Northern Australia Insurance Premiums Taskforce – Interim Report

Suncorp General Insurance Submission

One Company
Many Brands

SUNCORP GROUP

Executive Summary

Cyclones are a fact of life in northern Australia.

Since 2005, 17 severe cyclones have made landfall in northern Australia, and the risk to communities is only increasing as the region becomes more developed.

Insurance losses from cyclones are modelled to average $632 million per year. In any given year there is a 1 in 10 risk that cyclones could cost $1.4 billion and a 1 in 100 risk they could cost as much as $7 billion. Cyclones also cause significant social and economic losses beyond the insurance market, and the loss or damage of individuals' most treasured and irreplaceable possessions.

Insurance premiums reflect the high risk of financial loss, but they are only a symptom of a bigger problem. The real issue is why we allow cyclone losses, both economic and social, to continue growing.

Homes in northern Australia are simply not built to be cyclone resilient. Building codes focus on saving lives rather than minimising damage, and older properties may not even meet this minimum standard. Continued development in high risk areas also contributes to increasing damage bills.

Proposed market interventions such as introducing a pool or mutual do nothing to address risk or reduce the devastating impact of cyclones on northern communities.

The solution

We know what needs to be done to increase resilience and reduce cyclone risk.

Retrofitting existing buildings, strengthening standards for new buildings and better planning controls for developments in high risk areas are all part of the solution.

Suncorp is already acting to address risk and make insurance more affordable through our *Protecting the North* initiatives, which include:

- a process to comprehensively capture and report self-mitigation work already undertaken on older homes which could deliver savings of up to 20%;
- working with experts to design a cost effective retrofit program to strengthen older north Queensland homes against cyclone impacts;
- a new direct strata insurance product delivering savings of around 20%; and,
- a completely new insurance product tailored to low income earners, providing contents cover from just $4 a week.

The facts

- **Improving cyclone resilience is the only way to reduce risk and protect communities.** Retrofits save homeowners and the economy up to $13 for every dollar invested, and significantly reduce the amount of damage caused when a cyclone hits. Some options pay for themselves after one Yasi-like cyclone. Retrofitting homes also creates local jobs and boosts the economy.

- **There is no insurance market failure in northern Australia.** Multiple government reviews have concluded that insurance prices are reflective of cyclone risk and there is no evidence of market failure. Right now, there are as many insurers operating in Cairns as there are in Sydney. If government wants to increase competition, risk reduction would encourage more insurers to enter the market.

- **There is no widespread insurance affordability problem.** Anecdotal accounts do not reflect the experience of residents in the broader insurance market. In north Queensland, 97% of home building premiums are below $3000, renewal rates are consistent with other locations and excesses are not being significantly increased.

- **Strata insurance is cheaper, per unit, than home building insurance.** Strata insurance in northern Australia is more expensive than other locations, reflecting the level of cyclone risk. However, on average, it is cheaper than home building insurance when similar risks are compared on a per-unit basis.

- **Government intervention through a pool or mutual won't work.** It will be expensive, and it will leave communities vulnerable to increasing risk. International experience shows that insurance pools create a moral hazard that encourages further risky development, and expose governments and taxpayers to significant liabilities. The US flood pool has grown from covering 1.4 million homes in 1978 to 5.5 million in 2013 and currently holds USD$23 billion of debt. Closer to home, the Christchurch Earthquake exposed the New Zealand Government to NZD$16 billion of losses via the Earthquake Commission.

Outcomes

It is the role of government to protect communities, not to intervene in functioning markets. Government cannot commit to economic development in northern Australia while allowing cyclone risk to grow unchecked.

Suncorp calls on government to:

- work with insurers, industry and communities to develop a program of work that will improve the cyclone resilience of homes in northern Australia; and,
- commit to an ongoing investment in mitigation and resilience to fund the implementation of these measures.

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About the Suncorp Group

Suncorp Group is one of the largest insurers in Australia offering a range of personal and commercial insurance products, protecting the financial wellbeing of millions of Australians. As a Group, Suncorp has nearly 15,000 employees and more than nine million customers across the country. The General Insurance business alone paid out $5.5 billion in insurance claims in 2014-15, averaging more than $15 million each day.

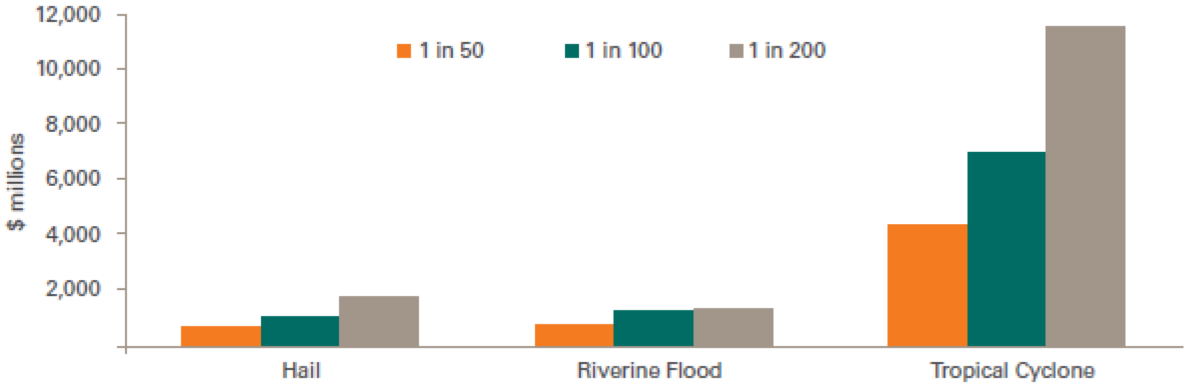
Suncorp has been protecting the Queensland way of life for almost 100 years, and has stood by north Queenslanders during some of their darkest moments including Tropical Cyclone Larry in 2006, Tropical Cyclone Yasi in 2011, and most recently, Tropical Cyclone Marcia in 2015.

Suncorp offers a range of personal insurance products including car, home and contents, travel, boat, motorcycle and caravan insurance. The key to Suncorp's success in personal insurance is its portfolio of well-known brands. These include Suncorp Insurance, Apia, AAMI, GIO, Vero, Shannons, Just Car Insurance, Insure My Ride, Bingle, Terri Scheer, CIL Insurance, Resilium and Essentials by AAI. These brands have built reputations for insurance innovation, outstanding customer service and trustworthy products.

Suncorp also offers commercial insurance products that serve the needs of a wide range of business customers, from small business operators to global companies. The commercial insurance portfolio of brands includes GIO, AAMI, Suncorp Insurance, Vero and Resilium. Suncorp is also Australia's largest personal injury insurer offering workers compensation and CTP insurance, which serve the needs of governments, employers and the community.

Cyclone risk in northern Australia

Many areas of Australia are at high risk of natural hazards. However, northern Australia's cyclone risk is unique. Cyclone events result in significantly higher losses than other natural hazards, including hail and riverine flood (figure 1). Many areas in northern Australia are susceptible to multiple natural hazards, adding to their risk exposure.



Source: Urbis

FIGURE 1: Estimated losses for insured residential property from natural hazards, Queensland

Insurance Council of Australia (ICA) Disaster Statistics show $3.4 billion in cyclone and flood disaster insurance costs in northern Australia since 2006. For much of this period, insurers were losing money in the region – the Australian Government Actuary (AGA) found insurers in north Queensland paid $1.40 in claims for every dollar collected over an eight year period.[1]

Insurance premiums should reflect risk, and Suncorp has priced policies across Australia in line with this philosophy. We do not believe people in lower risk areas should help to pay for the cost of insurance for those at high risk.

[1] Australian Government Actuary, *Report on Home and Contents Insurance Prices in North Queensland, 2014, p13*

The true cost of cyclone risk

High premiums are not the only consequence of unaddressed risk.

In addition to the cost of repairing building damage, cyclones also have a significant social and economic impact on communities.

Risk Frontiers estimates the social costs of disasters to be between 20-200% of insured property damage. In the case of Cyclone Yasi in 2011, these costs could have amounted to more than more than $1.5 billion. This includes impacts such as:

- death and injuries;
- loss of leisure time;
- higher crime rates;
- dislocation of families;
- community upheaval and disruption to local infrastructure; and,
- business interruption.[2]

The World Health Organisation also estimates that severe mental health disorders across the population can increase by around one percentage point following a large natural disaster.[3]

The risk problem faced by residents of northern Australia is far broader than just insurance premiums. Addressing only the financial impact of high premiums does nothing to reduce the devastating impact of natural disasters on individuals and communities.

[2] Risk Frontiers, *Application of insurance modelling tools to climate change adaptation decision making relating to the built environment*, 2015
[3] Deloitte Access Economics, *Four years on: Insurance and the Canterbury Earthquakes*, 2015

The value of risk reduction

Suncorp agrees with the Taskforce that "mitigation should be an important component of any effort to reduce insurance premiums."[4] We have long advocated for governments to focus natural disaster funding on preventative measures to better manage risk.

The Productivity Commission's Natural Disaster Funding Final Report supports our position, finding a significant over-investment in disaster recovery and under-investment in mitigation, with only 3% of disaster funding being directed to prevention and mitigation activities.

The Financial Systems Inquiry agreed, stating:

> The Inquiry believes this issue should be primarily handled by risk mitigation efforts rather than direct government intervention, which risks distorting price systems.[5]

An effective mitigation investment will lead to:

- more efficient and sustainable premium reductions compared to market intervention;
- community and social benefits due to a lower level of damage and disruption after a cyclone; and,
- strong economic benefits from the creation of a retrofit market, including job creation.

KPMG modelling shows that, over 10 years, a $250 million annual investment in disaster mitigation could result in a $6.5 billion boost to GDP, while a pool approach reduces GDP over the same period (Figure 2).

Creating demand for mitigation also has flow-on benefits. Urbis identified that an incentive program creating a market for building retrofits is likely to boost innovation and drive down costs over time:

> Experience curves for other products, notably solar panels, but also energy-efficiency innovations in the building sector more generally, demonstrate the potential for mitigation options to improve pricing outcomes over time. For example, capital expenses for solar are forecast to fall in Australia by over 40%, between 2010 and 2030, as the use of solar becomes more widespread (Hearps & McConnell, 2011).[6]

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[4] The Australian Government the Treasury, *Northern Australia Insurance Premiums Taskforce Interim Report*, 2015, p41
[5] *Financial System Inquiry: Final Report*, p 227
[6] Urbis, *Protecting the North: the benefits of cyclone mitigation,* 2015, piii

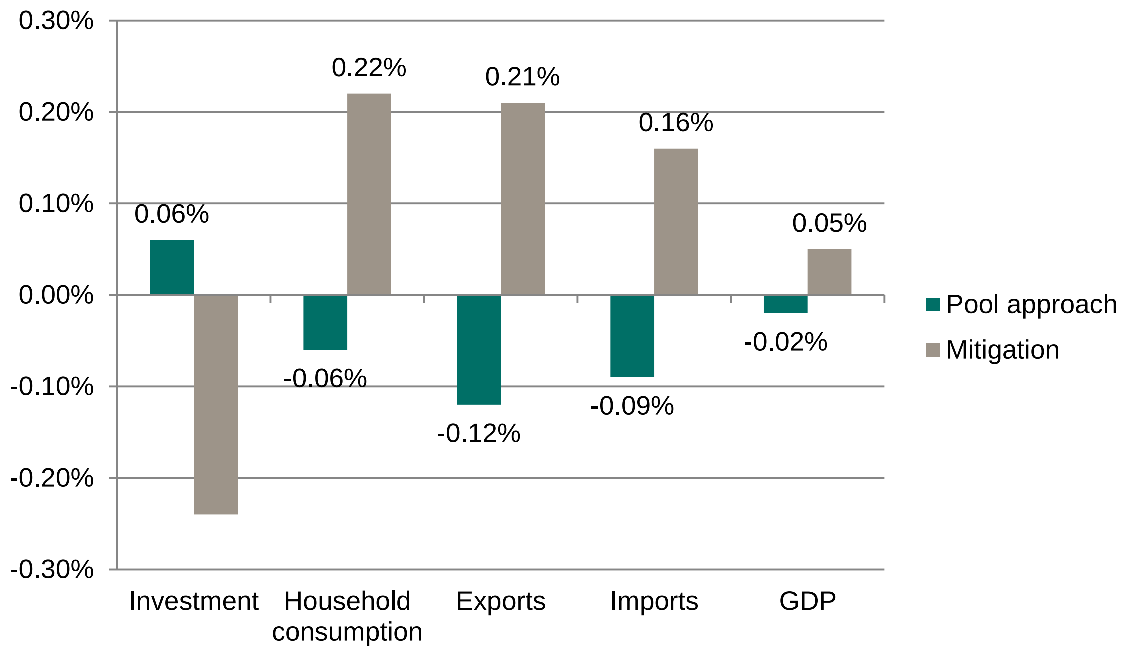
Preventing damage makes sense

The current approach to natural disaster funding is weighted toward disaster recovery funding, with limited levels of investment in preventative disaster mitigation. This results in the inefficient practice of minimising costs upfront only to be faced with significant recovery bills following each disaster.

This was recognised by the National Commission of Audit which characterised recovery funding as a “large and volatile expenditure [which] poses significant and ongoing risks to the Budget.”[7]

Current arrangements also lead to the highly inefficient practice of rebuilding assets and infrastructure to the original standard, maintaining high levels of risk and allowing the benefit of recovery investment to be wiped out by subsequent disasters.

Any approach to reducing premiums that does not focus on mitigation will fail to reduce the cost of cyclone recovery and lock in a cycle of high premiums and government subsidies.



Source: KPMG

FIGURE 2: Key modelling results - impact in the year of the event (or every ten years) total accumulated cost of the pool/mitigation over ten years and the total cost of one event (deviation from baseline, percentage)

[7] National Commission of Audit, *Towards Responsible Government,* Phase One Report, February 2014, pg. 187.

The importance of resilience

We know improving the resilience of homes reduces cyclone damage.

In 2006, Cyclone Larry damaged a number of homes in Innisfail, which were repaired or rebuilt subject to the new stronger building code. In 2011, when Cyclone Yasi again impacted Innisfail the rebuilt areas saw average repair costs of $56,000. This was almost half of the $110,000 repair costs in nearby Tully and Cardwell that were largely built prior to the new cyclone building standards.

The problem with current building standards, as noted in the interim report, is that they only apply to new homes. Unless an older building has had significant repairs or upgrades, it is unlikely to meet current codes. James Cook University (JCU) analysis of Suncorp claims data showed that properties built in north Queensland prior to the introduction of modern building codes were more likely to suffer structural damage in the event of a cyclone.[8]

Even though major structural failures represent a minority of claims, they are a major driver of claims cost. For example, less than 3% of Suncorp claims for Cyclone Yasi were for more than 50% of a policy's sum insured. These claims accounted for 27% of the total claims cost.[9]

Upgrading older homes to reduce the risk of structural damage due to a cyclone could significantly reduce the cost of claims and generate savings that can be passed through to policyholders.

However, building codes are only a minimum standard, and are designed primarily to protect lives and ensure structural integrity. Homes that meet this standard still have a large scope for increasing resilience and reducing the risk of loss.

For example, newer buildings are prone to damage from wind and water ingress through openings. This is because, while modern building codes have ensured the structure of the building is more resistant to cyclones, there is no requirement for openings to meet the same standards. If not properly protected, these become the weakest points in the building. Once an opening is breached, wind and water can enter the home, causing damage to interiors and contents and driving up claims costs.

[8] Cyclone Testing Station, James Cook University, *Insurance Claims Data Analysis for Cyclones Yasi and Larry*, 2015, p21
[9] Cyclone Testing Station, James Cook University, *Insurance Claims Data Analysis for Cyclones Yasi and Larry*, 2015, p21

Resilience retrofits

Retrofit opportunities identified by JCU to make homes more cyclone resilient include:

- roofing upgrades for older buildings, to reduce the likelihood of structural damage;
- protection of all building openings, to reduce damage caused by wind and water ingress; and,
- a community awareness campaign, designed to ensure residents are better prepared for cyclone events and reducing the incidence of small claims.

Further to the research conducted by JCU, Suncorp commissioned Urbis to conduct a cost-benefit analysis of several mitigation options.

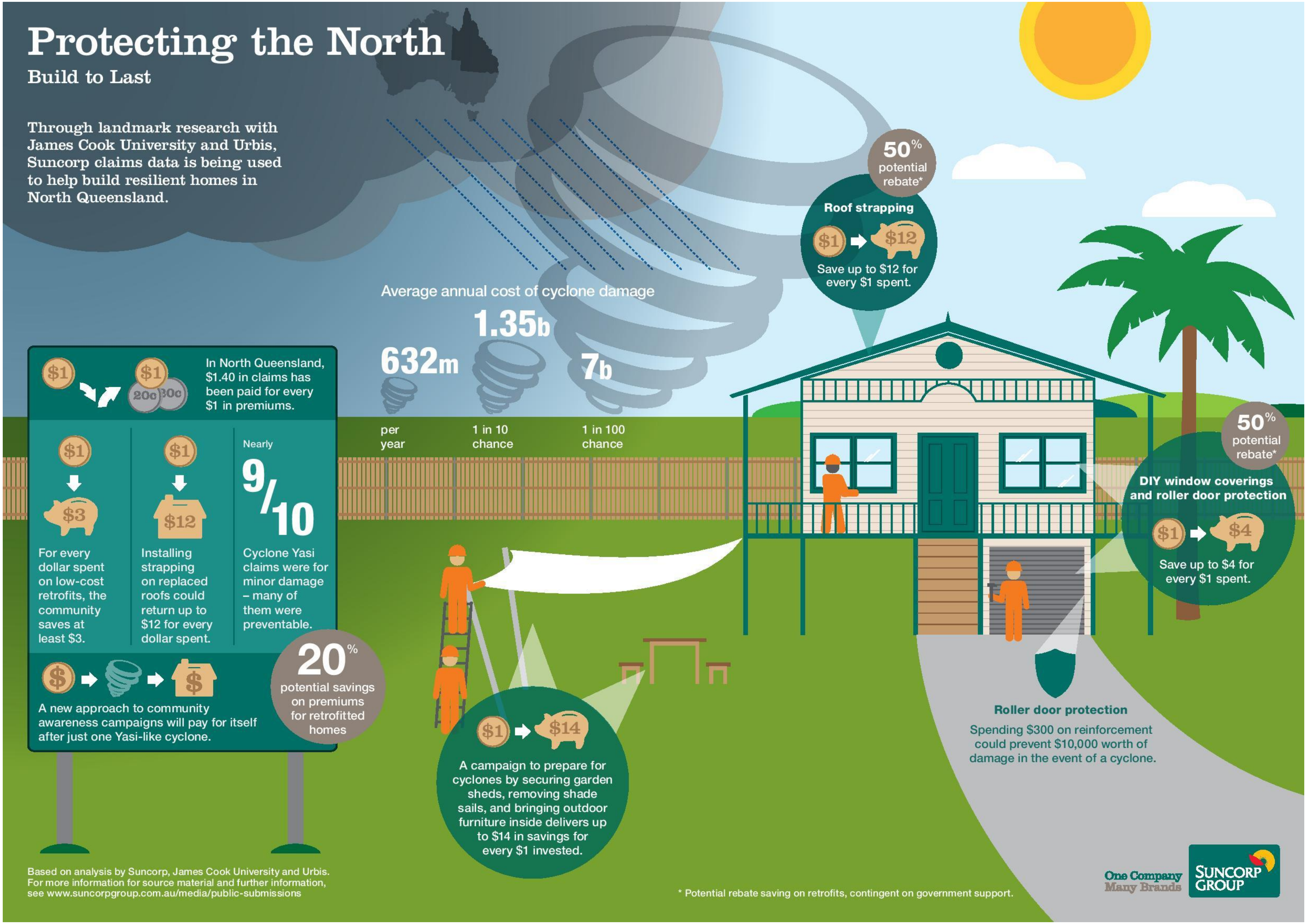
A range of mitigation options showed a positive benefit-cost ratio (BCR), shown in Figure 3. Overall, every dollar spent on low-cost retrofits will provide a return of at least $3. Some options, including an improved community awareness campaign to lower the incidence of small, preventable claims, would pay for themselves after just one Yasi-like cyclone.

Mitigation option	Cost per household	Total benefit per household**	BCR	Payback period***
Community awareness campaign*	$55 – $136	$440 – $820	3.2 – 14.8	<1 – 6 years
Opening protection – self-installed (Low cost scenario)	$1,660	$1,990 – $6,400	1.2 – 3.9	4 – 21 years
Roofing option – strapping only (Low cost scenario)	$3,000	$12,900 – $38,800	4.3 – 12.9	2 – 4 years
Roofing option – over-batten system (Medium cost scenario)	$12,000	$13,500 – $39,400	1.1 – 3.3	5 – 37 years

NB: Values taken as an average over House Type A and House Type B, except for community awareness campaign, which is an average over all house types. Total Benefit does not discount the cost of mitigation. The lower range of values are based on conservative wind speeds and are modelled over only 39 postcodes. *Government funded campaign, applied per household. **NPV over 50 years. ***Payback period refers to the number of years required for the value of benefit to outweigh cost of mitigation option – applied across all parties, not just the consumer. Source: Urbis modelling, JCU, Suncorp Group

FIGURE 3: Benefit cost ratios for mitigation

Key highlights of the JCU and Urbis research, as well as the full reports, can be found in the appendices to this submission.



Protecting the North
Build to Last
Through landmark research with James Cook University and Urbis, Suncorp claims data is being used to help build resilient homes in North Queensland.
Average annual cost of cyclone damage
632m
per year
1.35b
1 in 10 chance
7b
1 in 100 chance
$1
$1
20c
30c
In North Queensland, $1.40 in claims has been paid for every $1 in premiums.
$1
$3
For every dollar spent on low-cost retrofits, the community saves at least $3.
$1
$12
Installing strapping on replaced roofs could return up to $12 for every dollar spent.
Nearly
9/10
Cyclone Yasi claims were for minor damage – many of them were preventable.
$
$
A new approach to community awareness campaigns will pay for itself after just one Yasi-like cyclone.
20%
potential savings on premiums for retrofitted homes
50%
potential rebate*
Roof strapping
$1
$12
Save up to $12 for every $1 spent.
50%
potential rebate*
DIY window coverings and roller door protection
$1
$4
Save up to $4 for every $1 spent.
$1
$14
A campaign to prepare for cyclones by securing garden sheds, removing shade sails, and bringing outdoor furniture inside delivers up to $14 in savings for every $1 invested.
Roller door protection
Spending $300 on reinforcement could prevent $10,000 worth of damage in the event of a cyclone.
Based on analysis by Suncorp, James Cook University and Urbis. For more information for source material and further information, see www.suncorpgroup.com.au/media/public-submissions
* Potential rebate saving on retrofits, contingent on government support.
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Incentives for mitigation

Strengthening homes makes financial sense, but there are still barriers to uptake. A range of additional incentives will help drive the creation of a market for mitigation.

- **Reduced upfront costs for homeowners.** While there is a strong return on investment for activities such as the installation of roof strapping, these benefits may not be fully realised for many years if a damaging cyclone does not occur in the area. To overcome this barrier, Suncorp advocates for government investment in a large-scale retrofit subsidy program as an alternative to a pool or mutual.

- **Insurance premium discounts.** Suncorp has already committed to reducing premiums by up to 20% where homeowners have undertaken mitigation work. We have a strong track record in delivering savings where mitigation reduces risk – recently, creation of flood levees in Roma and Charleville lead to immediate and significant premium reductions for Suncorp customers. Lower risk will also lead to even more competition in the region.

- **Less intrusive retrofits.** Resilience solutions such as over-battens, while effective, can be unsightly. As part of our ongoing research partnership, Suncorp is working with JCU to foster development of innovative solutions that are less visually intrusive. Smarter, innovative, attractive solutions have never been encouraged because there has never been a market or price signal to spur better design.

Existing programs

Government sponsored mitigation programs have been highly successful internationally, and a similar model should be considered for northern Australia. The *My Safe Florida Home* program commenced in 2007, and undertook inspections on 400,000 single-family residential properties. Grants were provided to 35,000 applicants. The popular program averaged over 5000 sign-ups per day, with participating homeowners receiving a free wind inspection report with advice on how their home could be protected from storms and how much they could save on insurance premiums.

The insurance market

To date, the affordability debate has been characterised by anecdotal accounts of premium increases, and misleading data comparisons used to portray market failure. Many cases reported in the media describe outlier cases, which do not reflect the experience of residents in the broader insurance market.

The term “market failure” has also been used inappropriately to describe the situation in northern Australia. In order for the insurance market to be failing, there would need to be insufficient cover available to meet demand. This is not the case.

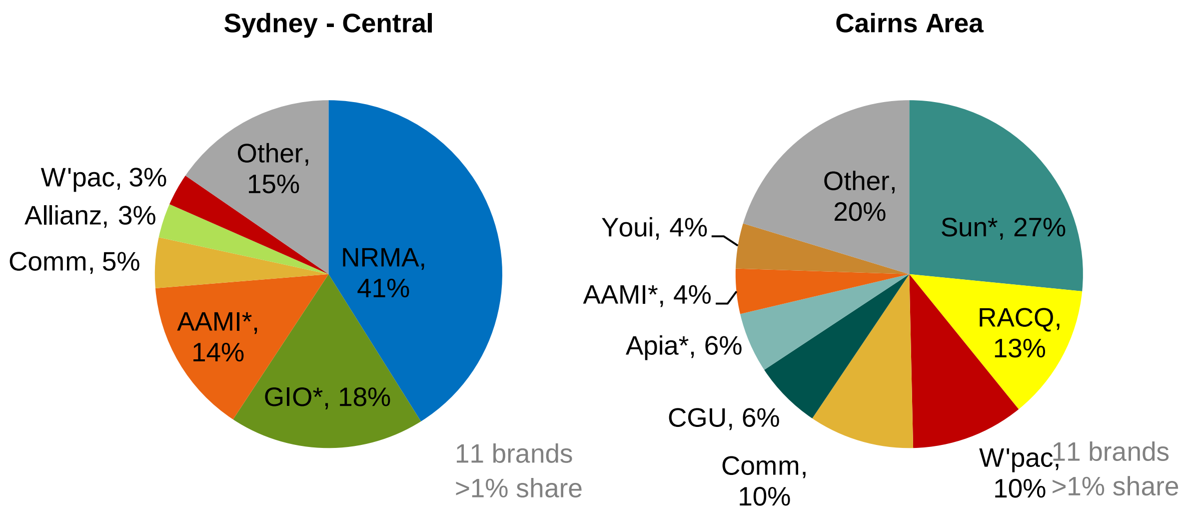
Previous inquiries, including those undertaken by the Productivity Commission, the AGA and the Financial System Inquiry (FSI), have concluded there is no market failure contributing to premiums in northern Australia.

Recent analysis from Suncorp and the ICA also shows that the insurance market is functioning:

- average home premiums in north Queensland are approximately 1.5 times those in the rest of Queensland, and twice those in Sydney and Melbourne – reflecting the higher level of risk carried by north Queensland communities;[10]
- the average is being pushed up by a small number of very high premiums – 97% of cyclone exposed policyholders pay $3000 or less for home building insurance;[11]
- there is no trend in north Queensland towards non-insurance or lowing of overall sum insured, reflecting that the market continues to work well;[12]
- there is no trend toward high excesses in high risk locations, with 92.5% of policyholders choosing an excess of $1000 or less, compared to 93% across Queensland.[13]
- Suncorp’s 91% renewal rate in north Queensland is consistently higher than in NSW (88%);[14] showing there is little evidence of customers dropping out of the market;
- ICA polling confirms that close to 9 out of 10 homeowners (88%) in north Queensland hold both building and contents insurance – this is consistent with national figures and demonstrates that cost is not reducing insurance levels;[15] and,

[10] Suncorp policy data – see Figure 6
[11] Based on ICA analysis of member policy data
[12] Based on ICA analysis of member policy data
[13] Based on ICA analysis of member policy data
[14] Suncorp policy data

- there is a similar level of competition across the home insurance markets in northern and southern Australia – as an indicative comparison, Figure 4 shows market share data across Sydney and Cairns.



Based on Roy Morgan Home Insurance market share (policies) analysis in Cairns (n=309) and Sydney (n=527). Population aged 18+, six month average at Jun 15.

FIGURE 4: Insurance market competition in Sydney and Cairns.

This data supports the taskforce view that:

> There does not seem strong support for the idea that insurance premiums are causing a greater number of people in northern Australia to non-insure compared to the southern regions.[16]

[15] Based on ICA polling data
[16] *Northern Australia Insurance Premiums Taskforce Interim Report*, 2015, p17

Availability of cover

Suncorp offers a range of insurance products throughout northern Australia as shown in Figure 5 below.

Area	Home**	Direct Strata	Broker Strata
North Queensland - general* (including the coastline up to 500m)	Suncorp, AAMI, Apia, Shannons, Vero, Resilium, Vero Corporate Partners	Suncorp, AAMI	Resilium, Longitude (underwritten by Vero)
Offshore Islands - QLD	Some Islands (postcodes) are acceptable with an excess and some are not accepted.	Some Islands (postcodes) are acceptable with an excess and some are not accepted.	Some Islands (postcodes) are acceptable with an excess and some are not accepted.
NT - general*	Suncorp, AAMI, Apia, Shannons, GIO, Vero, Resilium, Vero Corporate Partners	Suncorp, AAMI, GIO	Resilium, Longitude (underwritten by Vero)
WA - general*	Suncorp, AAMI, Apia, Shannons, GIO, Vero, Resilium, Vero Corporate Partners	Suncorp, AAMI, GIO	Resilium, Longitude (underwritten by Vero)
Offshore island territories (Christmas Island/Norfolk)	Norfolk Island only, through Vero broker only.	Nil	Nil

*some islands/postcodes are not accepted, or have an applicable excess; **includes broker and corporate partner offerings

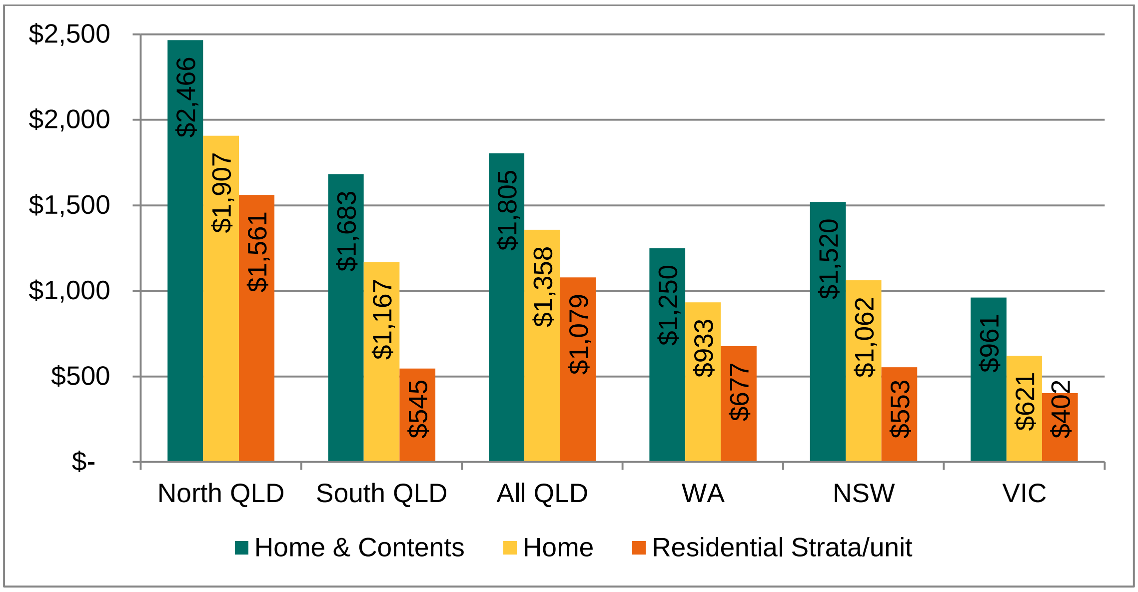
FIGURE 5: Coverage across northern Australia for Suncorp brands

Clarifying strata insurance

Suncorp is concerned that strata insurance premiums are being quoted out of context in discussions around insurance affordability. Strata premiums are not directly comparable unless broken down to a per-unit rate, because:

- strata premiums are split between unit owners, so one owner is not paying the entire premium – for instance, a 20-unit policy with a $40,000 annual premium equates to $2000 per unit; and,
- there is significantly more variation between different strata developments than between different free-standing homes – for example, it is difficult to compare the risk faced by a duplex to that of a large apartment complex with features such as basement car parking, pools and elevators.

When analysed on a comparable per-unit basis, Suncorp data shows strata insurance premiums are cheaper than home building insurance policies.



Premiums shown include taxes. Strata bar consists of intermediated policies up to 12 units for comparable residential risks. Source: Suncorp policy data

FIGURE 6: Average retail premium comparison.

It is also important to note that excess levels for strata policies tend to be set at a very low level. Suncorp has higher voluntary excess limits for brokered strata policies.

Housing and rental markets

The interim report referred to submissions to both the Taskforce and the Joint Select Committee Inquiry into the Development of Northern Australia, stating that insurance prices are forcing individuals to sell their properties, and making it harder to sell properties currently on the market.

However, at this stage there does not appear to be any evidence that insurance prices have had a significant impact on property market conditions in northern Australia. Taking into account both housing prices and income, northern Australia has some of the most affordable housing in the nation – for example:

- Townsville, Rockhampton and Mackay are among the top 10 most affordable localities in Australia; and,
- the median multiple (a housing affordability rating that divides the median house price by the median annual household income) for Townsville is 4.3, compared to Brisbane at 6.0, Melbourne at 8.7 and Sydney at 9.8.[17] This means that, relative to income, houses are more than twice as expensive in Sydney and Melbourne than Townsville.

[17] *11th Annual Demographia International Housing Affordability Survey: 2015,* available: http://www.demographia.com/dhi.pdf

There is also no market evidence of widespread sales or rising vacancy rates due to rising insurance premiums, with industry analysis showing that:

- rental vacancy rates are steady or declining across much of regional Queensland, with the Cairns market described as having a shortage of available properties ;[18]
- unemployment and the mining sector are the main drivers in vacancy rates;[19] and,
- home and apartment sale markets are not in any widespread distress.

The insurance price signal

No evidence has been presented to date that indicates an insurance market failure. Insurance premiums reflect high cyclone losses and the market is responding rationally. The key issue is not the insurance market itself but rather the underlying levels of cyclone risk in northern Australia that should be directly addressed.

The interim report states that high insurance premiums

> …are likely to discourage investment, particularly in areas identified as high risk, as well as discourage people moving to these areas.[20]

The report also notes:

> …insurance premiums should provide an incentive for development in areas with lower risk of natural perils. To the extent that government intervention in the market dampens these signals, it has the potential to foster greater investment in high risk areas.[21]

High insurance premiums are a reflection of high risks, and although premiums are the price signal discouraging investment, it is ultimately the underlying level of risk that is influencing decisions.

Appropriate planning policies are an important foundation for community resilience. Queensland already has a legacy of poor planning and development decisions placing communities in harms way. For example, a new development at Carrara on the Gold Coast must incorporate a helipad and lifeboats as a condition of development approval because it will place 970 dwellings on a high-risk floodplain. [22]

[18] Herron Todd White, *Month in Review – August 2015,* available: http://www.htw.com.au/Downloads/Files/273-Month-in-Review-August-2015.pdf
[19] Real Estate Institute of Queensland, *Regional Queensland vacancy rates patchy*, 24 July 2015, available: http://www.reiq.com/newsmedia/media-releases/2015/regional-queensland-vacancy-rates-patchy
[20] The Australian Government the Treasury, *Northern Australia Insurance Premiums Taskforce Interim* Report, 2015, p18
[21] The Australian Government the Treasury, *Northern Australia Insurance Premiums Taskforce Interim* Report, 2015, p23
[22]Courier Mail, *Development on cow paddock at Carrara, Gold Coast, expected to be approved but must have lifeboats*, 19 July 2013, available: http://www.couriermail.com.au/news/queensland/development-on-cow-paddock-at-carrara-gold-coast-expected-to-be-approved-but-must-have-lifeboats/story-fnihsrf2-1226681802980

In north Queensland, there are many examples of developments that do not meet planning criteria but are approved by councils despite natural hazard risk, such as the Rasmussen development approved by Townsville City Council earlier this year.[23]

Government policy should not seek to mask price signals and encourage more poor decisions. It is fundamental that the community has the opportunity to make their investment decisions with some signal of natural hazard risk.

[23] Townsville Bulletin, *$500m Rasmussen development gets green light*, 23 June 2015, available: http://www.townsvillebulletin.com.au/news/townsville/m-rasmussen-development-gets-green-light/story-fnjfzsax-1227410880652

The risks of market intervention

Creation of a mutual insurer or a reinsurance pool in northern Australia would be an inefficient and counterproductive approach to improving insurance affordability. More importantly, it would do nothing to protect lives, homes and irreplaceable possessions.

Whenever the insurance market has been examined, governments have always determined that market intervention is the wrong way to reduce premiums. This can be noted as far back as 1979, when then-Treasurer the Hon. John Howard issued a policy paper rejecting a policy proposal to introduce a reinsurance pool for north Queensland, stating:

> The Government is satisfied that a scheme of the kind that had been under discussion – that is, one involving the provision of Government financial backing to a 'pool' of insurance companies – would be inappropriate on budgetary, technical and insurance policy grounds. Beyond that, however, the Government also believes that such a scheme would be inconsistent with a basic tenet in its political philosophy – namely, that governments and government authorities should, to the maximum extent possible, seek to avoid intervention in matters that can be left to the private sector.[24]

This policy paper is attached for reference.

More recently in 2014, the Productivity Commission noted "international experience has shown that government intervention in property insurance markets through subsidies is overwhelmingly ineffective."[25]

The Financial System Inquiry has also concluded that, in the absence of market failure in northern Australia, government should refrain from intervention in the insurance market.[26]

The Interim Report acknowledges that international experiences of government intervention in insurance markets have been extremely poor. The Taskforce is yet to justify why or how an Australian pool or mutual would be any more successful.

[24] *Natural Disaster Insurance – A Policy Information paper issued by the Treasurer, The Hon. John Howard, M.P.,* 1979, piii
[25] Productivity Commission, *Natural Disaster Funding Arrangements: Inquiry Report*, 2014, p32
[26] *Financial System Inquiry: Final Report*, p 227

Moral hazard

Instances of market intervention internationally demonstrate that, without a price signal, moral hazard allows risks to continue to grow. For example, the increase in coverage of the US National Flood Insurance Program (NFIP) from 1.4 million homes in 1978 to 5.5 million homes in 2013 demonstrates the importance of maintaining a strong price signal on risk.

It is also incredibly difficult for government to withdraw from the market once government intervention occurs. In 2012, the Biggert-Waters Flood Insurance Reform Act attempted to increase premiums in line with flood risk to address long term insolvency in the US flood pool program. Voter backlash led to the repeal of many rate increases.

Dulling the insurance price signal and politicising insurance premiums inevitably fails, with governments effectively locked in to providing low cost insurance as risk exposure increases.

Ongoing government lock-in has also led to significant liabilities in international schemes. The NFIP currently holds USD$23 billion in debt,[27] and the New Zealand Government was left with a NZD$16 billion bill after the Christchurch earthquakes.[28]

Efficiency

Even if government is willing to commit to subsidising the substantial and ongoing risk of cyclone losses, a mutual or pool represents an inefficient method of delivering savings.

Premium reductions under this model would be spread too broadly to help those most in need. This is because a pool or mutual would reduce the costs of cyclone insurance for all policyholders, with the majority receiving a relatively small annual saving.

A cyclone only pool or mutual also removes risk diversification, a key efficiency gain of modern insurance portfolios that diversify risk across both perils and locations. Cover for a cyclone only pool in one region would, on a like for like basis, be proportionally more expensive to reinsure than a national multi-peril program. For example, removing cyclone risk from Suncorp's current program and purchasing an equivalent standalone cover is estimated to cost 213% more per dollar of capital required. [29] While the average annual loss and risk exposure would appear to simply transfer between entities, the volatility risk in a single-peril scheme is much higher, driving this cost disparity. In order to deliver a reduction in premiums, a government pool would need to absorb this additional cost.

The varying reinsurance arrangements of private insurers will also make it difficult for a government insurer to smoothly enter (or exit) the market.

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[27] US Government Accountability Office, *High Risk Series: An Update,* 2015, p77
[28] New Zealand Government, *Budget Policy Statement*, 2014, p10
[29] Suncorp and Aon Benfield modelling

Reinsurance contracts are often multi-year arrangements, and a change to market conditions during a contract could significantly impact private insurers and their willingness to participate in markets with high levels of cyclone risk. A transition that is equitable for all private insurers would be virtually impossible.

In addition, if government was to withdraw from offering cyclone cover in the future, it will have reinsurance pricing implications for private insurers re-entering this space. Re-incorporating cyclone cover into reinsurance arrangements would likely increase costs, making it difficult for insurers to see a business case for returning to the market. This would ultimately increase the long term cost to policy holders if a government scheme was not a permanent entry into the market.

Consumer outcomes

Separating cyclone risk from multi-risk insurance is also likely to lead to the kinds of poor customer experiences contemplated in the Interim Report, including:

- confusion at the time of purchase, particularly if an individual is required to take out multiple policies – increasing the possibility of consumers purchasing inadequate or incorrect cover; and,
- delays and confusion in the event of a claim, due to the difficulty in separating the causes of loss after an event – legal confusion such as that experienced after Hurricane Katrina and the Christchurch earthquakes will delay assessment and payment of claims, increase processing costs and stymie recovery and rebuilding efforts.

Any decline in consumer outcomes is concerning, particularly in light of the insurance industry’s current push to improve transparency of cover. Following recommendations from the FSI and ASIC, Suncorp is working with the ICA to improve disclosure documents and product transparency. Any government intervention that makes insurance more complex for consumers will undermine this industry commitment.

Direct subsidies – an alternative approach to support mitigation

Suncorp joins the ICA in rejecting the need for government market intervention. However, if Government policy insists on taxpayer assistance, Suncorp believes funds should help those who need it most.

In conjunction with the ICA, Suncorp has been working to develop an alternative pathway for government to target assistance only to those with high insurance premiums.

A direct subsidy scheme will lower insurance premiums for individual homeowners without distorting the broader insurance market. It will also work alongside a mitigation program, targeting those most in need as an interim measure while retrofits sustainably reduce premiums in high risk areas over the long term.

A direct subsidy scheme delivers several benefits over a market intervention, such as:

- a significantly faster delivery of tangible premium reductions to customers with high cyclone risk;
- the ability to target assistance, and provide significant premium relief to the small number of residents who need it most;
- the ability to maintain a functioning insurance market and retain a clear price signal relating to risk; and,
- a simpler pathway to winding-down assistance as mitigation work reduces risk.

The ICA has commissioned Urbis to investigate how such a scheme could be developed and funded. Outcomes of this analysis will be shared with the Taskforce as they become available.

Conclusion

Suncorp is generally supportive of the work of the Taskforce, and is pleased the Interim Report acknowledged the importance of mitigation in addressing insurance affordability for northern Australia.

We look forward to working closely with the Taskforce as models are developed for improving affordability, and again urge the Taskforce to undertake further formal consultation once these options are complete.

Suncorp recommends the Taskforce take a measured, evidence-based approach to assessing and comparing the potential impacts of insurance market intervention against other options proposed in this submission.

Cyclone risk mitigation, in combination with targeted, short term premium subsidies, is the only proposed policy option that contributes to the economic and social development of northern Australia.

We urge government not to ignore the source of the issue, and instead commit to a policy that addresses insurance affordability in a sustainable, permanent fashion – by reducing the risk cyclones pose to northern Australian communities.

Appendix 1: Focus questions

<u>Option 1: A mutual insurer offering cyclone cover to individuals</u>

1. What are the advantages and disadvantages of a cyclone mutual insurer, supported by the Government, with the objective of lowering consumer premiums for home, contents and strata title insurance for people experiencing affordability problems due to cyclone risk? What form of Government support would likely be required?

Suncorp does not support market intervention through a pool or mutual. We have provided a significant volume of information to the Taskforce regarding the risks and impacts of introducing a government-backed insurer into the market.

For further information, see page 20.

2. How can a cyclone policy be sufficiently defined to fit neatly with a consumer's 'non-cyclone' policy purchased from a private insurer so there are no gaps in coverage?

Suncorp does not believe that cyclone cover should be separated from other insured risks.

As noted in Suncorp's substantive submission, separating cyclone and non-cyclone cover is likely to result in confusion for customers both at the time of purchase and when lodging a claim.

From an insurer perspective, differentiating between causes of loss after an event adds significant complexity. Continuing legal battles relating to claims from the Christchurch earthquakes illustrate this.

For further information, see page 21.

3. How should a cyclone mutual insurer price its policies?

Current market pricing, based on risk, is the most appropriate pricing model for cyclone insurance. Any pricing model that does not reflect risk will blunt price incentives and leave communities vulnerable to increasing risk.

For further information, see page 18.

4. Should insurance from a mutual be open to all or should eligibility be limited, such as to consumers on lower incomes or consumers who take mitigation action?

The only way for a mutual to work is at scale. A limited mutual would lack risk diversification and could become highly unstable. Limiting access would also push up the price of cover, counteracting the stated purpose of the policy.

For further information, see page 21.

5. What would be required for private insurers to be an agent for a cyclone mutual insurer and sell its policies and manage claims against those policies?

There would be a significant regulatory compliance burden placed on a private insurer to be able to act as an agent for a government-backed insurer. Legal requirements, particularly around policy wordings and disclosures, would require significant revision to facilitate this new model.

It is difficult to see how government could require private insurers to act as an agent without compensation, and it is unclear how this could be provide at a lower cost than the current competitive market.

6. What would be a suitable organisational and governance structure for a mutual insurer — a discretionary fund or an APRA regulated entity?

The only way to provide certainty for residents in high risk areas is for any insurer in the market to be APRA regulated. A 1 in 100 year cyclone event carries a risk level of $7 billion. A discretionary fund could easily collapse in the event of a cyclone that directly hits Cairns or Townsville. Residents need assurance that their claims can be paid, and in a timely fashion. A properly regulated insurer is the only way to provide peace of mind.

7. What are the advantages and disadvantages of putting a cap on the payout from the cyclone policy offered by a mutual?

Capping payouts offers relatively small risk savings to government, yet adds significantly to complexity of claims handling in disasters.

The first dollar of cover is the most expensive in insurance. It is the most likely to be claimed and includes all fixed operating expenses. Each additional dollar of cover becomes progressively cheaper to insure, as the probability of claims reduces, so there is relatively little to be saved by capping policies.

In addition, a capped policy may require individuals to purchase additional top-up insurance in the private market.

For further information on the complexity and confusion this can create for consumers, see page 22.

8. When and how could the Government reduce support for a cyclone mutual insurer?

Once government has entered the private insurance market, it is extremely difficult to withdraw. The interim report noted the poor international experiences of governments who have undertaken this kind of intervention. There may also be disincentives for private insurers to re-enter the market, due to the cost of re-entering reinsurance markets for cyclone cover.

For further information, see page 21.

Option 2: A reinsurance pool for cyclone risk

9. What are the advantages and disadvantages of a cyclone reinsurance pool, supported by the Government, with the objective of lowering consumer premiums for home, contents and strata title insurance for people experiencing affordability problems due to cyclone risk? What form of Government support would likely be required?

Suncorp does not support market intervention through a pool or mutual. We have provided a significant volume of information to the Taskforce regarding the risks and impacts of introducing a government-backed insurer into the market.

For further information, see page 20.

10. How should a cyclone reinsurance pool be designed to best fit with insurance companies' existing arrangements, including reinsurance arrangements? For example, how could cyclone and cyclone damage be defined so as provide certainty about what is covered by the reinsurance pool?

As noted in Suncorp's substantive submission, separately reinsuring cyclone risk will make existing multi-peril reinsurance arrangements less efficient, and lead to higher reinsurance costs for a pool. Modelling indicates that it could be an average of 213% more expensive to cover cyclone separately, rather than as part of a multi-peril cover.

In addition, differing reinsurance arrangements will make it difficult to conduct a smooth transition without someone losing out – for example, if an insurer has just entered a reinsurance contract, they do not have the same options as an insurer at the end of their program.

11. How should the price insurers pay for reinsurance from a reinsurance pool be calculated?

The price of reinsurance would need to be calculated based on the price government wants consumers to pay. Without further detail around a model or target pricing, it is difficult to provide insight on pricing issues. However, as previously advised, it is likely that separating cyclone cover will increase the price of both cyclone and non-cyclone reinsurance, resulting in higher technical premiums.

12. What are the advantages and disadvantages of limiting payouts available under a reinsurance pool arrangement?

Capping payouts offers relatively small risk savings to government, yet adds significantly to complexity of claims handling in disasters.

The first dollar of cover is the most expensive in insurance. It is the most likely to be claimed and includes all fixed operating expenses. Each additional dollar of cover becomes progressively cheaper to insure, as the probability of claims reduces, so there is relatively little to be saved by capping policies.

In addition, a capped policy may require individuals to purchase additional top-up insurance in the private market.

For further information on the complexity and confusion this can create for consumers, see page 22.

13. When and how could the Government reduce support to the market through a cyclone reinsurance pool?

Once government has entered the private insurance market, it is extremely difficult to withdraw. The interim report noted the poor international experiences of governments who have undertaken this kind of intervention. There may also be disincentives for private insurers to re-enter the market, due to the cost of re-entering reinsurance markets for cyclone cover.

For further information, see page 21.

14. How could a cyclone reinsurance pool scheme be structured to provide an incentive to policy holders to mitigate the risk of cyclone damage?

By blunting the price signal provided by risk-based premiums, a pool is unlikely to act as an incentive for policyholders to undertake mitigation activities. In fact, a pool is likely to incentivise more risky behaviour.

The only way to encourage mitigation is through risk-based insurance pricing, coupled with targeted assistance where required.

Other options

15. Are there any other approaches that could lower premiums in areas where affordability is a concern due to cyclone risk?

Suncorp is proposing a government-supported retrofit scheme that will provide a pathway to cyclone resilient homes in northern Australia. Along with industry, we also propose that this could be complemented by short term, targeted assistance for those most in need of premium relief.

Along with our *Protecting the North* package of affordability and resilience initiatives, this approach will allow both quick relief and long-term risk reduction.

For more information on Suncorp's proposed approach, see page 8.

Mitigation

16. What can be done to encourage greater efforts to mitigate the risk of damage from cyclones? Are there impediments to insurance premiums being responsive to mitigation action by property owners?

Suncorp is already working to provide lower premiums for homeowners undertaking recognised mitigation activities. For more information, see Appendix 3.

Additional incentives may be needed to promote broad uptake of home retrofits. Suncorp has proposed a government supported home retrofit scheme, designed to reduce upfront costs of mitigation work.

17. What are the advantages and disadvantages of establishing an independent assessment process to determine the vulnerability of a house to cyclone damage and to verify what mitigation work has been undertaken? How could such a process be established?

In principle, Suncorp is supportive of an independent assessment program that would allow for more building accurate building information to be collected and made accessible to insurers.

If such a scheme was to be developed, it would be important for government, insurers and builders to work together to design a training and licensing program for assessors.

18. What are the advantages and disadvantages of (a) establishing a rating system for building vulnerability to cyclone damage that could be publicly disclosed at the time of sale, and (b) establishing a centralised database on building information that could be accessed by insurers?

In principle, Suncorp supports any measure that provides consumers with useful information about the risk profile of their property. Risk and the cost of insurance should not be an afterthought, and providing risk information to consumers at the point of sale will assist them in making informed purchasing decisions.

Suncorp also supports the general concept of establishing a centralised database of building information. Having building information centrally available would allow insurers to more effectively assess risk.

19. What are the advantages and disadvantages of using increased excesses or policy exclusions to reduce the number of small claims following a cyclone?

Suncorp data shows that minor claims represented 86% of claims filed, and 29% of the total claims cost. While it would be possible to exclude small items from policies, this would increase confusion and dissatisfaction for consumers.

We believe that customers should have confidence that all household goods are covered, particularly at a time when industry is focused on making our products easier to understand.

We believe that a community awareness campaign to drive behavioural change and mitigation efforts would be the most effective method of reducing the frequency of small claims – this is supported by JCU and Urbis analysis. For further information, see Appendix 4 and attached JCU and Urbis research.

Appendix 2: Suncorp affordability initiatives

Suncorp has been working independently and with the insurance industry to improve resilience and reduce the impact of premium increases in northern Australia. Through our *Protecting the North* initiative, Suncorp is demonstrating a commitment to building resilience into communities. Our ongoing *Build to Last* partnership with Green Cross, JCU and Urbis will continue to drive innovation in cyclone resilience.

We are also working through the ICA to coordinate a broad industry approach to improving the accessibility of insurance.

Strata insurance

Suncorp recognises that mandatory insurance is a major expense for strata committees.

Earlier in 2015, Suncorp introduced a strata insurance product targeted specifically at smaller complexes. The product is sold directly through Suncorp call centres, and on average is around 20% cheaper than competitor products.

In addition to cost savings upfront, a resilience feature is built into these policies. In the event of a major claim, policyholders can access an additional $10,000 to upgrade the building to be more resilient to natural hazards.

To date, over 140 properties in north Queensland have taken up direct strata policies.[30] It is anticipated that this number will continue to increase as strata title owners and managers reach the end of their existing annual policies.

This product is tailored for a specific segment of the strata market, but Suncorp is committed to exploring how we can best cater to other sectors of the strata insurance market.

In addition, mitigation measures identified in our *Build to Last* report will enhance the resilience of strata buildings, particularly the solutions to strengthen and protect windows, doors and roller doors. Suncorp, under its risk-based pricing approach, commits to rewarding these measures in reduced premiums if carried out.

Suncorp has also joined the insurance industry in welcoming $12.5 million in Federal Budget funds towards engineering assessment reports on strata buildings in north Queensland. There is still a lot of room for improvement in the area of risk data and such reports will help industry more accurately and confidently price strata buildings in north

[30] Suncorp policy data

Queensland. Suncorp looks forward to the expenditure of these funds and assessments being conducted in the region as soon as possible.

Suncorp has also taken steps to make higher voluntary excesses available to Vero strata policyholders, which will allow strata complexes to significantly reduce their premiums.

Resilience rating

The interim report noted that it has been difficult for insurers to incorporate individual household mitigation into pricing.

To address this gap, Suncorp is developing a system that will allow policyholders to have their premiums reduced by up to 20% if they can demonstrate a lower level of risk.

Once implemented, Suncorp will be able to ask customers a series of questions about any mitigation work they have undertaken on their home, in order to calculate a resilience rating. Suncorp will then be able to provide a reduced premium based on the resilience rating.

In addition to delivering immediately reduced premiums for proactive homeowners, the data collected through this system will allow Suncorp to develop a more detailed picture of our risk profile. In the longer term, this may provide sufficient evidence of reduced risk to help lower reinsurance costs – delivering further savings to customers.

Essentials by AAI

Insurance is not accessible to many low-income Australians. Up to one in five adults do not have insurance cover for their contents, car or home.[31]

This lack of cover places low-income earners in a precarious financial position. Even minor mishaps affecting key assets, like cars and fridges, can result in significant financial hardship and disrupt the day-to-day lives of low-income earning Australians.

This issue exists nationally and is not confined only to northern Australia. In order to make insurance more accessible to low income earners who may not be able to access traditional insurance products, Suncorp has partnered with Good Shepherd Microfinance to launch *Essentials by AAI*.

Initially offering home contents and car cover options tailored to the needs to low income earners, policies will start from $4 per week and scale based on the level of cover.

Essentials has been created to provide better access to affordable, easy to understand products via a trusted network of provider locations. This will enable low-income earners to accumulate and use assets with much greater safety and confidence.

[31] The Centre for Social Impact for NAB, *Measuring Financial Exclusion in Australia,* June 2013

Economic modelling by Strategic Project Partners (SPP) estimates that helping just 7% of low-income households to move into mainstream financial inclusion could deliver an annual GDP benefit of $19.7b.[32]

Essentials by AAI will allow many people to access insurance for the first time, in addition to offering substantial savings to low income earners currently struggling to pay premiums on traditional policies.

Disclosure

The Interim Report noted that, while insurers may have clear logic behind price increases in high risk areas, this has not always been communicated well to consumers.

Suncorp agrees that communication with customers relating to insurance can generally be improved, and is committed to developing better ways of talking with our customers and delivering important information. This is why we have been working with the ICA Effective Disclosure Taskforce to set the principles for a more effective relationship with customers. Better end-to-end disclosures will improve customer understanding of their policies, and improve consumer outcomes.

Outcomes from the Effective Disclosure Taskforce are expected in late 2015.

[32] SPP and Good Shepherd Microfinance*, Count Me In. Microfinance, Inclusion, and Economic Growth*

Appendix 3: Other policies impacting insurance prices

State and Territory governments have responsibility for a number of policies that influence natural hazard risk, insurance coverage and the price of premiums, including:

- land-use planning;
- the National Construction Code;
- insurance taxation;
- disaster mitigation funding programs;
- sharing of natural hazard risk information; and,
- improved support for local government.

Enhanced coordination of these policies would contribute to better natural hazard management and lower insurance premiums.

The role of building codes

The national construction code is a key piece of regulation that affects the level of risk throughout Australia. The value of requiring homes to be constructed to a stronger building code is particularly clear in cyclone prone areas.

While clearly building codes have already played an important role in lessening the impact of natural disasters, more can be done to improve their effectiveness. For instance, the current objective of the Australian Building Codes Board (ABCB) includes to:

> …establish codes and standards that are the minimum necessary to efficiently achieve the relevant mission of ensuring safety and health, and amenity and sustainability objectives.[33]

The mission of the ABCB should be expanded to include an explicit resilience objective. This would ensure the full range of economic benefits associated with code improvements are considered throughout regulatory impact analysis. Currently, the ABCB mission only supports analysis based on safety, health and sustainability objectives.

Changes that would improve resilience, but don't improve safety and health, are likely to fail regulatory impact analysis and are therefore not included in building codes. For example, protection against wind driven rain ingress around windows and doors has no

[33] Australian Building Codes Board, *Australian Building Codes Board Intergovernmental Agreement,* 2012, pg. 8.

effect on safety and health, but would significantly improve outcomes following a tropical cyclone by avoiding consequential damage to furnishings and plasterboard.[34]

This gap in objectives was recognised by the ABCB Chairman in his submission to the Productivity Commission's Inquiry *Barriers to effective climate change adaptation*:

> The ABCB's commitment through the IGA [Intergovernmental Agreement] to BCA [Building Code of Australia] provisions being cost effective may restrict efforts to make buildings more resilient. The costs change to building design is a real cost that can be easily estimated, while the benefits provided would be in terms of probable reductions in damage, injury or loss of life and are often intangible, difficult to estimate and have a long timeframe.[35]

We advocate for amendment of the mission and objectives of the Australian Building Codes Board (ABCB) to include an explicit focus on building community resilience to natural hazards. Importantly, this would recognise the economic and productive value of assets in addition to the protection of life goals currently within the regulation.

A stronger building code should also be supported by enforcement. The Queensland Building and Construction Commission recently conducted a random audit of 112 buildings in Mackay and found 11 did not meet cyclone standards.[36] It is crucial that the building code is robustly enforced to ensure new homes stand the best possible chance of withstanding future cyclones and natural hazards.

Smarter urban planning

Disaster risk management can also be achieved through risk-informed urban planning. As more homes and businesses are built, the impact of natural hazards increases due to the higher number of structures exposed to natural hazards. Placing homes and businesses in smarter locations will help reduce the likelihood and cost of natural disasters.

Our expanding built environment creates a clear need for risk-informed urban planning that helps to manage exposure to natural hazard risks. Risk-informed planning is not a new concept, indeed a 1909 Royal Commission into the town planning of Sydney states:

> Provision should also be made in such an Act to minimise fire risks arising from the overcrowding of building areas, the absence of fire breaks and proper means of access.[37]

[34] Boughton et. al, "Tech Report No 57", *Tropical Cyclone Yasi Structural Damage to Buildings*, James Cook University, 19 April 2011, pg. 81, available: https://www.jcu.edu.au/cts/publications/content/technical-reports/jcu-078421.pdf/view
[35] Australian Building Codes Board, *Submission to the Productivity Commission Inquiry into Regulatory and Policy Barriers to Effective Climate Change Adaption – Draft Report*, June 2012, pg.10.
[36] Melissa Maddison, *Mackay building audit reveals cyclone standards shortfall*, ABC News, 21 March 2013, available: http://www.abc.net.au/news/2014-03-21/mackay-building-audit-reveals-cyclone-standards-shortfall/5336012
[37] Royal Commission for the Improvement of the City of Sydney and its Suburbs, *Final Report*, 1909, pg. xxiv, available: http://www.photosau.com.au/CoSMaps/maps/pdf/RC_R/6%20-%20FINAL%20REPORT.pdf

More than a century later, the National Strategy for Disaster Resilience expresses a similar concept:

> The strategic planning system is particularly important in contributing to the creation of safer and sustainable communities. Locating new or expanding existing settlements and infrastructure in areas exposed to unreasonable risk is irresponsible.[38]

It is clear that urban planning is a challenging policy area with a huge range of competing priorities making regulation difficult for governments. The long lifespan of buildings and infrastructure however, mean that a shortfall in the planning scheme can leave the community at an unacceptable level of risk environment for 100 years or more.

It is crucial that smarter urban planning takes place today to ensure that new developments can proceed in a resilient manner, protecting future communities from the harsh impacts of natural disasters.

Taxes and charges

Insurance taxes, duties and levies currently form a significant barrier against Australians purchasing affordable insurance cover. Despite the vital economic protection insurance offers the community insurance premiums are currently subject to the imposition of multiple taxes. These taxes significantly increase the cost of insurance and may contribute to deterring customers both from purchasing insurance cover and from obtaining appropriate levels of cover. ICA research indicates that, across Australia, households would be likely to purchase or increase their insurance cover by a total of up to $36 billion if state and territory insurance taxes were abolished.

The effect that insurance taxation has on insurance affordability is significant. Throughout the 2014/15 financial year insurance premiums in Queensland were subject to two additional taxes - GST (10%) and Stamp Duty (9%). These taxes are charged in a compounding fashion (i.e. a tax on a tax) which further exacerbates the impact.

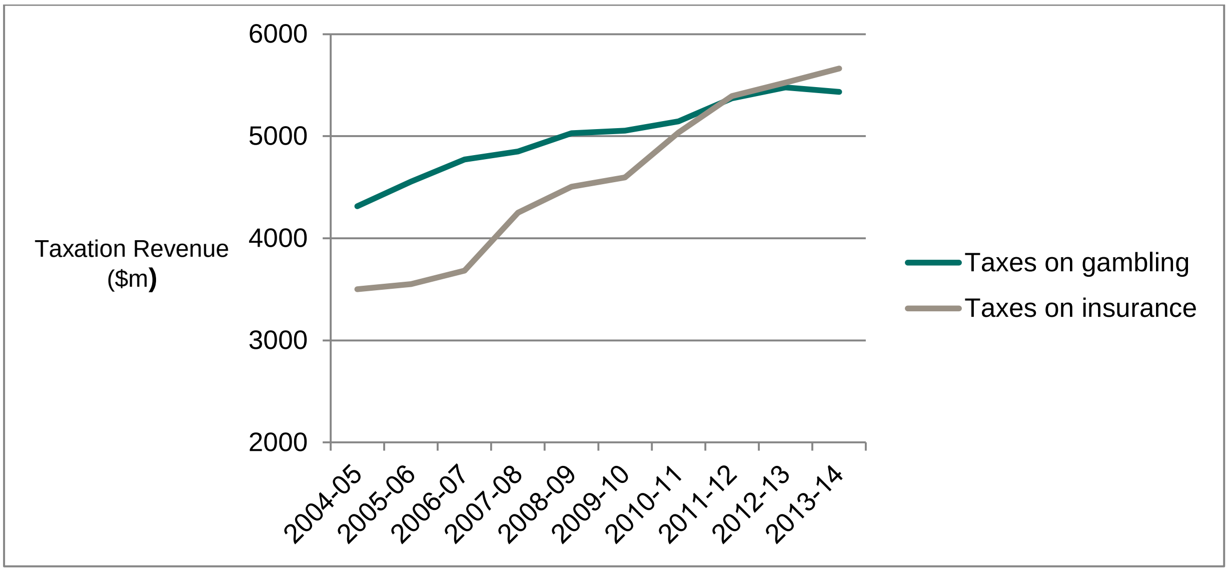
Base Premium $100 + **GST (10%) $110** + **Stamp Duty (9%) $119.90** = **Total Cost $119.90**

[38] Council of Australian Governments, *National Strategy for Disaster Resilience*, February 2011, pg. 11.

In combination, taxes add almost 20% to Queensland home and contents premiums. This tax regime also creates a tax multiplication effect on premium changes. As insurers adjust risk based pricing in recognition of new and increased risk related to extreme weather, any change in premium increase will be exacerbated by insurance taxes.

In the current taxation environment a $1 premium increase in Queensland will ultimately cost our customers an additional $1.20 in total premium. This government receives an additional $0.20 in unexpected revenue for every additional dollar of premiums collected by insurers.

This tax environment is not unique to Queensland. All states and territories have at least one tax, duty or levy applied on insurance premiums. The Australian Bureau of Statistics reports that insurance taxes contributed $5.66 billion in taxation revenue across all levels of government in the 2013-14 tax year.[39] By comparison, the so called ‘sin tax’ on gambling (designed to discourage gambling) contributed a broadly similar total of $5.43 billion over the same period. Insurance taxation revenues have increased to the point where they now outstrip gambling tax revenues.



Source: 5506.0 - Taxation Revenue, Australia Bureau of Statistics, 13/05/2015

FIGURE 7: Taxation Summary Data

[39] 5506.0 - Taxation Revenue, Australia, 2009-10, Australian Bureau of Statistics 13/05/2015

Appendix 4: JCU and Urbis research fact sheets

In Brief: JCU Cyclone Research

Overview

- Suncorp provided policy and claims data to the Cyclone Testing Station (CTS) at James Cook University (JCU) for analysis.
- Across north Queensland, Suncorp paid over $250 million in losses as a result of Cyclone Yasi:
    - In affected areas, 1 in 4 Suncorp policyholders (26%) made a claim.
    - If Yasi had hit a major population centre such as Townsville, the damage bill could have been 5 – 10 times higher.

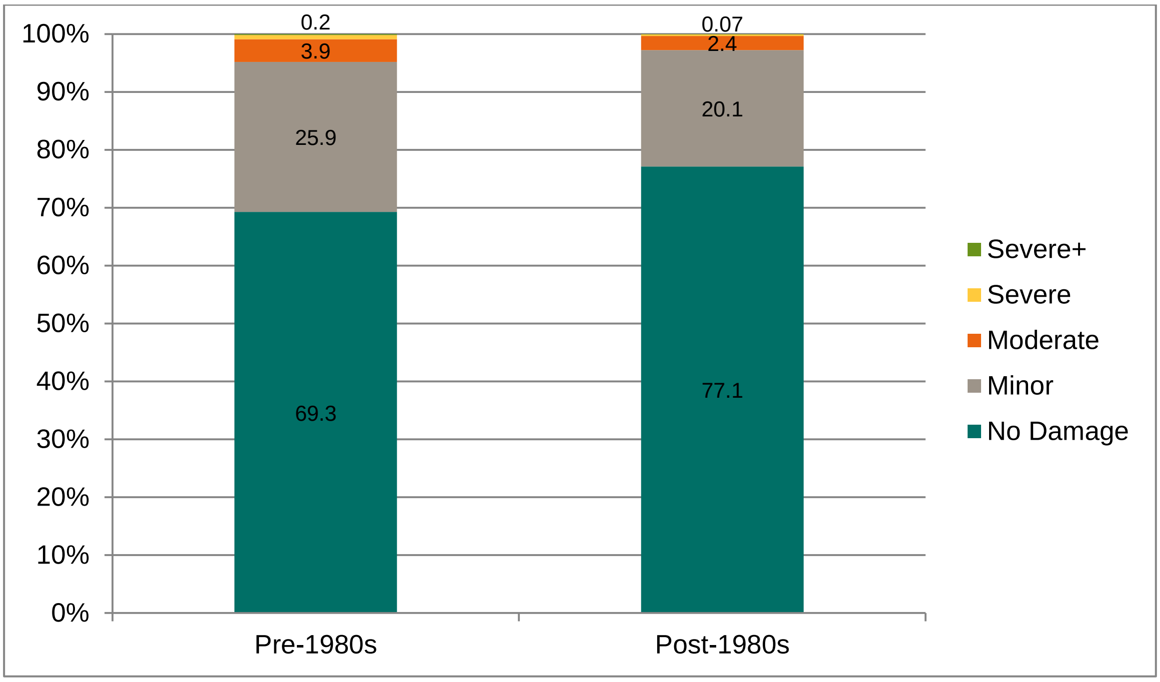
Cyclone Yasi Damage – North Queensland Coastal Region

Damage level	% of claims	Sum of claims	% total cost
Minor	86%	$73,470,201	29%
Moderate	12%	$110,404,702	44%
Severe	2%	$48,015,736	19%
Severe +	<1%	$19,753,513	8%

Research Highlights

- **Most claims for minor damage:**
    - Overall, **86%** of claims were for minor damage (less than 10% of sum insured)
    - Many **small claims are preventable** if residents properly prepare for cyclones
    - In Townsville, **94%** of claims were identified as minor (and in most cases preventable), accounting for **60%** of the claims costs for the region.
- **Major structural failures dominate losses**, even a small proportion of houses can dominate losses:
    - Overall, less than **3%** of claims were severe or worse (over 50% of sum insured), yet they accounted for **27%** of the total claims cost.
- **Resilience varies with building age:**
    - Homes built before 1982 (predating modern building codes) are more vulnerable to structural failure
    - **Windows and doors** are the weakest points in new buildings – when they fail, they allow wind and water into the building leading to further damage.

