

extreme societal stratagem that relies solely on insurance rather than investing in more resilient construction, as opposed to doing both. As a rule, Governments and local bodies do not insure assets against catastrophe losses; however, by not doing so, they are self-insuring and this methodology delivers the cost of this self-insurance.

This hypothetical premium, which Dr George Walker (Aon Re) calls the market cost of risk transfer, is calculated as:

$$\text{Premium} = \text{average annual loss} + \text{multiplier} \times \text{standard deviation of losses}$$

where the second term in the equation is the risk loading over and above the annual average loss. This term is needed to account for the volatility of annual losses. The multiplier is sometimes termed the reinsurer's reluctance. Modelling by Dr George Walker for Australian natural perils suggests that the multiplier has a numerical value of around 0.2.

The value of improvements in construction standards is estimated from the reduction in the annual premium and then this difference can be discounted over time.

Substituting for the values determined previously, we find that the:

Annual premium (without improved construction) = AUD 647 million

Annual premium (with improved construction) = AUD 222 million

Reduction in premium arising from improved construction = AUD 425 million

The reduction is again two-thirds.

The task for the ABCB is to estimate the reduction in financial losses as a dollar value attributable to improvements in construction as specified in the building code. As discussed earlier, we will adopt a conservative figure of 0.9 for the ratio of these estimated loss reductions to the relevant economic losses.

Reduction in the market cost of risk transfer for all direct losses impacted by the building code regulations

$$= 425/0.9 = \text{AUD } 472 \text{ million}$$

Present Value of the reduction in future losses arising from improved construction (using a discount rate of 10%)

$$= 472/0.1 = \text{AUD } 4.7 \text{ billion}$$

NOTE FOR YOUR DIARY

Risk Frontiers Seminar Series 2008

Wednesday 22nd October, 2008
2.30pm until 4.40pm
at the Museum of Sydney
(cnr Phillip & Bridge Sts, Sydney)



Conclusion

Our study suggests that regulatory changes that resulted in more wind-resistant construction in tropical cyclone prone areas have been enormously successful. An estimated two-thirds reduction in the average annual losses from cyclones and the cost of the risk of such losses may seem high, but is in line with what other studies claim could be achieved in Florida through a range of simple physical mitigation measures. While our study has limitations, it does show what can be achieved by appropriate regulatory change when there is a demonstrated need and political will.

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Natural Hazards Risk Profiles: MapData Sciences' Web Service

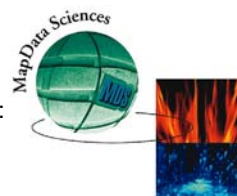
Using MapData Science's (MDS) Web Service, a corporate user can now access Risk Frontiers' Natural Hazard Risk Profiles and Ratings in *real-time* in order to determine whether or not to offer insurance or to inform premium pricing. This confers enormous benefits for handling phone or web based enquiries from prospective customers or brokers.

In summary, MDS Web Service:

- Enables cost-effective access to the Risk Frontiers Natural Risk Profiles;
- Provides input to in-house GIS applications for mapping Portfolio Risks;
- Removes the IT management burden for companies with limited in-house GIS capability;
- Enables ease-of-use for developers with any modern development environment;
- Delivers a service level commitment with in excess of 99.0 percent uptime.

MDS has a secure and supported server network with all of the necessary software and management tools, ISP partners and technical support to provide the MDS Web Service. MDS hosting facilities currently support more than 1 million transactions daily.

http://www.mapds.com.au/solutions_risk_frontiers.aspx



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Risk Frontiers

Assessing the Benefits of Improved Wind Loading Construction Standards in Tropical Cyclone Prone Areas of Australia

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The Australian Building Codes Board continually identifies building needs and market shortcomings, formulates building codes in consultation with community and industry, receives input from stakeholders before implementing code changes, and secures feedback on the effectiveness of the decisions made for possible further improvement.

With these objectives in mind, the ABCB engaged Risk Frontiers to estimate the financial benefits arising from the introduction of regulations requiring houses to be structurally designed to resist wind loads in tropical cyclone prone areas.

