Natural Hazards Risk Ratings

Address Information

Address: XX

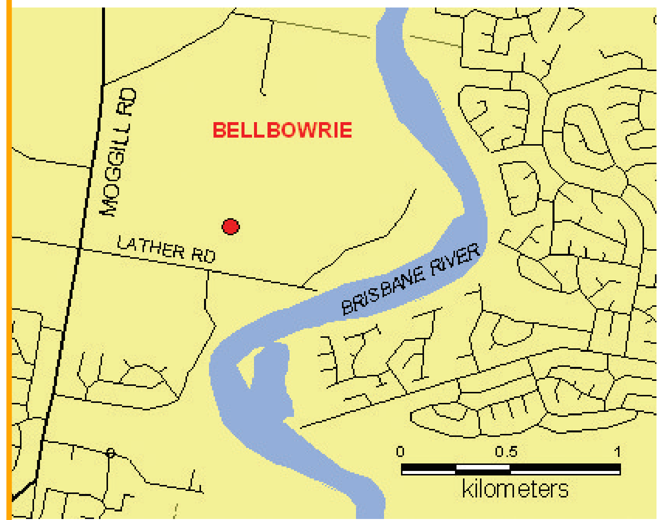
Street: LATHER ROAD

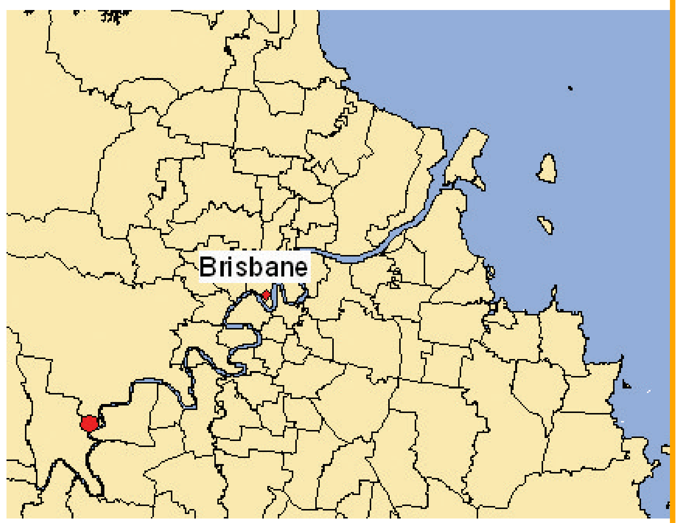
Suburb name: BELLBOWRIE

State: QLD

Postcode: 4070

Elevation: 13 m above mean sea level





Address Risk Rating

	Risk ratings		Overall
Bushfire	Distance to bushland (m)		
	200-400 (Medium)		
Flood	Average Recurrence Interval (year)	Water depth at 100-year ARI (m)	
	Above 100	None	
Earthquake	Peak Ground Acceleration (m/s^2)	Soil zonation	
	0.62 (Low)	2 (Low)	
Hailstorm	Storm zone		
	4 (High)		
T. Cyclone	Distance to coast line (km)	Wind zone	
	30	2 (Low)	

Indicative risk levels: Negligible Low Medium High Very High

Web: http://www.es.mq.edu.au/NHRC/

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Risk Frontiers

This Issue

STOP PRESS

New Appointment

Dr Paul Somerville, a renowned seismologist, will join Risk Frontiers as Deputy Director early in 2005. Further details in the next quarter

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Expected Shortfall

There is a tendency amongst insurers, both in Australia and the rest of the world, to only look at Exceedence Probability (EP) curves in terms of event losses of certain fixed magnitudes. In Australia, insurers and reinsurers are generally interested in 1 in 100 year event losses and more recently, due to APRA regulations, the 1 in 250 year event. Whilst in some ways this is quite sensible, these loss figures provide a reasonable idea of just how large rare losses could be for a given policy or portfolio, they are still inadequate in many ways for really assessing risk.

One of the basic ideas of risk management is that diversification should bring about some benefit. If risks are uncorrelated, then taking on more of them should decrease the chances of losses significantly different to the average. This is the whole idea of insurance. The problem is that this is not always apparent when considering such concepts as the 1 in 100 year event.

