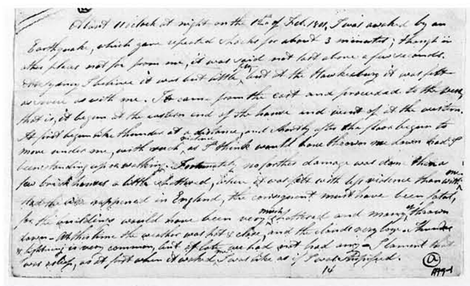
The following CATDAT criteria was used to classify damaging earthquakes.

- Any earthquake causing collapse of structural components.
- Any earthquake causing death, injury or homelessness.
- Any earthquake causing damage or flow-on effects exceeding $10,000 international dollars, Hybrid Natural Disaster Economic Conversion Index adjusted to 2011.
- Any earthquake causing disruption with a reasonable economic or social impact as deemed appropriate.
- A requirement of validation of the earthquake existence via 2 or more macroseismic recordings or seismological station information and at least 1 of the 4 definitions above.
- Additional socio-economic parameter, polity, governance and corruption, and data quality criteria.

The first major damaging earthquake recorded in Australia : 1801 Hawkesbury Earthquake

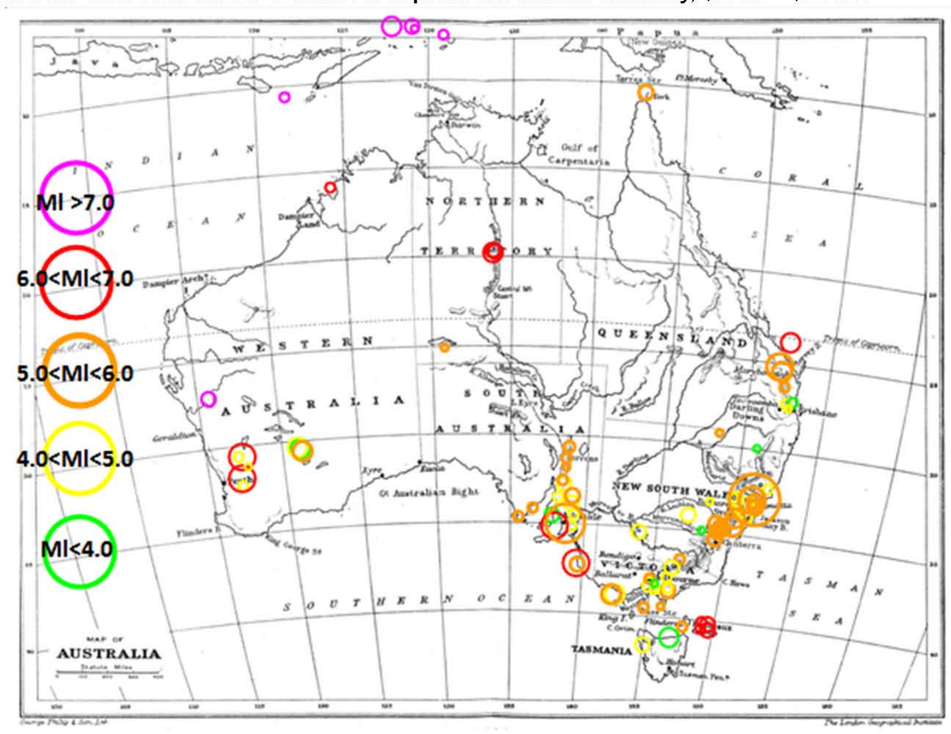
The earliest Australian damaging earthquake near Sydney on the 12.02.1801, shattering a few brick houses. Were this earthquake to be repeated today, the cost would be much greater. This is the letter from Caley to Banks—early Australian history!

These type of sources contribute to the CATDAT Earthquakes Database and this study.



Where have the damaging earthquakes occurred?

There have been 96 damaging earthquakes since 1801 impacting on Australian soil. This is compared to the 12200 damaging earthquakes recorded globally. Below the magnitudes and the economic losses of each earthquake are shown. Currently, $1AUD~$1USD.



