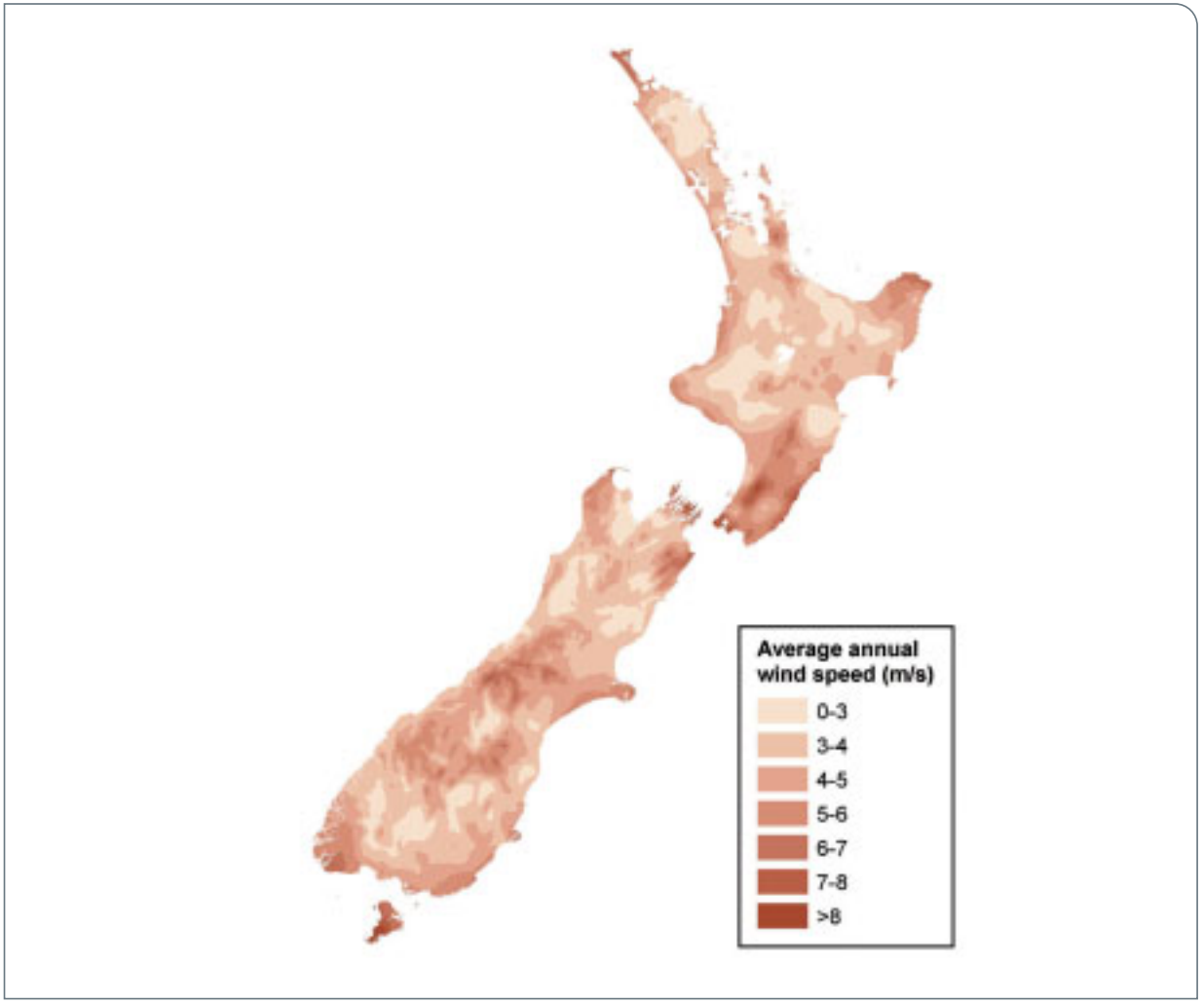
SEVERE WINDS

New Zealand lies in the path of the strong mid-latitude westerly winds, known as the 'roaring forties', and frequently experiences strong winds that can be extremely damaging.

