Some Historical Earthquakes in Tasmania with implications for Seismic Hazard assessment

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Abstract

The latest hazard estimate for Tasmania published by Geoscience Australia (GA) does not reflect the history of earthquakes in that state. Engineers, architects and town planners need to develop a better feel for the scope of the uncertainties in earthquake hazard estimates given the short observation period and lack of a physical model, for the large impact of the assumptions on the computation, and for the education and experience of the people making them. A series of earthquakes in eastern Tasmania occurred in the period 1927 – 1932 that are all but forgotten, those of 1928 and 1929 near Launceston were the most destructive earthquakes in Tasmania since European settlement. The great end-of-19th-century-swarm off NE Tasmania, 4 large earthquakes and thousands of felt earthquakes, is not reflected in the hazard results. The paleo-seismological evidence seems not to figure in their analysis either.

The GA study suggests that the 475 yr hazard value at Launceston be reduced to 0.04, 1/3 its current value of 0.12. This is simply a result of them neglecting the pre-1965 seismicity, two thirds of the available earthquake time sample.

Historic earthquakes dominate some earthquake hazard assessments overseas, notably those for Vancouver Canada and Christchurch New Zealand, both intraplate sites but threatened by distant plate boundary earthquakes too.

We as a profession must communicate our knowledge, and its limitations, not just to engineers but through the media to the general public who will pay for the consequences and therefore need to be involved in the decision as to what constitutes acceptable risk.

Keywords: seismicity, earthquake hazard, Tasmania

Introduction

Any earthquake hazard estimate is a combination of science and art (professional judgment). Analysts are limited by both the data span and the models they have adopted to manipulate the data, but the longer the data span, the more confidence one can have in the results. At Vancouver Canada, the earthquake hazard assessment for the city is totally controlled by an inferred pre-historic great Cascadia earthquake on 26 January 1700 that has been reconstructed from a tsunami observed in Japan and tsunami beach sand deposits off the west coast of Canada. At Christchurch New Zealand, the earthquake hazard prior to 2010 was dominated by pre-historic earthquakes on the Alpine Fault rather than by a few regional earthquakes that had caused damage in the city in the last 120 years.

Obviously scientists in Canada and New Zealand used the longest possible time window available to them to make earthquake hazard assessments, time windows that far exceeded the historical record. This is in stark contrast with Tasmania where the latest earthquake hazard assessment (Burbidge and others, 2012) is based just on the post-1965 record, historical and paleo-seismological records have been disregarded on the basis of lack of sample completeness for the recurrence model adopted.

In Tasmania, Macquarie Island aside, there is no interplate component to the hazard and we hope Tasmanians, and citizens of Vancouver, won't be horribly shocked as were those of Christchurch when the 'unthinkable' happens; a rare large close intraplate earthquake.

Seismicity of Tasmania

The seismicity of Tasmania has been well studied (Figure 1), and is dominated by two seismic crises. The first is the extraordinary swarm of strong earthquakes at the end of the 19th century off the northeast coast, more than 2500 of them felt, some caused minor damage in Launceston and were felt as far as Kiandra south of Sydney (Ripper, 1963). Michael-Leiba (1989) drew isoseismal maps for eight early earthquakes including the three larger earthquakes of 1884, 1885 and 1892 enabling her to evaluate their magnitudes. In her assessment, they ranged from 6.4 to magnitude 6.9. Isoseismal maps for Tasmanian earthquakes are compiled in the atlases by Everingham and others (1982) and McCue (1997). Included are maps of 4 and 15 Tasmanian earthquakes respectively. The worldwide recognition of these earthquakes led to the most interesting map reproduced in part in Figure 2 below.

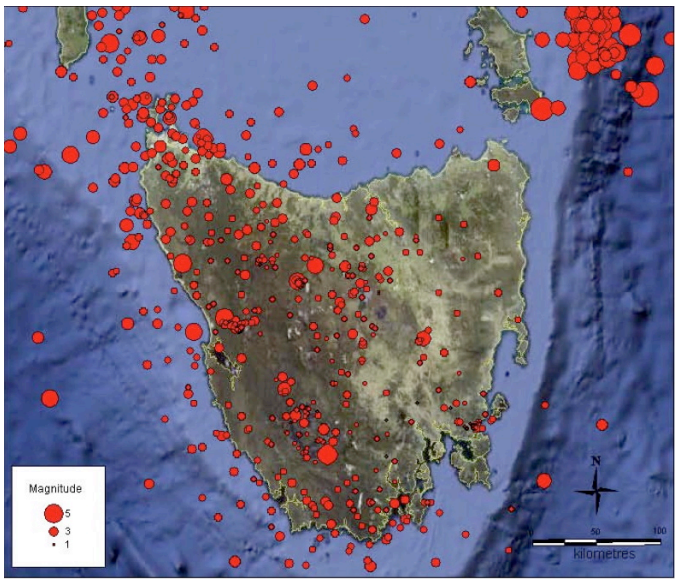


Figure 1 Seismicity of Tasmania, 1880 – 2010 (from Payne and others, 2010). The 1928 and 1929 earthquakes are not plotted here.

The second much earlier crisis is reflected in the paleoseismological record, two geologically young surface ruptures in central west Tasmania, indicative of several very large earthquakes at Lake Edgar and Gell River (Van Dissen and others, 1997; Clark and others, 2013). It was the identification of these two fault scarps by Professor Sam Carey (Carey and Newstead, 1960) that led to the commissioning

of the state seismograph network in 1957 supported by the Tasmanian Hydro-electric Commission; after all the fault scarps are nearer the Commission's large dams than were the more recent large earthquakes off the NE coast.

