Gallagher | Research Centre

Building Better:
Making Communities More Resilient to Natural Perils in Australia

Following the devastation to the Australian city of Darwin in 1974 by Tropical Cyclone (TC) Tracy, major changes were made to the building design standards and regulations for house construction in Australia. The impact of TC Tracy resulted in a legacy of stronger buildings. TC Tracy was also the catalyst for the formation of the Cyclone Testing Station at James Cook University in Townsville, Australia.

Key Findings:

- Following the devastating Tropical Cyclone Tracy in 1974, Australia's building design standards and regulations were significantly updated, creating a step change improvement with a focus on life safety.
- Despite these building code improvements, recent historical claims experience from tropical cyclones highlight that contemporary construction practices have created issues and lead to higher insured loss outcomes, even for events with wind speeds below the design wind speed.
- The issues will be exacerbated by our changing climate potentially increasing the natural peril risk in many areas.
- Insurers use risk-based pricing approaches to manage their natural peril risk and to ensure they can continue to protect our communities. However, the changing climate may result in pockets of undesirably high-risk where premiums will need to be higher to reflect the increased risk. This may give rise to affordability issues.
- Mitigation and further changes in building design and construction practices are key to reduce damage and insured losses, to make our communities more resilient and to ensure they can recover more quickly from these events.

The Cyclone Testing Station (CTS) is an independent, self-funded research and consulting unit within the College of Science and Engineering of James Cook University (JCU). The CTS has a research and awareness focus on the resilience of low-rise structures, through understanding the wind and rain actions, design and construction, with the aim of minimising loss and suffering in the face of severe weather events.

The CTS delivers real change through applied research, consulting to industry and government, and providing community education focused on the severe weather effects to the built environment. This year marks the Station's official 46th year of operation.

More than four decades of damage investigations by the CTS following cyclones have shown that there is a positive step change in performance for life safety and robustness of housing built after the code changes (post-1980) across the cyclone regions of Australia, which is comparable to code improvements following Hurricane Andrew in the USA.

However, successive damage surveys by the CTS also highlight issues with contemporary construction such as poor design choices, construction details, as well as a lack of maintenance—all leading to significant damage to buildings from winds well below the design wind speed.

Figure 1: Devastation caused by Cyclone Tracy in Darwin in 1974 (CTS).

Furthermore, an examination of Australian insurance claims reveals a high proportion of the rebuild costs or damages related to the loss of a property's functionality, are associated with contemporary construction. This raises questions as to whether the building construction, design codes and practices are entirely 'fit for purpose' when subjected to the combined impacts of severe wind loads and wind driven rain ingress.

Damage research in many parts of the world has shown that unmanaged water ingress has become a critical and recurring problem in residential constructions.[1-7] The result has been increased insurance losses due to interior damage.[2,8] Work by Sparks[2] 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 wind 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 (ICA) on insured losses in strata properties suffered during Cyclone Yasi.[9] The study found 80% of claims noted some damage resulting from water ingress.

Similarly, a survey following TC Larry showed 75% of houses had water ingress.[10] The damage was from wind speeds far below the structural design wind speeds as set out in the National Construction Code.

In a recent study for the ICA (2021), claims data from TC Debbie (2017) was compared with street survey Rapid Damage Assessment (RDA) datasets. RDA's are surveys carried out by trained emergency services personnel in the immediate aftermath of disaster events. The primary objective of the RDA is identifying life safety and recovery issues and most surveys are conducted on foot from the street and therefore less visible damages are likely to be underreported.

Figure 3 shows the RDA data collected in Proserpine following TC Debbie. The three areas circled in green denote locations with very little identifiable damage from the exterior. Figure 3 also shows claims for houses constructed 'post-2000' in Proserpine. The areas circled in green have a significant number of large insured losses, highlighting that the true extent of losses following TC events extends well beyond what can be seen visibly by the broader community.

Figure 2: CTS photos—extensive water ingress damage to internal cladding of modern buildings.