Cyclone Damage vs Building Age – North Queensland Coastal Region



Building age vs damage type contributions (pre- and post-1980s) to the total number of claims filed in relation to Cyclone Yasi for the North Queensland Coastal Region (note: "Severe+" bin proportions are less than 1% each and omitted from this figure for clarity)

Mitigation Opportunities

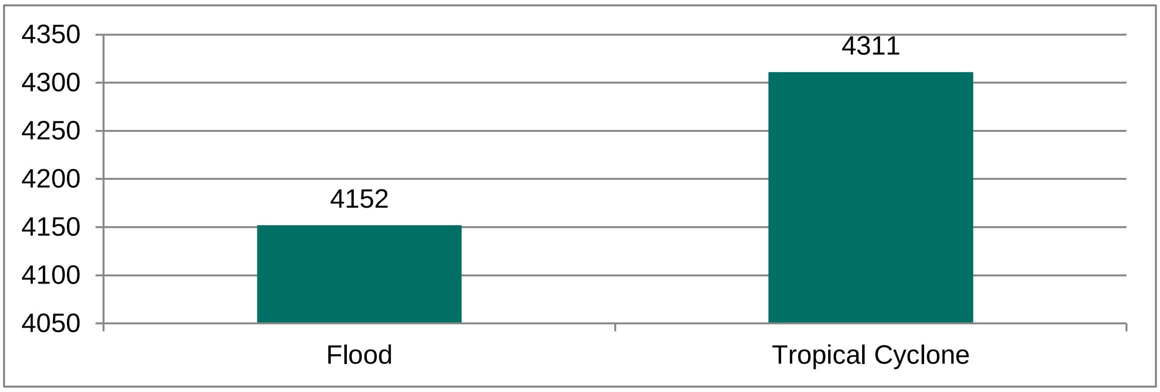
- **Roof upgrades (for pre-1980 houses only):**
  - Options include full replacements, additional strapping or over-battens, ranging in cost from $3,000 to $30,000
  - All upgrade options focus on tying the roof to the ground to handle high wind speeds.
- **Roller doors:**
  - Around 90% of modern homes have roller doors, and their failure contributes to almost one in three large claims.
  - After-market bracing costs just $300, and could prevent up to $10,000 worth of damage in the event of a cyclone.
- **Window coverings:**
  - DIY window coverings can be installed for around $1,360, and can reduce the cost of a claim by up to $15,000.
- **Community awareness:**
  - Simple actions like securing garden sheds, removing shade sails, and bringing outdoor furniture inside can prevent claims and reduce insurance costs.
  - Improving community awareness and engagement could be extremely cost-effective in reducing the number of minor claims.

In Brief: Urbis BCR Analysis

Overview

- Urbis used Suncorp data and James Cook University (JCU) analysis to determine the benefit cost ratios (BCRs) for different mitigation options.
- Cyclones have historically been the most damaging natural hazard risk facing north Queensland, making them an obvious target for mitigation activity.

North Queensland Housing Equivalent Natural Hazard Losses 1950-2011



Source: QDCS, 2012

Benefit Cost Ratios for Mitigation

Mitigation option	Cost per household	Total benefit per household	BCR	Payback period***
Community awareness campaign*	$55 – $136	$440 – $820	3.2 – 14.8	<1 – 6 years
Opening protection – self-installed (Low cost scenario)	$1,660	$1,990 – $6,400	1.2 – 3.9	4 – 21 years
Roofing option – strapping only (Low cost scenario)	$3,000	$12,900 – $38,800	4.3 – 12.9	2 – 4 years
Roofing option – over-batten system (Medium cost scenario)	$12,000	$13,500 – $39,400	1.1 – 3.3	5 – 37 years

*NB: Values taken as an average over House Type A and House Type B, except for community awareness campaign, which is an average over all house types. Total Benefit does not discount the cost of mitigation. The lower range of values are based on conservative wind speeds and are modelled over only 39 postcodes. *Government funded campaign, applied per household. **NPV over 50 years. ***Payback period refers to the number of years required for the value of benefit to outweigh cost of mitigation option – applied across all parties, not just the consumer.*
Source: Urbis modelling, JCU, Suncorp Group

Research Highlights

- Some **low-cost retrofits** will pay for themselves after only one Yasi-like cyclone.
- A suite of **low cost mitigation measures delivered a BCR of 3.2** under low wind speeds.
- A **community awareness** program is a highly effective option to reduce small claims.
- Retrofit **prices can be expected to reduce** as demand increases and a market is created for building upgrades:
    - Solar panel installation costs are expected to reduce by **over 40%** by 2030 due to economies of scale and increased innovation.
- A combination of **government rebates and insurance premium reduction** would ensure that households see a reasonable payback period, and are incentivised to invest in retrofits.

Cyclone Yasi case study

- Using Suncorp claims data and JCU analysis, Urbis modelled how proposed mitigation strategies could have changed the outcomes for houses damaged by Cyclone Yasi.

Mitigation Option:	Roofing	Opening	Community	Roofing	Opening	Community	Opening	Community
	House Type A (pre 1960)			House Type B (1960-1980)			House Type C (post 1980)	
High cost	0.1	0.2	**4.5**	0.2	0.2	**7.7**	0.1	**3.5**
Low cost	**1.5**	0.5	**4.5**	**1.4**	0.4	**7.7**	0.2	**3.5**
Medium cost	0.4	0.5	**4.5**	0.9	0.4	**7.7**	0.2	**3.5**

Source: Urbis modelling, JCU, Suncorp Group

- The **community awareness program** showed the highest BCR due to low implementation costs:
    - For all house types, a community awareness program **pays for itself after a single cyclone.**
- **Low cost roof strapping** also showed a positive return for houses built prior to 1980.
- This analysis is based on returns after a single cyclonic event – most houses would be subject to multiple cyclones over their lifespan.

Appendix 5: Additional documents

Please find the following additional documents attached separately:

1. *Build to Last* Report
2. JCU Cyclone Research – phase 1
3. JCU Cyclone Research – phase 2
4. Urbis Cyclone Mitigation Report
5. Risk Apportionment in the Insurance Sector
6. Natural Disaster Insurance – A Policy Information Paper issued by the Treasurer, The Hon. John Howard, M.P., May 1979

BUILD TO LAST

A Protecting the North initiative

CYCLONE TESTING STATION

GREEN CROSS Australia

urbis

One Company Many Brands

SUNCORP GROUP

Executive Summary

CYCLONES ARE A FACT OF LIFE FOR RESIDENTS OF NORTH QUEENSLAND AND SUNCORP HAS BEEN HELPING THE COMMUNITY MANAGE FOR ALMOST A CENTURY.

On average, we know that cyclones will cost $632 million per year, and that this can only increase into the future.

We must do a better job of protecting the community from this hazard. The risk to people's homes, their mental health and the local economy is too high.

We have an opportunity to take the adversity of Cyclones Larry, Yasi and Marcia and turn it into strength. North Queensland can and should become the world leader in cyclone resilience.

This is why Suncorp has partnered with the Cyclone Testing Station (CTS) at James Cook University (JCU) and Urbis to analyse insurance claim data to better understand cyclone vulnerabilities in homes, and what we can do to address them.

The research shows that simple, low-cost mitigation can pay for itself after just one cyclone.

Our *Protecting the North initiative* seeks to address these risks and cut the cost of insurance for those at high risk. We see this research as a first step toward a wider program of activity that will build a safer community and a more sustainable future for the North.

A resilient community is one that enjoys physical safety, mental wellbeing, the freedom to start a business and the confidence to buy a home. Reducing devastation brought by cyclones will support economic growth, create jobs and stimulate a market that rewards innovation in risk management.

A concerted effort to reduce disaster risk will also create a resilience market, drive innovation and reduce costs. This not only reduces the cost of mitigation in North Queensland, but could also position Australia as a world leader in cyclone resilience.

It's time for industry, government and the community to work together to Protect the North.

Pathways

ALREADY COMPLETE:

- Direct strata insurance
- CTS cyclone resilience research

2015:

- Essentials insurance for low income earners
- Protecting the North plan to government
- Suncorp resilience rating lowers premiums for resilient homes

2016:

- Better community preparation to reduce small claims
- Federal Government endorses mitigation
- Suncorp Bank supports privately funded retrofits
- Government retrofit incentives commence
- Home retrofits reduce premiums
- Strata retrofit scheme developed and backed by government
- Cost of retrofits is reduced as demand increases

2017 AND BEYOND

- Ongoing investment in disaster preparation
- Risk and resilience built into planning and approvals process
- Innovative retrofits increase resilience without compromising appearance
- Target of 10,000 resilient home upgrades
- Homeowners see return on resilience investment
- Australia exports world-leading cyclone resilience expertise

Key Research Findings

- As many as 100,000 older North Queensland homes may not meet current wind load codes.
- 1 in 4 Suncorp policyholders claimed for Cyclone Yasi, mostly for minor preventable damage.
- Some roof upgrade options pay for themselves after just one cyclone.
- Roof upgrades can cut cyclone damage bills in half. [1]

CYCLONE MITIGATION FOR HOMES

Queensland introduced modern building codes in 1982 and CTS Cyclone Testing Station analysis indicates that the approximately 100,000 homes built before this date may not be up to current wind load codes.[2]

To address cyclone risk, CTS proposed three mitigation options and Urbis assessed the Benefit-Cost Ratio (BCR) of each option for homes of various ages.

Urbis found that some upgrades pay for themselves after just one cyclone. Using Cyclone Yasi as a case study, low cost strapping upgrades at a cost of around $3,000 achieved a BCR of 1.5 for pre-1960 homes and a BCR of 1.4 for 1960-1980 homes.[3]

Roof upgrades can include full replacements, additional strapping or over-battens. These options range in cost from $3000 to $30,000 and all focus on tying the roof to the ground to handle high wind speeds.

There is also a strong opportunity for a community awareness program targeting minor claims such as fencing damage, loose shade cloths, unfixed objects in gardens and water ingress.

These minor claims, for less than 10% of the sum insured, can often be easily prevented. Targeting minor claims through a community awareness program achieves an average return of $10 for every dollar invested. [4]

Instant Payoff

Analysis by CTS and Urbis shows that a new approach to preparedness could pay for itself after just one cyclone.

9 out of 10 (86%) claims for Yasi were for minor claims, many of which are easily preventable.

Simple actions like securing garden sheds, removing shade sails, and bringing outdoor furniture inside can prevent claims and reduce insurance costs.

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1 Analysis based on Suncorp claims data
2 Urbis, *Protecting the North: The benefits of cyclone mitigation*, 2015, p13
3 Urbis, *Protecting the North: The benefits of cyclone mitigation*, 2015 p15
4 Urbis, *Protecting the North: The benefits of cyclone mitigation*, 2015 piii

BENEFIT COST RATIOS FOR MITIGATION

MITIGATION OPTION	COST PER HOUSEHOLD	TOTAL BENEFIT PER HOUSEHOLD**	BCR	PAYBACK PERIOD***
Community awareness campaign*	$55 - $136	$440-$820	3.2 – 14.8	<1- 6 years
Opening protection – self installed (Low cost scenario)	$1,660	$1,990-$6,400	1.2 – 3.9	4 – 21 years
Roofing option – strapping only (Low cost scenario)	$3,000	$12,900-$38,800	4.3 – 12.9	2 - 4 years
Roofing option – over-batten system (Medium cost scenario)	$12,000	$13,500-$39,400	1.1 – 3.3	5 – 37 years

*NB: Values taken as an average over House Type A and House Type B(pre-1960, 1960-1980), except for community awareness campaign, which is an average over all house types. Total Benefit does not discount the cost of mitigation. The lower range of values are based on conservative wind speeds and are modelled over only 39 postcodes. *Government funded campaign, applied per household. **NPV over 50 years. ***Payback period refers to the number of years required for the value of benefit to outweigh cost of mitigation option – applied across all parties, not just the consumer.*

Source: Urbis modelling, CTS, Suncorp Group

The CTS and Urbis analysis is backed up by Suncorp's own claims experience. Customers in Innisfail faced the full brunt of Cyclone Larry in 2006 with wind gusts of 240 kilometres an hour. The rebuild brought many damaged houses in the town up to modern, cyclone-resilient standards.

When Cyclone Yasi crossed the coast with similar wind speeds just five years later, claims from Innisfail were half the cost of those nearby towns that did not benefit from the post-Larry rebuild. [5]

OTHER RESILIENCE OPTIONS - DOORS AND WINDOWS

The analysis also highlights doors and windows as a common weak point driving damage.

Once breached, these openings allow wind into the building which significantly increases internal pressures on the structure. This in turn significantly increases the likelihood of major structural roof failures that can also cause further damage downwind.

CTS found that addressing weaknesses in modern homes could reduce cyclone damage bills by 8%.[6]

Roller doors are a prime candidate. Around 90 percent of modern homes have roller doors, and their failure contributes to almost one in three large claims.[7] After-market bracing costs just $300, and could save between $1500 and $10,000 in the event of a cyclone.[8] DIY window protection can be installed for around $1360, and can reduce claims costs by up to $15,000.[9]

Supporting Innovation

The upfront costs of disaster mitigation can be significantly reduced by creating a market for resilience through regulation and insurance incentives.

Promoting mitigation measures will drive innovation in the local industry and unlock economies of scale. By way of comparison, installation and service costs of rooftop solar panels in Australia are predicted to fall over 40% by 2020. [10]

5 Suncorp claims data
6 Analysis based on Suncorp claims data
7 Cyclone Testing Station, James Cook University, *Cyclone Resilience Research* – Phase II, 2015, p 19
8 Cyclone testing Station, James Cook University, *Cyclone Resilience Research* – Phase II, 2015, p20
9 Cyclone Testing Station, James Cook University, *Cyclone Resilience Research* – Phase II, 2015, p21
10 Melbourne Energy Institute, *Renewable Energy Technology Cost Review*, 2011

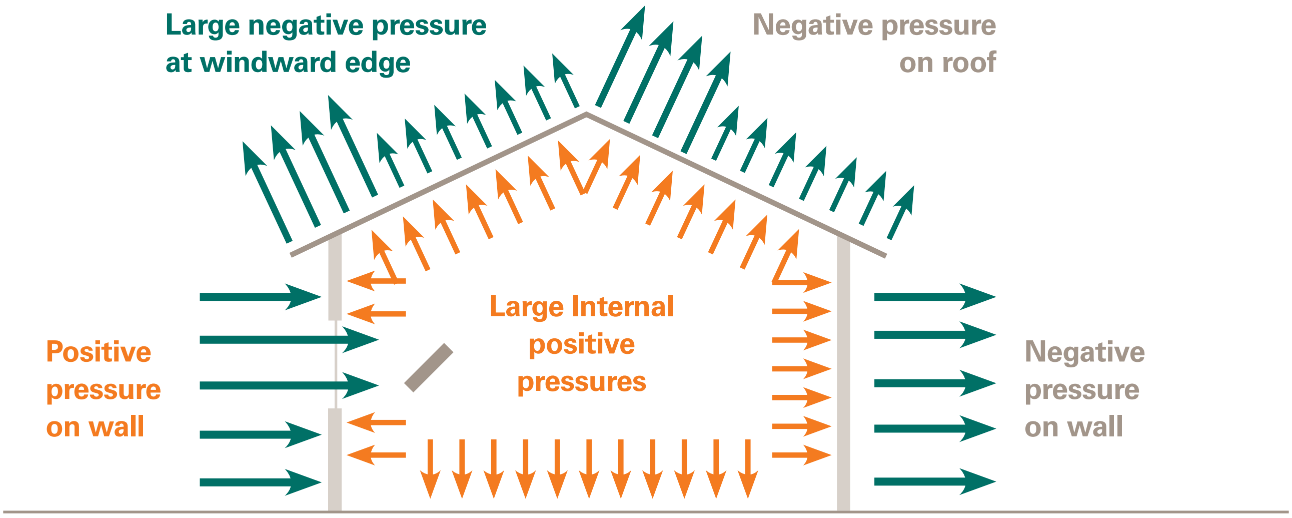


FIGURE 1. EFFECT OF BREACHES ON INTERNAL WIND PRESSURES (SOURCE: CTS)

The Building Code

The National Construction Code only covers structural elements of a home.

The code specifies wind speed design levels in cyclone-prone regions which are intended to reduce the risk of structural failure. The design requirements, however, only target structural elements, meaning that not all materials used in the building are required to meet the same wind resilience standards.

The Australian Standard for windows and doors, AS 2047, does not require resilience to the same wind speeds as the main structure of the building. This means that these openings, particularly garage doors, are often the weakest point in a new building and the first to fail during a cyclone.

Capturing non-structural building elements in standards could significantly improve resilience.

AGE MATTERS

Claims data confirms that older homes in North Queensland are less resilient than their newer counterparts. There is a significantly higher likelihood of a claim being filed for housing constructed before the introduction of modern building codes in 1982.

Older homes are also significantly more likely to suffer severe structural damage during a cyclone – ranging from the loss of roofing to collapsing walls.[11]

Newer homes built to the current code are more resilient than their older counterparts, though not to the degree we often assume.

A significant proportion of newer homes experienced severe damage, which suggests that homes did not perform as expected under the National Construction Code. [12]

11 Cyclone Testing Station, James Cook University, *Insurance Claims Data Analysis for Cyclones Yasi and Larry*, 2015, p21
12 Cyclone Testing Station, James Cook University, *Insurance Claims Data Analysis for Cyclones Yasi and Larry*, 2015, p27

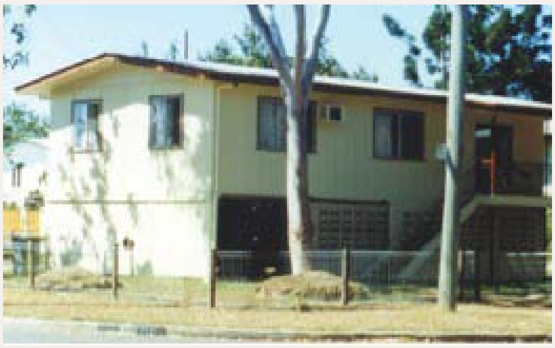
BUILT DURING: < 1920s

Hip roof, reduced rafter spans, central core, exposed studs, on stumps (low and high)

BUILT DURING: 1925 – 1959

Hip and gable, VJ lining, reduced rafter spans, on stumps (low and high)

BUILT DURING: 1960s – 1981



Gable low pitch, vermin proof flooring (studs not mortice and tennon into bearers), panel cladding, on stumps

BUILT DURING: 1981 - present

Reinforced masonry block, hip and gable, large truss spans, medium roof pitch, slab on ground

(SOURCE: CTS)

SOCIAL COSTS

Housing damage isn't the only impact of cyclones. In fact Risk Frontiers estimates social costs to be between 20-200% of insured property damage. This could include:

- Death and injuries
- Loss of leisure time
- Loss of personal property
- Higher crime rates
- Dislocation of families
- Community upheaval and disruption to local infrastructure
- Business interruption

The World Health Organisation also estimates that severe mental health disorders across the population can increase by around one percentage point following a large natural disaster.

Insuring Cyclone Risk

- Cyclone damage in Australia costs an average of $632 million annually.
- The risk, per policyholder, in North Queensland is higher than anywhere else.
- The only way to reduce premiums sustainably is to reduce the level of risk.

In North Queensland, the high risk of severe tropical cyclones means that average insurance premiums are higher than elsewhere in the country. Cyclones behave differently to floods, bushfires and storms, causing widespread damage affecting a much larger proportion of homes.

1 in 4 (26%) Suncorp policyholders in impacted areas made a home building claim in relation to Cyclone Yasi, with claims lodged from Bowen to Port Douglas, a distance of over 600 kilometres.[13] Analysis shows that there would have been significantly more damage if the most severe winds had hit a more densely populated area such as Townsville.[14]

These figures highlight the unique and widespread nature of cyclone risk. In comparison, the Brisbane and Ipswich floods in 2011 resulted in only 1 in 50 (2%) policyholders lodging a claim.[15]

This highlights the difference between the two natural hazards. Flood is highly localised, resulting in large premiums for a small number of policyholders. Cyclone is widespread resulting in comparatively smaller premium increases for a much larger number of policyholders.

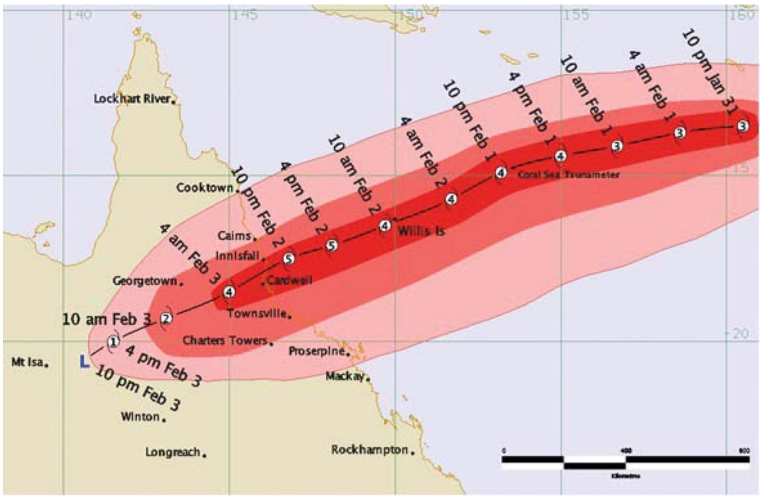
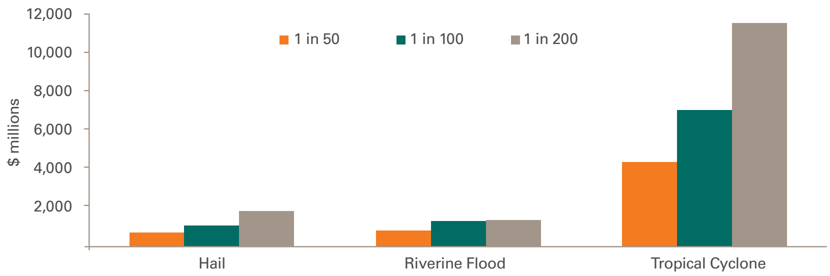


FIGURE 2. CYCLONE YASI TRACK MAP BEFORE AND AFTER LANDFALL (SOURCE: BUREAU OF METEOROLOGY)

Catastrophe modelling shows cyclones are likely to cause average losses of $632 million each year in Australia, but the exact cost in any one year is highly unpredictable.[16] Modelling undertaken by Risk Frontiers, shown below, estimates the insured losses to residential property for all of Queensland from 1 in 50 year, 1 in 100 year and 1 in 250 year natural hazards.

FIGURE 3. ESTIMATED LOSSES FOR INSURED RESIDENTIAL PROPERTY FROM NATURAL HAZARDS, QUEENSLAND (SOURCE: Urbis)



13 Suncorp claims data
14 Cyclone Testing Station, James Cook University, *Insurance Claims Data Analysis for Cyclones Yasi and Larry*, 2015, p16
15 Suncorp claims data
16 Internal modelling

INSURANCE SUBSIDIES

The large and highly variable costs of cyclones could be further transferred to the taxpayer, as has been recently proposed through subsidy mechanisms like a reinsurance pool or mutual. This would add private losses to the already large infrastructure damage bills received by the Australian Government. Suncorp believes subsidising risk, rather than addressing it at the source, would be a critical mistake.

Government backed pools and mutuals in place overseas demonstrate this mistake with schemes spiralling into debt, allowing risks to grow, slowing down claims and creating legal disputes.

The US National Flood Insurance Pool is currently $23 billion in debt and is attracting ongoing lawsuits for claims as far back as Cyclone Sandy in 2012. [17]

Similarly, the New Zealand Government was left with a $16 billion bill after the Christchurch earthquakes and residents suffered lengthy delays to claims due to overlap and confusion between private cover and government cover. [18]

International schemes have been assessed by the Productivity Commission as "overwhelmingly ineffective"[19] and the Financial Systems Inquiry agreed market intervention should be avoided.[20]

Three reviews by the Australian Government Actuary have also demonstrated that home and strata insurance pricing in Australia reflects the risks, and there is no evidence of market failure.[21]

The only way to reduce North Queensland's premiums in a permanent and sustainable way is to reduce the risk of damage from cyclones through increased Government and private investment in protecting the community, not just rebuilding it.

The US National Flood Insurance Pool

Government reinsurance pools push the cost of disasters onto the taxpayer and in doing so blunt a price signal that would otherwise encourage risk management in the commnity.

This allows risks to grow unchecked. The US National Flood Insurance Pool was established in 1978 and initially covered 1.4 million homes. In 2013 the pool had grown to cover over 5.5 million homes. [22]

That's more than 4 million new families exposed to flood risk.

The experience of the Biggert-Waters Act also highlights the political realities of government intervention. The Act attempted to increase premiums in line with flood risk, but voter backlash meant the Act was almost immediately repealed.

Politicising insurance premiums is a recipe for increased subsidies and increased debt.

17 US Government Accountability Office, *High-Risk Series: An Update*, 2015, p77
18 New Zealand Government, *Budget Policy Statement*, 2014, p10
19 Productivity Commission, *Natural Disaster Funding Arrangements: Inquiry Report,* 2014, p222
20 *Financial System Inquiry: Final Report*, 2014, p231
21 See: Australian Government Actuary, *Report on Home and Contents Insurance Prices in North Queensland*, 2014
22 Insurance Information Agency, *Flood Insurance Issues*, 2015

Protecting the North

Suncorp is taking action through our Protecting the North program, which provides a pathway to lower premiums by addressing the underlying risk. The plan includes:

- Proposing a comprehensive retrofit program to strengthen older homes in North Queensland – delivering immediate premium reductions of up to 20%;
- Building a process to recognise mitigation work already undertaken by homeowners, and reducing premiums accordingly;
- A new direct strata insurance product, delivering up to 20% savings for small strata schemes; and,
- A new insurance product, called Essentials, specifically tailored to low income earners, with policies starting from just $4 per week.

Together, these initiatives deliver sustainably lower insurance premiums for North Queensland residents.

More importantly, placing the focus on disaster mitigation ensures that risk will continue to be reduced in new and innovative ways into the future. As these new approaches take effect and risk reduces in North Queensland, insurance premiums will also reduce, and the community will enjoy the multitude of social and economic benefits associated with resilience.

My Safe Florida Home

In Florida, the State Government has been actively building a mitigation culture.

In 2007 the *My Safe Florida Home* commenced resilience inspections on 400,000 single family, residential properties with grants provided to 35,000 applicants.

The program was immensely popular with an average of over 5000 sign-ups a day.

Participating home owners received a free wind inspection report, which provided advice on how homeowners can protect their homes from storms and how much they could save on insurance premiums.

North Australia would benefit from a program similar to *My Safe Florida Home*.

About Suncorp

Suncorp is one of the largest general insurance groups in Australia offering a range of personal and commercial insurance products, protecting the financial wellbeing of millions of Australians. As a Group, Suncorp has nearly 15,000 employees and more than nine million customers across the country. The General Insurance business alone paid out $5.2 billion in insurance claims in 2013-14, averaging more than $14 million each day.

Suncorp offers a range of personal insurance products including car, home and contents, travel, boat, motorcycle and caravan insurance. The key to Suncorp's success in personal insurance is its portfolio of well-known brands. These include Suncorp Insurance, Apia, AAMI, GIO, Vero, Shannons, Just Car Insurance, Insure My Ride, Bingle, Terri Scheer, CIL Insurance and Resilium. These brands have built reputations for insurance innovation, outstanding customer service and trustworthy products.

Suncorp also offers commercial insurance products that serve the needs of a wide range of business customers, from small business operators to global companies. The commercial insurance portfolio of brands includes GIO, AAMI, Suncorp Insurance, Vero and Resilium. Suncorp is also Australia's largest personal injury insurer offering workers compensation and CTP insurance, which serve the needs of governments, employers and the community.

About Green Cross

Green Cross Australia is a Queensland based national not-for-profit dedicated to empowering a resilient Australia. Green Cross Australia is partnering with Suncorp Insurance and a range of other corporate, research and community partners to advance property resilience as a strategic priority.

Suncorp Insurance is a proud partner of Green Cross Australia's Build to Last collaborative initiative, which involves multiple stakeholders who together are working to encourage property resilience to all hazards across Australia. See more here: www.greencrossaustralia.org

Protecting the North is a practical, research-based example of how building to last can deliver lasting financial and social benefits to residents of North Queensland.

One Company
Many Brands

SUNCORP GROUP

CTS Report: TS1004.2 (version for public release)
July, 2015 (original version submitted April 2015)

Report for:

Suncorp Group Limited

Insurance Claims Data Analysis for Cyclones Yasi and Larry

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Executive Summary

Suncorp commissioned the Cyclone Testing Station (CTS) at James Cook University to conduct a comprehensive study to enhance Suncorp's understanding of the vulnerability of houses in North Queensland to natural hazards, particularly tropical cyclones and thunderstorms. CTS is an independent authority on building performance assessment for severe wind events in Australia.

The original report of this work submitted to Suncorp included commercial in confidence sections, including specific policy data. In the interests of a public release, these sections have been removed.

Housing vulnerability is a large contributor towards high claims costs for Suncorp, and the subsequent premium affordability issues for consumers. Reducing this will decrease the risk associated with cyclones events, which can then be reflected in pricing for consumers. Suncorp has sought further understanding of the below challenges associated with housing vulnerability:

- *Property Details* – what property features contribute to increased vulnerability
- *Mitigation* - work that consumers can implement to reduce vulnerability
- *Building Codes* - what can be done to make an existing property more resilient
- *Collective Risk* - what can be done to reduce impact to neighbouring addresses

To address the above challenges, the objective of the study was to analyse Suncorp claims information from Tropical Cyclones Yasi and Larry to determine parameters that differentiate cyclone-resilient housing stock from non-resilient stock. This was achieved by extracting qualitative and quantitative insights from aggregated Suncorp claims and policy data, including properties with and without claims from these events. Assessor reports as a subset of the claims data were also used to support the analysis.

Key Findings

<u>*Insurance loss drivers*</u>

The claims data clearly indicate the majority of damage sustained in cyclones is a result of:

- Roof damage
- Window damage
- Water ingress (predominantly the entry of wind-driven rain into home structures)

These types of damage are typical for moderate to large sized claims (above 10% of the property's sum insured), which represented 71% of losses from Cyclone Yasi. In the Tully/Mission Beach region, large claims (above 50% of the property's sum insured) accounted for 9% of total claims but 38% of the total claims cost. Reducing the number of major structural failures through retrofit mitigation could therefore be a very effective way of reducing property vulnerability and the cost of cyclones.

There are also significant gains to be made in reducing small claims (less than 10% of the sum insured value). These claims accounted for 29% of total Cyclone Yasi claims costs, but many were preventable. Poor cyclone preparation, including failing to remove or secure items in outdoor areas (such as outdoor furniture, sheds, shade sails etc) is making a significant impact on insurance losses. Better preparation by homeowners would not only prevent damage to these outdoor items, but also stop them from contributing to damaging other structures.

Housing age

The data indicate that houses constructed between 1925 and 1981 are at a higher risk of severe structural failure (including loss of roofing through to collapse of walls) than newer housing stock. Homes built before 1980 suffered higher rates of structural damage than those built post-1980. This shows that building codes, first introduced in Queensland in 1982, have had a positive impact on resilience. However, a significant number of contemporary houses also experienced severe damages. This suggests that modern housing is not performing as expected under the National Construction Code (NCC).

Key recommendations:

Recommendation 1:

Develop a targeted mitigation program that reduces vulnerability to the most common types of damage, focusing on:

- Structural roof upgrades for homes constructed before 1980 and other practical retrofit measures
- Upgrades to opening protections (e.g. windows and doors) for homes of all ages
- Emphasising the importance of regular maintenance

This presents great potential in delivering a range of community benefits, including insurance savings.

Recommendation 2:

Implement community education/awareness campaigns to reduce frequency of small claims, including an emphasis on cyclone preparation activities such as removing shade sales, outdoor furniture, debris and unsecured items from the yard as well as pruning trees.

Recommendation 3:

Use the data provided on failures in newer buildings to drive ongoing work around enhancing building standards to address resilience issues, as well as initiatives to support and encourage designers, builders and homeowners to use more resilient products.

Next steps

Suncorp and CTS will draw on these initial findings to design a mitigation program for vulnerable homes. This also forms the foundation of further research into increasing resilience and lowering insurance premiums in North Queensland.

Table of Contents

Limitations

The Cyclone Testing Station (CTS) has taken reasonable steps and due care to ensure that the information contained herein is correct at the time of publication. CTS expressly exclude all liability for loss, damage or other consequences that may result from the application of this report. This report may not be published except in full unless publication of an abstract includes a statement directing the reader to the full report.

1. Introduction and Scope

Vulnerability of housing in terms of insured losses is associated with not only the house structure (e.g. roof cladding, windows, frame, ceilings, doors), but the internal fitments (e.g. carpets, kitchens), ancillary items (e.g. fences, sheds) and also insured contents (e.g. personal possessions, household electronics).

The vulnerability of the house is a function of its resilience (e.g. strength) in the face of the impacting wind and rain along with wind borne debris etc. So to assess the vulnerability of a population of houses we need to ascertain details of the (a) house types, (b) the surrounds and (c) wind speed. There are also external environmental and planning factors that affect loss and vulnerability, such as proximity to the coast, height of the building above the high-tide level (storm tide is another aspect that must be considered) and the type and extent of surrounding vegetation.

Houses are constructed using many elements, with the interaction of these different components and connections not being well understood. Over time, changes are made to construction practices including building materials, often without a full understanding of how the individual changes might affect the performance of the whole system. In a period where the full "system" is not tested, a false sense of security can develop. Only when a cyclone occurs do the shortcomings become apparent, as noted by Walker (1975). This can be seen in the disproportionate amount of structural damage caused by cyclones Althea and Tracy to housing relative to that of engineered commercial buildings. A different trend has emerged in recent damage investigations, with a disproportionate level of damage to engineered light industrial sheds, where issues have been raised on appropriateness of for example design decisions and detailing (Henderson and Ginger, 2008). Actions have since been taken by the Steel Shed Group aimed at addressing any shortcomings. Damage investigations have also shown the better structural performance of housing built after the introduction of engineered "deemed to comply" provisions in Appendix 4 of the Queensland Home Building Code (1981).

Houses are complex structures and do not lend themselves to simple structural analysis. Some of the best understanding of how elements interact has come from full scale house testing, as conducted at CTS. Findings from damage investigations following severe weather events also play a critical role in understanding housing performance. Full-scale house testing at CTS and damage investigations have shown that typically failures occur at connections between the various elements. The engineering vulnerability model described by Henderson and Ginger (2007) uses this as its basis.

The aim of this pilot study was to identify drivers of insurance loss during extreme wind events. Claims data from Northern Queensland was provided for both Cyclones Yasi and Larry. An analysis area of coastal regions from Bowen to Port Douglas during Cyclone Yasi was selected, as a broad range of large numbers of house types were subjected to a range of wind speeds and subsequently a range of damage intensities. Two subset regions were also examined; (i) one area centred on Mission Beach region as higher wind speed impacts, and (ii) the Townsville region as a large percentage of houses were subjected to winds well below design level.

2. Overview of Data

Three data sets were provided by Suncorp including:

1) "General information" claims data for Cyclones Yasi and Larry supplemented with policy data

2) "General information" for policies in-force at the time of Cyclones Yasi and Larry but without an associated claim for these events

3) Assessors reports for a random subset of the claims data from set 1

It is important to note that the claims information provided by Suncorp, and hence the analysis, did not include contents damage as this study is about examining drivers of loss associated with the building property claim (and not the contents)**.**

Cyclone Yasi was a much larger event than Cyclone Larry and therefore generated much larger bands of consistent wind speed (i.e. larger regions were subjected to the same wind speed). Taking advantage of this, analysis was concentrated on Cyclone Yasi data to allow for comparisons to be made for various housing performance attributes (i.e. age, roofing type, wall types, etc.) within a region of constant wind speed (e.g., wind speed estimates for the entire Townsville region were approximately 135 km/h). The assessor's reports for claims filed after Cyclone Larry are discussed in Section 0, in addition to those for Cyclone Yasi. The data provided by Suncorp were refined into the following three data sets for analysis:

Data Set A

This data set included claims records for Cyclone Yasi. Information provided for each claim included date of occurrence, incurred costs, sum insured, occupancy type, number of storeys, location (including street, suburb and postcode as well as GPS coordinates), age of the customer, number of years insured, year of construction, roof and wall type, and building type.

Data Set B

This data set included policies that were active in the region but did not have an associated claim during the time of Cyclone Yasi. The information provided was similar to the claims data Set A but with a lesser degree of detail (e.g., items such as GPS coordinates were not included). This data set was used to understand relationships between various building attributes and likelihood that a claim was filed.

Data Set C

This data set included 179 assessor's reports from Cyclone Yasi and 56 assessor's reports from Cyclone Larry provided by Suncorp for a random subset of the claims in data set 1. These reports were separated into three groups based on the claim value/sum insured ratio (i.e. loss ratio) in order to compare typical damage modes for similar claim sizes.

3. Claims Analysis (Aggregate Data)

Data for the entire state of Queensland was provided. However, to simplify the analysis in relation to Cyclone Yasi wind damage, the data was filtered to include only those geographic regions for which reliable wind speed estimates were available. Three regions were selected. The boundaries of these regions were selected based on postcode, to allow for a convenient filtering method of policies associated with each region. Table 1 conveys the number of policies with and without claims included in the analysis for each of the three regions.

Table 1. Ratio of policies that claimed in the three analysis regions

Analysis Region	# Claim vs # Policies
North Qld Coastal	26%
Townsville	30%
Tully/Mission Beach	67%

Northern Queensland Coastal Region (entire affected area)
This represents the bulk area affected by Cyclone Yasi. This analysis area was of larger scale and included coastal towns from Bowen to Port Douglas. Policies in the Townsville and Tully/Mission Beach regions are also included in this region.

Townsville Region (low wind speed)
This region was isolated to Townsville and surrounding suburbs to provide a more detailed assessment of vulnerability. Townsville was selected because most of the homes in the area experienced similar wind loading (i.e. intensity, duration, and direction) and rainfall during Cyclone Yasi, which facilitated comparative performance assessment between homes of various age, construction type, etc.

Tully/Mission Beach Region (high wind speed)
This region represents the area subjected to highest wind speeds from Cyclone Yasi. Similar to the rationale for choosing the Townsville region, wind speeds in the Tully/Mission Beach region of analysis were of similar intensity, duration, and direction to facilitate comparative performance assessments of various building attributes.

3.1. Loss Ratios

Loss ratio refers to the ratio of the claims cost over the sum insured of a property i.e. what proportion of the sum insured was claimed. The claims and policy data were analysed to determine trends in vulnerability due to various building attributes and relationships between damage and wind speed. In order to make inferences about damage from claims information, five damage levels were established. **Each damage level corresponds to range of loss ratios (claim value/sum insured).** The five loss ratio bins are as described in Table 2.

Table 2. Loss ratio bins for claims analysis with description and typical damage modes (note: typical damages for higher loss ratio bins also include all damages from lower ratio bins)

Loss Ratio Bin	Damage Type	Typical Damage
0	No claim filed	N/A
0 – 0.09	Minor damage	Minor roofing issues and water ingress, minor tree damage, fencing, shade sails, whirly birds, etc.
0.1 – 0.49	Moderate damage	Roofing and water ingress, ceiling damage, broken windows, wall cladding, etc.
0.5 – 0.99	Severe damage	Major roofing failures, water ingress damages, and broken windows, etc.
> 1.0	Severe+ damage/underinsured	Major roofing failures, water ingress damage, etc.

The five loss ratio bins were selected based on a general estimation of the type of damage expected for a given range of claim values. For example, the "No damage filed" bin refers to the number of policies that did not file a claim following Cyclone Yasi and hence are assumed to have avoided damage. The "Minor damage: 0-0.09" bin refers to claims with a very small loss ratio (< 10%), which generally seem to be associated with ancillary damages i.e. shade sails, fencing, whirly birds, etc. The "Moderate damage: 0.1-0.49" bin refers to claims with larger loss ratios associated with major damages typically to roofing, interior, wall cladding, etc. The "Severe damage: 0.5-0.99" bin refers to claims with very large loss ratios associated with severe damages typically to including major roofing failures, water ingress damage to building contents, etc. The "Severe+ damage/underinsured: > 1.0" bin refers to claims with loss ratios greater than one (meaning the loss exceeds the policy limit) and generally associated with very severe damages typically including major roofing failures, water ingress damage to building contents, the need to relocate occupants etc. and can also be indicative of underinsured policies.

3.1.1. Loss Ratios – Northern Queensland Coastal Region

Figure 1 shows the spatial distribution of properties falling within the four non-zero loss ratio bins (i.e. policies with claims) for the Northern Queensland Coastal Region. Figure 2 shows the estimated track for Cyclone Yasi and Figure 3 shows the estimated wind field near the point of landfall. As expected, loss ratios increase directly with wind speed. The frequency of large loss ratios (i.e. large claims) was greatest, in locations nearest the point of landfall (i.e. Cardwell, Mission Beach, etc.) where wind speed estimates were 210-240 km/h. However, claims were filed across the entire North Queensland region, even in areas of significantly lower wind speed (i.e. ~135 km/h in Townsville, ~90 km/h in Cairns).

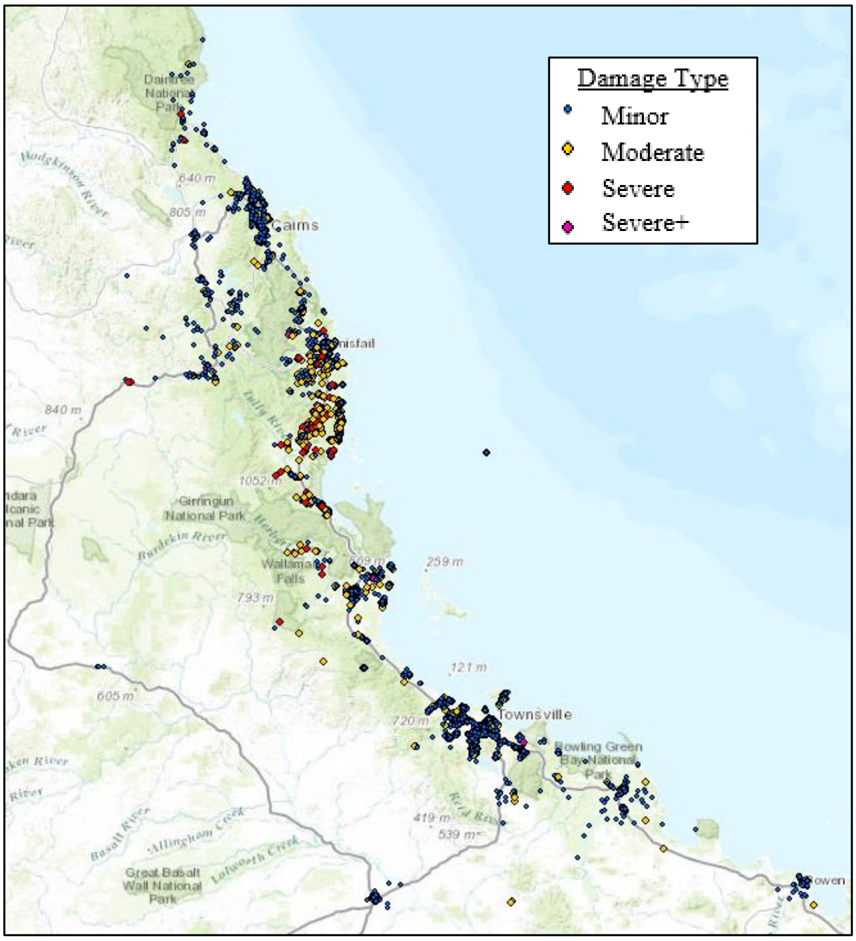


Figure 1. Northern Queensland Coastal Region impacted by Cyclone Yasi and selected for analysis including the distribution of damage types

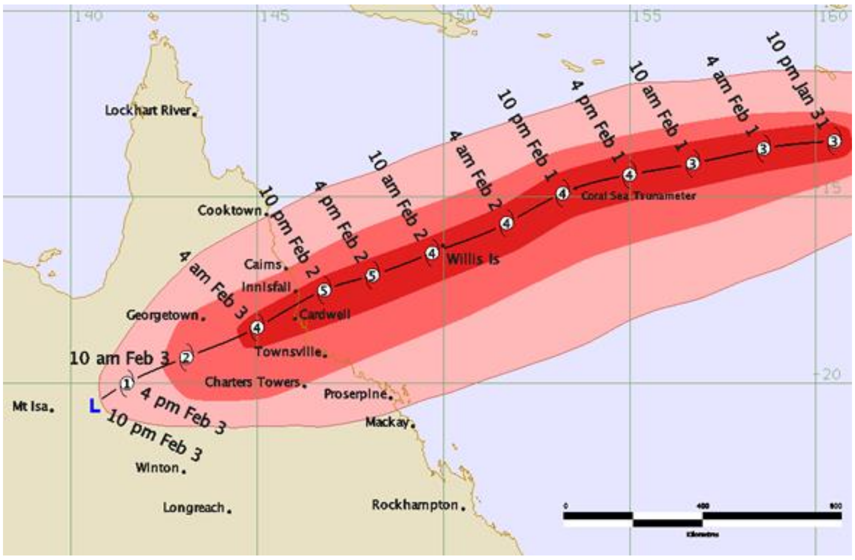


Figure 2. Cyclone Yasi track map before and after landfall (source: Bureau of Meteorology)

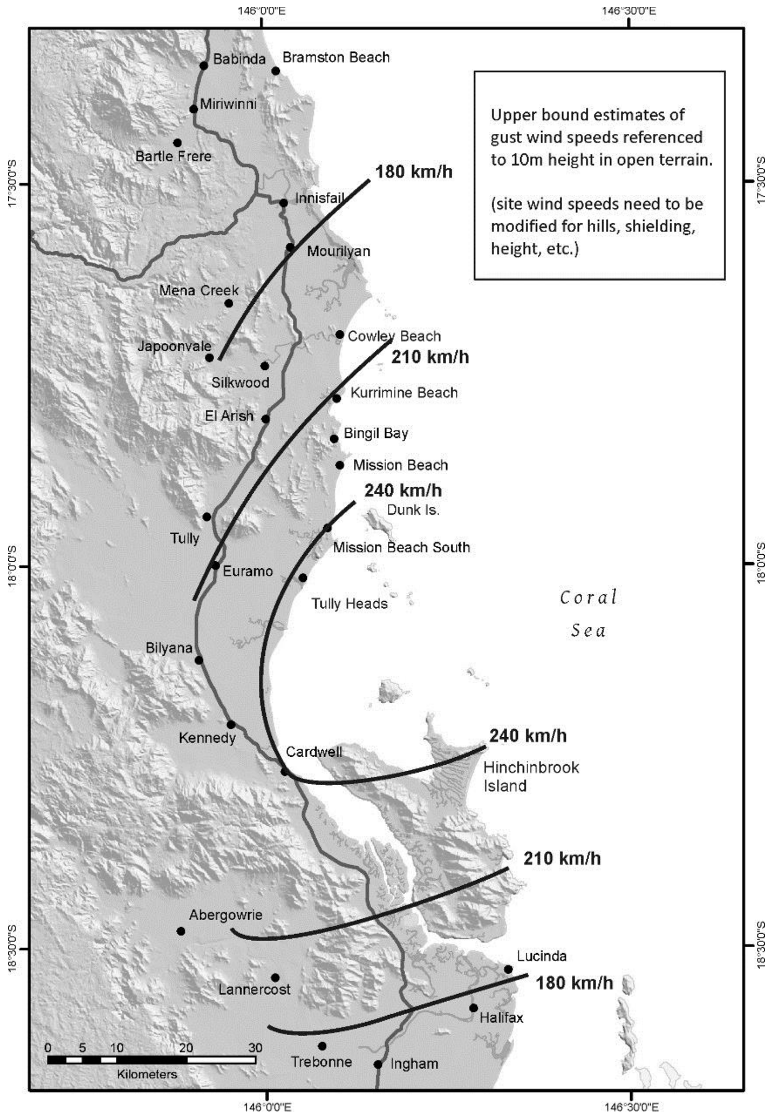


Figure 3. Cyclone Testing Station wind field estimation for Cyclone Yasi

The claims filed in the North Queensland Coastal Region were separated into four bins based on loss ratio. Figure 4 shows the proportion and number of claims allocated to each bin.

Table 3 displays the percentage of claims for each damage level by analysis region while Table 4 shows the costing statistics for each damage intensity type.

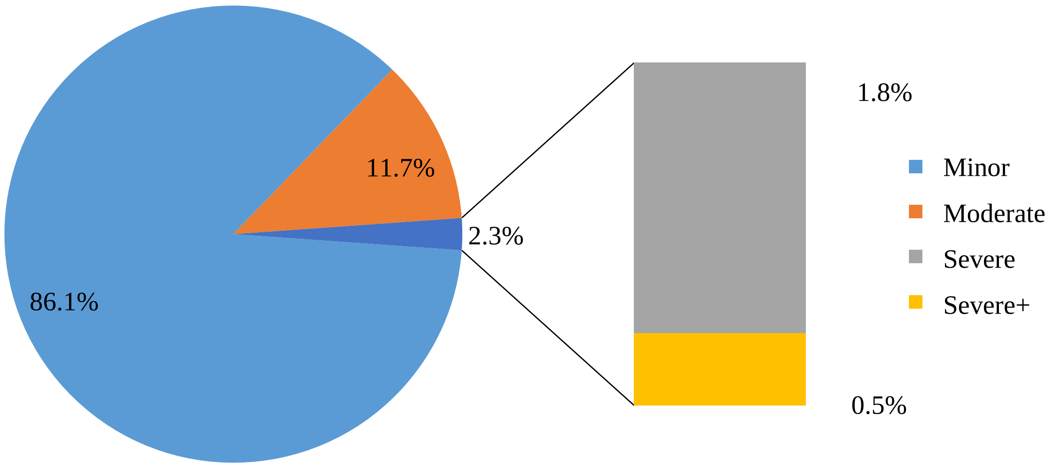


Figure 4. Proportions of damage types for the North Queensland Coastal Region

Table 3. Percentage of claims for each damage level by analysis region

Damage Type	**% of Claims by Analysis Region**		
	N. QLD	*Townsville*	*Tully/Mission Beach*
Minor	86.1%	94.2%	55.2%
Moderate	11.7%	5.4%	35.4%
Severe	1.8%	0.4%	7.5%
Severe or underinsured	0.5%	0.1%	1.9%

Table 4. Costing statistics for the four damage levels selected to describe claims in the North Queensland Coastal Region

Damage Type	**Avg. Loss Ratio**	**Avg. Sum Ins.**	**Max Cost**	**Avg. Cost**	**Median Cost**	**Sum Cost**	**% Total Cost**	**% of Claims**
Minor	0.02	$330,579	$236,727	$5,976	$3,365	$73,470,201	29%	86%
Moderate	0.22	$303,496	$533,466	$66,309	$54,504	$110,404,702	44%	12%
Severe	0.70	$275,176	$710,084	$188,297	$165,482	$48,015,736	19%	2%
Severe+	1.20	$241,429	$1,968,469	$290,492	$254,633	$19,753,513	8%	<1%
Total	**0.06**	$326,008	$1,968,469	$17,619	-	$251,644,154	**100%**	**100%**

Minor Damages (claim/sum insured = 0-9%)

Approximately 86% of claims were between 0 and 9% of the policy sum insured value. Review of the detailed claims information (Data Set C) suggests that claims in this range were most often associated with minor damages (i.e. fence damage, awnings, gutters, water ingress, shade sails, whirly birds, etc.) rather than significant structural damages. Claims in this loss ratio bin represent 29% ($73,470,201) of the total claims payout cost ($251,644,154) for Cyclone Yasi in the North Queensland Coastal Region. The average and median costs of claims in this bin were $5,976 and $3,365 respectively. Claims of this size were filed across the entire North Queensland Coastal Region. However, **due to a relatively large population size, claim trends in the Townsville Region generally tend to dominate aggregate claims trends for the entire North Queensland Coastal Region.**

The contribution of small claims to overall losses was significant (29%). The CTS suggests that community education/awareness campaigns may be the most effective method of reducing the frequency of claims of this size. Such campaigns should emphasise the importance of cyclone preparation activities in the short-term like; removing shade sails, pruning trees, removing debris and unsecured items from the yard, etc. The campaigns should also focus on implementing a home maintenance routine in the long-term, e.g. repairing corroded metal supports, monitoring roof cladding tie-downs and water-tightness, replacing degraded timber, etc.

Moderate Damages (claim/sum insured = 10-50%)

Approximately 12% of claims in the North Queensland Coastal Region were between 10 and 50% of the policy sum insured value. These claims were generally associated with more extensive damage to roofing systems and water ingress related issues in addition to the typical damage modes described for claims in the 0-10% loss ratio bin. Claims in this loss ratio bin represent 44% ($110,404,702) of the total claims payout cost ($251,644,154) for Cyclone Yasi in the North Queensland Coastal Region. The average and median costs of claims in this bin were $66,309 and $54,504 respectively. Of the 12% of claims in this ratio bin, the majority were filed in the Tully/Mission Beach Region but many also were filed in the Townsville Region. A majority proportion of this claim size in the Tully/Mission Beach Region was expected considering wind speeds in this region (~240 km/h) did approach the design wind speed of 250 km/h. However, the proportion of moderate sized claims in the Townville Region was counterintuitive considering wind speed estimates in this region (~135 km/h) were significantly lower than design level (250 km/h). Claims in the Townsville Region are discussed in further detail in Section 0.

Moderate damages in this claim ratio bin represent the largest proportion of claim related losses (44% = $110,404,702) for the Northern Queensland Coastal Region and therefore present the strongest case for mitigation. Roofing and water ingress related issues are typical for claims of this size (see Section 0). To reduce losses (i.e. claim frequency) from moderate claims, the CTS recommends a mitigation program that emphasizes structural roofing upgrades to older homes (pre-1980s) and opening protection upgrades (i.e. shutters for windows, roller door bracing, etc.) for homes of all ages.

Severe Damages (claim/sum insured = 50-100%)

Approximately 2% of claims in the North Queensland Coastal Region were between 50 and 100% of the policy sum insured value. These claims were associated with severe damage to roofing systems, broken windows, and extensive water ingress related issues in addition to damage modes for smaller claims. Claims in this loss ratio bin represent 19% ($48,015,736) of the total claims payout cost ($251,644,154) for Cyclone Yasi in the North Queensland Coastal Region, despite only representing 2% of the total number of claims. The average and median costs of claims in this bin were $188,297 and $165,482 respectively. Of the 2% of claims in this ratio bin, the majority were filed in the Tully/Mission Beach Region.

Severe Damage/underinsured (claim/sum insured = >100%)
Less than 0.5% of claims in the North Queensland Coastal Region were greater than 100% of the policy sum insured value. These claims were associated with severe damages as defined by the 50-100% loss ratio bin (i.e. roofing systems, broken windows, and extensive water ingress related issues in addition to damage modes for smaller claims). Claims in this loss ratio bin represent 8% ($19,753,513) of the total claims payout cost ($251,644,154) for Cyclone Yasi in the North Queensland Coastal Region. The average and median costs of claims in this bin were $290,492 and $254,633 respectively. Of the 0.5% of claims in this ratio bin, the majority were filed in the Tully/Mission Beach Region and the majority of the rest were filed in the Townsville Region. It is understood that certain policies offered by Suncorp Group offer a "safety-net" coverage option that allows for payout above the sum insured value of a home. This may have impacted the number of claims with loss ratios greater than one.

Severe damage claims (including underinsured bin) represent at total of 27% ($67,769,249) of the claim-related losses for the Northern Queensland Coastal Region. Typical damage modes for claims of this size generally more extreme version than those described for the moderate damage bin (i.e. roofing, water ingress, broken windows, etc.). A mitigation program focused on structural roofing and opening protection upgrades (as suggested above) also has potential to dramatically reduce the frequency of severe damage claims.

3.1.2. Loss Ratios - Townsville
In general, loss ratio trends for the Townsville Region are similar to those for the North Queensland Coastal Region (Section 3.1.1) due to the number of policies in Townsville relative to the other affected areas (see Table 1).

Figure 5 shows the distribution of loss ratio by bin for the Townsville Region. Minor claims (loss ratio of 0-0.9) are dominant and occur uniformly throughout the region. The occurrence of minor claims appears to be independent of housing age and proximity to the coast. However, moderate and severe loss ratio claims (0.1-0.49 and 0.5-0.99) are more prevalent moving toward the coast where older housing is also prevalent.

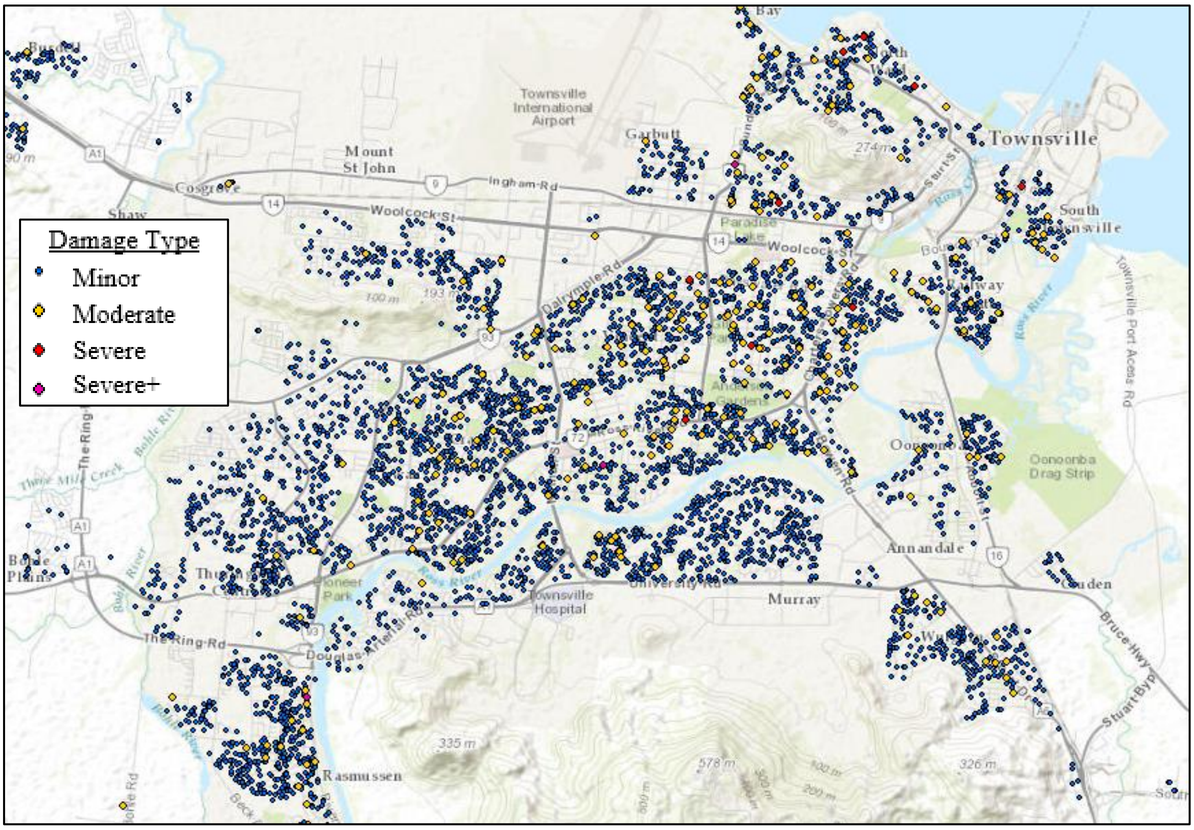


Figure 5. Locations and severity of damage across Townsville Region

Table 5 shows the relative contributions of claims in each loss ratio bin as a proportion of the total number of claims filed in the Townsville Region. As suggested by Table 5, the overwhelming majority of claims (~94%) were between 0 and 0.09 of the sum insured value. These minor claims (e.g., fencing, shade sails, creased garage doors, etc.) accounted for $38,169,597 (60%) of the total claims related cost ($63,575,021) of Cyclone Yasi for the Townsville Region. The CTS recommends a community education approach to mitigating.

Table 5. Costing statistics for the four damage levels selected to describe claims in the Townsville Region

Damage Type	Avg. Loss Ratio	Avg. Sum Ins.	Min Cost	Max Cost	Avg. Cost	Sum Cost	% Total Cost	% Claims
Minor	0.02	$338,323	-	$236,727	$5,571	$38,169,597	60%	94%
Moderate	0.19	$278,766	$2,004	$259,731	$52,163	$20,343,691	32%	5%
Severe	0.70	$215,327	$68,027	$246,653	$148,077	$3,998,082	6%	<0.5%
Severe+	1.14	$189,420	$146,300	$320,010	$212,730	$1,063,650	2%	<0.1%
Total		$334,571	-	$320,010	$8,741	$63,575,021	**100 %**	**100%**

For moderate claim loss ratios (0.1-0.49) in the Townsville Region, only 5% of claims were filed with an average value of $52,000. (That is, **5% of the Townsville regions claims accounted for 30% of the total claims cost**) These claims are generally associated with moderate structural damage to the roofing structure (typical roofing replacement costs $20-40k), water ingress damages, etc. and have occurred in an area where wind speed estimates were 135 km/h despite the design wind speed for the region being 240 km/h. **This finding**

provides an evidence base to support the need for improved building standards for both upgrading of older housing and maintenance and certification for newer construction.

3.1.3. Loss Ratios – Tully/Mission Beach

The Tully/Mission Beach Region was the most severely impacted area during Cyclone Yasi (i.e. most intense wind, rain, and storm tide). Figure 6 shows the distribution of loss ratio by bin for the Tully/Mission Beach Region. Table 6 shows the costing statistics for the four damage levels in the Tully/Mission Beach Region. Minor claims (loss ratio of 0-0.09), while still frequent, were not as dominant as for the Townsville Region. **While the number of policies in the Tully/Mission Beach Region are nearly a tenth of those in the Townsville Region**, **the total claims cost for the Tully/Mission Beach Region was more than twice that of the Townsville Region** ($140,511,665 vs $63,575,021)**. This is due to the increased proportion of moderate and severe loss ratio claims (0.1-0.49 and 0.5-0.99) which generally include structural damage.** Claim-related losses would have been significantly higher (potentially by factor of 5-10) if the most severe winds of Cyclone Yasi had been in the Townsville Region**.**

A large portion of claims (~55%) were between 0 and 0.09 of the sum insured value. **Despite the high frequency, minor claims (e.g., fencing, shade sails, minor water ingress, etc.) only accounted for 11% ($15,281,323) of the total claims related cost ($140,511,665) of Cyclone Yasi for the Tully/Mission Beach Region.** A proportion of this loss is due to storm tide affecting some properties in this high impact area. Damage from the storm tide ranged from; some water through the carport to major structural damage. Attempts were made to separate the major storm tide damage from the data set.

The largest contribution to losses (51%) came from claims with moderate loss ratios (0.1-0.49), with an average value of $75,104. These claims were generally associated with structural damage to the roof (roofing replacement = $20-40k), water ingress damages, etc. in addition to the typical damages seen in minor claims. These claims are frequent throughout the Tully/Mission Beach Region despite the fact that wind speed estimates (see Figure 3) only approached design level (240 km/h) along the coast line (e.g., Tully Heads, Mission Beach, Cardwell) and gradually tapered to 180 km/h near Innisfail.

Severe claims (0.5-1 and >1) in the Tully/Mission Beach Region, including the underinsured bin, comprise 38% of the total cost for this region despite only accounting for 9% of the total number of claims. In other words, major failures to even a relatively small number of houses can be a dominant driver of loss. This suggests that preventing even a small portion of major structural failures through structural retrofit mitigation could be very effective in reducing losses. The type of mitigation would also reduce losses from claims with moderate loss ratios, which comprise 51% of the total cost.

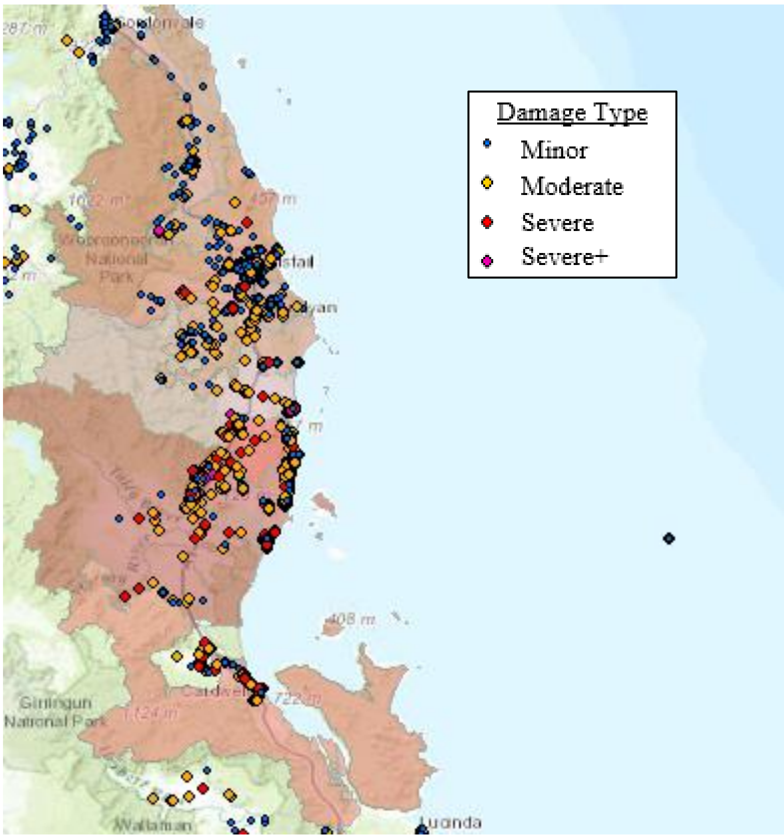


Figure 6. Locations and severity damage across the Tully/Mission Beach Region

Table 6. Costing statistics for the four damage levels selected to describe claims in the Tully/Mission Beach Region

	Avg. Ratio	Avg. Sum Ins.	Min Claim	Max Claim	Avg. Claim	Sum of Claims	% Total Cost	Count %
Minor	0.03	$317,007	-	$156,968	$10,249	$15,281,323	11%	55%
Moderate	0.24	$318,607	$3,385	$533,466	$75,104	$71,724,442	51%	35%
Severe	0.69	$283,972	$16,371	$710,084	$192,721	$38,929,654	28%	7%
Severe+	1.20	$238,675	$43,320	$1,968,469	$285,808	$14,576,245	10%	2%
Total						$140,511,665	100%	100%

3.2. Damage vs Building Age

3.2.1. Damage vs Building Age – Northern Queensland Coastal Region

Age of construction is often used as an indicator of general construction trends and therefore is often used for estimating the relative vulnerability of homes built in different eras. Figure 7 shows the correlation between claim ratio and age of construction for homes in the North Queensland Coastal Region after Cyclone Yasi. The proportion that each loss ratio bin (see Section 3.1.1 for description) contributed to the total number of claims for a specified construction age range is shown (i.e. each percentage represents the numbers of claims in that loss ratio bin divided by the total number of claims for the age grouping). The five construction time periods were selected based on the progression of typical housing characteristics in Queensland as described in Section 6.4.

The plot shows that the majority of homes for all ages did not file a claim after Cyclone Yasi. The implication is that the total claim-related loss in this region ($251,644,154) was the result of claims from just ~25-30% of the housing stock. **The data suggests the likelihood of a claim being filed is higher for housing constructed between 1925 and 1981. In addition, claims filed for housing in this range are more likely to be of a higher severity than housing constructed after 1981.**

Figure 7 shows clearly that minor claims are prevalent for housing of all ages (i.e. minor claims are independent of housing age). Figure 8 shows a closer view of the higher intensity damage types and Figure 9 and Figure 10 provide similar plots for comparison of pre- and post-1980s (modern code era) housing. While the frequency of moderately sized claims (2.4%) for modern housing was lower than housing constructed between 1925 and 1981, these claims are often associated with structural damages which should not occur for housing built to modern standards. **Considering this, future work should investigate drivers of loss for modern housing (e.g., insufficient opening protection, etc.) so that retrofit solutions can be developed for existing housing and code-improvement solutions can be developed for future housing.**

Housing built prior to 1925 exhibits similar vulnerability to modern housing, however it should be noted that there are relatively few houses of this age in the North Queensland Coastal Region portfolio. Materials in these houses may be less prone to water damages due to the construction materials of the time period (e.g., water goes through timber floors, fibro/timber ceilings are water-resistant, etc.). Also many of these older houses are more likely to be upgraded structurally or renovated because of increased market value, historic value, etc. **The insured's policy recorded 'age of construction' is based on the original house and does not take into account appropriate structural retrofitting or upgrading that may have occurred to houses built prior to the 80s.** There may be some percentage of skew in the age comparison data due to some older housing having appropriate structural retrofitting undertaken as well as some modern housing suffering significant damage due to having construction or design issues.