Shirley (1980) and Richardson (1989) wrote relatively recently about the seismicity of Tasmania and a review was compiled by Gibson & others (2000).

Most of the post-1965 on-shore epicentres are in the ancient Pre-Cambrian rocks of western Tasmania while the dramatic sequence of late 19th century events are in the younger Paleozoic crust of eastern Tasmania, the two separated by the Tamar Fracture System.

The historical and instrumental records are very short so van Dissen and others (1997) launched a study of the young fault scarp identified by Carey (1960) on the shore of Lake Pedder, a scarp formed by the largest known earthquake, or series of earthquakes, that ruptured the crust of SW Tasmania near the present-day Lake Pedder in prehistoric times, the magnitude assessed at ~7.

Figure 2 Detail from the map published by Mallet in 1858 and reproduced by Lee and others (2002).

Early earthquakes in southeast Australia were widely enough noted that Mallet (in Lee, and others, 2000) included the area in the circum-Pacific seismic belt (Figure 2), yet the hazard map of Tasmania (AS1170.4 - 2007) suggests the state is relatively aseismic compared with Victoria, South Australia or New South Wales because earthquake damage was minimal in Tasmania in these past large earthquakes. This author was most surprised then to come across an unknown (to him) damaging earthquake there in 1929, which caused similar damage to those later earthquakes in Adelaide and Newcastle that put the latter cities on the engineer's radar and into the hazard map. Other significant earthquakes on the east coast were reported in the short period 1927 to 1932 that have not previously been documented, but ought to be included in future hazard models.

Felt reports and isoseismal maps, 1927 - 1932

What led to the disclosure was the recent publishing on-line by the Australian National Library of their scanned collection of early Australian Newspapers. The site TROVE allows users to correct the OCR of the scanned images that makes the collection even more valuable as this corrected text can be searched online by all. Examples of both the corrected text and scanned newspaper are documented below

1927. Embedded in a story about an earthquake felt in Hobart in 1928, the Hobart Mercury journalist mentioned that the barograph at the weather bureau showed only a slight movement compared with the earthquake of September 20 last. This led to a search for information about the earlier earthquake and ultimately an isoseismal map, shown on the left in Figure 3. This earthquake was most strongly felt in Hobart and at Port Arthur.

1928. On 18th January 1928 a strong earthquake was felt throughout Tasmania with minor damage reported, plaster cracked and dislodged in a bank building in Fingal, southeast of Launceston. A farmer out droving sheep near Campbell Town (50km southwest of Fingal) felt the earth tremble enough to frighten his sheepdogs, clearly a near-epicentre report. The isoseismal map is shown in Figure 3 with a tentative epicentre near Fingal and a magnitude, from the felt area, of 5.4.

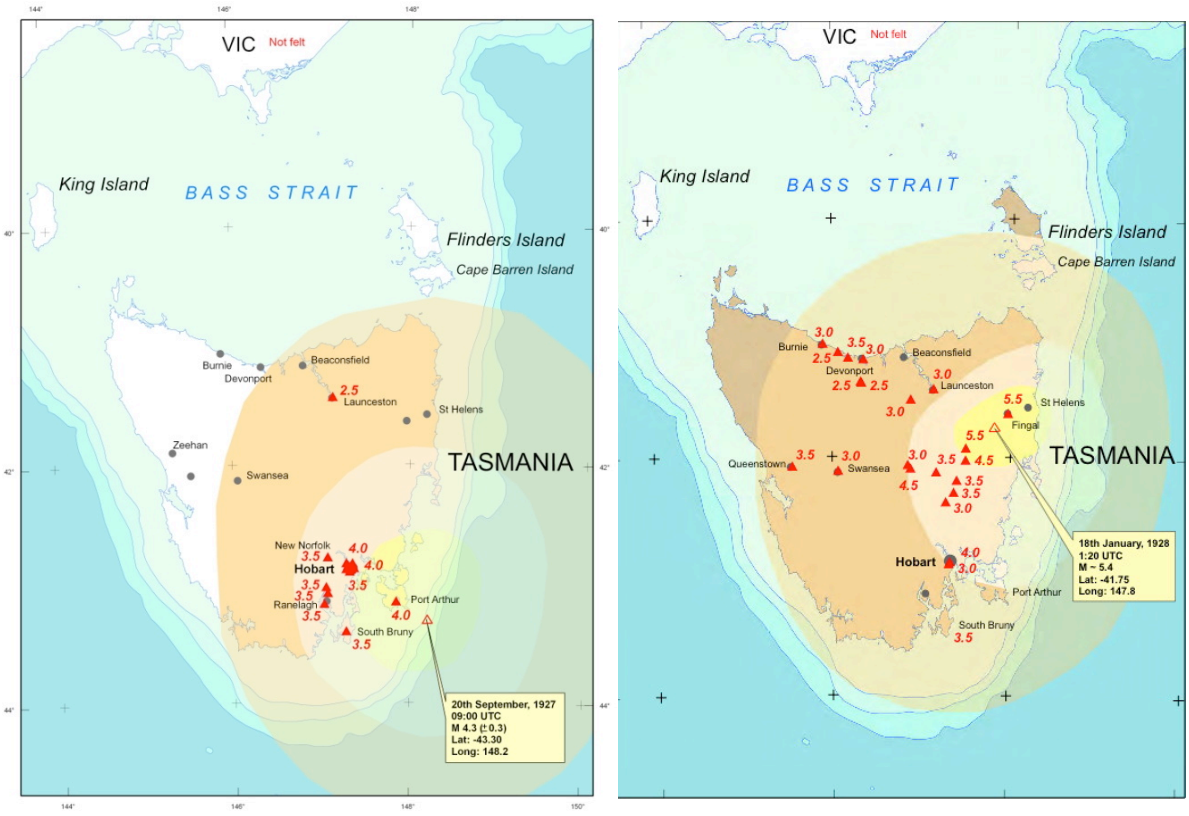
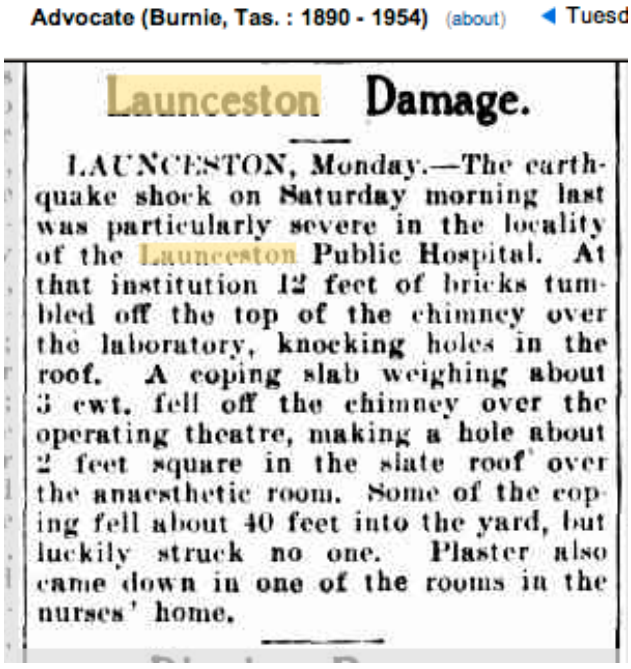