The Risk Frontiers study concludes that these changes in building design and construction practice have been enormously successful, reducing the annual average losses from cyclones by nearly two thirds. To a large measure, this reduction can be attributed to the wind loading improvements mentioned above, although these were not the only regulatory change during this period.

Introduction

The financial benefits gained from improved building wind load requirements were calculated using 'normalised' insurance industry losses and several other key assumptions as outlined below:

- The normalised insurance losses, about 20% of which arise from tropical cyclones, approximate likely losses as if these historical events were to recur in 2006. The normalisation process adjusts historic loss figures for changes in population, wealth, and inflation since the year of the original event, as well as improvements in building performance arising from the introduction of regulations requiring more wind resistant construction in tropical cyclone-prone areas.
- While improved wind load regulations were introduced in Darwin after Cyclone Tracy in 1974, in Townsville about 1976, throughout Queensland in 1982, and in the rest of Australia about 1990, the statistical modelling that forms the basis of the report assumes a 'common' introduction date of 1981, a year that also coincides with the Australian census.
- Since Australia has very high levels of insurance penetration, insured losses will represent a high proportion of the total losses influenced by improvements in construction. For this study a figure of 0.9 was adopted as the ratio of insured losses to the relevant total losses.
- A simple reinsurance pricing model was used to estimate the annual financial benefits arising from improved construction. This model takes into account both the estimated reduction in the average annual loss and the volatility in losses about this average to estimate a hypothetical premium for what can be termed the market cost of risk transfer. The financial gain (reduction in premium arising from improvements in construction) can be discounted over time as for a conventional Net Present Value investment analysis.



Normalisation of the Insurance Council of Australia (ICA) Disaster List

The study used the ICA Natural Disaster Event List ("Disaster List") as a starting point. Spanning 40 years, it is one of the more comprehensive disaster loss records in the world. The Disaster List comprises a catalogue of natural hazard events in Australia that have caused significant insured losses; each entry contains details of each event including date, areas affected, and the industry-wide insured loss in "original" dollars.

The Hobart Bushfires of 1967 was the first significant natural disaster for which credible insurance industry loss figures were available. The threshold for inclusion has changed over time but most events exceed a nominal value of AUD 10 million.

As a result of regulation stipulating more wind resistant construction in tropical cyclone-prone areas and improvements to the Australian Standard Wind Codes, newer construction is much less vulnerable to wind damage and failure to properly account for this would lead to unrealistic normalised values. How this is done is briefly outlined in the following two sections.

Normalisation methodology

Adjusting for changes in population, wealth and inflation

Crompton and McAneney (2008) (*Environmental Science & Policy* 11: 371-378) used changes in both the number and average nominal value of new dwellings over time as surrogate variables to account for changes in population, wealth and inflation. Change in the numbers of residential dwellings were estimated from Census on Population and Housing (<http://www.abs.gov.au>) for the area most affected by the original event; dwelling values were calculated by dividing the value of building work completed within a year for each State/Territory by the number of completions within the same year (<http://www.abs.gov.au>). The term 'nominal' refers to the dollars of the day.

The increase in the dwelling value is in part due to increasing average dwelling size as well as improvements in the quality of the housing stock. The average dwelling value excludes the price of land and, as the nominal value

Table 1: Ten highest ranked normalised losses (AUD million).

Rank	Event	Year	Location	State	Original Loss (AUD million)	Normalised Loss (2006) (AUD million)
1	Earthquake	1989	Newcastle	NSW	862	4300
2	Tropical Cyclone Tracy	1974	Darwin	NT	200	3650
3	Hailstorm	1999	Sydney	NSW	1700	3300
4	Tropical Cyclone Wanda	1974	Brisbane	QLD	68	2090
5	Hailstorm	1985	Brisbane	QLD	180	1710
6	Ash Wednesday Bushfires ¹	1983	Multiple	VIC/SA	176	1630
7	Hailstorm	1990	Sydney	NSW	319	1470
8	Tropical Cyclone Madge	1973	Multiple	QLD/NT/WA	30	1150
9	Hailstorm	1976	Sydney	NSW	40	730
10	Hailstorm	1986	Sydney	NSW	104	710

¹ The two separate loss entries in the Disaster List for this event have been combined into a single loss

already includes inflation, no further adjustment for this variable is required. For event losses other than tropical cyclones, no further adjustments are needed to bring these losses into line with 2006 societal values. The additional adjustment for tropical cyclone losses is described below.