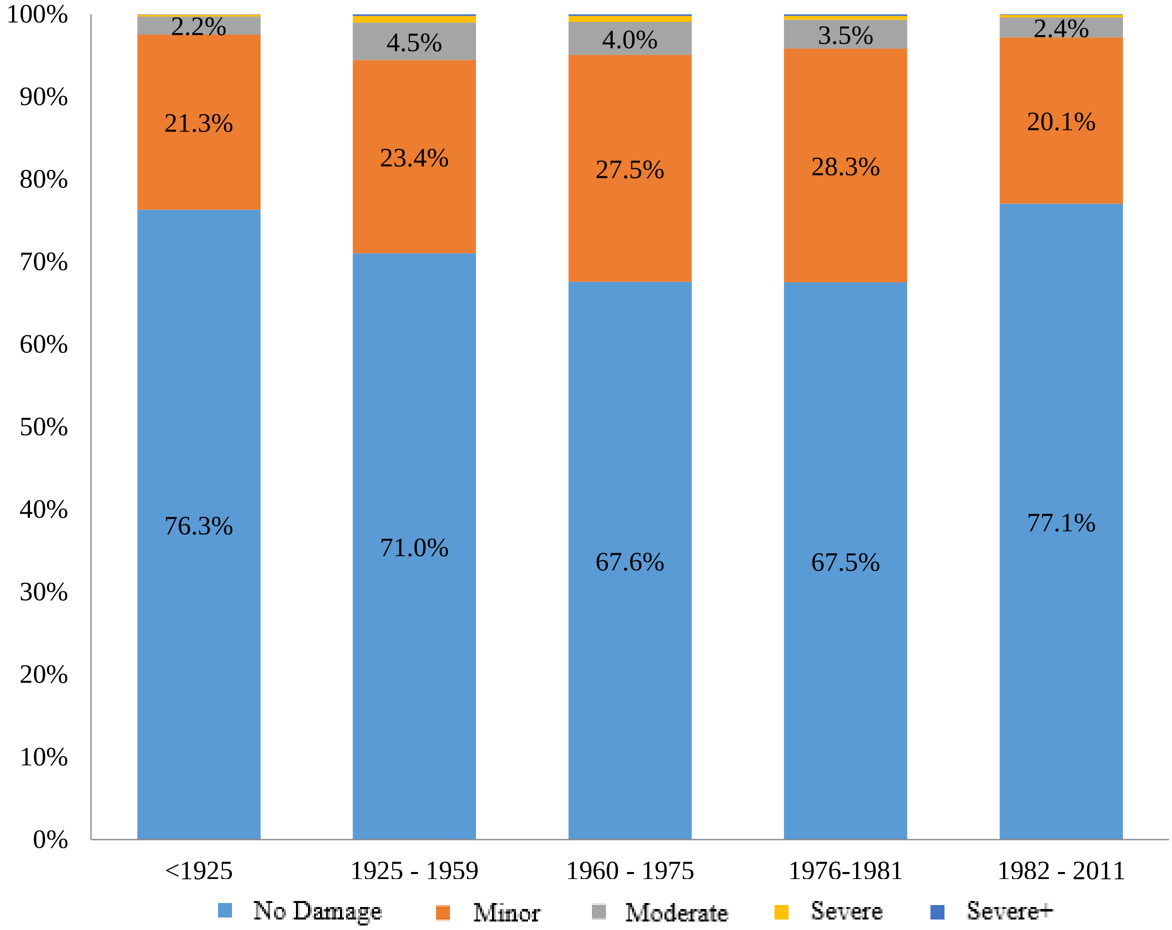


Figure 7. Building age vs damage type contributions to the total number of claims filed in relation to Cyclone Yasi for the North Queensland Coastal Region (note: "Severe" and "Severe+" bin proportions are less than 1% each and text omitted from this figure for clarity)

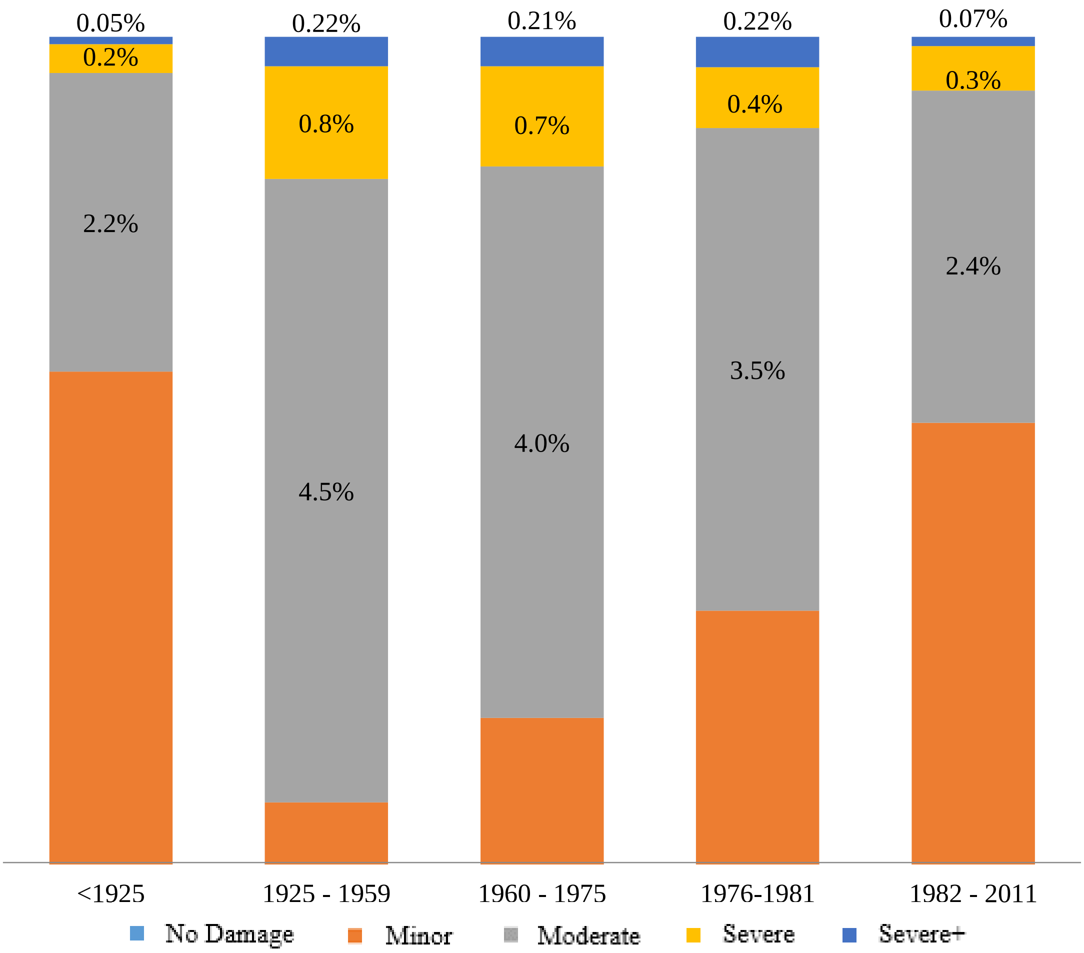


Figure 8. Building age vs damage type contributions to the total number of claims filed in relation to Cyclone Yasi for the North Queensland Coastal Region (Note: This figure is a magnified view of higher intensity damage types in Figure 7 per Suncorp request)

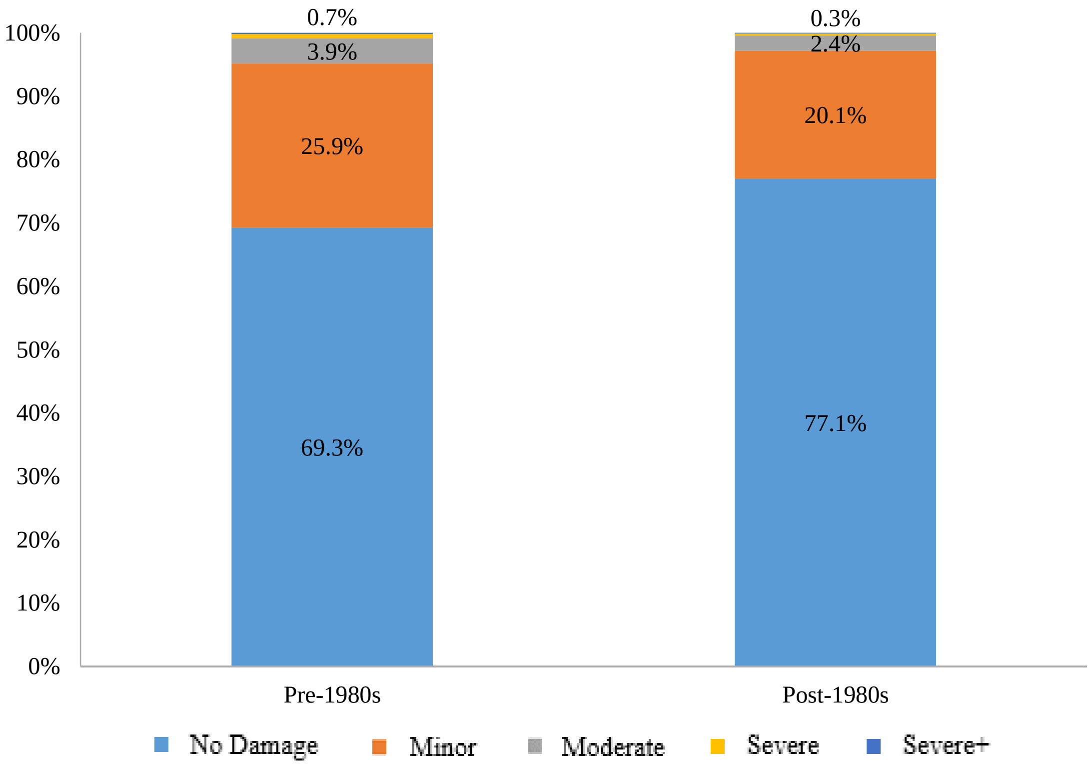


Figure 9. Building age vs damage type contributions (pre- and post-1980s) to the total number of claims filed in relation to Cyclone Yasi for the North Queensland Coastal Region (note: “Severe+” bin proportions are less than 1% each and omitted from this figure for clarity)

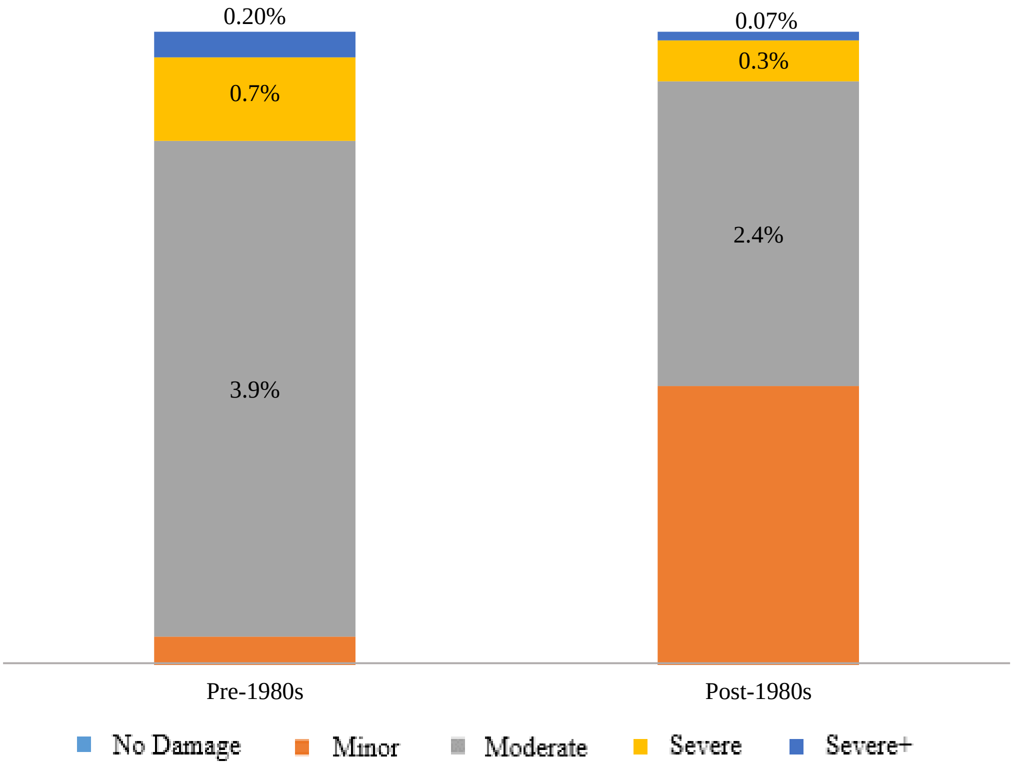


Figure 10. Building age vs damage type contributions (pre- and post-1980s) to the total number of claims filed in relation to Cyclone Yasi for the North Queensland Coastal Region (Note: This figure is a magnified view of higher intensity damage types in Figure 9 per Suncorp request)

3.2.2. Damage vs Building Age - Townsville

Figure 11 shows the relationship between claim ratio and age of construction for homes in the Townsville Region. Figure 12 is shows a closer view of the higher intensity damage types and Figure 13 and Figure 14 provide similar plots for comparison of pre- and post-1980s (modern code era) housing. Each percentage represents the number of claims in that loss ratio bin divided by the total number of claims for the age grouping. The five construction time periods were selected based on the progression of typical housing characteristics in Queensland as described in Section 6.4.

The loss ratio trends for the Townsville Region are similar to those for the North Queensland Coastal region. Key findings include:

1. The proportion of policy holders that did not file a claim (e.g., 70.8%, 65.9%, 64.7%, etc.) were lower for the Townsville Region than for the North Queensland Coastal Region (see Figure 7) for all ages of housing. In other words, the likelihood that a claim was filed in the Townsville Region was higher than for the entire Cyclone Yasi affected area, despite the relatively low wind speeds that were generated in the area.

2. The Townsville Region data is similar to the overall North Queensland Coastal Region data set that housing constructed between 1925 and 1981 does not perform as well as housing constructed either before or after this time period. Examples of roof loss and other significant damage were observed in Townsville during CTS damage survey.

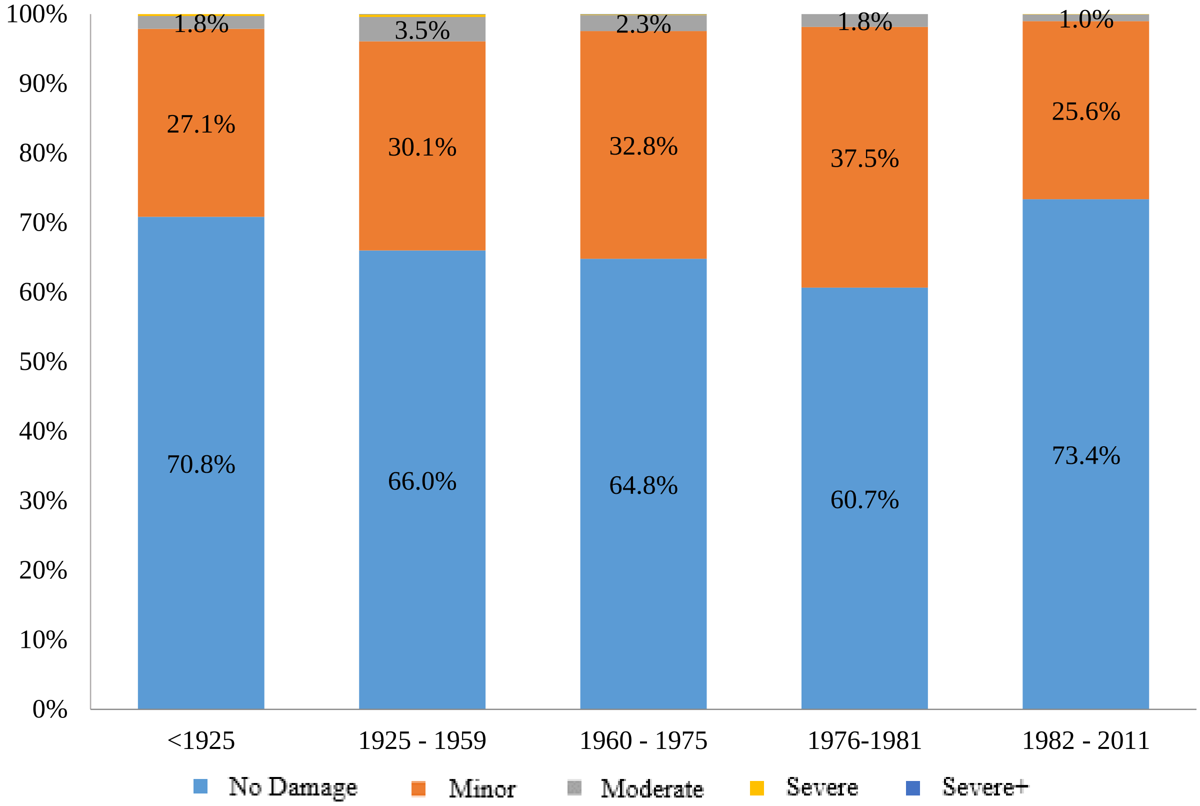


Figure 11. Building age vs damage type contributions to the total number of claims filed in relation to Cyclone Yasi for the Townsville Region (note: “Severe” and “Severe+” bin proportions are less than 1% each and omitted from this figure for clarity)

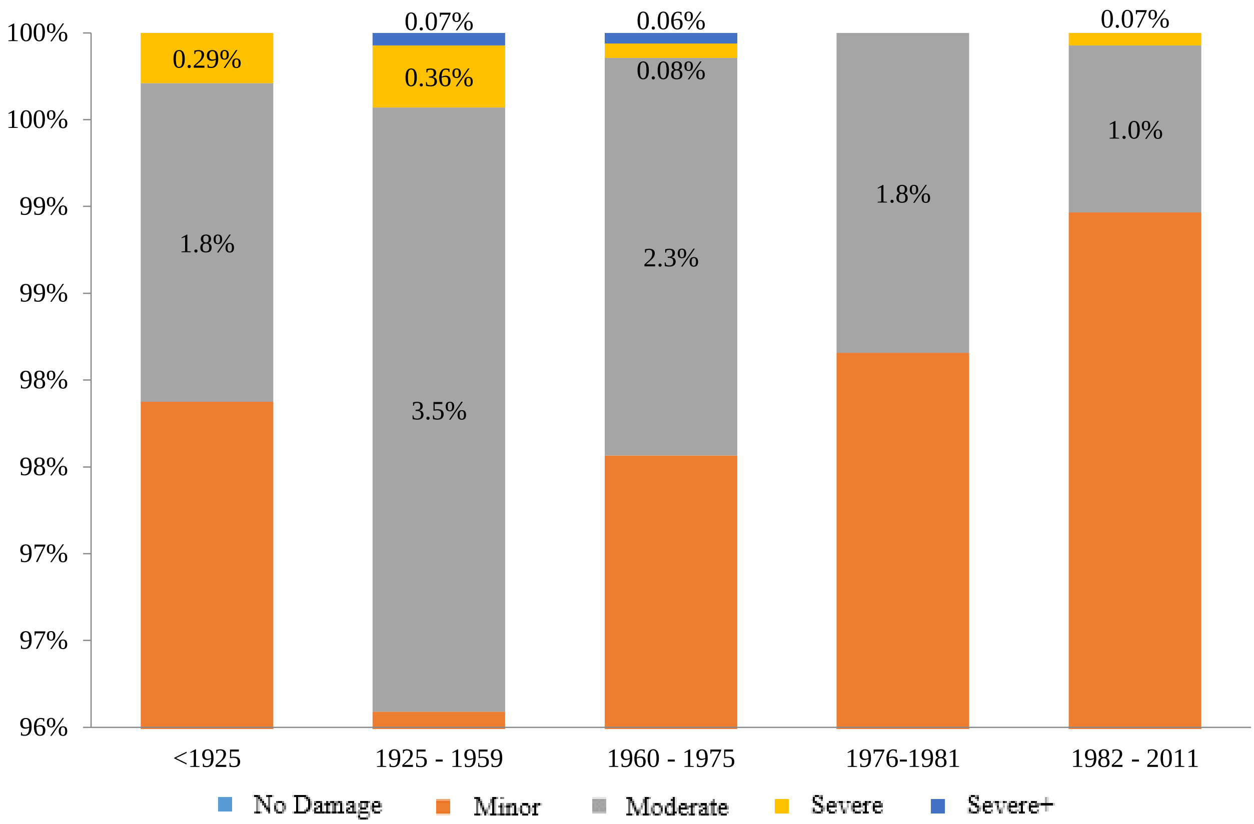


Figure 12. Building age vs damage type contributions to the total number of claims filed in relation to Cyclone Yasi for the Townsville Region (Note 2: This figure is a magnified view of higher intensity damage types in Figure 11 per Suncorp request)

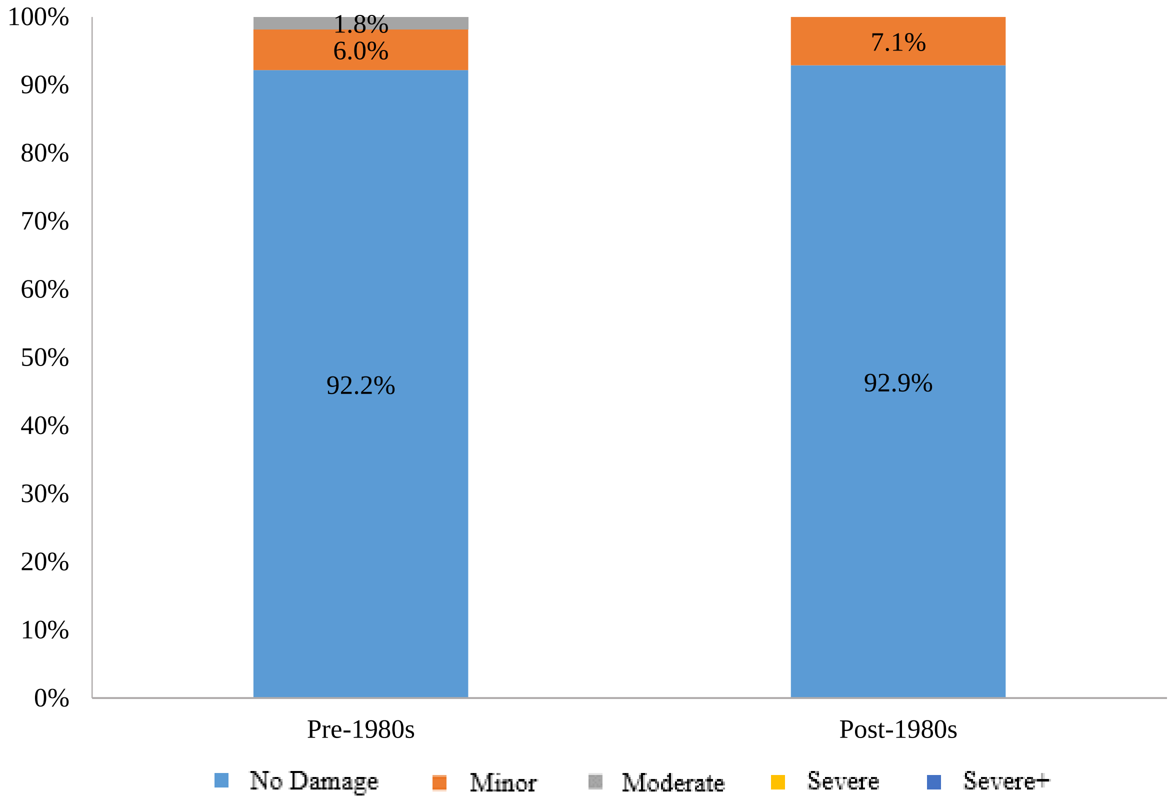


Figure 13. Building age vs damage type contributions (pre- and post-1980s) to the total number of claims filed in relation to Cyclone Yasi for the Townsville Region (note: “Severe” and “Severe+” bin proportions are less than 1% each and omitted from this figure for clarity)

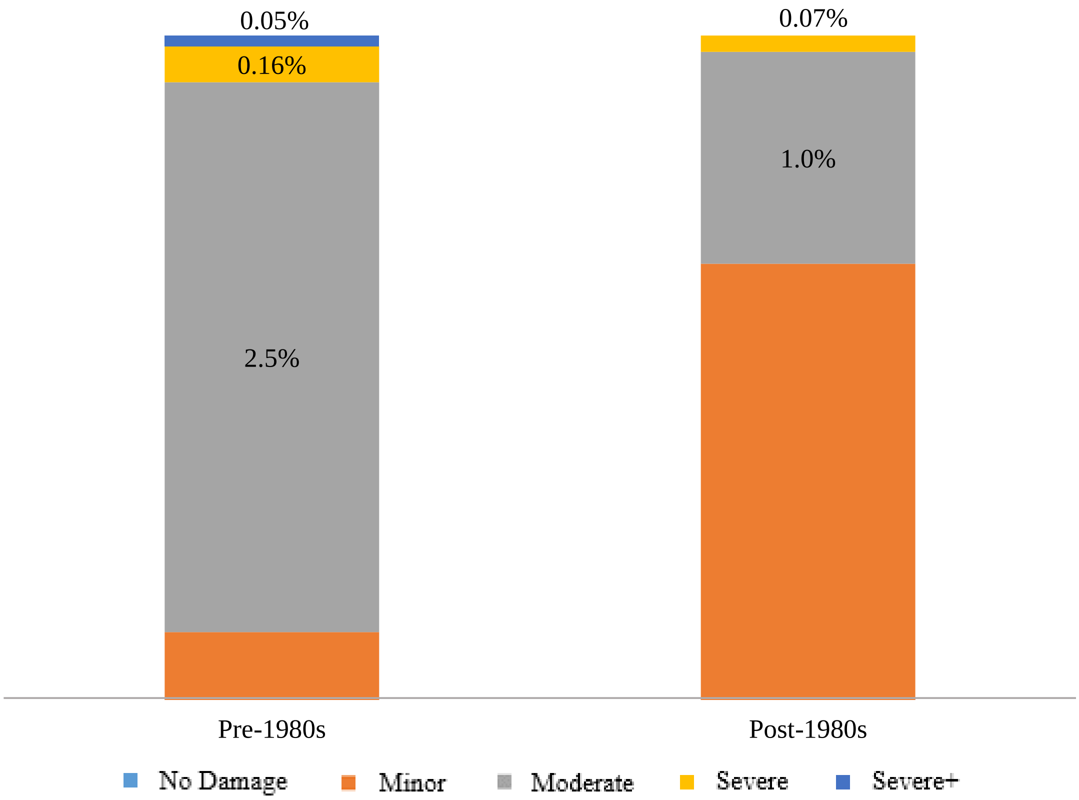


Figure 14. Building age vs damage type contributions (pre- and post-1980s) to the total number of claims filed in relation to Cyclone Yasi for the Townsville Region (Note 2: This figure is a magnified view of higher intensity damage types in Figure 13 per Suncorp request)

3.2.3. Damage vs Building Age – Tully/Mission Beach

Figure 15 shows the relationship between claim loss ratio and age of construction for homes in the Tully/Mission Beach Region. Each percentage represents the number of claims in that loss ratio bin divided by the total number of claims for the age grouping. The five construction time periods were selected based on the progression of typical housing characteristics in Queensland as described in Section 6.4.

The likelihood of a policy not filing a claim in this region was much lower than for the Townsville Region, i.e. 56%, 41%, 32%, etc. for Tully/Mission Beach versus 71%, 66%, 65%, etc. for Townsville (see Figure 11). Higher claim frequencies were expected due to the more extreme wind conditions in this area. However, trends in claim frequency for individual construction age groups are also different than those for the low wind speed Townsville Region.

The data support the previously stated finding that housing constructed between 1925 and 1981 is at a relatively higher risk of severe structural failure.

Figure 166 highlights typical examples of major structural failures of older housing (TC Yasi damage survey). In many cases this damage propagated. Following TC Yasi, the CTS estimated that approximately 20 to 40% of major elements from a damaged house went on to impact other houses downwind (Figure 17).

A significant proportion of contemporary housing also experienced severe loss ratio damages, which supports the previously stated finding that modern housing did not perform as expected per the National Construction Code (NCC). The data demonstrate the need for change and can help to facilitate change within building standards and education of designers, builders and homeowners. Some changes to modern housing design criteria and components have been made since TC Yasi. For example, hip and ridge roof tiles now need to be appropriately fixed to roof structure, garage doors now need to be cyclonic wind load rated in accordance with latest Standard, and soffits have specific wind load requirements, to name a few.

Typical damage patterns are discussed in Section 4. **Wind-driven rain (water ingress) is a major driver of loss for housing of all ages (including contemporary construction)**. This is supported by CTS damage surveys where approximately 80% of surveyed housing had water damage.

In addition to severe claims, a significant proportion of minor claims were filed across all ages of housing. This, in light of findings from the Townsville Region, suggests minor claims are equally likely to be filed by housing of all ages in both high-wind and low-wind areas of a cyclone.

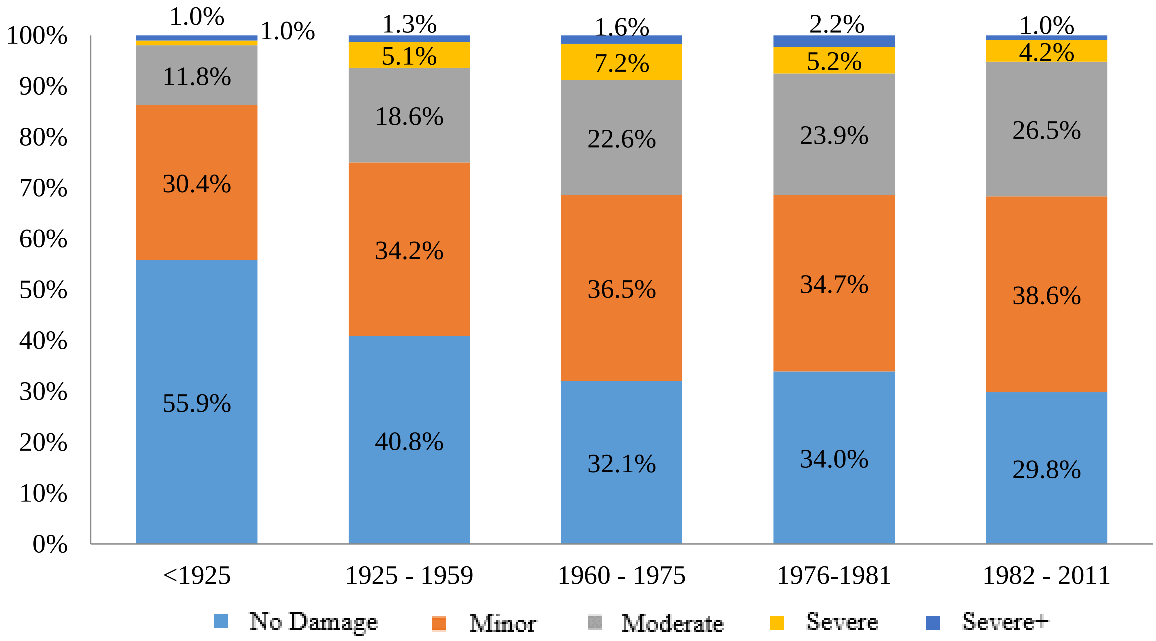


Figure 15. Building age vs loss ratio bin (see legend) contributions to the total number of claims filed in relation to Cyclone Yasi for the Tully/Mission Beach Region (note: "Severe" and "Severe+" bin proportions are less than 1% each and omitted from this figure for clarity)

Figure 16. Examples of roofing failures from post-1980s housing following Cyclone Larry

Figure 17. Wind-driven debris damage from structural failure of neighboring housing

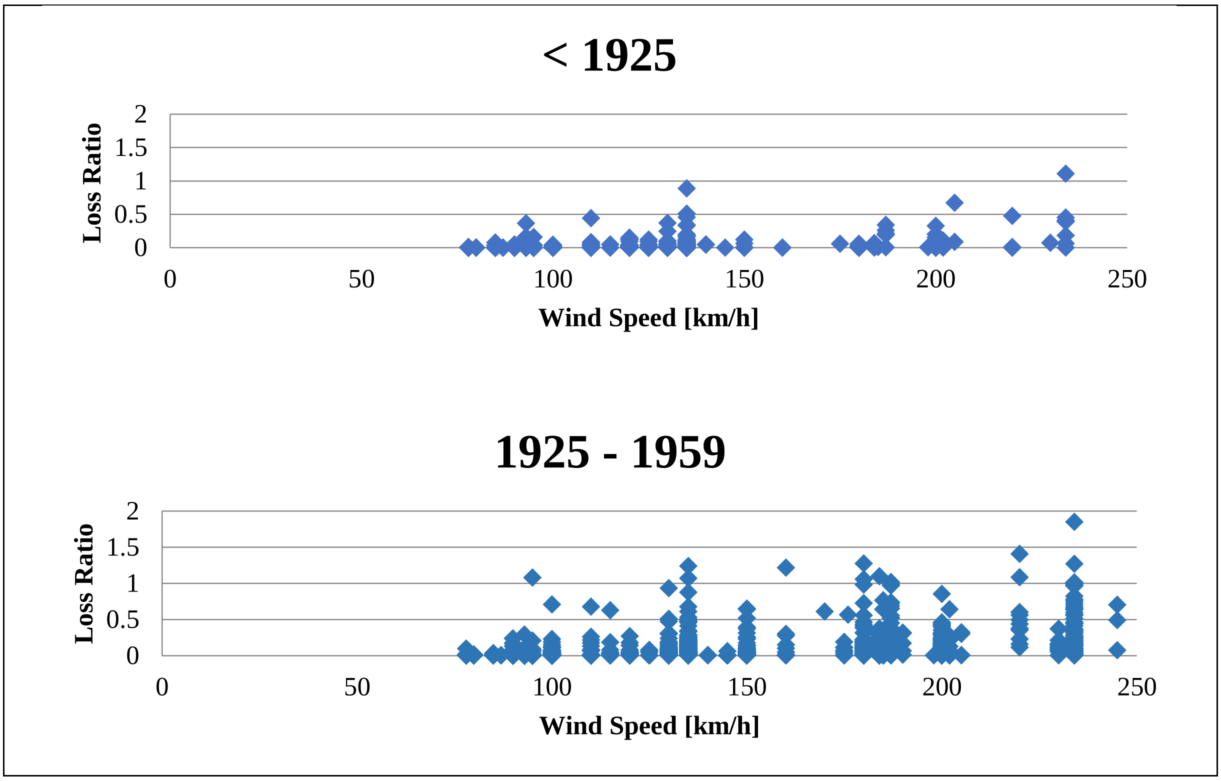
3.3. Damage vs Wind Speed

To analyse correlation between loss ratio and wind speed, these two parameters were plotted for each of five housing age groups in Figure 18. For these relationships, data is filtered to include only housing structures. Due to the nature of the wind field in relation to highly populated areas (i.e. Townsville), a large number of data points are available for the wind speed 135 km/h. The age group ranges were selected based on the progression of typical housing characteristics as described in Section 6.4.

Minor damage claims (e.g., shade sails, fences, “whirly birds”, minor water ingress, etc.) are prevalent at all wind speeds and for all housing ages. These claims are, in general, not caused by structural-related issues and may be prevented by improved cyclone preparedness (e.g., remove shade sails, prune trees, install window protection, etc.).

Claim instances where loss ratio is high for relatively low wind speed (e.g., <50 km/h) are more common for homes built between 1925 and 1975. This suggests that homes built before 1925 or after the 1970s (i.e. modern building code era) are less likely to experience severe damage at relatively low wind speeds. This trend is expected for modern housing, which is engineered to a higher performance requirement than “pre-code” housing. Housing built prior to 1925 often included stronger structural members than newer construction (i.e. >1925), which may act to mitigate severe damages at low wind speeds for this age of housing.

Design wind speed in the North Queensland Coastal Region is 240 km/h. Engineering requirements for housing constructed after 1982 are designed to ensure structural stability, minimised local damage and loss of amenity, and avoid damage other properties. The high occurrence rate of large claims at wind speeds from 150-240 km/h for modern housing indicates that modern housing did not perform as predicted by the National Construction Code (NCC).



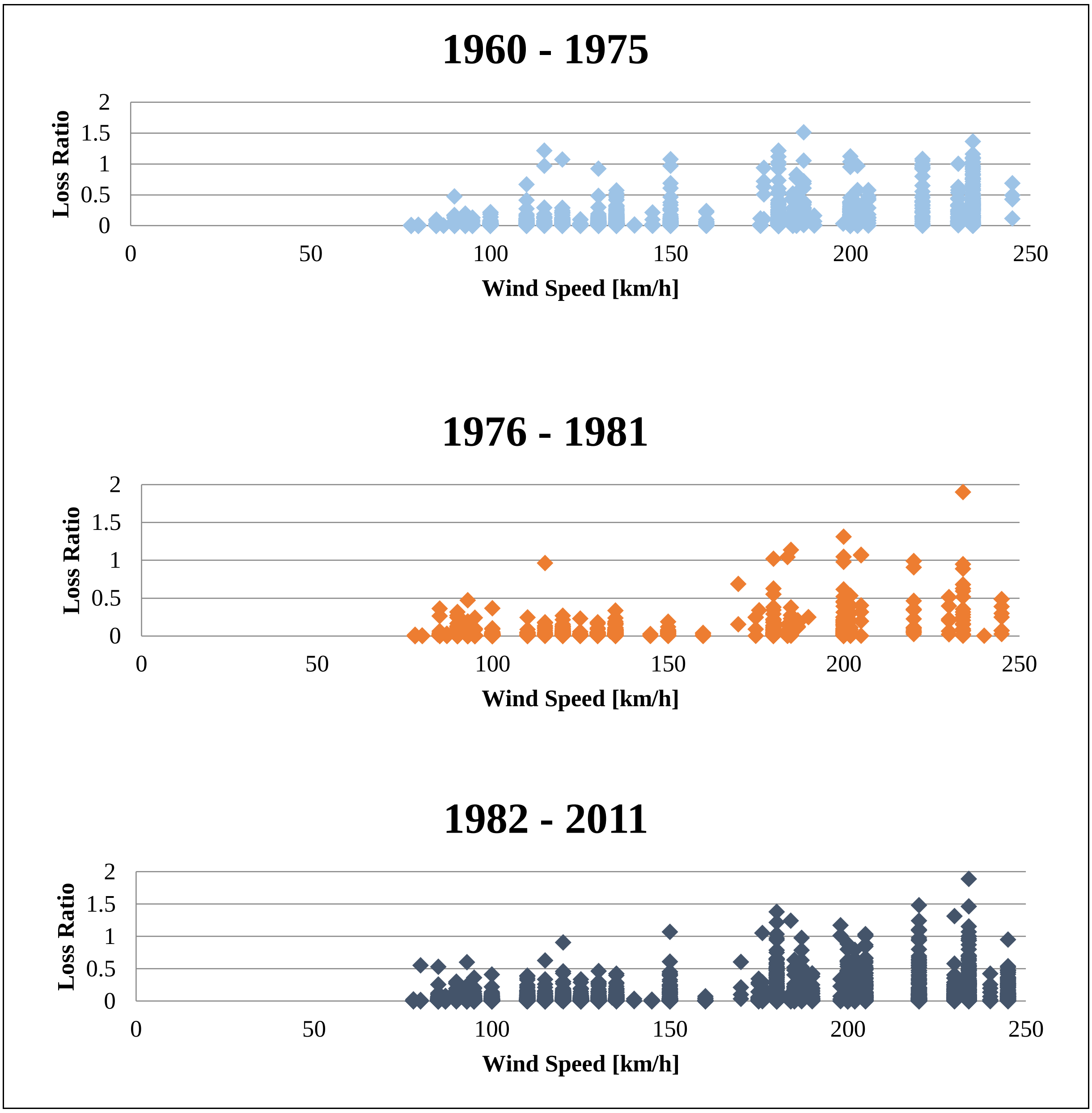


Figure 18. Loss ratio vs wind speed grouped by age for all claims in the North Queensland Coastal Region

3.4. Key Building Attributes

3.4.1. Roofing Type

Roofing type is potentially the most important building attribute in predicting vulnerability and potential modes of failure due to wind and water ingress. As discussed in the Section 4 assessor's reports analysis, **roof damage is very strongly correlated to wind and water ingress induced losses.** The mechanism by which wind and water interact with roof cladding is very different depending on the type of cladding material. Each roofing type has a unique set of vulnerability-related strengths and weaknesses. For example, sheet metal cladding comes in much larger sections than individual tile roofing elements, which changes the area on which wind-induced pressures act. In addition, sheet metal roofing is more continuous than tiled roofing (i.e. sheeting overlap regions have less profile than tile overlap regions), which affects modes of water ingress (and wind loading).

The largest proportion of roofing type in the Northern Queensland Coastal Region is "iron/steel" roofing which comprises ~68%.

The remaining proportion of roofing classifications includes "Tiles", "Aluminium", and a combination of others. Reconstruction costs of different roofing types can vary dramatically (e.g., asbestos (fibro) roofing is much more expensive than for other materials due to the hazardous nature of the material).

Figure 21 shows the proportion of roof loss damage (damage index 0 to 4+) as observed by CTS teams conducting street surveys in the Mission Beach, Tully, Cardwell areas following TC Yasi (Boughton et al 2011). Notwithstanding the low proportion of concrete tile roofs compared to metal sheet roofs, Figure 21 indicates a disproportionate level of damage of tile vs metal roofs. Roof damage does lead to interior damage via wind driven rain ingress.

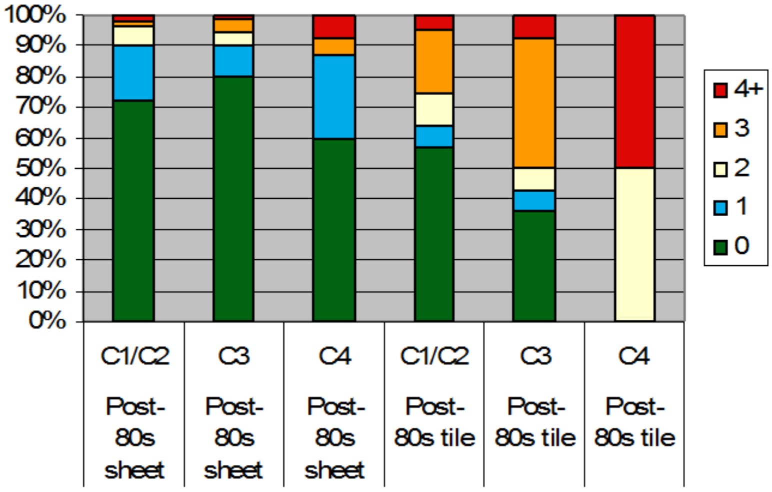


Figure 19. Roof damage index for post-1980s housing following TC Yasi determined from street survey data from the Cassowary Coast region (Boughton et al 2011)

3.4.2. Year of Construction

The age of construction for a home is used to estimate construction features when more detailed information is unavailable. This is generally done by reviewing the building standards that were in effect at the time of construction. Figure 22 details 43% of the policies are for homes built prior to the 80s, with 57% built subsequent to the mid-80s.

Tropical Cyclone Tracy resulted in extreme damage to housing in December 1974, especially in the Northern suburbs of Darwin (Walker, 1975). Changes to design and building standards of houses were implemented during the reconstruction. The Queensland Home Building Code (HBC) was introduced as legislation in 1982 with realization of the need to provide adequate strength in housing. By the mid-1980s it is reasonable to presume that houses in the cyclonic region of Queensland were being fully designed and built to its requirements. This information can be used to aid estimations of building performance at an aggregate level.

However, prior to the 1980s building standards in Australia were not as uniform as they are today. Building features were highly dependent on geographic location, availability of materials, and the construction practices within local regions. Through years of building science research, the CTS has estimated typical construction features for several broad time periods as discussed in Section 6.4.

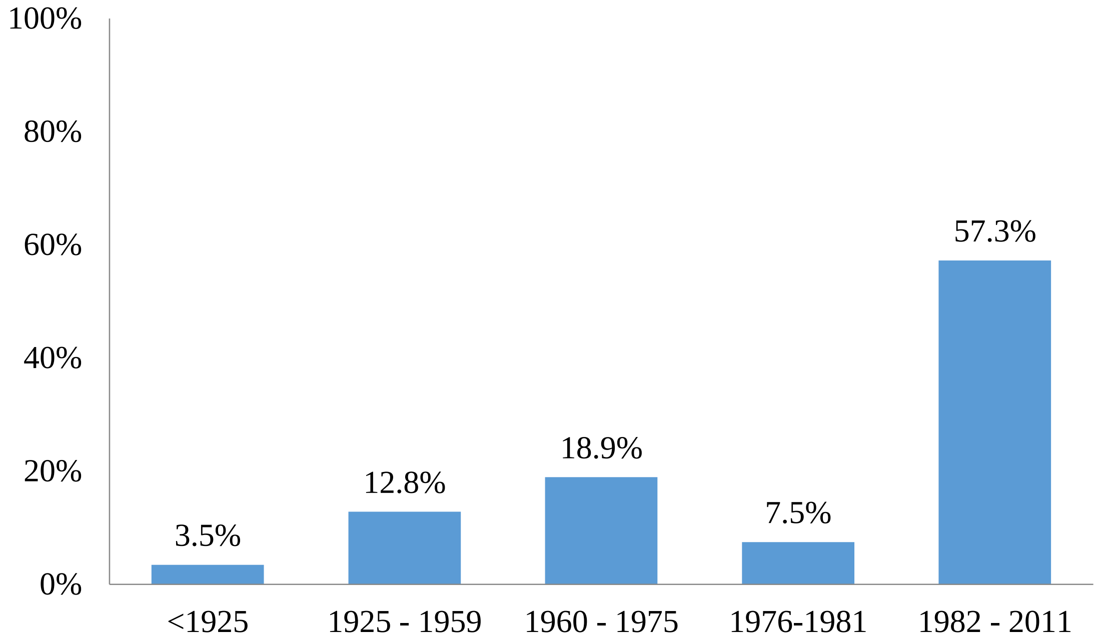


Figure 20. Proportions of property age groups in the North Queensland Coastal Region of analysis

3.4.2.1. Year of Construction - Townsville

Figure 23 shows the age of housing by construction period for policies in the Townsville Region that filed a claim for Cyclone Yasi. For clarity, extreme northern and southern areas of the Townsville Region are not included in the figure. The inland moving housing development of the central area over time is clearly shown. In general, for the main part of the city, the housing stock near the coastline is of an older construction age. This is an important finding from a risk modelling perspective, considering that wind conditions near the coast will generally be more severe than inland areas during a cyclonic event.

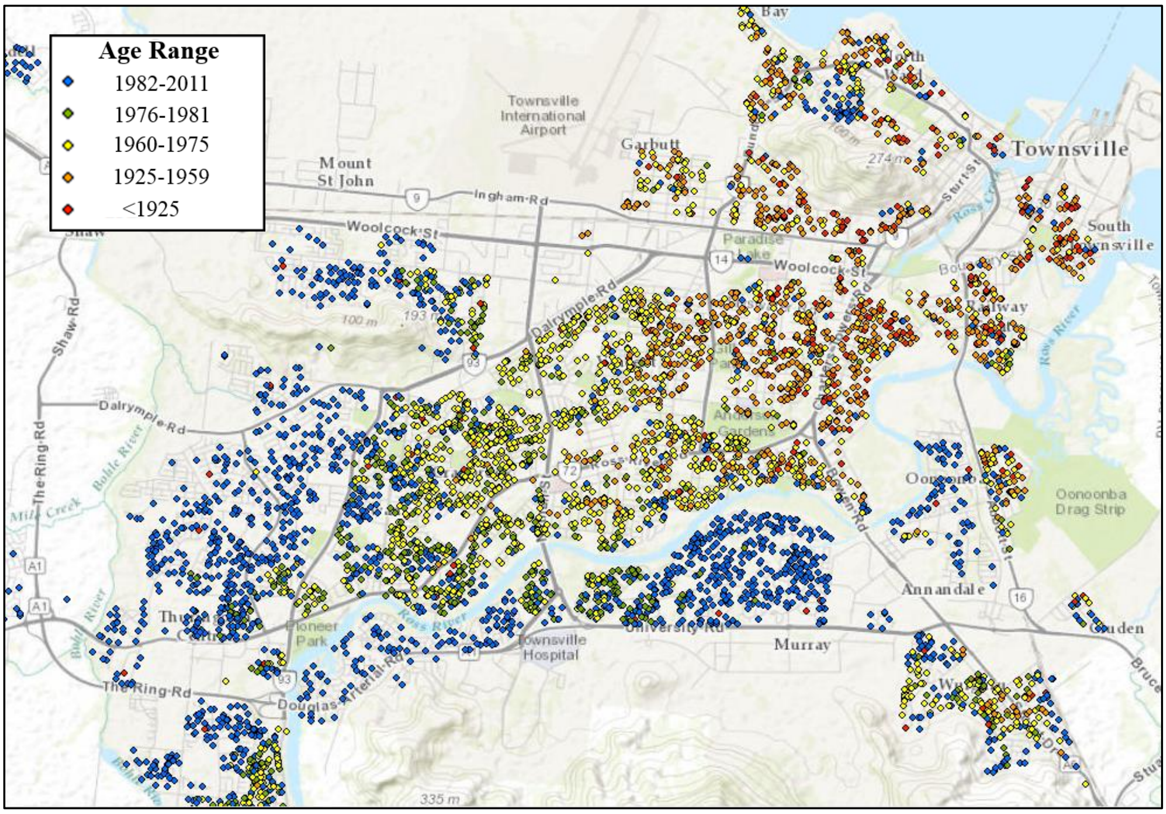


Figure 21. Distribution of property age groups across the Townsville Region

3.4.2.2. Year of Construction – Tully/Mission Beach

Figure 24 shows the age of housing by construction period for policies in the Tully/Mission Beach Region. The distribution of ages in this region does not follow the same pattern of inland expansion shown for the Townsville Region. Instead, construction age in the Innisfail and Mission Beach area appears to be evenly distributed between the five age ranges. However, moving to the south and in particular to the north of these areas, modern construction is more common. The quantity of housing constructed prior to 1925 is very small and generally confined to the Innisfail area. This should be considered when reviewing loss ratio trends (Sections 3.1.3 and 3.2.3) for housing in this age group.

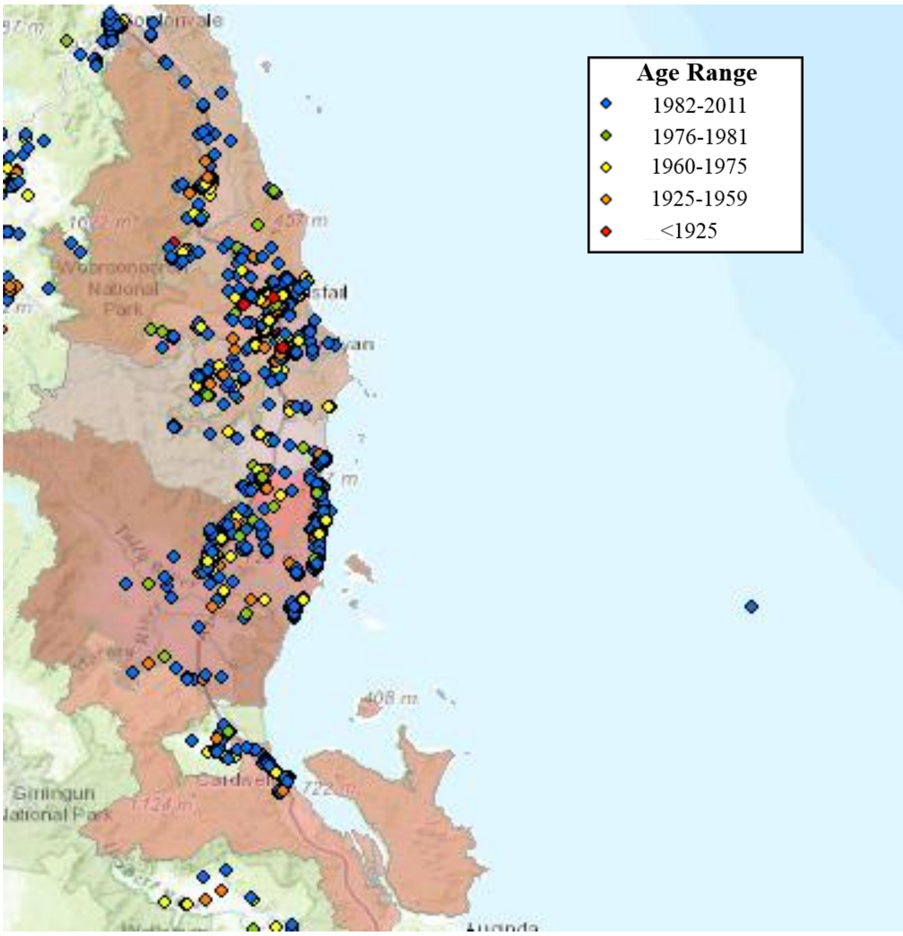


Figure 22. Distribution of property age groups across the Tully/Mission Beach Region

4. Claims Analysis (Assessors Reports)

The assessors reports provided by Suncorp were randomly sampled (*Data Set C*) in each of the three analysis regions for both Cyclones Yasi and Larry. In general, claims were classified based on a tabulation of words mentioned in the assessors reports (i.e. roof damage, water damage, etc.) to determine common themes or drivers of loss.

This data set included 179 assessor's reports from Cyclone Yasi and 56 assessor's reports from Cyclone Larry for a random subset of the claims data provided by Suncorp. These reports were separated into three groups based on loss ratio (claim value/sum insured) to compare typical damage modes for similar claim sizes. Table 7 shows the typical damage modes mentioned in assessors reports for each loss ratio bin and region of analysis.

The data clearly indicate that roofing damage, window damage, and water ingress are major drivers of loss during cyclones for claims of all sizes. The data also suggest that if a claim loss ratio is high, it is very likely that roofing damage (e.g., cladding failure, etc.), window damage (i.e. broken glass or casing damage), and water damage (e.g., ingress through windows/roofing) have occurred. **This implies that a targeted mitigation program that reduces vulnerability to these damage modes, will reduce losses from insurance claims. Furthermore, reducing the frequency of severe claims by even a small proportion, has the potential to greatly decrease loss potential.**

Table 7. Damage modes (by word mention) from claim assessor's reports for Cyclones Yasi and Larry grouped by loss ratio and analysis region

Loss Ratio	Cyclone/ Region	# of Claims	Tree	Roof	Window	Ceiling	Roller Door	Water Damage
0-.09	TC Yasi/ Townsville	157	21%	31%	15%	17%	2%	30%
0.1-.49	TC Yasi/ Townsville	9	22%	89%	33%	67%	0%	78%
0.1-.49	TC Larry/ Innisfail	43	14%	91%	67%	56%	16%	88%
>= 0.5	TC Larry/ Innisfail	13	15%	100%	77%	69%	31%	92%
>= 0.5	TC Yasi/ N. QLD	13	31%	100%	85%	100%	8%	100%

General observations on damage from assessor's reports:

- "Roof" damage includes guttering, downpipes, fascia board, 'whirly bird' type roof ventilators, as well as the cladding and flashing etc.
- For older housing, vulnerability to roof leakage was generally increased due to age, neglect and lack of maintenance
- For modern construction, roof leaking was caused by poor design, inadequate flashings, overflowing gutters etc.
- A commonly reported damage was to shade sails. There are no cyclone ratings for shade sails. They should be removed as part of a comprehensive cyclone preparation protocol.
- Fences and garden sheds were both featured heavily in the descriptions of loss. Fences were predominantly damaged by trees, with some blowing over of larger solid styles of fence. Shed damage from trees was also common.

- Cracked block walls were also mentioned in claims but not strictly cyclone related damage, rather poor construction and shrink swell behaviour of the soil.
- A number of the properties had roofs in poor condition.
- Damage/removal of components on one home, was often reported as having caused damage to and adjacent or neighbouring home.
- In one instance, a home constructed in the 1980s did not meet modern construction standards or typical features used at that time.
- Guttering was often reported as being unclipped and removed by wind.

5. Summary of Findings/Recommendations

Drivers of loss

The data clearly indicates that roofing damage, window damage, and water ingress are major drivers of loss during cyclones for claims of all sizes. The data also suggest that if a claim loss ratio is high, it is very likely that roofing damage (e.g., cladding failure, etc.), window damage (i.e. broken glass or casing damage), and water damage (e.g., ingress through windows/roofing) have occurred. *Current design and test criteria for water penetration of windows and doors is typically a tenth of the wind load design pressures.* **A targeted mitigation program that reduces vulnerability to these damage modes, will reduce losses from insurance claims.**

Moderate sized claims (claim/sum-insured = 0.1-0.5) represent the largest proportion of claim related losses (44% = $110,404,702) for the Northern Queensland Coastal Region from Cyclone Yasi. Roofing damage, window damage, and water ingress related issues are typical for claims of this size. Large sized claims (claim/sum-insured = >0.5) represent at total of 27% ($67,769,249) of the claim related losses for the Northern Queensland Coastal Region. Typical damage modes for claims of this size are generally more extreme versions of those described for moderate sized claims. **To reduce losses (i.e. claim frequency), the CTS recommends a mitigation program that emphasizes structural roofing upgrades (e.g., batten/rafter connections, etc.) to older homes (pre-1980s) and opening protection upgrades (i.e. shutters for windows, roller door bracing, etc.) for homes of all ages. Programs should also emphasise the importance of implementing a home maintenance routine in the long-term (e.g., repairing corroded metal supports, monitoring roof cladding tie-downs and water-tightness, replacing degraded timber, etc.).**

Large claims (claim/sum-insured = >0.5) in the Tully/Mission Beach Region, including the underinsured bin, comprise 38% of the total cost for this region despite only accounting for 9% of the total number of claims. In other words, major failures to even a relatively small number of houses can be a dominant driver of loss. *Preventing even a small portion of major structural failures through structural retrofit mitigation could be very effective in reducing losses.*

Minor claims (e.g., fencing, shade sails, minor water ingress, etc.) represent 86% of the total number of filed claims for Cyclone Yasi in the North Queensland Coastal Region and comprise 29% of the total cost (not including Suncorp processing overhead). Minor claims are equally likely to be filed by housing of all ages in both high-wind and low-wind areas of a cyclone. **The CTS suggests that community education/awareness campaigns may be the most effective method of reducing the frequency of claims of this size. Including emphasis on cyclone preparation activities such as removing shade sales, outdoor furniture, debris and unsecured items from the yard as well as pruning trees.**

Housing Age

The data indicate that housing constructed between 1925 and 1981 is at a relatively higher risk of structural damage. However, a significant proportion of contemporary housing also experienced severe loss ratio damages, which suggests that modern housing did not perform as expected per the National Construction Code (NCC). **This Suncorp data can provide a cost of this issue to the community and provide significant impetus in enhancing building standards to address water ingress, as well as to the education of designers, builders and homeowners to use more resilient products in the market.**

Key recommendations:
Recommendation 1:
Develop a targeted mitigation program that reduces vulnerability to the most common types of damage, focusing on:

- Structural roof upgrades for homes constructed before 1980 and other practical retrofit measures
- Upgrades to opening protections (e.g. windows and doors) for homes of all ages
- Emphasising the importance of regular maintenance.

This presents great potential in delivering a range of community benefits, including insurance savings.

Recommendation 2:
Implement community education/awareness campaigns to reduce frequency of small claims, including an emphasis on cyclone preparation activities such as removing shade sales, outdoor furniture, debris and unsecured items from the yard as well as pruning trees.

Recommendation 3:
Use the data provided on failures in newer buildings to drive ongoing work around enhancing building standards to address resilience issues, as well as initiatives to support and encourage designers, builders and homeowners to use more resilient products.

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Appendix A: Background Information
This section provides relevant background information on building damage induced by extreme wind events (e.g., common modes of damage, vulnerability modelling techniques, etc.). This information has been compiled from multiple sources of building science research, including the Cyclone Testing Station database.

6.1. Tropical Cyclone Wind Speeds
The destructive force of tropical cyclones is usually expressed in terms of the strongest gusts likely to be experienced, which is related to the central pressure, speed of movement and internal structure of the storm system. The Bureau of Meteorology uses the five-category system shown in Table 8 for classifying tropical cyclone intensity in Australia.

Table 8. Bureau of Meteorology Cyclone Categories

Cyclone Category	**Gust Wind Speed at 10 m height in flat open terrain (V_R)**			**Central Pressure**
	km/h	*knots*	*m/s*	hPa
1	<125	<68	<35	990
2	125-170	68-92	35-47	970-985
3	170-225	92-122	47-63	950-965
4	225-280	122-155	63-78	930-945
5	>280	>151	>78	<925

The main features of a severe tropical cyclone at the earth's surface are the eye, the eye wall and the spiral rain bands. The eye is the area at the centre of the cyclone at which the surface atmospheric pressure is lowest and where the wind is slight and the sky is often clear. The cyclone's intense winds are associated with the eye wall. For any given central pressure, the spatial size of individual tropical cyclones can vary enormously. Severe cyclones can have eye diameters from 15 to 50 km.

6.2. National Construction Code (NCC) of Australia
The NCC's structural performance requirements specify that a building or structure, to the degree necessary, must resist the wind actions to which it may reasonably be subjected and also:

- Remain stable and not collapse
- Prevent progressive collapse
- Minimise local damage and loss of amenity
- Avoid causing damage to other properties

The Australian Building Codes Board sets the societal risk for the ultimate limit state strength of a structure, in the NCC (2014). The level of risk is evaluated depending on the location and type of structure. The wind loads for housing standard (AS-4055 2006) derives its wind loads for housing based on Level 2 importance which has a minimum annual probability of exceedance of 1:500. Other structure types assume a different level of importance. For example, a hospital has a higher level of importance (Level 3) than an isolated farm shed (Level 1). The design level for housing (Importance Level 2 as noted in the Guide to the BCA 2007) is to be a minimum annual probability of exceedance of 1:500.
Accordingly, a house is required withstand its ultimate limit state design wind speeds thereby protecting its occupants. For cyclonic Region C (Figure 25) as defined in AS/NZS 1170.2,

the regional 10 m height 3-second gust wind speed (V_R) for a 1:500 probability is 69 m/s, **a mid-range Category 4 cyclone. This wind speed has a nominal probability of exceedance of about 10% in 50 yrs**.

6.3. Wind Regions for Design

Windstorms can broadly be classified according to their meteorological parameters as: tropical cyclones, thunderstorms, tornados, monsoons and gales. Different parts of the world are influenced by these various types of storms. Cyclones generally impact on coastal regions in the tropics, and extend hundreds of kilometres and therefore have the potential to cause the most damage. Thunderstorms and tornados are much more local, with their influence affecting distances of up to 10's of kilometres. A tornado impacting on a community in Australia is a relatively rare occurrence, compared to that of the US. Nevertheless, tornadoes can generate extremely high wind speeds and cause extensive destruction in local areas. For more detailed information on the different types of windstorms see texts such as Crowder (1995) and Holmes (2001).

These variations in weather systems are accounted for in the Australian and New Zealand Standard for structural design wind actions, AS/NZS 1170.2-2011, which divides Australia into several regions, as shown in Figure 25. Wind loads used in the design of structures (e.g. houses, shops, large storage sheds, 4 to 5 storey apartments, etc) are calculated from the data specified in AS/NZS 1170.2 which excludes tornados from its scope of wind actions.

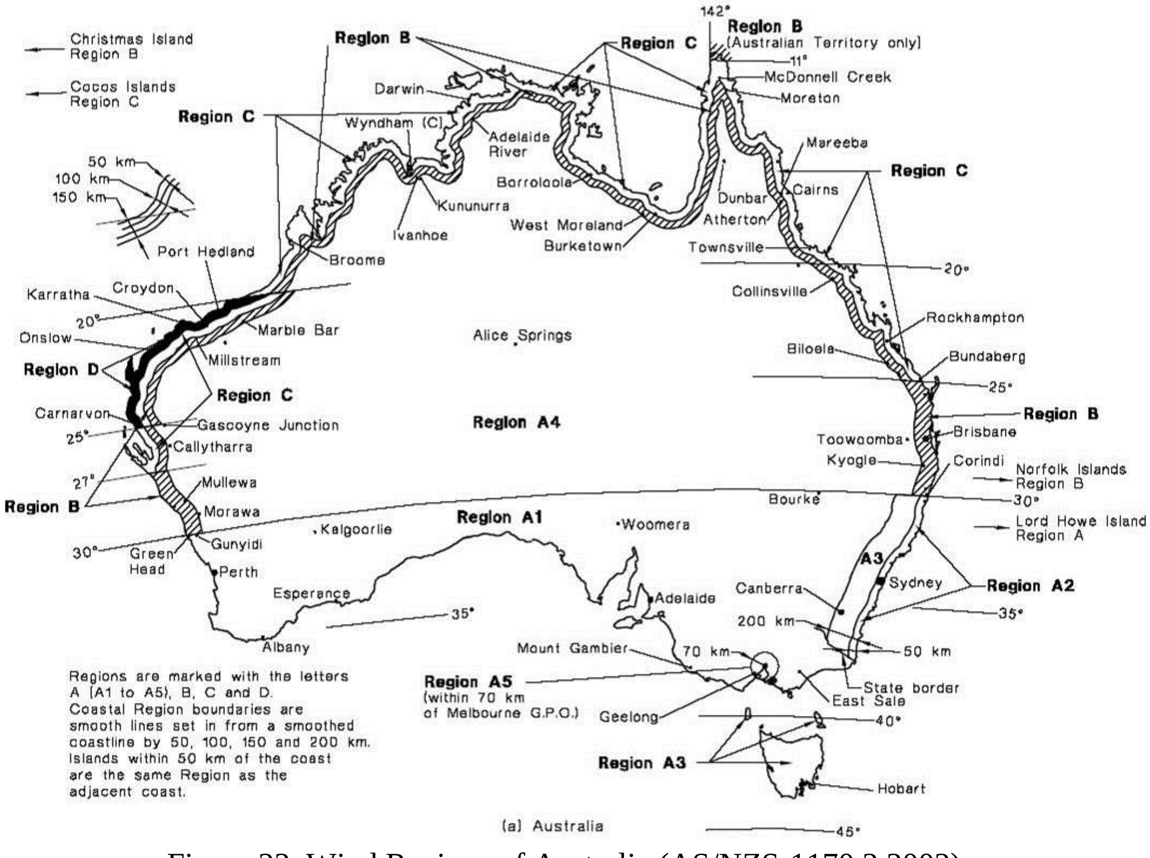

Figure 23. Wind Regions of Australia (AS/NZS-1170.2 2002)

6.4. Typical Housing Construction Types

Populated regions are typically comprised of a mixture of house types. There are differences in size, shape, window size, cladding type, roof shape, age, and methods of construction. Each of these parameters can have an effect on the resilience of the house to resist wind forces. For the purpose of vulnerability analysis, these details are averaged over a population of similar style/types of houses. Thus, any analysis is therefore representing a population and not individual examples.

Older housing types were generally designed to deal with humid climate and not destructive winds. A "Queenslander" style home was common in northern regions of Queensland and consists of a timber frame house elevated to up to a second storey on timber or concrete stumps. These older houses now often have had their open area under the house partially or completely enclosed, which may have implications for vulnerability (both in terms of wind load resistance and increased interior living space and contents loss).

Timber framing can have many different types of cladding attached to it, such as brick, metal, fibre cement or timber weatherboards. There are many types of connections needed in timber frame houses since a variety of different members need to be connected. Connections can be made using nails, screws, glue, bolts, plates, straps or a combination of them. A common form of connection used in older houses is a mortice and tenon joint. Standards such as AS1684, specify the appropriate type of connections. Figure 25 shows general structural systems in timber frame houses and the compents used.

Brick veneer housing uses typically a timber frame to provide the structural wind load resistance. The brickwork is merely a cladding that is supported horizontally by a timber frame. It consists of a single external brick layer which is attached to the timber frame using brick ties.

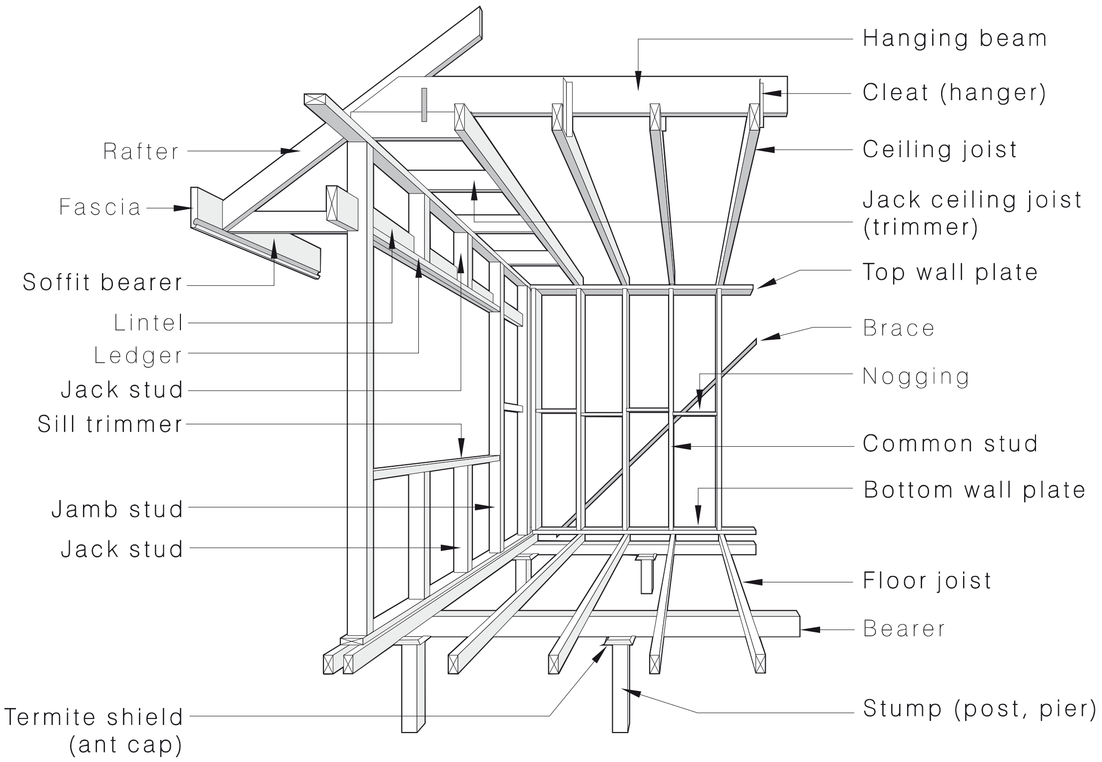

Figure 24. Typical arrangement of timber framing, Source: AS1684.3

Reinforced masonry (concrete) block houses have become very common in North Queensland since the late 80s. Masonry blocks are bigger than traditional bricks and have large hollow sections called cores. Steel reinforcing is placed both vertically and horizontally in the cores which are then filled with concrete. The houses are built on concrete slabs (foundation) with the reinforcing starter embedded in the concrete slab to provide tie down and load path for the walls and roof. Horizontal steel reinforcement is used along with shear ties in the concrete bond beam at the top of the walls. The roof frame is generally timber, and is bolted to brackets or cleats on the bond beam (Figure 27).