Figure 3. Isoseismal map of (left) the Port Arthur earthquake of 20 September 1927, magnitude ~4.3 and (right) the Fingal earthquake of 18 January 1928, magnitude ~5.4

Figure 4 Extract from the *Burnie Advocate* Tuesday 31 December 1929.


Advocate (Burnie, Tas. : 1890 - 1954) (about) ◀ Tuesd

Launceston Damage.

LAUNCESTON, Monday.—The earthquake shock on Saturday morning last was particularly severe in the locality of the Launceston Public Hospital. At that institution 12 feet of bricks tumbled off the top of the chimney over the laboratory, knocking holes in the roof. A coping slab weighing about 3 cwt. fell off the chimney over the operating theatre, making a hole about 2 feet square in the slate roof over the anaesthetic room. Some of the coping fell about 40 feet into the yard, but luckily struck no one. Plaster also came down in one of the rooms in the nurses' home.

1929. Various newspapers reported the December 1929 earthquake and the story titled *Launceston Damage* in the north coast based *Burnie Advocate* on Tuesday 31 December is shown in the scanned extract in Figure 4, detailing the damage observed.

The south coast Hobart Mercury of Monday 30 December 1929 page 5 reports the following story: *Shortly before half-past eleven on Saturday morning a very noticeable earth tremor was experienced in Hobart and its surroundings. The pronounced vibration was felt in all parts of "The*

Mercury" building, the rattling of windows accompanying the earth movement.

In city offices and establishments generally the same disturbance was noted. In domestic residences bells rang of their own accord, crockery danced, and clotheslines heaved. No actual damage to property is reported.

*The disturbance registered Itself at the Hobart observatory at Anglesea Barracks by a sudden violent movement on the part of the sensitive instrument (*Ed. meteorological instruments*), indicating that it was centred in a distant earthquake of more than ordinary severity.*

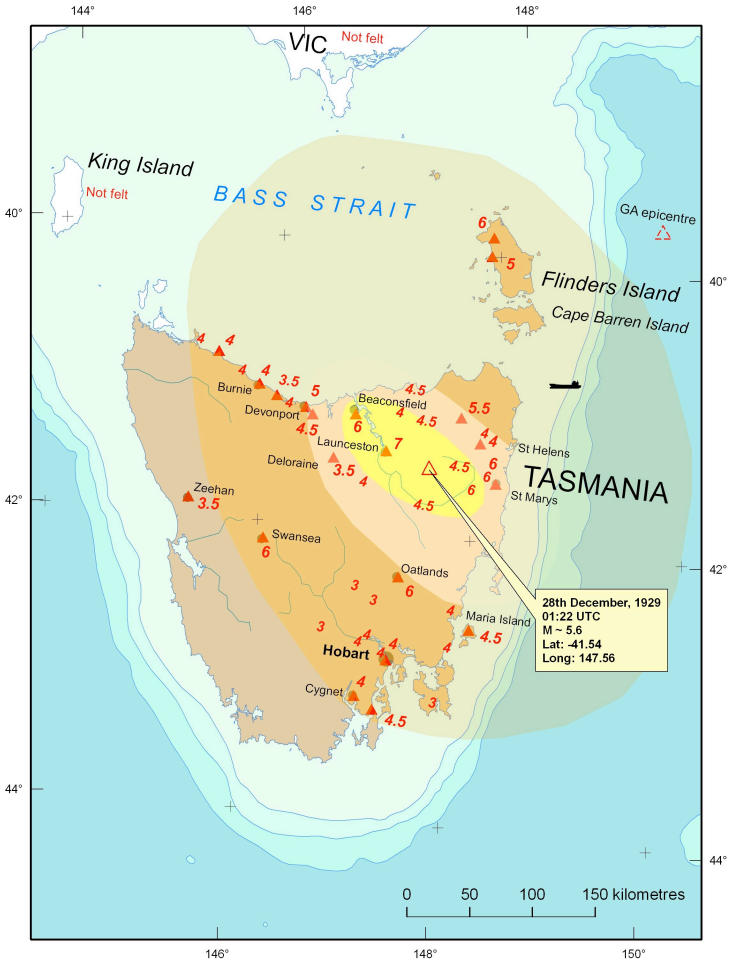


Figure 5 Isoseismal Map 28 December 1929 earthquake, Modified Mercalli intensities based on newspaper reports.

