Australia and New Zealand

Expect the unexpected

Scientific facts and economic impacts of natural disasters

Munich RE

Are you prepared?

The magnitude and frequency of hazards are rising while metropolitan areas and their value concentrations are also growing. Will your business withstand the ever-increasing perils?

Rely on the financial strength of Munich Re and our expertise as a strong partner to safely withstand large nat cat events – even the unexpected ones.

Australia and New Zealand have been hit hard by natural catastrophes in recent years: floods, cyclones, hailstorms, bushfires and earthquakes. The consequences of these severe nat cat events are among the worst in the world, and the risks associated with them are changing fast.

Contents

"We are committed to the Australian and New Zealand markets"

Heinrich Eder, Managing Director, and Scott Hawkins, General Manager Non-Life, of Munich Re in Australasia, comment on the current situation, trends and developments on the (re)insurance markets in Australia and New Zealand.

Scott Hawkins

Mr. Hawkins, Mr. Eder, how would you sum up the natural catastrophe situation in Australia and New Zealand at present?

Scott Hawkins: Over the past ten years, we have observed an increased frequency of medium and large natural catastrophe events. This has impacted many regions of Australia and New Zealand and has included various perils: earthquakes, cyclones, floods, bushfires and hailstorms.

Heinrich Eder: As much as these perils – unfortunately – seem to be part of life, events in recent years have demonstrated that insurers need to focus more on the "unexpected". All we know is that perils might now hit us more often, harder or in unexpected places. Insurers need to be financially prepared for such unforeseen large natural disasters. With this publication, we want to highlight such scenarios and help our clients through financially stormy days and rough waters to come.

What developments do you see?

Hawkins: El Niño and La Niña periods will pose many challenges in the natural catastrophe environment. We may witness more powerful cyclones, increased drought and more bushfires. But regardless of climate variability, constant vigilance is required when assessing your exposure, in order to be more resilient to large natural catastrophes.

How does Munich Re help clients and the public to be more resilient to natural disasters?

Eder: We are very committed to the Australian and New Zealand markets. We have operated here for the last sixty years, offer valuable local and global experience and financial strength, and have built up unique expertise on all kinds of natural hazards. But there is more to it than that: we are always in close contact with our clients, pay claims swiftly and offer reliable support in difficult times. We stand behind our clients all the way, and this is something they can always expect from us.

Heinrich Eder

Hawkins: Of course, we also demonstrate our strong commitment in terms of the capacity that we deploy in the market. Our local presence and empowerment enable us to bring the Munich Re (Group) balance sheet to our clients in the region.

What does Munich Re contribute to higher resilience?

Eder: When it comes to local engagement, we certainly walk the talk. We are highly driven to helping boost resilience to natural catastrophe events. As a founding member of the Australian Business Roundtable, we actively support the development of a more sustainable, coordinated national approach to making our communities stronger and Australians safer – so that we are able to overcome the expected and even the unexpected.

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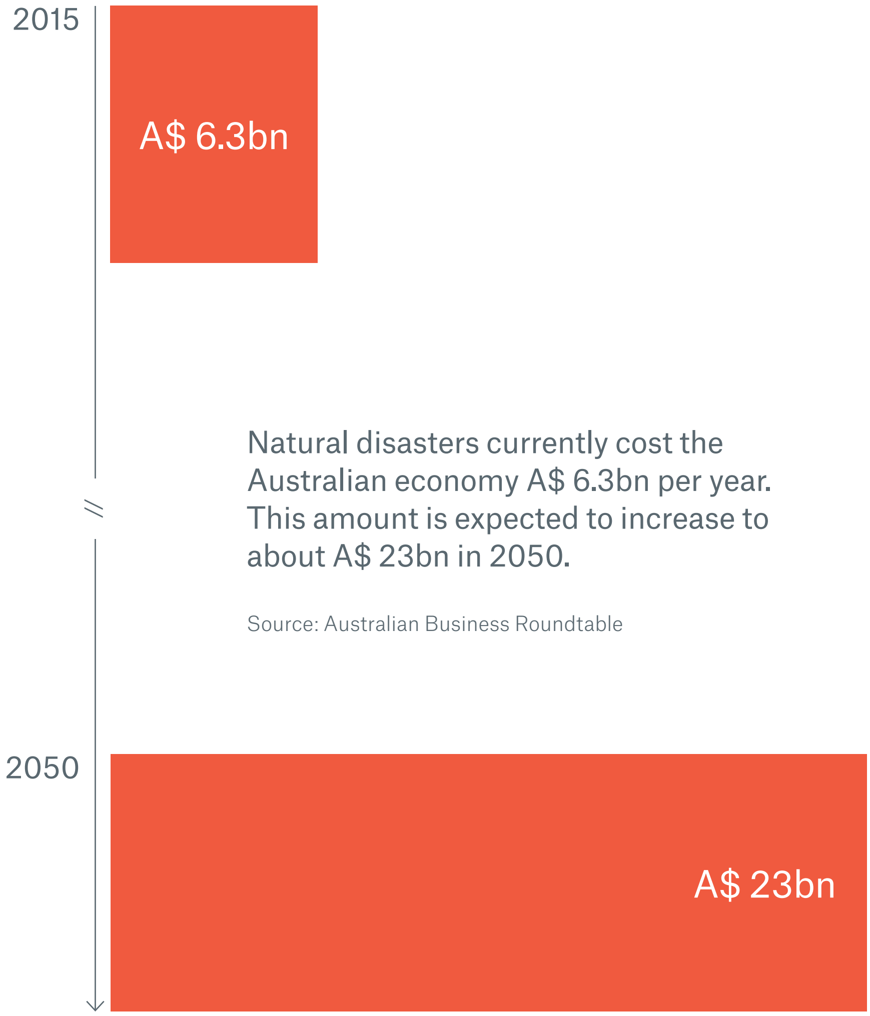
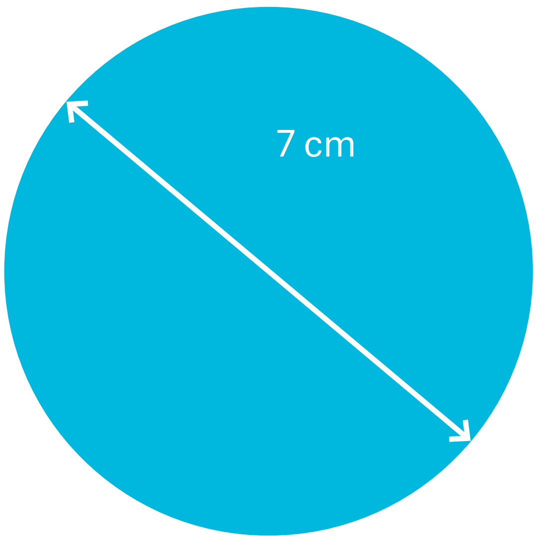
Facts and figures



Natural disasters currently cost the Australian economy A$ 6.3bn per year. This amount is expected to increase to about A$ 23bn in 2050.