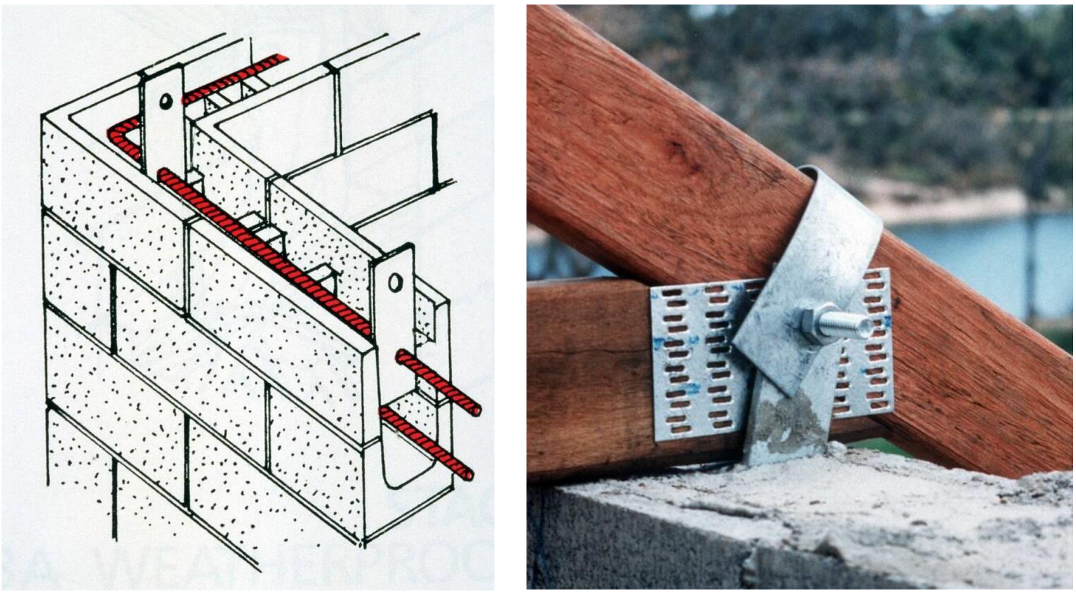

Figure 25. Bond beam reinforcing and truss cleat plate (left) and cleat plate with overstrap providing hold down to hardwood truss in cyclonic region (right)

6.4.1. Early 1900s

Houses built in the early part of the century were considerably smaller than current houses. They commonly have a central square core with verandas on two or three sides. Usually a high-pitched pyramid shaped roof for the core with the veranda roofs at a lower pitch. Mostly mortice and tenon construction for the wall frame. Supported by stumps on which bearers were bolted to.

6.4.2. 1920s to 1950s

Gables were common as housing shapes were no longer square or rectangular. Mortice and tenon wall frames were still used. Also still supported by stumps on which bearers were bolted to. Many houses have vertically joined internal timber lining, which connected from joists to battens and provided tie down. External cladding was usually timber weatherboards.

6.4.3. 1960s and 1970s

Commonly timber framed houses with a rectangular shape and elevated on stumps around 2.5 m high. External walls were usually clad with fibre cement or timber weatherboards. The vertical timber lining in earlier vintage houses was replaced by sheet lining, which provided reduced tie-down capacity. Cyclone rods were used in perimeter walls at about 3 m spacing. Single storey brick veneer houses were also present and were becoming increasingly common. This house type typically has a low pitch to flat roof. Roofing for both styles was generally metal sheeting.

6.4.4. 1980s and 1990s

Queensland Home Building Code was introduced in 1982, so houses built prior to this are assumed to be designed and built to requirements for cyclonic conditions. Typically single storey houses with truss roofs ranging from low to high pitch. External cladding is reinforced masonry block or brick veneer. Steel roof cladding is most common.

North Queensland
Most new houses tend to be single storey, slab on ground, reinforced masonry block. Roofing structure is still predominantly timber however provisions at connections, such as nail plates and metal straps, are used to ensure sufficient tie down capacity. Metal roof cladding is almost exclusively used in new homes. Steel frames are also used in some houses.

South Queensland
Unlike north Queensland, the predominant structural system is light weight timber framing Often with a brick veneer cladding. Local councils particularly in Brisbane recognize the cultural significance of Queenslander style houses and put restrictions on their demolition. This has led to an increase in the number of renovations and additions made to old Queenslander houses to allow for a more modern life style and upgrade them to meet the current building code.

Table 9. Generalized examples of housing construction types in North Queensland

Built During	Example of geometry and features	Generalised features
< 1920s		Hip roof, reduced rafter spans, central core, exposed studs, on stumps (low and high)
1925 – 1959		Hip and gable, VJ lining, reduced rafter spans, on stumps (low and high)
1960s – 1981		Gable low pitch, vermin proof flooring (studs not mortice and tennon into bearers), panel cladding, on stumps
1981 - present		Reinforced masonry block, hip and gable, large truss spans, medium roof pitch, slab on ground

6.5. Wind Speed

Winds impacting the house cause both positive pressures pushing on wind ward walls as well as large negative pressures (suctions) acting on roofs as well as side and leeward walls. In addition, sudden openings in the building envelope, typically caused by wind-borne debris, can lead to an increase in the pressure inside the building, adding to the overall load on roof cladding, walls, etc. (Figure 28). Small increases in wind speed result in larger increases in pressure. It is therefore important to ascertain the impacting wind speed at a location.

The loads induced by wind flow are also affected by the terrain over which it blows (e.g. accelerates up a slope; reduces with increasing terrain roughness such as suburbs as opposed to open fields; and increases with height above ground) and by shielding from nearby similarly sized objects such as houses immediately in front of the "target" house.

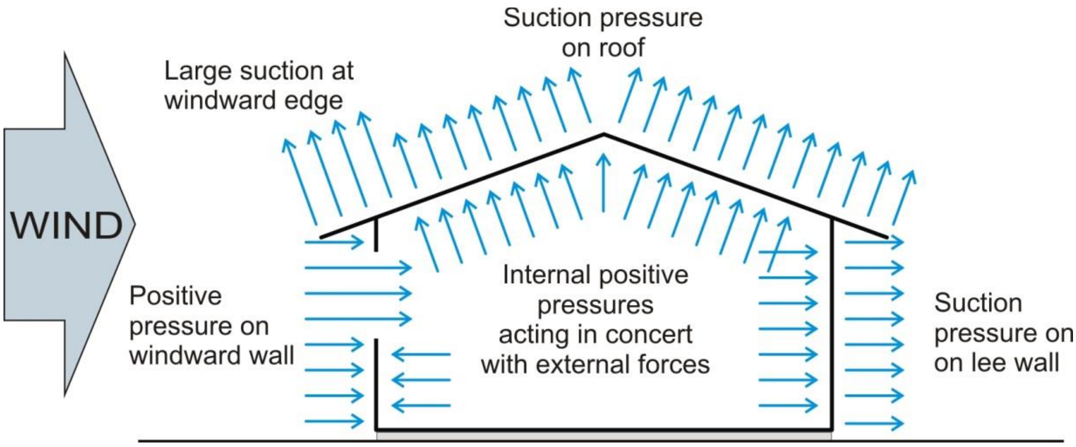

Figure 26. Simplified representation of wind pressures acting on building

6.6. Water Ingress Through Wind-driven Rain

Water ingress can cause damage to internal linings, resulting in costly repairs, potential long term durability concerns and mould growth, in addition to the loss of amenity. This damage will arise from the ingress of rain-water with a pressure difference across the envelope (i.e. net positive pressure across the roof or wall), and also from the envelope being damaged by flying debris or failure of cladding elements (i.e. soffits, gutters or fascia).

Due to low design (test) requirements for windows/doors (e.g. AS 2047) water ingress and associated damage to the house can be expected when heavy rain occurs with wind speeds greater than about 120 km/h (Henderson and Ginger 2008). This is due to the wind load pressures exceeding the test pressures specified. Water ingress in areas other than windows is also possible, although the wind speed at which this might occur is less understood for the other elements such as valley gutters or eaves vents.

Damage investigations in many parts of the world (Sheffield 1994, Sparks et al 1994, Henderson et al 2006, Van De Lindt et al 2007, Franco et al 2010, Boughton et al 2011, Gurley and Masters 2011) have shown that unmanaged water ingress has become a critical and recurring problem in residential constructions. The result is increased insurance losses due to interior damage (Sparks et al 1994, Pita et al 2012). Sparks et al (1994) suggested that insurance losses in buildings due to rain entering can be magnified by a factor ranging from two, at lower wind speeds, to nine at higher speeds. They recommended that building envelopes be designed for the same probability of failure as the main structural system.

The CTS conducted a study for the Insurance Council of Australia on insured losses in strata properties suffered during Cyclone Yasi (Henderson 2013). The study found 80% of claims noted damage resulting from water ingress (Figure 29). This result is strikingly similar to that of a survey following Cyclone Larry (Melita 2007) showing 75% of contemporary houses having envelope damage and water ingress. All this damage was from wind speeds far less than the structural design wind speeds as set out in the National Construction Code. From analysing the available strata claims and ratios of losses to sum insured (LR/SI) it can be inferred that approximately one quarter of the claims were associated with wind driven rain entering via the building envelope (roof space, windows, doors, etc) without mention of structural or other damage to breaching the envelope. These claims account for 20% of the total losses – just from wind driven rain ingress via "undamaged/code compliant" building envelope (Henderson 2013).

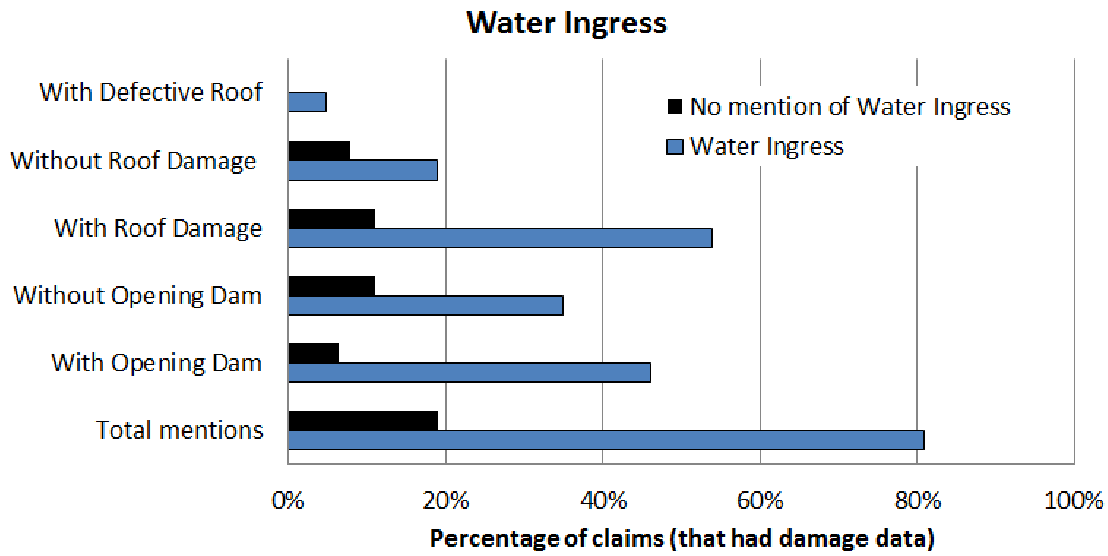

Figure 27. Wind driven rain water ingress damage from insurance claims data (Henderson 2013)

6.6.1. Observations for Australian Housing

The damage surveys by Boughton et al (2011) and Henderson et al (2006) from tropical cyclones Yasi and Larry, and Leitch et al (2010) from the Brisbane Thunderstorms of 2008 describe that wind-driven rain passed through the building envelope at openings such as windows and doors (even if closed), around flashings, through linings, or where the envelope has been damaged.

Boughton et al (2011) noted that high differential pressure between the inside and the outside of the building can be established in strong winds. This differential pressure can force water through gaps and spaces that it would otherwise not penetrate (Pringle 2003). The air flow around and over a building in an extreme wind event can drag water upwards over the building envelope. Flashings that are meant to channel downward-moving water away from the envelope, direct the upward-moving water into the building.

The following points of water entry into buildings were observed during the investigation of Cyclone Yasi (Boughton et al 2011):

- *Through ventilators.* Ventilators in gables, soffits or in the roof surface normally keep out driven rain that has a significant downward component to its motion. However in extreme winds, the upward component in the driven rain means that water was driven upwards through the soffit ventilators or between the slats in gable ventilators.

- *Around doors and windows.* The high differential pressure across the building envelope drove water through the small spaces around doors and windows and upwards through window weep holes. Some occupants reported a steady spray of water from the base of windows into rooms on the windward side of the house.
- *Under flashings.* Wind-driven rain moving upwards against the building envelope was pushed under flashings and into the building. This effect was particularly noticeable at the top of valley gutters. Water was driven up the valley gutter by wind where the direction of the gutter was aligned with the wind direction, entering the building near the top of the gutter and causing damage to the ceiling.
- *Through perforations of the envelope.* Water ingress was observed in buildings with a perfect structural performance, but where the building envelope had been damaged through either impact of debris or structural loss of cladding, significant quantities of water were able to bypass all of the normal water-tightness features of the building and enter the building (Figure 30).

Figure 28. Damage to ceiling and fittings from wind driven rain via in part debris damage to gable end (TC Larry)

As described by Boughton et al (2011), Leitch et al (2010) and Henderson et al (2006), regardless of the cladding material, roof complexity adds to the potential for water ingress. Valley gutters, box gutters, and parapets all require additional flashings and therefore create more potential locations for water to be driven into the roof space.

Damage from windborne debris also provides a means of water ingress into buildings (Walker 1975, Reardon et al 1986, Henderson et al 2006, Henderson et al 2010, Leitch et al

2010, Boughton et al 2011). Debris mainly impacts windward walls (including doors and windows) and the upwind slope of steep pitch roofs. Investigations have shown that building envelopes constructed from fibre cement or metal sheeting, glass windows, roof tiles etc. are especially susceptible to debris impact damage and hence have higher likelihood of water ingress.

Appendix B: Analysis Regions

Northern Queensland Coastal Region

In order to isolate regions that were predominantly impacted by wind during Cyclone Yasi, the coastal region of North Queensland extending from Bowen to Port Douglas was selected for analysis. In the first instance, this area was to be selected by post-codes located along the coast (Figure 31). However, it was discovered that several post-codes include multiple non-continuous geographic regions (e.g. see post code 4816), with some regions located in coastal areas and others located farther inland. These multi-region postal codes were removed from the Northern Queensland Coastal Region analysis for simplicity and alignment with the range of estimated wind speeds by region that the Cyclone Testing Station developed after Cyclone Yasi. The selected analysis region is shown in Figure 32.

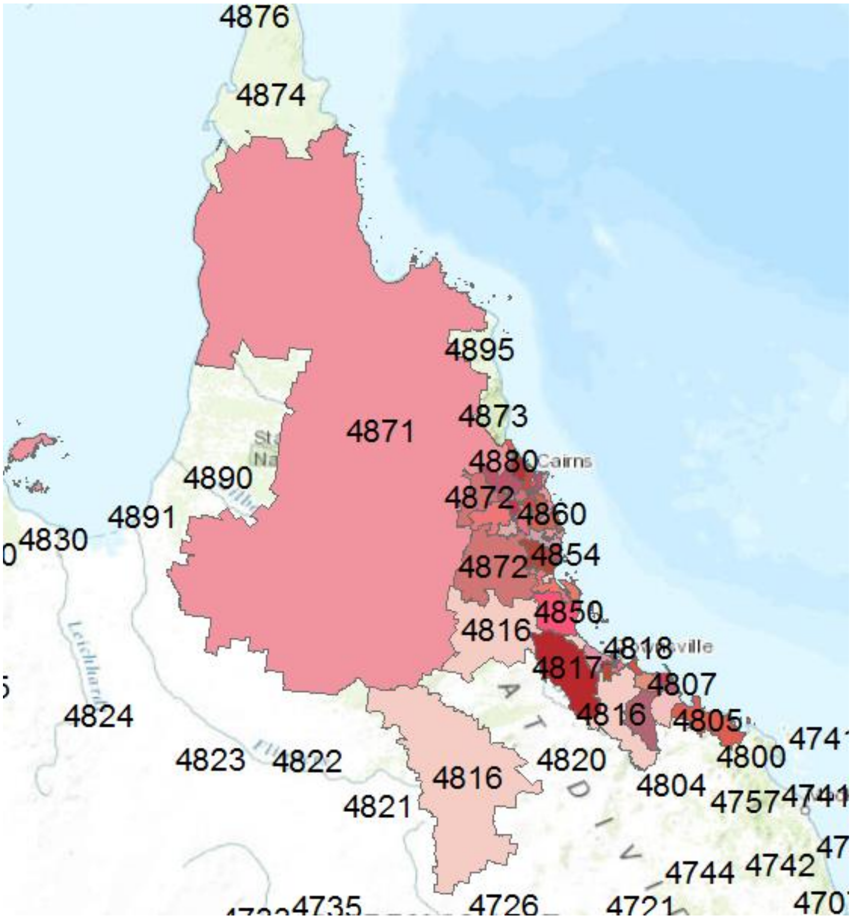

Figure 29. Geographic postal code regions in North Queensland

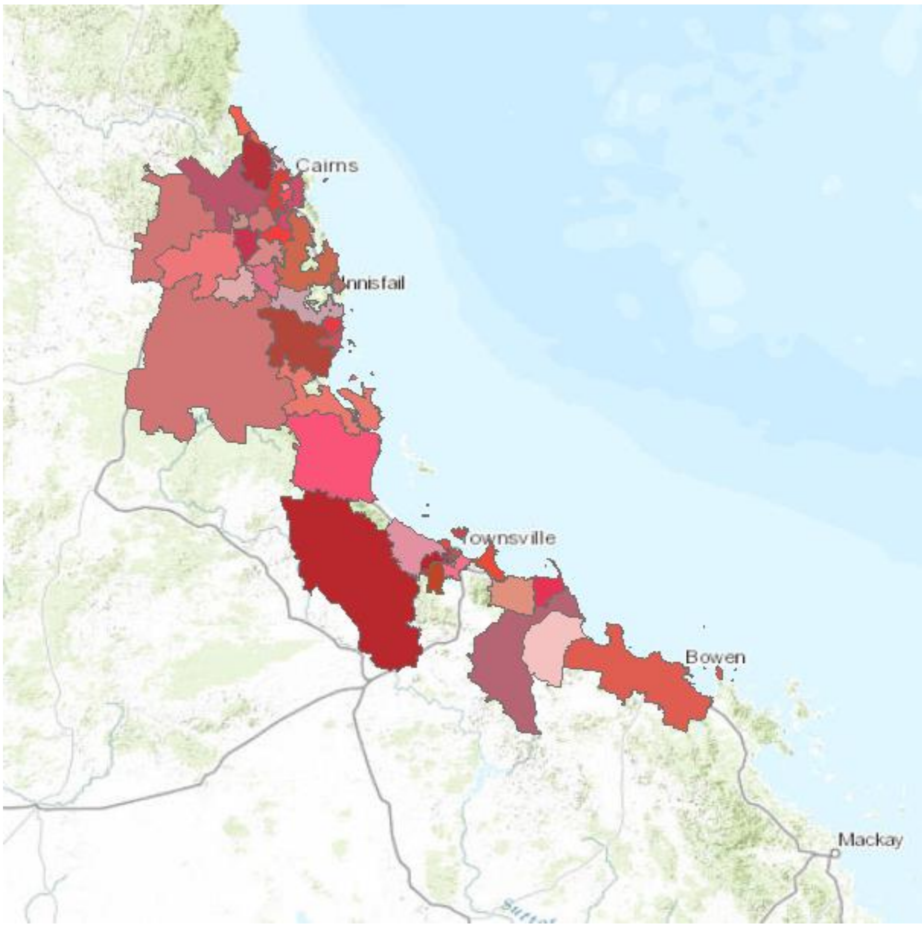

Figure 30. Postal code regions in the Northern Queensland Coastal Region of analysis which represents the bulk area affected by Cyclone Yasi.

Townsville Region (low wind speed area)

Due to the relatively large wind bands generated by Cyclone Yasi, the entire Townsville area in broad brush terms can be assumed for this study to have been subjected to a similar range of relatively low wind speeds, wind directions, and rain fall intensity. Hence, analysis of Townsville Region allowed performance comparisons between housing of various construction ages while limiting the uncertainty associated with variations in wind speed. Figure 33 defines the Townsville region by post-code, which extends from Alligator Creek to Bushland Beach. Of the policies within the Townsville Region, 30% filed a claim associated with Cyclone Yasi for a wind event which was about half of the wind load structural design criteria.

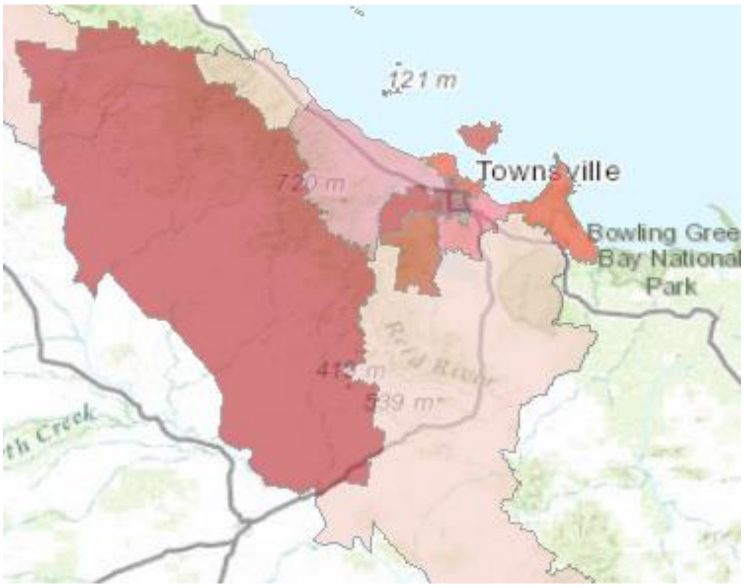

Figure 31. Postcodes in the Townsville study area

Tully/Mission Beach Region (high wind speed area)
The Tully/Mission Beach Region, which extends from Cardwell to Gordonvale, was selected for analysis due to the similar range of relatively high wind speeds, wind directions, and rain fall intensity. Hence, analysis of Tully/Mission Beach Region allowed performance comparisons between housing of various construction ages and provided a broad brush basis for comparing claim trends between high- and low-wind (i.e. Townsville) regions.

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Suncorp Group Limited

Cyclone Resilience Research – Phase II

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Executive Summary

Housing vulnerability is a large contributor towards high claims costs for Suncorp, and the subsequent premium affordability issues for consumers. Reducing this vulnerability will decrease the risk associated with severe wind events, which can then be reflected in pricing for consumers.

In 2014, Suncorp commissioned the Cyclone Testing Station (CTS) at James Cook University to conduct a comprehensive study to enhance Suncorp's understanding of the vulnerability of houses in North Queensland to natural hazards, particularly tropical cyclones and thunderstorms. The study involved the analysis of insurance claims for residential homes in North Queensland (NQ) after Cyclone Yasi. Key drivers of cyclone-induced losses were identified in the Phase I analysis. As a recent extension of that work, the current study (Phase II) builds on the Phase 1 by estimating the reduction in losses based on retrofit and mitigation solutions for the typical loss drivers.

The cost-benefit analysis was conducted through collaboration between Suncorp, CTS and economic consultant Urbis. The primary objectives for the CTS Phase II report included the following:

- Identify a sample-set of mitigation solutions
- Estimate the benefits of each solution (i.e. reduced loss) for a range of wind speeds
- Estimate the cost of each solution

As Urbis conducted the economic modelling aspect of cost-benefit analysis, those results are not discussed herein. Instead, the methodologies used to develop the basis of the cost-benefit model are presented.

In addition, a literature review of mitigation programs used internationally is presented from a consumer engagement perspective. The success/failures of these programs are identified (where possible) and applicability to Northern Australia is emphasized.

Finally, conceptual frameworks for a mitigation program are presented, illustrating how the process of inspections, reporting, mitigation and interaction with insurers may work.

Key Outcomes

- Three mitigation solutions are presented based on the Phase I report
- The report shows that there is scope for further development of these options and others (e.g., more aesthetic alternative to overbattens)
- Based on a review of the literature and discussions with building industry, Northern Australia is well poised to become a leader in resilience and mitigation
- There is much that can be learned from other work abroad but regional aspects must be considered

Estimation of Vulnerability

To estimate the benefits of the selected mitigation solutions, vulnerability of North Queensland homes to cyclone-induced damages was estimated (before and after mitigation upgrade) based on year of construction. Three groups were established (pre-1960s, 1960-80s, post-1980s) based on typical construction trends in each era. Three mitigation solutions were analysed:

1. Structural roof upgrading (i.e. connection upgrades, etc.) (pre-1960s and 1960-80s only)
2. Opening protection (i.e. window shutters, roller door bracing, etc.)
3. Community preparedness (i.e. unblocking roof-gutters, removing shade coverings, etc.)

The cost of implementing mitigation solutions was estimated via component costs, claims data, and scenario based estimates by selected builders and assessors.

Existing Mitigation Programs
Research found that the presence of coordinated, planned and implemented programs in Australia with the aim of increasing homeowner engagement in mitigation strategies to strengthen their home is lacking. Also a "one size fits all" approach to mitigation programs is not appropriate as individuals are motivated by different incentives.

Programs must be appropriately marketed to individuals and communities based on identified key motivators for engaging in mitigation strategies. These motivators will differ between individuals and communities based on their level of experience with extreme weather events, perceptions of risk and responsibility, connectedness and trust towards others and the availability of assistance and resources. Research is needed to characterize key motivators for Northern Australia communities so that a future mitigation program is efficient and optimized for community engagement. A scope for this research is discussed.

Proposed Mitigation Programs
Based on the literature review and CTS experience as a long-term proponent for cyclone mitigation practices, two conceptual frameworks for a mitigation program are outlined. The first includes a more traditional approach where inspections are completed by a qualified inspector, while the second makes use of smart-phone technologies allowing consumers to "self-assess" with periodic "spot checks" for quality assurance and continued improvement to the process. An effective mitigation program may also require a combination of the options considered.

Community Engagement Considerations
There is an opportunity for the whole community to benefit from an increased focus on mitigation:

- Homeowner – increased security during storm, promoted increase in house market value if retrofits undertaken, reduction in insurance premiums
- Government – reduction in drain on community services during and after severe event, more resilient community
- Industry – niche market for retrofitting and upgrading products as well as the building trades to professionally undertake retrofitting

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Limitations

1. Introduction

The current mitigation-focused work builds on the Phase I study conducted by CTS and Suncorp which analysed insurance claims from Cyclone Yasi to determine typical drivers of insured loss (i.e. roofing failures, etc.) for residential housing. The scope of the current project (Phase II) includes cost-benefit analysis of mitigation solutions selected as a result of loss drivers identified in the Phase I work.

The CTS role in the cost-benefit analysis included engineering analysis to estimate the benefits of selected mitigation options. Typical methods of vulnerability modelling are discussed in detail to provide context for the empirical methodology selected for this study. The overall strategy was to use the Suncorp Cyclone Yasi claims data (Phase I) to estimate the vulnerability of non-mitigated structures. Then, using a structural engineering software package (SPACE GASS), simplified roof systems were analysed with and without upgrading to estimate the relative change in load at critical connections. This information was combined with survey results from builders and assessors to estimate the reduced vulnerability of the same set of properties with mitigation. The results were used to estimate the intensity and frequency of damage before and after mitigation for a range of wind speeds. This information was provided to Urbis for economic modelling.

A literature review of mitigation programs used internationally is also discussed with emphasis on a consumer engagement perspective. Programs in Australia are discussed where possible, however the majority of works originate from the cyclone-prone southeastern coast of the United States. The applicability of these programs to a Northern Queensland context is emphasized. Based on the literature review, a research schema is proposed to identify drivers of mitigation action in Northern Queensland homeowners in order to optimize the effectiveness of a future mitigation program.

Finally, conceptual frameworks for a mitigation program in Northern Queensland are discussed. A more traditional approach is presented, utilizing qualified personnel to perform inspections. Alternatively, a more contemporary approach is discussed, making use of smart-phone technologies to educate homeowners about mitigation and efficiently transfer information back to insurers and researchers.

2. Background Information (Vulnerability Modeling)

Performance modeling of buildings during extreme natural hazards has become an essential part of modern catastrophe insurance analysis, and is largely related to the development of performance based design in structural engineering. Modern insurance catastrophe models are typically comprised of a series of sub-models that produce probabilistic estimations for: (1) the occurrence of an event, (2) the associated hazards, (3) the properties of interest in terms of characteristics deemed to affect their vulnerability to damage, and (4) the vulnerability of particular sets of building characteristics in terms of predicted insured loss (i.e. vulnerability model) as a function of the associated hazards of the event (Walker 2011).

Most commercial catastrophe models used in the insurance industry utilize vulnerability models based primarily on an empirical approach originally developed by Friedman (1975). He developed a procedure for estimating probable maximum insurance losses from hurricanes in which the vulnerability curves were developed from superimposing the estimated contours of maximum wind speeds from actual events on maps of the portfolio of the insurance company which had been exposed to the event. The vulnerability curves were derived by analyzing the ratio of an individual property's loss to its insured value. This ratio was termed the damage loss ratio, and was computed as a function of the estimated maximum wind speed which the individual properties had experienced.

Insurance vulnerability models for wind are meant to simulate the pattern of wind damage arising from a separately defined wind field. The most common method of expressing damage is by the cost of repairing or replacing the damaged building. Vulnerability models do not generally provide accurate simulation of damages to individual properties but rather they are expected to simulate the overall pattern of damage to the entire population of properties exposed to the wind event in terms of major statistical characteristics. Typically this pattern may be represented for a particular building classification by a plot of the observed damage loss ratio of individual properties versus the maximum wind speed experienced by them, where the damage loss ratio is the ratio of damage repair costs to the replacement cost of the property.

Figure 1 gives an example of loss ratio versus increasing wind speed for a fully engineered steel structure building and a residential house. The broader foot of the residential curve (Walker) indicates a greater variability in performance than that of the steeper engineered curve.

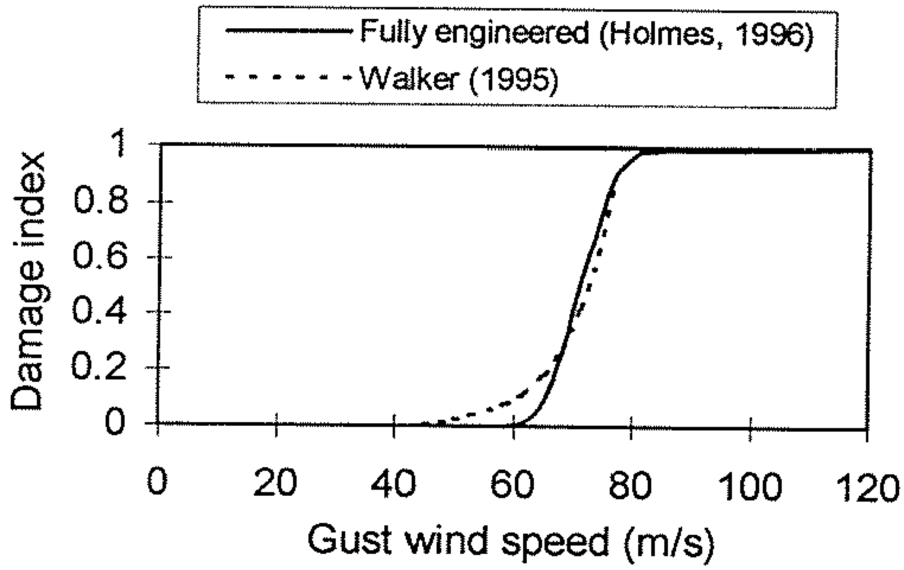

Figure 1. Example of “vulnerability” curves: An increasing damage ratio with increasing wind speed (Holmes 2007)

2.1. Empirically-Based Vulnerability Relationships

Vulnerability models used by the insurance industry are primarily empirical models based on fitting curves to damage data at individual building level, generally as a damage loss ratio, as a function of wind speed estimates for the given location. This approach relies on large amounts of loss data. Separate models are developed for various building classifications (i.e. single family dwelling, multi-story reinforced concrete, timber frame, etc.). Often there is sufficient data on all buildings to establish a general curve but insufficient data to produce individual curves based on data for individual building types alone. In these cases empirical models are derived for a few broad building classifications, with allowance for modification for differences within the broad classification that have been observed to result in increases or decreases in damages, based on both expert opinion and statistical analysis. Khanduri and Morrow (2003) present a good example of this approach.

The most extensive development of empirical vulnerability models utilizes the relatively large amount of data for hurricane losses in the US. Development of models for other countries has been more difficult due to relatively smaller amounts of data on losses from severe weather events. Further, direct application of US models in other countries is difficult due to differing forms of construction, building regulations, construction quality, etc. Adding to the complexity, standards of building construction often change in response to observed damage trends after a severe event which ties loss data to the set of standards used in a that time period.

An approach used commonly outside the US has been to assume the shape of US based vulnerability curves for building types that are considered to be similar, with adjustment to fit available data on losses or by utilizing engineering judgment and expert opinion. A similar approach was used in Northern Australia in the 1990s by modifying the Sparks and Bhindarwala

(1993) model for Hurricane Andrew to produce estimates of loss from Cyclones Tracy and Althea that were similar to recorded values for losses from these events.

The advantage of empirical models is that they inherently incorporate many of the uncertainties in the relationship between damage loss ratio and wind speed, especially if based on data from several different events for a similar type of building construction. For example, in the US where hurricane damage is relatively frequent in the same areas, or in areas of similar forms and standards of building construction and where hundreds of thousands of individual records of insurance loss data have been accumulated in recent years, it is expected that modelers with access to this data would be able to produce relatively reliable empirical models for estimating insurance losses for this area. The weakness of these models lies in their lack of applicability to other regions due to differences in construction standards.

Another typical issue with empirical models is the accuracy at higher wind speeds as the data is generally sparse at the high end of the scale because high-wind events are relatively uncommon. Consequently empirical models are generally more accurate at lower wind speeds. This has implications to estimating losses for extreme winds. Varying construction costs also introduce further uncertainty.

Outside of the limited areas where large loss information data sets are available, empirical vulnerability models are relatively unreliable, making them the most unreliable component of the overall catastrophe loss model. However, being based directly on insurance loss data they can still provide very useful information for computing insurance risk provided they are primarily used for aggregating risk as opposed to calculating the specific risk at a local level.

2.2. Engineering-Based Vulnerability Relationships

Engineering based vulnerability relationships rely on estimations of damage level for different hazards based on scientific engineering knowledge of the structural and material behaviors of building components and then estimations for cost of repairing that damage. This methodology relies on a high level of understanding of the mechanics of wind flow around a structure and the resultant forces on different building components including time dependent effects (e.g., fatigue loading) and redistribution of forces after local building element failures. Vickery, Lin, et al. (2006) and Vickery, Skerlj, et al. (2006) review the basic elements that should be included for the development of fully engineering based vulnerability relationships.

Even if the objective is a deterministic vulnerability model, its development should be undertaken in a probabilistic manner because of the non-linearity of the relationships between wind speed and wind loads, and between wind loads and damage (Walker 2011). The consequence of these non-linear relationships is that actual mean damage loss can be much greater than that estimated based solely on the estimated mean wind speed and mean building response.

There is also considerable uncertainty associated with the estimation of actual wind loads on a structure based on a given wind speed and angle of incidence. These loads vary based on housing construction, surrounding terrain, cladding elements, building height, etc. Partial damages (i.e. failure of door/window) and wind borne debris can also have dramatic effects on load magnitude and damages, and can only be modelled in a probabilistic sense. Because of these uncertainties, the development of fully engineered vulnerability models is a very difficult task that requires large amounts of research on wind load interactions with buildings and the associated structural responses. There has been quite a bit of research completed to date but the focus has been more so on improving design parameters rather than estimated building losses (Walker 2011).

Several approaches to developing engineering based vulnerability relationships have been explored over the last four decades (Hart 1976; Stubbs and Boissonnade 1993; Chiu 1994), however, Sciaudone et al. (1997) and Unanwa et al. (2000) are considered landmark papers in this field. While earlier papers were deterministic, both Sciaudone et al. (1997) and Unanwa et al. (2000) incorporated the probabilistic nature of the problem. These models still incorporated a large amount of expert engineering judgment where statistical knowledge of the components was not available; however, they represented a great step forward and set the framework for subsequent research in this field.

Pinelli et al. (2004) developed a vulnerability model in Florida for the Florida Public Hurricane Loss Model (FPHLM) based on the work of Unanwa et al. (2000). A follow-up paper (Pinelli et al. 2008) describes how the model was calibrated against recorded loss data from Hurricane Andrew and then the three damaging hurricanes that crossed Florida in 2004. This paper also provides insight into the model including allowances for contents losses and different building standards.

Vickery et al (2006a, 2006b) describe the methods used in development of the HAZUS hurricane model for the US Federal Emergency Management Agency (FEMA). These papers provide a comprehensive overview of what is likely the most well developed engineering based vulnerability model to date. Included is the modelling of debris damage, internal pressurization due to building envelop failure, contents loss as a result primarily of water damage, and modelling of associated rainfall.

Henderson and Ginger (2007) provide an example of this approach applied to the development of a vulnerability model for a typical Australian house built prior to current building standards and included consideration of progressive failure and the effects of windborne debris and internal pressurization. For example (Figure 2), analysis was conducted for a structure that began in an undamaged state and depending on the probability of failure of the difference building components damage and ultimately failure could progress via roof or wall structure of pier (stump) failure. Reasonable agreement was found when comparing recorded information from damage surveys undertaken following major tropical cyclones that have impacted northern Australia.

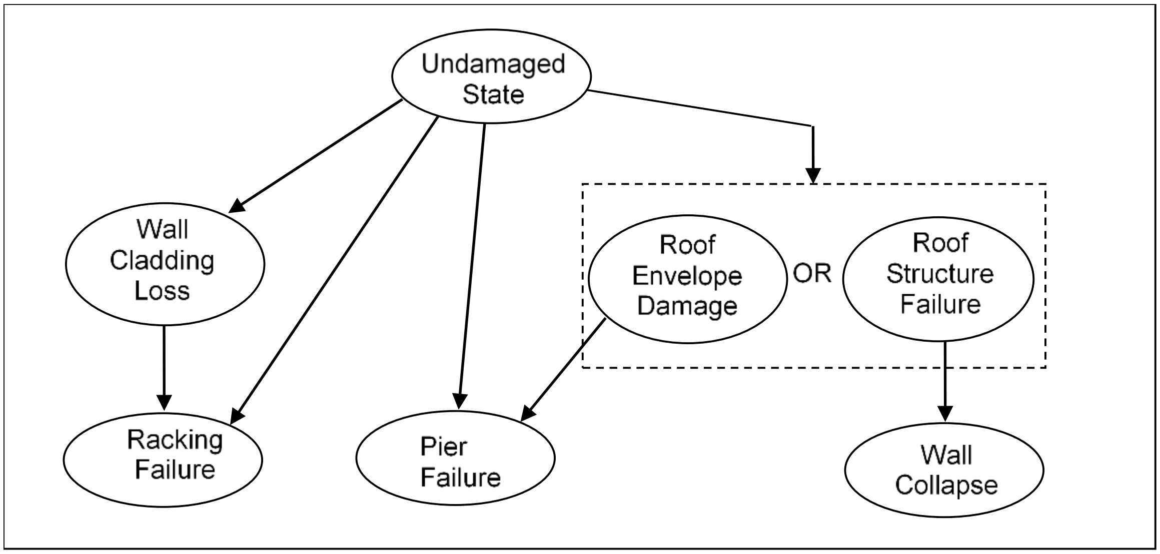

Figure 2. Possible damage propagation paths for Pre-1980s high-set house model (Henderson and Ginger 2007)

Engineering models are far more complex to develop than empirical ones, but they do have the great advantage of being able to investigate various scenarios as demonstrated in Figure 3 (King et al. 2013). The figure shows the capability of engineering based models to perform analysis for specific changes to the structural system (e.g., mitigation upgrades to roof and batten), versus empirical models that are based solely insurance claim data. A similar approach for developing vulnerability relationships for a timber framed house in the US including the effects of windborne debris has also been published (Apirakvoropinit and Daneshvaran 2009).

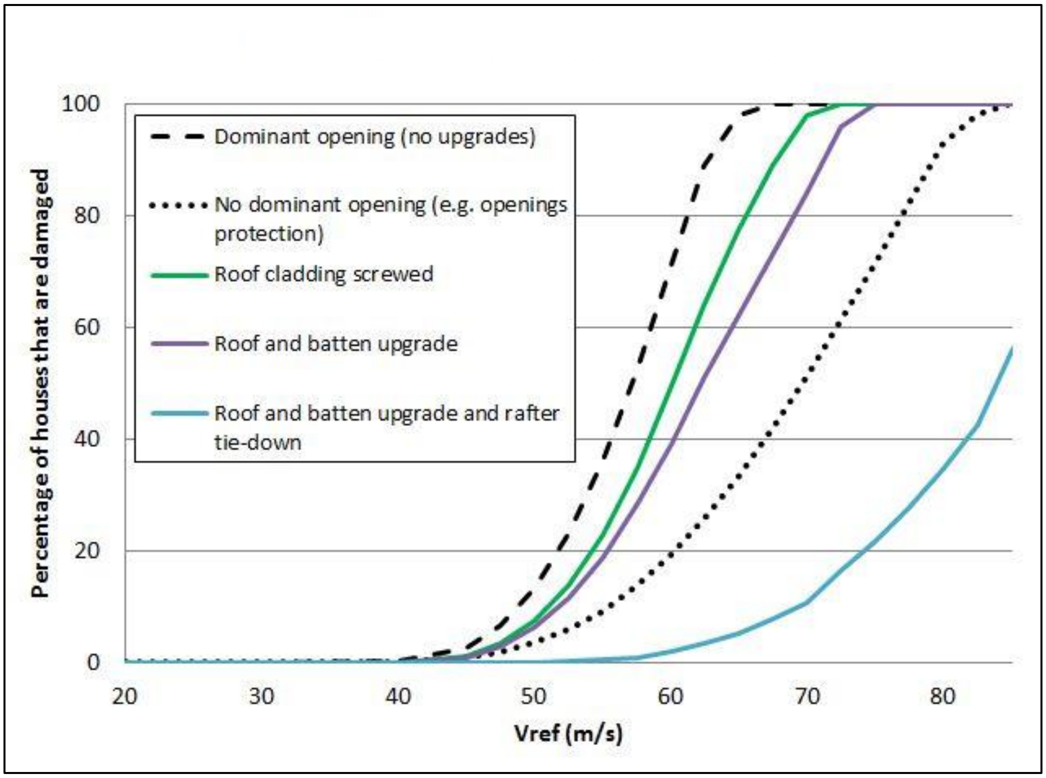

Figure 3: Estimated damage from wind loads to houses with different structural adaptation measures for house model as shown in Figure 2 (King et al. 2013)

While most engineering based vulnerability model investigations have focused on residential structures, Pita et al. (2009) describes an application to low-rise commercial buildings in Florida.

2.3. Water Ingress

As demonstrated by many damage investigations following windstorms, damage to building contents is strongly related to wind-driven rain and water ingress. Estimation of interior damage relies on expert opinion (Unanwa et al. 2000), engineering judgments (Pinelli et al. 2008), insurance data (Sparks, Schiff, and Reinhold 1994) or a combination these (Vickery, Skerlj, et al. 2006). Some of these approaches calculate the interior damage as a function of the exterior damage.

Dao and van de Lindt (2010) discussed a methodology to develop fragility curves and fragility surfaces for the volume of rainwater intrusion and demonstrated this on an example structure. They combined nonlinear structural analysis, computational fluid dynamics, and reliability theory with particle dynamics for rainwater trajectory modelling. It was assumed that the rainwater intrudes only through the roof-sheathing panel at one roof corner. However, they mentioned that the probability of rainwater intrusion should be estimated for different areas of the roof system, and then combined together statistically to determine intrusion for the overall roof system.

Pita et al. (2012) proposed a new approach based on an estimation of rain entering through envelope breaches and building deficiencies. Their approach consists of three steps: (1) estimation of the rain impinging on the building, (2) computation of wind-driven rain inside the building, and (3) conversion of the water ingress to interior damage. A flowchart of their detailed model is shown in Figure 4 with an example of model output shown in Figure 5. This approach has also been implemented in the Florida Public Hurricane Loss Model (FPHLM) (Hamid et al. 2010). However, these models have not yet been validated due to limited availability of full scale studies and insurance claim data.

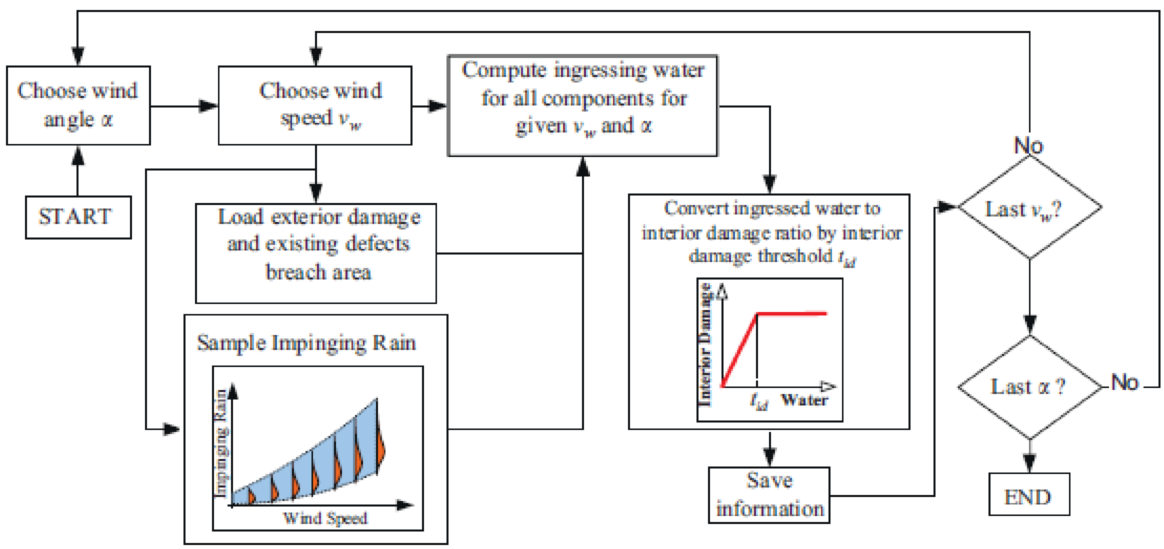

Figure 4. Flowchart of interior damage probabilistic model by Pita et al. (2012)

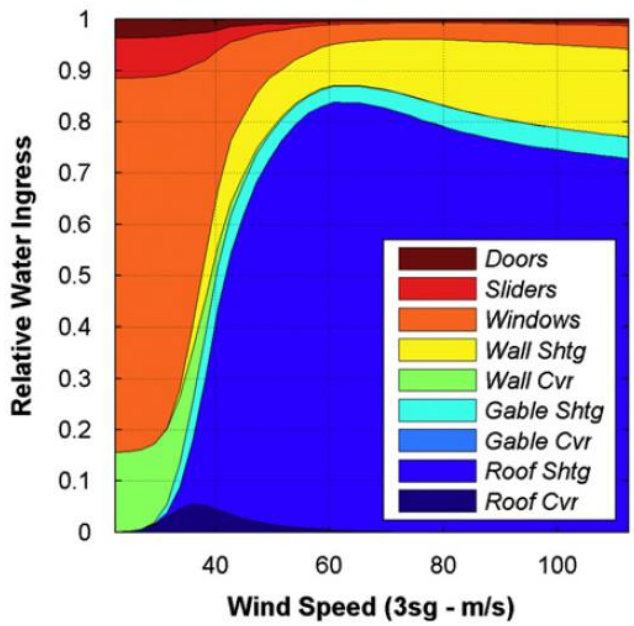

Figure 5. Relative contribution of each envelope component to "amount" of water ingress for increasing wind speeds by Pita et al. (2012)

2.4. Method of Analysis for Current Study

An empirical based analysis has been employed for the derivation of loss for increasing wind speeds for selected "generic" house types. The analysis uses the Suncorp policy and claims data from TC Yasi period (both policies with claims and without claims). The use of such data for modelling does not take into account ongoing incremental improvements to new buildings (i.e. changes to the garage door standard and roof tile Australian Standards should result in reduced damage to new housing with these components).

3. Fragility Analysis based on Suncorp Data

3.1. Overview

A computer algorithm program was developed to perform fragility analysis for the Phase II work. Using Suncorp policy data from TC Yasi as a proxy for future performance of the greater Queensland cyclone region coastal population, proportions of homes expected to incur varying levels of loss for a given wind speed were estimated for four mitigation actions:

1. No mitigation upgrading
2. Structural roof upgrading (applies to pre-60s and 1960-80s housing)
3. Opening protection for windows and roller doors (applies to all housing ages)
4. Community preparedness upgrades (applies to all housing ages)

The effect of combinations of each mitigation upgrade (items 2-4 above) were also estimated. The program was written based on five variables from the Suncorp data including:

- Age of construction (in three bins: pre-1960, 1960-80s, post-1980)
- Estimated wind speed during TC Yasi (km/h)
- Sum insured value ($)
- Claim value ($, includes null claims)
- Loss ratio (computed as Claim value / Sum insured value)

From the unaltered Suncorp data, a baseline performance case for non-mitigated structures (item 1 above) was generated by assuming that policies had not been upgraded (by the methods above) prior to TC Yasi. At each of six wind speed ranges (60-100, 100-120, 120-150, 150-180, 180-210, 210-240 km/h), the proportion of homes within four loss ratio groups (0, 0-0.1, 0.1-0.5, >0.5) were determined for each of the three housing age groups.

The effects of mitigation were simulated by modifying claim values in the original data set, and re-evaluating proportions of homes falling into the various loss ratio groups. The criteria for modifying claim values were dependent on the type of mitigation action, age of construction, estimated wind speed, and loss ratio (as an indication of more/less extreme damage modes). The criteria and assumptions used for applying modifications are detailed in the following sections.

Statistical assumptions (see Table 2, Table 3, Table 4) for "Proportions of claims affected" (e.g., the proportions of policies with avoided damage, i.e. mitigated loss) are estimated based on damage modes extracted from assessor's reports from Cyclones Yasi and Larry (Table 1). Format and content were non-uniform across the selected reports (e.g., if a report didn't mention roofing damage, it does not mean that roofing damage did not occur).

The number of available reports on claims with high loss ratios was limited (see Table 1), with care therefore being needed in the extrapolation of statistics from these samples to larger claims sets in the fragility analysis. However, these values provide a baseline from which higher a fidelity analysis could be built.

Table 1. Damage modes (by word mention) from claim assessor's reports for Cyclones Yasi and Larry grouped by loss ratio and analysis region

Loss Ratio	Cyclone/ Region	# of Claims	Tree	Roof	Window	Ceiling	Roller Door	Water Damage
0-.09	TC Yasi/ Townsville	157	21%	31%	15%	17%	2%	30%
0.1-.49	TC Yasi/ Townsville	9	22%	89%	33%	67%	0%	78%
0.1-.49	TC Larry/ Innisfail	43	14%	91%	67%	56%	16%	88%
>= 0.5	TC Larry/ Innisfail	13	15%	100%	77%	69%	31%	92%
>= 0.5	TC Yasi/ N. QLD	13	31%	100%	85%	100%	8%	100%

3.2. Mitigation Action #1 - Structural Roof Upgrades

Damage to the roofing structure is a well-known driver of loss during cyclones and other high-wind events. In addition to direct loss, roofing damage often leads to water ingress and additional wind-borne debris. The basic engineering design principles for wind loads on roofing structures require that each element of the system (i.e. cladding, battens, and rafters) be connected to each other and to the foundation of the structure through supports in the wall system. This design configuration is meant to ensure that wind loads on cladding elements are transferred to the supporting members below (i.e. battens, rafters) and on to the stronger foundation region of the house.

Roofing failures generally occur when one or more of the connections in the system fails. Contemporary housing is generally constructed with stronger connections than legacy housing (pre-1980s) due to enhanced building standards. Therefore, Mitigation Action #1 is focused on the following roofing connection upgrades in pre-1960s and 1960-80s housing:

1. Strapping at batten/rafter and ridge connections (pre-1960s and 1960-80s)
2. Collar ties between rafters (pre-1960s)
3. Vertical tension members between rafters and ceiling joists (1960-80s)

3.2.1. Basic Structural Analysis Modeling

In order to quantify basic estimates for the performance increase achieved by structural roof upgrading, simple structural analysis models were generated for Pre-1960s and 1960-80s typical roofing shapes using a structural engineering software package (SPACE GASS). Using SPACE GASS, before -and after- upgrade versions of a simple two-dimensional roof systems were subjected to wind uplift loads based on approximations from AS/NZS 1170.2. As severe roofing failures typically occur due to failed connections (e.g., batten/rafter, ridge, etc.), the mitigation upgrades are designed to disperse loading throughout the roofing structure and down to the foundation supports, thus reducing the concentrated loads at critical connections.

The upgrades also strengthen the load capacity of critical connections (via strapping). The combination of these effects creates a situation where the strength of connections are increased AND the load they are required to resist is decreased.

Pre-1960s roofing structures (Figure 6 and Figure 7) generally consist of high-slope, pitched frame hip construction (see Phase I report). The mitigation upgrades selected for this roofing type include additional strapping at batten/rafter and ridge connections as well as collar ties to join rafters (where not already installed).

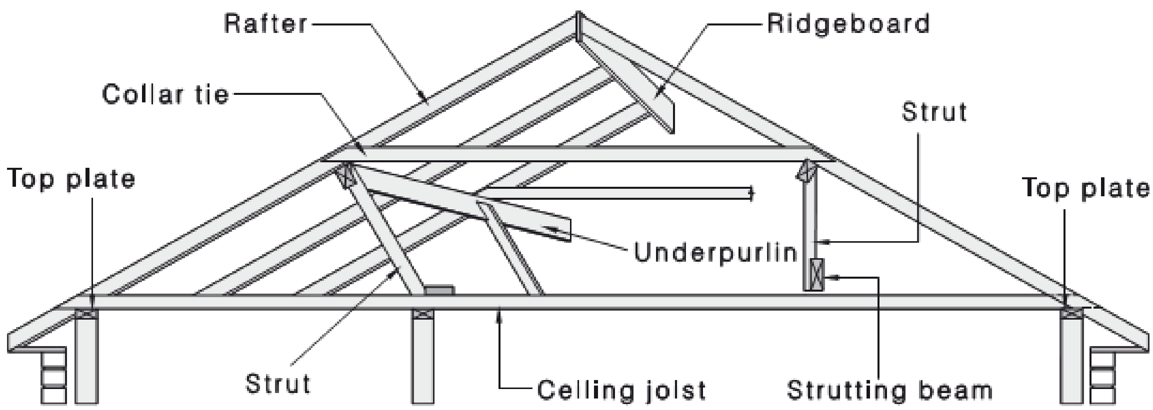

Figure 6. Arrangement for typical pitch frame construction (Source: AS1684.3)

Figure 7. Example of typical pitch frame construction (pre-1960s)

Roofing structures from the 1960-80s (Figure 8) generally consist of low-slope, pitched frame gable construction (see Phase I report). The mitigation upgrades selected for this roofing type include additional strapping at batten/rafter and ridge connections as well as tension members to join rafters down to ceiling joists.

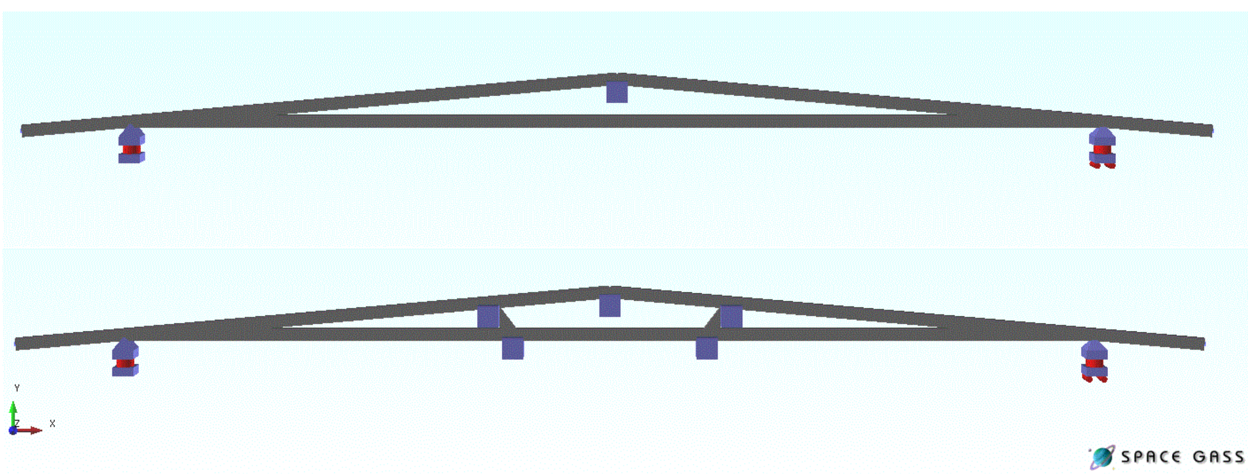

Figure 8. Basic structural analysis modeling of before (top) and after (bottom) upgrading a typical 1960-80s roofing structure

To estimate the performance benefits of upgrading, the loads at the rafter/batten interface (a critical connection for wind uplift) were estimated for a range of wind speeds (10 m height, suburban terrain) both before and after the upgrades. The performance trends are shown in Figure 9.

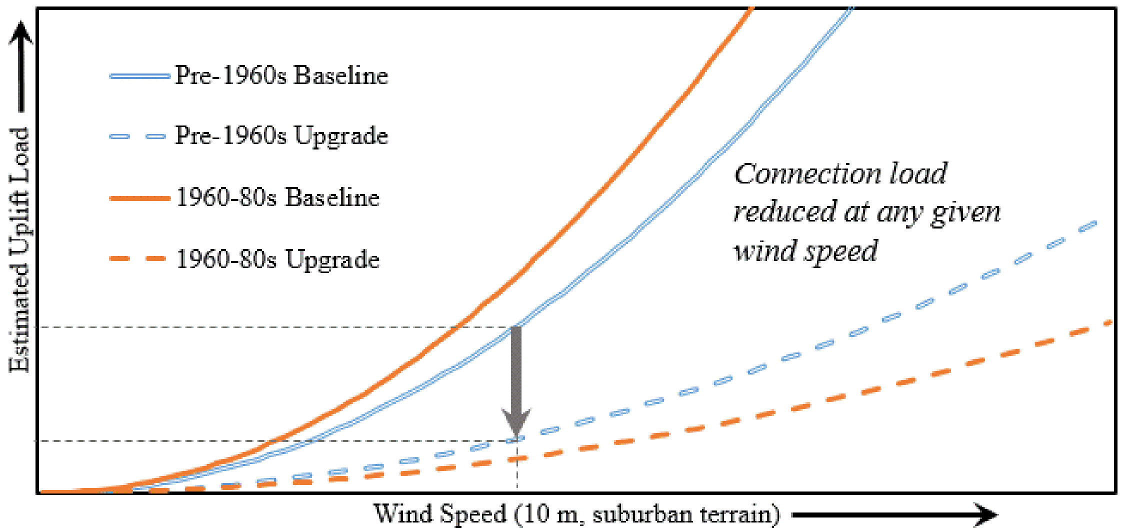

Figure 9. Estimated uplift load trends at batten/rafter connections for Pre-1960s and 1960-80s housing before and after structural roofing upgrades

3.2.2. Fragility Estimation

In order to simulate the effects of these upgrades during Cyclone Yasi, educated assumptions were made about the likelihood of roofing failure and severity of loss, based on the wind speed and loss ratio of any given policy in the Suncorp data set. These assumptions were used to form criteria for modifying policy claim values based on the estimated loss mitigation resulting from the upgrade. From the Phase I report (see Table 1) on Suncorp claims data from Cyclone Yasi, the following statistical assumptions were made for claims with pre-1960s and 1960-80s housing:

- 30% in the lowest wind band (80-145 km/h) and in the lowest loss ratio band (0-0.1) had minor roofing damage
- 40% in the medium wind band (145-170 km/h) and in the lowest loss ratio band (0-0.1) had minor roofing damage
- 50% in the highest wind band (>170 km/h) and in the lowest loss ratio band (0-0.1) had minor roofing damage
- 90% in the low/medium wind speed bands and the medium loss ratio band (0.1-0.5) had moderate roofing damage
- 100% in large loss ratio band (>=0.5) had severe roofing damage

From these assumptions, and correspondence with claims assessors in Queensland, the criteria for reducing claim values (i.e. simulating loss mitigation) in the Suncorp data set were established. Specifically, the mitigated loss value (claim reduction value in $) and the proportion of policies it applies to were estimated for various combinations of wind speed and loss ratio (Table 2).

Table 2. Applied criteria for reducing claim values based on structural roofing mitigation upgrades (applies to pre-1960s and 1960-80s housing)

Wind Speed (km/h)	Loss Ratio (%)	Proportion of Claims Affected	Mitigated Loss ($)
80-145	<10	30%	2,000
	10-50	90%	25,000
	>50	100%	70,000
145-170	<10	40%	2,000
	10-50	90%	30,000
	>50	100%	100,000
>170	<10	50%	2,000
	10-50	90%	70,000
	>50	100%	150,000

3.3. Mitigation Action #2 - Opening Protection

Damage to openings in the external shell of a building (e.g., windows, roller doors, etc.) during cyclonic or severe storm events often exposes the interior of the home to both wind and water ingress. Wind flow into the building can create positive internal pressure, adding to the overall loads on cladding elements (i.e. roofing, etc.) and increasing the likelihood of roofing or other failures.

Water ingress into the building can cause extensive damage to building contents and is well-known to dramatically increase insurance losses. Mitigation Action #2 is focused on reducing the likelihood of these damages by protecting vulnerable openings (i.e. windows, roller doors) from wind-borne debris impact and pressurized water ingress. The types of mitigation upgrades that can be used to protect windows differ from those of roller doors and thus the two upgrades are discussed in separate sections below.

3.3.1. Roller Doors

Roller door failures generally occur due to loads generated by wind-induced pressures. At lower wind speeds, damage is typically limited to buckling failure. However, at higher wind speeds buckled doors can become dislodged from tracks, causing additional damage to the surrounding structure and becoming wind-borne debris in some cases. To mitigate these damages, the upgrade model for roller doors includes aftermarket bracing to retrain the door from buckling in either the inward or outward direction.

Based on construction experience in Queensland, the CTS estimates that approximately ~20% of Pre-1960s and 1960-80s housing is equipped with a roller door. Alternatively, ~90% of Post-1980s housing are equipped with a roller door. Therefore, the mitigation benefits of roller door upgrades were applied to these proportions of claims for each age group. For example, of all the

Suncorp claims for Post-1980s housing, a random subset including 90% of those claims was selected, to which the mitigation criteria in Table 3 were applied. From the Phase I report (see Table 15) on Suncorp claims data, the following statistical assumptions were made to form the mitigated loss criteria:

- 2% in the low loss ratio band (0-10%) had roller door damage
- 15% in the medium loss ratio band (10-50%) had roller door damage
- 30% in the high loss ratio band (>50%) had roller door damage

Table 3. Applied criteria for reducing claim values based on roller door mitigation upgrade (applies to all housing ages)

Wind Speed (km/h)	Loss Ratio (%)	Proportion of Claims Affected	Mitigated Loss ($)
80-145	<10	2%	1500
	10-50	15%	1500
	>50	30%	1500
145-170	<10	2%	3000
	10-50	15%	5000
	>50	30%	5000
>170	<10	2%	3000
	10-50	15%	8000
	>50	30%	10000

3.3.2. Windows

Window-related damage modes may include direct damage from wind-borne debris, which can also increase the likelihood of roofing failure from internal pressure increases, and water ingress damage to the building walls and contents from poor window casing or sealing performance. The primary damage mode varies by wind speed, the amount of wind-borne debris or rain, etc.

For modeling, the window mitigation upgrade was assumed to effectively reduce the loss associated with each of these damage modes, the positive benefits of which increase with wind speed. The upgrades include plywood covering (installed DIY) and commercially available shuttering systems. From the Phase I report (see Table 15) on Suncorp claims data, the following statistical assumptions were made to form the mitigated loss criteria:

- 15% in the low loss ratio band (0-10%) had window related damage
- 50% in the medium loss ratio band (10-50%) had window related damage
- 80% in the high loss ratio band (>50%) had window related damage

Table 4. Applied criteria for reducing claim values based on structural roofing mitigation upgrades (pre-1960s and 1960-80s housing)

Wind Speed (km/h)	**Loss Ratio (%)**	**Proportion of Claims Affected**	**Mitigated Loss ($)**
75-145	<10	15%	1,000
	10-50	50%	2,000
	>50	80%	5,000
145-170	<10	15%	2,000
	10-50	50%	5,000
	>50	80%	10,000
>170	<10	15%	5,000
	10-50	50%	10,000
	>50	80%	15,000

3.4. Mitigation Action #3 – Community Preparedness

From the Phase I report, minor claims represent 86% of the total number of filed claims for Cyclone Yasi in the North Queensland Coastal Region. These minor claims typically include damage shade sails, minor water ingress, minor debris damage, etc.

Community education/awareness campaigns, with emphasis on cyclone preparation (e.g., removing shade sails, pruning trees, removing debris and unsecured items from the yard, etc.), may be an effective method of reducing the frequency of claims of this size. Past experience suggests that 100% implementation of these "preparation upgrades" is unlikely, and actual implementation rates will be much lower, depending on the method of dissemination adopted by the community outreach campaign. Therefore, for modeling purposes, it was assumed that the positive benefits of these upgrades were realized in only 30% of claims. The magnitude of these benefits were assumed to increase with wind speed as shown in Table 5.

Table 5. Applied rules for modifying claim values based on community awareness upgrades (all housing ages)

Wind Speed	**Loss Ratio (%)**	**Proportion of Claims Affected**	**Mitigated Loss ($)**
All	<10	30%	2000
	10-50		3000
	>50		5000

The costing associated with a community awareness campaign for cyclone preparedness upgrades is outside the CTS scope of work and will be undertaken by Urbis during cost-benefit analysis.

Additional Assumptions for Fragility Analysis

- All policies were assumed to be without any mitigation upgrades at the time of TC Yasi
- Future wind and rain conditions are similar to the those generating loss during TC Yasi
- All adjustments that result in claim values below zero were assumed equal to zero
- Storm tide damaged properties not considered

4. Damage Repair Cost Estimation

The following damage scenarios were presented to assessors, builders and engineers to provide estimates of cost of repair based on their experience. The estimates were used for the modelling of mitigated loss (i.e. claim reduction) for each upgrade solution in the fragility analysis. For each of the four 3 sec gust wind speed scenarios discussed (Australian Bureau of Meteorology Cyclone Categories 2-4), damage modes are based on typical damages noted during post-event field survey by the CTS and the Suncorp claims data for Cyclone Yasi. Items covered under a contents policy (e.g. furniture, white goods, etc.) were not included in the estimations.

4.1. Category 2 (125-165 km/h)

4.1.1. Fence Damage

Removal and replacement of a treated timber (pine) paling fence (15 m length x 1.8 m tall) that has been blown over.

Cost: $1,500 (~$100.00 per m) to $2,250

4.1.2. Shade-Cloth Damage

A shade-cloth (5 m x 3 m) is attached to two poles and at two locations on the side of single storey masonry block house. The cloth breaks loose from pole attachments and “flaps”, causing paint damage to blockwork wall and guttering on that side of house. Repair includes shade-cloth replacement, guttering (7 m length assuming Colorbond match exists), and wall repaint.

Cost: $3,650 to $4,000

4.1.3. Garage Door Damage

A double width (4.8 m) roller door is buckled/creased from wind pressure on a 1990s single storey block work house. Interior water or impact damage doesn’t occur as a result of the buckled door.

Cost: $1,500 to $3,200

4.1.4. Wind Driven Rain Damage to Modern House

Wind driven rain enters under a sliding glass window in the bedroom and another door in the living room of a contemporary single storey masonry block house. Walls and ceiling are internally lined with plasterboard. Floors are tiled in the living room but carpeted in the bedroom. Skirting boards are damaged (separating/bowing from wall linings) 2 metres either side of the door and under the window. Wall lining painting is blistered under window. Water has soaked the carpet to 2 metres out from the window. Water runs down over the electrical power point in the bedroom wall near the window. No water damage is observed in the ceiling. Electrical wiring must be checked.