The earth tremor was felt very clearly throughout the Huon about 11.25 on Saturday morning. Windows rattled, and crockery and pictures shook perceptibly. It was very noticeable at Cygnet among the yachts at anchor in the bay, the boats tossing about as if in the wash of a large steamer, (Ed. a good description of a seiche in the bay).

A number of chimneys partially collapsed or cracked, the most severe being in a private house in Paterson Street, and the Launceston Public Hospital, where a kitchen chimney gave way. At St. Andrew's Church, Paterson Street, a stone ornament at the top of the spire was dislodged, and fell into the street.

From these and many other reports in Tasmanian newspapers an isoseismal map was constructed as shown in Figure 5. No photographs of the damage were discovered which is disappointing. There are a number of intensity reports that seem to be inconsistent with the contoured rating but such outliers are often observed and may reflect geological features like the sediment-filled Tamar Graben under Launceston causing amplification of shaking or simply a lack of factual reporting.

The high intensities on Flinders Island are surprising, probably the reason for the GA epicentre being where it is. One could play a bit with the contours but they don't change the interpretation that this was a moderate shallow earthquake under northeastern

Tasmania rather than an offshore earthquake like the large ones in the 1880s, 1890s and 1946 (Ripper, 1963 and Michael-Leiba, 1989).

The report about the shock being felt at sea is interesting but doesn't exclude either epicenter. Another observation, by Mr. E J Gillian from Devonport, that there were two shocks with an interval of only a few seconds in between would support an epicenter within 20 to 40 km or so if what he felt were the separate P and S waves.

DECEMBER 31, 1929.

EARTH TREMOR.

Felt at Sea.

VESSEL ROCKED FROM STEM TO STERN.

SYDNEY, Monday.—Captain M'Kenzie, of the collier Kiwitea, has reported to the Acting-Director of Navigation that on the voyage from Hobart to Sydney, when 30 miles east-south-east of Banks Strait, the Kiwitea trembled violently from stem to stern for 30 seconds, and appeared to move bodily in the water.

The steamer vibrated so violently that the engineer rushed to stop the engines, as he was under the impression that the propeller shaft had gone.

The disturbance continued for some time.

Figure 6 Extract from the Burnie Advocate, Tuesday 31 December. The earthquake was strongly felt on board the collier Kiwitea approximately where the ship icon is plotted on the isoseismal map.

Earthquake location and magnitude

A search of the GA database restricted to Tasmania in 1929 returned zero events but changing the selection criteria to Australia gave the top row in the following table. The second line is the epicenter shown on the isoseismal map at the centre of the high intensity contour.

Table 1 Earthquake details reported by different sources

Date	*Time UTC*	*Lat °S*	*Long °E*	*Depth (km)*	*Mag*	*Approx Location*	*Source*
28 12 1929	01:22	39.69	149.45	10	5.4	Flinders Is	GA
		41.54	147.56	5-15	5.6	Launceston	KFM

There were few regional seismograph stations operating in 1929; Melbourne, Riverview, Adelaide, Perth and Christchurch and of these only Riverview was equipped to record local earthquakes. The uncertainty in the GA location is much larger than the 2nd decimal place of the reported epicentre would indicate, perhaps ±1.0° at best. The GA epicentre is 200km from the centre of the MM6 isoseismal contour shown in the isoseismal map above, the point adopted here as the epicentre.

The GA magnitude is a Richter magnitude measured at Riverview Observatory. Using the method relating magnitude to radius of perceptibility devised by McCue (1980) and allowing for a reasonable MM 3 contour yields an ML equivalent of 5.6 which is compatible with the damage observed, and is similar, within the uncertainties, to the magnitude reported by GA.

Recent scanning of country Victoria newspapers by the National Library of Australia in late 2013 has revealed that the earthquake was felt in Victoria, at Wonthaggi and Leongatha though the reports are word-for-word perfect, both in the Kilmore Free Press,

Thursday 2 January 1930, page 2 and the Gippsland Times of Monday 6 January 1930, page 2 "*In one of the stores a glass tray, suspended by brass chains, containing electroplate ware, swayed from side to side, and tinware rattled on the shelves. People standing in offices or shops felt a swaying sensation as if on a boat at sea*", so something is not quite right.

There is no information to assess focal depth except for the high intensities in the mezoseismal area so we agree the earthquake was in the upper crust.

1932. There are other earthquakes that are not listed in earthquake databases or have not been accommodated in a hazard assessment, earthquakes with magnitudes near 5.