A = 2010 HNDECI-Adjusted AUD value of less than $10,000.
$10,000<B<$100,000<C<$1,000,000<D<$10,000,000<E<$100,000,000
$100m<F<$1000m<G<$10000m

Further Losses and Normalisation to current conditions

Casualty Bearing Earthquakes in Australia

Earthquake	State	Ml	Deaths	Serious Injuries	Minor Injuries	Cause
07.07.1883 Adelaide	SA	4.9			1	1 Person injured jumping from a window
10.05.1897 Beachport	SA	6.8		5	45	Numerous injuries including several serious at Beachport
19.09.1902 Warooka	SA	6.0	2		1	2 heart attacks related to the earthquake
25.06.1903 Moonta	SA	RB		1	9	Rock fall in mine due to rockburst
27.08.1917 Kalgoorlie	WA	RB	1			1 death due to underground rock fall
02.09.1932 Selwyn Fault	VIC	4.5			3	At least 3 people treated for shock
12.04.1935 Gayndah	QLD	5.5	1			1 railway worker shaken off a railway bridge (Biggenden)
28.02.1954 Adelaide	SA	5.4		3		3 serious injuries
22.05.1960 Chile Tsunami	NSW	Tsu			2	2 minor injuries.
14.10.1968 Meckering	WA	6.8 Ms		5	28	At least 5 serious injuries and over 20 minor injuries
02.12.1977 Balliang	VIC	5.0			1	1 broken arm of a child falling from a bunk
02.06.1979 Cadoux	WA	6.1			1-5	Between 1 and 5 minor injuries.
27.12.1989 Newcastle	NSW	5.4 Mw	13	30	135	12 collapse, 1 heart attack. 165 hospitalised.
06.08.1994 Ellalong	NSW	5.4			5	5 minor injuries
1996-1998 Rockbursts	WA		3			Potkin et al., 2000.
25.04.2006 Beaconsfield	TAS	2.2	1	2		1 died due to rockburst – rock fall, 2 major injuries
20.04.2010 Kalgoorlie	WA	5.2 Mw			2	A man and woman were hospitalised with minor injuries

- There have been 6 fatality bearing rockbursts and earthquakes in Australia with 17 total casualty-bearing events. However, significant future losses are expected.

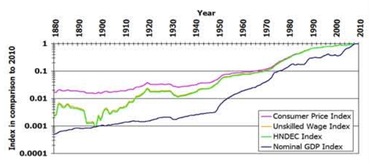
Top 10 Economic Losses from Earthquakes in Australia

Location information			Economic Loss in AUD x 10^6 (date of event)			Median HNDECI-adjusted 2010 Economic Loss (AUD x 10^6)
Earthquake	State	Ml	Best Estimate	CATDAT Upper	CATDAT Lower	
1989 Newcastle	NSW	5.4 Mw	3246	4000	1650	5313.1
1954 Adelaide	SA	5.4	9.07	9.07	6.2	152.5
1994 Ellalong	NSW	5.4	50.05	50.05	36	70.7
1968 Meckering	WA	6.8 Ms	5.23	7	5	57.2
1902 Warooka	SA	6.0	0.048	0.06	0.02	12.1
1979 Cadoux	WA	6.1 Mw	4.08	4.08	3.8	15.5
1897 Beachport	SA	6.8	0.0145	0.015	0.01	11.5
1918 Bundaberg	QLD	5.4	0.12	0.12	0.12	8.3
2006 Beaconsfield	TAS	2.2 RB	6.49	12	4	7.2
1961 Robertstown	NSW	5.0	0.5	0.5	0.5	6.6

- Due to the difference in plausible estimates, CATDAT shows ranges of losses.
- Newspapers, K. McCue, G. Walker, R. Blong and many more, Australian Yearbooks, global databases, reports and own cost estimates based on building construction and damage reports using economic indices since 1788.

A simplified normalisation to the conditions of today

- Having used the HNDECI to create an exact historic loss in today's dollars, by accounting for other factors we can predict a simplified loss estimate!



$$NormD_{2010,loc} = D_{2010,loc} \times PD_{y,loc} \times V_{y,loc} \times CW_{y,loc}$$

- $D_{2010,loc}$ = 2010 HNDECI adjusted damage as expressed through CATDAT
- $PD_{y,loc}$ = Population-dwelling change factor (no. of dwellings/population)
- $V_{y,loc}$ = Building vulnerability change factor (code, material changes, building practice change, risk perception)
- $CW_{y,loc}$ = Community wealth factor (GDP, wealth influence within populated centres including utilities, transportation etc.)

This does not account for the indirect losses and current economic climate flow-on consequences in historic earthquakes. It is undertaken on a state by state basis.