Cost: $3,000 to $4,400

4.1.5. Gutter Loss to High-Set 1970s Home

Replacement for missing quad-guttering from one side (12 m) and both down-pipes of a high-set (elevated) 1970’s house.

Cost: $1,500 to $2,500 (high-set) and $600 to $750 (low-set)

4.1.6. Roofing Damage to High-Set 1920s Home

Loss of roof cladding and battens along one side including the gutter. Rain has damaged the kitchen cupboards and electrics. No damage to floor coverings. No damage below the house. (refer Figure 10)

Cost:

$15,000 (if not required to upgrade, repair battens and replace affected roof sheeting)

$35,000 to $50,000 (if upgrade required, full roof replacement, roof structure upgrade and tie down with certification)

Note: Responses commented that about 20% of the roof area is affected which is potential trigger point for minor (no upgrade work) or major work (upgrade work with full roof replacement). One respondent noted that it appears more than 20% of the roof area is affected but not 20% of the roof structure so it could be major/minor depending on the certifier and assessor. This contrasts current advice from the QBCC which states that roof cladding is a structural component and that with 20% of cladding damaged, a certified upgrade is required.

Figure 10. Wind-induced roofing damage to high-set 1920s home as presented to builders, assessors, and engineers for experience based estimates of repair cost

4.2. Category 3 (165-224 km/h)

4.2.1. Garage Door Damage

Replacement of a torn and buckled double width (4.8 m) roller door on a 1990s single storey masonry block house. As the door is failing it scratches the paint on the block work wall supporting the tracks. There is also damage to the internal fibre cement ceiling with gouges and marks. Paint on the ceiling and the rear FC timber framed wall has water marks and blistering.

Cost: $3,000 to $5,000 (includes a cyclone rated door per latest building standard)

4.2.2. Wind Driven Rain Damage to Modern House

Wind driven rain enters underneath the sliding glass door in the living room of a 2000s single storey L-shaped masonry block house. The dimensions of living room are 4 metres x 6 metres with 2.7 metre wall height. Walls and ceiling are internally lined with plasterboard and the floor is tiled. Wind driven rain is "pushed" up the valley gutter, overflowing the pans (no sarking) and entering into the roof space causing ceiling damage (refer Figure 11 for an example). Ceiling damage extends in roughly a 2 metre radius from the centre of the room with partial collapse in this area. A light fixture is in the affected area. Skirting boards and the lower 200 mm of wall lining are damaged to 2 metres on either side of the door. There is access to roof space via manhole.

Cost: $4,500 to $8,000

Figure 11. Wind driven rain damage to a modern (2000s) masonry block home as presented to builders, assessors, and engineers for experience based estimates of repair cost

4.2.3. Roofing Damage to Low-Set 1930s Home

Replacement for loss of roofing and battens on a low-set timber clad 1930s house (assuming central area 8 m x 8 m with 3 m wide "enclosed sleep outs"). Refer to Figure 12 as an example. AC ceilings have been damaged in the living room. The floors are polished timber in most rooms with linoleum in the kitchen and bathroom. The kitchen and bathroom cabinets are water damaged (chipboard). The walls are lined with masonite.

Cost: $55,000 to $75,000 (average of approx. $70,000)

Figure 12. Wind-induced roofing damage to a low-set 1930s home as presented to builders, assessors, and engineers for experience based estimates of repair cost

4.2.4. Roofing Damage to High-Set 1970s Home

Loss of roofing and battens from a fibro clad elevated 1970s house (assume 12 m long x 8 m wide) with low pitch gable roof. AC ceilings have been holed in living room. The floors are polished timber in most rooms with linoleum in the kitchen and bathroom. Kitchen and bathroom cabinets are water damaged (chipboard). Walls lined with Masonite. Assume no damage to under the house.

Cost: $65,000 to $87,500 (full wrap scaffolding needed, assumption of extra $15,000 above low-set in previous scenario)

Figure 13. Wind-induced roofing damage to a high-set 1970s home as presented to builders, assessors, and engineers for experience based estimates of repair cost

4.3. Category 4 (225-279 km/h)

4.3.1. Garage Door Damage

Replacement for a torn and buckled double width (4.8 m) roller door on a 1990s single storey masonry block house. As the door is failing it completely tears loose and in doing so punches holes in the fibre cement ceiling, dents the guttering and roof cladding and marks the block work wall adjacent to where the tracks are fixed. There is water damage to the fibre cement lining, the ceiling and the back wall.

Cost: $6,800 to $10,000

4.3.2. Wind Driven Debris Damage to Modern Home

A neighbouring legacy home loses part of its roof and generates debris. Repair is needed for the 12 m long wall of an elevated steel framed house (assume rectangular wall and not the “gable” as shown in Figure 14). The wall cladding has been damaged, causing marks across the building wall. Guttering and downpipes have been removed. The eave lining needs replacement (assume 900 mm wide). The steel frame of the home is undamaged and internal water damage has not occurred.

Cost: $23,200 to $55,000

Figure 14. Wind driven debris damage to a modern home as presented to builders, assessors, and engineers for experience based estimates of repair cost

4.3.3. Roofing and Wall Damage to Low-Set 1930s Home

Loss includes all of the roof structure and half of the front wall for a timber clad low-set 1930s house (Figure 15). Extensive water ingress occurs in all rooms and damages the kitchen and bathroom cabinets (chipboard). All of the internal doors have delaminated. There are no built-in wardrobes in the bedrooms. The floors are polished timber in most rooms with linoleum in the kitchen and bathroom. The walls are lined with masonite. It is assumed that no damage occurs under the house. Respondents were asked to consider whether this scenario is a rebuild or a demolition.

Cost:

$120,000 to $165,000 (low-set repair) and $130,000 to $175,000 (high-set repair)

~$195,000 (low-set rebuild) and ~$250,000 (high-set rebuild)

Note: One responder noted that in their opinion it is faster to repair this style of house than demolish and build a new house (with estimate of a new build being $200,000 to $250,000) while another response noted demolition with a new build with estimate of $195,000 for low-set and $250,000 for high-set house.

Figure 15. Roofing and wall damage to a low-set 1930s home as presented to builders, assessors, and engineers for experience based estimates of repair cost (high-set costs were also evaluated)

4.3.4. Roofing and Wall Damage to High-Set 1970s Home

Loss of roofing, part of the roof structure and half of the front wall from a fibro clad elevated 1970s house (assume 12 m long x 8 m wide) with a low pitch gable roof (e.g. Figure 16). Extensive water ingress occurs in all rooms, damaging the kitchen and bathroom cabinets (chipboard). All internal doors have delaminated. There are no built-in wardrobes in the bedrooms. The floors are polished timber in most rooms with linoleum in the kitchen and bathroom. The walls are lined with masonite. It was assumed that no damage occurred underneath the house.

Cost: $155,000 to $200,000

Note: Responses included comment "should be able to be repaired and brought up to code without demolition, depending on the lower wall structure construction type"

Figure 16. Roofing and wall damage to a high-set 1970s home as presented to builders, assessors, and engineers for experience based estimates of repair cost

5. Retrofit Upgrade Cost Estimation

The selected mitigation solutions (roofing upgrades and opening protection only) were presented in "scenario" format to assessors, builders and engineers to provide cost estimates for implementing each solution in an undamaged structure (i.e. prior to a severe wind event). The roofing upgrades were applied only to pre-1960s and 1960-80s housing while the opening protection upgrades were applied to all housing ages. The first roof upgrade scenario includes replacement of the metal cladding and then strapping of the rafter to top plates. The second roof upgrade method is per HB132.2: Structural Upgrading of Older Housing and includes an external over-batten (steel angle 100 x 50 x 5mm or steel pipe 55mm OD) and threaded rod running down the exterior of the wall.

5.1. Cladding Replacement and Strapping of Roof Members

Replacement of the roof cladding (assume existing 75 x 50 mm hardwood battens are in good condition and correct spacing) and upgrade to roof structure connections via strapping. A rectangular housing plan of 12 m x 8 m was assumed with a hip roof 22.5 degree slope. Specifically the costing scenario included the following:

- Battens to be strapped or batten-screwed to rafters (Figure 17 and Figure 18)
- Collar ties installed for each rafter pair
- Strapping at rafter to top plate connections (Figure 19)
- Strap struts at ridge to hip beams down to ceiling joists

Cost: $30,000 to $53,200

Based on the costing feedback, the following values were provided to Urbis for economic cost-benefit modelling:

Pre60s housing

- Scenario 1 - $30,000 for complete roof replacement and strapping upgrades
- Scenario 2 - $3,000 for strapping upgrades (assuming upgrade when owner is replacing roof for other reasons)

1960-80s housing

- Scenario 1 - $27,000 for complete roof replacement and strapping upgrades
- Scenario 2 - $3,000 for strapping upgrades (assuming upgrade when owner is replacing roof for other reasons)

Figure 17. Batten screw from battens to rafters (pre drill before installing batten screws)

Figure 18. Example of nailed strapping for batten to rafter connection

Figure 19. Typical example of strapping for rafter to top plate connections

5.2. Over-batten Installation (HB132.2)

Over-batten construction for both a pre-1940s high-set house and a 1970s high-set house. The upgrade includes 12 mm tie rods at less than 3 m spacing. It was assumed that the pre-1940s house had a rectangular plan of 12 m x 8 m and a hip roof with 22.5 degree slope. The cost estimate includes over-batten installation for all four sides of the home. The 1970s house was assumed to have a low pitch gable roof (12 m x 8 m) with over-battens only needed along the two 12 m sides (e.g. Figure 20).

Cost: $11,000 to $17,000

Note: One of the responses included a comment that in their experience, the overbatten solution would not be preferred and should be improved as clients always want their home to appear equal or better than its appearance prior to repair.

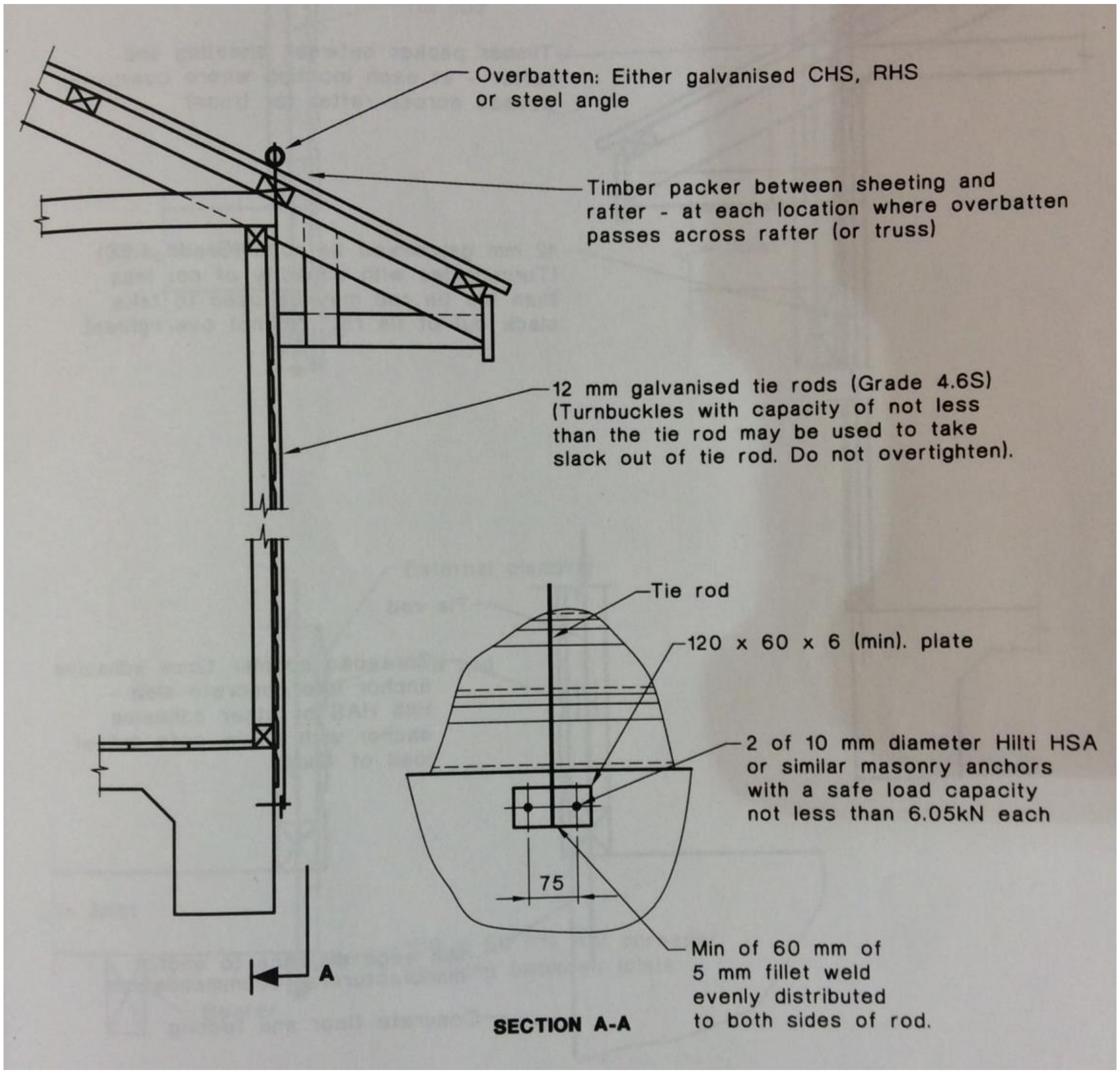

Figure 20. Drawing from Australian Standard's Handbook HB132.2 and Typical over-batten installation per HB132.2 Structural Upgrading of Older Houses

5.3. Opening Protection: Roller Door Upgrade

The costs associated with roller door upgrading were estimated at $300 for aftermarket supports (on a per house basis) from discussions with product manufacturers.

5.4. Opening Protection: Window Protection

The costs associated with window upgrading were estimated (on a per house basis) from correspondence with building contractors in Queensland and provided to Urbis for cost-benefit analysis. Each home was assumed to have eight windows and where upgrades were applied to all windows. It was assumed that the number of windows, window performance, and cost of upgrading were independent of the building age or construction type. The two upgrading scenarios (plywood vs commercial systems) were assumed to have the same performance benefits once installed (e.g. Figure 21). The costing was estimated as follows:

- Scenario 1 - Plywood shutters, $170/window for materials (DIY, not costing labour) = $1,360
- Scenario 2 - Commercial window protection shutters/screens, $400/window with labour = $3,200

Figure 21. Examples of plywood (DIY install) (left) and commercial (center and right) shutters for window protection

6. Literature Review: Drivers of Community Engagement in Mitigation

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In addition engineering analysis for mitigation solutions, a literature review of mitigation programs used internationally was conducted to inform the implementation of a Northern Australia program. The review emphasizes the consumer engagement perspective. Programs in Australia are discussed where possible, however the majority of works originate from the cyclone-prone southeastern coast of the United States. The applicability of these programs to Northern Queensland are discussed. The following are provided:

- A critical summary of the key facilitators of behavioural preparedness or mitigation action
- A summary of existing programs (emphasizing parallel work in Florida, USA)
- Recommendations for enhancing the effectiveness of mitigation programs in Queensland

6.1. Introduction

In Australia, extreme weather events have brought to focus the need to ensure that the communities in these vulnerable regions are appropriately prepared (Boon et al. 2012). Between November 2014 and May 2015 there have been eight natural disasters declared in Queensland (e.g., Tropical Cyclone Marcia, Brisbane floods, etc.), resulting in government funding assistance activations for people and communities adversely affected (Queensland Government 2015). These regions in Queensland are therefore increasingly vulnerable not only due to high frequency and intensity of extreme weather events but also due to increasing population density particularly near exposed coastal regions. This increased population density has resulted in a larger proportion of people, built environments and infrastructure at risk of negative physical, mental, social and economic outcomes (Middelmann 2007).

Increased vulnerability of built environments and infrastructure yields larger post-event financial costs in repair and recovery. Cyclone Yasi in Queensland was estimated to have cost $800 million in rebuilding assets and providing community support (The Queensland Cabinet and Ministerial Directory 2011). Research has suggested that the extent of damage experienced and the costs of repair and recovery can be minimised if appropriate mitigating actions are taken (Pinelli et al. 2009). Appropriate and effective mitigating actions include strengthening the house structure (Leatherman, Chowdhury, and Robertson 2007; Lavelle and Vickery 2013). It is therefore imperative that communities and individuals in these vulnerable regions are aware of the risks and are engaging in appropriate mitigation strategies to effectively prepare for an event.

In terms of human factors, preparedness is a building block of psychological resilience which in turn contributes to the mitigation of harm to mental, physical, social and economic wellbeing post-event (Ramirez, Antrobus, and Williamson 2013; Poussin, Botzen, and Aerts 2014; Boon et al. 2012). Building psychological resilience is particularly important due to the interconnectedness of these wellbeing outcomes. For example, poor emotional wellbeing has been associated with delayed recovery from economic loss potentially due to associated stressors of being financially restricted and as such inhibiting individual capacity to recover, rebuild and move on.

There are some suggestions that Queenslanders are relatively well prepared for the impacts of seasonal cyclonic events such as cleaning up yards, preparing food, water and medical provisions and securing furniture and belongings (King, Goudie, and Dominey-Howes 2006; The Office of the Inspector-General Emergency Management 2014). Yet this preparedness is limited in the context of structural mitigation actions (Poussin, Botzen, and Aerts 2014; The Office of the Inspector-General Emergency Management 2014).

A challenge to identifying facilitators of different preparedness behaviours is that these facilitators are typically situationally and contextually specific. **Factors affecting the success of a mitigation strategy differ by region, event type and targeted behaviour.** This review is specifically aimed at identifying facilitators to increasing homeowner engagement in strengthening or retrofitting homes vulnerable to tropical cyclones in Queensland. From the literature, the situational and contextual factors that influence the level of preparedness (Sattler, Kaiser, and Hittner 2000; Terpstra 2011; Pennings and Grossman 2008; Poussin, Botzen, and Aerts 2014; Norris et al. 2002; Bonanno et al. 2007) in this region include:

1. Existing community experience with event
2. Defined roles of responsibility for preparedness
3. Existing strategies
4. Policies and legislation that provides standards for preparedness
5. Quality of existing horizontal and vertical social and community relationships that influence responses to communicated preparedness messages

6.2. Facilitators of Preparedness Behaviour

Research investigating behavioural responses to threat suggests that adaptive responses are influenced by an individual's perceptions of vulnerability to and severity of the impact of the threat as well as their assessment of their perceived capacity to mitigate the negative impact of the threat event (Witte 1992; Grothmann and Reusswig 2006; Poussin, Botzen, and Aerts 2014; Maloney, Lapinski, and Witte 2011).

Research suggests that if an individual's appraises the likelihood of a threat as very low, then they will tend not respond to the threat (Maloney, Lapinski, and Witte 2011; Witte 1992). Similarly, if the individual's appraises the likelihood of the threat as high yet the perception of their ability to cope with these impacts is low, their response will tend to be one of fear and disengagement (Witte 1992; Maloney, Lapinski, and Witte 2011). Therefore, though it is important that a person perceives personal vulnerability to a threat, their perceived capacity to mitigate the negative outcomes of the threat must be higher than that of their perceived vulnerability in order for effective actions to be initiated. **This process of risk assessment can be conceptualised as a cost-benefit analysis.** However it needs to be noted that not all people assess risk similarly, particularly when taking into account specific contextual and situational factors.

Residents of Queensland face extreme weather event threats, such as cyclones and flooding, on an annual seasonal basis (Middelmann 2007). The events often have distinct warning periods, suggesting that people are aware of the likelihood of a future event and the regional vulnerability to an immediate event. However, not all warnings eventuate into actual events due to, for example, the size of the watch and warning zones and the directional changes of the cyclone path. This ratio of warning to event differs for different regions within Queensland, with some areas experiencing a high number of warnings and very low numbers of events. These contextual and situational factors result in a particular profile for residents of this region, (e.g., residents of Queensland have a high level of experience with disaster or potential disaster events).

Research has demonstrated that those who have had prior experiences with disaster events are more likely to respond adaptively to an event threat (Boon et al. 2012; Paton, Smith, and Violanti 2000). As a result of these past experiences and the seasonality of the potential events, residents are likely to expect future actual or potential events to occur and expect that they may be personally affected by this. However, residents differ in terms of their analysis of the risk involved and the cost-benefit of preparing for a potential event. This difference in analysis can be a result of multiple factors (e.g., complacency due to high warning/low event experience and low damage/high event experience). For example, research by Terpstra (2011) found that within communities who had experienced extensive flooding, those who had higher trust in public flood protection strategies reported lower personal preparedness intentions. These past experiences of few events or low levels of damage following a threat warning reinforces the perceptions of low personal vulnerability to an event (Pennings and Grossman 2008; Usher et al. 2013), even though perceptions of the probability of a severe event occurring may be high.

In a recent survey of household preparedness in Queensland it was found that though Queenslanders undertook basic preparedness activities, they also tended to overestimate their level of preparedness and, for some Queenslander's, their complacency was a major barrier in adequately preparing for an event (The Office of the Inspector-General Emergency Management 2014). **Therefore, the challenge lies in increasing preparation behaviour in a population that is highly vulnerable to an event but has great individual differences in the manner in which risk is perceived and the way the costs and benefits of preparations is evaluated.**

Research suggests that evaluation of risks and benefits of potential actions is influenced by the source of the message, the type of action being requested and the associated outcomes of that action. For instance, an individual's relationship with others in the community may influence the perceived quality and importance of the message being delivered (Ramirez, Antrobus, and Williamson 2013; Pennings and Grossman 2008). This relationship to community, sometimes called social capital, encompasses a person's sense of shared experience, reciprocity and trust towards others within their community (Cocklin and Alston 2002; Malecki 2011).

Social capital can include bonds between familiar in-groups such as family, peers and neighbours as well as horizontal connections towards unfamiliar out-groups such as the broader residential homeowner community or other regional residential communities vulnerable to the threat event (Woodhouse 2006; Woolcock and Narayan 2000; Pretty 2003). Further, social capital can include the vertical connections with unfamiliar out-groups such as an individual's trust and perceived connection to local government or state and national organisations (Szreter and Woolcock 2004; Pretty 2003). For example, if there was low vertical social capital between homeowners within a Queensland community and the State government, then homeowners may not attend to the government's message requesting homeowners to access services to assess the structural integrity of their homes to minimise risk of damage from cyclonic winds.

Establishing trust and connectedness between the target population and the source of the message influences attention and adherence to preparation advice (Ramirez, Antrobus, and

Williamson 2013). Yet attending to messages is only the beginning. **Research has also clearly established that though the target audience may attend to a message of behaviour change and acknowledge the adverse outcomes of not adapting, such attention does not necessarily translate into action (Witte 1992; Maloney, Lapinski, and Witte 2011).**

As mentioned previously, the second stage of threat appraisal is that of assessing levels of personal skills, resources and capacity to engage in the target behaviour (Maloney, Lapinski, and Witte 2011; Witte 1992; Poussin, Botzen, and Aerts 2014). It is therefore important to identify the factors that facilitate the acquisition of such skills, resources and capacity. These facilitators may include the acquisition of knowledge that increases confidence and capability of performing the behaviour or it may be receiving necessary support to complete the requested action. For instance, research by Mishra and Suar (2012) on flood and heatwave preparedness in India found that those who had greater preparedness education and greater access to resources, such as income, education and social resources, were more likely to be adequately prepared than those who had lower preparedness education and access to resources. Further, preparedness education and access to resources was found to mediate the relationship between anxiety and preparedness behaviour, with higher education and resources related to lower levels of anxiety.

As discussed previously, lowering anxiety or fear responses to potential threats are important in facilitating a positive assessment of a person's capacity to cope with the threat and consequently increases the likelihood of responding adaptively to a threat (Witte 1992; Maloney, Lapinski, and Witte 2011).

As stated, access to resources can help increase the uptake of preparedness actions. Yet access to resources seems particularly important if the intended mitigating behaviour is costly. For instance, research has suggested that the provision of financial subsidies is an important facilitator for engaging in structural mitigation behaviours (Poussin, Botzen, and Aerts 2014). Further, the personal time required for the mitigating behaviour also comes into the decision process. However, the decision to engage in the mitigating action is not only influenced by the cost of engaging but also the perceived beneficial outcomes (Poussin, Botzen, and Aerts 2014). Such beneficial outcomes can include the degree to which the behaviour is perceived to be effective in increasing resilience to negative outcomes.

Perceived effectiveness of outcomes can be influenced by, as previously discussed, the level of existing community connectedness and cohesion as well as the trust in those communicating the preparedness message (Ramirez, Antrobus, and Williamson 2013). Other beneficial outcomes for engage in preparedness behaviours may be the perceived usefulness of increased skills or knowledge that enhances the individual's ability to respond to a disaster or the beneficial financial outcomes of the preparedness action, such as a reduction in insurance costs (Poussin, Botzen, and Aerts 2014). For instance, research by Botzen, Aerts, and van den Bergh (2009) found that a majority of respondents from flood prone regions in the Netherlands were willing to undertake structural mitigation measures in exchange for reduction on insurance premiums.

These findings emphasize that although factors that facilitate mitigation action may be complex, targeted strategies that communicate the multiple benefits of undertaking action can be successful in changing behaviour.

6.3. Existing Programs and Strategies for Increasing Preparedness

The review of programs and incentives for homeowners to retrofit or strengthen their homes against extreme weather events is limited to storms and flooding since the process of risk assessment and cost-benefit analysis differs for different types of disaster events. Programs, policy and legislation for mitigation strategies that have been developed for increasing the resilience of residential structures against extreme wind conditions (and flooding) are discussed. Clear themes emerged for the types of strategies employed internationally including legislated building codes, funding opportunities for homeowners, financial incentives and community workshops.

6.3.1. Legislated Building Codes

Minimum building standard legislation and policy was the most common strategy employed by governments to decrease the vulnerability of communities to the adverse impacts of an extreme weather event (e.g. Office of Disaster Preparedness and Emergency Management, Jamaica, 2015; Department of Environment and Heritage Protection, Queensland, 2012; Florida Division of Emergency Management, US, 2011) (Department of Environment and Heritage Protection (Queensland) 2012; Florida Division of Emergency Management (USA) 2013; Office of Disaster Preparedness and Emergency Management (Jamaica) 2008).

This strategy predominantly involved outlining a minimum building standard with which new structures needed to comply. Failure to comply meant owners would be subjected to infringement fines and possibly prosecution. However, while these initiatives were often based within state-level government legislation, enforcement of the standards was a local-level government responsibility, as in the case of Queensland (Middelmann 2007). This suggests a potential for discrepancy of the operationalization of building standards between regional council communities due to differences in resource availability and therefore enforcement of the standards.

Additionally, in many cases where building standards are used as a mitigation strategy, the standards applied to only new building structures and are not retroactive. For example, residents of houses built prior to the standards implemented in 2002 in Florida, are not legally required to retrofit their homes to meet the post-legislative standards. Therefore, if this type of legislation and policy is the only residential building mitigation strategy in place in a vulnerable region, owners of older houses within these regions do not necessarily have adequate incentive to upgrade their homes. Further, if homeowners trust current mitigation strategies for associated extreme weather event impacts (e.g. flood management, warning systems, emergency relief and evacuation) to be adequate to protect them against substantial impacts, this may also reduce their willingness to undertake additional preparedness action (Terpstra 2011).

The level of action required to strengthen a home may require substantial costs and as such clear benefits, adequate perceived personal risk and adequate knowledge on how to respond must be communicated to homeowners (Witte 1992; Maloney, Lapinski, and Witte 2011; Poussin, Botzen, and Aerts 2014). Legislation- and policy-based mitigation on its own is probably not sufficient to engage homeowners in strengthening their homes against potential extreme weather events. This could be partially addressed by amending legislation to require homeowners of older homes to upgrade the building structure if the homeowner had, for example, replaced the roof of the house. However, this still requires homeowners to see the value in investing in a new roof, which may be further impeded by the additional costs that the amended legislation would require.

6.3.2. Funding Opportunities for Homeowners

Most mitigation programs and strategies identified originated from the USA, particularly Florida where there has been an increasing focus on mitigation strategies to protect against the adverse human and financial impacts of natural disasters (e.g., cyclones, thunderstorm, etc.). Funding opportunities varied with some opportunities originating from private companies/organisations in the form of long-term loans to strengthen and retrofit homes, while others were offered by government as a small grant.

For example, the PACE (Property Assessed Clean Energy) funding program was developed and delivered by a private company who offers loans to homeowners to make improvements on their homes (Florida PACE Funding Agency 2015). Originally developed in California for earthquake mitigation, the PACE program operates in conjunction with local governments in Florida to provide loans to eligible residents to undertake home improvements through state-approved contractors. The loans are available to commercial or residential buildings as long as there is existing insurance for the building. The government also provides financial security for mortgage lenders to reduce financial risks associated with defaults on mortgages. The length of the loan is approximately 15-20 years and is attached to the building, not the owner, and has repayment priority over the mortgage. These conditions have generated concern about the financial risk involved for an individual undertaking the loan and thus may make the program unattractive in the long term (Federal Housing Finance Agency 2010; Moody's Investors Service 2014). The conditions also present barriers to those who have limited financial security and therefore cannot undertake the additional financial burden.

Though a review of the effectiveness of the PACE program in Florida cannot be identified, past evaluations in other states in the USA have reported success in the uptake of the program by residents as well as considerable economic benefits for the immediate community and broader population (Goldberg, Cliburn, and Coughlin 2011; Saha 2012). For example, in the Boulder County, Colorado, the PACE-funded program funded $US9.8 million in residential retrofit projects in the first phase of the program’s delivery (Goldberg, Cliburn, and Coughlin 2011). It was estimated that delivery of this program contributed to $US14 million in economic activity in the county. Therefore, despite the concerns raised regarding the financial risk for homeowners, the PACE program can be considerably beneficial for regional communities not only through reducing structural vulnerability but enhancing the economic wellbeing of the region.

The ‘My Safe Florida Home’ project by the Florida Department of Financial Services offered Floridian homeowners the opportunity to apply for a $US5000 grant to retrofit their homes (Sink 2013). This program also offered a free house assessment for structural vulnerabilities to wind, with the findings provided to the homeowner in a report. The report outlined the appropriate structural improvements that could be undertaken, the cost of these improvements and the associated discount in insurance premiums if improvements were undertaken. This program targeted residents who were owners of a single-family, site-built home, living in a high risk region for wind damage who had had an older home and were of a lower-socio economic status. The targeting of residents of lower financial security who lived in older homes in a high risk area would help to reduce the impact of adverse outcomes to one of a region’s most vulnerable populations.

As highlighted previously, financial limitations can be a major barrier to undertaking recommended actions to effectively prepare for a potential event (Poussin, Botzen, and Aerts 2014; Mishra and Suar 2012). Therefore, this type of targeted provision of assistance is a more equitable approach to enhancing the strength of homes to those who would otherwise be unable to afford to do so. As of 2008 there were 179,390 inspection applications submitted from across Florida, with 109,000 of these applicants eligible for funding (Sink 2008). It was estimated that on average homeowners saved $US224 in insurance costs, with a potential state-wide insurance savings of $US24.5 million (Sink 2008). A study by Chatterjee and Mozumder (2014) found that residents who were more likely to seek home inspection as a part of the My Safe Florida Home program had home insurance, prior experience with damages and a higher sense of vulnerability.

However, these strategies of providing funds to homeowners to enhance the strength of their home may not be attractive to all homeowners. For example, low trust in the source of the support can result in this support being seen as undesirable (Pennings and Grossman 2008; Ramirez, Antrobus, and Williamson 2013). Therefore, other strategies need to be used to increase engagement from homeowners that are not attracted to offers of financial assistance.

6.3.3. Insurance Premium Reductions

As demonstrated in the 'My Safe Florida Home' program, one possible incentive for homeowners to strengthen their homes is that of reduced insurance premiums. In Florida, it is now a legislated requirement for insurance companies to provide homeowners with reduced premiums based on the evaluated strength of the structure. In some programs for reduced insurance premiums, these reductions can differ depending on the level of structural strengthening in place. For example, the Fortified program developed by the Insurance Institute for Business and Home Safety provides gold, silver and bronze standards for insurance companies and residents which provide guidelines of home strength (Insurance Institute for Business and Home Safety 2013). Insurance premiums are then reduced based on the level of standard followed, with a gold standard having the highest level of protection/strength against potential damaging weather events.

A public opinion survey of Floridian residents indicated that for 40% of respondents, the reduced insurance premiums were a key motivator for homeowners in undertaking improvements on their home (Sink 2008), a finding which is consistent with past research (Botzen, Aerts, and van den Bergh 2009). Results also indicated that it was important to respondents that this option was something they could choose to do rather than being forced upon them (Sink 2008). This may be analogous to residents feeling a sense of control over the suggested action. Control over choice is consistently associated with increased likelihood of performing an action (Brody, Grover, and Vedlitz 2011; Sattler, Kaiser, and Hittner 2000). Taking up the option would also tend to enhance confidence in the resident's control over adverse outcomes. Further, 40% of respondents also reported that they were more likely to undertake improvements if others in their community were also strengthening their homes (Sink 2008). This is consistent with research that reports people are more likely to respond in a manner similar to those with whom they have connections and that they trust (Ramirez, Antrobus, and Williamson 2013), which is more likely to be 'familiar others', such as neighbours and friends, than 'unfamiliar others' such as hypothetical exemplars in promotional materials.

These types of insurance incentives seem to be a predominately American technique though some alternative forms of financial incentives are evident in the Australian context. For example, the Victorian Country Fire Authority and the Building Commission developed a set of guidelines for renovating and rebuilding homes in areas highly vulnerable to destruction from bushfires (Department of Environment and Heritage Protection (Queensland) 2012; Victoria Building Authority 2015). The guideline offers a list of recommendations for strengthening homes against bushfire impacts. Though insurance premium reductions are not offered, homeowners are informed that the environmental rating of the home would be improved and outcomes are operationalised in terms of dollars as reductions in heating and cooling energy costs. Despite this incentive, some anecdotal evidence suggests that homeowners in bushfire vulnerable regions of Australia are not upgrading homes to the highest level of protection due to the misconception that the suggested mitigation strategies are too costly (Weir 2015).

It is argued that if the benefits of these strategies were appropriately communicated, then there would be a higher uptake in homeowners strengthening their home. This again supports research evidence regarding the importance of social capital in communication (Ramirez, Antrobus, and Williamson 2013; Pennings and Grossman 2008; Szreter and Woolcock 2004).

6.3.4. Two Example Programs in USA

Two mitigation programs from Florida, USA are provided as examples. The first is a previously active program that assumes a key motivator will be insurance savings and uses a form of self-assessment. In this quasi-government run program, homeowners answer a series of questions about their property to understand the insurance savings that they may currently be entitled to from different insurers. A link to the assessment tool is provided below:

http://www.floridadisaster.org/wisc/

The second program identifies similar mitigation features to those relevant in Australia and includes a funded mitigation program based on retrofitting key items, as outlined below and illustrated in Figure 22:

Benefits of Wind Mitigation (from program website)

- Protects the homeowners family and the home’s value
- Reduces disruption of communities, Improves health and safety
- Reduces or eliminates the need for post-storm sheltering costs
- Potentially reduces hurricane insurance premiums
- Creates jobs and revenue in the community
- Reduces financial impact on state and federal treasuries
- $1 spent on mitigation saves $4 in response and recovery costs (FEMA estimate)

Figure 22. Illustrative example of a USA mitigation program that offers funding for upgrading (http://retrofitswfla.org/)

Both these mitigation programs have relevant components to older building issues in Australia but need to be explored to determine whether outcomes were/are successful.

6.4. Communication with Target Communities

As research has repeatedly demonstrated, developing and delivering programs and services does not necessarily result in people being aware of the existence of, or understanding, the benefits of using the service (Updegraff et al. 2007; Terpstra, Lindell, and Gutteling 2009; Kellens, Terpstra, and De Maeyer 2013; Hawkins et al. 2008). Therefore for a program to be successful it needs to be effectively communicated to the target audience. For example, in Florida the government has also developed a number of community programs and workshops that aim to enhance resident knowledge and understanding of the assistance and services available for them to improve their homes as well as providing a cost-benefit analysis for engaging such assistance and services (Florida Division of Emergency Management (USA) 2013). This is a similar strategy employed by the Queensland Government for disaster preparedness (e.g. Get Ready Qld program) with the exception that in Queensland the focus is on communicating information rather than providing incentives. For example, in the lead up to the start of the cyclone season in Queensland, local and state government work in coordination to deliver preparedness information at local community events (Disaster Management 2015).

This type of strategy employed by the Florida government can achieve a number of outcomes. First, the knowledge that is being disseminated to residents provides them with a better understanding of their personal risk in an extreme weather event. Second, it provides an avenue to increase understanding of the nature of effective actions that can be taken to reduce such risk. It is this type of information that is critical in building self-efficacy and resilience. Third, the cost-benefit analysis that individuals engage in when deciding whether or not to engage in preparatory actions can be guided so as to optimise the performance of desirable behaviours. Direct interaction with community members also helps identify those most at need of particular assistance allowing better match between the individual and the program, therefore contributing to improved distribution of resources.

6.5. Summary

This review has highlighted a number of factors. First, though there are a number of programs existing internationally, particularly in the United States, there are no coordinated, planned and implemented programs in Australia with the aim of increasing homeowner engagement in mitigation strategies to strengthen their home. Secondly, of the programs and services reviewed, it is clear that a "one size fits all" approach is not appropriate as individuals are motivated by different incentives. Third, using only one approach may also not be sustainable over longer periods of time, such as the provision of government grants. Fourth, programs must be appropriately marketed to individuals and communities based on identified key motivators for engaging in mitigation strategies. These motivators will differ between individuals and communities based on their level of experience with extreme weather events, perceptions of risk and responsibility, connectedness and trust towards others and the availability of resources (Bonanno et al. 2007; Sattler, Kaiser, and Hittner 2000; Poussin, Botzen, and Aerts 2014; Pennings and Grossman 2008; Terpstra 2011).

6.6. Recommendations and Suggested Research

To inform an effective mitigation program, it is recommended that homeowners in Queensland be profiled based on their likelihood of accepting different types of incentives. Profiles of owners who do, and do not, perform different types of damage mitigation behaviours will be interviewed, enabling the delivery of targeted communication and tailored incentive programs aiming to increase desirable behaviours. For example, younger homeowners with less experience of extreme events and high intentions to sell properties in the near future, may find 'cash back' offers for retrofitting more attractive than decreases in insurance premium costs over the longer term. Further, individuals in areas where residents have strong community ties may respond to communications inviting social comparisons ("What are your neighbours doing about this?") more favourably than residents in areas without such linkages.

Using a survey methodology, the suggested research would investigate how social and community characteristics, information seeking behaviour and preferences, past extreme weather event experiences, and perceptions of threat and risk, influence behavioural preparedness. The interaction of such variables and demographic characteristics of individuals should also be investigated. It is suggested that at least three different communities be targeted based on differences in objective levels of vulnerability to adverse outcomes from an extreme weather event. This will enable inclusion in the design consideration of objective risk of extreme weather events, types of housing stock, and the experience of the residents with extreme events. To ensure adequate sampling of individuals, a research team at JCU has in the past used a combination of 'pen and paper' and electronic delivery of survey instruments. Both have advantages and both tend to reach different segments of the population.

Predictive modelling should be used to examine the interrelationships between the assessed variables and the behavioural outcomes. This will allow the relative contribution of variables to the desired outcomes to be assessed and enable the resulting model of behaviour to be refined. This procedure provides evidence of causal relationships and identifies possible intervention points. Profiles of homeowner typology should then be developed using a cluster analysis technique. This analysis technique is routinely used in marketing research to develop profiles of particular types of individuals from known standing on a set of descriptive variables (e.g., gender, income, age) with reference to standing on an measure of consumer behaviour (e.g., purchase of a type of car). This latter technique provides a rich picture of population segments in terms of the variables known to be related to behaviour.

Along with appropriate knowledge of the relevant evidence base, the research should have a history in the practice of survey design, implementation and data analysis. Ideally, they will have worked with communities within the North Australia area and have links to community and government organisations within the region. Such linkages are important to the implementation phase where community good will is essential for promoting the research and gaining adequate and representative sampling of individuals and households.

7. Proposed Mitigation Program Framework

Building on the analysis and information from the literature provided herein, conceptual frameworks for the inspection and reporting aspects of a mitigation program in north Queensland were developed in a preliminary sense. In this first instance, it was assumed that the sample-set of mitigation solutions discussed in Section 3 are to be implemented. The outcomes are presented with the understanding that they may inform the development of comprehensive programs for north Queensland in the near future. Two concepts were considered, the first includes a more traditional approach where inspections are completed by a qualified inspector, while the second makes use of smart-phone technologies allowing consumers to "self-assess". An alternative framework for a current program in the US is also discussed. It is important to note that an effective mitigation program may require a combination of each of the options considered.

7.1. Option A: Formal Inspections

The evaluation is based on assessment of risk via property inspections conducted by a suitably qualified inspector. This could be (a) government funded, (b) from the insurer or agent or (c) a third party on behalf of owner. Inspectors would need to demonstrate an adequate level of current knowledge and may need additional training for this work.

This option is similar in principle to what has been proposed by CTS to the Insurance Council of Australia for strata properties in cyclonic regions. Details of the inspection process including the survey scoring system, required level and content of training of the inspectors, and possible administration are documented in the following reports:

CTS report TS899: *Pilot study: Examination of strata building risks from cyclonic weather by utilizing policy claims data*
www.insurancecouncil.com.au/assets/report/Independent%20strata%20study.pdf

CTS Report TS948: *A scheme to estimate the resilience of strata properties in cyclonic areas*
www.insurancecouncil.com.au/assets/media_release/2014/July%202014/100714%20Report%20JCU%20Engineering%20Inspection%20Scheme.pdf

The survey process as described in the reports to ICA for strata properties is by necessity more detailed that what would be required for a formal survey/inspection for housing. Nevertheless, the process would deliver an overall building rating for the estimated resilience of the property and provides details on possible areas/components of concern. Mitigation options could be provided based on the survey results. It is estimated that each survey would cost in the order of $500.

Benefits of this work extend beyond the potential for reduced premiums and the increased understanding of an insurer's own portfolio. The process will improve the resilience of the wider community through both increased awareness and building maintenance/retro-fitting. The survey of buildings will allow a comprehensive assessment of building performance and potential issues. Remediation of the identified building elements that may limit strength or amenity will result in lower damage bills and a more resilient community.

In terms of housing, it has been considered too expensive to conduct individual property inspections as part of the insurance of residential property. However, with premiums in the order of $3000 a reduction of 20% will “pay” for the survey over one to two years. Most of the information that is captured in an inspection will not change from year to year, so a repeat inspection may only be necessary every 7-10 years, with additional inspections after any significant mitigation process. Given these factors, it may be possible to contain the cost of inspections to 2-3% of the premiums paid over the same period.

In cases where an inspection shows that risks were adequately controlled, this information might help to justify a reduction in premiums such that the inspection cost was met in the first year, with savings to the homeowner in subsequent years along with confidence that the insurer was not overly exposed to risk.

Where inspections result in a recommendation for mitigation actions, there would need to be adequate incentive to encourage the homeowner to take action. The insurer may be prepared to share some percentage of the initial cost, along with agreeing to a discount on premiums if the mitigation work is completed. It may also be possible to encourage governments to assist in the cost of inspections, retrofitting programs, interest free loans, etc., all with the outcome that will improve the communities’ resilience.

To enable the formal inspection process to provide confidence to owners, insurers and regulators, specific guidance in the form of AIBS webinars will need to be provided to qualified building inspectors/certifiers as explored in the ICA strata reports. In addition to the training, a Queensland Building Code form for structural retrofitting/renovation will be needed. It is envisaged that this would be a modified form of existing compliance forms (e.g. Form 21) where the level of retrofitting is inspected and “signed off”. In discussions with the QBCC, a modified version of the form was seen as an appropriate path with the process also improving inspection processes for the reroofing of housing following wind storms.

7.2. Option B: Self-Assessment

The second option considered is based on supplying additional information about property resilience to the insurer, through a combination of self-assessment by the property owner and some level of auditing by the insurer or their agent.

7.2.1. The Self-Assessment Form

It is proposed that a self-assessment form be developed, to allow property owners to report on key factors about their property. In addition to traditional paper format, a mobile application software tool for self-assessment (and mitigation action decision support) could be developed. In both formats, the captured information can be used to inform insurance pricing.

The self-assessment process could be supported by some level of auditing. The extent of this auditing may vary depending upon the initial results. While the auditing may help to improve confidence in the data, the main intent of the auditing would not be to act as a “policeman” but rather to refine the self-assessment process to ensure that homeowners are capable of answering the questions easily and reliably.

The challenges in developing a self-reporting form is to focus only on those factors that are easy for the homeowner to answer, while capturing key information that is relevant to the resilience of the property. To do this, the CTS suggests drawing on experience from previous damage investigations, as well as insurance claims data, to categorise the key areas of vulnerability. Some considerations that may be used to develop the self-assessment form include:

- The age of the property can affect its performance for a number of reasons
- There are specific vulnerabilities in new construction that may affect property resilience (e.g., water ingress around windows and doors)
- Construction quality affects performance
- Property maintenance affects performance
- Additions to homes that are not to the same standard as the original dwelling, or that have not been formally approved, generally do not perform as well as the original dwelling
- Specific construction details can affect water ingress, which is a significant driver of loss

7.2.2. A Mobile Application Tool for Self-Assessment

The development and near ubiquitous adoption of smartphones in Australia make it an ideal platform for enabling homeowner self-assessment and mitigation decision support. Research has also established the effectiveness of smartphones as mobile education devices (Wood et al. 2012) and has proposed the use of smartphones in disaster communication (Riddell et al. 2011; Meltzer et al. 2014). A smartphone application is proposed as a self-assessment tool that also educates and engages homeowners in cyclone-prone regions to make better decisions regarding mitigation.

The CTS suggests leveraging the efforts already invested in a US-based version of a similar application, entitled “ResilientResidence”, and currently in development phase in the State of Florida. The framework for the app, currently provides a personalized wind risk assessment of the user’s home, including the anticipated losses that would occur in a scenario event (e.g., Category 5 cyclone). Further, based on the self-assessment data supplied by the user, the app provides retrofit solutions that are specifically tailored to reducing wind-induced losses for that home. The core objective of application is to promote decision-support for homeowners to engage in mitigation activities and to information reporting. The self-assessed information recorded by the application can be aligned with the paper format version of the self-assessment form and transmitted to the insurer and collated at aggregate level for research. The app concept hinges upon the idea that mitigation information presented in abstract, large-scale terms is often less impactful to an individual’s mitigation decision-making process than specific, personalized content (Wood et al. 2012).

The current wireframe version of the app (Figure 23) allows individual homeowners to define the location (using either location based services or user input) and structural characteristics of their homes through an interactive series of questions, and then receive an engineering assessment (in simplistic format) of the expected damage their home would receive during a Category 1 through Category 5 cyclone event. The app then recommends three retrofit options that are likely to minimize the loss potential for the home, showing the homeowner the estimated reduction in expected losses from a cyclone for each retrofit. Homeowners are provided with helpful hints and graphics throughout the process in order to educate them on construction features deemed critical for wind-resistance. In addition, there are options for contacting a team of experts to answer questions.

Figure 23. Images of the "ResilientResidence" mobile application. A user supplies resilience-essential information about the home (left), and retrofits are recommended with estimated loss reduction of each for varying cyclonic events

8. Summary and Recommendations

Mitigation pricing and associated reductions in loss for cyclone intensities were estimated from Suncorp claims data, and estimates from assessors, builders and manufacturers.
The mitigation measures costed were;

- retrofitting to roof structure for pre 1980s houses (upgrading roof framing connections),
- Protection of windows and doors to reduce wind driven rain ingress and reduce likelihood of a windward dominant opening forming, and
- Community awareness measures (effective ongoing maintenance of house, dismantle shade cloth awnings, unblock gutters, prune trees away from house, appropriate tie down for garden sheds, etc.)

The pricing and loss data were supplied to Urbis to conduct a cost-benefit analysis. The cost baselines (numbers and amount of damage) are based on the TC Yasi Suncorp claims data. The data is provided as reductions in percentages of loss ratio.

It is recommended that the models be developed further to include probabilistic components for both wind speed, and capacity and damage/loss of building elements. The resultant models could be (a) validated with other cyclone loss data, and (b) include other loss reduction measures such as ongoing improvements in building codes (e.g. changes to garage door standard following Cyclone Yasi).

Community awareness mitigation programs
In terms of a community awareness program for mitigation, the literature review noted a "one size fits all" approach to mitigation programs is not appropriate as individuals are motivated by different incentives (e.g. financial, level of hassle, engagement with the neighbours). The incentives and motivators will differ between individuals and communities based on their level of experience with extreme weather events, perceptions of risk and responsibility, connectedness and trust towards others and the availability of resources. Further research (e.g. via online and phone polls) to ascertain most effective motivators for different demographic groups is required.

Community Engagement Considerations
There is an opportunity for the whole community to benefit from an increased focus on mitigation:

- Homeowner – increased security during storm, promoted increase in house market value if retrofits undertaken, reduction in insurance premiums
- Government – reduction in drain on community services during and after severe event, more resilient community
- Industry – niche market for retrofitting and upgrading products as well as the building trades to professionally undertake retrofitting

Proposed "structural" mitigation programs
Based on the literature review and CTS experience as a long-term proponent for cyclone mitigation practices, two conceptual frameworks for a mitigation program were developed. The first includes a more traditional approach where inspections are completed by a qualified inspector, while the second makes use of smart-phone technologies allowing consumers to "self-

assess”. It is important to note that an effective mitigation program may require a combination of each of the options considered.

It is recommended that further investigation be conducted into;

- Engagement with QBCC regarding development of a targeted building certification form for retrofitting work to older housing to allow insurers and home owners to demonstrate effective structural mitigation.
- Collaboration with building product manufacturing associations to explore economies of scale for components for retrofitting (e.g. roof space framing connectors, door braces, gutter brackets, fence supports, shed tie-down, etc.)
- Continued discussions with building associations (MBA, HIA) to promote skills and market niche branding for structural retrofitting of older housing

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Protecting the North

The benefits of cyclone mitigation

20 July 2015

urbis

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An MS Word version of this report, Protecting the North, has been provided to Suncorp for convenience. However, for purposes of certainty, the PDF version, dated 20 July 2015, should be regarded as the final and definitive version.

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CHARTS

PICTURES:

TABLES:

Executive summary

Over the past decade alone, Northern Australia has experienced 18 severe tropical cyclones that have made landfall[1], resulting in loss of life, extensive property damage and social and economic disruption to both the region and more broadly across Australia.

The financial cost of such disasters has had a measurable impact on insurance premium affordability for home-owners in cyclone-prone regions. In 2012-13, Australian premium rates were, on average, around 50 per cent of North Queensland premiums (Martin, 2014).

Declining premium affordability prompted the Federal Government to announce, in March 2015, the Northern Australia Insurance Premiums Taskforce, which is

> *charged with exploring the feasibility of options that use the Commonwealth balance sheet to reduce home, contents and strata insurance premiums in those regions of Northern Australia that are experiencing insurance affordability concerns due to cyclone risk. (Josh Frydenberg MP, 2015)*

Two options put forward by the Taskforce for consideration include a mutual cyclone insurer and a cyclone reinsurance pool. These options – an example of which is the US National Flood Insurance Program (NFIP) – reduce premiums to consumers by providing a government subsidy. The cost of such an approach is increased cost and risk to Government.

By contrast, mitigation options to reduce property damage from cyclones have the potential to not only lower premiums **but also to reduce the indirect economic costs borne by the community and governments**.

Such costs include loss of life and injury (both physical and psychological), disruption to businesses and services, absenteeism, presenteeism, dislocation and wider community property damage. These costs are difficult to estimate precisely, but are reported to be in the order of 20% (minor flooding) to 200% (Hurricanes Sandy and Katrina) of total property losses, increasing with the severity of the event (Walker et al, 2015). The portion of these broader impacts that is directly attributable to damage to housing – rather than the winds themselves – is difficult to estimate, but would conservatively be in the order of 10% for higher category cyclones.

The Taskforce's remit includes both housing stock and strata properties across all of Northern Australia. North Queensland, with more than 350,000 houses and a population of over one million, including a number of major regional population centres is the largest and most densely populated cyclone-prone region in Australia. This combination of factors also makes the region potentially the most viable in terms of investing in cyclone mitigation strategies.

Understanding the fragility of strata complexes and the implications for insurance premiums is covered separately in research undertaken by James Cook University's (JCU) Cyclone Testing Station on behalf of the Insurance Council of Australia (Henderson & Ginger, 2013).

This report examines costs and benefits of a range of mitigation options for housing stock in North Queensland, drawing on work undertaken by JCU's Cyclone Testing Station based on outcomes from Tropical Cyclone (TC) Yasi, and detailed insurance information provided by Suncorp Group.

Mitigation strategies modelled were chosen based on a range of research that supports the proposed options, including the CSIRO submission to the Productivity Commission Inquiry into Natural Disaster Funding which states that:

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[1] TC Ingrid (2005), TC Claire (2006, WA), TC Larry (2006), TC Glenda (2006, WA), TC Monica (2006), TC George (2007, WA), TC Hamish (2009), TC Laurence (2009), TC Magda (2010, WA), TC Ului (2010, QLD), TC Yasi (2011), TC Heidi (2012), TC Lua (2012), TC Rusty (2013), TC Christine (2013), TC Ita (2014), TC Lam (2015), TC Marcia (2015); (Queensland Government, 2014) (BOM, 2015b)

There are some retrofitting activities which are inexpensive and easily implemented, which provide significant benefits (even if these fall considerably short of those achievable in new buildings), and which could be encouraged by governments and potentially by building standards. For example, modest and inexpensive improvements to roof ties deliver significant protection for old buildings in cyclone areas. (CSIRO, 2014)

Findings from Queensland (Smith & Henderson, 2015) and Florida (Malik, Brown, & York, 2012) both identified roofing and damage through openings as key drivers of insured losses.

APPROACH TO COST BENEFIT ANALYSIS

Modelling undertaken assessed the relative costs and benefits of three mitigation measures for houses:

1. structural roof upgrading (applied to pre-1980s housing only)
2. opening protection for windows and roller doors (applied to all housing ages)
3. community preparedness/awareness campaign (applied to all housing ages).

Costing for each housing measure was provided by JCU's Cyclone Testing Station with a range of options at different price points. The community awareness campaign was costed on the basis of the *Get Ready Queensland* program; it is assumed that a similar (additional) program that specifically targets cyclone prevention measures is delivered annually over the forecast period.

Three different house types were modelled, based on age brackets and design similarities.

- House Type A: Pre-1960
- House Type B: 1960-1980
- House Type C: Post-1980

Benefits were measured in terms of avoided losses to houses as a result of implementing mitigation options, using estimates provided by JCU's Cyclone Testing Station. These estimates have been derived based on actual outcomes for TC Yasi, drawing on Suncorp Group's database. Losses for household contents and global community losses were also taken into account.

Costs and benefits were measured over a fifty year period, with payback periods calculated for each measure (the payback period is applied across all parties, not just the consumer).

Forecast wind speeds over the fifty year period were modelled using eight return period events, ranging from five years through one thousand years. The modelling captures speeds of between 75 kph and 250 kph, Both cyclonic and non-cyclonic winds below this band are excluded while winds in excess of 250 kph are treated as inflicting the same level of damage as a 250 kph wind. Estimates are therefore likely to be conservative.

The wind speeds modelled drew on four reputable catastrophe models. The range of forecasts across the four models was used to reflect what is inherently an uncertain outlook by effectively providing sensitivity testing for the analysis; actual outcomes are most likely to fall somewhere between the range of results presented and Urbis has used the two central case outcomes as a benchmark, with both the lower and upper bounds considered less probable.

FINDINGS

Low-cost mitigation options for roofing and openings produced benefit-cost ratios (BCRs) above one, (that is, benefits outweighed costs) under modelled wind speeds, as shown in the following table. The table reflects the range of possible outcomes for the two central case models.

TABLE E-1 BENEFIT COST RATIOS FOR MITIGATION

MITIGATION OPTION	COST PER HOUSEHOLD	TOTAL BENEFIT PER HOUSEHOLD**	BCR	PAYBACK PERIOD***
Community awareness campaign*	$55 - $136	$440-$820	3.2 – 14.8	<1- 6 years
Opening protection – self-installed (Low cost scenario)	$1,660	$1,990-$6,400	1.2 – 3.9	4 – 21 years
Roofing option – strapping only (Low cost scenario)	$3,000	$12,900-$38,800	4.3 – 12.9	2 - 4 years
Roofing option – over-batten system (Medium cost scenario)	$12,000	$13,500-$39,400	1.1 – 3.3	5 – 37 years

*NB: Values taken as an average over House Type A and House Type B, except for community awareness campaign, which is an average over all house types. Total Benefit does not discount the cost of mitigation. The lower range of values are based on conservative wind speeds and are modelled over only 39 postcodes. *Government funded campaign, applied per household. **NPV over 50 years. ***Payback period refers to the number of years required for the value of benefit to outweigh cost of mitigation option – applied across all parties, not just the consumer.*

Source: Urbis modelling, JCU, Suncorp Group

The community awareness campaign and the low-cost ($3,000) roofing option delivered BCRs greater than one for all four modelled wind speeds.

A suite of low cost mitigation measures delivered a BCR of 3.2 under low wind speeds and, in the case of TC Yasi, the BCR for the same options was 1.2 for this single event.

It is important to note that the avoided costs of physical damage to property as a result of mitigation fall across different groups. Insured households avoid any excess that would be payable, insurance companies avoid payouts and government avoids the cost of collateral damage to community property.

CONCLUSION

The benefit cost modelling for mitigation strategies demonstrates that these can be cost-effective at the right price points in high-risk areas. Implementation of these options can therefore lead to lower premiums for households as well as improved economic outcomes for the broader community through lower direct and collateral damage.

Households will only undertake mitigation, however, if there is the correct incentive to do so; in particular, any reduction in premiums must be at least equal to the cost of mitigation. In other words, the lower payout and recovery costs for insurance companies and governments need to be at least in part transferred to households so that they do not bear all the cost of mitigation without commensurate benefit. At current price points, a combination of government rebate and insurance premium reduction is likely to be necessary to ensure a reasonable pay-back period.

The level of rebates required over and above premium reductions to ensure take-up will, in some instances, exceed the estimated benefit to government via avoided community losses. In such instances, a benefit cost analysis of alternative options to government (as the provider of rebates), needs to be considered to ensure this represents the best outcome. Current alternative options under consideration are a reinsurance pool or mutual insurance, which involve increased cost to government in the event of a cyclone, in contrast to mitigation which lowers costs for all parties.

In addition, it is worth exploring new ways to reduce mitigation costs through further detailed research of enhanced, lower cost product options and large scale roll-outs to achieve economies of scale. There may be a role for government to fund such research, to be conducted by existing centres of excellence in Australia, such as JCU's Cyclone Testing Station.

Creating a market for mitigation products may also provide opportunities for cost reductions. Experience curves for other products, notably solar panels, but also energy-efficiency innovations in the building sector more generally, demonstrate the potential for mitigation options to improve pricing outcomes over time. For example, capital expenses for solar are forecast to fall in Australia by over 40%, between 2010 and 2030, as the use of solar becomes more widespread (Hearps & McConnell, 2011).

Undertaking mitigation reduces the risk and magnitude of damage to a household. Furthermore, mitigation strategies such as the community awareness campaign can reduce the large number of minor claims that typically result from a cyclone which are also administratively burdensome for householders and insurance companies. These improved outcomes provide scope for potential reductions in insurance premiums.

This report is a first step towards understanding the potential for mitigation options to deliver substantial economic and social benefit by reducing damage when cyclones hit and by lowering premiums. This outcome is considered superior to that of a reinsurance pool or mutual insurance that reduce premiums only, through increased risk to government balance sheets without any concurrent reduction in actual damage.

Finally, in recognition of the importance of Northern Australia – that is, the Northern Territory and those parts of Queensland and Western Australia that sit above the Tropic of Capricorn – to Australia's future economic prosperity, the Federal Government this year released the White Paper, *Developing Northern Australia (2015).*The White Paper looks at opportunities to expand the economic development of Northern Australia, particularly in agriculture, mining and tourism, through investment in infrastructure and a strong workforce. Building resilience in the homes of that workforce will be a significant element in the successful further development of the North.

Introduction

> *As Australia's population density increases as well as the severity and frequency of storms, floods, cyclones and bushfires, costs [are] projected to soar from $6.3 billion a year [in 2013] to about $23 billion a year in 2050. (Munich Re, 2013)*

As Australia's economic development increases the stock of the economy's physical assets, and especially housing, the impact and cost of natural disasters is also rising. This has been exacerbated over the last decade by an increasing incidence of extreme weather events, including 18 severe tropical cyclones in Northern Australia that have made landfall.

The differing nature of housing types and ages, population density and cyclone frequency and severity differs across the expanse of Northern Australia indicates that mitigation measures may have quite varied outcomes in different locations.

Properties in North Queensland are exposed to a much higher cyclone risk than other areas of Australia (James Cook University, 2015), which in turn has led to a significant increase in residential property premiums – and a decline in affordability – for home-owners in cyclone-prone regions. For this reason, modelling has been focussed, in the first instance, on housing stock in North Queensland.

The Australian Government Actuary has observed that property insurance prices in North Queensland are significantly higher for home insurance than elsewhere in Australia (Martin, 2014). The Northern Australia Insurance Premiums Taskforce was established by the Federal Government in March 2015 in response to declining insurance affordability and increased costs for damage repair falling on Government following cyclones.

The Taskforce has therefore been

> *charged with exploring the feasibility of options that use the Commonwealth balance sheet to reduce home, contents and strata insurance premiums in those regions of Northern Australia that are experiencing insurance affordability concerns due to cyclone risk. (Josh Frydenberg MP, 2015)*

While the initial focus of the Taskforce was around a mutual cyclone insurer and a cyclone reinsurance pool, the Taskforce is open to other options.

In this context, Urbis was engaged by Suncorp Group to examine the economic benefits of cyclone mitigation investments and to understand how outcomes could lead to a cost-effective reduction in cyclone damage that can be passed on to households in the form of lower premiums.

Using a forward-looking framework for considering new cyclone mitigation activities, this paper demonstrates the value of a number of different mitigation strategies which involve a broad community education and awareness program and the retrofitting of existing housing in North Queensland.

The work undertaken in this report builds on Smith & Henderson (2015). It is recommended that this report be read in conjunction with the JCU report.

This report is a first step towards understanding the potential for mitigation options to deliver substantial economic and social benefit by reducing damage when cyclones hit and by lowering premiums. There is room to achieve better mitigation outcomes by driving down costs through improved products and economies of scale in roll-outs. There may be a role for governments to fund additional research in this field.

This report is structured in the following chapters.

Chapter 1 discusses the nature and degree of cyclone risks in North Queensland and the damage which can be inflicted, with reference to historical cyclone impacts.

Chapter 2 examines the role of cyclone mitigation investments in reducing vulnerability and the case for mitigation strategies.

Chapter 3 discusses cost benefit modelling undertaken by Urbis.

Chapter 4 looks at implications, recommendations and next steps as a result of the cost benefit modelling.

1 Cyclone risks in Northern Australia

There is an extensive history of tropical cyclones in coastal regions of Australia, in particular Northern Australia. While all northern coastal regions of Australia are vulnerable to cyclones, the density of population and housing stock on the North Queensland coast increase the risk of significant damage. Furthermore, there have been 207 known impacts of cyclones along the east coast of Australia dating back to 1858, with the majority falling in North Queensland (Bureau of Meteorology (BOM), 2015).

Given the risk posed to the population centres, and the availability of data, the focus of the modelling undertaken for this report is North Queensland. To some extent, the analysis can be extrapolated to other parts of Northern Australia. However the specific impacts will vary according to population density, the nature of wind events and house age and structure. Therefore, separate modelling would need to be undertaken to fully appreciate the specific benefit-cost ratios (BCRs) that apply to other parts of Northern Australia.

This chapter discusses the extent and impact of cyclone risks in North Queensland, including the impact of recent category four and five cyclones. The wider economic impact of cyclones is also covered.

1.1 HOUSING AND POPULATION PROFILE

Profile of North Queensland

The North Queensland region has over 350,000 houses (RP Data, 2015) and a population of over one million (Australian Bureau of Statistics (ABS), 2014), including a number of major regional population centres. It is the largest and most densely populated cyclone prone region in Australia. Listed below are four of the largest local government areas (LGAs) in the region.

TABLE 1-1 – NORTH QUEENSLAND LOCAL GOVERNMENT AREAS

LGA	HOUSING STOCK	POPULATION	DENSITY
Townsville	59,000	192,038	51.5 pop/km^2
Cairns	45,000	158,985	94.2 pop/km^2
Mackay	38,000	123,383	16.2 pop/km^2
Rockhampton	28,000	83,439	12.7 pop/km^2

Source: Population and density data from ABS. Housing stock data from RP Data

The combination of large, dense population areas and high frequency of cyclones makes the region especially vulnerable to cyclone damage. With over 350,000 houses, this combination of factors also makes the region potentially the most viable in terms of investing in cyclone mitigation strategies.

1.2 THE EXTENT AND NATURE OF CYCLONE RISKS

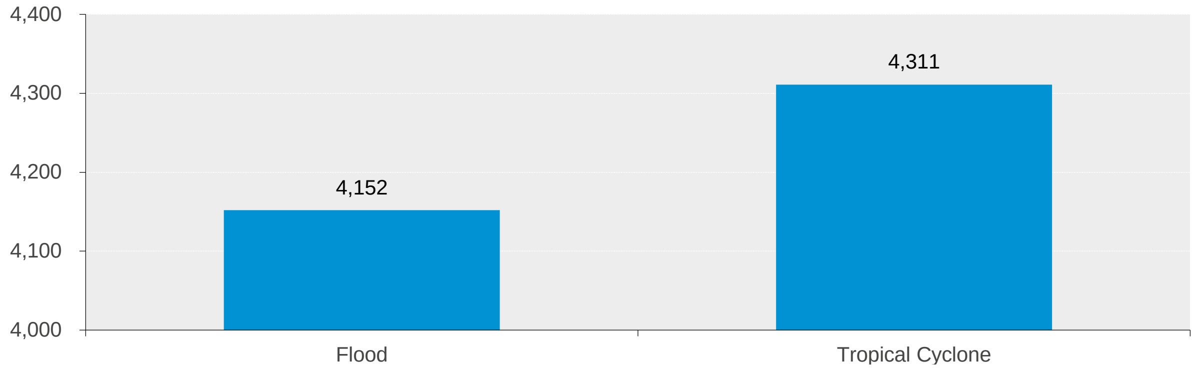
Tropical cyclones are a frequent occurrence along the north east coast of Australia, particularly in North Queensland. The east coast of Australia is one of the most cyclone prone regions in Australia, affected by an average of 4.7 tropical cyclones per year, with more than one a year causing an impact on land (BOM, 2015c).

Risk compared to other natural hazards

Cyclones have historically been the most damaging natural hazard risk facing North Queensland, based on House Equivalent (HE) losses (Queensland Department of Community Safety (QDCS) 2012). The QDCS report records historical losses attributed to different forms of natural disasters, using HE losses. Each single HE lost is equivalent to the loss of a single median-sized residential home, allowing loss comparisons over time as housing sizes and prices change. This measure also takes into account non-residential buildings including hospitals, schools etc. However, it does not include damage to building contents and agriculture.

In the region spanning from Mackay to the northern most point of Queensland, the largest HE losses from natural hazards since 1950 are from tropical cyclones, at 4,311 HE losses. Flood damage, from both cyclone-related storm surges and other flooding, is the second largest cause of HE losses.

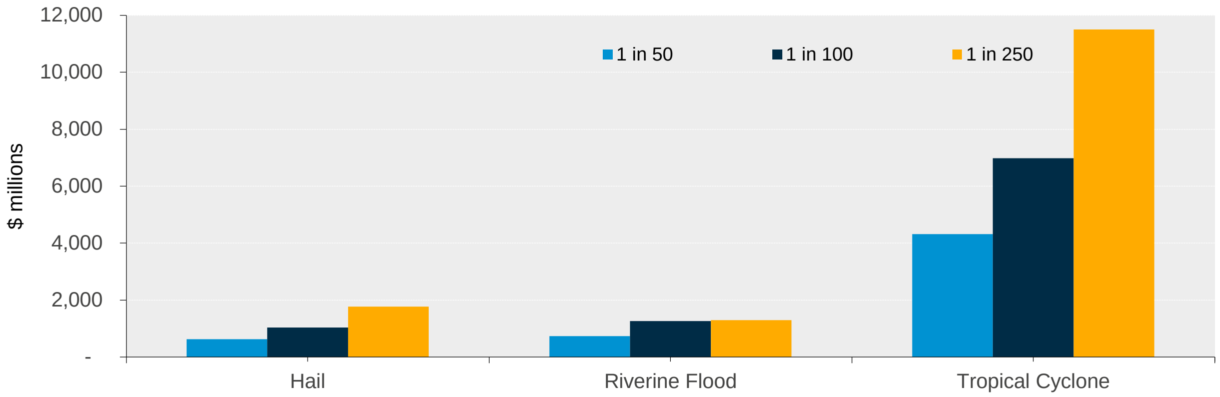
CHART 1-1 – NORTH QUEENSLAND HOUSING EQUIVALENT NATURAL HAZARD LOSSES 1950-2011



Source: (QDCS, 2012)

When compared to other natural hazards, a major source of damage from tropical cyclones is to residential property. Modelling undertaken by Risk Frontiers on behalf of QDCS estimated the insured losses to residential property for all of Queensland from 1 in 50 year, 1 in 100 year and 1 in 250 year natural hazards.