Source: Australian Business Roundtable

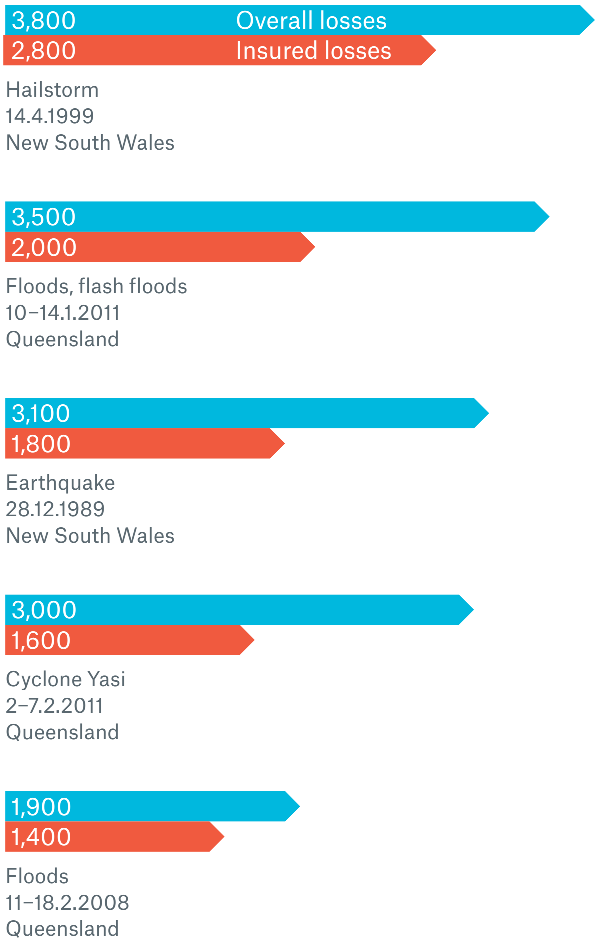
80% of the insured people affected by the Black Saturday Victorian Fires in 2009 were underinsured.



The Sydney hailstorm of 1999 produced hailstones the size of cricket balls.

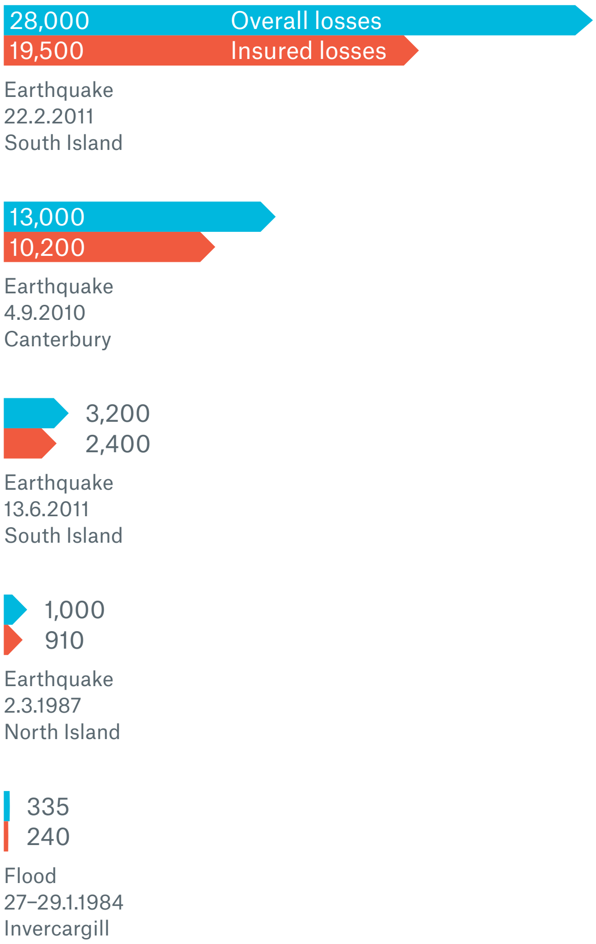
Losses (CPI-adjusted in A$ m)

The 5 most significant loss events in Australia 1980–2015



Losses (CPI-adjusted in A$ m)

The 5 most significant loss events in New Zealand 1980–2015



Source: Munich Re NatCatSERVICE

Raising the Warragamba Dam wall by 23 metres would reduce annualised average flood costs by around three quarters.

Source: Australian Business Roundtable

Expect a Big One

Alexander Allmann
Munich Re expert on earthquakes

Earthquakes in Australia are infrequent and mostly moderate in size. At first glance, this appears to be a much more comfortable situation than in New Zealand, Japan or the United States. However, on closer examination the picture looks different: earthquakes in Australia could cause insured losses in the same order of magnitude as in the highest-exposed regions worldwide.

#Earthquakes in Australia? It could happen close to every major city: low probability, high consequences #seismic activity, #lessons learned, #Christchurch

Australia is not known as an earthquake hotspot – but neither was Christchurch in New Zealand. As it turned out, in Christchurch in 2010/2011 an unexpected series of severe earthquakes with a magnitude of up to 7.1 surprised even the experts and destroyed large parts of the city – it was one of the most expensive insured natural catastrophes in history. Since Australia is not located at the margins of tectonic plates, where 90% of the world's seismicity occurs, many Australians are not aware that this is a peril we need to worry about – but maybe we should.

