Natural Hazards

Dealing to wind hazards in New Zealand

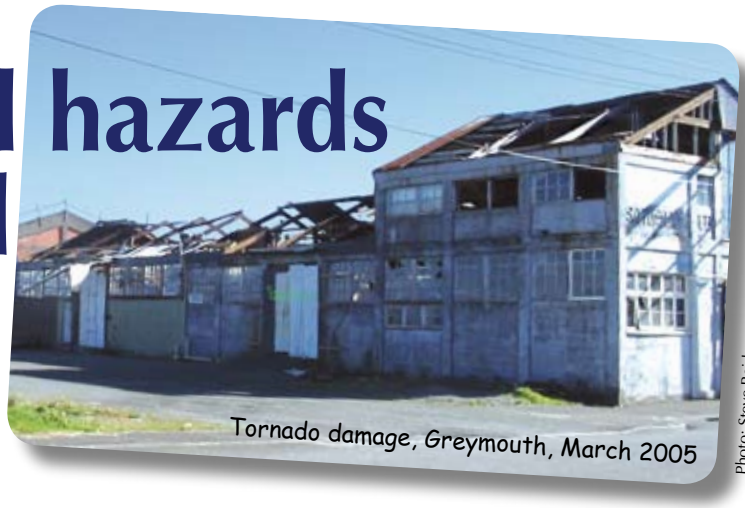


Photo: Steve Reid

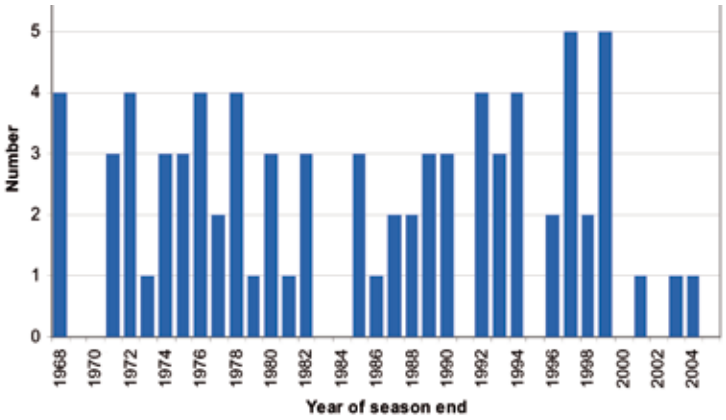
*Our country is buffeted by winds from top to toe. **Stefan Reese** and **Steve Reid** explain the different types of wind hazard and introduce a Regional RiskScape project to help planners and managers.*

New Zealand is exposed to a wide variety of natural hazards. Even though wind is something we experience almost every day, severe winds can cause considerable damage and occasionally result in many casualties. Sometimes wind can totally disrupt life as we know it, closing down airports and roads, knocking out power and telecommunication, and destroying houses.

New Zealand faces the potential for numerous severe wind events each year. And it could get worse in the future because storm intensity is linked to the ocean warming trends associated with global warming. Although New Zealand is also influenced by other long-term climate patterns such as El Niño and La Niña, it is most likely that climate change will cause long-term shifts in frequency and intensity of wind hazards in New Zealand.

Types of wind hazards

As the name implies, **tropical cyclones** originate in the tropics. The same types of storms are called hurricanes in the North Atlantic and eastern Pacific, typhoons in Southeast Asia and China, and tropical cyclones in the southwest Pacific and Indian Ocean region. By the time they reach New Zealand, they usually lose characteristic hurricane features, but they often maintain sufficient vigour to produce damaging winds, high seas, and heavy rain. The worst cyclones tend to occur from December to April. As shown in the graph, the New Zealand region was affected by 78 tropical cyclones between 1968 and 2005, with an average of 2 per year.



Number of tropical cyclones entering the New Zealand region each year.

A mighty wind

- Damaging winds visit New Zealand in various guises, including cyclones, tornadoes, downbursts, and lee waves.
- By analysing wind conditions and resulting damage, scientists and engineers can help improve planning and emergency response.
- A Regional RiskScape project is addressing various natural hazards, including severe winds.

Tornadoes are probably the most intense and destructive wind events; fortunately, they don't last long and affect only a small area. They are often associated with thunderstorms, but can also occur with tropical cyclones. Due to their high wind speeds – which can exceed 400 km/h – the result can be total devastation. The west coast of the South Island and the North Island coast from Taranaki to Northland have been particularly affected by tornadoes in the past. Many other tornadoes in remote rural areas will be unreported; hence, it is difficult to determine an annual number of events. The tornado in Greymouth on 10 March 2005 was classified as an F2 event on the Fujita–Pearson scale because flying timber and roofing-nail missiles were one of the causes of damage; this translates to wind speeds of about 180–250 km/h.

Speed (m/s)	Speed (knots)	Speed (km/h)	Effects
10	19	36	Raises dust and light objects. Whitecaps on water.
20	39	72	People have difficulty keeping balance in open. Small branches break. Spray patches over water.
30	58	108	People unable to walk in open areas. Some damage to poor construction. Continuous spray over water.
40	78	144	Poorly attached roof iron removed. Trees break. People seek shelter.
50	97	180	Heavy objects moved along ground. Many structures damaged.
60	117	216	Whole roofs torn from houses. A lot of flying debris. Some casualties.
70	136	252	Complete disintegration of many houses. Many casualties.