Consider the following example. There are two identical cities, each exposed to risks from identical earthquake faults. Insurers in each city face the same financial liability but the cities are far enough apart that they will not be affected by the same event. Their losses are thus uncorrelated. The loss profile for the 10 largest events in a millennium for each city is given in the following table.

RANK	EVENT LOSS ($M)	ARI
1	1000	1001
2	250	501
3	100	334
4	50	250
5	40	200
6	30	167
7	25	143
8	20	125
9	15	111
10	**14**	**100**

As is quickly apparent, each city is subject to many small earthquakes so the 1 in 100 year event is quite modest at $14M, whereas the 1 in 200 year event is significantly larger at $40M. Now if you create a combined loss table for the two risks it looks like this:

RANK	EVENT LOSS ($M)	ARI
1	1000	1001
2	1000	501
3	250	334
4	250	250
5	100	200
6	100	167
7	50	143
8	50	125
9	40	111
10	**40**	**100**
11	30	91
12	30	83
13	25	77
14	25	72
15	20	67
16	20	63
17	15	59
18	15	56
19	14	53
20	14	50

By combining the two risks, the likelihood of a 1 in 200 year event on one of them during a 100 year period has to be considered. However, the 1 in 100 year event for the combined portfolio ($40M) is considerably larger than the sum of those for the single risks ($28M). Whilst this is a constructed example, it is not uncommon for earthquake curves to display similar, heavy tailed, characteristics. This is not a good thing, since it implies that the insurance company would be better off not diversifying.

The problem here, however, is not with the diversification but with the failure of the concept of the 1 in 100 year loss, (or any other event loss with a fixed Average Recurrence Interval (ARI)) to give an idea of how the EP curve varies on either side of the chosen ARI. In particular, it completely ignores anything in the tail of the curve.

Does this matter? Well from a regulatory sense, apparently not. Nowhere is there any indication in the regulations that an insurance company must consider such factors. However, in reality it is vital. After all, if the 1 in 100-year event is exceeded, it is as likely to be above the 200 year event as below. So if an EP curve is very light tailed, then reinsuring out to the 1 in 250 year event may be unnecessary. The losses are not likely to be much larger than the 1 in 100 year loss and so the company can take on more of the risk than it might otherwise. On the other hand, if an EP curve is very heavy tailed, as with earthquake, then it might be prudent to reinsure further out than the 1 in 250 year event, perhaps to the 1 in 500 year level or higher.

In his paper, *Natural Catastrophe Probable Maximum Loss*, Gordon Woo comes up with a measure called the Expected Shortfall (ES) that is easy to calculate and gives a reasonably good idea of what the shape of the tail is like beyond a particular point. We have altered Gordon's definition to make it more intuitively useful. For catastrophe model results, this is simply the average of the losses over the given level minus the loss at the level. If someone is working from a EP curve, rather than a set of model results, then the ES is simply calculated by taking the area under the tail and dividing through by the probability of getting in the tail. Intuitively, it is a measure of how much bigger a bigger event is likely to be.

By looking at not only what the 1 in 100 year loss is like, but also what bigger events are possible, an insurance company is much better able to understand its exposure to larger natural catastrophes. After all, there is no point in reinsuring up to the 250 year level blindly for all perils. Whereas it might take a 1 in 10,000 year flood loss to bankrupt the company, a 1 in 300 year earthquake loss could do the same job. It is better to spread the risks around, and thus provide the smallest possible chance, for the amount of money being spent, of the company running into trouble. Diversification is, after all, a good thing.

References:

Woo, Gordon, *Natural Catastrophe Probable Maximum Loss*, British Actuarial Journal, 2002, vol. 8, no. 5, pp. 943-959.