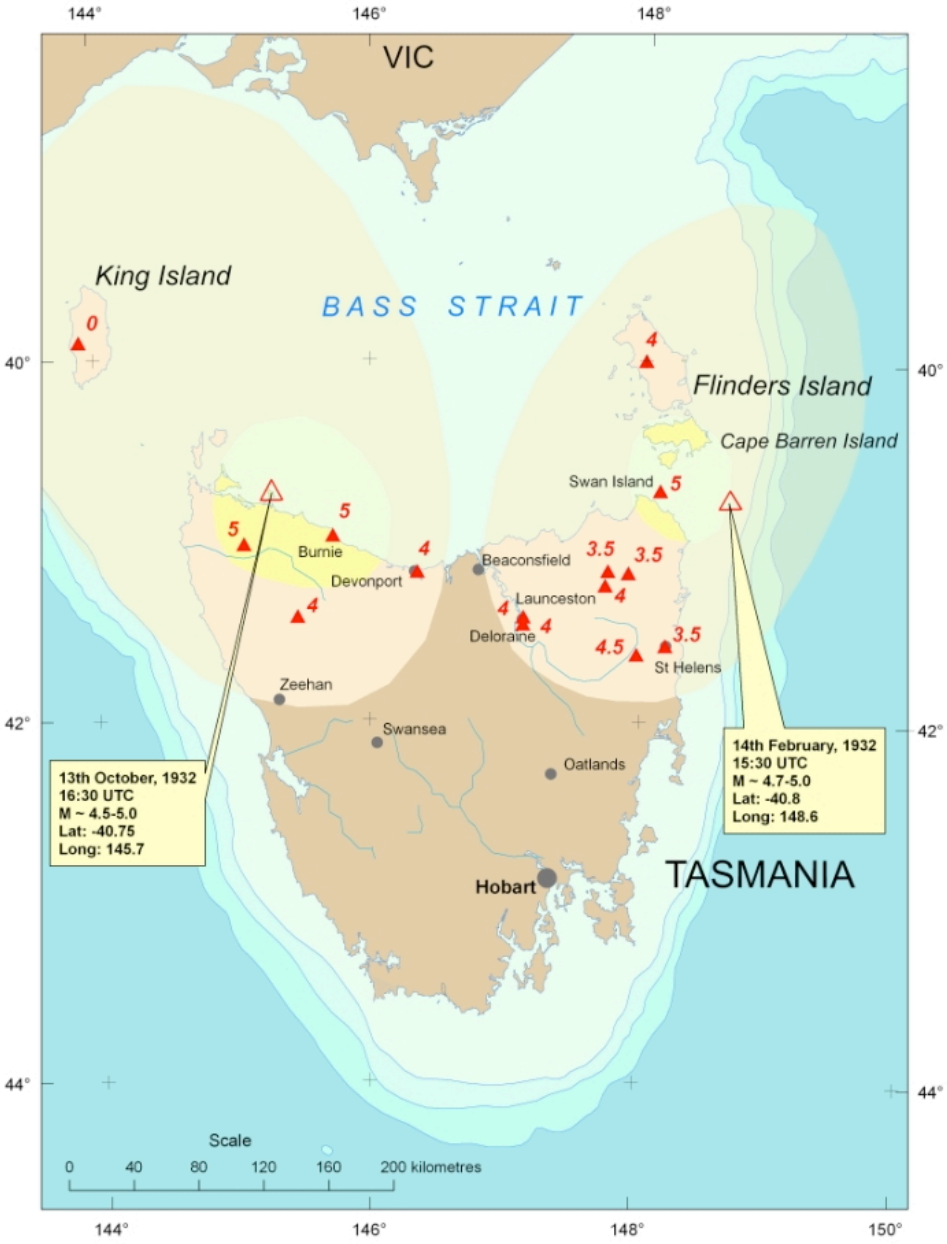


Figure 7 Isoseismal map of the 14 February and 13 October 1932 earthquakes in NE and NW Tasmania respectively.

Two quite separate events struck in 1932, the first in the northeast, somewhere to the south of Cape Barren Island, its magnitude in the 4.7 to 5.0 range. The second earthquake, in October, was off the northwest coast and perhaps slightly smaller in the magnitude range 4.5 to 5.0. Both earthquakes occurred in the early morning hours so only those already awake or awakened by the shaking filed reports, which is why there are no intensities rated MM3.

Any earthquake hazard assessment should include all these earthquakes, events above magnitude 5 have all now been documented dating back to about 1850, thanks to progress with the National Library of Australia's scanning project 'Trove'.

Earthquake Hazard assessments in Tasmania

Underwood (1973) produced the first hazard map of Tasmania (Figure 6 left below) using just the short dataset observed since the first seismographs were installed in 1958. His map was later modified by McEwin & others (1976). The highest hazard is indicated by the MM5 contour, a ridge from the NW to central and then SW Tasmania.