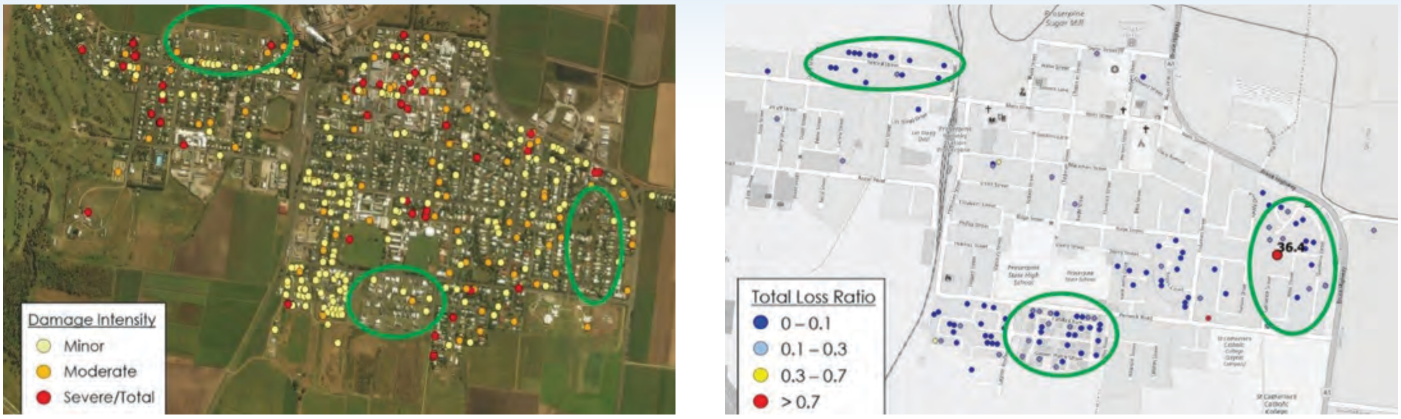

Figure 3: (Left) RDA data collected by QFES and NSW SES in Proserpine following TC Debbie. (Right) Total loss ratio (building + contents) in Proserpine for all insurers following TC Debbie. Note: Areas within green ellipses show claims for modern housing where RDA data did not identify damage had occurred to the building exterior.

TC Seroja impacted the Western Australia coast in 2021 at a similar latitude to that of South East Queensland, which is a major population area, and at a latitude that is commonly referred to as non-cyclonic design region. Although wind speeds were less than design winds, around 70% of buildings had some damage to the roof, ranging from minor through to complete loss of roof structure. It was estimated that more than 10% of contemporary houses in Kalbarri had significant damage to the roof due to internal pressure following damage to doors or windows resulting in loss of more than one-third of the roofing or roof structure. Most of these structural failures involved a contribution to loading from high internal pressure following the development of an opening on the windward wall.[9]

Buildings in non-cyclonic regions of Australia are typically not designed for this load case. The damage experience from TC Seroja demonstrated that buildings are currently vulnerable to wind loads if designed for low internal pressures and are in the path of a severe weather system, even if the design wind speed is not exceeded.

The CTS is working with government, regulators and the building industry to implement changes in building design and construction. Building codes need better processes to enable resistance of coincident impacts, such as from wind and rain—so damage and insured losses are reduced and our communities become more resilient to recover more quickly from these events.

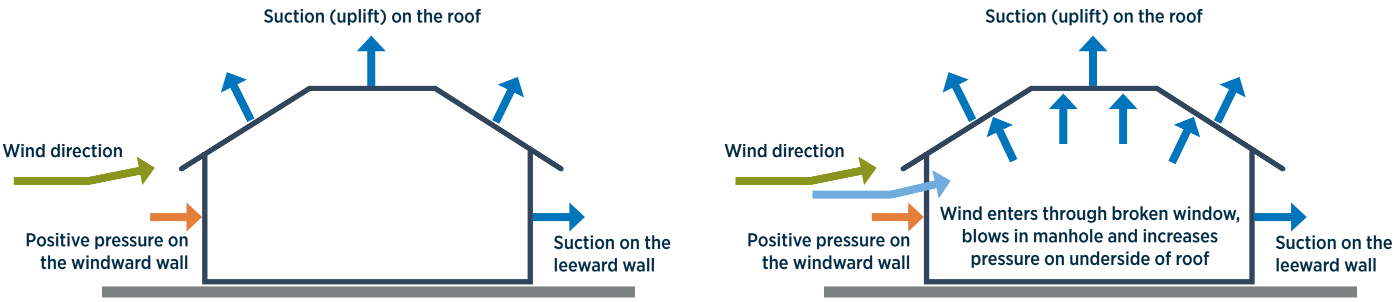

Figure 4: Wind loadings on a house increase significantly due to high internal pressure following the development of an opening on the windward wall.

An insurance perspective

Many insurance companies apply risk-based pricing and underwriting approaches, assessing risks for individual natural perils and for individual property locations. Risk based pricing and underwriting has been enabled through the development of high-resolution hazard models, providing us, for example, with detailed flood maps or bushfire zones.