Earthquake	State	Historic Pop.	2010 Pop.	PD	V	CW	D_{2010}	$NormD_{2010}$ w/o CW	Norm D_{2010}
1989 Newcastle	NSW	130000CD 432865SD	147000CD 540000SD	1.17	0.77	1.12	5313	5229	5361
1954 Adelaide	SA	483500	1190000	2.46	0.81	1.66	152.5	303.9	504.4
1994 Ellalong	NSW	470 43500 (C)	1015 51600 (C)	2.0	0.94	1.14	70.7	132.9	151.5
1968 Meckering	WA	240 (606000)	116 (1700000)	2.0	0.85	1.24	57.2	97.2	120.6
1979 Cadoux	WA	stable (36)	stable	1.2	0.82	1.12	15.5	15.3	17.1
1897 Beachport	SA	655* (154000)	2880 (1190000)	6.6	0.9	2.60	11.5	68.3	177.6
1902 Warooka	SA	187** (163000)	1122 (1190000)	6.3	0.89	2.72	10.4	58.6	159.2
1918 Bundaberg	QLD	23178***	145000	6.3	0.95	2.96	8.3	49.7	147.0
1961 Robertstown	NSW	5000°	12000	2.4	0.8	1.38	7.2	13.8	19.1
1903 Warrnambool	VIC	6450°°	30000	4.65	0.92	2.53	5.5	23.5	59.5

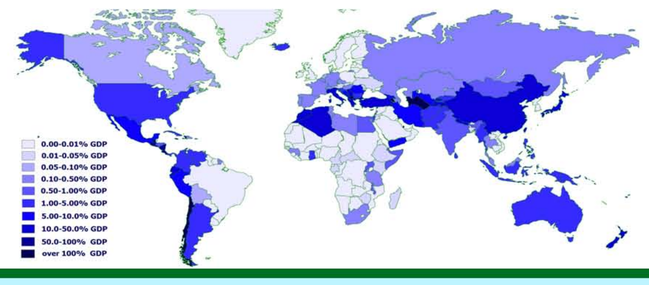
*Robe and Kingston SE population, ° Bowral population, **Ardrossan and Warooka, °°In 1903 Warrnambool had 1260 inhabited dwellings, ***Bundaberg (8727) and Rockhampton (15451), CD – city district, SD – state district, C - Cessnock

Conclusions for Seismic Risk in Australia

Only 1 major event (Newcastle 1989) has caused 90% of the economic losses in Australia. However, with major faults going through all cities of >1 million people in Australia, it is only a matter of time until our URM buildings see major damage.

The vulnerability of Australia towards earthquakes

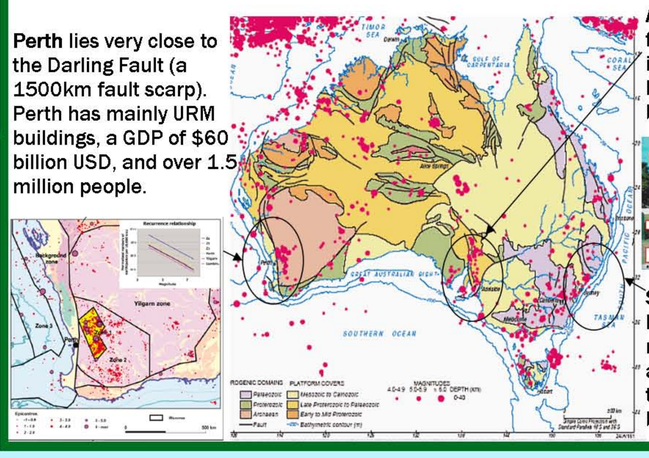
The destruction of URM buildings in the 2010 and 2011 Christchurch earthquakes show the vulnerability of Australian building typologies. The Adelaide and Newcastle earthquakes of 1954 and 1989 caused comparatively large damage from low magnitude earthquakes. Adelaide has faults capable of M7 earthquakes, similarly faults around Perth could also cause such earthquakes. Given the developed nature of Australia, exceptional economic losses can be expected. Most of the GDP loss seen below came from Newcastle.



Conclusion

- The importance of an acceptable range of economic and social losses for Australia trended with correct measuring of worth has been seen.
- Although Newcastle dominates the statistics, the fact is that Australia only has 220 years of earthquake history to calibrate it's hazard and thus risk map.
- Much more work needs to be done to quantify seismic risk in Australia and given the increasing insurance takeout and rapid growth of wealth, this becomes increasingly important in an economic driven world.

Perth lies very close to the Darling Fault (a 1500km fault scarp). Perth has mainly URM buildings, a GDP of $60 billion USD, and over 1.5 million people.



Adelaide has many faults running through it. Up to M7.2 quakes. Pop=1.1 million, $32 billion GDP.

Sydney has a slightly lower hazard but with major faults and around 5 million ppl in the vicinity—$175 billion GDP.

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