The Australian continent experiences small earthquakes all the time because the Indo-Australian tectonic plate is being pushed north and thus collides with other plates. This leads to a build-up of mainly compressive stresses that are released in shallow earthquakes. Although earthquakes can occur anywhere in Australia, this seismicity is spatially heterogeneous; some regions have significantly increased seismic activity. Statistical analyses on recorded earthquakes show that events with a magnitude similar to or higher than that in Newcastle in 1989 (magnitude 5.6) can be expected every two years, with a magnitude of 6.0 or more every five years on average. Fortunately, most of them happen in unpopulated or sparsely populated regions.

Our models show that regions of elevated seismicity are in close proximity to most of the major conurbations (Perth, Adelaide, Melbourne and Sydney). For each individual area, the seismicity is too low for a robust statistical analysis of the probability of a severe event right underneath a city or the maximum size of such an event. What we do know is that each of the cities has the potential to be hit by earthquakes bigger than a magnitude of 6. Earthquakes like those in Christchurch should not come as a surprise and are very realistic scenarios.

Many buildings will not survive strong ground motions

A few small to moderate earthquake events have provided data that have helped us to constrain our modelling of the potential ground motions that can be expected in Australia. Overall, the data set is still very limited and there are barely any data for bigger events. The uncertainty associated with these ground motion estimates is high. Fortunately, the soil conditions in cities like Sydney are much better than in Christchurch. Although ground motion amplification is expected in some regions that have soft soils, no widespread liquefaction is expected.

Given the moderate earthquake hazard in Australia, buildings are not constructed to resist very strong ground motions. The moderate Newcastle event in 1989 provided a good illustration of the very poor behaviour of structures such as unreinforced masonry buildings. Should a severe earthquake occur underneath one of the major cities, the ground motions will significantly exceed the design ground motion in the building codes. This will inevitably lead to very high loss levels close to the earthquake epicentre. In Christchurch, the design ground motion was exceeded by more than a factor of three. The Central Business District (CBD) had to be cordoned off for years, and many buildings suffered a total loss.

Exposures will be factors higher than in Christchurch

What if the unexpected were to happen? It will happen. We know an earthquake will hit one of the cities. The only questions that remain are: when and how severe? So far, we have not experienced a major earthquake catastrophe in Australia. This is consistent with our expectation of a low to moderate seismicity. For return periods of several hundred years, this is different. Loss estimates are very high, with considerable uncertainties. They increase sharply for higher return periods. This makes risk management difficult for the insurance industry.

In Japan, insurance cover is strictly limited and extreme events are expected, so that potential losses are not likely to be significantly underestimated. In Australia, a really unpleasant wake-up call from an extreme event is much more likely. This is because earthquake insurance penetration in Australia is generally very high (above 80%), and risks are covered on a full-value basis with very small deductibles. Most of the exposure in Australia is concentrated in the big cities. The value concentration is enormous. If an earthquake strikes one of the cities, the exposure affected by high ground motions will be factors higher than in Christchurch – and the major part of any earthquake loss will be borne by the insurance industry.

Challenges for claims handling

While the local insurance industry has experience with handling mass claims due to cyclones, hailstorms and floods, the earthquake engineering community is not very strong. So the handling of earthquake losses would also be a great challenge for insurers – despite the steep learning curve insurers experienced while dealing with the Christchurch earthquakes.

The experience from Christchurch demonstrates that claims handling and reconstruction would be a complex and long-lasting process. Such unexpected complexities arise after nearly every major natural catastrophe event worldwide. Many of the challenges following the Christchurch events were associated with the structure of the market – the Earthquake Commission (EQC) in particular. In addition, legal aspects slowed down claims handling.

Prepared for a Big One with Munich Re

Australia's largest earthquake, with a magnitude of 7.2, occurred in 1941 in Western Australia – far away from any of the bigger cities. The earthquakes in Christchurch have shown us that even moderate earthquakes can cause huge losses for the insurance industry. Such an earthquake – but with significantly higher losses – is a very realistic scenario for Australia.

The vulnerable, highly concentrated building stock has the potential for extreme losses. A repetition of the 1954 Adelaide earthquake (magnitude 5.7) would result today in multi-billion insured losses. A bigger event closer to Adelaide could cause a loss costing tens of billions.

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Historic earthquakes in Australia

5.4 Magnitude
2012
Victoria – Moe

5.3 Magnitude
2011
Queensland – Bowen

5.6 Magnitude
1989
New South Wales – Newcastle

6.3–6.7 Magnitude
1988
Northern Territory – Tennant Creek

6.2 Magnitude
1979
Western Australia – Cadoux

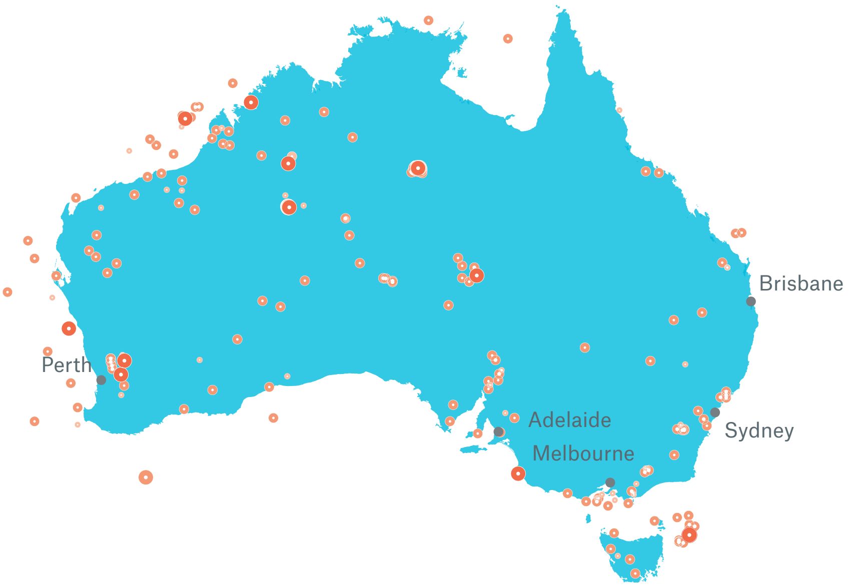
6.9 Magnitude
1968
Western Australia – Meckering