This approach reduces the uncertainty around the risk at a granular level and allows insurers to charge a premium that is reflective of the risk at a given location. Risk-based pricing approaches typically result in competitive premiums for low-risk areas. However, by reducing cross-subsidisation within a region or portfolio, it emphasises pockets of high-risk, where premiums need to be higher to reflect the risk. This can result in affordability issues, and has led to an ongoing debate about mitigation and the resilience of our building stock to natural perils.

Climate change further exacerbates this issue as we expect to see more severe bushfires, more intense rainfall events and subsequent flooding. The potential increase in the intensity of severe tropical cyclones coupled with a poleward shift in track occurrence could mean more insurance losses reaching the densely populated regions of South East Queensland, northern New South Wales and the south-western coast of Western Australia. Many more regions may become riskier and therefore more expensive to insure as extreme weather risks continue to increase in the future.

Gallagher Re in Australia have used our proprietary high resolution hazard models in combination with several climate change scenarios to create climate change conditioned views of natural peril risk in Australia. The selected climate change scenarios follow recommendations from the Task Force on Climate-Related Financial Disclosures (TCFD) and consider Representative Concentration Pathways (RCPs) 4.5 and 8.5 for two key time horizons, 2050 and 2090.

The modelling provides insights on both, the magnitude and geographic distribution of potential changes in natural peril risk across Australia under different climate change scenarios. Of course, there is high uncertainty in this process; however, it is immensely useful as it allows our clients to consider what potential changes they may have to contemplate and adapt to. By using the high-quality, validated baseline information provided by our proprietary hazard models, we can assign a higher level of confidence to our climate change modelling and draw meaningful and decision-useful conclusions, especially from the magnitude and distribution of the relative changes.

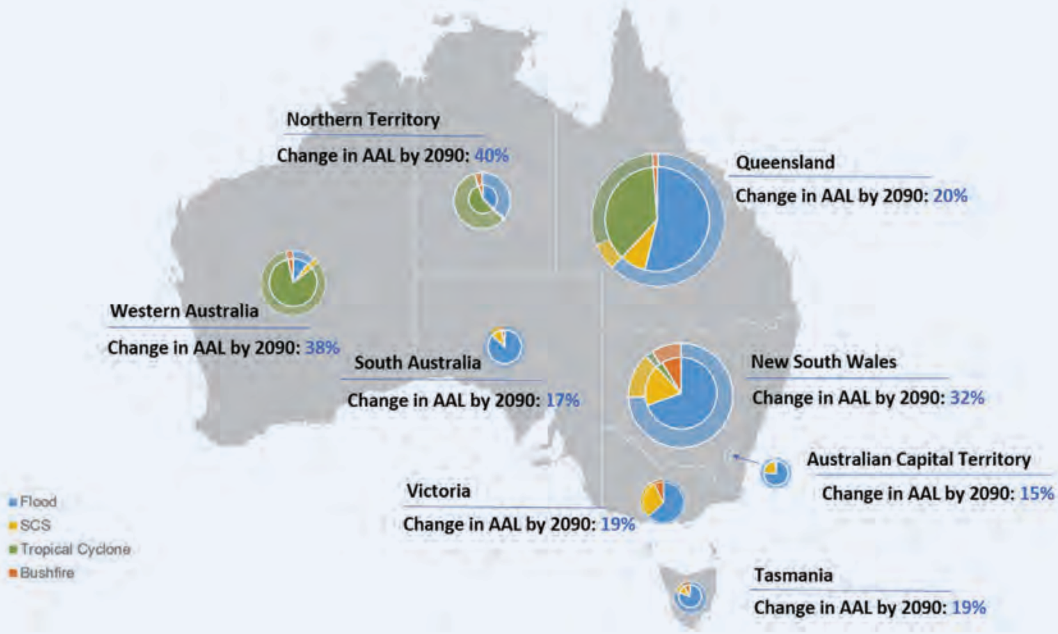

Figure 5: Modelled changes in AALs by state and by peril, for residential exposures. Scenario: RCP 8.5 by 2090. NB: Charts are not proportional; NT, TAS and ACT scaled up for better visualisation.

As shown in Figure 5, our modelling suggests 15%–40% increases in Annual Average Losses (AALs) with significant variations by state and by peril; emphasising that these changes consider the annual average or mean of the full loss distribution. Regardless of what form of distribution the losses may follow, a small change in the mean is almost always certain to translate into a huge potential for the extremes to get a lot worse.