CHART 1-2 -ESTIMATED LOSSES FOR INSURED RESIDENTIAL PROPERTY FROM NATURAL HAZARDS, QUEENSLAND



Source: (QDCS, 2011)

The outcomes modelled, as shown above, demonstrate the scale of potential insured losses that tropical cyclones pose to Queensland. A once in 50 year tropical cyclone would on average cause $4.3 billion in insured losses to residential property. A once in 100 year event would have on average $7 billion in insured losses, while a once in 250 year event would have average insured losses of $11.5 billion. For comparison, a 1 in 250 year flood event would have insured losses of $1.3 billion (QDCS, 2011).

Damage to residential property in Tropical Cyclone (TC) Yasi came predominately from roofing damage, window damage and water ingress (Smith & Henderson, 2015).

The scope of insured losses to residential property from tropical cyclones provides a strong case to investigate opportunities to minimise losses. The opportunities should focus on creating a more resilient housing stock.

Scope of damage from tropical cyclones

Not all tropical cyclones make landfall or cause serious damage. However those that do have the potential to cause significant damage: to property, infrastructure and agricultural land.

Five out of the ten largest natural hazard events (based on insured loss) in Queensland since 1900 have been tropical cyclones, with all five occurring in North Queensland. Four of the cyclones occurred since 1970. Insured losses are listed below, adjusted for if the events had occurred in 2011 (i.e. changes in demographics, housing stock, inflation) (QDCS, 2012):

TABLE 1-2 – IMPACT OF TROPICAL CYCLONES

CYCLONE	YEAR	CATEGORY	INSURED LOSSES*	GOVERNMENT DAMAGE BILL
Ada	1970	4	$1,001m	N/A
Althea	1971	4	$648m	N/A
Larry	2006	4	$609m	$480m**
Yasi	2011	5	$1,405m	$800m

*Note: 2011 prices. *adjusted for if the event occurred in 2011. **includes damage from Cyclone Monica.*

Source: (Queensland Government, 2014), (BOM, 2015c)

It is worth noting the wider effects of cyclone damage. As a result of TC Yasi agricultural production (particularly banana and sugarcane crops), mining and local government losses were in the region of $2 billion. Total economic loss from Yasi was estimated at $3.5 billion (Deloitte Access Economics, 2011)

Significantly, neither Yasi nor Larry made landfall over major regional centres such as Cairns and Townsville. Had a major regional centre been the worst hit region, the damage bill could have been significantly larger.

The changing nature of natural disaster risks

Changing demographics within cyclone prone regions, such as the expansion and consolidation of town centres, and development of the built environment, influence the scale of impacts on people, property and local as well as national economies.

Looking forward, climate change could compound the risks of disruption through more intense cyclones. A key implication is that any increase in underlying natural disaster risks in the decades ahead would increase the returns from mitigation investments made today.

1.3 THE ECONOMIC AND SOCIAL IMPACT OF CYCLONES

Insured costs represent only a portion of total costs associated with cyclones. Losses to residential property are often only 50% of total insured losses, and 25% of the total economic loss (QDCS, 2011).

Other costs that must be considered in line with insured costs include (Walker, Mason, Crompton, & Musulin, 2015):

- damage to household contents
- death and injuries (including psychological) to occupants due to structural failure or consequences such as fire
- loss of recreational, cultural and leisure time facilities
- dealing with insurance issues in relation to personal property, including making decisions about home damage, repairs and relocation
- dislocation of population due to buildings being made uninhabitable for safety or health reasons
- community disruption due to failures of essential services such as water, electricity and gas supply, and transport and communication networks
- business interruption due to damage to buildings and facilities and disruption to employees.

Further indirect costs found in the wake of the 2010 Canterbury Earthquakes (Deloitte Access Economics, 2015), but can apply to cyclonic events and disasters more broadly, include:

- higher crime rates post natural disasters
- pressure on temporary accommodation resulting in increased rental prices due to lower availability (from losses due to cyclone damage) and increased demand for temporary accommodation from displaced households and temporary workforce coming to area to rebuild.

Other costs can be difficult to measure directly in the aftermath of natural disasters, yet can have large impacts. For example, mental health issues have been strongly correlated to large natural disaster events. The World Health Organisation estimates that severe mental health disorders across the population can increase by around one percentage point following a large natural disaster (Deloitte Access Economics, 2015). Impacts such as these need to be considered when assessing the total costs of cyclone, or other natural disasters.

Household contents are treated separately and are estimated from Suncorp data to be on average 20% of insured property loss.

Other costs have been estimated in a number of studies (for example see Walker et al, 2015) at between 20% (minor flooding) and 200% (Hurricanes Sandy and Katrina) of insured property damage.

Estimating these other losses that result from damage to housing structures is more problematic and is not available from a literature review.

Urbis has estimated the impact at 10% of insured damage, based on the relative damage costs associated with previous cyclone events, using Suncorp data.

This report includes estimates on the cost of losses through both direct damage to housing as well as indirect social and economic costs.

2 Opportunities for cyclone mitigation

Given North Queensland's recurring history with cyclones and the large damage bills often associated with them, mitigation opportunities are worth investigating

Disaster mitigation measure can work in three key ways: (Geosciences Australia, 2015)

- hazard reduction
- reducing community vulnerability
- changing the environment in which hazards and communities interact.

In the case of cyclones, neither hazard nor environment can be altered, so focus must be on options to reduce community vulnerability. A potential means of reducing vulnerability is through actions to improve building resilience, for older housing stock in particular.

CURRENT GOVERNMENT POLICY

There are a number of government policies at state and federal level addressing disaster management in Queensland and Australia more broadly. These range from educational campaigns on cyclone and disaster preparedness to post-disaster relief funds.

The *Natural Disaster Resilience Program* is a $24 million competitive grant program targeting disaster mitigation and community resilience, jointly run by the Queensland and Federal Governments. Mitigation and resilience projects targeting any natural disaster are eligible (Queensland Government, 2015c).

Get Ready Queensland is an educational campaign aimed at improving community preparedness for extreme weather events in general. A fund of $1 million is available for local councils to conduct community events raising awareness. The program also provides information online for household emergency plans including information specific to preparing homes for tropical cyclones (Queensland Government, 2015a). Given the extent of minor damage claims from TC Yasi, it would appear that this program could be better targeted.

However, disaster relief funding is the main policy tool, providing post-disaster assistance to affected communities. The *Natural Disaster Relief and Recovery Arrangement* (NDRRA) is a joint state and federal relief fund, whereby recovery costs are shared between the Queensland and Federal Governments. Services include grants at a household level to restore essential services and improve safety, restoration of public assets, and loans to businesses to assist in disaster recovery (Queensland Government, 2015b).

In the 2015-16 Queensland State budget, $40 million was allocated to the *Community Resilience Fund,* designed to assist local councils mitigate against natural disasters. A further $23 million was provided through the *Local Government Grants and Subsidies program* to fund community infrastructure (Queensland Government, 2015d).

There is currently limited policy specifically aimed at retrofitting mitigation programs at either a state or federal level; the Insurance Premiums Taskforce has the capacity to support implementation of mitigation strategies (such as retrofitting houses) that have a demonstrated, cost-effective benefit.

TYPES OF CYCLONE MITIGATION

The existing literature on cyclone mitigation identifies a number of retrofitting strategies that are most effective in reducing loss. These include a variety of roofing upgrades, opening protection, and structural upgrades.

Findings from Queensland (Smith & Henderson, 2015) and Florida (Malik, Brown, & York, 2012) both identified roofing and damage through openings as key drivers of insured losses.

Smith & Henderson (2015) also identified that minor claims (e.g. fencing, shade sails and minor water damage) constituted the majority of total claims and were a significant driver of the total cost. JCU recommended that simple education/awareness campaigns to improve cyclone preparedness could be the most effective way to reduce the number of minor claims.

ARGUMENTS FOR MITIGATION

Any proposed mitigation policy must display value for money. If the cost of the mitigation, such as retrofitting housing, is prohibitively expensive it is unlikely to be undertaken regardless of potential avoided costs to property, individuals or community.

Mitigation through retrofitting has two benefits that are most apparent – avoided costs of damage to the household, and the resulting reduction in insurance premiums. Other policy options such as a reinsurance pool solely address the cost of insurance premiums; the potential damage remains unchanged.

Reducing insurance premiums is a significant issue for North Queensland households. Over the period 2006 to 2013, North Queensland home and contents insurance premiums increased by 80% (Martin, 2014). In comparison, insurance premiums increased by around 12% in Sydney and Melbourne (Martin, 2014). The increase in premiums has been attributed to increased losses caused by natural disasters, and the increasing prevalence of these disasters. North Queensland premiums were historically under-priced with expenses (including insured losses) around 30% above revenue over the period 2007-2012 (Australian Government Actuary, 2014), thus increasing the magnitude of premium price increases as prices adjusted. Cyclone claim costs are the largest drivers of claim costs, at about 55% of total claims (Martin, 2014). Retrofitting mitigation can limit losses to homes, with the potential to in turn lower insurance premiums.

While some retrofitting mitigation measures can be costly, there are modest and inexpensive improvements to buildings that can be cost effective (CSIRO, 2014). For example, upgrading roof ties for old buildings can deliver significant protection against cyclone damage at low cost.

By appraising different retrofitting measures and applying the most cost-effective, a greater number of residential properties can avoid loss at a reasonable cost.

Retrofitting mitigation evidence in international literature

Though there are many natural hazard mitigation programs in operation internationally – especially in the developing world – there are few examples of rigorous investigation into the cost and benefits of such programs. The existing literature is further diluted by the sheer diversity of mitigation measures, implementation strategies and targeted natural hazards. Despite this there are some studies which have specifically modelled the effects of retro-fitting property against cyclone damage in the developed world.

An analysis of four states in the US has shown that hurricane damage would be significantly reduced if all residential homes were fitted according to building standards (Kunreuther & Michel-Kerjan, 2011). Particularly, were all homes to comply with building standards, there would be a 50% reduction in resultant losses in the event of a once in 500 year storm.

In the US, the Institute for Business Home and Safety (IBHS) *FORTIFIED Home Hurricane Program* aims to incrementally retrofit older housing in hurricane-prone areas up to current building standards, which have been found to perform considerably better under hurricane and storm conditions (Malik, Brown, & York, 2012). Using claim data from Hurricane Charley in Florida, the most frequent type of damage to all homes was roof damage, while damage to openings and windows was also common.

Targeted retrofitting options from the IBHS program include improvements to roofing, reducing water intrusion, protecting openings and strengthening elements of the house structure. It was found that simple roofing upgrades alone could improve the performance of existing housing, in terms of losses avoided, to around 40% of that of a new home. Further incremental upgrades to homes saw avoided losses almost identical to a new home built to current building standards (Malik, Brown, & York, 2012). However, the IBHS report did not detail the cost of implementing upgrades.

Other methods to reduce insurance premiums such reinsurance pools and mutual insurers for cyclones may not be feasible long term. In the US, the National Flood Insurance Program (NFIP) was designed to provide affordable insurance for disaster-prone areas, underwritten by government. As the NFIP has expanded, and disaster frequency increased, the program has become exposed to unsustainable risk. The subsidised insurance provides perverse incentives that create more risk and reduce the uptake of resilience measures, as households can afford to stay in high-risk areas without needing to invest in mitigation measures (Cleetus, 2014). By interfering with the price signal, the NFIP has grown from covering 2.1 million homes in 1980 to 5.6 million in 2013 (Insurance Information Agency, 2015) and currently holds US$23 billion in debt (U.S. Government Accountability Office, 2015). While the issues here relate to flood insurance, many of the lessons around perverse incentives and price signals can be applied to cyclone insurance.

Similar lessons can be found in New Zealand, where a government backed insurance pool, the Natural Disaster Fund, is operated by the Earthquake Commission (EQC). The EQC has paid out NZ$6.5 billion in insurance costs following the Canterbury earthquakes in 2010. Due to claims associated with the Canterbury earthquakes, the Natural Disaster Fund is expected to be fully exhausted (EQC, 2013), with any further liabilities needed to be backed by the New Zealand Government.

Retrofitting mitigation evidence in Australia

The avoided costs of cyclone damage resulting from the construction of more resilient housing in South East Queensland (Brisbane and the Gold Coast) has also been modelled (Deloitte Access Economics, 2013). The BCRs of constructing more resilient housing varied greatly. Using the lowest-cost resilience measures, new houses in the highest risk areas had BCRs up to 3.1. However, if the highest-cost resilience measures were implemented on existing houses in low risk inland areas, the BCR was as low as 0.06. No existing houses, regardless of the cost of resilience measures and presence in high risk area, had a BCR above 1. This modelling demonstrates the importance of **targeted** mitigation strategies.

Research undertaken by JCU on the significant drivers of insured losses to residential property from TC Yasi (Smith & Henderson, 2015) provides evidence in favour of mitigation. The main drivers of loss were from roofing damage, window damage and water ingress, with older homes (pre-1981) at most risk. If mitigation measures were targeted at roofing and opening protection (e.g. windows, doors) upgrades for the most at risk houses alone, a significant portion of insured losses could be avoided.

As previously noted, the Productivity Commission has also reported potential low cost mitigation options such as roof tie upgrades could prove cost effective (Productivity Commission, 2014).

Broader economic benefits of mitigation

Research undertaken by KPMG estimated the wider economic benefits of mitigation strategies against all natural disasters, and compared these to a government-backed insurance pool and the business-as-usual system of insurance coverage (KPMG, 2014). Compared to the current system of coverage, a mitigation strategy leads to a 0.05% increase in GDP after a one-in-ten year disaster event, while a pooled insurance model led to a 0.02% *decrease* in GDP.

It is likely that any widespread roll-out of retrofitting mitigation options would have a positive impact on employment opportunities, in particular creating demand for high-skilled construction jobs.

The KPMG findings suggest that, over the long term, government investment in mitigation strategies can have the greatest economic value, rather than post disaster assistance and/or insurance pools.

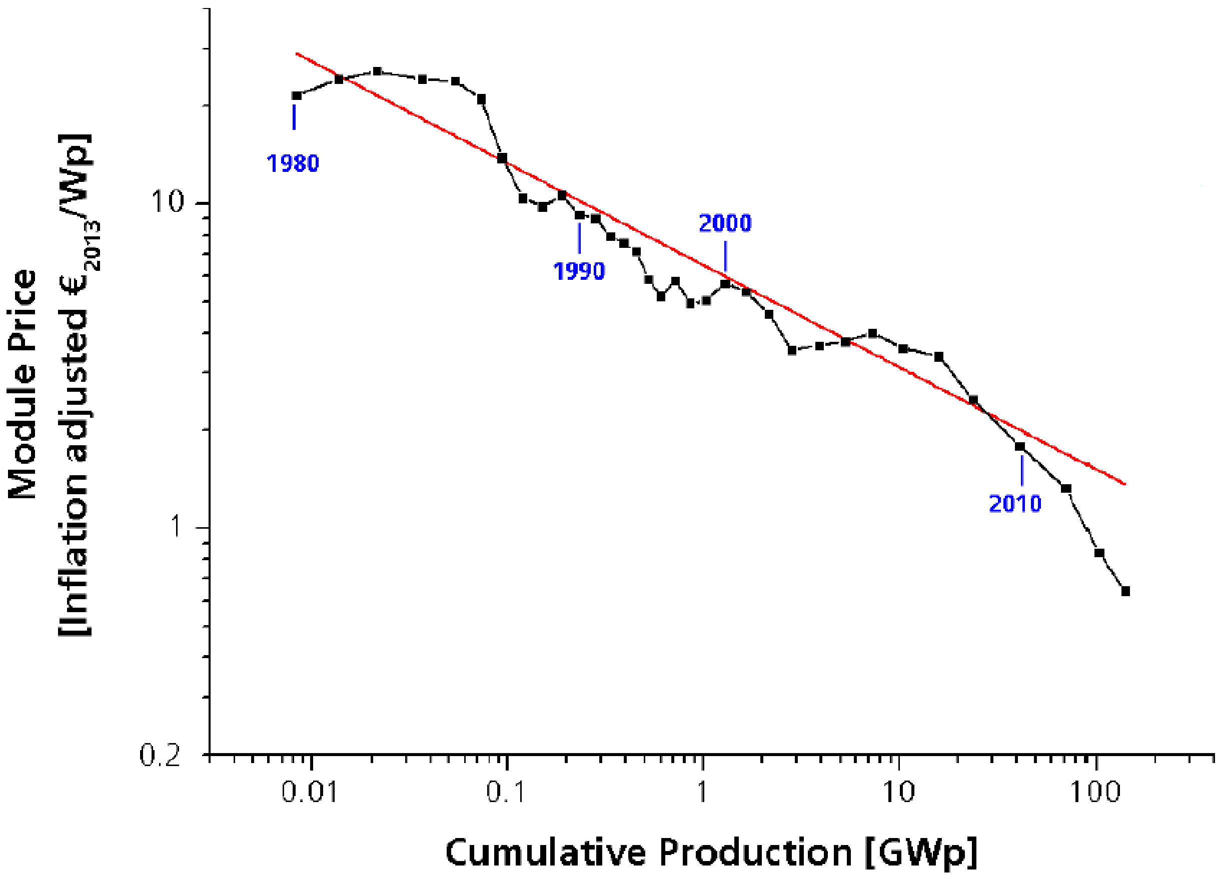
Creation of a retrofitting mitigation market

Benefit-cost outcomes and attractiveness to households of mitigation options will naturally be enhanced by reductions in cost. Such cost reduction can occur through the development of a mitigation market that assists in:

- development of new lower-cost options, through enhanced techniques and innovation (Hearps & McConnell, 2011)
- economies of scale

The former will occur through both research and development and increased experience. Experience curves for other products, notably solar panels, but also for energy-efficiency innovations in the building sector more generally, demonstrate the potential for mitigation options to improve pricing outcomes over time. The capital expenses for solar are forecast to fall in Australia by over 40%, between 2010 and 2030, as the use of solar becomes more widespread (Hearps & McConnell, 2011). In Europe, since 1980 each time the total production of solar doubled (measured in Gigawatt-peak), the price of solar decreased by 20% (Fraunhofer Institute, 2014) (See Table 2-1).

TABLE 2-1 – PRICE LEARNING CURVE ALL BULK SOLAR TECHOLOGIES, EUROPE



NB: Cumulative Production measured in Gigawatt-peak (GWp). Learning rate: over the period 1980-2013, each time the cumulative production doubled, the price decreased by 20%
Source: (Fraunhofer Institute, 2014)

Price gains will vary, according to the type of mitigation product, its design complexity and the materials used as well as the rate of take-up. While households have an infinite range of designs that can make product standardisation challenging, there are some offerings, such as impact-resistant glass, that will lend themselves well to cost reduction over time.

With government and industry body backing, there is potential for a broad-based rollout of cyclone mitigation strategies across Northern Australia, creating a significant market for mitigation. This market could be augmented by exports to other cyclone-prone regions globally.

3 Cost benefit modelling

This chapter details the methodology used to estimate the impact of various mitigation strategies to minimise cyclone impacts on housing in North Queensland.

3.1 MITIGATION OPTIONS

The JCU report identified the most common drivers of loss from TC Yasi as roofing damage, openings damage and water ingress

PICTURE 3-1 – ROOFING DAMAGE

Source: JCU 2011, Tropical Cyclone Yasi Structural damage to buildings

PICTURE 3-2 – OPENINGS DAMAGE

Source: JCU 2011, Tropical Cyclone Yasi Structural damage to buildings

As such, three mitigation options were identified by JCU as the most likely to prevent damage to households from cyclones.

1. Structural roof upgrading
2. Opening protection for doors and windows
3. Community preparedness and awareness campaign – assumed to avoid the large quantity of small claims from untied shade cloths, loose debris in garden, water ingress etc.

The three mitigation options were applied over three different house types:

- House Type A: Pre-1960
- House Type B: 1960-1980
- House Type C: Post-1980

Due to the introduction of stricter building codes in 1981, structural roof upgrading was not considered appropriate for post-1980 houses. Only Mitigation Options 2 and 3 were modelled for post-1980 houses. Further detail on house types is examined in Section 3.2

The Mitigation Options 1 and 2 were costed by JCU under three different scenarios: high cost, low cost and medium cost. Each mitigation option was assumed to perform to the same standard, regardless of cost.

The community preparedness and awareness campaign was costed by Urbis, based on funding for the *Get Ready Queensland* program, which targets disaster prone houses in Queensland. The cost was based on additional annual funding of $1 million (on top of already funded awareness programs) over the 50 year period. This is equivalent to $15 million in Net Present Value (NPV). This was spread proportionally over House Type A, House Type B and post 1980s houses.

TABLE 3-1 – SCENARIO 1 – HIGH COST

MITIGATION TYPE	COST	DETAIL
1. Structural roof upgrading	▪ House Type A: $30,000 (per house) ▪ House Type B: $27,000 (per house)	Complete roof replacement and strapping upgrades
2. Openings protection for windows and doors	$3,500 (per house)	Aftermarket roller door support upgrade ($300) with commercial window covering ($3,200)
3. Community preparedness/awareness campaign	▪ House Type A: $3.1m ▪ House Type B: $3.5m ▪ House Type C: $8.4m	Implement widespread community awareness program; costing based on *Get Ready Queensland* program.

TABLE 3-2 – SCENARIO 2 – LOW COST

MITIGATION TYPE	COST	DETAIL
1. Structural roof upgrading	▪ House Type A and B: $3,000 (per house)	The additional cost of strapping upgrades, assuming house owner is replacing roof for other reasons
2. Openings protection for windows and doors	$1,660 (per house)	Aftermarket roller door support upgrade ($300) with plywood window covering ($1,360); assumed DIY
3. Community preparedness/awareness campaign	Same as Scenario 1	

TABLE 3-3 – SCENARIO 3 – MEDIUM COST

MITIGATION TYPE	COST	DETAIL
1. Structural roof upgrading	▪ House Type A and B: $12,000 (per house)	Roof and strapping upgrades, using over-batten system
2. Openings protection for windows and doors	Same as Scenario 2	
3. Community preparedness/awareness campaign	Same as Scenario 1	

3.2 ESTIMATING BENEFITS

KEY ASSUMPTIONS

Geographical area

The area being modelled is the north-east coast of Queensland that falls into Wind Region C from the Australian/New Zealand wind loading standard 1170.2 (Yang, Nadimpalli, & Cechet, 2014). Of this area, Suncorp Group claims data was available for 71 of a possible 87 postcodes. These 71 postcodes will be the focus of the model.

Housing type

Damage to housing was taken from claims data post TC Yasi supplied by Suncorp Group. Analysis of claims data by JCU found that housing constructed before 1981 performed particularly poorly in terms of cyclone damage against those built after the introduction of stricter building codes in 1981. Looking at pre-1981 houses in more detail, similar levels of housing damage could be attributed to houses of similar design. There are three different housing age groups.

- House Type A: Pre-1960. Houses in this age bracket saw the greatest proportion of houses suffering damage over 10% of the insured value of the house.
- House Type B: 1960-1980. These houses saw a large number of claims, particularly small claims between 0% - 10% of the insured value.
- House Type C: Post-1980. These houses were the best performing age group, due to the introduction of stricter building codes in 1981

TABLE 3-4 – HOUSING STOCK BY AGE BRACKET

TOTAL HOUSING STOCK	HOUSE TYPE A (PRE-1960)	HOUSE TYPE B (1960-1980)	HOUSE TYPE C (POST – 1980)
271,207	52,861	61,867	156,379

Source: RP Data, Suncorp Group
Note: Number of House Type A, B and C are estimates extrapolated using the ratio of house ages in Suncorp Group insured housing stock applied to RP Data on total housing stock.

Uptake of mitigation

For all mitigation options, it was assumed that the uptake rate of mitigation for all houses was 50%. The rate of uptake does not affect the Benefit Cost Ratio of each measure, but does say something about the aggregate level of damage likely to be sustained or avoided.

Wind speeds

Wind speeds were modelled to represent events ranging from a one in five year cyclonic event up to a one in one-thousand year cyclonic event. Each of these events had an associated wind speed, which was risk-adjusted to reflect the probability of such a wind speed occurring in any one year. For example, the wind speed associated with a one in five year event has a 20% chance of occurring in any one year.

Due to the inherent uncertainty with forecasting wind speeds, four different reputable catastrophe models were used in this analysis. Given the range in wind speeds forecast under the different models, outcomes from the two models falling in the middle of the range are presented in detail. The highest and lowest wind speed models are treated as extremes.

The lower of the two middle models will be referred to as Model 1, while the higher will be referred to as Model 2.

Under Model 1 wind speeds, BCRs were effective for the $12,000 roofing upgrade in 39 of 71 postcodes. These 39 postcodes are in high-risk coastal areas.

Results reported for Model 1 include the 39 cost-effective postcodes

Prices

All prices are in 2015 prices.

BENEFIT TYPES

The benefits of the mitigation options were recorded as the difference in avoided damage between the business-as-usual case and the mitigation case.

Avoided damage falls under three categories:

- Housing – this was modelled using JCU fragility matrices, which apportion housing damage through loss as a proportion of total insured value, based on a given house type and wind speed. This is approximately 77% of total benefit of mitigation (avoided loss).

- Contents – this is an additional cost above housing damage. It is assumed to be 20% of housing damage, based on Suncorp claims data. Avoided contents damage accounts for 15% of total benefits.

- Community damage (indirect economic costs) – this is the additional costs over and above housing damage. It includes collateral damage to community and public infrastructure caused by damage to houses as well as broader loss categories such as death and injury, dislocation and service and business disruption. In this modelling, it has been assumed to be 10% of housing damage. This is a conservative estimate based on research by (Walker, Mason, Crompton, & Musulin, 2015). Avoided community damage accounts for 8% of total benefits.

There are a number of other benefits not included in the model, but are important to consider qualitatively such as avoided death and injury (included psychological), avoided dislocation of population and avoided business interruption

The avoided damages flow to different beneficiaries:

- Households through reduced premiums, avoided loss of life and avoided psychological trauma

- Insurers through reduced insured losses (some of which is passed on to households through reduced premiums)

- Community/government through reduced collateral damage to community and public infrastructure.

CALCULATION OF BENEFITS (AVOIDED DAMAGE COSTS)

Avoided damage costs were recorded for a single house of each House Type at a postcode level, and built up to cover the total model area, i.e. the 71 postcodes on the North Queensland coast.

The JCU fragility matrix assigns a probability to each house type of falling into a specific loss-ratio bin, for a given mitigation option in place and the wind speed with which it is hit. The JCU fragility matrix measures damages from wind speeds between 75 and 250 kph. There are wind speeds below 75kph from both cyclonic and non-cyclonic events that are not captured in this matrix but that have the potential to cause damage. Similarly,, wind speeds over 250kph are assumed to inflict the same damage level as 250kph winds; while rare, such winds can and do occur, implying a conservative bias to the estimates presented here. Capturing these wind speeds would increase the BCR estimates presented in this report.

For each postcode, there are specific probabilities for different wind speeds occurring.

House Type A and House Type B are initially assumed to have no mitigation options in place. House Type C is assumed to already have roofing upgrades in place, in line with newer building code standards.

Using wind speed probabilities and probabilities of loss from the JCU fragility matrix, a probability associated loss is assigned at a single house level in each postcode – for a house with no mitigation, Mitigation Option 1, Mitigation Option 2 and Mitigation Option 3.

To find the avoided damage cost for each Mitigation Option, the damage cost to a house with no mitigation is compared to the damage cost of a house with a specific Mitigation Option. The difference between the two damage costs is the avoided damage assigned to that Mitigation Option.

The avoided damage for each Mitigation Option for each House Type is recorded for a single house across each postcode. This is then built up, based on housing stock data, to find the avoided cost for each Mitigation Option and each House Type over the total model area, i.e. the 71 postcodes on the North Queensland coast. A 50% uptake for all mitigation options is assumed. The take-up rate does not affect the benefit cost ratio outcomes for any individual household.

Case Study: Tropical Cyclone Yasi

Using Suncorp Group claims data and fragility matrices provided by JCU, Urbis modelled the change in outcomes that would have occurred for houses damaged by TC Yasi, had proposed mitigation strategies been put in place. This was for Suncorp Group insured houses only.

The community awareness program performed best. It had a BCR well above one for both House Type A, B and C in part due to its low implementation cost.

Other than the community awareness program, outcomes using the low cost mitigation options had the highest BCRs. In particular, the low cost roof strapping upgrade, at $3,000, achieved a BCR above one for both House Type A and House Type B. For House Type A, the roofing upgrade had a BCR of 1.5, while House Type B recorded a BCR of 1.4 for the roofing upgrade.

The openings protection, did not have a BCR above one for either the low or high cost alternatives, for any house type.

TABLE 3-5 – MITIGATION OPTION BCRs, TC YASI

MITIGATION OPTION:	ROOFING	OPENING	COMMUNITY	ROOFING	OPENING	COMMUNITY	OPENING	COMMUNITY
	HOUSE TYPE A (PRE 1960)			HOUSE TYPE B (1960-1980)			HOUSE TYPE C (POST 1980)	
High cost	0.1	0.2	**4.5**	0.2	0.2	**7.7**	0.1	**3.5**
Low cost	**1.5**	0.5	**4.5**	**1.4**	0.4	**7.7**	0.2	**3.5**
Medium cost	0.4	0.5	**4.5**	0.9	0.4	**7.7**	0.2	**3.5**

Source: Urbis modelling, JCU, Suncorp Group

It is important to note that the above results were based on mitigation against a **single** cyclonic event. All mitigation options have considerable lifespans, so it is likely that houses with these mitigation options in place will experience a number of cyclonic events over the course of their effective lifetime. There is therefore scope that the more expensive costings for roofing upgrades and opening protection have a chance of achieving a BCR above one over a longer time period that includes more than one event, particularly the $12,000 over-batten roofing upgrade.

It is also worth noting that TC Yasi did not make landfall over a major regional centre such as Townsville or Cairns. Had a major regional centre been the worst hit region, while the BCRs would not change, the aggregate damage bill would have been considerably larger.

3.3 LOOKING FORWARD

To understand the potential gains over a longer period of time, Urbis modelled the impact of mitigation options on different house types over a 50-year period. Given the conservative nature of the lower bound of the middle catastrophe model wind speeds (Model 1), any mitigation options that return BCRs above one under this model should be considered significant from a policy standpoint.

Mitigation options that return BCRs above one under all four catastrophe models are most likely to be cost-effective.

It is important to note the way the benefits fall. 77% of benefits are avoided cost to the house, 15% of benefits are avoided cost to contents, and 8% of benefits are avoided cost to community.

The outcomes were modelled across North Queensland only. To outline the impact mitigation would have on other cyclone prone regions in Northern Australia differences in cyclone risk, population density, and age of housing stock need to be considered.

3.3.1 OUTCOMES – MITIGATION OPTION 1: ROOFING UPGRADES

Under Scenario 3 (medium cost) the $12,000 roof replacement and strapping upgrades using an over-batten system was considered the most realistic costing option for Mitigation Option 1. A $27,000-$30,000 roofing upgrade was considered too expensive for most households. The $3,000 strapping upgrade in (low cost), while affordable, assumes the owner is replacing the roof already. As such, the modelling results for the medium cost $12,000 Mitigation Option 1 are considered to be optimal for future policy considerations.

For the $12,000 roofing upgrade, Model 1 outcomes produced a BCR of close to 1, while Model 2 BCR outcomes were around four times higher than Model 1. The payback period[2] for House Type A was between 4 and 24 years, while for House Type B it was between 3 and 37 years.

Under all four catastrophe models the $3,000 strapping upgrade returned a BCR above one.

Given the $12,000 roofing upgrade had BCRs above one for both house types, it should be considered as a potentially viable mitigation option.

There is an opportunity for government to mandate roof strapping at the point of any substantive roofing renovation, thus reducing installation costs associated with mitigation.

Suncorp Group has indicated a willingness to run a resilience rating program for households. Older homes would be eligible for premium reductions based on reported mitigation work (Suncorp Group, 2015).

3.3.2 OUTCOMES – MITIGATION OPTION 2: OPENING PROTECTION

Mitigation Option 2 under the $3,500 (high cost) opening protection option, is unlikely to be a viable option. The $1,660 (low cost) option, however, is more affordable and achieved positive outcomes.

The $3,500 option only achieved BCRs above one for either house type under Model 2.

Mitigation Option 2 ($1,660) reduced costs through using a plywood window covering, as opposed to a commercial window covering, and assumed that the protection was self-installed. Significantly, the lower cost option achieved BCRs above one for both house types under both Model 1 and 2. However, payback periods were up to 20 years for each. Under Model 1, a BCR above one was not returned for post-1980 houses.

Given the above findings, the low cost, self-installed $1,660 option appears the most viable.

3.3.3 OUTCOMES – MITIGATION OPTION 3: COMMUNITY AWARENESS PROGRAM

Mitigation Option 3, the community awareness program, is the most cost effective mitigation option presented. The low cost of implementation means only a small level of avoided costs are required to produce a BCR above one.

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[2] Payback period refers to the number of years required for the value of the benefit to outweigh the cost of the mitigation option. As benefits accrue over time, the larger the benefit the shorter the payback period will be. The payback is spread between the bearers of cost; that is the household, insurers and government.

The community awareness program addresses low-hanging fruit such as fencing damage, loose shade cloths, unfixed objects in gardens and minor water ingress. The JCU report found that 86% of total claims for TC Yasi were minor claims, compromising 29% of the total cost.

For all house types, the avoided costs were at least three times the cost of implementation. Furthermore, the cost of implementation was returned in six years or less for all situations.

The community awareness program was cost effective under all four catastrophe models.

It is highly likely that a targeted and effective community education/awareness campaign would also be cost-effective across other cyclone regions of Northern Australia.

4 Implications, recommendations and next steps

It is important to acknowledge that there is inherit variability and uncertainty in forecasting cyclone behaviour, particularly over a lengthy period. For this reason, four separate Wind Models were used to sensitivity test the results and to provide indicative results with a lower and upper bound for BCRs.

The cost benefit modelling for mitigation strategies demonstrates that these can be cost-effective at the right price points in high-risk areas. Implementation of these options can therefore lead to lower premiums for households.

However, households will only undertake mitigation if the reduction in premiums is at least equal to the cost of mitigation. In other words, the lower payout and recovery costs for insurance companies and government that result from mitigation implementation need to be at least in part transferred to households so that they do not bear all the cost of mitigation without any monetary benefit.

A combination of government rebate and lower insurance premiums are likely to be necessary, but can be achieved cost-effectively. The scope of cost-effectiveness may be further increased if a bulk rollout of mitigation options can create economies of scale in a locality. This has been demonstrated with solar panel installation.

The cost of rebates in some instances exceeds the estimated benefit to government via community losses. In these instances, a benefit cost analysis of alternative options needs to be considered to ensure this represents the best outcome. In addition, it is worth exploring further ways to reduce mitigation costs through further detailed research including of enhanced, lower cost product options and large scale roll-outs to achieve economies of scale.

Further research funding

Further funding for research at centres of excellence could help drive improved outcomes – particularly into two key areas.

- Understanding markets and consumers. There is a gap in the understanding of the full range of house types and mitigation options appropriate to each, as well as the drivers of uptake of mitigation measures.

  Households also have other incentives to implement mitigation options, beyond monetary considerations. These include: safety and peace of mind, "keeping up with the Jones'", and, in some cases, a potential increase in the value of the house.

  Evidence from Florida provides a broad range of reasons behind choosing mitigation (Carson, McCullough, & Pooser, 2013). Regression analysis found that financial reasons such as income, cost of mitigation, value of the house, and price of and potential reductions in insurance premiums are all key drivers. However, non-financial factors influence the decision to mitigate, notably the number of openings the house has (reflecting potential vulnerability), whether children live in the house, and whether other homes in the neighbourhood are undertaking mitigation measures.

  There are other simple factors influencing the uptake of mitigation. Empirical evidence in Australia suggests that a major stumbling block for homes to undertake mitigation is aesthetics. Effective, yet visually unappealing mitigation measures are unlikely to see widespread implementation.

- Developing optimal mitigation products. Specifically, mitigation methods that are both effective and popular with homeowners and can drive lower prices though economies of scale and continuation along experience curves.

These two areas are complementary. In Florida, a range of mitigation products have been developed, yet the level of uptake has varied as the understanding of the market – much broader than in Queensland – is still incomplete. There is an opportunity for research to help optimise the market in North Queensland and globally.

Certification of mitigation

Insurance companies need assurances that mitigation work done, whether installed professionally or by the homeowner, is of an acceptable standard. There are two potential certification programs to address this issue, as outlined by JCU (Smith & Henderson, 2015).

Formal assessment of property risk undertaken by a qualified inspector. Should the property pass assessment, reduced premiums can be passed on to the homeowner. Benefits are wide ranging, including increasing awareness in the wider community, in addition to building resilience through higher standards of building. Although the estimated cost is $500-$1,000 per household, certification is likely to produce enhanced outcomes for retrofits and damage avoidance .

Self-assessment system, potentially online or through a mobile application, supported by some level of auditing. This provides a more affordable option than a formal assessment. The key difficulty is for the homeowner to provide reliable information. Auditing, undertaken by the insurer – potentially on an ad hoc basis – can help to educate and support homeowners in providing information.

A combination of the approaches outlined above may prove to be the most effective. Further research is required to determine the optimal approach, including a cost-benefit analysis to compare cost of certification against the benefits of enhanced standards of retrofitting.

Potential premium reductions

Undertaking mitigation reduces the risk and magnitude of damage to a household. Furthermore, mitigation strategies such as the community awareness campaign can reduce the large number of minor claims that typically result from a cyclone which are also administratively burdensome for householders and insurance companies. These improved outcomes provide scope for potential reductions in insurance premiums.

There may be a case for introducing substantial rebates, at least in the initial stages of roll out, if further analysis can demonstrate that mitigation is a more cost-effective strategy for the Federal Government than the reinsurance pool or mutual insurance options. Unlike a reinsurance pool or mutual insurance, mitigation strategies address actual damage, rather than shifting the costs from households (premium prices) and insurers (insured losses) to government.

Mitigation efforts can result in lower premium outcomes. They are therefore worth consideration by the Taskforce, alongside other potential measures.

Appendix A Detailed cost benefit modelling results

The following appendix includes detailed cost breakdowns, benefits, BCRs and payback periods[3] for two different models (Model 1 and Model 2) – assuming 50% take-up of each mitigation option – as well as for the TC Yasi modelling.

3 Payback period refers to the number of years required for the value of benefit to outweigh cost of mitigation option

MODEL 1– 39 OF 71 POSTCODES

TABLE A-1 – HIGH COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – Complete roof replacement and strapping upgrade	$327 m	- $156 m	- $120 m	- $24 m	- $12 m	0.5	> 50 years
Opening protection	$38 m	- $14 m	- $11 m	- $2.1 m	- $1.1 m	0.6	> 50 years
Community preparedness/awareness campaign	$3.1 m	$7.3 m	$5.6 m	$1.1 m	$0.6 m	3.3	6 years
HOUSE TYPE B (1960 - 1980)							
Roofing option – Complete roof replacement and strapping upgrade	$310 m	- $154 m	- $118 m	- $24 m	- $12 m	0.5	> 50 years
Opening protection	$40 m	- $17 m	- $13 m	- $2.7 m	- $1.3 m	0.6	> 50 years
Community preparedness/awareness campaign	$3.5 m	$8.9 m	$6.8 m	$1.4 m	$0.7 m	3.5	6 years
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	$4.2 m	$17 m	$13 m	$2.7 m	$1.3 m	3.1	6 years

[1] NPV over 50 years
** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

TABLE A-2 – LOW COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – strapping upgrade only	$33 m	$118 m	$91 m	$18 m	$9.1 m	4.6	4 years
Opening protection	$18 m	$5.0 m	$3.9 m	$0.8 m	$0.4 m	1.3	21 years
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE B (1960 - 1980)							
Roofing option –strapping upgrade only	$34 m	$104 m	$80 m	$16 m	$7.9 m	4.0	4 years
Opening protection	$19 m	$2.3 m	$1.8 m	$0.4 m	$0.2 m	1.1	29 years
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	Same as low cost scenario						

[1] NPV over 50 years
** Columns may not add due to rounding*
Source: Urbis modelling, JCU, Suncorp Group

TABLE A-3 – MEDIUM COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – over-batten system	$131 m	$27 m	$21 m	$4.1 m	$2.1 m	1.2	24 years
Opening protection	Same as low cost scenario						
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE B (1960 - 1980)							
Roofing option – over-batten system	$138 m	$7.0 m	$5.4 m	$1.1 m	$0.5 m	1.05	37 years
Opening protection	Same as low cost scenario						
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	Same as high cost scenario						

[1] NPV over 50 years
** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

MODEL 1 – ALL 71 POSTCODES

TABLE A-4 – HIGH COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – Complete roof replacement and strapping upgrade	$793 m	- $503 m	- $387 m	- $77 m	- $39 m	0.4	> 50 years
Opening protection	$93 m	- $52 m	- $40 m	- $8 m	- $4.0 m	0.4	> 50 years
Community preparedness/awareness campaign	$3.1 m	$14 m	$11 m	$2.2 m	$1.1 m	5.5	4 years
HOUSE TYPE B (1960 - 1980)							
Roofing option – Complete roof replacement and strapping upgrade	$835 m	- $529 m	- $407 m	- $81 m	- $41 m	0.4	> 50 years
Opening protection	$108 m	- $64 m	- $49 m	- $10 m	- $4.9 m	0.4	> 50 years
Community preparedness/awareness campaign	$3.5m	$20 m	$16 m	$3.1 m	$1.6 m	6.8	4 years
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	$8.4 m	$36 m	$28 m	$5.5 m	$2.8 m	5.3	4 years

[1] *NPV over 50 years*

** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

TABLE A-5 – LOW COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option –strapping upgrade only	$79 m	$164 m	$126 m	$25 m	$13 m	3.1	6 years
Opening protection	$44 m	-$6.8 m	- $5.2 m	- $1.0 m	- $0.5 m	0.8	> 50 years
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE B (1960 - 1980)							
Roofing option – strapping upgrade only	$93 m	$165 m	$127 m	$25 m	$13 m	2.8	6 years
Opening protection	$51 m	- $11 m	- $8.2 m	- $1.6 m	- $0.8 m	0.8	> 50 years
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	Same as high cost scenario						

[1] *NPV over 50 years*
** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

TABLE A-6 – MEDIUM COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – over-batten system	$317 m	- $58 m	- $45 m	- $8.9 m	- $4.5 m	0.8	> 50 years
Opening protection	Same as low cost scenario						
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE B (1960 - 1980)							
Roofing option – over-batten system	$371 m	- $96 m	- $74 m	- $15 m	- $7.4 m	0.7	> 50 years
Opening protection	Same as low cost scenario						
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	Same as high cost scenario						

[1] *NPV over 50 years*
** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

MODEL 2 – ALL 71 POSTCODES

TABLE A-7 – HIGH COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – Complete roof replacement and strapping upgrade	$793 m	$295 m	$227 m	$45 m	$23 m	1.4	18 years
Opening protection	$93 m	$91 m	$70 m	$14 m	$7 m	2.0	10 years
Community preparedness/awareness campaign	$3.1 m	$41 m	$31 m	$6.2 m	$3.1 m	13.6	<1 year
HOUSE TYPE B (1960 - 1980)							
Roofing option – Complete roof replacement and strapping upgrade	$835 m	$398 m	$306 m	$61 m	$31 m	1.5	16 years
Opening protection	$108 m	$83 m	$64 m	$13 m	$6.4 m	1.8	12 years
Community preparedness/awareness campaign	$3.5 m	$55 m	$42 m	$8.5 m	$4.2 m	16.3	<1 year
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	$8.4 m	$111 m	$86 m	$17 m	$6.9 m	13.7	<1 year

[1] *NPV over 50 years*

* *Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

TABLE A-8 – LOW COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option –strapping upgrade only	$79 m	$962 m	$740 m	$148 m	$74 m	13.1	2 years
Opening protection	$44 m	$136 m	$105 m	$21 m	$10 m	4.1	4 years
Community preparedness/awareness campaign	Sa me as high cost scenario						
HOUSE TYPE B (1960 - 1980)							
Roofing option – strapping upgrade only	$93 m	$1,092 m	$840 m	$168 m	$84 m	12.8	2 years
Opening protection	$51 m	$137 m	$105 m	$21 m	$11 m	3.7	5 years
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	Same as high cost scenario						

[1] NPV over 50 years
** Columns may not add due to rounding*
Source: Urbis modelling, JCU, Suncorp Group

TABLE A-9 – MEDIUM COST

MITIGATION OPTION	COSTS[1]	NET BENEFIT[1]				BCR	PAYBACK PERIOD
		TOTAL	HOUSES	CONTENTS	COMMUNITY		
HOUSE TYPE A (PRE 1960)							
Roofing option – over-batten system	$317 m	$740 m	$569 m	$114 m	$57 m	3.3	5 years
Opening protection	Sa me as low cost scenario						
Community preparedness/awareness campaign	Sa me as high cost scenario						
HOUSE TYPE B (1960 - 1980)							
Roofing option – over-batten system	$371 m	$832 m	$640 m	$128 m	$64 m	3.2	5 years
Opening protection	Same as low cost scenario						
Community preparedness/awareness campaign	Same as high cost scenario						
HOUSE TYPE C (POST 1980)							
Community preparedness/awareness campaign	Same as high cost scenario						

[1]*NPV over 50 years*
** Columns may not add due to rounding*
Source: Urbis modelling, JCU, Suncorp Group

TC YASI CASE STUDY

TABLE A-10– HIGH COST

MITIGATION OPTION	COST	AVOIDED COST	BCR
HOUSE TYPE A (PRE 1960)			
Roofing option – Complete roof replacement and strapping upgrade	$129 m	$19 m	0.15
Opening protection	$14 m	$3.2 m	0.23
Community preparedness/awareness campaign	$0.2 m	$0.9 m	4.5
HOUSE TYPE B (1960 - 1980)			
Roofing option – Complete roof replacement and strapping upgrade	$192 m	$31 m	0.16
Opening protection	$25 m	$4.9 m	0.20
Community preparedness/awareness campaign	$0.2 m	$1.8 m	7.72
HOUSE TYPE C (POST 1980)			
Community preparedness/awareness campaign	$0.6 m	$2.6 m	4.59

** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

TABLE A-11 – LOW COST

MITIGATION OPTION	COST	AVOIDED COST	BCR
HOUSE TYPE A (PRE 1960)			
Roofing option –strapping upgrade only	$12 m	$19 m	1.55
Opening protection	$6.7 m	$3.2 m	0.48
Community preparedness/awareness campaign	Same as high cost scenario		
HOUSE TYPE B (1960 - 1980)			
Roofing option –strapping upgrade only	$21 m	$31 m	1.44
Opening protection	$12 m	$4.9 m	0.42
Community preparedness/awareness campaign	Same as high cost scenario		
HOUSE TYPE C (POST 1980)			
Community preparedness/awareness campaign	Same as high cost scenario		

** Columns may not add due to rounding*
Source: Urbis modelling, JCU, Suncorp Group

TABLE A-12 – MEDIUM COST

MITIGATION OPTION	COST	AVOIDED COST	BCR
HOUSE TYPE A (PRE 1960)			
Roofing option – over-batten system	$48 m	$19 m	0.39
Opening protection	Same as low cost scenario		
Community preparedness/awareness campaign	Same as high cost scenario		
HOUSE TYPE B (1960 - 1980)			
Roofing option – over-batten system	$36 m	$31 m	0.86
Opening protection	Same as low cost scenario		
Community preparedness/awareness campaign	Same as high cost scenario		
HOUSE TYPE C (POST 1980)			
Community preparedness/awareness campaign	Same as high cost scenario		

** Columns may not add due to rounding*

Source: Urbis modelling, JCU, Suncorp Group

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KPMG

cutting through complexity

Risk Apportionment in the Insurance Sector

Prepared for Suncorp Group

FINAL REPORT

27 March 2014

Disclaimer

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Contents

Executive Summary

Recent periods of severe and numerous natural disasters have stressed the current system for risk apportionment. Pricing methods for insurance which take into account the likelihood of these events in the future have meant insurance is becoming unaffordable for some sections of the community. A comprehensive review of the current system and possible options for risk apportionment or minimisation is required.

The current system for risk apportionment is characterised by individuals seeking to minimise their own financial risk through the use of insurance, and has seen government outlay required where insurance cover does not exist or is insufficient. Although mitigation projects undertaken to minimise physical risk impacts are occurring these are limited and uncoordinated.

In this document we refer to pool systems to reference structures which coordinate, typically through some form of government coordination, the financing of risk outside of open market competition. There are many global examples of pool systems. Pool systems may be appropriate in particular circumstances, but evaluation is required to consider the unplanned effects when a pool system removes the price signal and lacks explicit mechanisms that aim to minimise risk. Where participants have some ability to control the risk, removing the price signal can result in increased risk overall. A pool system may be appropriate where the likelihood of an event is of equal likelihood across the whole pool or across the majority of that pool, and therefore it is reasonable for participants to share the contribution to risk equitably. In that case, arguably, the pool will not remove incentives to mitigate risk as the pool shares in the benefits of risk mitigation.

Our study identifies that a program of structured mitigation has significant upside and could be of greatest benefit where it is targeted to highest risk areas. The potential savings are demonstrable through numerous case studies.

Central to our review is the qualitative analysis of each of the three alternative risk apportionment strategies, and an empirical analysis using a comparative static, computable general equilibrium (CGE) model to test the material impacts on the economy from switching from the current structure to either a pooled insurance system or a publically mitigated system. KPMG's latest CGE model, FLAGSHIP, was developed over the past two years and is based on the most up-to-date detailed data available from the Australian Bureau of Statistics.

The baseline in the CGE model already reflects the current situation, which assumes continuation of current natural peril risk exposures (i.e. no increase for land use patterns and or other factors such as climate change). This means that the modelling results present the impact of an event if two alternative risk mitigation strategies were in place, <u>in comparison</u> to the impact of the event under the status quo.[1] Thus, under this CGE approach, the baseline scenario of continuing the current structure is effectively a no change scenario.

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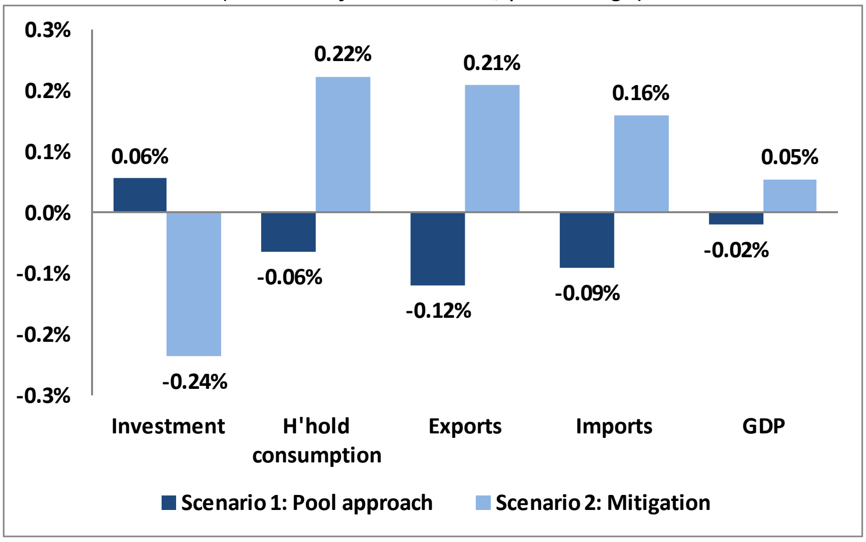
[1] Say, for illustrative purposes that an event leads to 5% lower GDP, the modelling results will show how this impact on GDP would vary as a result of the alternative strategies (So a result showing 1% lower GDP means that the event would have 1% more GDP loss compared to what it would have had under the baseline. That is, the overall impact of the event would be -5% + -1% = 6% lower GDP under that strategy).

The CGE economic assessment of the impact of a pool system or structured mitigation relative to the current system demonstrates the following:

- A pool system is expected to lead to higher costs from a 1-in-10 year catastrophe, which negatively impacts capital stocks, leading to a lower GDP compared to baseline. Investments (and returns) increase in response to this fall in capital stocks (largely in reconstruction activities), further drawing resources away from consumption and trade.
- Structured mitigation is expected to lead to a reduction in the costs from a 1-in-10 year catastrophe, which lessens the negative impact on capital stocks, leading to a higher GDP compared to baseline. Investments (and returns) are lower in response to the relatively higher capital stocks (as less reconstruction activity is required), while the additional productive capacity in the economy flows through to benefits in consumption and trade.

Figure 1: Key modelling results - impact in the year of the event (or every ten years) total accumulated cost of the pool/mitigation over ten years and the total cost of one event (deviation from baseline, percentage)



Source: KPMG modelling

Key findings from the qualitative research include:

- Globally, a number of insurance pools have been established in response to risk exposure from earthquakes. The insurance pool provides coverage to the affected population and is coupled with regulated improvements in building standards. Each pool is unique and there is no one common or prevalent model. The pools that appear most effective cover risks that are prevalent to all or the majority of the populace and those that are not at this time subject to strong mitigating actions and controls (for example earthquake risk) in respect of property damage
- A comparative insurance pool is established in the USA to provide flood insurance at subsidised rates to high risk areas. Mandatory mitigation activities have not been successful in lowering the exposure in high risk areas. The scheme is in substantial deficit ($24 billion USD) and does not appear to be financially viable.
- These case studies highlight the likelihood that financial risk from natural disasters is unlikely to decrease following the implementation of an insurance pool, and there is strong evidence that subsidised premiums act to mask the value of risk mitigation in the absence of compensating mechanisms. There is also concern that pools can create disincentives to risk adaptation and mitigation.

- Within Australia, natural disaster perils are not evenly spread or prevalent to all. Uncertainty and unpredictability around natural hazards has been reduced due to advancements in modelling technology and the funding of specialised research facilities, which is highlighting this position to consumers.
- Pre-disaster mitigation strategies have been demonstrated to be cost-effective when comparing the upfront cost of mitigation to the reduction in potential losses they provide. This can be quantified in the Benefit Cost Ratio for specific projects.

From the findings in the economic modelling, with support from the qualitative research, we conclude that:

- The disparate exposure to natural disaster risk in exposure does not appear to readily lend itself to national level pool solutions, particularly in respect of flood, cyclone and bushfire risks.
- The pool system performing worse than the baseline scenario supports the continuation of the current system of risk apportionment as the most effective method of financial risk transfer.
- Over the long term government investment in natural disaster management can have the greatest economic value in structured mitigation programs, rather than post disaster assistance.

1. Introduction

Financial risk from a natural disaster is shared in varying proportions between the Government, Business and Households. The upward trend in overall losses as a result of natural disasters experienced has resulted in challenges to those providing financial relief. As such, there is growing impetus to determine how best to manage and share the risks associated with catastrophic events.

A well functioning financial system relies on maintaining accessibility of financial risk management alternatives to those exposed to risk. Underlying this risk sharing are embedded certain assumptions, which are currently being tested due to increasing costs, improvements in technology and resulting unaffordability of insurance as a means of financial risk transfer. Part of the insurer role is the emphasis of risk management principals and to ensure that as a nation we retain focus on the value of risk mitigation[2].

1.1 Objectives

The structure of Australia's insurance industry frames the way in which risks are apportioned across society and is a major component of the nation's resilience to natural disasters.

The objective of this study is to examine how effective the current structure is comparative to alternative risk apportionment options. More specifically, the study aims to compare the relative costs and benefits from an economy wide standpoint of the current insurance market relative to the expected outcomes under a pooled insurance market and a government led mitigation alternative. This is achieved by a qualitative analysis of each of the three alternatives as well as an empirical analysis using a comparative static, computable general equilibrium (CGE) model to test the material impacts on the economy from transitioning to a pooled insurance system versus a publically mitigated system.

1.2 Scope

Technological advances have enabled a fundamental change in the understanding and hence the visible cost of weather related natural disaster risks and exposures at very granular levels. KPMG have been engaged to write a report in this context to:

- provide an analysis of the current system of risk apportionment across the Australian insurance sector;
- provide commentary on alternate approaches to risk apportionment within Australia and internationally; and
- undertake economic modelling of alternative models to estimate the net cost/benefit of alternative approaches compared to the current system.

The scope of the study has been limited to an Australian focus covering all weather related natural disaster phenomenon. The empirical analysis captures economy wide impacts and the investigation into insurance alternatives has been conducted on an industry level.

[2] Insurance Council of Australia's Property Resilience Exposure Program

1.3 Methodology

The two risk apportionment alternatives being considered in this paper are a pool insurance system (coordinated by government), and government led structured mitigation.

Insurance can be viewed as a mechanism through which risk is pooled. In this report, references to an insurance pool, pooled insurance market and pool system refer to risk financing structures operating outside open market competition. Example structures include those operated or coordinated by government and insurance markets working within government led intervention – such as compulsory underwriting rates that cross-subsidise high-risk areas.

Within our modelling we are referring to a hypothetical insurance pool established for the cover of risks arising from natural disasters.

The qualitative study on these two approaches (Section 3.2 and 3.3 respectively) involved desktop research into currently existing schemes and case studies. The output of the qualitative study was the development of assumptions which could then be used in the quantitative assessment to test the effect each alternative would have on the overall economy, relative to a base scenario representing the current system.

The economic assessment (Section 4) tests the performance of both scenarios in the event of a major natural catastrophe occurring in year 10, relative to the current system of insurance coverage and government support. The approach uses KPMG's existing in-house CGE model, which itself is based on a modelling framework established over a number of decades as a base for investigations such as this. The CGE Model used allows for the relative impact of each alternative on economic performance to be modelled on a national scale.

KPMG's latest CGE model, FLAGSHIP, was developed over the past two years and is based on the most up-to-date detailed data available from the Australian Bureau of Statistics. FLAGSHIP brings together 80 years of combined modelling experience (gained with the world's pre-eminent economic modelling institutions, and in economic policy advice and research roles with several international governments), the latest theoretical developments in the field and a database constructed from the latest available data. The model embodies an array of features that enhance its utility in policy and economic modelling, including sophisticated economic and behavioural assumptions (further discussed in Attachment A). This makes CGE modelling the most appropriate tool to use when assessing the economy-wide impacts of any policy or economic shock.

The data used to design the CGE simulations were sourced from a variety of databases including Australian Government Budget, the Insurance Council of Australia, the Australian Prudential Regulation Authority and Suncorp. We also tested the sensitivity of the results to some of the key assumptions input into the modelling as part of the analysis (discussed in Section 5).

1.4 Report structure

The remainder of this report is structured as follows.

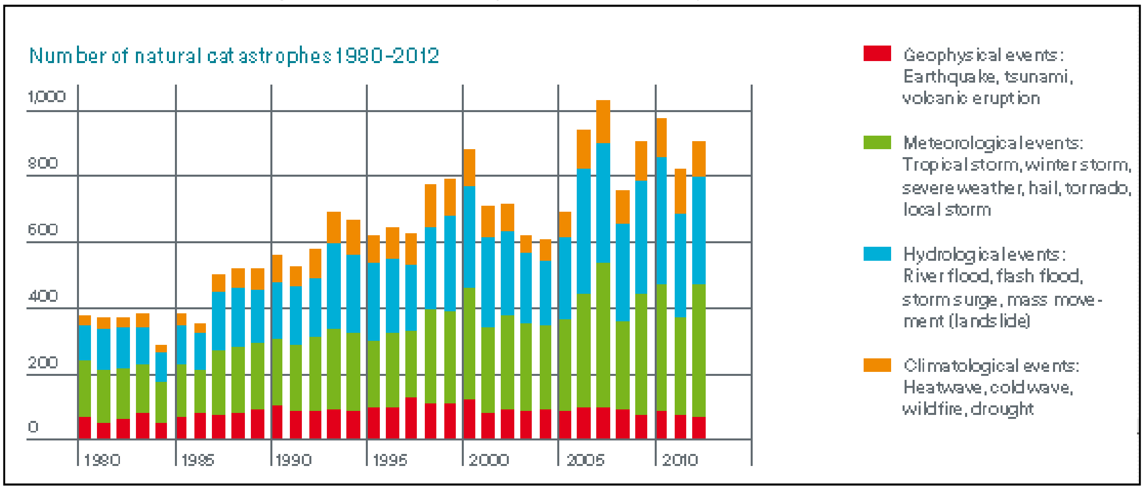
- ***Section 2 Background*** - This section establishes the context of the study and the key dynamics that have informed our research.
- ***Section 3 Risk Apportionment Alternatives*** - This section provides a detailed examination of three risk apportionment models: Current system, Insurance Pool Alternative and Structured Mitigation.
- ***Section 4 Economic Assessment*** – This sections details the assumptions and approach used in the economic assessment and the detailed results from the General Equilibrium Model.
- ***Section 5 Discussion*** - This section considers the output from the economic modelling in the context of the full report.

2. Background

2.1 Rising costs

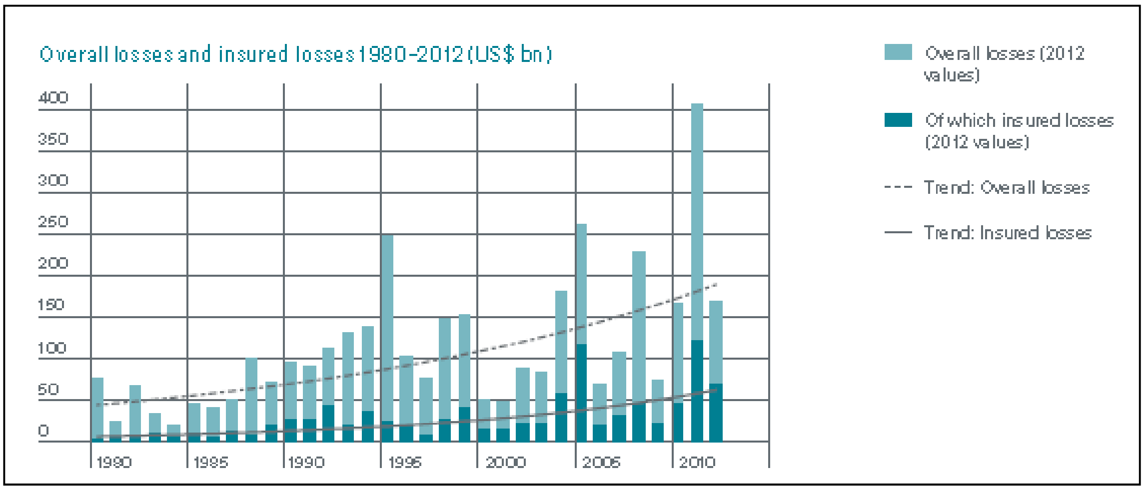
According to the Institute of Actuaries of Australia (2010), global trends in disaster incidences have shown a significant rise in the frequency of shock events (by number, see Figure 2-1) over the last 60 years. This trend is most prevalent since the 1980s and is forecast to continue into the future. In addition to this expected rise in frequency, the severity of natural disaster events in terms of damage costs has also been increasing (see Figure 2-2). This is largely driven by the effects of population growth, increases in the concentration of infrastructure density and domestic migration to more vulnerable regions (sea changes and tree changes). These observations are reflected in other studies such as the graphs below prepared by Munich Re, a large global reinsurance company.

Figure 2-1: Number of natural catastrophes 1980-2012



Source: Munich Re (2013) "Natural Catastrophes 2012: Analyses, assessments and positions" Topics Geo

Figure 2-2: Overall losses and insured losses 1980-2012



Source: Munich Re (2013) "Natural Catastrophes 2012: Analyses, assessments and positions" Topics *Geo*

According to a study conducted by Deloitte Access Economics (2013) the economy wide cost of natural disasters in Australia was over 6 billion AUD in 2012 alone. Excluding the potential effects of climate change this was estimated to double by 2030 and increase to a per annum average of 23 billion AUD by 2050. Whether this is funded by government, the insurance sector or individuals, this represents a substantial increase in the expenditure on natural disaster assistance, placing significant pressure on the economy. An assessment is needed on the best way to minimise the overall economic impact of these events.

2.2 Principles for risk management

The general principles for risk management can be described with the following hierarchy:

- ***Avoiding or reducing*** the level of risk, by adopting alternative approaches to achieving an objective.
- ***Transferring*** the risk to another party which has greater control over the risk situation, or is less susceptible to the impact of the risk.
- ***Accepting*** some or all of the risk and developing contingency plans to manage the risk that minimise the impact should the risk eventuate.[3]

Within the context of managing the financial risks arising from natural disasters in Australia, these general principles apply. Certain actions can be taken to avoid or reduce financial loss from natural disasters, insurance is available to transfer a portion of the financial risk; and any remaining risk exposure is accepted and plans are put in place to manage this impact.

2.3 Key parties

The different parties who share exposure to financial risk from natural disasters creates layers of complexity in any decision making process around reducing, transferring and accepting of risk. Financial risk from a natural disaster is shared in varying proportions between the Government, Business and Households. The Business sector includes Insurers, Banks and Business owners.

While this report has focused on the role of insurers, it is worth acknowledging that the financial risk exposure of banks through their mortgage portfolio at present also relies on the availability of insurance to the home-owner and the system is based upon a strong presumption that such cover will remain available.

The apportionment of risk for natural disasters in Australia sits largely with the Insurance Industry; supplemented by State and Federal Governments[4]. Insured losses from natural disasters in Australia average over $1.2 billion each year, supplemented by an additional per annum average $560 million from the Australian Government[5]. The Business Roundtable for Disaster Resilience and Safer Communities 2013 whitepaper indicates that by 2050, natural disasters may cost the Australian economy as much as $23 billion AUD per annum. A key question for insurers and governments that are responsible for rebuilding communities in the aftermath of natural disasters

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[3] *Review of the insurance arrangements of State and Territory Governments under the Natural Disaster Relief and Recovery Arrangements Determination 2011*. Commonwealth of Australia, Department of Finance and Deregulation. August 2012.
[4] *Natural disasters in Australia: An issue of funding and insurance*. Chris Latham, Peter McCourt and Chris Larkin. Prepared for the Institute of Actuaries of Australia's (Institute) 17th General Insurance Seminar (November 2010)
[5] *Building our nation's resilience to natural disasters.* Prepared for the Australian Business Roundtable for Disaster Resilience and Safer Communities by Deloitte Access Economics (June 2013). http://australianbusinessroundtable.com.au/white-paper

therefore is, *'is the current approach sustainable in the face of increased frequency, intensity and costs of natural disasters?'*

2.4 Extent of structured mitigation

While investment in mitigation has been occurring in Australia for decades, implementation has occurred on a project to project basis. As such, a nation-wide mitigation strategy targeted at reducing exposure in the most vulnerable areas has not had the funding nor the granularity in natural disaster modelling to deliver a coordinated and targeted approach.

Due to the inherently uncertain and unpredictable nature of natural hazards, mitigation strategies tend to focus on reducing the vulnerability of communities (i.e. reducing the sensitivity and increasing the adaptive capacity of local communities, public assets and the services they use). In recent years this uncertainty and unpredictability around natural hazards has been reduced due to advancements in modelling technology (e.g. aerial surveys and LiDAR) and the funding of specialised research facilities such as the CSIRO Climate Adaptation Flagship, the James Cook University Cyclone Testing Station in Townsville and the Bushfire Cooperative Research Centre in Melbourne. These advances in technology and research enables more refined and localised data, which provides a clearer understanding of the extent of hazard-prone areas, the probability of events occurring, and the effectiveness of various mitigation techniques.

2.5 Loss of life

Whilst mitigation can be successful in reducing the costs of a natural disaster mitigants also play a critical role in preserving human life and reducing the occurrence of injury. In a 2007 review into the cost-benefits of FEMA Hazard Mitigation Grants in the United States, grants to mitigate the effects of floods, hurricanes, tornados, and earthquakes between 1993 and 2003 are expected to save more than 220 lives and prevent almost 4,700 injuries.[6]

Some of the worst Australian natural disasters have occurred in recent years including the 2009 Black Saturday bushfires in Victoria, the Queensland floods in 2010/11 and Cyclone Yasi in 2011. In the three years 2009 – 2011, over 200 lives were lost and hundreds of thousands of people were affected.[7] The desire to protect life and property is paramount for all Australians, driving the need for a cost-effective and long term approach to managing the risk associated with natural disasters.

The economic modelling within this paper has not taken into consideration any economic consequences associated with loss of life arising from natural disasters and we have not modelled the additional benefit that might arise from a reduction in such impacts through structured mitigation.

2.6 Pricing and risk granularity

Pricing of insurance premiums requires identification of risks associated with the asset to be covered, to allow an estimate of expected losses to be calculated. When one insurer improves its understanding of risk it can price more effectively. Those insurers that do not follow such trends will retain those higher risks that are, as a result, inadequately priced under less granular pricing

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[6] *Benefit-cost analysis of FEMA Hazard Mitigation Grants*. Natural Hazards Review ASCE. Adam Rose; Keith Porter; Nicole Dash; Jawhar Bouabid; Charles Huyck; John Whitehead; Douglass Shaw; Ronald Eguchi; Craig Taylor; Thomas McLane1; L. Thomas Tobin1; Philip T. Ganderton; David Godschalk; Anne S. Kiremidjian; Kathleen Tierney; and Carol Taylor West, November 2007.