New Zealand's predominant winds are from the west quarter – between northwest and southwest. When stable westerly airstreams hit the mountains they are forced up, over, and down into the lee of the ranges, creating strong eddies and downstream winds in areas such as Canterbury, Wairarapa, and southern Hawke's Bay. Winds are also funnelled through gaps in the ranges, such as the Manawatu Gorge, Cook Strait, Waitaki Valley and Foveaux Strait, making the surrounding areas particularly windy. Westerly winds are strongest in spring when the temperature difference between the equator and the South Pole is greatest.

The north and east of the North Island can also be affected by strong winds from the remnants of tropical cyclones moving down from the tropics during the summer. Localised wind gusts and tornadoes are often experienced with thunderstorms, most commonly in the west and north of the country.



Average annual wind speed in New Zealand. The values are for 10m above the ground surface and do not take into account small-scale topographic effects. *National Institute of Water and Atmospheric Research*.

Downslope wind storms

Wave motions are generated in the atmosphere in the lee of mountain ranges, which can cause strong downslope winds. The nature of these wave disturbances depends on the strength of the airflow over the mountains, how stable the atmosphere is, and topography.

Downslope wind storms occur in Canterbury in the lee of the Southern Alps, and in Wairarapa in the lee of the Tararua Range in strong northwesterlies. They have also occurred in Te Aroha in the lee of the Kaimai Range during strong easterlies.

Downslope wind storms can be relatively localised and do not generally bring rain, because most of the rain falls on the windward side of the mountains. Strong winds blew down power lines in Canterbury in October 1988, even though no high wind speeds were recorded at any monitoring stations. The behaviour of wind in the lee of mountains – the strength, duration and location of wave activity – remains difficult to forecast, although developments have been made recently in refining wind models.

1975 CANTERBURY WIND STORM

The Canterbury wind storm of 1 August 1975 was generated by a front moving over New Zealand between 31 July and 1 August with a strong northwesterly flow ahead of it. The situation was worsened by a stationary high-pressure system to the north of the country.

The storm affected areas from Southland to Wairarapa but was most intense in Canterbury. Lee waves formed to the east of the Southern Alps, producing bands of strong gusty winds along the Canterbury Plains. The period of highest winds only lasted one to two hours but caused severe damage. Northwesterly winds in Timaru reached 130km/h (70 knots) gusting to 165km/h. At the peak of the storm winds in Christchurch reached 130km/h (70 knots) gusting to 190km/h.

The strongest gust of 195km/h was recorded in Kaikoura. Roofs were blown off many buildings, aircraft were damaged, and garages and sheds were destroyed. Many electrical fires were ignited by falling power lines. Many trees were blown down or uprooted – Temuka lost 300 trees, some 80–100 years old, from its domain.

Eleven thousand hectares of plantation forest were damaged. Most of the pine plantations beside State Highway 1 north of Rakaia were flattened and there was widespread damage in the Eyrewell, Ashley, Balmoral, and Hanmer forests in North Canterbury.

Glasshouses damaged in the 1975 Canterbury wind storm. The return period of the storm was estimated at more than 100 years and insured damage was around $55 million (2006 value). *The Christchurch Press*.

Tornadoes

In certain circumstances, rotation inside a thunderstorm produces a tornado – a narrow, tightly spinning funnel of air which extends below the cloud. Wind speeds within a tornado can be up to 300km/h, but tornadoes in New Zealand are mostly small and short-lived, unlike the very destructive tornadoes of the United States.

Around 20–30 tornadoes are observed in New Zealand each year, most lasting less than 15 minutes. They are most frequent in the west and north of the country, particularly the Waikato, Bay of Plenty, and Westland. Damage paths are 10–20m wide and usually less than 5km long.