Tropical Wind Code adjustment

The Tropical Wind Code adjustment is unique to each tropical cyclone event loss and incorporates the proportion of the loss attributable to wind damage (as opposed to flooding or storm surge); the proportion of pre- and post-1981 residential buildings in the impacted location both in the year the event occurred and in 2006; and pre- and post-1981 residential building loss ratios (ratios of insured losses to insured value) that are a function of peak gust speed. This loss ratio also includes damage due to wind-driven rain following wind damage to the envelope of the dwelling. The approach is based entirely on residential structures and assumes the post-1981 buildings were built in accordance with regulation, i.e. no more or less vulnerable than prescribed.

Details of this adjustment can be found in Crompton and McAneney (2008) but the reader can see flavour of the process from the following illustrative example for Tropical Cyclone Tracy losses in 1974:

Wind damage proportion of losses in 1974	100%
Proportion of Pre-code buildings: in 1974	100%
in 2006	44%
Notional maximum gust speed at landfall	61m/s
Residential building loss ratio: Pre-code	78%
Post-code	10%
Original Loss (1974)	AUD200 million
Total Sum Insured (1974)	AUD256 million
Total Sum Insured in 2006	AUD9.2 billion
Normalised loss without building code adjustment	AUD7.1 billion
Normalised Loss after building code adjustment	AUD3.7 billion

The importance of accounting for the reduced vulnerability of post-1981 construction is evident. If the inflation in the total sum insured sounds too high, it should be realised that between 1974 and 2006 the number of buildings in Darwin increased by roughly a factor of three and the average cost by a factor 13.

The fact that the use of the wind code was introduced earlier than 1981 in Darwin will mean that the calculated value is on the high side; on the other hand, in 1974, a high proportion of buildings were government owned and thus insurers were spared much of the true cost of the disaster. This will not be the case next time around.

Normalisation results

Figures 1(a) and (b) show annual aggregated original and normalised losses for the weather-related events in the Disaster List. Annual losses have been calculated for years beginning July 1 to take account of the southern hemisphere seasonality of the meteorological hazards.

The most salient observation is that the time series of normalised losses exhibits no obvious trend over time. The conclusion is that the increasing trend in original losses is largely attributable to changes in dwelling numbers and nominal dwelling values, in other words, it is demographic factors that are driving increased losses from natural perils. The wind loading improvements act in the opposite direction to reduce losses from tropical cyclones.

The ten highest ranked losses are presented in Table 1 with the Newcastle earthquake heading the list.

Although Cyclone Tracy was a much bigger disaster than the Newcastle earthquake in the sense that Tracy almost

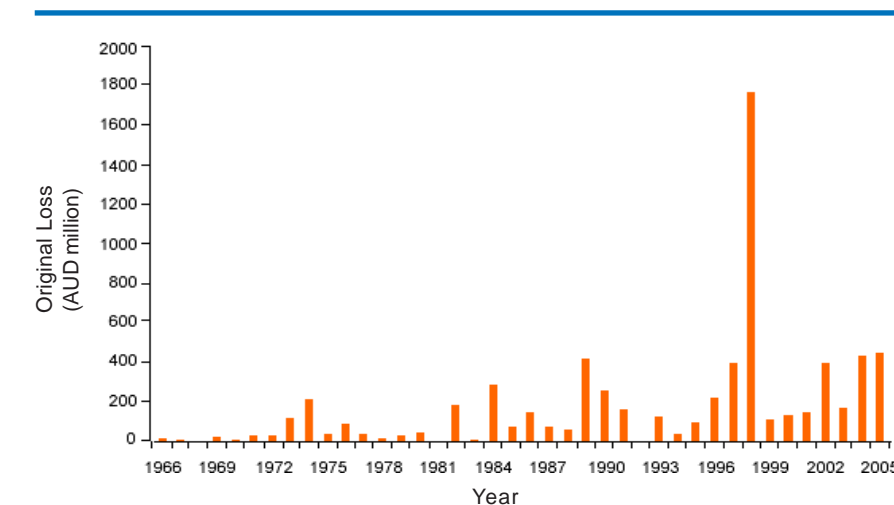


Figure 1 (a): Original annual aggregate insured losses (AUD million) for weather-related events in the Disaster List for years beginning 1 July.