5.4 Magnitude
1954
South Australia – Adelaide

7.2 Magnitude
1941
Western Australia – Meeberrie

Maps of earthquake epicentres in Australia and New Zealand

Australia

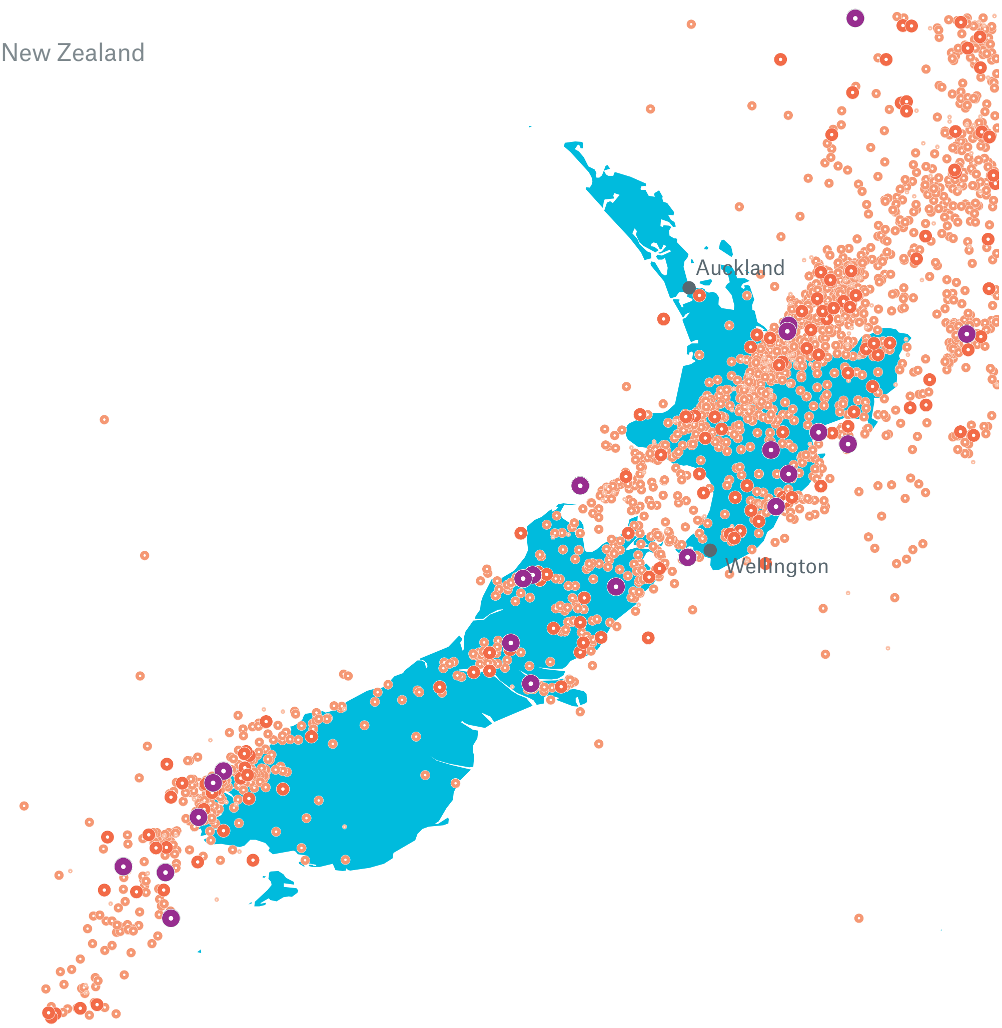


Earthquake epicentres since 1840

Source: Munich Re

Magnitude
- 5.0
- 5.1 – 6.0
- 6.1 – 7.0
- > 7.0

New Zealand



Earthquake epicentres since 1840

Source: Munich Re

Magnitude
- 5.0
- 5.1 – 6.0
- 6.1 – 7.0
- > 7.0

When a city fights back – New Zealand earthquake sequence 2010–2011

New Zealanders showed resilience in the aftermath of the quake that rocked Christchurch in the autumn of 2010. Despite aftershocks, the prevailing attitude was positive and people were eager to pick up the pieces and get on with their lives.

Yet a far more devastating earthquake with 185 deaths in early 2011 challenged the community's spirit. Four years after this complex and unanticipated series of events, reconstruction efforts and insurance settlement processes are still under way.

Container village in the CBD: Christchurch has made a virtue of necessity.

Stand by your country – together for a resilient Australia

Jim Parkes, Client Manager

Recognising that governments acting alone cannot address the challenge of natural disaster management, the Australian Business Roundtable aims to support the development of a more sustainable, coordinated national approach to making communities more resilient and the Australian people safer. Munich Re is among the founding members.

The Australian Business Roundtable for Disaster Resilience & Safer Communities was formed in December 2012 by the Chief Executive Officers of the Australian Red Cross, Insurance Australia Group, Investa Property Group, Munich Re, Optus and Westpac Group. The CEOs created the Roundtable because they all consider having resilient communities that can adapt to extreme weather events to be of national importance. This is the first time such a broad spectrum of organisations has come together to champion this issue.

New approaches to mitigation and pre-disaster investment urgently needed

This remarkable coalition is helping shape Australia's future by releasing evidence-based reports to government, industry and the media that highlight the unsustainable cost of natural disasters to life, property and the economy, and outline a new approach to pre-disaster investments in Australia.

By pursuing key recommendations put forward in the Roundtable's commissioned papers, economic costs can be materially reduced to take long-term pressure off government budgets. More importantly, a safer Australia can be created by building resilience against the trauma and loss of life that all too frequently confront many of our communities when a natural disaster strikes.

Costs of natural disasters on the economy will skyrocket in the next few years

The Roundtable's first 2013 White Paper "Building our Nation's Resilience to Natural Disasters" estimated that natural disasters cost the Australian economy A$ 6.3bn per year, and forecast costs to rise to A$ 23bn annually by 2050. The research also demonstrated that carefully targeted resilience investments of A$ 250m per annum have the potential to generate budget savings of A$ 12.2bn for all levels of government and would reduce natural disaster costs by more than 50% by 2050.