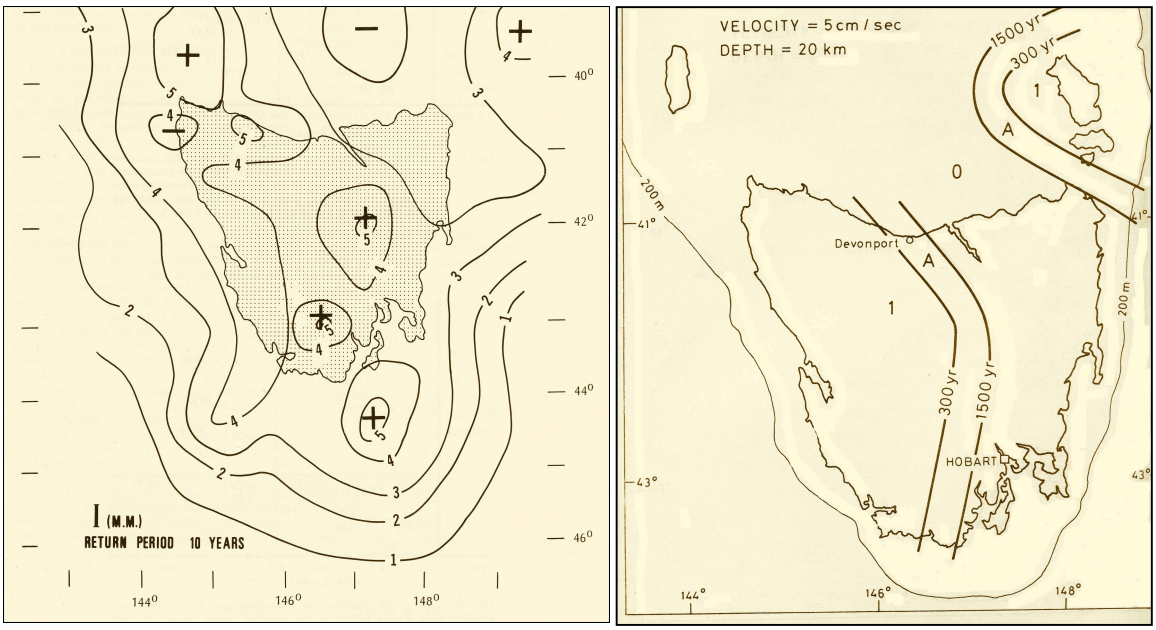


Figure 8 Left: Earthquake hazard map of Tasmania, expressed as the MM intensity in a 10 year return period based on a 10.5 year sample of recorded seismicity to mid-1973 (Underwood, 1973). Right: The earthquake hazard re-evaluated by McCue (1978), this time plotting return period for selected values of peak ground velocity or PGV, in this case 50mm/s.

McCue (1978) used earthquakes in the time period 1900 – 1975 and showed the zone configuration in use in the first version of the Australian Building Code AS2121-1979) then (0, A, 1, 2 comparable to the US zone designations at the time). A PGV of 50mm/s equates with the onset of damage at Modified Mercalli intensity 6 and so can be compared with Underwood's version.

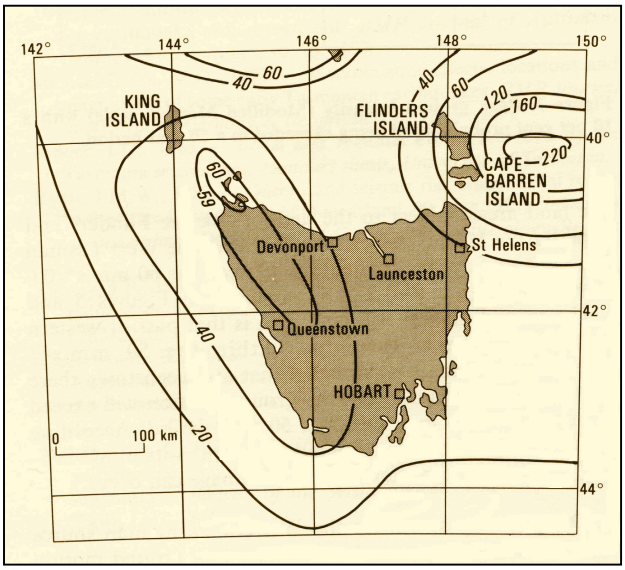


Figure 9 Earthquake hazard map compiled in 1989 by Michael-Leiba and Gaull and for a 475yr return period. Contours are PGV in mm/s.

Michael-Leiba & Gaull (1989) made an estimate of the earthquake hazard in Tasmania using data for the period 1883-1984. Their depiction is in the more useful form of contoured PGV (mm/s) for a 475yr return period. None of these three early studies had uncovered the earthquakes in the 1920s and 1930s in eastern Tasmania so it is not so

surprising that the results of the two more recent studies are remarkably similar, maximum hazard in the northeast and offshore islands, and in the western half of the island reflecting what was known about the seismicity.

These 'new' early earthquakes would either add a new source zone or extend the Tasman Sea West source zone under Northeastern Tasmania, and Launceston, changing the hazard there quite dramatically.

The latest revision of earthquake hazard in Tasmania by Burbidge and others (2012) is a shock, normally hazard increases with time as new earthquakes occur closer to the site than previously (eg Christchurch, NZ) or old or pre-historic earthquakes are discovered (Vancouver Canada). According to the Burbidge results (475 yr return period), the Launceston hazard assessment for the design of buildings should be downgraded from 0.12 to 0.03 and in Hobart, from 0.03 to 0.01, non-trivial factors of 4 and 3. [Tasmania is not alone in the downgrade, every city/town in Australia has been downgraded about a factor of 2 with the exception of Tennant Creek which has been upgraded from 0.13 to 0.15.]

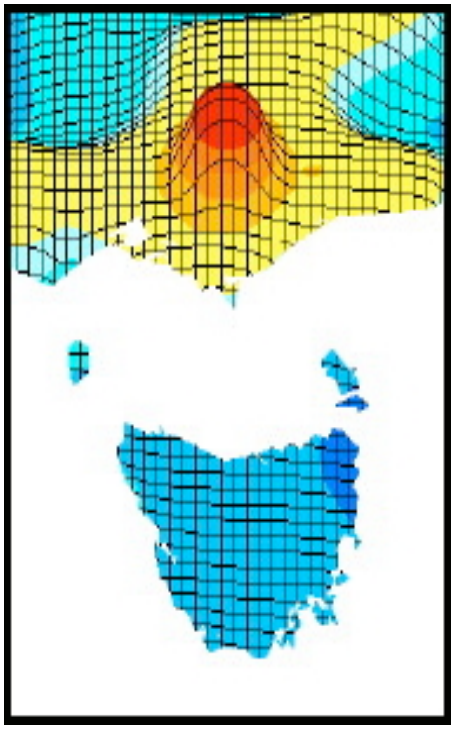


Figure 10 Modified detail from the GA 500yr PGA earthquake hazard map on rock 'shown in 3D evaluated for the geometric mean of the horizontal components. This map is the closest in return period and response spectral period to the current hazard map in AS1170.4-2007.'