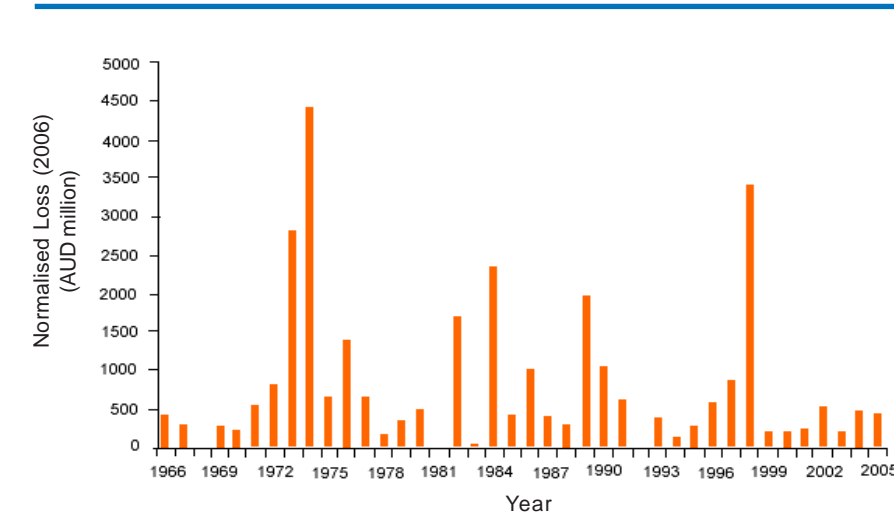


Figure 1(b): As for (a) but with weather-related losses normalised to 2006 values

destroyed an entire city, the ranking in Table 1 does not reflect this. This arises because most of the current building stock in Darwin has benefited from the improved construction standards that are the subject of this study. Equivalent standards for earthquake do not exist in this country and so losses for a repeat of even a modest sized earthquake in a major metropolitan centre are likely to be considerable.

Results

Normalised to 2006 values, tropical cyclone-related losses average AUD261 million per year with a standard deviation of AUD675 million. These estimates include those from Cyclone Larry (AUD540 million), which were mainly due to wind and wind-driven water penetration, and Cyclone Wanda for which wind damage losses were classified as nil.

Normalised losses rise to AUD410 million (standard deviation AUD1185 million) in the absence of regulations dictating use of the Wind Code; they fall to AUD146 million (standard deviation AUD382 million) if the Wind Code, which existed at the time of regulation, had been enforced for the entire period covered by the Disaster List.

We now used the above statistics to estimate the financial benefits that have accrued from improvements in construction standards in relation to wind loading in tropical cyclone-prone areas.

Valuing benefits arising from changes to the Building Code

The benefits are calculated in a number of ways, the first being as the reduction in the average annual damage as a consequence of the regulated use of the Wind Code. The comparison considers likely losses as if the building regulations had never been implemented or had always been in place (or at least since 1967).

Our analyses suggest that the annual saving due to a reduction in the insured losses is of the order of AUD264 million, a 64% reduction. In short, improvements in construction standards have reduced average annual losses by nearly two-thirds.

Treating these modelled gains in perpetuity gives a Present Value (PV) of AUD2.6 billion, where the discount rate has been notionally taken as 10%. This result assumes 2006 societal conditions going forward.

Rather than just relying on the reduction in the annual average losses, a better approach is to assume a hypothetical insurance premium that measures the market cost of insuring against building losses in tropical cyclones. In a sense, we imagine one