Natural peril risk, expressed here as an Annual Average Loss, directly drives insurance premiums and hence is a key factor that can impact insurance affordability. Insurance affordability is sometimes quantified by considering the ratio of insurance premiums over the sum insured in the context of household disposable income.[12] In real life, affordability is of course a lot more complex, and will depend on many additional, including subjective factors.

Gallagher Re in Australia have undertaken a simplified, preliminary analysis using a metric based on our climate change projected AALs over sum insured. Defining a somewhat arbitrary peril risk threshold, our analysis highlights areas where natural peril risk potentially increases beyond a point at which affordability issues could arise. The analysis shows that there are already today dozens of postcodes with more than 20% of property locations exceeding the defined peril risk threshold. Considering the RCP 8.5 climate change scenario, the modelling suggests that by 2090 there could be a 56% increase in the number of properties (approximately >500,000) exceeding this peril risk threshold.

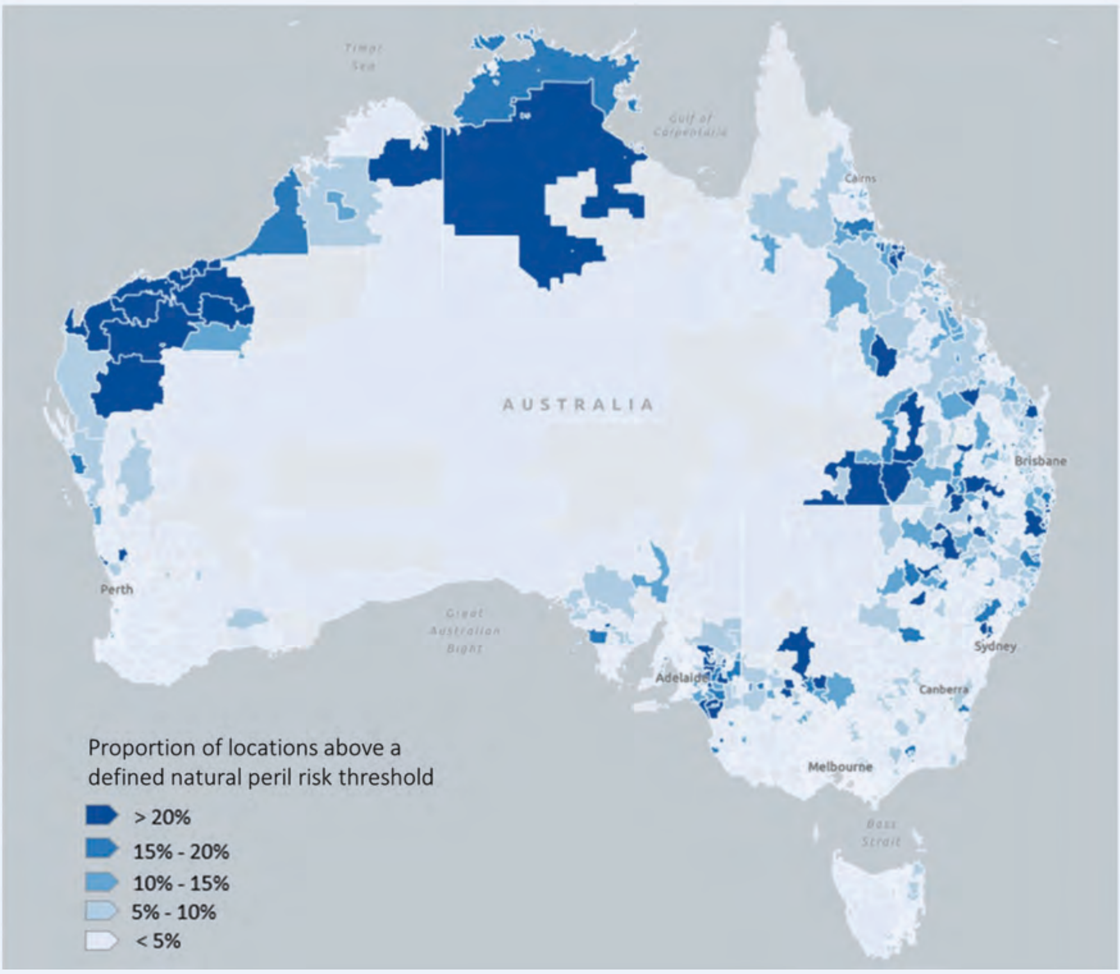

Figure 6: Proportion of locations above a defined natural peril risk threshold.