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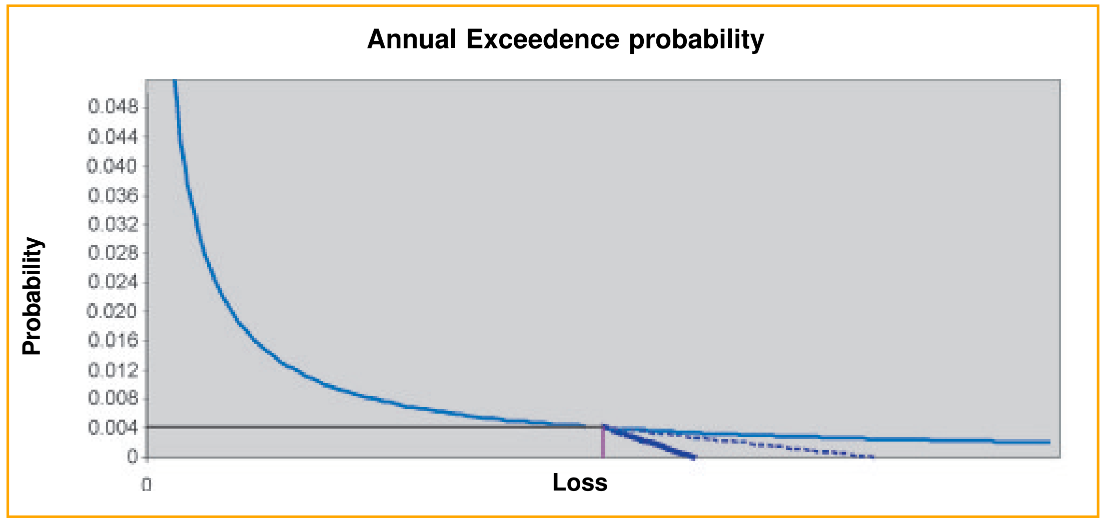

Figure 1. Each of these tails needs to be handled very differently from an insurance perspective, despite the fact that they all have the same 250 year loss.

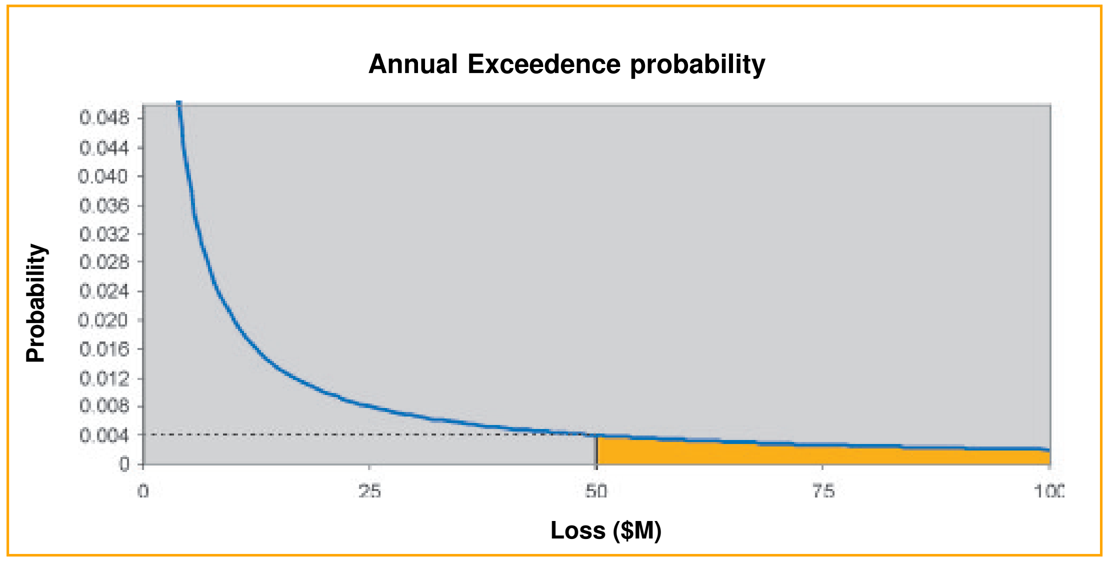

Figure 2. The shaded area under the tail represents the expected shortfall for the 250 year event.

Natural Hazard Risk Ratings

Since 1999 insurers and others have been using Risk Frontiers' PerilAUS software to determine the relative risk posed by natural perils in Australia across a range of spatial levels; usually Postcode, Local Government Area or CRESTA zone. While natural hazard risk ratings at these scales are useful and widely used, some applications require more spatially-explicit risk ratings. Moreover, some perils - particularly flood and bushfire - are much better represented at very fine spatial resolutions. Risk rating at address level is the next natural step.