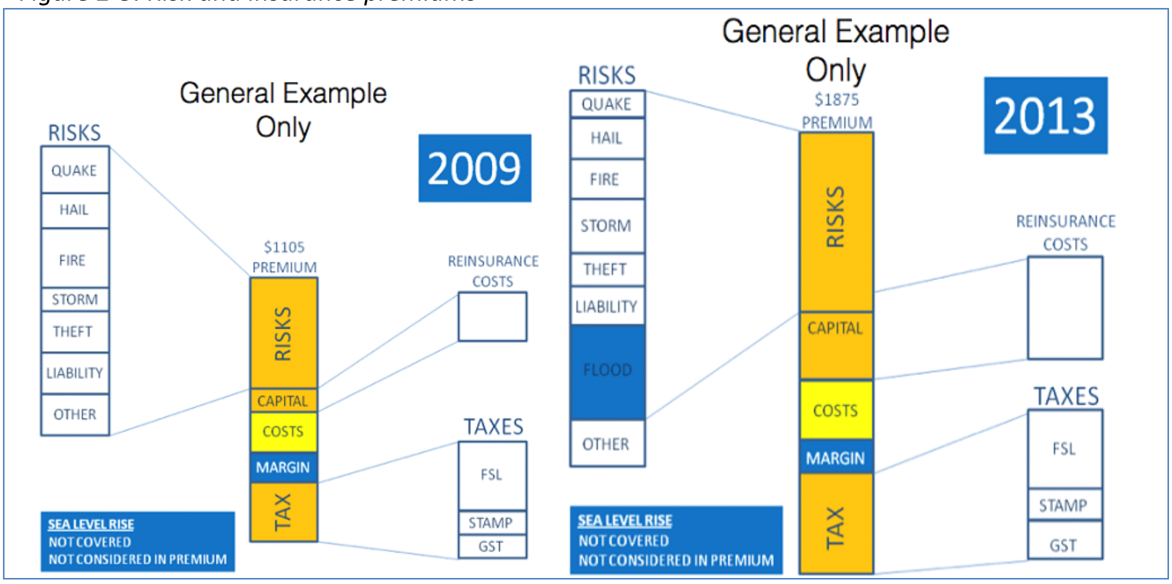
[7] *Natural disasters in Australia: An issue of funding and insurance*. Chris Latham, Peter McCourt and Chris Larkin. Prepared for the Institute of Actuaries of Australia's (Institute) 17th General Insurance Seminar (November 2010)

structures. Referred to as adverse-selection or anti-selection these features drive the insurance industry, when operating in open competitive markets to pursue an improved understanding of risk at granular levels and to price each risk accordingly.

Technological advances in modelling enable fundamental improvements in the understanding and pricing of weather related natural disaster risks and exposures. This provides increased granularity in forecasting specific risk exposure for specific houses, which leads to higher premiums for those in high-risk areas. Two neighbours may now have vastly different premiums, as the granular level of pricing now established by insurers allows for more accurate pricing of individual risks. The high risk exposure associated with flood prone localities makes the provision of private insurance challenging as in order for insurance companies to cover their risks, premiums would need to be close to the value of the expected loss payment stream.[8] In the past some insurers may have excluded flood events from their coverage, in an effort to keep premiums lower, and eliminate uncertainty associated with flood events.

The change in insurance premiums arising from the change in the assessment of risk from flooding, as well as other cost such as reinsurance is illustrated in figure below over the period 2009 to 2013.

Figure 2-3: Risk and insurance premiums



Source: Insurance Council of Australia, presentation 20 March 2014 with Edge Environment.

Premiums in some high risk flood areas are quoted at over $10,000[9]. The current alternatives to this approach, is for insurers to withdraw coverage from high-risk areas, decline to renew policies, or in exceptional circumstances, internalise costs that can no longer be backed by re-insurance at affordable prices (as reinsurers also seek to avoid anti-selection). The insurance industry faces significant challenges in balancing the need to provide affordable coverage for natural disasters (including flooding), to their customers with competitive pressures to remain profitable. Unaffordable insurance premiums exacerbate problems of non-insurance or underinsurance which result in greater sections of the population turning to government or charities to help them

[8] Sigma (2011) “State Involvement in Insurance Markets,” Swiss Re
[9] Disaster insurance premiums becoming unaffordable as floods and bushfires increase. ABC Ratio national 11 February 2013. http://www.abc.net.au/radionational/programs/breakfast/more-natural-disasters-as-insurance-premiums-rise/4511192

manage the financial impact from a natural disaster. In addition, better measurement of risk allows a better measure of liability for the insurers which dictates the extent of capital required to be held. In this way, more accurate liability measurement maintains the stability of the financial stystem.

It is in everybody's interest to resolve the pricing challenges which have been brought about through the increasing accuracy in pricing of risk. If not remedied it appears that the presumption that all homeowners will have access to insurance, for example as appears to be the base assumption in the home mortgage market, will not hold going forward.

2.7 Aims

This research paper will explore the themes introduced above and investigate whether changing the apportionment of risk through the establishment of insurance pools will have a material impact on the costs to the Australian economy from natural disaster or whether investment in targeted natural disaster mitigation is a more sustainable approach to reduce overall impacts to both the economy and communities.

The investigation will draw on domestic and global case studies on risk pooling and targeted mitigation as well as economic modelling to inform out findings.

3. Risk Apportionment Alternatives

3.1 Key observations

The current system in Australia:

- Insurance is the primary mechanism by which households reduce their financial risk exposure from natural disasters. Technological advances have allowed for more accurate pricing based on individual risk exposure.
- Portions of the population remain exposed as a result of accurate pricing in high risk localities which yields unaffordable premiums.
- Underinsurance also exposes some portion of the population, resulting from numerous factors, both intentional and unintentional.
- The State and Federal governments have historically taken responsibility for providing post disaster assistance to under or non insured segments of society; however the extent of this contribution is varied.
- Mitigation has been very successful where implemented, but remains largely unstructured.

Insurance pool:

- Insurance pools have been established in a number of countries internationally to combat insurance coverage issues.
- The nature of such pools globally is varied with regard to premium pricing, exposure of underlying population and funding. No clear common themes or single model is apparent.
- Key challenges in the establishment of a pool include reduction or removal of risk sensitive price signals, reduction in risk adaptation, large financial burdens placed on governments and inequitable distribution of financial burden comparative to risk exposure.
- A flood cover insurance pool in the United States has proved financially unviable following large accumulations of public debt. This is likely to be caused by subsidised premiums failing to reduce exposure in high risk localities.

Structured mitigation:

- Targeted mitigation programs have been successful in reducing the impacts and costs of natural disasters in communities and seen significant reductions in insurance premiums.
- Recent advancements in technology are allowing risks to be more accurately identified, priced and managed.
- A sufficiently incentivized community, with access to funding can lead the coordination of mitigation programs at a regional level and effectively drive down the cost of insurance premiums. There are many examples where individuals, communities and insurers have taken such steps even in the absence of government structured mitigation.
- Communities need to be educated in the benefits of mitigation and including the return on investments that can be expected from investment in risk reduction. A key barrier against households (and governments), investing in risk mitigation is the up-front cost relative to other investments (i.e: education, transport infrastructure) and the perceived benefits of these actions.

3.2 The current system

The current system of disaster risk apportionment in Australia is characterised by the sharing of risks between insurers, the government and households. While the insurance industry captures a large segment of these risks, the ability to cover high to extreme risk households is limited by financial capacity and the competitive drivers to avoid anti-selection as risk is understood at more granular levels. As such, the government's role in providing post disaster assistance has become increasingly significant in supporting disaster prone communities. Furthermore, while some households have taken responsibility for some of the risk exposure of their properties by engaging in private mitigation, such activities remain largely unstructured. As a result the pool of risks associated with natural catastrophes is larger than if mitigation was formally recognised as a significant policy priority, placing greater financial strain on government resources.

3.2.1 Insurers

The insurance industry is critical in allowing the economy to manage financial risks and reduce the financial uncertainties associated with natural disaster events. The availability of sufficient reinsurance is critical for insurers to be able to provide cover for properties. Reinsurance is particularly important in managing exposure to natural disaster as risk of loss is generally well known and generates highly correlated claims. The diversified risk portfolio of reinsurance companies allows them to bear some of the risk of loss from natural disasters at a lower cost, ultimately allowing primary insurers to expand their coverage capacity. For the costs of reinsurance to be sustainable premiums must be in equilibrium with payouts with an additional allowance for profit, it is critical that the level of risk associated with a property is not under-reflected in the insurance premium. In addition sufficient capital must be available to respond to the accumulated risk following a natural disaster event. As insurers and reinsurers must dedicate capital to these accumulations, noting they must also pass off some of that risk, the premium charged must ultimately provide a return on the capital committed at each level. The principals of the capital that must be held to protect against insurers largest insurance risk concentration are well illustrated through the role this element plays in the APRA capital regime through both a vertical and horizontal natural perils assessment.[10]

3.2.2 Insurance challenges

Coverage

Typically, all home and contents insurance policies in Australia include compulsory cover for bushfires, earthquakes and storms. As a result the economy was able to recover rapidly from the losses associated with natural disaster events such as the 2009 bush fires in Victoria and cyclone Yasi in 2011. Until relatively recently, flood cover however was generally excluded and frequently offered on an opt-in basis (Natural Disaster Insurance Review, 2011). This generates a coverage problem. According to the Australian Insurance Contracts Regulations, a flood is defined as "*the covering of normally dry land by water that has escaped or been released from the normal confines of any of the following: a lake, a river, a creek, another natural watercourse, a reservoir, a canal or a dam.*[11]

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[10] APRA Prudential Standard GPS 116, Capital Adequacy: Insurance Concentration Risk Charge

[11] *Australian Insurance Contracts Regulations* http://www.comlaw.gov.au/Details/F2012C00369, last amended June 2012

If households do not have flood cover then the financial burden of post disaster restoration falls into the hands of the individual who must bear the costs themselves or rely on governments schemes such as the Australian Government Disaster Relief Payment (AGDRP)[12] , to relieve the cost burden. This can lead to severe personal and financial distress with potential flow on effects throughout the wider community.

The polarised exposure of properties to flood risk underpins this issue – the vast majority of Australian homes have minimal exposure to flood risk while a small proportion have a known (and likely), exposure to extreme flood risk. When these high risk properties are priced by insurers the premiums matching specific risk exposure are often so high that coverage is in practice unaffordable. In contrast, a larger proportion of homes are exposed to storm and bushfire risk, however uncertainty regarding where these natural disasters may occur and the likelihood of occurrence reduces the actuarial risk associated with these properties and hence coverage for these natural disasters is at present more accessible and affordable.

In an attempt to correct the flood coverage problem, insurers have begun incorporating flood cover into policies, leading to increases in the cost of insurance premiums which has in turn forced many of the most vulnerable households out of the market. According to the National Disaster Insurance Review "those most exposed to the risk of flood are the least likely to purchase it"[13]. This generates a problematic set of circumstances; if insurance companies price their premiums correctly then existing customers in high risk localities may 'drop-off' leading to an underinsured or uninsured market and hence an increase in the cost to government to cover the uninsured 'gap' for recovery. If insurance companies keep premiums at a more competitive level however, they will themselves bear the financial risks associated with a potential disaster event and risk financial insolvency.

We note that as modelling improves the understanding of bushfire and cyclone exposures the premiums for these risks will also in time become more concentrated on specific areas and homes. Such patterns have already emerged, for example in respect of Strata dwellings (without retro-fitting to new standards) in North Queensland becoming difficult to insure due to cyclone risk. We are also aware of increased examination and modelling of the proximity of homes to bush areas as insurers further refine the understanding of that risk.

We therefore expect that the current issues in respect of flood cover and those emerging for Cyclone risk will become an even more pronounced issue for high-risk homes.

Non-insurance

Non-insurance is a situation where a person either does not have an insurance policy, or an insurance policy is held but an event occurs which is excluded from coverage.[3] The extent of non-insurance has been difficult to measure and is likely to vary across Australia due to different exposure to risks as well as socioeconomic factors. The Insurance Council of Australia estimates that currently 3.8% of Australian homes and 29% of contents are not insured. However, within the portion of the market who hold insurance cover for home and contents, close to 10% of policies do not include flood cover[14]. These estimates appear low compared to the findings of the Victorian Bushfire Royal Commission.

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[12] *Australian Government Disaster Recovery Payment website.* http://www.humanservices.gov.au/customer/services/centrelink/australian-government-disaster-recovery-payment. Accessed March 2014.

[13] *Natural disaster Insurance Review – Inquiry into flood insurance and related matters.* The Australian Government the Treasury (September 2011). http://ndir.gov.au, p2.

[14] Insurance Council of Australia Flood Cover as at 31 March 2013.

The Victorian Bushfire Royal Commission found that 13% of properties destroyed by the Black Saturday bushfires may not have had insurance. This percentage is likely to be higher in the case of flooding as discussed in the previous section. Non-insurance occurs due to lack of coverage by insurers, unaffordable premiums, the underestimation of the risk that an event will have consequences that warrant insurance or 'moral peril' (where by individuals believe that in the event of a disaster, Governments will provide the financial assistance they require).[15]

Under insurance

Under insurance occurs when the extent of a household's insurance coverage falls below the cost of recovery, leaving the household financially responsible for some portion of the restoration expenses. There are a number of different causes of underinsurance and these can be both intentional and non intentional. Under insurance can occur as a result of the complexity associated with estimating the correct amount of coverage required. As this task is typically left to the policyholder, who generally has no expertise in insurance, errors in estimation often occur, even when insurers provide calculations. Furthermore while insurers use indexation to adjust policies to account for changes in economic conditions it is uncommon for households to increase their coverage over time as they make improvements to their property. The Blue Mountain bushfires that occurred west of Sydney Australia in November 2013, highlighted the knowledge gap that consumers have regarding what value to place on their homes when purchasing an insurance policy. New building requirements for fire-prone areas have been in place since 2010, however the cost of these additional requirement, was not been reflected in the insured value of homes. As a result the cost of replacing a home following the fires has increased by up to AUD $100,000 and homeowners did not understand this well prior to the event.[16]

Conversely under insurance may be a premeditated decision made by policyholders in response to rising premiums. This is particularly common across households in high risk localities that recognise the importance of attaining some sort of coverage but cannot afford or do not wish to pay the premiums associated with full coverage over their properties.

Finally under insurance may result from a rise in the cost of restoration in post disaster periods. Even if coverage is accurately selected in the purchase period, a surge in the demand for restoration services following a disaster shock or changes in the regulatory requirements for new developments may push the price of construction and restoration up beyond competitive, business as usual prices. Hence coverage would not be adequate enough to fund these amplified costs.

For the above reasons, under insurance continues to be prevalent across Australian households. A study conducted by the Australian Securities and Investments Commission (ASIC) in 2005 stated that between 27 and 89 percent of households were underinsured by 10 percent or more during the Canberra bushfires of 2003. The Institute of Actuaries of Australia published a report in 2010 that estimated that 23% of the costs incurred during the Sydney hailstorm of 1999 were under or uninsured. This equates to an estimated figure of 0.5 billion AUD.[17]

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[15] *Review of the insurance arrangements of State and Territory Governments under the Natural Disaster Relief and Recovery Arrangements Determination 2011*. Commonwealth of Australia, Department of Finance and Deregulation. August 2012.

[16] *Under-insurance a significant issue in fire devastated Blue Mountains*. ABC News. 12 November 2013.http://www.abc.net.au/news/2013-11-12/under-insurance-a-significant-issue-in-fire-devastated-blue-mou/5085040

[17] *Natural disasters in Australia: An issue of funding and insurance*. Chris Latham, Peter McCourt and Chris Larkin. Prepared for the Institute of Actuaries of Australia's (Institute) 17th General Insurance Seminar (November 2010)

3.2.3 Government

The proportion of Australian households who are uninsured or under insured is likely to grow as affordability of insurance declines in line with predicted increase in the frequency and intensity of natural disasters. Under the current system the insurance industry does not have the capacity to support the whole market, with price signals deterring high risk households from attaining coverage. Consequently, the government is assumed to have a responsibility for supporting the uninsured and under insured population to ensure they are not left to carry the full financial burden of post disaster recovery. Ultimately the government's role is two-pronged involving both pre disaster regulatory action and post disaster restoration assistance. A key question is whether the Government can sustain its role in supplementing insurance as the cost of natural disasters grows.

Building pre disaster resilience

The current system of natural disaster risk management is characterised by a fragmented framework spread across a number of different government agendas and bodies. While the Council of Australian Governments (COAG) has recognised that a "national, coordinated and cooperative effort" is critical in building Australia's resilience to emergencies and disasters[18], the current framework of pre disaster risk management is still inherently incoherent and segmented across bodies including the Australia New Zealand Emergency Management Committee, Trusted Information Sharing Network, and the National Insurance Affordability Council[19].

COAG's National Strategy for Disaster Resilience (NSDR) describes the role of the government in pre disaster risk management as comprising of three main elements (COAG Natural Disaster Resilience Statement, 2009):

(1) Education – the government is responsible for informing communities about how to reduce their vulnerability to natural disasters and how to respond to a hazard as it approaches.

(2) Support – the government is responsible for supporting communities in both preparation before a natural disaster event and in recovery following a natural disaster event. Further, the government has a role in supporting emergencies services in order to ensure they can respond effectively to any hazard.

(3) Land management – the government is responsible for implementing land management and planning arrangements that account for disaster risks and engaging in other mitigation activities, the specifics of which are not detailed.

According to the NSDR, governments of all levels are responsible for the provision of these components of pre disaster risk management with a specific focus on allocating resources to initiatives designed to respond to local conditions. The National Partnership Agreement on Natural Disaster Resilience provides approximately $27 million of funding to states and territories per annum to finance local and state initiatives.[20] Despite this focus on local action, according to local government consultations conducted by Deloitte Access Economics there is still some confusion around applying for funding which has the potential to limit the scale of local mitigation activities. Building pre disaster resilience at a local level therefore could be improved by incorporating local governments into the planning stages and educating them about how to effectively source and

[18] *COAG Natural Disaster Resilience Statement*, http://www.coag.gov.au/sites/default/files/national_strategy_disaster_resilience.pdf, 2009

[19] *Building our nation's resilience to natural disasters.* Prepared for the Australian Business Roundtable for Disaster Resilience and Safer Communities by Deloitte Access Economics (June 2013). http://australianbusinessroundtable.com.au/white-paper

[20] *The National Partnership Agreement on Natural Disaster Resilience* http://www.em.gov.au/npa, 2009

utilise data to better inform planning decisions. In addition to issues regarding pre disaster risk management, the coordination of local government responses to natural disaster events has also received criticism. According to a study conducted by NCCARF (2010) residents in Mackay, Queensland rated their Local Council poorly in terms of its response to the flood event of 2008, with only 26 percent rating it very responsive. Furthermore, 93 percent of residents received no warning about the onset of the flood and only 5 percent of residents would consider themselves to have been significantly prepared.[21]

Post disaster assistance

In line with the increasing severity of natural disaster events in Australia the trends of government expenditure have been increasing exponentially across all levels of government. This is estimated to continue and worsen as a result of both population growth and increasing urban densities[22].

Figure 3-1: Historical government support for natural disasters

Year Ending 30 June	Historical NDRRA Support ($ m)								
	ACT	NSW	VIC	QLD	WA	SA	TAS	NT	Total
2002	0.0	81.7	0.0	29.0	0.0	0.0	0.0	4.4	115.2
2003	16.0	53.2	30.9	3.5	0.0	0.0	0.0	0.0	103.7
2004	0.0	0.1	1.0	4.8	0.0	0.0	0.0	0.3	6.1
2005	0.0	0.0	0.1	22.8	0.3	2.3	0.0	0.2	25.8
2006	0.0	0.6	0.2	47.4	0.5	0.3	0.6	3.1	52.7
2007	0.0	0.5	50.6	157.8	0.0	0.6	0.0	7.2	216.7
2008	0.0	12.6	4.5	90.1	0.2	1.3	0.0	8.1	116.7
2009	0.0	3.8	226.4	170.3	0.0	0.0	0.0	4.2	404.7
2010	0.0	58.3	102.0	354.2	0.2	0.1	0.0	2.4	517.3
2011	0.0	71.9	126.1	1,288.8	0.8	0.1	8.9	7.7	1,504.2
2002 - 2011	16.0	282.8	541.7	2,168.7	2.0	4.7	9.5	37.7	3,063.1

Source: Department of Finance and Deregulation; *Review of insurance arrangements of states and territories under the Natural Disaster Relief and Recover Arrangements*. Historical Payouts

The current scheme of post disaster assistance is characterised by a cost sharing relationship between the federal government and the states and territories and comprises of a range of on the ground projects as well as financial aid. Resources are distributed from the federal government to the states via the National Disaster Relief and Recovery Arrangement (NDRRA). This framework establishes the conditions for funding to be granted and includes assistance to both individuals through the provision of Personal Hardship and Distress payments (PHD) and to communities which comes in the form of reimbursements to state and territory governments for 50 to 75 percent of all disaster recovery related expenses. Under the NDRRA the federal government also provides a one off financial aid payment to Australian residents who have been affected by a natural disaster both domestically and international. This financial assistance also extends to the private sector via the Disaster Income Recovery Subsidy which provides aid to farmers, small businesses and employees whose operations have been affected by a natural disaster event.

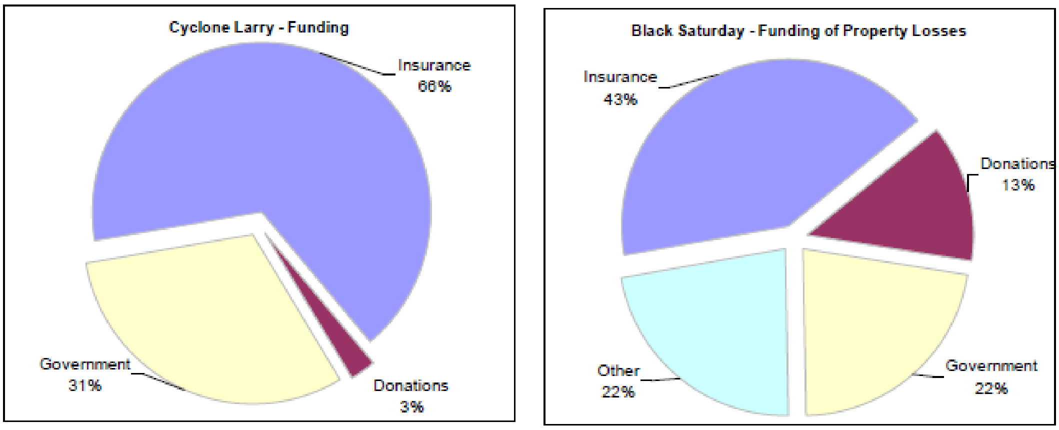
As populations grow and the cost of natural disasters increases, State and Federal Governments will increasingly face the challenge of finding sufficient funds to provide these services – a task which is most often achieved through cuts to other budgeted programs and initiatives. Following

[21] *The 2008 floods in Queensland: A case study of vulnerability, resilience and adaptive capacity.* National Climate Change Adaptation Research Facility (2010) NCCARF Synthesis and Integrative Research Program
[22] *Natural disasters in Australia: An issue of funding and insurance*. Chris Latham, Peter McCourt and Chris Larkin. Prepared for the Institute of Actuaries of Australia's (Institute) 17th General Insurance Seminar (November 2010)

the 2011 Queensland floods, the estimated cost to the Australian Government to rebuild Queensland was in the order of $5.6 billion AUD. To assist in reducing the cost burden, the Government introduced a temporary flood and cyclone reconstruction levy which applied during the 2011-12 financial year. Treasury estimated that the levy would raise around $1.8 billion AUD, this required a further $2.8 billion AUD to be re-prioritised and cut from established program budgets and infrastructure projects[23].

While the relative proportion of risks covered by the government versus the insurance industry varies from one disaster event to another, the government's contribution is generally substantial. With marginal assistance from charities the government acts as an insurer of last resort, funding the excess recovery that is not covered by insurance. The following charts generated by the Institute of Actuaries of Australia illustrate the mix of funding in the aftermath of Cyclone Larry in 2006 and the Black Saturday Bushfires of 2009. From both these case studies it can be observed that at least one third of the funding is not provided by the insurance industry demonstrating an inherent insurance coverage gap.

Figure 3-2: Natural disasters in Australia: An issue of funding and insurance.



Source: Chris Latham, Peter McCourt and Chris Larkin. Prepared for the Institute of Actuaries of Australia's, 17th General Insurance Seminar (November 2010)[1]
Note: Other is largely an estimate of timber losses (including plantation forests) which was included in the damage estimates made by the Royal Commission.

3.2.4 Government challenges

These two areas of government involvement prior to and following a natural disaster have been associated with several challenges, the most critical being effectiveness and budget capacity. Firstly, the regulatory framework laid out in the NDRS has received criticism for being fragmented across too many government bodies, preventing an efficient, cohesive response to catastrophes.[24] Secondly, while both the NSDR and the Select Committee for Climate Change specify businesses as playing a fundamental role in building pre disaster resilience, this potential has not been adequately realised as while cooperation between the government and private enterprise is written into the policy dialogue, it has in many cases not been fostered through regulatory action or education. The establishment of the Australian Buildings Code Board represents one example where regulatory action has attempted to ensure that the activities of businesses are in line with

[23] *Building our nation's resilience to natural disasters.* Prepared for the Australian Business Roundtable for Disaster Resilience and Safer Communities by Deloitte Access Economics (June 2013). http://australianbusinessroundtable.com.au/white-paper
[24] *See reference 23 above*

the government's pre disaster resilience objectives. This however has failed to be effective in informing construction decisions in regions vulnerable to flooding. This was evident in the Charleville, Queensland flood of 2008. The settlement plan of Bradley's Gully, Charleville has been noted as being a significant contributor to the vulnerability of the area and has remained unchanged despite the region's history of flood.[25]

There are significant challenges associated with supplementing the cost of disaster recovery. For households, the provision of post disaster government assistance has been inconsistent across historic natural disaster events generating uncertainty and, if you are assuming some degree of government support, that in turn makes pre disaster decision making difficult. This is demonstrated starkly by estimates of the Institute of Actuaries of Australia (2010). These show that government assistance contributed considerably to recovery and restoration activities following disaster events such as Cyclone Larry, 2006 and the Black Saturday fires of 2009, funding 31 percent and 22 percent of all property losses respectively. This kind of support however can't always be expected. Following the Sydney hailstorms of 1999 which generated the largest insurance cost of any single event in Australian history, the government didn't contribute any funding or aid to assist in recovery and restoration. This kind of inconsistency in government support across different disaster events is problematic for high risk households who need to make informed decisions about how to prepare for a potential disaster event and how to apportion the risks associated with their property.[26]

In addition, the use of a levy mechanism to raise finances for post disaster recovery has significant social and economic implications. It generated widespread public debate surrounding issues of inequality as households who had chosen to live in low risk localities were charged with the same cost as those households that had actively chosen to live in flood prone areas. The uniform nature of the levy did not account for differences in risk exposure and this was not received well by communities who were not exposed to any flood risks. Furthermore a uniform charge has the affect of disrupting regular incentive structures creating the potential for moral hazard to emerge. If households in high risk localities know that in the event of a natural disaster they will be charged the same as households in low risk localities then they will have no motivation to relocate or reduce the risk exposure of their property via private mitigation.

3.2.5 Modelling assumptions

The base scenario in the economic modelling assumes that the current system of risk apportionment remains in place. This includes the significant contributions of both the insurance sector and the government in the event of a major natural catastrophe. In normal years the existing equilibrium is maintained to reflect current levels of spending around premiums, claims, reinsurance and Government contributions.

In addition an assumption has been made regarding the extent of unstructured mitigation which is likely to occur as a result of the current condition of pricing risk premiums. Following the recent natural disasters, customers in high and extreme risk areas are now experiencing unaffordable insurance premiums – which can only be made more affordable through individual or Government led mitigation measures. Individual mitigation for a home in a high flood risk area, such as raising the height of the house, could reduce the insurance premium for the individual, as the risk rating is reduced. Recent media coverage has noted the substantial change in the premiums in townships

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[25] *The 2008 floods in Queensland: A case study of vulnerability, resilience and adaptive capacity.* National Climate Change Adaptation Research Facility (2010) NCCARF Synthesis and Integrative Research Program
[26] *Natural disasters in Australia: An issue of funding and insurance*. Chris Latham, Peter McCourt and Chris Larkin. Prepared for the Institute of Actuaries of Australia's (Institute) 17th General Insurance Seminar (November 2010)

where levees have been built as mitigation of flood risk. In this way, insurance premiums charged (or quoted) to customers act as a price signal which may result in mitigation by individuals. The potential spend on mitigation and the potential reduction in losses as a result of individual mitigation has therefore been included within the current system model.

3.3 Insurance pool: an alternative risk sharing model

3.3.1 Purpose and benefits

The issues of availability and affordability which characterise the current natural disaster insurance market have provided impetus for reform in the way in which natural disaster risks are apportioned and managed. The establishment of natural disaster insurance pools are being tested globally as an alternate risk apportionment model.

An insurance pool is a collective pool of assets from multiple insurance companies or governments designed to spread the risk exposure of each contributor. The mutually beneficial implications of such risk sharing behaviour are most starkly realised in the case of catastrophic events, when independently insurance companies would not have the capacity to respond to all damage claims or where open market competition would not naturally lead to that result.

Cummins, Doherty and Lo (2002) conducted a study of the financial capacity of the United States insurance and reinsurance industry to pay catastrophic losses. It was estimated that for a $100 billion USD catastrophe, the industry could pay up to 93% of insured losses, 84% for a $200 billion USD catastrophe and 78% for a $300 billion USD catastrophe, leaving $7 billion USD, $32 billion USD and $66 billion USD respectively in unpaid damage claims. As a result, independent insurers would face the risk of insolvency in the case of such catastrophes, a risk that could be offset via risk pooling[27].

Risk sharing schemes can act to minimise risk exposure to all participating entities via diversification which will in turn increase the financial capacity of the insurance industry at an aggregate level. In this way, pools can act to expand coverage, allowing high risk or low income consumers who were previously priced out of the market to re-enter. An effective way to allow for coverage expansion is a pooled system with mandatory participation of all the population with pricing based on the ability to pay. This ultimately acts to redistribute funds from low risk, high income segments of society to households that under competitive market conditions could not afford coverage.

3.3.2 Challenges

In theory insurance pools offer a potential solution to the issues of availability and affordability of natural disaster cover by reducing risk exposure via enforced diversification, expanding financial capacity, and broadening coverage of the market. However, whether these benefits translate in practice remains a contentious topic of debate.

Several pools that are currently in operation such as the USA's National Flood Insurance Program (NFIP) have become characterised by severe levels of public debt and a breakdown of efficient

[27] Cummins, J.D., N. Doherty and A. Lo. 2002. Can insurers pay for the "Big One"? Measuring the capacity of the insurance market to respond to catastrophic losses. *Journal of Banking and Finance* 26, 557-583.

incentive structures. This ultimately results from the inherently non-rivalrous and non-excludable nature of public goods.[28]

Risk minimisation is an outcome consistent with competitive markets that is difficult to achieve via the public provision of goods and services such as insurance. The market framework enforces effective risk reduction by applying heterogeneous charges to customers based on risk level, allowing discrimination in order to minimise adverse selection and constraining benefits to minimise moral hazard. Due to these factors, a competitive market structure allows insurers to be rewarded privately for their ability to reduce aggregate risks. Conversely governments are fundamentally unable to provide these foundations necessary for risk reduction. The inherently non-discriminatory nature of public goods prevents the control of adverse selection. The prevention of moral hazard is hindered by the Government's motivations to respond to voter interests through benefits. And the inclusiveness and scale of Government insurance prevents efficient risk aggregation.[29]

This conclusion is supported by studies conducted by the United States Government Accountability Office (GAO) into the structural inefficiencies of the current NFIP. After accruing 24 billion USD in debt the program was reviewed and integration into the private sector has since been encouraged. Along with the privatisation of the NFIP, the GAO suggests eliminating subsidized premium rates to reinstate competitive pricing that reflects real risks such that individual property owners pay for the risks associated with flood damage rather than taxpayers. Currently, high risk properties in this program have been granted premium subsidisation of up to 60 percent.[30] This subsidisation of premium rates prevents property owners from responding to real price signals and consequently dampens incentives to engage in private mitigation which may ultimately amplify damage costs comparative to those that would prevail under competitive market conditions. The GAO believes that if flood cover is distributed privately these inefficiencies and the associated moral hazards will be reduced. In order to regulate against these moral hazards the NFIP previously required communities to engage in mandatory mitigation activities as a prerequisite to be eligible for flood cover. Such mitigation was required to be cost effective and government approved, however as these mitigation efforts were driven by regulatory forces rather than incentives structures they were inefficient, never exceeded minimum requirements and were difficult and costly to monitor, cementing the NFIP's indebtedness.

3.3.3 Implementation challenges

The perceived benefits of pooled insurance in the context of natural disaster events, has driven the establishment of several insurance pool schemes internationally, often as a result of the realisation of severe financial distress following a natural catastrophe. We note as an example that effectively the combination of the NDRRA and tax levied in 2011/12 established that outcome in Australia after the events of late 2010 and early 2011.

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[28] United States Government Accountability Office, Strategies for Increasing Private Sector Involvement, 2014, http://www.gao.gov/assets/670/660309.pdf

[29] *The Government, the Market, and the Problem of Catastrophic Loss.* Priest. G .L (1996). Journal of Risk and Uncertainty, 12:219-237, 1996 Kluwer Academic Publishers

[30] *Extreme events require a disaster scheme.* Anthony Bergin (2011). Australian Strategic Policy Institute

The structure, scope and operations of such schemes vary considerably from case to case with no standardised framework being regarded as most effective. A summary of a number of existing pools is included in Appendix C. The key implementation challenges identified with risk pooling can be summarised as:

1. Disruption of the price signals that are inherent in competitive markets generating moral hazard which may reduce private mitigation or migration to low risk localities.
2. Inequitable distribution of financial burden occurs when pooling is used in situations where risk exposure is not evenly distributed.
3. At a macro level reduced level and pace of risk adaptation.
4. Large financial burdens placed on governments in order to expand coverage to high risk households. There is therefore a need to establish platforms through which funds or contributions are gathered from the public and the need to examine the extent to which additional capital is retained by government to back the risks assumed (akin to the regulatory capital required of insurers).
5. It is difficult to conclude on the individual effectiveness of a pool insurance scheme, as they are often established to meet a social need, and so a financial assessment may not be appropriate. The current schemes and the scheme proposed by the National Disaster Insurance Review are summarised in the table below including an assessment against these challenges identified (1-4).

Figure 3-3: Example insurance pool schemes currently in operation

Scheme	Country	Govt involvement	Funding	Compulsory participation	Implementation Challenges			
					Priced premiums (1)	Proportion of population exposed to potential event (2)	Ability for individuals to minimize risk (3)	Financial viability (4)
EarthQuake Cover	New Zealand	Yes	Disaster Insurance Premium (levy).	No	Yes (cross-subsidised)	Majority	Minimal beyond meeting building standards.	Current deficit $1.4bn. Higher levy implemented to help recover funds following very material (in excess of 20% of GDP) claims.
Flood Re	United Kingdom	Yes	Levy imposed on insurance companies which is reflected in higher premiums.	No	Yes	Many	Yes - household flood mitigation is possible but not encouraged by the eminent introduction of Flood Re. Since 2010 21% of new houses built in London are in high flood risk areas.	The scheme is yet to be implemented. While it will be established as being dependant on government funds, it is envisaged that the scheme will ultimately become self sufficient.
National Flood Insurance Program	United States	Yes	United States Government	No	Yes, however subsidized premiums are available for high risk households.	Minority	Yes	The program has accrued 24 billion USD in debt.

Scheme	Country	Govt involvement	Funding	Compulsory participation	Implementation Challenges			
					Priced premiums (1)	Proportion of population exposed to potential event (2)	Ability for individuals to minimize risk (3)	Financial viability (4)
Turkish Catastrophic Insurance Pool (primarily for earthquake risk)	Turkey	Yes	World Bank and Turkish Government	Mandatory according to a decree law however this has little weight as no sanctions can be imposed to enforce participation.	Yes, however subsidized premiums are available for high risk households.	Majority	Minimal beyond meeting building standards.	The scheme has a 4 billion USD claims paying capacity and is backed by the World Bank.
California Earthquake Authority	United States	No	CEA premiums	No	Yes	Majority	Minimal beyond meeting building standards.	As the scheme is not backed by the United States government, financial pressures have translated into escalating premiums – now more than 15 times higher than the NZ EQC.
Australian reinsurance pool corporation (terrorism risks)	Australia	Yes	Premiums	No	Yes	Majority	No	Despite being established in 2003 there have been no claims to date. The capacity of the scheme is 13.4 billion AUD.

3.3.4 Model assumptions

To model the effectiveness of an insurance pool scheme in managing natural disaster risks, several assumptions had to be made regarding the design of a hypothetical scheme which could then be empirically examined. The structure of the hypothetical pool is as follows:

- A Government run pool, funded by a levy on all Australians.
- Participation is mandatory.
- The resulting insurance pool will cover:
  - natural disaster cover for all uninsured Australian homes;
  - a 50% subsidy for natural disaster coverage of homes in high risk areas; and
  - administrative costs.
- The natural disaster insurance will cover all natural hazards, including floods.
- The levy will be uniform, e.g. via a general tax, and not linked to individuals' risk exposure.
- Insurers' approach to identify exposure and calculate premiums for homes will not change.

3.4 Mitigation options

Concerns regarding the ability of the current system to manage impacts of natural disasters in the long term, without significant impact to the Australian economy, has triggered an exploration of the feasibility of alternate approaches. Alternatives such as risk pooling allow risks to be spread and diluted. However, as the total costs of natural disasters grows it appears based on the background research discussed above, that it is questionable whether simply redistributing costs and risk is sustainable for Australia in the long term. It also appears that mitigation options will hold greater long-term value and we explore mitigation further below.

3.4.1 What are mitigation strategies?

In this context, mitigation strategies include actions taken to help cope with hazards associated with natural disasters, leading to a reduction in harm or risk of harm, or realisation of economic benefits through a reduction in the damage to property and lower costs or quicker restoration of economic activity.

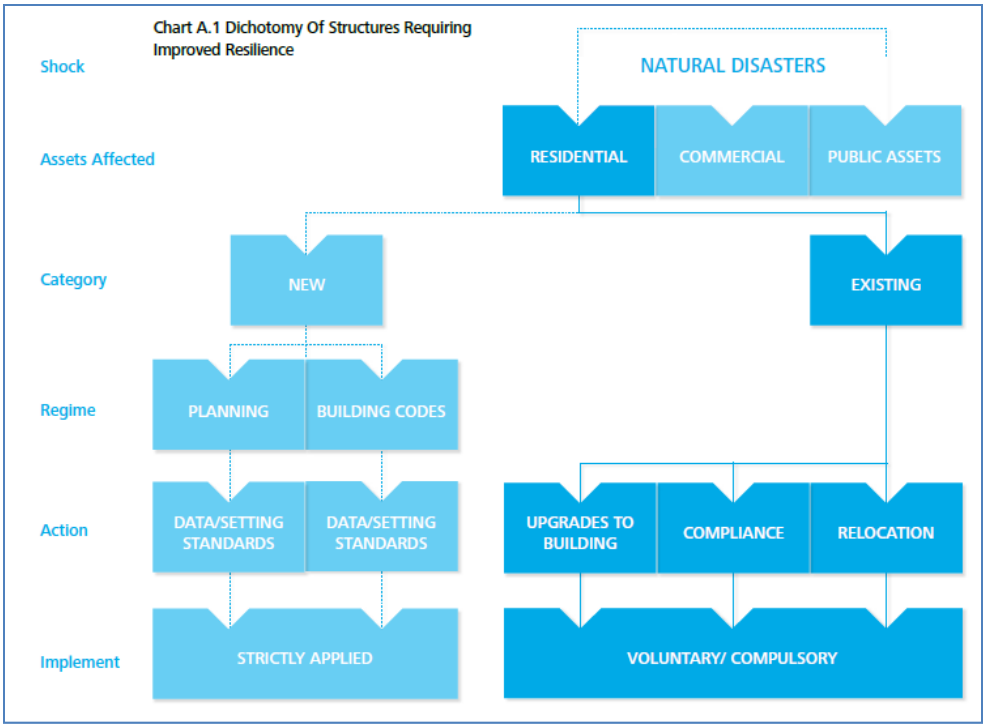
Due to the inherently uncertain and unpredictable nature of natural hazards, mitigation strategies tend to focus on reducing the vulnerability of communities (i.e. reducing the sensitivity and increasing the adaptive capacity of local communities, public assets and the services they use). In recent years this uncertainty and unpredictability around natural hazards has been reduced due to advancements in modelling technology (e.g. aerial surveys and LiDAR) and the funding of specialised research facilities such as the CSIRO Climate Adaptation Flagship, the Cyclone Testing Station in Townsville and the Bushfire Cooperative Research Centre in Melbourne. These advances in technology and research enables more refined and localised data, which provides a clearer understanding of the extent of hazard-prone areas and the probability of events occurring.

In hazard-prone areas (whether floods, cyclones or bushfires), the need to design new buildings to withstand impacts through building regulation, zoning restrictions and improved design standards have been proven to reduce the overall vulnerability of a development. Coupled with this, there is an underlying issue of an aging housing stock built prior to the introduction of zoning restrictions and many design standards. Evidence is that these homes will continue to remain highly vulnerable if not retrofitted to current standards.

3.4.2 Types of mitigation strategies

There a variety of mitigation strategies that may be considered. Many of these strategies are implemented to protect either private property or public assets. The appropriate mitigation strategy can also be different for new and existing assets. The following figure introduces a range of mitigation strategies that assists in illustrating the varying approaches to mitigation based on the type and category of the asset affected.

Figure 3-4: Dichotomy of structures requiring improved resilience



Source: Australian Business Roundtable for Disaster Resilience and Safer Communities 2013.

At the action level (refer to figure above), pre-disaster mitigation strategies may include the following:

- **Flood mitigation** – transfer of development rights, asset relocation, construction of easements, barriers and levees, elevated development, rezoning of flood prone areas, resizing of drainage and the raising of dam walls.
- **Bushfire mitigation** – rezoning of bushfire prone areas, vegetation management, placing power utilities underground and introducing design standards to reduce ember attack on homes.
- **Cyclone mitigation** – rezoning of cyclone regions, design standards for increases in wind speed, roofing deck attachments, secondary water barriers, strengthening of roof coverings, bracing and glazing protection.

3.4.3 Cost and benefits of mitigation & model assumptions

Although a greater upfront expenditure is required to invest in mitigation strategies, these methods have been shown to be cost-effective, when comparing the ultimate cost of mitigation, to the reduction in potential losses they provide[31].

By understanding the costs and benefits of different mitigation strategies, more economically informed decision-making will be achieved. This in turn leads to safer, more responsible, economically sound communities. In the long term, entire communities benefit by investing in mitigation strategies. Post natural disaster, power and water utilities will be restored more quickly, businesses will re-open sooner and communities will be functioning again with minimal disruption[32].

Up-front investments in mitigation strategies have demonstrated that they contribute to a successful future. By accounting for the full costs of risks including the improvement of outcomes in respect of injury, loss of life and disease post event, all levels of government can make strategic decisions about where, when, and how to make investments in mitigation strategies to maximise benefits and minimise risk. The full costs of mitigation may include the varying costs associated with specific mitigation strategies, non-economic factors such as community profile and engagement, as well as the lifespan and effectiveness of any mitigation measure which is dependent upon maintenance costs and the severity of future event[33].

The figure overleaf provides a summary of the net benefits of various mitigation strategies reviewed. In some of the case studies presented a Benefit Cost Ratio (BCR) has been used as an indicator of the programs cost effectiveness. This measure captures the return on investment yielding from mitigation by quantifying the ratio of benefits to costs both expressed in a present value, monetary metric. A ratio of greater than one indicates that benefits exceed costs generating a positive return on investment while a ratio of less than one indicates the reverse. The key findings outlined in the figure overleaf were used to inform the assumptions for the economic modelling of the three alternative options being considered.

Testament to the effectiveness of mitigation strategies in reducing the cost of impacts, is the recent move for Insurance companies to fund mitigation strategies directly. Following a hailstorm that swept through Calgary Canada in 2010 resulting in insured losses of over $400 million, a consortium of insurance companies jointly financed Weather Modification Incorporated (WMI). Since 1996 WMI has identified severe storms and sent aircraft to disperse chemical agents to reduce the storms severity. Early evidence suggests that the insurance industry has saved as much as $50 million each year as a result.[34]

[31] RMS 2009 *Analysing the Effects of the My Safe Florida Home Program on Florida Insurance Risk*, Florida Department of Financial Services

[32] *An economic framework for coastal community infrastructure* Prepared for National Oceanic and atmospheric Administration by Easton Research Group (June 2013)

[33] *See reference 32 above*

[34] *Sharing risk – Financing Australia's disaster resilience*. Australian Strategic Policy Institute (February 2011).

Figure 3-5: Summary of the net benefits of mitigation strategies

Study	Scope of mitigation measures	Key findings
RMS 2009 *Analysing the Effects of the My Safe Florida Home Program on Florida Insurance Risk*, Florida Department of Financial Services	Mitigation program assisting the general public with mitigating the risk of property damage due to high winds following a hurricane. This is achieved through the promotion of retrofitting and education through an inspection program and public outreach campaign.	• Reductions in 100 year loss of between US$1.50 and $2.75 per $1.00 spend in hurricane mitigation can be achieved, i.e. a benefit to cost ratio (BCR) of up to 2.75 can be achieved. • Reductions in 100 year loss of up to 77% can be achieved for claims liability.
Mason & Haynes 2010 *Adaptation lessons from Cyclone Tracey*, NCCARF	Changes to Australian design standards in cyclone prone regions – considering low-frequency, high-impact events.	• Cyclone mitigation measures post 1974 can achieve up to 85% reduction in damage.
Mortimer, Bergin & Carter 2011 *Sharing risk: Financing Australia's disaster resilience*, ASPI	Storm mitigation program in Alberta, Canada initiated by the insurance industry that cloud seeds severe storms to minimise the extent of insured losses.	• Insurance industry saves up to AU$51M each year.
Deloitte 2013 *Building of nation's resilience to natural disasters*, Australian Business Roundtable for Disaster Resilience and Safer Communities	Program focusing on building more resilient new houses in cyclone risk areas of South East Queensland that reduces the risk of cyclone-related damage.	• A BCR of up to 3 can be achieved for cyclone mitigation measures.
	Flood mitigation program that involved the raising of the dam wall at Warragamba Dam, NSW that reduces annualised average flood costs.	• BCR between 2.2 and 8.5 can be achieved for flood mitigation measures.
	Program of building more resilient housing in high risk bushfire areas in Victoria through improved vegetation management and the placing of electricity wires underground.	• BCR of between 1.3 and 3.1 can be achieved for bushfire mitigation measures.
Australian Government 2004 *Natural Disasters in Australia: Reforming mitigation, relief and recovery arrangements*, COAG	National flood mitigation program that funded 149 structural and non-structural projects over a three year period.	• Flood mitigation can achieve savings and reduction in damage of up to AU $0.6 to $29M.
Case Study - Charleville and Roma, Suncorp	Flood mitigation program that included a flood levee in Charleville and Roma, as well as house raising in Charleville.	• Flood mitigation is expected to reduce premiums between 30% and 80%.
Woodruff (2008) Samoa Technical Report – Economic Analysis of Flood Risk Reduction Measures for the Lower Vaisigano Catchment Area	A study conducted on household flood mitigation activities in Samoa found that the highest return on investment was generated from constructing homes with raised floors[35]. More specifically, the benefit cost ratio was determined to range from 4 to 44 for wooden homes, and from 2 to 28 for cement block homes.	

[35] Woodruff, A. 2008 (February). Samoa Technical Report – Economic Analysis of Flood Risk Reduction Measures for the Lower Vaisigano Catchment Area. EU EDF – SOPAC Project Report 69g Reducing Vulnerability of Pacific ACP States. SOPAC (Pacific Islands Applied Geosciences Commission), Suva, Fiji.

4. Economic Assessment

4.1 Economic modelling – key findings

This part of the report considers the possible impact of two alternative risk apportionment strategies on the Australian economy, including the impacts on activity across the whole economy and at the industry level.

To estimate the different direct costs/benefits associated with the two alternative approaches (insurance pool and system with natural catastrophe mitigation), each approach will be examined under a 'significant natural catastrophe' scenario which creates a "shock" to the economy.

The size of this shock is based on the impacts observed during 2010 and 2011 natural catastrophe events. That is, we have assumed that the 'significant natural catastrophe' under the current system leads to losses of the same magnitude as those actually incurred as a result of these 2010/11 natural catastrophes. For modelling purposes, we will also assume that these catastrophes are 1-in-10 year events.

Figure 4-1: Key impacts under alternative risk mitigation strategies

	Scenario 1: Pool approach	Scenario 2: Mitigation
Total change over ten year period ($million, 2009/10 terms)		
Investment	198	-845
H'hold consumption	-462	1,621
Exports	-354	618
Imports	-227	401
GDP	-276	741
Selected Industries - gross value added:		
Residential construction	875	-1,994
Finance and insurance	228	39
Services from housing stock	483	-967
Other construction	-1,064	2,340
Average annual change in employment over ten year period (jobs)		
Residential construction	1,008	-2,293
Finance and insurance	146	-83
Other construction	-757	1,680
Total employment	0	0

Source: KPMG estimates. Note: the results above show the estimated cumulative or total impacts every ten years, assuming one event occurs in this time period.

The results above indicate that:

- A pool system is expected to lead to higher costs from a 1-in-10 year catastrophe, which impacts capital stocks, leading to a lower GDP compared to baseline. Investments (and returns) respond to this fall in capital stocks at the expense of consumption and other expenditures.
- Structured mitigation is expected to lead to a reduction in the costs from a 1-in-10 year catastrophe, which lessens the impact on capital stocks, leading to a higher GDP compared to baseline. Investments (and returns) are impacted by higher capital stocks, while the additional productive capacity in the economy benefits consumption and other expenditures.

4.2 Proposed risk apportionment strategies

Based on the research undertaken in the previous sections of this report, the following baseline and two alternate scenarios were examined.

Figure 4-2: Estimated cost of event under alternative risk mitigation strategies

	BAU: current approach	Scenario 1: Pool approach	Scenario 2: Mitigation
Insurance Sector spend	$7,375 million	$7,375 million	$7,375 million
Government spend	$7,279 million	$7,279 million	$7,279 million
Impact from unstructured mitigation	-$2,317 million		-$2,317 million
Impact from structured mitigation			-$7,548 million
Cost of event (1-in-10 year)	$12,337 million	$14,654 million	$4,789 million

Source: KPMG estimates

Current System

The Computable General Equilibrium (CGE) model takes into account all economic flows which are in a stable state. For this reason, no specific inputs are required for the continued growth in insurance premiums, claims or uncovered economic losses, as they are already reflected in the stable state of the economy. Variation from the normal state will occur from the following assumptions:

- A series of major natural disaster events will affect Australia every 10 years. The magnitude of these events will be based on the scale of the 2010 and 2011 series of natural disasters which occurred in Australia. Costs associated with these events include both Insurance sector costs paid out and Government contributions (as shown in the first two rows in the Figure above).
- One further adjustment has been made to these actual costs under the current scenario. That is, following the recent natural disasters, customers in high and extreme risk areas are now experiencing unaffordable insurance premiums - which we assume can only be made more affordable through individual or government led mitigation measures. Individual mitigation for a home in a high flood risk area, such as raising the height of the house, could reduce the insurance premium for the individual, as the risk rating is reduced. In this way, insurance premiums charged (or quoted) to customers act as a price signal which may result in mitigation by individuals. The potential spend on mitigation and the potential reduction in losses as a result of individual mitigation has therefore been included within the current system model (shown in row 3 of the figure above).

Insurance Pool Model

The Insurance pool will function as described in section 3.2.4, providing natural disaster coverage to the uninsured and subsidising the natural disaster cover for those in high risk areas. The key assumptions included in modelling the pool scenario include:

- Premiums and claims paid out on a normal year remain unchanged from the Current System. An assumption is made that any decrease in premiums from the government subsidy will be offset by an increase in uptake of insurance policies (triggered by the subsidy).
- Any price signal in the pricing of premiums to encourage mitigation is removed, and so no reduction in the cost of natural disasters relative to the shock scenario is assumed. The

government contribution under the current system will now be funded by the insurance pool, but there is no difference in the assumed overall funding required.

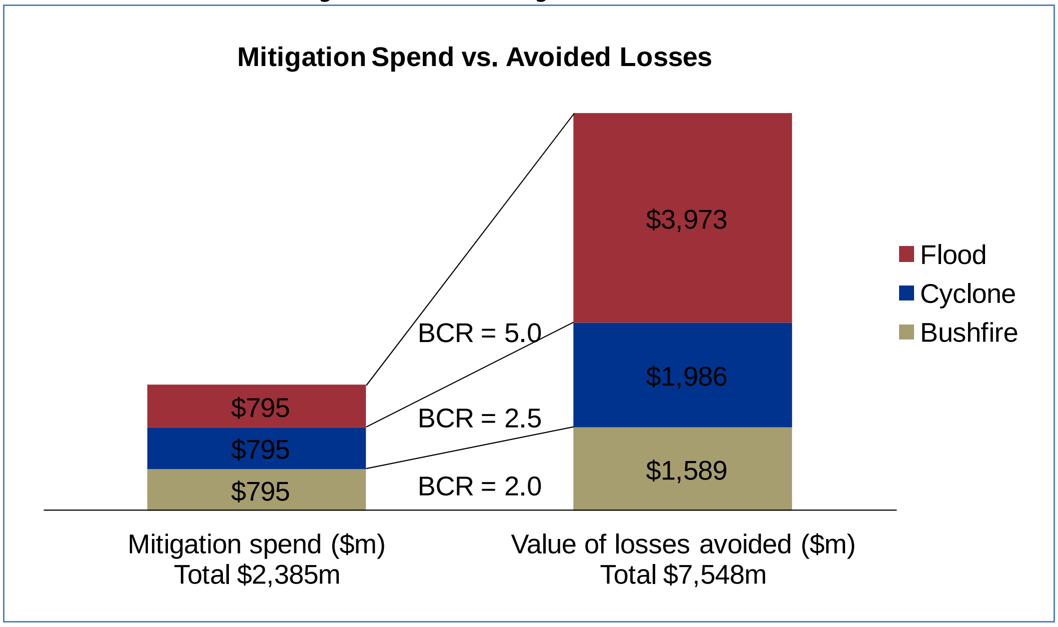
- The size of the pool has been calculated on the expected premiums that would be required to fund the risk exposure, plus an allowance for the cost of administration of the fund. These premiums are then spent on rebuilding after the event.

Mitigation

The mitigation approach assumes that government led mitigation will occur with a budget equal to the amount of funds which would be required under the insurance pool. The key assumptions are:

- Premiums and claims paid out on a normal year remain unchanged from the Current System. An assumption is made that any decrease in cost of premiums as a result of mitigation measures will be offset by an increase in uptake of insurance policies.
- 10 years of mitigation expenditure has occurred by the time the major natural catastrophe occurs.
- Mitigation will be undertaken strategically at the areas with highest risk. It is assumed that mitigation funding will be equally split between the spending on Bushfires, Floods and Cyclones The reduction in losses experienced in the event of the major natural catastrophes scenario is based on an average Benefit Cost Ratio for the three types of natural disasters. The figure below illustrates how this expenditure is then translated into a value of avoided losses.

Figure 4-3: Estimating avoided losses



Research into mitigation case studies was used to inform the selection of Benefit Cost Ratios (BCR) that could be applied to cyclone, bushfire and flood mitigation programs separately. Assumptions were then selected, with some degree of conservatism relative to the case studies observed, to model the monetary inputs and outputs associated with future mitigation activities.

- A BCR of 2 was determined to be appropriate for bushfire mitigation programs which was supported by a fire prevention program in Victoria that generated a BCR ranging from 1.3 to 3.1. This was considered to be a reasonable estimate given that 2 is below the median of this range.
- A BCR of 2.5 was selected for cyclone mitigation programs based on a case study of a program in South East Queensland involving the construction of cyclone resilient housing which generated a BCR of 3.
- For flood mitigation a BCR of 5 was determined to be appropriate based on extensive desktop research. There is an expansive range of BCRs associated with different flood mitigation programs between 2.2 and 44 from academic literature examined (See 3.3.4). Furthermore a case study of flood events in Roma Queensland, which has had no flood mitigation, demonstrated that since 2005 the community has incurred 500 million AUD worth of damage from reoccurring floods. Mitigation in the form of a flood levee however would only cost the community 2 to 15 million AUD generating a BCR ranging from 33.3 to 250.

4.3 Economic Scenarios

The risk apportionment strategies outlined above will have different impacts in terms of the costs associated with the risk (or event occurring), the cost of insurance/mitigation, and those that ultimately bear these costs. The key cost implications are shown in the table below.

Figure 4-4: Key modelling data

	BAU: current approach	Scenario 1: Pool approach	Scenario 2: Mitigation
Cost of event (1-in-10 year)	$12,337 million	$14,654 million	$4,789 million
Annual Costs			
Pool Administration		$60 million	
Pool Premiums		$178 million	
Mitigation			$238 million

Source: KPMG estimates

These costs have been converted into model inputs as outlined in the table below. These inputs were then applied to KPMG's in-house CGE modelling framework (more details provided in Appendix A) to identify the impacts across the economy, including the impact on GDP, industry output, and employment.

The table below shows how the two alternate risk apportionment strategies change activity in the economy, compared to the current approach. These changes are in four main areas:

- returns to the housing industry during the period of reconstruction;
- activity in the insurance industry with the additional administration of the Pool;
- activity in the construction industry resulting from any change in rebuilding required after the event and the construction activity associated with any mitigation; and
- government spending as a result of funding the pool/mitigation, plus any changes in the cost of the event *net* of any costs covered by the pool.

Figure 4-5: Model Scenarios (annualised costs, assuming one event every 10 years)

	Scenario 1: Pool approach	Scenario 2: Mitigation
Change in returns to dwelling sector (annualised)	**-0.013%**	**0.044%**
Change in insurance activity - pool administration	**$60 million**	
Dwelling construction		
- change in re-building costs	$232 million	-$755 million
- mitigation costs		$238 million
Net change in construction activity	**$232 million**	**-$516 million**
Change in Government funding		
- change in cost of event annualised	$232 million	-$755 million
- less annual payments from pool	$178 million	
net change in government payments for event	$54 million	
plus pool/mitigation funding	$238 million	$238 million
Net change in gov't outlay (annualised)	**$292 million**	**-$516 million**

Source: KPMG estimates

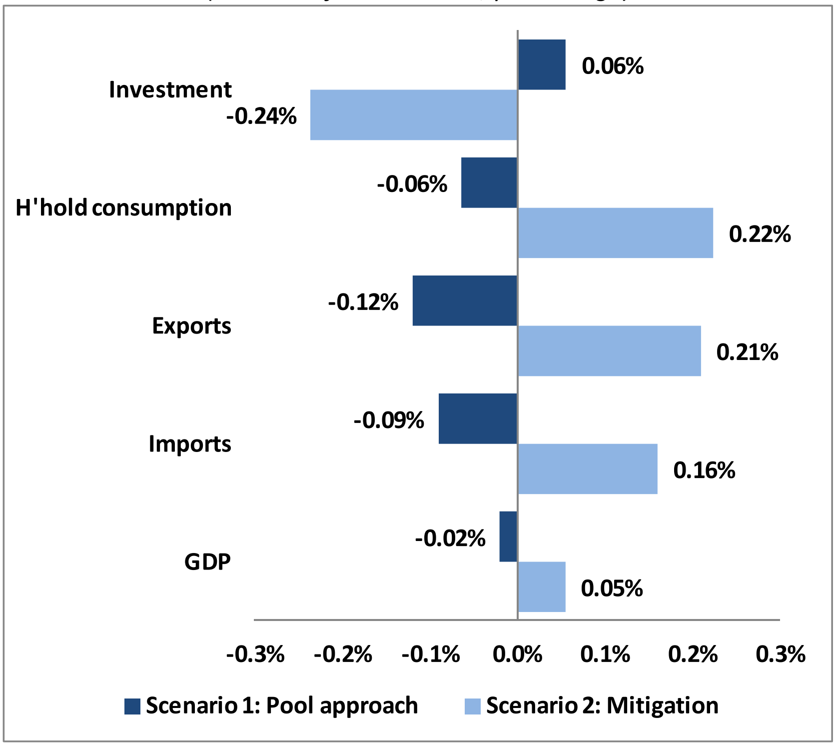
4.4 Economic Impacts

The results of the alternative risk apportionment strategy scenarios are now provided in a series of sub-sections. These results are provided in terms of deviations (or changes) in activity compared to the business as usual (current) baseline (discussed in section 3.1). This section starts by discussing the national or macro results and then drills down into how these impacts vary across industries.

4.4.1 Macro Impacts

The expected higher costs of a 1-in-10 year event across the economy under the pool scenario (when compared with the expected costs under the baseline) lead to lower real GDP. In contrast, the expected lower costs of a 1-in-10 year event across the economy under the mitigation scenario (when compared with the expected costs under the baseline) lead to comparatively higher real GDP. The figure below shows the total estimated change over each ten year period going forward, expressed as a percentage of current annual macro levels.

Figure 4-6: Impact on the Macro economy - impact in the year of the event (or every ten years) total accumulated cost of the pool/mitigation over ten years and the total cost of one event (deviation from baseline, percentage)



Source: KPMG CGE modelling

Lower GDP in the pool scenario is largely driven by the event having a larger negative impact on capital stocks. Under the pool scenario, in each ten year period, total GDP is estimated to be almost $280 million lower (in 2009/10 terms) than it would have been in the baseline. Access to less (or less productive) capital means lower production across the economy, and the diversion of output to reconstruction activities in larger volumes than in the mitigation scenario.

Investment responds to restore the level of the capital stocks, particularly in housing. Resources move into investment and away from final demand categories like consumption and exports. As a result, both household consumption and exports are lower than they would have been under the baseline. Lower activity in the economy also leads to lower imports (compared to the baseline) *but* also a negative impact on the trade balance – less output and domestic income leads to lower saving, and capital goods must be imported to supply investment.

Higher GDP in the mitigation scenario compared to the baseline is results from the event having a smaller negative impact on housing stocks as a result of implementing mitigation strategies. In this case, in each ten year period, total GDP is estimated to be $750 million higher (in 2009/10 terms) than it would have been under the baseline.

This means that capital stocks (and returns to the economy) are comparatively higher under the mitigation scenario compared to the baseline.

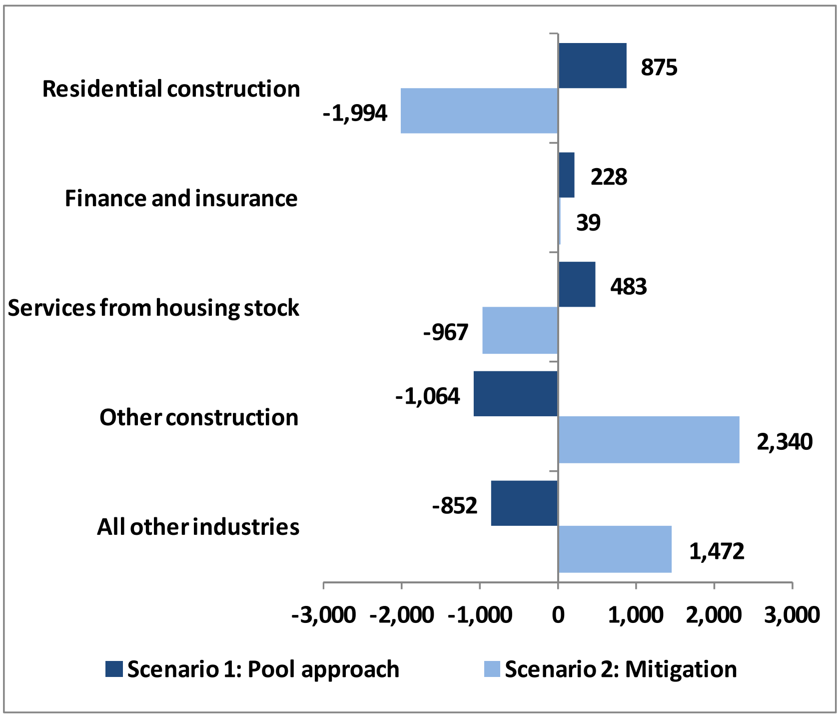
Less investment is needed to restore the level of capital stock than in the baseline, and this leaves more resources available for the other demand categories – consumption and exports. As a result, both household consumption and exports are higher than they would have been under the baseline. Household consumption is also boosted by the lower government costs (due to the mitigation of the event) being returned to consumers through a reduction in income tax rates (as assumed in the simulation design).

Higher activity in the economy also leads to higher imports compared to under the baseline, but in this case with an improvement in the trade balance – higher domestic income and saving coupled with lower investment leads to an improvement in the trade balance.

4.4.2 Industry impacts

The figure below shows the impact of a pool strategy and a mitigation strategy on industries, both in comparison to the activity expected under the business as usual, or current, baseline. The figure below shows the total estimated change over each ten year period going forward, expressed in 2009-10 dollars.

Figure 4-7: Impact on Industry Value-added - cumulative impacts every ten years including the total cost of the pool/mitigation over ten years and the total cost of one event (deviation from baseline, $m 2009-10 terms)



Source: KPMG CGE modelling.

There is expected to be additional rebuilding required under the **pool scenario** compared to the baseline. This occurs because it is assumed the introduction of the pool removes some of the price signals that discourage risk taking behaviour, or, alternatively that encourage risk mitigation activities. The chart above shows higher residential construction activity as a result of this re-building.

Activity in the insurance industry is higher under the pool scheme. This slightly higher level of insurance activity is because this industry is tasked with administration of the scheme.

There are two opposing forces impacting on dwellings sector – a sector that captures the flows of services ("imputed rents") from the housing stock - activity under the pool scenario, as follows:

- The event leads to a higher loss of housing capital productivity under the pool (as more housing stock is off-line whilst rebuilding occurs). This reduction in capacity leads to a reduction in services provided by this housing capital stock ("imputed rents").
- After the rebuilding is completed, the services that can now be provided by the housing stock are at a slightly higher value than under the baseline. This is because the scenario targets a specific rebuilding value that is replacing the damaged existing homes with new homes. The new homes are likely to be now subject to different building standards/methods etc. This will result in higher construction costs and therefore, by this view of valuation, a higher value for the housing stock. In this scenario, the economy ends up with a higher new-house share in the total housing stock compared to the baseline.
- Housing construction costs for new houses are higher, and on this cost basis the value of the housing stock increases. The modelling assumes that these new houses have higher market values than those they replace. If the market value of the housing stock did not change when housing is rebuilt, this would reduce the positive impact of this scenario on services flowing from housing. This means that the modelling results under this scenario potentially underestimate the negative impacts of the pool scheme.

The additional residential construction activity will also increase demand for inputs, driving up costs to industries that use similar inputs. The other construction sector illustrates this, with a slightly lower level of output under this scenario compared to baseline.

Under the **mitigation scenario**, there is expected to be less rebuilding required compared to the baseline, as less housing capital is affected. The chart above shows a reduction in residential construction activity compared to the baseline as a result. This lower rebuilding activity will be slightly offset by the construction activity associated with the mitigation measures.

In a similar manner to the pool strategy impacts, but working in the opposite direction, there are two opposing forces impacting on dwellings sector activity under this mitigation scenario, as follows.

- The comparatively lower impact of the event leads to a higher level of housing capital productivity under the mitigation strategy compared to the baseline (as less housing stock is off-line whilst rebuilding occurs). This comparatively high capacity leads to comparatively higher services flowing from this housing capital stock.
- Fewer houses need to be replaced under the mitigation scenario (compared to the baseline), leading to a slightly lower flow of services provided by the housing stock than under the baseline. In a similar way to the response in the pool scenario, the rebuilding under the baseline is likely to be subject to different building standards/methods etc – and this will mean a slightly higher value of new housing compared to old. Compared to baseline, there is

therefore a slightly lower value of housing stock under the mitigation scenario because less new dwellings will be rebuilt (i.e. the housing capital stock will contain less new houses).

- The assumptions regarding market values outlined above work here in the opposite direction, leading potentially to an underestimate of the positive impact of mitigation strategies. Further, it should be noted that under a mitigation scheme, the mitigation activities themselves would also potentially improve the value of housing stock. This would further offset some of the negative impacts on the services from housing stock. This adds to the potential for the modelling results under this scenario to underestimate of the positive impacts of mitigation.

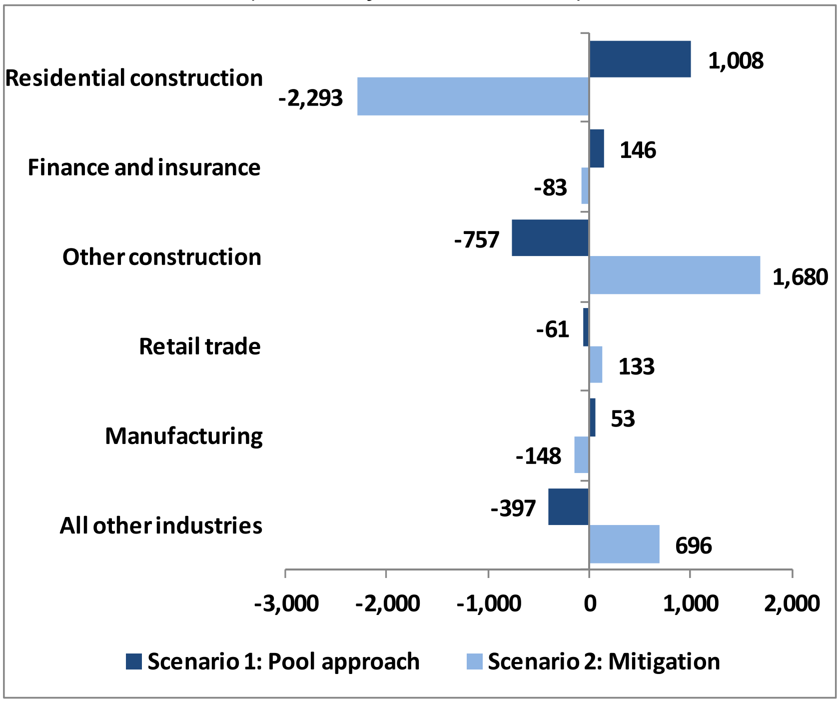
The lower residential construction activity will also lower demand for some inputs, reducing costs to industries that use similar inputs. The other construction sector illustrates this, with a slightly higher level of output under this scenario compared to baseline.