The second report released in 2014 – "Building an Open Platform for Natural Disaster Research Decisions" – examined the criticality of natural disaster data for mitigation investments and demonstrated that by providing improved access to accurate relevant data and research, additional savings of A$ 2.4bn could be generated.

Tremendous savings through mitigation investments

In total, the two reports highlight potential savings to the Australian economy of up to A$ 14.6bn by 2050 through regular well-planned mitigation investments. This series of reports will be continued with further papers, for example covering the issues of building resilient infrastructure and compiling social resilience guidelines.

The work of the Australian Business Roundtable earns international recognition

Based on its work since 2012, the Australian Business Roundtable was awarded the Australian Government's 2013 National Resilient Australia Award, as well as the Certificate of Distinction at the prestigious 2015 United Nations Sasakawa Award for Disaster Risk Reduction. The Australian Business Roundtable is the first private sector organisation to win in the 30-year history of these awards.

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Climate change on the rocks – did you know …

Peter Höppe
Head of Geo Risks Research/Corporate Climate Centre

… that the sea level in Sydney will rise more than on the coast of Iceland?

Global warming is causing the sea level to rise – even as a result of thermal expansion of the water. However, the extent of the rise varies in different ocean regions and at the coasts, as a result of the ocean currents, vertical land movements, and other factors. The sea level around Iceland will only rise about half as much as in Sydney!

… that the melting of the ice in the Arctic Ocean will not cause the sea level to rise at all?

The reason: ice masses floating in water are in a state of equilibrium with the surrounding fluid, technically termed buoyant stability. The effect of this can be observed when having a drink "on the rocks". When the ice cubes melt, the level of the fluid in the glass does not change – unless you take a sip of course.

… that the number of tropical cyclones could reduce considerably?

Current climate models show that the number of cyclones occurring in the northeast of Australia could fall by 15% to 35% due to climate change. The reduction will be in storms of moderate to medium intensity. The number of very intense storms, on the other hand, will increase and, along with it, the risk for insurers.

… that the frequency of extreme droughts in Australia could increase by one and a half times by the end of the 21st century?

This result of current climate models, referring to events in which precipitation is two standard deviations below the average, will present major challenges to the agricultural sector and water supplies.

… that the number of days a year in Adelaide with daily top temperatures of 35°C or more may increase from the current 20 to as much as 47 by the end of this century?

Current climate models project increases in other cities, such as Cairns from 3 to 48 days, or Perth from 28 to 63.

… that the number of days of extreme bushfire danger in southern and eastern Australia could almost triple by the end of the century?

Climate models driven by the most extreme scenario recognised in the IPCC report have produced this prognosis. The scenario assumes the continuation of the current path of emission levels.

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Turbulence on the Gold Coast

Doris Anwender
Munich Re expert on cyclones

Severe cyclones rarely reach the east coast of southern Queensland – the last time was in the 1970s. However, current climate change predictions and increasing concentrations of values are making risk researchers sit up and take notice, because should a storm event occur, the consequences could be devastating.

As the probability of #cyclones hitting Brisbane increases, insurers need to prepare for #major losses and emergency plans #cost explosion, #climate change.

The east coast of Queensland, where the state capital of Brisbane is situated, has grown dramatically over the last 50 years. The population has soared and led to massive urban expansion. Fuelled by the rising worldwide demand for raw materials, southeast Queensland has seen strong economic development and is currently Australia's fastest-growing region. The Australian Bureau of Statistics expects the population in and around Brisbane to grow by 34–57% over the next 20 years.

Tourism in the region is also booming. Gold Coast, for instance, with over 500,000 residents, has become Queensland's second-largest "city" or urban region. It also has the second-fastest growing population, again after Brisbane. Thanks to two major airports in Brisbane and Coolangata, this holiday paradise can be reached quickly and conveniently. The Pacific Highway, completed in 2000, additionally connects the tourist hub to Brisbane.

Climate change will bring severe cyclones closer to Brisbane

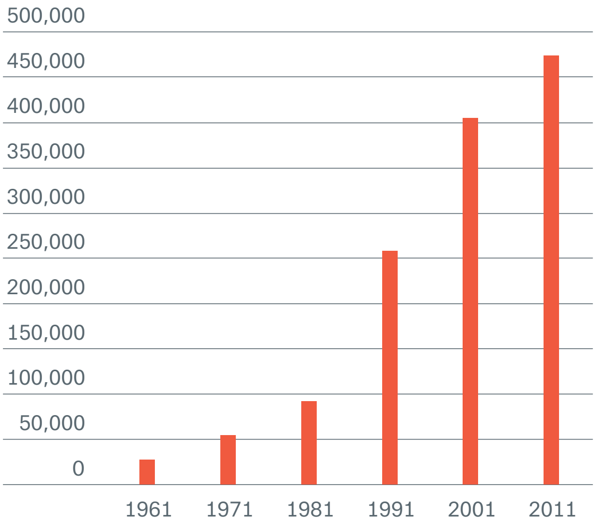
Greater Brisbane is constantly exposed to the risk of tropical storms and their outer bands. With its high concentration of values, this makes Greater Brisbane one of the regions with the highest loss potential. Though most major storm events have so far been confined to the northern part of Queensland, Brisbane has still had several uncomfortably close brushes with strong cyclones. Furthermore, as climate change takes hold, the Queensland region is expected to see an increase in long-lived cyclones, which will increasingly shift southwards. According to current climate research, the number of storm events is likely to decrease, but their severity increase. Based on these indicators, the possibility of a major event in and around Brisbane does indeed exist.

Brisbane 1960

Brisbane 2011

Brisbane today has a population of over 2 million. In 1960 it was 700,000.