The quest for address-based risk assessments has been markedly aided by the recent availability of high-resolution spatial data, such as the G-NAF (Geocoded National Address File) address database, high-resolution digital terrain data and satellite imagery. Using these tools and building on existing and new research, Risk Frontiers has developed risk ratings for individual addresses in Australia for 5 key perils. The risk ratings, plus some geographic information are presented in a clear single page format as shown on the following page. Short explanatory notes are also provided.

Risk Frontiers' address risk ratings focus on the hazard - bushfire, flood, earthquake, hailstorm and tropical cyclone - rather than on the potential property damage. The bushfire and flood ratings refer to individual street address risk while the ratings for hailstorm, earthquake and tropical cyclone are derived from broader scale zones that contain the specified address. This application is aimed at commercial properties and high value residential assets.

Bushfire

Analysis by Risk Frontiers of major historical bushfires shows distance from the bushland fringe to be the single-most important factor determining the probability of building destruction given a major fire[1]. We adopt here a five-point scale, where in bushfire-prone areas risk is highest at distances less than 100 m from bushland; high between 100 and 200 m; medium between 200 and 400 m; low between 400 and 700 m; and negligible for distances beyond 700 m. Areas with a high potential for bushfires are generally confined to the southeast and southwest of the continent and Tasmania[2]. Bushfires do occur north of the Tropic of Capricorn but since they have not involved large property losses to date, we categorise these areas as having negligible bushfire risk.

Flood

Two flood risk ratings are provided: 1) the average recurrence interval (ARI) of inundation of the ground at the property and 2) the water depth during a flood with an ARI of 100 years. The first quantifies the probability of flooding at the property. The second provides one measure of the severity of flooding.

The ARI is categorised into 5 levels: less than 20 years; 20-50 years; 50-100 years; above 100 years; and not flood prone. The ratings are for mainstream flooding only and are available for about 1.3 million of the most flood-prone addresses in Australia.

Earthquake

Australia is located entirely within a tectonic plate and experiences moderate to low levels of seismic activity compared with say Japan, New Zealand and California. Nonetheless destructive earthquakes have occurred, and poor building stock can exacerbate losses from even modest ground shaking.

The 5-level peril scale adopted here is based on the relative intensity of peak ground accelerations in the Global Seismic Hazard Assessment Program[3]. This gives peak ground accelerations in bedrock having a 10% chance of exceedance in 50 years (equivalent to a 475 ARI). Shaking intensity felt at ground level can be modulated by the response of soils overlying basal rocks. This tendency to amplify ground motions is described by a five-point soil zonation developed by Blong.[4] It is high for unconsolidated and swampy soils and minimal for bedrock.

Hail

Hailstorms can cause substantial damage to property. Most areas on the mainland south of the Tropic of Capricorn are at risk from hail. Damaging hail is rare in the tropics and in Tasmania. Hail risk is a function of the intensity and frequency of hail[5].

The hail risk scale is based on the product of maximum recorded hail size and normalised annual frequency for key locations around the country. High risk regions are those that experience relatively frequent hail storms and have a history of damaging hail. Low risk regions rarely experience damaging hail at all, while damaging hail is possible in medium risk regions.

Tropical Cyclone

Tropical cyclone wind risk in Australia is analysed on a broad scale with risk varying both along the coastline and with the distance inland for regions north of latitude 30°S. A 5-tier scale (5 being the highest risk) is used to categorise the risk, based on Risk Frontiers' frequency-magnitude analysis of past cyclones. The ratio of likely damage between categories is roughly proportional to the ratios in the widely-used 5-point Saffir-Simpson Hurricane Scale.

References

[1] Chen K. and McAneney K.J. 2004, Quantifying bushfire penetration into urban areas in Australia, *Geophysical Research Letters*, 31, L12212, doi:10.1029/2004GL020244.
[2] Blong R. Sinai D. and Packham C. 2000, *Natural Perils in Australia and New Zealand*, Swiss Re Australia Ltd.
[3] The Global Hazard Assessment Program (GSAP) 1999, http://www.seismo.ethz.ch/GSAP/
[4] Greig Fester 1997, *Earthquake PML: Household Buildings Sydney II*, Greig Fester (Australia) Pty Ltd.
[5] Leigh R. and Kuhnel I. 2001, Hailstorm loss modelling and risk assessment in the Sydney region, Australia, *Natural Hazards*, 24:171-185.

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