New Zealand's worst tornado killed three people in Hamilton in 1948. More recently, two Taranaki people were killed in August 2004 when their house was destroyed by a tornado, and a tornado swept through Greymouth in March 2005 causing $9.6 million worth of damage (2006 value).

The passage of squall lines associated with thunderstorms can also produce the sudden onset of very strong wind gusts followed by a gradual decrease in intensity over several minutes. Squall lines have been responsible for some of the highest wind gusts recorded – up to 145km/h – in northern New Zealand. Squalls can also be experienced within tropical cyclones and more commonly with southerly changes along the east coast of the country. Downbursts (plummeting downdraughts of cold, heavy air out of thunderstorms) pose a major risk to aviation.

1948 FRANKTON TORNADO

New Zealand's worst tornado struck Frankton and other parts of Hamilton on 25 August 1948. The tornado, which was accompanied by heavy rain, originated in the northwest of Frankton and swept through the village before travelling through Hamilton West and over the Waikato River into Hamilton East.

The tornado demolished most commercial buildings along the main street of Frankton and damaged 163 houses. It uprooted trees and threw corrugated iron, timber, and other debris into the air. It killed three people and badly injured seven. Damage was estimated at $60 million (2006 value).

Damage to houses from the 1948 Frankton tornado. The tornado was New Zealand's deadliest, killing three people. *Hamilton City Library.*

Ex-tropical cyclones

Ex-tropical cyclones and depressions of subtropical origin are the most common source of widespread high wind in the northern half of the North Island, especially Northland, Auckland and the Bay of Plenty, and they are often accompanied by heavy rain causing flooding. New Zealand's most memorable storms have been ex-tropical cyclones – the 1936 storm, the Wahine Storm in 1968, Cyclone Bernie in 1982, Cyclone Bola in 1988 and Cyclones Drena and Fergus in the summer of 1996/97.

Between November and April tropical cyclones, containing belts of sustained strong winds rotating around an area of low pressure, form in the tropics to the north of New Zealand, at around 10 to 20 south. The heaviest rain and highest winds of a tropical cyclone, sometimes more than 200km/h, are mostly confined to a belt 10–20km wide around the centre or 'eye' of the storm.

Tropical cyclones are fuelled by warm water and either weaken or change their structure as they travel over increasingly cool seas away from the tropics. Sometimes, as ex-tropical cyclones head south toward New Zealand, they can evolve into large, damaging mid-latitude storms with the infusion of colder air. However, they retain the circulation pattern and the large amounts of moist air of the former tropical cyclone. Of the 10 or so tropical cyclones that form on average each year in the tropical southwest Pacific, only one or two are likely to affect New Zealand as ex-tropical cyclones.

The frequency of tropical cyclones is unlikely to increase with climate change. However, the rise in average sea surface and air temperatures will provide tropical cyclones with more energy, so ex-tropical cyclones affecting New Zealand are likely to be more intense in future.

1936 STORM

The 1936 storm has been described as the North Island's worst storm of the twentieth century. It caused widespread wind and rain damage from Northland to Marlborough. The storm initially formed in late January as a tropical cyclone near the Solomon Islands. As it moved south it joined a cold front over the north Tasman Sea and redeveloped into an intense mid-latitude storm.

The storm crossed the North Island on 2 February causing most rivers to flood resulting in widespread damage. Winds generated by the storm destroyed buildings from the Bay of Plenty to Taranaki and Manawatu, blew fruit off trees, and flattened crops.

The Manawatu was particularly hard-hit. Many houses lost roofs and the grandstands of the A&P Association, the Awapuni Racecourse, and the sports ground were demolished. A man was killed when he was blown off his roof while repairing it. The Longburn Anglican church was scattered over the adjacent road and railway line. The Feilding Aero Club hangar and two planes were destroyed. Trees were uprooted from ridges in the Tararua Range and thrown into valleys.