Population growth Gold Coast 1961–2011



Source: Queensland Government Statistician's Office, Australian Bureau of Statistics

Major losses in the 1970s

In recent decades, very few cyclones have made landfall in Greater Brisbane. Nevertheless, there is an ever-present possibility of a powerful storm event. For example, the region experienced several very heavy storms in the 1970s. In 1972, Cyclone Daisy resulted in an insured loss of A$ 116m in the Brisbane and Gold Coast region. In 1974, Cyclone Wanda caused insured losses amounting to A$ 2.6bn. Zoe followed soon after with an insured loss of A$ 171m (all figures indexed to 2011, ICA).

Such events are rare because of strong westerly winds along the latitudes of Brisbane, which break down the vertical structure of a cyclone. However, the precondition for the development of a tropical cyclone, namely a high temperature of over 26°C in the ocean's surface layer to a depth of at least 50 m, also exists south of Brisbane in summer. This situation can not only promote the

Loss potential for Brisbane and Gold Coast

Due to the steady increase in values along the Queensland coast, the sums insured, and thus also the loss potentials in this region, have increased greatly in recent decades. The following percentage values can serve as a basis for loss estimates. Even in regions like Brisbane, where tropical cyclones are a rarity, losses amounting to 5% of the total sum insured are possible.

The figures are not based on modelled results.

	Brisbane	Gold Coast
Total sum insured (TSI)	A$ 400–425bn	A$ 150–180bn
Loss potential on median TSI	A$ 412bn	A$ 165bn
1%	A$ 4.1bn	A$ 1.7bn
2%	A$ 8.2bn	A$ 3.4bn
3%	A$ 12.4bn	A$ 5.0bn
4%	A$ 16.5bn	A$ 6.6bn
5%	A$ 20.6bn	A$ 8.3bn

Source: Munich Re, status 2013

Australian cyclone scale

Category	Wind speed
1	90–124 km/h
2	125–164 km/h
3	165–224 km/h
4	225–279 km/h
5	≥ 280 km/h

Source: Bureau of Meteorology, Australia

development of a cyclone, but also help to sustain an approaching one. In other words, local winds at higher altitudes need only be weak, for example due to a southward shift in the west wind zone, for a severe cyclone to develop and make landfall in the region around Brisbane.

Loss potential rising in the region

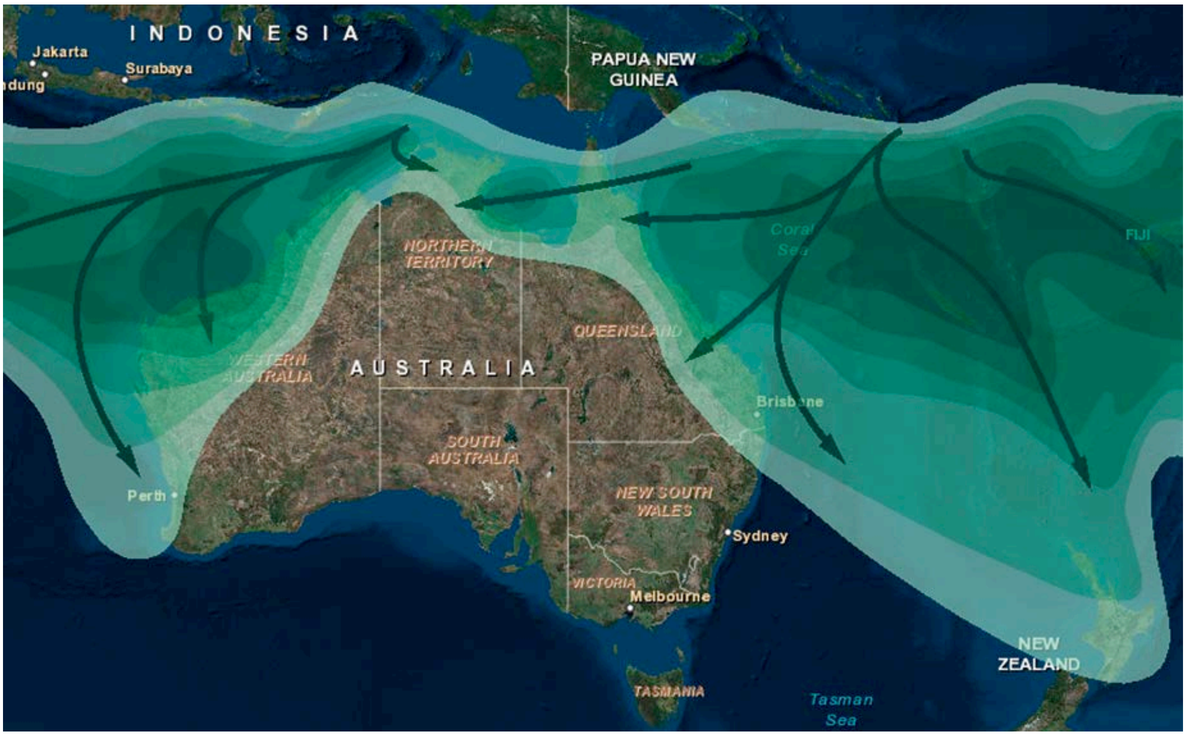
Munich Re calculated the loss potential existing in Greater Brisbane in a Best Practices Study in 2013: based on a stochastic set of cyclones, the 1,000-year insured loss that would be expected to occur in Brisbane in the event of a category 4 cyclone was calculated to be a lower two-digit billion A$ amount.

The region has experienced many near misses, as in 1967, for example, when category 3 Cyclone Dinah veered away just off the coast. If a storm of this magnitude were to pass over the region today and not turn back, we would have a scenario with high wind speeds, flooding and a storm surge of catastrophic proportions.

Large-loss amplification – Cost explosion after a storm

Events like Hurricane Katrina have shown us that the loss directly associated with a strong storm can rise significantly due to secondary factors. This is referred to as post-loss or large-loss amplification. The central factor in this case is the failure of the infrastructure.

Tropical cyclones in Australia



Area affected by tropical cyclones in Australia and New Zealand.

Source: NATHAN Risk Suite

Gold Coast's geographical features make it extremely vulnerable to storms and flooding. The region's flat surface allows storms to sweep overland at full force. Meanwhile, the lagoon landscape brings an increased chance of flooding which extends far inland.

Many businesses and supermarkets are located in the basements or semi-basements of high-rises and would no longer be accessible in the event of a major catastrophe.