How can we explain this downgrade in the hazard estimate? Another 10 years of data would normally increase the hazard, if anything. GA seismologists reduced the magnitude of past earthquakes, some events by up to 0.5 of a magnitude unit, and they used a different attenuation relationship (developed theoretically but compared against the few available local strong motion records of small to moderate earthquakes), but the biggest single reason for this downgrade in hazard is the source zone selection (see Figure 11). The zone boundaries are lines around past earthquakes 1965 and later, there is no geological, tectonic or structural significance to them. Tasmania is effectively their source zone 13 though the northern boundary is not clearly defined, whether it includes King Island and the northwest projection towards Cape Otway in Victoria, or not. Burbidge (2012) itemises the selection criteria for regional source zones as follows:

> *The criteria, in order of importance, were that the zones should: (i) contain at least 60 earthquakes; (ii) encompass contiguous areas of approximately uniform earthquake density; (iii) include sufficient "complete" (since 1st of January 1965 with $M \geq 3.0$) earthquakes to robustly calculate the recurrence parameters; (iv) be small enough area to provide meaningful differentiation between regions; (v) avoid encompassing multiple major tectonic units; and (vi) be simple rather than complicated polygon shapes.*

It is not clear how criteria (v) is satisfied, as zone 13 encompasses elements of the Pre-Cambrian rocks of western Tasmania, the younger Paleozoic crust of eastern Tasmania and the Tamar Fracture Zone.

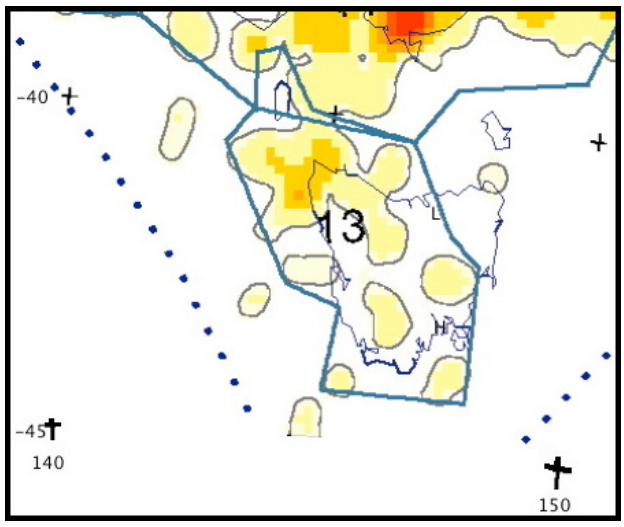


Figure 11 Source zone #13, the blue quadrilateral, used by Geoscience Australia in their earthquake hazard assessment of Tasmania shown in Figure 10. L and H designate Launceston and Hobart. The coloured blobs are deemed to satisfy the GA criteria listed above.

Obviously this was a quiet period for the northeast of Tasmania with a very small 'contiguous area of uniform earthquake density (criteria (ii)),' as can be seen in the following plot (Figure 12).

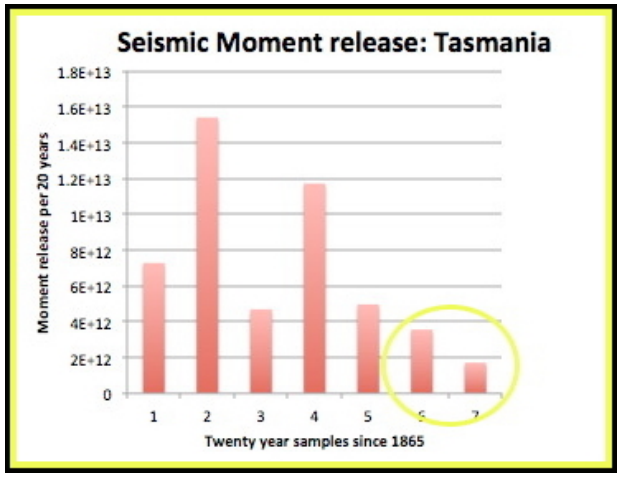


Figure 12 Seismic moment release (M_0), the abscissae are 20-year bins starting 1865 i.e.1865-1884, 1885-1904 etc. The average moment release rate is just under 8E+12 per 20 years and decades from 1965 are circled.

A table of known earthquakes ~M≥5 is listed below. A new isoseismal map has been drafted for the second large earthquake in 1984 but was not completed in time for this paper. Its epicentre and magnitude were derived in the usual way based on the felt area.

The post-1965 period chosen by GA seismologists is the period of lowest seismicity in Tasmania since the 1880s as shown in the simple histogram of moment release vs. time. Not a single event over magnitude 5 has occurred since 1958, which is rather unusual given the history. The moment magnitude M_w is assumed to equate with the magnitude scale used here and the equation relating moment M_0 (Nm) to M_w is:

$$M_w = 2/3\log_{10}M_0 - 6.$$

The absolute numbers are approximate, given the intensity-based magnitude scales are equated here with M_w, and possible missing earthquakes, at least pre-1965. The twenty-year time intervals were selected forward and backward from January 01, 1965 so that the four recent decades from 1965 adopted by GA could be compared with the known historical record.

The question on this evidence is: which decades of the last 140 years represent the long-term average seismicity rate for Tasmania?