More than 40 boats were blown from their moorings in the Waitemata and Manukau Harbours in Auckland, and the ferry *Rangatira* hit rocks at the mouth of Wellington Harbour with 800 people on board. In today's dollars, this storm is estimated to have cost New Zealand $800 million.

The A&P showground grandstand in Palmerston North, demolished in the 1936 storm. The storm was possibly New Zealand's worst storm of the twentieth century. *Palmerston North City Library.*

Severe wind impacts

Widespread strong winds can be produced by different large-scale weather systems over New Zealand. However, wind speed experienced at a particular site on the ground is highly dependent on local topography. Wind accelerates over ridges, hilltops and coastal escarpments – the steeper and nearer the top of the slope, the greater the wind speed. Factors such as whether the site is surrounded by substantial buildings or trees, and whether the site is urban or rural, also influence wind speed but to a lesser degree.

The most common effects of high winds are damage to buildings, particularly roofs, and infrastructure such as power lines. Driving can be difficult and Cook Strait ferry crossings are sometimes cancelled due to high winds and associated swells in the strait.

Exotic plantation forests are particularly susceptible to wind damage during downstream wind storms and tropical cyclones, especially where trees are of an even age. Windthrow is one of the most significant risks to forestry investments, and there is evidence that wind can affect wood quality. Also, dead wood debris left after wind damage to forests increases the wildfire risk.

Managing severe winds

Risk reduction

The design and construction of buildings and infrastructure has a large influence on their resilience to severe winds. New Zealand's Building Code has provisions that ensure wind loading is taken into account during design and construction. Wind zones, which consider local topography, site exposure, ground roughness, and wind region, dictate a structure's bracing requirements.

While severe wind is generally not addressed in district plans, several urban territorial authorities have provisions that aim to avoid or mitigate local effects such as wind tunnelling in high-rise streets.

Probabilistic wind analyses have been undertaken as part of local or regional engineering lifeline projects. This information enables lifeline utilities to design and site infrastructure to minimise the risk of severe wind damage.

The risk of wind damage to forestry can be reduced by selecting low-wind condition sites for planting and employing particular planting, pruning and felling regimes.

Readiness

The MetService issues a severe weather warning when widespread (over a 1000km^2 area) gales with a minimum wind speed of 90km/h, or frequent gusts exceeding 110km/h, are expected within 24 hours. A severe-weather watch is generated if these conditions are expected to occur 24–72 hours ahead.

Response and recovery

A widespread severe-wind event can cause significant damage in several regions. However, most wind events are able to be managed at a local level, or are often part of a larger flood event response. Tornadoes are localised events and, unless they impact on a critical area, infrastructure, or building, are unlikely to require a regional or national response.

MAF's On-Farm Readiness and Recovery Plan for Adverse Climatic Events and Natural Disasters sets out individual and community responsibility to adverse events that affect farm businesses and outlines available recovery measures for different scale events.

Any CDEM response to severe winds follows generic response and recovery procedures set out in CDEM Group plans, the National CDEM Plan and the Guide to the National CDEM Plan.

FURTHER INFORMATION

GENERAL WIND INFORMATION

TE ARA ENCYCLOPAEDIA OF NEW ZEALAND
www.teara.govt.nz/EarthSeaAndSky/ClimateAndAtmosphere/Weather/en
MINISTRY OF CIVIL DEFENCE & EMERGENCY MANAGEMENT
www.civildefence.govt.nz/MEMWebsite.nsf/Files/tephra97/$file/tephra97.pdf
www.civildefence.govt.nz/memwebsite.NSF/Files/TephraVol20%20complete/$file/TephraVol20%
METSERVICE LEARNING CENTRE
www.metservice.co.nz/default/index.php?alias=learningcentre

METSERVICE WARNINGS

METSERVICE
www.metservice.co.nz/default/index.php?alias=weatherwarningcriteria

WIND DAMAGE TO FORESTRY

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