It is important to note that the analysis described above considers a status quo, especially regarding risk mitigation. Changes and improvements to building practices and disaster mitigation, that might occur over coming years are not considered.

Risk mitigation

There are currently various government funded schemes in Australia looking to improve the resilience of homes and communities. Another important aspect stems from significant expected population growth and the associated need for new homes. On this point, there is an opportunity to build these new homes in a smarter way, in better locations and with better design.

The insurance industry continues to play a pivotal role in protecting our communities. We can encourage mitigation behaviour through education and financial incentives, and we must continue to invest in modelling capabilities and associated enhanced data collection to keep improving our understanding of natural peril risk.

The modelling tools and language of risk developed and used in our industry for many decades has proven to work and provide decision useful output. The industry would welcome other parts of the community, across the public and private spectrum to explore using the same modelling tools and capabilities, thus facilitating a shared language of risk. This would help inform a wider debate and facilitate improved decision-making.

Informing insurance underwriting and pricing as well as key aspects of design, building consents and even emergency response planning, using the same language of risk, helps remove the 'uncertainty friction' from the system and create the potential to significantly improve the resilience of our communities.

It's clear that the solution to the challenges posed by the changing climate must be tackled by collaborating across multiple industries and sectors and the wider community.

Dr David Henderson is Chief Engineer of the Cyclone Testing Station (CTS) based out of James Cook University, Queensland, Australia. The CTS are a Gallagher Research Centre (GRC) partner.

Michael Barkhausen is Director and Head of Analytics Business Development Australia & New Zealand, Gallagher Re.

How can we help?

For more information on Gallagher Re in Australia's catastrophe analytics, climate change or Model Research and Evaluation services, please contact your local client representative. Gallagher Re at Level 15, 123 Pitt Street Sydney, NSW 2000

GallagherRe.com

References

[1]Sheffield, J., 1994. Survey of building performance in hurricane Iniki and typhoon omar. Hurricanes of 1992: Lessons Learned and Implications for the Future, 446-455.

[2]Sparks, P. R., Schiff, S. D., & Reinhold, T. A. (1994). Wind damage to envelopes of houses and consequent insurance losses. Journal of wind engineering and industrial aerodynamics, 53(1-2), 145-155.

[3]Smith, D., Henderson, D., Assessing the Vulnerability of Modern Homes to Tropical Cyclones and the Suitability of Current Building Codes in Australia, 20th Australasian Wind Engineering Society Workshop, 2021.

[4]Van De Lindt, J.W., Graettinger, A., Gupta, R., Skaggs, T., Pryor, S., Fridley, K.J., 2007. Performance of wood-frame structures during hurricane Katrina. Journal of Performance of Constructed Facilities 21, 108-116.

[5]Franco, G., Green, R., Khazai, B., Smyth, A., Deodatis, G., 2010. Field Damage Survey of New Orleans Homes in the Aftermath of Hurricane Katrina. Natural Hazards Review 11, 7-18.

[6]Boughton, G., Henderson, D., Ginger, J., Holmes, J., Walker, G., Leitch, C., Somerville, L., Frye, U., Jayasinghe, N., and Kim, P., Tropical Cyclone Yasi Structural Damage to Buildings, Cyclone Testing Station, James Cook University, Townsville. Report TR 57, 2011.

[7]Gurley, K., Masters, F., 2011. Post-2004 Hurricane Field Survey of Residential Building Performance. Natural Hazards Review 12, 177-183.

[8]Pita, G., Pinelli, J.P., Cocke, S., Gurley, K., Mitrani-Reiser, J., Weekes, J., Hamid, S., 2012. Assessment of hurricane-induced internal damage to low-rise buildings in the Florida Public Hurricane Loss Model. J Wind Eng Ind Aerod 104-106, 76-87.

[9]Smith, D., & Henderson, D. (2015). Insurance Claims Data Analysis for Cyclones Yasi and Larry [Report for Suncorp Group Limited].

[10]Melita, B., 2007. Performance of Housing Envelope in Tropical Cyclone Larry, School of Engineering. James Cook University, Townsville.

[11]Boughton, G., Falck, D., Parackal, K., Henderson, D., Bodhinayake G., Tropical Cyclone Seroja Damage to buildings in the Mid-West region of Western Australia, Cyclone Testing Station, James Cook University, Townsville. Report TR 66, 2021.

[12]Paddam, S., Liu, C., & Philip, S. (2022). Home insurance affordability and socioeconomic equity in a changing climate. Actuaries Institute. Sydney. Actuaries Institute.

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