Table 2 Tasmanian earthquakes at shallow depth[§], magnitude ~5 or more*

Date	*Time UTC*	*Latitude °S*	*Longitude °E*	*ML/Ms*	*Place*
18591121	18:50	-40.7	145.0	5.4	Northwest Coast
18800203	06:30	-43.0	146.4	5.5	Southwest Tasmania
18840713	03:55	-40.5	148.5	6.4	East of C Barren Is.
18840919	10:27	-40.5	149.5	6.3	East of C Barren Is
18850512	23:37	-39.9	148.9	6.8	East of Flinders Is
18920126	16:48	-40.4	149.5	6.9	East of Flinders Is
19020620	19:15	-40.7	147.0	4.8	NE Tasmania
19080504	09:50	-42.0	145.4	5	Queenstown
19111104	01:27	-42.1	145.1	4.8	West Coast
19220410	10:47	-40	147.5	5.3	Bass Strait
19240301	11:55	-41.6	145	5.1	West Coast
19270920	09:00	-43.3	148.2	4.3	SE Coast
19280119	01:20	-41.75	147.8	5.4	Fingal
19291228	01:22	-41.54	147.56	5.6/5.2	Launceston
19291228	01:22	-39.69	149.45	5.4/5.2	East of Flinders Is
19320214	15:30	-40.8	148.6	4.7–5.0	C Barren Is
19321013	16:30	-40.75	145.25	4.5–5.0	NW Coast
19460914	19:48	-39.97	149.35	6.0/5.4	East of Flinders Is
19580101	00:07:22	-42.2	146.1	5.3	Central West Tasmania

* Not included are the earthquakes out in the Tasman Sea at about (44°S, 155°E) that threaten seafloor cables but not structures onshore in Tasmania.

§ Focal depths are poorly constrained, all have been fixed by the analyst so are not included in the table but are in the upper crust, 0-20 km deep.

The GA result in Figure 10 shows that the area of Tasmania with highest earthquake hazard in the past, the northeast, is predicted to have the lowest hazard for the future, the deep blue signifies lower hazard than the medium blue colour. The west coast is rated the same hazard as Hobart. The historical record belies these ratings. Note the surprisingly high rating of Gippsland in Victoria for comparison, where the largest known earthquake was magnitude 5.6, yet GA rate it the 4th highest hazard zone in the country after Tennant Ck, NT and two small areas of Western Australia!

Discussion

Doing earthquake hazard assessments anywhere can be challenging but doing them in intraplate regions with a short written history and an even shorter period of monitoring with modern seismographs could be called adventurous. One thing is clear and that is that every conceivable skerrick of data needs to be examined and utilised. Choosing source zones and recurrence relations implicitly assumes that the earthquake process is stationary within those zones and whilst we know that isn't obvious on a human's timescale (take the experience of a citizen from Launceston for example), we are fairly confident that the pattern of earthquakes in Australia is not that of a random distribution (Sinadinovski and McCue, 2010) so the stationarity might be better approximated by a multi-hundred year sample.

Christchurch is a good example of the problem, or perception of the problem. There the PSHA model assumed the hazard was dominated by relatively frequent interplate earthquakes on the plate boundary more than 100km away, yet it was clobbered by a large

intraplate earthquake under the city, in the PSHA model a very rare event (a once-in-10 year-earthquake in Australia). Post earthquake, an arbitrary loading has been applied to the pre-2010 seismic zoning factor for the design and construction of new buildings in recognition of the enhanced level of hazard there following the September 2010 intraplate mainshock and series of destructive aftershocks. The interplate component of the hazard hasn't changed so the intraplate component has been dramatically increased. Christchurch is in a similar state to the offshore region of NE Tasmania post 1883/5 after the large earthquake sequence there. But when should the Christchurch loading begin to taper back to the pre-2010 level? In 1892 and again in 1946 large earthquakes occurred off NE Tasmania where the 1883/5 swarm had occurred and small earthquakes continue there to this day. We just don't know when the next large earthquake sequence will strike, when or where. There needs to be a public discussion of earthquake risk and particularly what constitutes an acceptable level of risk. Prior to 2010, in Christchurch, building owners did not want to pay to upgrade the seismic demand on their buildings as required by the new loading code so they were given longer to make the required strengthening. As it transpired, 5 years was too long. What was seemingly acceptable in early 2010 was demonstrably not acceptable a year later.

The stress drop in such moderate earthquakes is a small fraction of the crustal stress and the source region is also small so the earthquake process intraplate might be expected to be memory-less: it shouldn't matter which direction 'times arrow' points so any hazard assessment should apply equally in both time directions.

The re-discovery of this forgotten 1920s/1930s earthquake sequence in eastern Tasmania must force a rethink about the hazard in Tasmania, east vs. west and has raised the specter of more 'missing' earthquakes in Australia. No doubt this reappraisal will lead to an extension of Michael-Leiba's West Tasman Sea Zone and a higher assessment of earthquake risk in NE Tasmania. We hope that other researchers using Trove and other tools will continue to fill in any gaps in our knowledge.

Several attempts have been made to assess the relative earthquake hazard of Tasmania, the latest attempt by Geoscience Australia has all but reduced the apparent hazard to zero which is grossly at odds with the historical and pre-historical record.

A useable earthquake hazard map must be adopted by the Australian Buildings Code Board but it will have to be one that is a consensus of all the professionals involved in undertaking earthquake hazard assessments in Australia. The solution to finding an acceptable earthquake hazard map for Tasmania is either for Geoscience Australia to redo their assessment, taking into account all known earthquakes, not just those since 1965, or the Board using a longer return period say 1000 or 1500 years rather than the 475 years currently used, but preferably, getting all seismologists with regionally specific knowledge together to nut out and sign off on a new consensus map.

Acknowledgment

The author would like to acknowledge some of the helpful comments by the anonymous reviewer though I reject the assertion that one could not compare hazard estimates for regions with different slip rates e.g. Wellington and Christchurch NZ, the implication being that Vancouver, Christchurch and Tasmania similarly were not comparable.

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