Destroyed transportation network

In moderate catastrophes, the transportation network is usually restored in just a few days. After more serious events, however, it can be months before roads, railways, airports or ports are back in full operation.

The destruction of infrastructure frequently leaves the hardest-hit areas inaccessible. Transporting relief supplies and rescue services to these areas is impossible or at best extremely difficult. Hotels, restaurants and grocery stores are closed. Relief workers, repair crews and loss adjusters must find accommodation outside the disaster areas and travel up to several hours a day to their places of assignment. Delays in relief supplies, loss adjustment and repairs are the result. Buildings sustain further damage, for example from mould, which can have terrible effects on their condition.

Scarcity of resources

Because of the increased demand and poor transportation conditions, building materials become scarce, which in turn pushes up prices. The demand for skilled workers also increases. Lucrative major contracts are usually given priority. Above all, private buildings that have suffered just minor damage remain unrepaired for an extended period, during which time the damage gets worse.

The increased demand for skilled workers also causes wages to rise. What is more, as skilled workers are in short supply, poorly trained workmen are hired who do not repair the damage professionally, leaving the buildings even more vulnerable when the next storm strikes. This "demand surge" increases the cost of recovery by up to 40% compared to standard conditions – as we learned in the aftermath of Katrina.

Further loss drivers

Failed energy provision, water supplies and telecommunication services can compound the situation further and even lead to serious health risks. Furthermore, additional losses must be expected from looting and the destruction of buildings and property. It can be months before commercial businesses and service providers are able to resume their activities. Some businesses do not survive the catastrophe at all.

What insurers must be prepared for

In the event of major or complex catastrophes, insurers face tremendous financial and personnel-related challenges. For example, the inaccessibility of heavily damaged areas means that loss adjusters often begin by investigating smaller losses in outlying areas. In other words, when estimating losses and calculating reserves, an insurer must bear in mind that the worst losses will not be assessed until late in the adjustment process.

Extreme pressure on loss adjustment

Exceptional situations like a storm-related disaster place a particularly heavy burden on loss adjusters. For instance, in the aftermath of Katrina, staff had to be replaced with fresh teams several times during the loss adjustment process. In such cases, insurers are called upon to ensure they have the necessary personnel available.

Experience with major catastrophes like Katrina has borne out the importance of emergency plans. Insurers have learned that when a major disaster strikes or several loss events coincide, they must be in a position to provide additional loss adjusters, engineering experts and claims managers. In emergency planning, the most extreme, exceptional situations must be anticipated, e.g. several events in different regions within a single year.

State of alert remains in effect

In general, no reduction in the risk of cyclones in the southeast Queensland region can be expected over the next few years. The rising probability of heavy storms, combined with the growth of the region, will inevitably be accompanied by an increase in loss potential. Furthermore, insurers must try to be as well prepared as possible for major catastrophes, ensuring the availability of corresponding emergency response plans and sufficient human resources.

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What is risk?

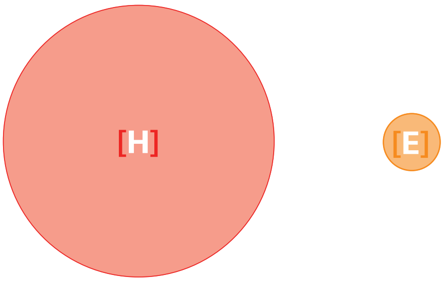
Wolfgang Kron
Munich Re expert on risk communication

In the context of natural disasters, the scientific community agrees that risk is the product of (the probability of) a hazard and its adverse consequences. Where there are no people or values that can be affected by a natural phenomenon, there is no risk. Similarly, an event is only termed a disaster if people are harmed and/or their possessions damaged.

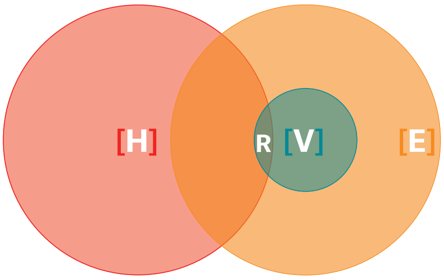
Drivers of risk

Circular graphs are used to describe the dependency of Risk [R] on the variables Hazard [H], Exposure [E] and Vulnerability [V], with vulnerability being the damageable exposure. 100% vulnerability means an expected total loss. The risk is represented by the area intersection of H, E and V.

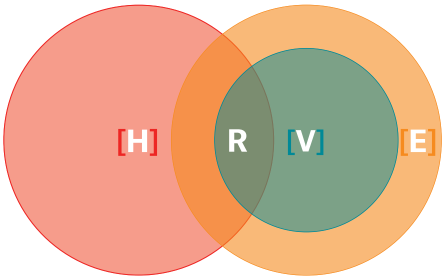
NO RISK
A strong storm in an uninhabited region
(no exposure affected)



LOW RISK
A strong storm in a well-prepared region
(low vulnerability)



HIGH RISK
A strong storm in a poorly prepared region
(high vulnerability)



The risk formula

The intensity and frequency of a natural phenomenon (Hazard) is only one of three factors which determine the overall risk. The amount of values present in the area concerned (Exposure) as well as their loss susceptibility (Vulnerability) are crucial for the resulting risk. Hence, the risk formula can be written as a function of these three quantities. With regard to the insured risk, a fourth factor, insurance penetration, also plays a role.

All factors that determine the risk are variable. While we cannot influence occurrence and intensity of a natural phenomenon, we may control the exposure by avoiding hazard-prone areas. Vulnerability can be reduced by increasing the structural resistance of objects, with measures depending on specific hazards. A higher insurance penetration generally increases the geographical spread of risks, but may also increase the probability of higher accumulation losses.

Risk

The integral over the hazard density function multiplied by the corresponding consequences.

R = [H] x

[H]azard

The degree of hazard, i.e. the full range of intensities of threatening natural phenomena, including their probabilities of occurrence.

[E]xposure

The total exposed values or values at risk – real/personal property – present at the location affected/threatened.

[I]nsurance penetration

The proportion of insured values at risk.