A simplified wind scale derived by combining the Beaufort scale, a wind-tunnel study of effects of strong winds on humans, and observations of damage from tornadoes and in Darwin after Cyclone Tracy.

Downbursts happen when air is swept downwards out of thunderstorm clouds by intense rainfall; they can be as destructive as tornadoes, though the winds never reach the intensity of severe tornadoes. In New Zealand, the highest recorded wind speed from a downburst was 146 km/h at Auckland International Airport on 6 September 1981.

Lee waves, which are created by air passing over a mountain range, can cause extreme wind on the eastern side of the Southern Alps. One stunning example was on 3 October 1981, when the wind reached over 185 km/h at Lauder in Central Otago and at Mt Cook.

Dealing with damage through analysis

Severe winds can disrupt lives and cause property damage, financial loss, and casualties. Scientists and engineers study the devastation to identify why structures fail and to relate the extent of damage to wind speeds. By analysing past events we can understand what went wrong and what needs to be improved.

Builders and engineers, for instance, rely on building codes and so called wind-loading standards when they are designing buildings to withstand severe winds in a particular region. These codes and standards are based on findings of damage analysis. Insurance companies also use this specific knowledge when they work out insurance premiums.

Climate change is another important consideration for building design. If we have to build more wind-resistant houses in the future due to increased storm intensity, we must first know about the causes of damage at higher wind speeds.

Creating a RiskScape

Modelling potential losses from a particular natural hazard is a relatively new field where damage analysis is relevant. These models help planners and hazard managers identify what could happen during different hazard events, the likely extent of damage, and where the damage would be most severe.

In the Regional RiskScape project, NIWA and GNS Science are jointly developing a decision-support tool for land-use and emergency-management planners. The model incorporates data on a range of natural hazards – including severe winds – so that planners can compare the risk posed by each hazard in a consistent way, using outputs such as physical damage, direct and indirect losses (in dollars), civil disruption, and casualties. This analysis can then inform decisions on topics ranging from investment in infrastructure, to land development, and on to emergency preparedness. W&A

Dr Stefan Reese and Dr Steve Reid work in the areas of meteorology and remote sensing at NIWA in Wellington.

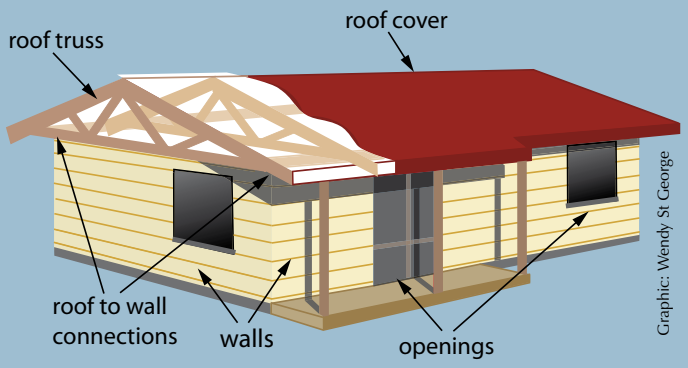
Blown away?

To further refine and improve this important work, we depend on data from real events. We'd like to hear from anyone who has had building damage caused by strong winds.
You can download a damage report form from the Natural Hazards Centre website:
www.naturalhazards.net.nz/report_hazard_damage

Determining damage from wind

We can estimate the damage to an individual building based on the building characteristics (such as type, age, roof material, and wall material) by looking at two key aspects.

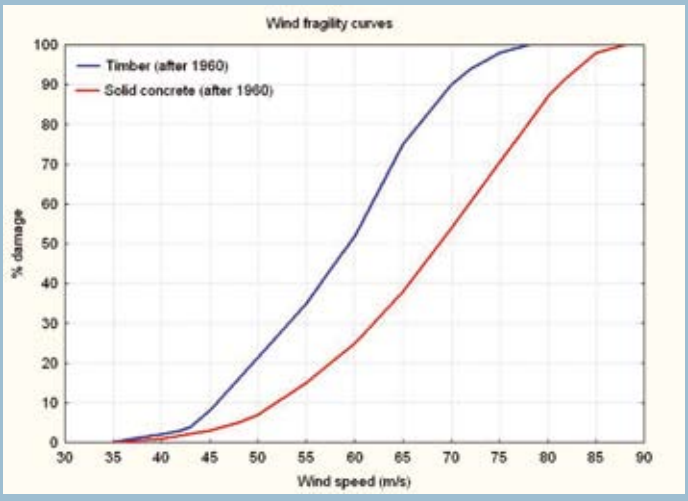
1. Some damages tend to occur most frequently. These are loss of roof, failure of roof truss to wall connection, failure of wall, and loss of glass panels in windows and doors.



2. Almost more important is the correlation between wind speed and the extent of damage. This allows us to develop so-called fragility curves which use this correlation to indicate the percentage of damage for a certain wind speed. This damage ratio refers to the reconstruction costs of the individual building.

   Fragility curves are developed for different types of house, different wall materials, roof types, etc., because the overall damage is dependent on the characteristics of the building. For example, a timber-framed house with a weatherboard wall cladding is more vulnerable to wind than a house made of concrete of the same age class.

   The damages indicated are averages and often a band with an upper and lower limit is used instead. This is because there are numerous parameters which can influence the extent of damage, such as the condition of the house. If a house is not well maintained, the likelihood is quite high that the damage will be above the average.



These wind fragility curves for timber and concrete houses show the ability of different types of construction to withstand increasing winds. (The graph is only an example and not based on actual data.)