4.4.3 Employment Impacts

Employment shows a similar pattern to value-added across the industries.

The modelling makes the standard long-run assumption that the labour supply is not affected by these policies – or, alternatively, that these scenarios do not impact the long-run level of employment. This labour market assumption reflects the fact that, in the long-run, the level of employment is primarily determined by population growth and demographics, rather than by the level of output of the dwelling, construction or insurance sectors. Changes in economic activity in the long-run are reflected in real wages. Thus, there is no overall impact on employment in the simulations, but there will be a movement of jobs between industries.

Figure 4-8: Impact on Employment – average annual impacts (deviation from baseline, FTE)



Source: KPMG CGE modelling.

Similarly to the value-added impacts, the pool is expected to lead to higher employment in the residential construction sector and the insurance sector, and reduce employment across other sectors compared to the baseline scenario. In comparison, the mitigation is expected to reduce employment in residential construction and move it towards other activities, including other construction. These are essentially driven by output levels in these sectors.

Note that the impacts above have been converted into average annual impacts because jobs are not accumulated (there may be the same single job over the ten years or ten different annual jobs over the ten years).

It is likely that, given the nature of these scenarios – including a 1-in-10 year event – that the impacts will be quite lumpy, with much of the residential construction impacts being felt in the year of the event. This would lead to a much higher impact on residential construction employment in that year than is observed in the average annual impacts shown above. On the other hand, if this big employment impact was removed from the average calculation, then the ongoing impacts would be smaller than those observed on average.

5. Discussion

5.1 Key findings

The scenarios tested aimed to quantify the benefits to the economy if the proportion of government investment was shifted toward Pool Insurance, as a way to allow individuals to *transfer* some of their risk, or to Mitigation, as a way to *avoid or reduce* the level of the risk.

As discussed in Chapter 4, with consideration to impacts on the Australian economy, investment in the development of a pooled insurance scheme results in lower GDP equivalent to 0.03 percent of annual GDP every ten years. This is the result of the investment in an insurance pool not leading to any actual decrease in the overall risk/cost of the disaster, but rather transference of the risk/cost. Additionally, the cost to the economy in this scenario is exacerbated by the removal of price signals (i.e: cheaper insurance premiums), that would otherwise incentivise individuals to reduce their own risk exposure. Under the current system, there is an expectation that individuals will act to an extent possible to implement some amounts of risk reduction, as they have a financial incentive to do so. Their remaining exposure can be transferred through the purchase of insurance, and there is an expectation that some of the risk is accepted by the government.

Under the mitigation scenario, investment of the same amount of money into natural disaster mitigation activities, results in a *higher* GDP equivalent to 0.01 percent of annual GDP every ten years. This is the result of a reduction in the overall impact of the natural disaster, provided by mitigation, reducing the costs of recovery to the Australian economy. The modelling (based on the benefit cost ratios assumed) shows that the Australian economy will be stronger investing in mitigation, rather than pooled insurance, by (a total every ten years) equivalent to 0.04 percent of annual GDP.

5.2 Sensitivity testing

Two of the key assumptions included in the economic modelling were tested for sensitivity to assess the extent to which changes in the assumptions would alter the overall output from the CGE.

The **time period** over which a major natural catastrophe occurs was increased from 10 years to 20 years.

- While the average annual cost of the event was halved: we assumed that the annual cost of administering the pool remained at the same level (which makes the relative cost of the pool slightly higher); and we assumed that the total cost of mitigating remained the same.
- There was no significant change in the cumulative impact on GDP (or the impact in the year of the event). However, this means that the average annual impact on GDP would be half of the size if the event happened every 20 years instead of every 10 years.

The assumption around the **level of individual mitigation** which would occur as a result of current price signals was tested - by halving the uptake and also taking into account some mitigation by a proportion of the uninsured population. This resulted in:

- A lower change in the costs of the event under the pool scenario – dropping to just under two-thirds of the originally assumed value.
- This flowed through to reduce the impact on GDP from 0.02 per cent to 0.014 percent.

5.3 Other considerations

The focus of the research and economic modelling in this paper has been conducted on the comparison between two different responses to managing the potential losses from natural catastrophes namely between an insurance pool approach when compared to a mitigation approach. However, it is important to note that the scale of any event can be such that physical adaptation measures can be overwhelmed. In such situations it is not unknown for authorities to take deliberate actions that result in for example flooding of one area in order to save larger losses in another. In this scenario the analysis of the two scenarios become more complex and hybrid – "mitigation plus" options would need to be examined.

5.4 Case studies

Implementation of a coordinated and effective mitigation scheme will be critical in reducing the risks and costs of natural disasters. While an analysis of a transition to a mitigation scheme is beyond the scope of this study, through the research undertaken, case studies and insights have emerged that confirm the benefits of mitigation and identify elements to aid success. These case studies and key learning's are described below:

Charleville, South west Queensland, Australia

The Charleville case study is an example of where investment in mitigation has successfully resulted in risk reduction, and reduced insurance premiums. It also highlights the need for mitigation design to be based on projected climatic conditions rather than historic data, to optimize risk reduction and ultimately return on investment.

Prior to the 2008, only 32 percent of households in Charleville were covered by insurance. In a study conducted by NCCARF, residents described flood insurance in Charleville as being very expensive and difficult to obtain. As a result the uninsured financial costs to households in Charleville resulting directly from the flood were recorded as reaching $100,130 AUD and $375,000 AUD for the 57 percent of businesses who were not covered by flood insurance. This is a significant cost for a community of less than 3,500 residents.[36]

In 2008 stage 1 of the Charleville flood levee was completed at a cost of approximately $6 million AUD, unfortunately this did not sufficiently address the flood risk (i.e: it was constructed to provide protection up to the 1997 flood levels), resulting in substantial losses. In 2011, stage 2 of the flood levee was announced along with a house raising program. As a result of the planned protection measures, average home insurance premiums have reduced from over $3,000 AUD to an approximate average of $990 AUD.

National Flood Insurance Program – Community Rating System, United States

The Community Rating System case study is an example of how a measurement system has been established to directly link mitigation activities with guaranteed reduction in premiums. Such a system allows additional certainty in the level of premiums included in any cost benefit assessment of planned mitigation activities.

The National Flood Insurance Program's (NFIP) Community Rating System (CRP), is a voluntary program that rewards investment in flood mitigation activities (that exceed the minimum NFIP requirement), with discounted flood insurance premium rates. For participating communities,

[36] *The 2008 floods in Queensland: A case study of vulnerability, resilience and adaptive capacity.* National Climate Change Adaptation Research Facility (2010) NCCARF Synthesis and Integrative Research Program

flood insurance premium rates are discounted in increments of 5 percent (up to 45 percent discount), placing participants into a specified 'class' that reflects the extent of mitigation activities undertaken. A class 1 community would receive the highest 45 percent discount, while a class 10 community would receive no discount.[37]

Four communities currently occupy the highest levels of the CRS. Each has developed a floodplain management program tailored to its own particular hazards, character, and goals. Roseville, California was the first to reach this rating (Class 1). Through strengthening and broadened its floodplain management program, average premium discount for policies in the Special Flood Hazard Area (SFHA) is $79,238 USD.

Currently, nearly 3.8 million policyholders across 1,211 communities participate in CRS by implementing local mitigation, floodplain management and outreach activities. Although these communities represent only 5 percent of over 21,000 communities participating in the NFIP, more than 67 percent of all flood insurance policies are written in CRS communities.[39]

Weather Modification Incorporated, Calgary, Canada

The Weather Modification Incorporated case study provides an example of where Insurers have invested in mitigation strategies and this has led to a reduction in the cost of claims.

Following a hailstorm that swept through Calgary Canada in 2010 resulting in insured losses of over $400 million, a consortium of insurance companies jointly financed Weather Modification Incorporated (WMI). Since 1996 WMI has identified severe storms and sent aircraft to disperse chemical agents to reduce the storms severity. Early evidence suggests that the insurance industry has saved as much as $50 million each year as a result.[40]

5.5 Key learnings

The following observations are informed by the research conducted for this study and may provide insights for decision makers into lessons learns from others who have transitioned to a mitigation focused risk management approach to disaster management:

- Targeted mitigation programs have been successful in reducing the impacts and costs of natural disasters in communities and seen significant reductions in insurance premiums.
- A sufficiently incentivized community, with access to funding can lead the coordination of mitigation programs at a regional level and effectively drive down the cost of insurance premiums.
- Communities need to be educated in the benefits of mitigation and including the return on investments that can be expected from investment in risk reduction. A key barrier against households (and governments), investing in risk mitigation is the up-front cost relative to other investments (i.e: education, transport infrastructure) and the perceived benefits of these actions.
- Appropriate regulation coupled with financial oversight and monitoring at a national level can be effective in encouraging investment in risk reduction.

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[37] *National Flood Insurance Program Community Rating System* website. Federal Emergency Management Agency. Accessed March 2014. http://www.fema.gov/national-flood-insurance-program-community-rating-system

[39] *Community Rating System Fact Sheet*. Federal Insurance and Mitigation Administration. 2013 http://www.fema.gov/media-library-data/20130726-1605-20490-8915/nfip_crs_fact__sheet_sept_2012.txt

[40] *Sharing risk – Financing Australia's disaster resilience*. Australian Strategic Policy Institute (February 2011).

- Accurate risk pricing by insurers is critical in communicating actual risks to customers and incentivizing risk reducing decision making.
- Direct investment by insurers in risk mitigation has been effective in reducing the impact of events.
- To be effective in the long term, mitigation measures (such as flood levees), must be built to withstand natural disasters aligned with projected climatic conditions rather than historic events to be effective in the long term.
- Making mitigation a prerequisite for coverage (by either insurers or government based relief), has shown to be effective in reducing risk.[41]

[41] *Adaptation to Climate Change: Linking disaster risk reduction and insurance*. Paper submitted to the UNFCCC for the 6th session of the Ad Hoc Working Group on long term cooperative action under the Convention (AWG-LCA 6). Munich Climate Insurance Initiative. (June 2009)._These key learning's have been adapted from a paper produced by a working group who participated in UNFCCC workshop at the 14th COP in Poznan Poland. The workshop was held to consider the role of insurance in natural disaster risk reduction. The group sought to answer the key question of 'whether and how, insurance related mechanisms could lead to a reduction in risk and losses, particularly for developing countries and vulnerable groups?'Their investigations concluded that collaboration between the insurance industry and governments could promote risk reduction through some of the actions described here.

Appendix A: Economic Modelling

This attachment discusses and presents the economic modelling approach used to estimate the economic impact of alternative risk apportionment strategies on the Australian economy.

To estimate these impacts, this study will employ a comparative static, computable general equilibrium (CGE) model, described below. KPMG's latest CGE model, FLAGSHIP, was developed over the past two years and is based on the most up-to-date detailed data available from the Australian Bureau of Statistics. FLAGSHIP brings together 80 years of combined modelling experience (gained with the world's pre-eminent economic modelling institutions, and in economic policy advice and research roles with several international governments), the latest theoretical developments in the field and a database constructed from the latest available data.

FLAGSHIP is a development of the world-leading ORANI and MONASH model lineage created at the Centre of Policy Studies, and is based in the powerful GEMPACK modelling software. FLAGSHIP brings the best of this world-renowned modelling tradition together with several new theoretical advancements – developed by Dr Ashley Winston as part of economic modelling and policy work with the US government – to create a cutting-edge CGE framework.

The model embodies an array of features that enhance its utility in policy and economic modelling, including sophisticated economic and behavioural assumptions (further discussed in Attachment A). This makes CGE modelling the most appropriate tool to use when assessing the economy-wide impacts of any policy or economic shock.

To model the economic impacts beyond those that directly relate to the insurance and property sectors, it is necessary to employ a modelling technique that makes use of information about the linkages of the sector within the broader economic context. Input-output (IO) tables published by the ABS provide detailed information on the upstream and downstream linkages of each industry in the economy.

- **Upstream linkages** refer to the sources of inputs to the insurance or property sector. These linkages may be in the form of the use of intermediate inputs produced by other domestic industries, imported intermediate inputs, labour and other factors of production. For example, these sectors would use inputs such as labour, and other industry services such as construction, telecommunications etc. This can thought of as information regarding the cost-side of the insurance or property sectors.

- **Downstream linkages** refer to those of economic agents that purchase the insurance or property sectors' output. For example, the finance sector might purchase property services as part of its operations and households pay rent to the property services industry. Consequently, downstream linkages include sales to other industries that use the output of the insurance or property sector as an intermediate input to their own production process or final users of the product like households, the government or foreigners. This can thought of as information regarding the sales-side of the insurance and property sectors.

An IO table is a useful tool as a snapshot of the economic flows within the economy at the time the data was collected. An input-output table can be used to provide simplified estimates of the sensitivity of the economy (measured by employment, value added or turnover) to small changes (termed 'shocks') within industries. An example of such a shock might be a ten per cent increase in the price of fuel. This would lead to an increase in the costs for all industries that use fuel, particularly impacting on demand for those industries that use a relatively large proportion of fuel. This sort of analysis can be used at the industry-wide level to estimate IO multipliers – that is, the total economy-wide impact on employment or output resulting from a change in one industry, taking into account the change in demand for the outputs of other industries.

An IO table in itself is not an economic model, and IO multipliers are raw and ad hoc in nature. A major limitation of the use of IO multipliers when used to conduct impact analysis is that the relationship between industry inputs and outputs (the coefficients) are fixed, implying that industry structure remains unchanged by the shock to the industry (for example, a change in demand or prices). Furthermore, IO analysis imposes no resource constraints and so industries (and indeed the entire economy) can access unlimited supplies of inputs at fixed costs.

In reality, scarcity of inputs (e.g. skilled labour, land etc) mean that these inputs are affected by and respond to changes in prices (e.g. wages) driven by supply and demand adjustments. For example, higher prices/wages driven by the increase in demand for labour to service higher construction activity will, at the margin, increase costs in other sectors and reduce demand for labour by some other parts of the economy.

In IO analysis, where all adjustments relate only to quantities produced, this type of feedback response does not to occur, and sectors can access infinite amounts of inputs at fixed costs. Consequently, an IO model can result in an overstatement of the impacts on the economy. For these reasons, while the ABS did for some time publish IO multipliers, it has ceased publishing these estimates in recent years over concerns about their validity.

A computable general equilibrium (CGE) model makes use of an IO table in the construction of its database, but is extended to make more sophisticated economic and behavioural assumptions including:

- recognising resource constraints and responses of businesses, workers through adjusting prices/wages.
- capturing employment/capital (and other factors inputs) substitution for example, by responding to higher wages by increasing the use of capital.
- capturing a much wider set of economic impacts such as behavioural responses to price changes of consumers, investors, foreigners etc.
- can include the effects of such things as technological change and shifts in consumer preferences – which is likely to be a key factor in this study.

By introducing these additional economic variables and constraints, CGE models are able to model beyond the first round impact of an event or policy, account for scarcity and understand behavioural response to economic variables. This added sophistication means that a CGE model allows for feedback responses by producers, consumers, investors and foreigners and so the results are less likely to be overstated particularly over the medium to long run.

Appendix B: Detailed Assumptions

1. Cost of Event

The estimated cost of the event is calculated as shown, based on assumptions below.

Column1	BAU: Current approac	Scenario 1: Pool approac	Scenario 2: Mitigatio
Insurance sector spend (1.1)	7,374,891,000	7,374,891,000	7,374,891,000
Government spend (1.1)	7,279,145,000	7,279,145,000	7,279,145,000
Decrease in impact due to unstructured mitigation (1.2)	(2,317,224,872)		(2,317,224,872)
Decrease in impact due to structured mitigation (1.3)			(7,548,090,451)
Total cost of event	12,336,811,128	14,654,036,000	4,788,720,677

1.1 Insurance sector and government spend

The following natural events which occurred during 2010 and 2011 were summed together to give the insurance industries cost from the natural disasters (Source: Insurance Council of Australia Historic disaster statistics).

Total insurance payout on natural catastrophes 2010-11	7,374,891,000
VIC Christmas Day Storms (Dec 2011)	728,640,000
WA Margaret River Bushfires (Nov 2011)	53,450,000
Perth Bushfires (Feb 2011)	35,128,000
VIC Severe Storms (Feb 2011)	487,615,000
QLD Cyclone Yasi (Feb 2011)	1,412,239,000
VIC Flooding (Jan 2011)	126,495,000
QLD Flooding (Dec 2010 - Jan 2011)	2,387,624,000
Perth Storm (March 2010)	1,053,000,000
Melbourne Storm (March 2010)	1,044,000,000
West QLD flooding (March 2010)	46,700,000

The portion of the government expenditure associated with the disasters was determined looking at the spend on natural disasters disclosed by financial year. Only those states with significant contributions related to natural disasters in the period were included.

Total significant govt payout on natural catastrophes 2010-11	7,279,145,000	
VIC (Jan Floods and Feb Severe Storm)	271,266,000	2011
QLD (Dec Floods and Cyclone Yasi)	5,442,857,000	2011
WA (Perth Bushfires)	148,638,000	2011
VIC (Christmas Storms and Feb 2012 Floods)	45,633,000	2012
QLD	1,370,751,000	2012

1.2 Decrease from unstructured mitigation - Price Signal influencing mitigation

An estimation has been made of the extent of individual mitigation likely to occur under current risk pricing to reduce insurance premiums from high or extreme risk to low or nil as the premium pricing relates to natural disasters. The potential spend on mitigation has then had an average benefit cost ratios applied for both Cyclone and Flood risks (50 percent mitigation apportioned across both event types) to give an assumption for the reduced extent of losses which would occur given the current system for risk pricing, which would not exist if this was removed through price subsidisation in an insurance pool.

Total potential spend on mitigation			617,926,632
(4) Potential avoided losses			
Split between Cyclone and flood			
	Cyclone BCR	2.5	772,408,291
	Flood BCR	5	1,544,816,581
Potential reduction in losses			2,317,224,872

Other considerations

The assumptions above are for the purpose of demonstrating some effect from the price signal. The calculation only takes into account the current market, and does not account for the 10 percent who do not have flood cover, and are likely to be in high risk zones, where premiums being quoted are greater than $7,000. The relative modest individual budgets for mitigation would allow for smaller scale actions such as roofing fasteners and securing rolling doors for cyclones, and changing flooring and relocating electrical outlets for flooding.

1.3 Decrease from structured mitigation

The value raised to cover the insurance pool scenario, has been assumed to be the amount available to spend on structured mitigation. This annual spend has been accumulated to determine an amount spent over 10 years (in today's dollars), which has been assumed to be evenly spread across bushfire, flood and cyclone mitigation. The value of losses is calculated using an average Benefit Cost Ratio for each respective type of natural disaster, to give an amount of avoided losses.

Column1	Total	Bushfire	Cyclone	Flood
Annual spend on mitigation	238,360,751			
Proportion of spend		33%	33%	33%
Benefit Cost Ratio (BCR)		2.00	2.50	5.00
10 year cumulative	2,383,607,511			
Split between 3 mitigation scenarios		794,535,837	794,535,837	794,535,837
Value of losses avoided	7,548,090,451	1,589,071,674	1,986,339,592	3,972,679,185

2. Size of Insurance Pool

The Insurance pool has two components: Uninsured and High Risk premium and Administration cost. These were calculated using data from Suncorp's insurance book which were then extrapolated out to cover the whole market, and estimate the extent of exposure of uninsured households. The premium and administration cost was determined using data from Suncorp's premium pricing policy.

Pool	Uninsured	High risk	Total
Assets	298,154,399,612	92,931,551,736	391,085,951,348
Number of policies	1,254,816	190,871	1,445,688
Premiums	60,798,486	117,207,697	178,006,183
Administration cost	52,386,066.18	7,968,502.25	60,354,568
Sum of premium and administration costs			$ 238,360,751.09

Appendix C: Insurance Pools

1. Currently operating schemes

New Zealand

In New Zealand earthquake cover is provided based on an annually adjusted property valuation by the government run pool EQC. The EQC was effectively established in 1945. In order to attain EQCover the policyholder is required to purchase an insurance policy from the open market that includes a disaster premium. That element is passed onto the EQC and pooled in the Natural Disaster Fund. This premium can be up to 207NZD depending on the individual policy. After purchasing EQCover the policyholder is entitled to up to 100,00NZD for specific property damage and up to 200,00NZD for contents losses, with any claim values beyond these levels being paid out by the policyholder's primary insurer. Access to the pool is therefore dependent on purchasing additional protection from the insurance industry. While the disaster insurance premium acts as a levy in covering a substantial portion of the pool's risk exposure, the EQC further minimises risk via use of reinsurance from the global reinsurance market. If payouts required by the EQC exceed the capacity of the Natural Disaster Fund and the revenue derived from reinsurance then the Crown guarantee requires the Government to provide financial support[42].

United Kingdom

In the United Kingdom, Flood Re has been proposed as a government run reinsurance pool that is due to be implemented in 2015. It has been designed to cover the cost of flood claims from flood prone properties. While the pool will be funded by a levy imposed upon member insurance companies, these costs will ultimately trickle down to households through an increase in their insurance premiums proportional to the size of the primary premium and the underlying risk exposure. Essentially the flood insurance agreement aims to ensure that homeowners and residents living in high flood risk areas of Britain can continue to find affordable flood insurance by placing a limit on the total cost. The associated rise in insurance premiums caused by Flood Re will see households across the UK pay into a aggregate fund which will be used to offset the costs of flood damage and fund the flood insurance cap. The flood insurance element of home insurance policies will be limited to a yearly maximum. The maximum cost of flood insurance will be based on council tax bands with limited flood insurance premiums starting at £210 per annum for homes in Bands A and B rising to £540 pa for homes in Band G[43].

United States

In the United States, the National Flood Insurance Program (NFIP) was established in 1968 through the National Flood Insurance Act. The program enables the purchase of insurance protection by households in participating communities from the government to cover losses associated with flood events. The program provides a pre disaster insurance alternative to post disaster government provided support in order to meet the rising property damage costs associated with flood events. Local communities can opt into the program by making agreements with the federal government to implement a floodplain management ordinate in order to reduce the flood risks associated with new developments in flood prone localities. In exchange for agreeing to these

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[42] EQC Earthquake Commission, http://www.eqc.govt.nz/what-we-do/eqc-insurance

[43] United Kingdom Department for Environment, Food and Rural Affairs, 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/265445/water-bill-flood-insurance-finance-accountablity.pdf

management practices the federal government provides flood cover to the community as a financial protection against flood losses[44].

An Australian scheme

Australian reinsurance pool corporation (ARPC)

While no natural disaster insurance pool is currently in operation in Australia, the Australia Reinsurance Pool Corporation (ARPC) was established in 2003 as a by-product of the Terrorism Insurance Act and is currently valued at 13.4 billion AUD. The ARPC scheme allows insurance companies to voluntarily minimise their risk exposure from claims for eligible terrorism losses by paying premiums to ARPC. This provides coverage to holders of eligible insurance contracts in the event of a declared terrorist incident. Claims against the scheme are only fulfilled once the policyholder's primary insurance company has reached the capacity its risk retention. Claims will then be paid out from the ARPC's pool until an agreed upon reinsurance deductible is reached. Beyond this value, claims are paid out by the reinsurance scheme, of which ARPC is a participant. Ultimately if the capacity of the reinsurance facility is exhausted the government guarantees financial backing to cover any unpaid claims.[45]

Currently no claims have been made against the scheme however it represents an already established insurance pool framework in Australia. Suggestions have been made to expand the scope of the pool to incorporate natural disaster cover using the already operating infrastructure however this remains merely as a future possibility.

Pool proposed in National Disaster Insurance Review (NDIR)

In the aftermath of several severe storm, cyclone and flood events in 2010-11, the National Disaster Insurance Review was conducted to examine the issues surrounding flood coverage in Australia. The review identified several key recommendations designed to improve the current system and reduce the financial distress felt by high risk households following these catastrophes. One such recommendation involved the establishment of a pooled insurance scheme to allow for discounted insurance premiums in medium to high risk areas.

The proposed scheme was designed to allow the current insurance industry to remain operating competitively, i.e. pricing premiums based on risk. This would ensure that their relationships with policyholders for writing policies and paying out claims was untouched. This primary market would be supplemented by a government funded reinsurance pool that would subsidise some portion of claims payed out. More specifically, discounts would be delivered via a mechanism in which the primary market is responsible for retaining, underwriting and pricing some portion of the flood risk, and the government's reinsurance facility cover the risks not retained by insurers. As such, discounts would be delivered to policyholders by the reinsurance facility offering insurers a discounted premium in return for taking on some portion of their risk exposure. The review also recommends a limit be placed on the discounts available to high value homes. It proposes that this be achieved by limiting the size of the risk exposure that the reinsurance facility would offer insurers a discounted premium on to the difference between the size of the risk retained by the insurer and $500,00 AUD[46].

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[44] United States Federal Emergency Management Agency, https://www.floodsmart.gov/toolkits/flood/downloads/NFIP-SummaryCoverage.pdf
[45] Australian Reinsurance Pool Corporation, 2013, http://arpc.gov.au/news-and-publications/general/brochure
[46] National Disaster Insurance Review, 2011

2. Drivers for the selection of the assumptions

Due to the diversity of designs among currently operating pools these assumptions were largely based on the framework proposed by the Natural Disaster Insurance Review (NDIR, 2011). According to the NDIR, an ideal public insurance scheme would allow for high risk households to be granted a discounted premium allowing them to enter an otherwise unaffordable market. This is supported by Sigma (2011) which states that government operated insurance programs allow for an expansion in coverage by redistributing funds such that low risk policyholders cover some proportion of the risk exposure attached to high risk customers. This kind of flattening of premium differentials between different risk categories is consistent across the literature and actively in operation in schemes such as the NFIP that allows for subsidised premiums in high risk localities. As a result it will be assumed in our hypothetical scheme that premiums are not priced based on the sum of individual risk pricing but rather than the pool is funded by a uniform levy paid by all Australian taxpayers based on aggregate risk.

As described above, mandatory participation is required for pools to effectively expand coverage of the market as otherwise low risk policyholders would opt out of the scheme. As a result mandatory participation is assumed in this model. A government run insurance pool has the potential to enforce such mandatory participation and in turn eliminate, or in practice reduce, the issues of adverse selection that may otherwise prevail in insurance markets. Furthermore according to Calabresi (1970), the government being the largest social entity in operation has the capacity to capture the highest degree of diversification available in the insurance market and hence spread risks more broadly than private entities.[47]

As a result, the hypothetical scheme used in this study was assumed to be government run. This assumption is supported by Table 1 which demonstrates that despite the diversity among scheme design, the one component of a pooled scheme that appears to be consistent internationally is government involvement which underpins every case study excluding the TCIP.

[47] Calabresi, Guido, (1970). "The Costs of Accidents."

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Natural Disaster Insurance

A Policy Information Paper issued by the Treasurer,
The Hon. John Howard, M.P.

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Preface

On 17 January 1979 I announced that the Government had decided not to proceed with the implementation of a natural disaster insurance scheme of the kind that had previously been mooted. I said that '. . . the Government had concluded that a number of practical measures, dealing more directly with the problems that had been identified and involving less Government intervention, would be more appropriate'.

The purpose of this Paper is to state the reasons for the Government's decisions in more detail.

The Government is satisfied that a scheme of the kind that had been under discussion—that is, one involving the provision of Government financial backing to a 'pool' of insurance companies—would be inappropriate on budgetary, technical and insurance policy grounds. Beyond that, however, the Government also believes that such a scheme would be inconsistent with a basic tenet in its political philosophy—namely, that governments and government authorities should, to the maximum extent possible, seek to avoid intervention in matters that can be left to the private sector. Some general comments on these broader policy considerations are to be found in the final Section; they form the foundation for the remainder of the analysis.

This paper has been prepared and issued in accordance with the Government's view that information on the considerations underlying its decisions should be made available in as much detail as possible to the Parliament and to interested members of the public. Background to this view—and a fuller statement of the purposes of Policy Information Papers—may be found in a statement on 'Access to Official Information' made by the Attorney-General in the Senate on 9 June 1978.

JOHN HOWARD
Treasurer

Contents

Section I: Background

In February 1974, following major flooding that had occurred in the Brisbane–Ipswich area and in the northern part of New South Wales, the then Prime Minister announced that a review of the capacity of the nation to meet major natural disasters had been carried out.

2. Various specific steps that had been, or were to be, taken by the Government were announced at that time by the Prime Minister, the Minister for Defence and the Treasurer. One of them was the establishment of the Natural Disasters Organisation. Another was that the Government had accepted an offer by the Australian Insurance Association to explore with the Commonwealth Government the question of the inclusion of cover for natural disasters in house insurance policies.

Proposals by the insurance industry for a Natural Disaster Insurance Scheme

3. In October 1974, the Insurance Conference Committee (comprising members of the Australian Insurance Association as well as representatives of overseas reinsurers, brokers and loss adjusters) presented a report to the Government entitled a *Feasibility Study into the Introduction of a Natural Disaster Insurance Scheme for Australia.*

4. The study suggested a scheme for the provision of insurance cover against flooding and several other natural hazards. Part of the background had been some criticism of insurance companies following the Brisbane floods for not including cover for damage from flooding in 'standard' insurance policies for households. The study pointed out that an ingredient in the 1974 Brisbane flood situation was the development for housing purposes of flood plains which had not been previously inundated within the memory of most residents.

5. The approach taken in the study was to test a number of natural hazard risks against criteria—such as demand for coverage, catastrophe potential, and availability of data to determine the frequency and magnitude of losses—which the Committee believed would be required to support insurability by the insurance industry. The Committee concluded that a natural disaster insurance scheme for Australia should cover the hazards of flood and earthquake and associated hazards (including sea and high water, subsidence or landslip, subterranean fire and volcanic eruption) for both domestic and commercial interests. It was suggested that the Commonwealth Government establish an insurance fund for these hazards financed by a compulsory levy on fire insurance policies and reinsured on the overseas market and with insurance companies in Australia; that insurance companies also act as agents in the collection of the levy and payment of claims; and that the Government take responsibility, as lender of last resort, for any shortfall in the insurance fund in the event of a major disaster.

6. Following the Darwin disaster in December 1974, the Insurance Conference Committee produced a detailed addendum to its earlier study submitting that potential losses from tropical cyclones had been under-estimated and that tropical cyclones should be included as a natural hazard risk to be covered by the proposed scheme. It suggested that an additional levy be charged in high risk areas (for example, northern Queensland).

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Announcement of in-principle decision by the Government

7. In March 1976 the Government announced agreement, in principle, to the introduction of a natural disaster insurance scheme and the establishment of a Working Party of officials to formulate a scheme in consultation with the insurance industry and, as necessary, with the States.

Discussion paper issued by the Government in December 1976

8. A Discussion Paper, based on the Working Party's report, was tabled in Parliament in December 1976. The paper gave an outline of a possible scheme for the purpose of seeking public comment, emphasising that the Government was not committed to these proposals. The paper also included summaries of the current availability of natural disaster insurance cover provided by the insurance industry, arrangements under which Commonwealth financial assistance for natural disaster relief was provided to the States, and schemes operating in other countries. Various other options, which had been considered in detail, were listed.

9. The major elements of the scheme outlined in the Discussion Paper may be summarised as follows:

(1) A pool of general insurers would be established to offer natural disaster cover against selected natural hazards and for specified kinds of property. The pool would directly underwrite risks and would meet all claims from its own resources and from private reinsurance up to a pre-determined amount, beyond which Commonwealth support facilities would be available.

(2) The Commonwealth would not be involved in direct underwriting but would offer reinsurance facilities to the pool up to a specified maximum limit. Reinsurance premiums would be paid by the pool to the Commonwealth. The reinsurance arrangements would be developed in accordance with sound insurance principles but, in the determination of premium rates for such reinsurance, consideration would be given to the possible need to assist in producing reasonable premiums on cover provided to the public. The pool would be expected to take out private reinsurance to cover its liabilities beyond the extent of Commonwealth reinsurance, subject to availability and reasonable cost.

(3) All insurers authorised under the *Insurance Act* 1973, State Government insurance offices, the Defence Services Homes Insurance Scheme, and other Commonwealth agencies which insure property would be eligible to participate. The Government would seek to ensure maximum participation by insurers. If participation proved to be inadequate, consideration could be given to placing an obligation on insurers to participate.

(4) The Government and the insurance industry would actively encourage maximum participation by the public in the scheme on a voluntary basis. However, it was indicated that the Government might need to consider the possibility of using some form of compulsion if experience showed that to be necessary.

(5) The natural hazards covered by the scheme would initially be restricted to earthquakes, floods, tropical cyclones and related hazards such as landslide and storm surge.

(6) The scheme would extend initially to all ordinary household property and contents, and to small businesses (urban and rural). In appropriate cases State and local government assets could be covered.

(7) A Premiums Advisory Committee would be established to determine rates of premium and related conditions of cover on a basis to take account of differing risks. All participating insurers would be required to apply these determined premiums and conditions.

(8) Special arrangements would be considered for assistance to be provided to those who, subject to a strict means test, could not afford to take out natural disaster insurance cover.

(9) As an essential requirement of a successful scheme, governments would vigorously pursue policies to mitigate the risk of exposure to hazards.

(10) A Commonwealth agency would be established to administer the scheme, particularly the proposed reinsurance arrangements, to co-ordinate government activities and to liaise with other organisations involved.

Establishment of committees

10. When issuing the Discussion Paper in December 1976 the Government also indicated that two specialist Committees would be established in order to assist the Working Party of officials which would continue to co-ordinate work on natural disaster insurance.

11. A Technical Committee was established to undertake a technical examination of aspects of the proposals in the Discussion Paper. The Committee was chaired by the Australian Government Actuary and included representatives of other Commonwealth departments and agencies and the general insurance industry. Briefly, the main matters upon which the Technical Committee reported were as follows:

- possible definitions of the natural hazards that were included within the Discussion Paper scheme and the types of property to be covered; and
- the methods by which premiums might be determined on an actuarial basis to take account of differing levels of risk and some indicative premium rates based on the application of these methods to available information.

12. The report of the Technical Committee contained much useful—and in some respects pioneering—analysis of methods of assessing appropriate premium rates for insurance against earthquakes, tropical cyclones and floods. This analysis underlined the influence of the structural strength of buildings on likely damage costs and deficiencies in the data base available. The report suggested that, in many areas, actuarially-sound premium levels in respect of the three hazards would be quite low but confirmed that they would be extremely high in more risk-prone areas, particularly certain flood areas.

13. Copies of the report have been widely disseminated within the general insurance industry and amongst technical experts and interested members of the public. The Institute of Actuaries of Australia has had it under close study. Copies of the report are available on request.

14. A Mitigation Committee was also established, the aim being that it would provide advice on measures to avoid or reduce exposure to natural hazard risks in connection with natural disaster insurance. It commenced its work somewhat later than the Technical Committee and its report is not expected for some months yet. Members of the Committee include representatives of relevant Commonwealth departments, the general insurance industry and, in recognition of the significant responsibilities of the States in this area, State officials.

15. The Committee's terms of reference are as follows:

(i) to compile information on present and prospective policies and procedures (such as risk assessment, land-use planning regulations and building codes) which affect or can affect either exposure to risk or the damages from natural hazards;

(ii) to analyse the implications which those policies and procedures have for natural disaster insurance and vice versa;

(iii) to make any proposals that may seem desirable in relation to longer-term action that might be taken in connection with natural disaster insurance with respect to appropriate research and information gathering in relation to natural disasters and their effects;

(iv) to report on such other matters as may be referred to the Committee by the Working Party.

16. The Government will be making an assessment of the Committee's report as soon as possible after it becomes available. The issues under examination by the Committee are clearly most important.

Reactions to the scheme outlined in the Discussion Paper

17. Comments on the scheme outlined in the Discussion Paper were received from a wide cross-section of the community, including business and community organisations, insurers, professional and academic people, local government bodies and private individuals. At the invitation of the Prime Minister the majority of State Governments also put forward views.

18. Broadly, the comments received suggested that there was a wide-spread view that improvements would be desirable in relation to the means of handling the financial effects of major disasters on households and other aspects of natural disasters. There was also some support for aspects of the specific proposals in the Discussion Paper. At the same time, however, a number of major disagreements with or difficulties or weaknesses in the proposals emerged. Some of the more important of these are summarised in the following paragraphs.

19. It was argued that the hazards proposed to be covered had little relevance to the needs and risk exposures of some States—for example, Victoria and Tasmania had major bushfire problems (not covered by the proposals as the insurance industry had submitted that it was capable of providing adequate cover for bushfires at reasonable premium rates) but were not threatened by tropical cyclones (that were covered in the scheme as proposed). In relation to landslip (one of the hazards proposed to be covered), substantial practical problems in offering insurance were identified. (Such problems were also referred to in the report of the Technical Committee.)

20. The Insurance Council of Australia, at least two State Governments and various others were of the view that a scheme along the lines proposed would need to be made compulsory on either or both insureds and insurers if it were to be successful. It was suggested that this view was supported by the experience of schemes operating in other countries. In particular, it was noted that since the initial commencement of the U.S. National Flood Insurance Program more stringent conditions have been progressively introduced to counter lack of participation by the community. (The Technical Committee had also noted that maximum participation by insureds was essential to achieve an adequate spread of risks and reasonable premium levels.)

21. On the question of reinsurance, there seemed to be a large measure of consensus amongst experts in the insurance industry—both in Australia and overseas—that, under existing arrangements for catastrophe reinsurance cover, the net effect of the

pooling arrangement and Government backing proposed could well be to reduce the overall availability to Australia of catastrophe cover from the international reinsurance market compared with reinsurance arrangements as they are presently structured. It was suggested that insurers approaching the international reinsurance market individually could obtain more reinsurance cover than if an approach were made on a collective basis via a pool arrangement of the kind envisaged.

22. The view was expressed that a scheme of the kind proposed would not relieve State and Commonwealth Governments of the need to provide special assistance to those in need following major natural disasters. (The Commonwealth usually does not provide assistance for the repair or restoration of private assets damaged or destroyed as a result of a natural disaster. Major exceptions have been where widespread damage has occurred (see paragraph 32 below).)

23. There remained considerable uncertainty as to the degree of participation that a scheme along the lines proposed would attract from underwriters, including State Government insurance offices. It was noted that non-participating insurers could have a competitive advantage in low-risk areas.

24. In addition to the foregoing, there were more 'philosophical' points raised, in particular concerning the appropriateness and desirability of detailed intervention by government in the provision of insurance.

25. Discussions with insurance industry representatives indicated—and this is hardly surprising—that there was considerable diversity of opinion on the need for, and appropriateness of, a government-backed natural disaster insurance scheme. Some in the industry were firmly in favour of a scheme; others were just as firmly of the opposite view.

Section II: Current Commonwealth Government Policies and Procedures in Relation to Natural Disasters

26. It is helpful to set analysis of the question of natural disaster insurance in the context of the Government's general approach to the handling of the effects of natural disasters. The purpose of this Section is to outline current policies and arrangements in this area.

Natural Disasters Organisation

27. In February 1974 the then Government created the Natural Disasters Organisation (NDO) which absorbed the previous Civil Defence Organisation. This Organisation is responsible for co-ordinating physical assistance provided by the Commonwealth (including that provided by the Defence Force) with the efforts made by State emergency services and local and voluntary organisations to cope with major natural disasters. The basic responsibility for the provision of emergency services and disaster preparedness continues to rest with the States.

28. The Australian Counter Disaster College at Mt Macedon, Victoria, under the direction of the NDO, offers various training facilities. Students are drawn from Commonwealth, State and local government authorities and voluntary organisations. These facilities are provided free of charge. Other functions of the NDO include the sponsorship and management of a number of financial and material programs of assistance to State emergency services. For further details of these see Budget Paper No. 7 *Payments to or for the States, the Northern Territory and Local Government Authorities 1978–79*, pages 36 and 37.

Commonwealth Natural Disaster Relief Arrangements with the States

29. When natural disasters causing damage and destruction occur in a State, the Commonwealth Government stands ready to join with the State Government concerned in meeting expenditure on a dollar for dollar basis on the immediate relief of personal hardship and distress, except where such expenditure is of a very minor nature. Such expenditures may cover provision of food, clothing, shelter and repair of homes to make them habitable and secure.

30. In respect of 'major' disasters, the Commonwealth also assists with expenditures on other agreed relief and restoration measures when the expenditures are considered to be beyond the capacity of the State concerned to meet from its own resources. In 1977 arrangements were made to enable the States to assume automatic Commonwealth agreement to inclusion of certain 'standard' measures under the arrangements following specified major disasters. The States are required to seek Commonwealth approval if they wish to change the terms of previously applied standard measures. It remains open to a State to request Commonwealth support for non-standard measures which it might wish to implement for a given disaster.

31. The financial arrangements which have applied since 1971 have been modified for 1978–79 and beyond. The Commonwealth previously met all expenditures by a State in a year on agreed measures necessitated by major disasters in excess of

a base amount set for the State. Under the new arrangements above-base expenditures are financed on a $3 Commonwealth : $1 State basis. The base amounts at present range from $10 million for New South Wales down to $1.2 million for Tasmania.

32. The Commonwealth does not normally grant assistance for the repair or restoration of dwellings or other private assets damaged or destroyed as a result of a natural disaster (although minor assistance for repair of dwellings and replacement of household assets may be granted under the relief of personal hardship and distress category). Major exceptions have been where widespread damage has occurred; for example, the bushfires in Tasmania in 1967, flooding in Queensland in the early part of 1974 and the Darwin cyclone.

33. The following table shows State natural disaster relief expenditure attracting Commonwealth assistance over the years 1973–74 to 1977–78. It will be seen that expenditures on the restoration of public assets and loans to primary producers have been by far the major categories. The relatively small amount granted for housing repair and rebuilding is also to be noted.

Expenditure by States on Natural Disaster Relief
Eligible for Commonwealth Reimbursement(*a*) 1973-74 to 1977-78

	$ million
Personal hardship and distress	10.7
Housing repair and rebuilding	12.0
Rail and road freight subsidies	4.8
Loans to primary producers	54.0
Loans to small businesses	4.8
Restoration of State, local and semi-government assets	163.2
Emergency protection works and repairs to essential services	4.2
Other(*b*)	2.5
	256.2(*c*)

(*a*) Payments by the Commonwealth to States were less than State expenditure as shown in this table because arrangements provide for 'base' expenditures by the State before they are eligible for Commonwealth assistance.
(*b*) Comprising minor amounts on fodder airdrop subsidies, stock slaughter assistance and subsidies, loans to sporting clubs, assistance to non-government schools and tertiary education institutions, grants for fire-fighting costs, water cartage and assistance for the repair of fencing.
(*c*) Note that expenditure of more than $58 million for losses arising out of the Darwin disaster in 1974 is not included.

34. Further details on Commonwealth payments to the States under these arrangements may be found in the Budget Paper referred to in paragraph 28 above, pages 84–6 and 139–41.

The Bureau of Meteorology

35. The Bureau of Meteorology plays an important role in limiting losses from natural disasters. The Bureau's forecasting systems provide advance warnings of gales, storms, tropical cyclones, flood and bushfire conditions and other weather conditions likely to endanger life or property. The Bureau collects and records data and also publishes and promotes the use of meteorological information, furnishes advice on meteorological matters, and actively promotes the advancement of meteorology by research and investigation.

Building research

36. The Department of Housing and Construction carries out building research through its Experimental Building Station. As part of this function the Department examines and recommends designs for buildings that are subject to extremes of natural phenomena such as excessive wind speeds, earthquakes and flooding. The Department played an active role in the design and rebuilding of Darwin following the devastating damage caused by Cyclone Tracy. As a result of this work, the potential for damage of the order previously experienced in that city has been greatly reduced. The CSIRO is involved in assessment of the effects of natural hazards—winds, earthquakes, bushfires and floods—on housing and maintains a program of engineering research related to mitigation of damage to housing from winds. The Commonwealth Government, through the Department of Science and the Environment, also provides financial support for the Standards Association of Australia whose current work on standards for the structural safety of buildings includes the preparation of codes for cyclone resistant and earthquake resistant structures.

Crop and livestock insurance

37. Early in 1974 the then Government announced that an examination would be undertaken into the adequacy of insurance for crops and livestock against natural disasters.

38. Following an investigation by relevant Commonwealth departments, the then Government decided in February 1975 that further action in relation to natural disaster *livestock* insurance was not necessary in the light of the facilities provided by the insurance industry and existing Government assistance arrangements. However, the Insurance Council of Australia (whose role now incorporates the former functions of the Insurance Conference Committee) was invited to examine the possibilities for increasing the availability of insurance for *crops* against natural disasters. The Insurance Council of Australia has recently submitted a comprehensive report to the Treasurer on the matter and a study of the report is currently being undertaken by relevant departments and authorities.

Flood mitigation and other aspects

39. The Commonwealth and its agencies are involved in matters related to natural disasters in a variety of other significant ways—for example, financial assistance to or through the States for flood mitigation and various associated research and planning activities of the Department of National Development.

General comment

40. It will be seen that the Commonwealth participates in planning for and handling the effects of natural disasters in various ways. They add up to a very substantial contribution. It is to be noted that the various forms of Commonwealth involvement have been designed in such a way as to complement, rather than to duplicate or cut across, the proper responsibilities of the States and the insurance industry.

Section III: Re-assessment of Proposals for a Natural Disaster Insurance Scheme

41. Against the background sketched above—and in particular having regard to the reactions to the possible scheme outlined in the December 1976 Discussion Paper as summarised in paragraphs 19–25 above—the Government thought it appropriate to give further consideration to the problems which led to the Government's in-principle decision to have a scheme and to re-assess the extent to which a scheme of the kind envisaged would meet these problems.

Summary of the problems that led to the Government's original commitment

42. In very brief terms, the main problems that led to industry and other representations to the Government on this matter may be summarised as follows:

(a) Natural disasters occurring in 1974 and subsequently have shown that many householders lack insurance against natural hazards, or are substantially 'under insured'. This reflects a number of factors, including the failure of insureds to increase their insurance cover commensurately with increases in the value of their dwellings and, in some cases, lack of availability of insurance or very high premium levels (this has been particularly relevant in the case of floods).

(b) This situation had led governments to provide assistance to households following some major disasters; this assistance has been determined on an *ad hoc* basis and, it has been argued, on an inequitable basis insofar as a person involved in a major disaster could receive more assistance from governments than a person affected by an event that has been of a relatively minor nature in aggregate terms but of possibly equal severity so far as the individual affected was concerned. It has been suggested that further inequities are involved in that people who take greater precautions in obtaining adequate insurance can obtain less government assistance than those who did not insure or who insured inadequately.

(c) Following several major disasters, the price charged on international reinsurance markets for catastrophe cover for Australian underwriters had increased; underwriters claimed that there were difficulties in passing this cost on to the insured because of the resistance shown to higher premium rates.

(d) Some fears were expressed concerning the solvency of sections of the Australian insurance industry and about the possibility of the international reinsurance market withdrawing reinsurance cover or significantly increasing reinsurance premium rates in the event of a very large catastrophe or series of catastrophes.

(e) There was concern that inadequate land use planning and policies, such as those relating to the determination and implementation of adequate building codes, contributed to the problems of provision of insurance cover against natural hazards. Building in patently hazardous areas, such as flood plains, was continuing and, particularly in some tropical cyclone areas, buildings were not being constructed in such a way as to avoid or reduce damage from natural hazards. The view was expressed by some members of the insurance industry that the Commonwealth Government could exercise a greater degree of influence over the implementation of mitigation measures by closer oversight of Commonwealth assistance provided through assistance arrangements with the States.

(f) Industry representatives expressed concern that fire brigade levies, being based on amounts of premium paid or sums insured, acted as a disincentive to adequate insurance and to proper premium rating based on degree of risk, and that they also involved inequities insofar as people or corporations who did not insure avoided these contributions but still gained the benefits of protection from fire brigades. It was claimed that in some cases contributions could be avoided when insurance cover was arranged overseas.

(g) It was suggested that data deficiencies were hampering the development of sound methods for premium rating, disaster prediction and risk reduction. For instance, for most flood plains in Australia, flood risk maps, which could assist in the determination of the degree of exposure to the risk of flooding for individual households, had not been drawn up.

Assessment of the scheme circulated for comment in December 1976 as a means of meeting the problems

The question of reinsurance

43. Much of the discussion on this aspect centred on the cost to insurance companies operating in Australia of purchasing catastrophe cover on the international reinsurance market. Such cover is an important element in the operations of insurance companies. Information available suggests that costs did rise substantially following the Brisbane floods and the Darwin cyclone, though part of this reflected an increased amount of cover as well as increased cost per dollar of cover. Although rates may have come down somewhat since, they remain above those prevailing prior to the major disasters of 1974. The concensus in industry circles appears to be that the rates now more realistically reflect the degree of risk and that rates are not unduly high.

44. Representatives of some underwriters in Australia have, however, argued that under existing arrangements they are 'at the mercy' of the overseas market in the sense that if another very large disaster, or series of disasters, occurred rates would increase—to the detriment of the Australian public—as reinsurers attempted to recover their losses over a relatively short period of time.

45. It was against this background that it was proposed that the Commonwealth provide a 'layer' of reinsurance to a pool formed by general insurance companies, the basic purpose being to reduce reliance on the international market.

46. Some considerations of relevance to this proposal are:

(a) the arrangement would expose the Government to a potentially very large budgetary commitment, unpredictable as to amount and timing; this would not appear to be consistent with the Government's general budgetary aims;

(b) if the Government did provide reinsurance, any costs incurred in the event of a large disaster would in all probability be additional to, and not in lieu of, those incurred under existing Commonwealth-State assistance arrangements;

(c) faced with a large claim or series of claims (particularly in the early years of the scheme) the Government could, at least in some circumstances, be looking to recover some of the budgetary costs by way of larger premiums—that is, underwriters could be faced with the same problem vis-a-vis the Government as vis-a-vis commercial reinsurers;

(d) indeed, the problem could be worse in that the Government, unlike commercial reinsurers, would not be in a position to offset losses in one area of the world against profits in others;

(e) the Government could be faced with pressure to keep reinsurance premium rates below commercial levels because of the implications for premiums ultimately paid by householders; the end result could well be political determination of premiums and other aspects of the scheme which could impinge adversely on the financial viability of private sector insurers. Further, if premiums were to contain a subsidy element provided by the Government (or by insureds in less risk-prone areas) then this could tend to distort risk assessment and encourage development in high-risk areas.

47. To sum up, *the provision of reinsurance cover by the Government would not solve such problems as may be considered to exist—it would merely shift them from the commercial to the political arena.*

48. The foregoing comments are not intended to rule out the possibility of improved reinsurance arrangements being effected; however, the Government would not see any such improvement coming as a result of direct financial involvement on its part.

The question of a pool arrangement

49. It is not clear whether the industry would see advantage in a pool arrangement in circumstances where the Commonwealth Government would not be providing reinsurance or similar forms of financial assistance. This is a matter for the industry to consider. However, any pool arrangement, if it were to be considered, would need to be carefully designed to avoid problems such as the possible reduction in the overall availability of reinsurance cover and to cope with differences between States in the main hazards affecting them.

50. The creation of a pool would, by itself, do nothing to lessen the problems associated with lack of insurance by individual households or under insurance.

51. In the light of these points it was concluded that there was not a sufficient basis for the Government to initiate a national pooling arrangement; however, this would not preclude exploration of other possible pooling arrangements by the insurance industry or a State Government.

The question of under insurance and proposals for compulsion on individual households

52. The question of compulsion obviously raises very basic issues of policy. The following points may be made:

- problems of under insurance are to some extent being reduced by improved industry practices—for example, an increasing number of insurance companies transacting householder insurance are taking steps to inform individuals completing proposal forms, or renewing existing policies, of the need to maintain adequate cover; attention may also be drawn to a policy condition which entitles a company to settle a claim on the basis that the policyowner shares the cost of the claim if his property is under insured;
- to deal successfully, by way of compulsion, with the problems of lack of adequate insurance, it would be necessary not only to require insurance, but to require it at an appropriate level to reflect degrees of exposure of property to risk—the determination of that level for all individual households would be a truly gargantuan task;
- some householders are at present living in high-risk areas without adequate insurance cover, their choice being a conscious one related, in part, to low property values; this is not necessarily an irrational attitude and to force very high premium rates on the householders concerned could well be unfair or impracticable, or both. In other cases householders may be unaware that they are exposed to risk because of a general lack of information; in these cases, the gathering and dissemination of relevant information could be of considerable assistance;

- compulsion could have significant effects on property values in some areas to the detriment of the householders concerned; it could also lead to a serious reduction in the incentives for risk avoidance and risk reduction by property owners and the community generally, particularly if premium rate structures did not properly take into account the degree of risk involved;
- also relevant is concern expressed by some within the insurance industry that, if natural disaster insurance were to be made compulsory, the Government could well wish to control premiums, resulting in rates being set at uneconomic levels thereby forcing private sector insurers out of the market. It is relevant that the Insurance Council of Australia has in other contexts indicated that it is strongly opposed to any further extensions of compulsory insurance.

53. In the light of the foregoing, it was considered that the most appropriate course towards reduction of under insurance would be to seek to implement measures of an 'educational' and 'persuasional' kind designed to encourage greater insurance cover by households. This could appropriately be a joint effort between governments and industry.

54. It is noted that the Commonwealth–State natural disaster assistance arrangements do not include, as a 'core' measure, the provision of assistance to households in respect of insurable assets (other than the rather limited assistance given under the heading 'personal hardship and distress'), although such assistance has been given on some occasions. Attention has been drawn to the possible adverse effect that the provision of this kind of assistance might have on the incentive to insure. Although there is no evidence that this has been a significant factor so far, it is an aspect that warrants careful attention as the on-going arrangements are reviewed and as the responses to particular disasters are considered.

Solvency of underwriters

55. With regard to the solvency of underwriters, the *Insurance Act* 1973 is relevant—in particular, section 34 and related provisions which require authorised insurers to have arrangements approved by the Insurance Commissioner for reinsurance of liabilities. In gauging the effectiveness of the Discussion Paper scheme for reducing the risk of insolvencies within the insurance industry in the event of a catastrophe, it should be borne in mind that insurance losses incurred by commercial interests that would have fallen outside the scope of that scheme could well be greater than losses arising from damage caused to property covered by the scheme.

56. The Government believes that any strengthening of the basic solvency position of underwriters considered to be necessary, having regard to possible catastrophe losses, should be taken up in the context of the Insurance Act. A strengthening of the solvency position of insurers could, of course, lead to a reduction in the extent to which the insurer must rely on reinsurance.

Conclusions

57. The Government has firmly concluded that a natural disaster insurance scheme of the type outlined in the Discussion Paper would not be a cost-effective way of assisting in solutions to the problems identified. Such a scheme would not address itself, in an efficient manner, to the alleviation of these problems. The Government has taken a firm decision not to proceed with the implementation of such a scheme.

The Government recognises that in these circumstances it will be appropriate for the industry to continue to make decisions affecting their exposure to liabilities arising from natural disasters on a commercial basis.

58. Efforts have been concentrated on the development of measures that the Commonwealth could take which would not involve a substantial commitment of funds and which would be more directly aimed at alleviating the problems that have been identified.

The Government's Policies and Proposals

59. Following is a summary of the policies and proposals the Government has decided to adopt in lieu of proceeding with a natural disaster insurance scheme.

60. Given the complex nature of the problems that exist in the area of natural disaster insurance and the inherent constraints on government action, these policies have been carefully designed to build on the established expertise and resources of the insurance industry in a pragmatic fashion. They are designed to deal with the root causes of the problems that have been evident and to effect long-term improvement in a manner that recognises the proper and continuing roles of the States and the insurance industry.

1. Question of a possible 'pool' or similar arrangement

61 (a) If the general insurance industry were to put forward a firm proposal, based on sound insurance principles, for a 'pooling' scheme on a national or a State-by-State basis, the Commonwealth Government would consider what forms of support it might usefully give, provided that:

- (i) the scheme did not involve the provision of reinsurance or other substantial financial assistance by the Commonwealth Government;
- (ii) the scheme had demonstrated support from the whole industry, or at least a substantial portion thereof;
- (iii) the scheme had clear overall benefits outweighing any costs or problems;
- (iv) full account was taken of any Trade Practices Act considerations.

(b) The Commonwealth Government similarly undertakes to examine, on the same basis, any scheme put forward by an individual State Government for application in its State.

(c) If a State Government felt that some form of compulsory arrangement would be desirable it would, of course, be free to legislate for such an arrangement, although desirably this should be done in full consultation with the industry and with the Commonwealth Government and have regard to the major practical problems that would undoubtedly arise.

2. Reinsurance

62. The Commonwealth Government is prepared to join with the industry, if it so wishes, in examining the question whether practical means might be available to increase reinsurance capacity in Australia, to improve the position of underwriters in Australia vis-a-vis the international reinsurance market or to otherwise assist in the meeting of large catastrophe claims. This is subject to the proviso that significant forms of Commonwealth financial assistance would not be involved and that the concept would need to have wide industry support.

3. Solvency of underwriters

63 (a) This is regarded as a matter for continuing attention in the context of the *Insurance Act* 1973, including section 34 (reinsurance) in particular. The Commonwealth Government would naturally be prepared to consider any proposals for strengthening or improving relevant areas of the Act. In this

context it is relevant that the Insurance Commissioner, in his latest annual report, has stressed the importance of section 34 and related provisions and is in the process of developing additional guidelines for assessing the acceptability of reinsurance arrangements. Further, a number of proposals are currently being considered for strengthening the *Insurance Act* 1973—proposals being considered include amendments to increase the minimum paid-up capital and solvency requirements laid down in the Act.

(b) If a disaster were to occur of such substantial proportions that it produced claims that exhausted industry resources, including reinsurance arrangements, such an event would have to be regarded as a national emergency. The nature and extent of Commonwealth–State Government assistance would need to be tailored to meet the prevailing conditions. In such circumstances, considerations of economic management, allocation of national resources and relative needs would be among the factors to be taken into account.

4. Technical work on premium rates and related matters

64 (a) Subject to staffing and financial constraints, the Commonwealth offers the services and facilities of relevant agencies (for example, the Office of the Australian Government Actuary, the Bureau of Meteorology, the Bureau of Mineral Resources and the Department of Housing and Construction) in the continuation and development of technical work on premium rates and associated matters, such work to be undertaken in conjunction with the State Governments and industry.

(b) Consideration could be given to putting this work on to a State-by-State basis (the appropriateness of this may differ as between the various kinds of disasters).

(c) Funding of this work would be shared between the Commonwealth Government, the State Governments and industry on an appropriate basis; the fact that insuring households could be expected eventually to benefit from this work would be an argument in favour of a significant industry contribution.

5. Mitigation policies

65. The work of the Mitigation Committee will continue and the results of that work will be given priority attention as they become available. Full attention will need to be given to the very significant responsibilities of the States and local government authorities in this area. The Government recognises that, by the careful and co-ordinated use of appropriate measures, significant gains could be made not only in reducing the cost of natural disasters to the community as a whole but also by increasing the availability of insurance at reasonable rates.

6. Flood plain management

66. One of the objectives of the recently announced Commonwealth Water Policy is to 'minimize losses and disruption caused by floods'. Consistent with this policy objective the Commonwealth Government has announced the establishment of a sub-program for flood plain management within the National Water Resources Program. Under the National Water Resources Program the Commonwealth will provide

$200 million spread over several years to the States for all aspects of water resources development. Through this program it is anticipated that the flood risk in urban areas will be reduced. This should have the effect of reducing the level of flood insurance premiums for households to more acceptable levels.

7. Measures to encourage adequate insurance by households

67. The Government is initiating discussions with a view to the establishment of joint industry–State–Commonwealth committee arrangements, possibly of a continuing kind, to gather information on this question and to co-ordinate 'educational' and 'persuasional' activities designed to improve the degree of insurance coverage of households. These could, as considered appropriate, be on a State-by-State basis. These activities could include informing the public of the risks associated with natural hazards, the advantages of insuring adequately against these risks, and the possible consequences of not insuring.

8. Measures to facilitate payment of insurance claims in the event of major disasters

68. Following representations made by the insurance industry on this aspect, arrangements will be initiated with State and Territory authorities to seek to ensure that, in the aftermath of a major disaster, the insurance industry is given access to facilities and any necessary co-operation in the speedy and co-ordinated assessment and payment of claims.

9. Commonwealth–State disaster assistance arrangements

69 (a) The departments responsible for the administration and review of Commonwealth–State natural disaster relief assistance arrangements have been asked to keep under notice the matters referred to in this Paper, including the equity and incentive aspects of the provision of assistance to households.

(b) The departments concerned have also been asked to examine the question whether there is any advance preparatory action that could usefully be taken (without prejudicing on-going policies in this area) to ensure that, if and when a disaster causing major social and economic dislocation incapable of being handled under the normal arrangements does occur, any necessary consideration of possible forms of financial assistance in respect of the insurable assets of households can be given on an urgent basis. Arrangements will be made to secure any necessary input from the insurance industry.

10. Arrangements to improve and co-ordinate information and review

70. In addition to relevant aspects noted above, the following possibilities will be discussed with the States and industry:

(a) the establishment of a 'team' of government, industry and/or other expert people to be ready to visit disaster areas for the purpose of gathering 'on the spot' information relevant to the on-going assessment of policies and practices in relation to natural disaster insurance; aspects of this question are being examined in more detail by the Mitigation Committee;

(b) the formulation of improved arrangements (in which governments and industry would participate) for the gathering, cataloguing and dissemination of information on natural hazards and to assist in co-ordination of research in this field;

(c) the creation of appropriate *overall* liason arrangements (for example, a permanent committee) between the Commonwealth Government, the State Governments and the industry to monitor progress on the natural disaster insurance matters referred to above, in order to make recommendations for improved machinery.

11. Trade practices aspects

71. There have been suggestions from the insurance industry that the development of proper rating structures requires a co-operative endeavour to properly assess risks and to rate accordingly. In this context it is relevant that the Trade Practices Commission is currently examining certain applications from insurance companies for authorisation of arrangements relating to premium rates.

Section V: Some Broader Comments

72. The Government believes, for the reasons set out in previous Sections of this paper, that a natural disaster insurance scheme of the kind that has recently been under discussion would not meet in an efficient manner the problems that it was designed to overcome.

73. Assuming that to be a correct conclusion, the question arises whether an attempt should be made to devise a different scheme, with characteristics designed to overcome the deficiencies that have been revealed.

74. The answer to that question depends, in part, on what is meant by the word 'scheme'. If it means an arrangement designed to deal with the problems on a national, comprehensive basis with substantial financial or other assistance provided by the Commonwealth Government, then the Government would answer the question very firmly in the negative.

75. The Government believes, in other words, that at least some of the problems that have been identified with the *particular* scheme that has been under notice would be inherent in *any* arrangements that represented an attempt by government to deal with the problems that exist by the creation of a national scheme.

76. This view rests on political philosophy as well as on the facts and arguments as they relate to the particular question of natural disaster insurance. Full analysis of these broader issues would go beyond the scope of this Paper. It is, however, appropriate that some general comments be recorded.

77. As is so often the case in discussion of social policy questions of this kind, problems that undoubtedly do exist tend to be highlighted to the extent of obscuring good features that exist just as certainly. In this particular area, those features include:

- the diversity, capacity and expertise of the Australian insurance industry;
- the access of the industry to the international market for 'back up' (reinsurance) facilities;
- the existence of a very substantial and genuine measure of competition in the industry, with consumers gaining very practical benefits therefrom in the form of low premium levels;
- freedom of choice on the part of households and others as to the location of their dwellings or other assets and as to the kind and level of insurance purchased.

78. Attempts by governments to 'solve' problems in this kind of area may—in the longer term if not immediately—bring in their train problems of equal or even greater magnitude. Take for example the problems of under insurance and a lack of insurance, which can lead to:

- personal hardship when the households concerned are hit by a disaster;
- inequities when governments attempt to assist householders in that situation—inequities as between those who have adequately insured and those who have not and as between those affected by a larger disaster attracting government assistance and those affected by a smaller one not attracting such assistance.

79. There are two ways by which governments could attempt to 'solve' these problems. First, by compelling households to take out adequate insurance. That, however, would be a truly gargantuan task and involve all kinds of practical problems, quite apart from interference in reasonable freedom of choice. The other possible approach

would be for the Government to establish some arrangements—whether directly, through the States or through the insurance industry—to compensate for losses due to under insurance on a set, defined basis to assist those affected by small as well as large disasters. That again would be a huge task, fraught with practical problems and difficult questions of equity. Beyond that, however, it could, in the longer run, if not immediately, have very significant adverse affects on the incentive for households to insure adequately.

80. Under current arrangements householders cannot count on government financial assistance in the event of a disaster, although in the case of a very large disaster some such assistance may be forthcoming. If it is, the likelihood is that the assistance will be of a partial nature and subject to limit. Some may describe this as an '*ad hoc*' and unsatisfactory approach. It is suggested, however, that a more reasonable way of describing it would be as a balanced approach which has regard to the several and conflicting considerations involved—to the need to leave individuals with adequate incentive for them to provide against contingencies, to the reasonable expectation that governments will assist when there is large scale distress, to the contribution that has always been made from community resources outside government and to general budgetary and other circumstances as they may apply at the time.

81. On the question of inadequate insurance, the policy measures proposed by the Government as outlined in Section IV above include provisions for governmental assistance towards encouragement of improved insurance coverage on a voluntary basis.

82. The Government fully recognises that this and other aspects of the proposals cannot be expected to lead to any quick or dramatic improvement in natural disaster insurance arrangements. Short of legislation compelling households to insure and determining the nature and extent of that insurance—which as noted above would raise considerably more problems than it would solve—there is no 'short cut' available. The problem is complex, and relates to the situations of, and the decisions taken by, millions of individual households. Any successful action will, in the Government's opinion, necessarily be of a long-term gradual nature, based on careful planning and co-ordination. Measures of a pragmatic kind are called for. Attempts to develop some radical new 'superstructure' acceptable to the various parties involved would necessarily divert attention away from more modest, but practical and more achievable measures of the kind outlined in the previous Section of this Paper.

83. This leads to an even more fundamental point. Past experience—both in the insurance area and more widely—suggests that once governments become involved in one aspect of a particular activity they tend to be drawn into closer and closer involvement, often to the long run detriment of the particular industry and consumers concerned. The Commonwealth Government accepts an obligation to provide a basic legislative framework in which the insurance industry can operate on a stable financial basis. But it sees considerable danger in attempting to go further than that by becoming involved in the provision of, or the detailed control over, particular kinds of insurance services. Indeed, it can well be argued that those areas of insurance in which governments have become most involved in the past are those that are currently causing the most problems. Once 'initiatives' are taken by government, it is extremely difficult for them to be regained by the private sector.

84. These general thoughts are, of course, by no means new. The following, written nearly a century ago and no doubt in a style and from a viewpoint that many would regard as somewhat radical, might nevertheless be thought to contain truths of great relevance to the issues that confront society and governments today:

> See, then, the many concurrent causes which threaten continually to accelerate the transformation now going on. There is that spread of regulation caused by following precedents, which become the more authoritative the further the policy is carried. There is that increasing need which results from the unforseen evils and shortcomings of preceding compulsion and restraints. Moreover, every additional State-interference strengthens the tacit assumption that it is the duty of the State to deal with all evils and secure all benefits. Increasing power of a growing administrative organization is accompanied by decreasing power of the rest of the society to resist its further growth and control. The multiplication of careers opened by a developing bureaucracy tempts members of the classes regulated by it to favour its extension, as adding to the chances of safe and respectable places for their relatives. The people at large, led to look on benefits received through public agencies as gratis benefits, have their hopes continually excited by the prospects of more. A spreading education, furthering the diffusion of pleasing errors rather than of stern truths, renders such hopes both stronger and more general. Worse still, such hopes are ministered to by candidates for public choice to augment their chances of success; and leading statesmen, in pursuit of party ends, bid for popular favour by countenancing them. Getting repeated justifications from new laws harmonizing with their doctrines, political enthusiasts and unwise philanthropists push their agitations with growing confidence and success. Journalism, ever responsive to popular opinion, daily strengthens it by giving it voice; while counter-opinion, more and more discouraged, finds little utterance.
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> Thus influences of various kinds conspire to increase corporate action and decrease individual action. And the change is being on all sides aided by schemers, each of whom thinks only of his pet project and not at all of the general re-organization which his, joined with others such, are working out. (Herbert Spencer, 1884).

85. The Government is thus concerned to resist the—admittedly very popular and seductive—notion that the answer to social problems of the kind discussed in this paper is more and more governmental compulsions and/or more and more public expenditure. The Government believes that the contrary view—that intervention of that kind is often unsuccessful in the longer run and has considerable costs and dangers associated with it—is perceptibly, if still relatively slowly, growing stronger and is destined to continue to do so. It has been part of the purpose of these brief remarks to give support and encouragement to that viewpoint.

86. That viewpoint does not deny that there is a legitimate role for governments in the specific areas discussed in this Paper nor that, in our Federal system, there is a significant part to be played at the Commonwealth level. It does, however, assert that the role of the Commonwealth Government should be appropriately confined and that it should complement, and not duplicate or overlap with, the activities of the States and the insurance industry. The Government believes that the policies and proposals outlined earlier in this Paper meet these tests.