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Beating the BIG BLOWS

New research assesses severe-wind risks.

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On Christmas Day 1974, Cyclone Tracy devastated Darwin with winds gusting to 237 km/h. Tracy killed 65 people and caused damage of over A$837 million (1999 dollars), according to the Insurance Disaster Response Organisation.

Although tropical cyclones rarely assault Australian cities, severe winds cause significant damage each year. While cyclonic winds are a northern Australian phenomenon, winds driven by thunderstorms and tornadoes also inflict serious damage and sometimes cause loss of life in southern states. Data from insurance companies indicate that severe winds account for around 40% of damage to Australian residential buildings (Blong 2005)—significantly more than other natural hazards, such as floods (22%), bushfires (19%), and earthquakes (6%).

New research by Geoscience Australia's Risk Research Group aims to reduce the loss of life and the property damage from such severe-wind events in Australia.

▲ **Figure 1.** Housing estate destroyed by Cyclone Tracy in 1974 (Bureau of Meteorology).

Cyclones

Most Australian cyclones develop in the Indian Ocean off the northwest coast of Western Australia, off the northeast coast of Queensland in the Coral Sea and, to a lesser extent, in the Arafura Sea northwest of the Northern Territory.

Western Australia's northwest coast has endured the strongest Australian cyclones, but the region is so sparsely populated that cyclones which would cause massive destruction in more densely settled areas often cross the coast with little impact on communities. The Pilbara, Western Australia's critical northwest resources region, escaped major damage from the passage of Cyclone Clare in January 2006, but the key industrial centres of Karratha and Dampier were hit by winds of up to 195 km/h as the Category 3 cyclone struck the coastal region.

Queensland has seen relatively few tropical cyclones in recent decades compared to the long-term average. The last to cause considerable damage in the state was Cyclone Aivu, which crossed the coast near the towns of Ayr and Home Hill in April 1989. Aivu's winds gusted close to 200 km/h and caused over $70 million damage, mainly to sugarcane crops.

Thunderstorms

Severe thunderstorms, which are more common than other natural hazards, usually affect smaller areas than tropical cyclones. They can occur anywhere in Australia but are most significant in northeast New South Wales and southeast Queensland. Although severe thunderstorms can occur at any time of the year, they are rare during the dry winter months in the north, and most strike between September and March because of the high solar energy loads in spring and summer. Severe winter storms linked to cold fronts are common in the southwest of Western Australia and southern Australia.

In mature thunderstorms, falling rain and hail drag the surrounding air downwards. Evaporation from raindrops cools nearby air, accelerating the downward rush. This strong downdraught, often referred to as a 'thunderstorm downburst' or 'micro-burst', spreads out (mainly in the direction of storm movement) when it reaches the ground, producing cool, gusty wind that can cause serious damage. Each year, on average, severe storms (thunderstorms and tornadoes) are responsible for about one quarter of the annual damage attributable to wind events (Blong 2005). Records of storm impact show that the most damaging storms have occurred in the populous southeast quarter of the continent.

Tornadoes

Tornadoes are the rarest and most violent storms. Thought to be formed by interaction between strong updraughts and downdraughts of air in severe thunderstorm clouds, they are rapidly rotating columns of air that descend in the well-known funnel shape (vortex) from the base of the storm cloud. A tornado vortex, which can range in width from a few metres to hundreds of metres, contains very damaging winds that can reach more than 450 km/h. Tornado damage is normally restricted to small areas but is very intense.

On 2 February 1918, the weather in Melbourne was humid and unsettled. A slow-moving low-pressure trough crossed Victoria and late afternoon thunderstorms developed over the city. About 4.50 pm, the so-called 'Brighton cyclone' struck the bayside suburb. The 'cyclone', which was apparently two separate tornadoes, followed about five minutes later by a third, caused significant damage. Wind speeds were estimated at 320 km/h, making this possibly the most intense tornado to hit a major Australian city (BoM 2006b). Many buildings were totally destroyed, and even well-constructed houses were severely damaged. At one location, two tornado tracks crossed, creating (in the language of the day) a 'veritable

Figure 2. Housing damaged by a tornado in Bendigo, Victoria, in May 2003 (Geoscience Australia).

orgy of destruction' (BoM 2006b).

The Bureau of Meteorology's severe storms database records over 360 tornadoes across NSW since 1795, with most occurring in late spring and summer (BoM 2006a). However, many more tornadoes are likely to have twisted, unnoticed, across sparsely populated or unpopulated regions.

Tornadoes occur more often in Australia than most people suspect, but they are neither as prevalent nor as intense as those in 'tornado alley' in the great plains of the central United States. There the relatively flat land allows cold, dry, polar air from Canada to meet warm, moist, tropical air from the Gulf of Mexico, making the plains the world's best breeding ground for storms that produce tornadoes.

Defining the risk

Geoscience Australia's Risk Research Group is collaborating with the Bureau of Meteorology and CSIRO to analyse the historical and geological record of all severe-wind events in Australia, as well as in the numerical modelling of the spatial hazard associated with significant events. This work is undertaken in relation to the Disaster Mitigation Australia Package (DMAP) coordinated by the Department of Transport and Regional Services (DOTARS). Geoscience Australia is funded by DOTARS to facilitate national, systematic and rigorous risk assessments for sudden-impact national hazards as a part of DMAP.

The Bureau of Meteorology has valuable information describing the patterns and regularity of severe winds experienced by Australian capital cities, major country towns and other sites over the past 100 years. However, severe winds from small-scale events such as thunderstorms and tornadoes have not always been captured in the observed record. Additional information in the geological record, properly interpreted, can extend our understanding of wind patterns and regional-scale extreme events back many thousands of years. Using statistical analysis, sophisticated computer models and our understanding of climate change, it will be possible to estimate the likelihood of severe winds occurring in every part of the continent during the 21st century and beyond.

This information will be used by Risk Research Group engineers to estimate the damage such winds are likely to cause to commercial and residential buildings and the impact on critical infrastructure. Consequently, likely patterns of damage and financial losses can be estimated for regions, cities and towns across the nation. These informed estimates can be used by Geoscience Australia economists to assess longer term direct and indirect economic impacts of severe- wind events, and by our social scientists to develop strategies to support communities recovering from them.

This will build preparedness, help to mitigate future impacts, make communities more resilient, and enable swifter disaster recovery:

- Emergency managers will be able to improve response planning by utilising the predicted consequences and assessed likelihoods of scenario events.
- Capability gaps can then be more clearly identified and plans developed to improve the effectiveness of post-event emergency and recovery operations.
- Planners and engineers will be able to identify more accurately factors contributing to the risk of damage to infrastructure and develop strategies to improve resilience through measures such as improved building codes and community awareness.
- Insurance companies will be better able to estimate their portfolio risk and thus develop the most appropriate insurance premium schedules and incentives for property holders in high-risk areas and the broader community.
- Community members will be better informed about their relative level of risk and thus be more likely to take up appropriate insurance cover.

Planning for this research took a significant step forward in December 2005, when engineers and severe-weather meteorologists from Australia and New Zealand gathered in Canberra to review and refine Geoscience Australia's proposed wind risk assessment strategies. Chaired by Dr John Holmes, chairperson of the Australia – New Zealand Structural Wind Loading Standards Committee, this workshop assisted the Risk Research Group to consider methodologies for investigating the temporal and spatial distribution of severe-wind risk within Australia.

The research will allow us to better understand cyclone, thunderstorm, tornado and winter storm hazards, anticipate their impacts and, with appropriate planning, mitigate or reduce their effects.

References

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Related websites
Insurance Disaster Response Organisation: **www.idro.com.au**