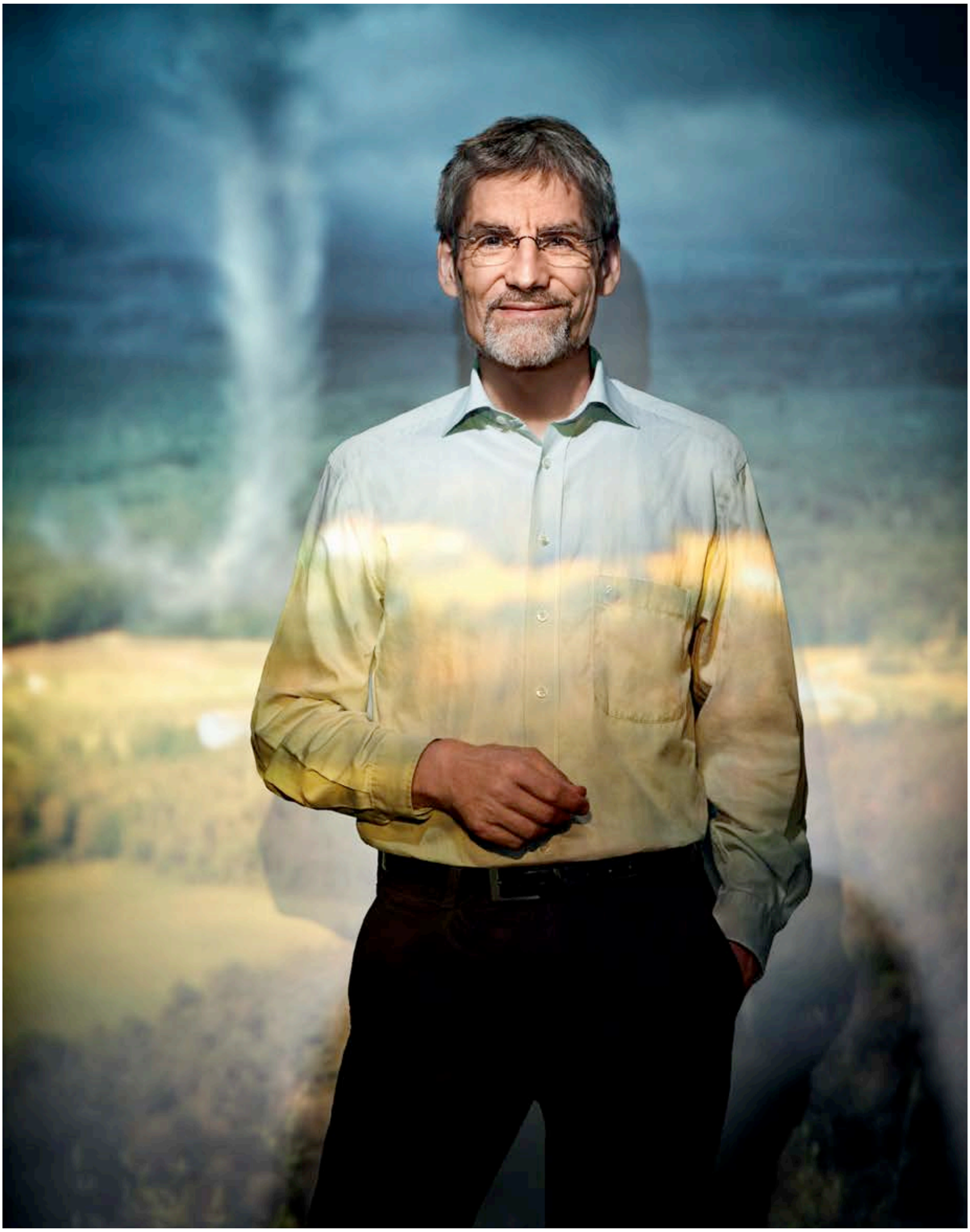
[E] x [V] x [I]

[V]ulnerability

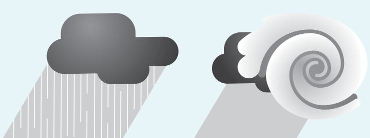
The degree of vulnerability, i.e. the lack of resistance to damaging forces, or the ratio of exposure that can potentially be damaged.

Natural climate variability

Eberhard Faust
Munich Re climate expert



Extreme droughts, floods and tropical cyclones: atmospheric natural hazards and heavy losses seem to go hand in hand. In many cases, these weather events can be attributed to natural climate variability. The deviations can last for weeks, months or even years, and can present the insurance industry with immense challenges in terms of risk management.



Knowing about natural climate variability and #climate change, and their predictable impacts, is essential in mastering risk management challenges.

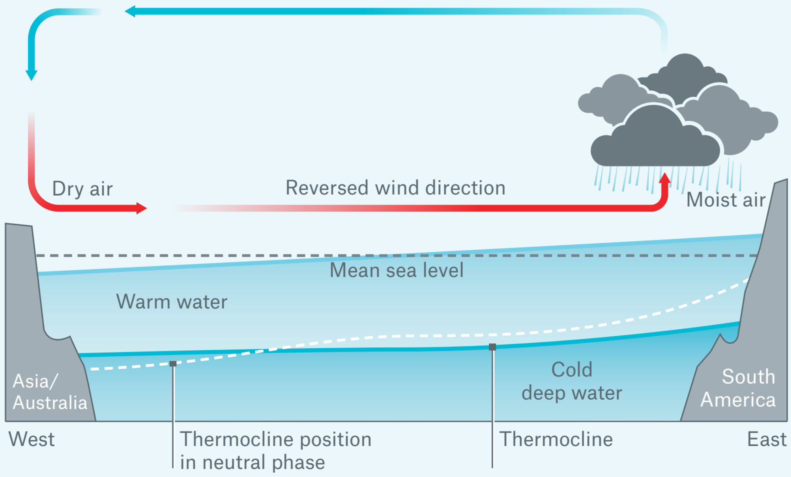
Australia and New Zealand are exposed to natural climate oscillations which have a strong influence on the activity levels of atmospheric natural hazards. The ENSO cycle (El Niño/Southern Oscillation), in particular, impacts the entire region, causing variations that extend over many months. The phenomenon is caused by two components of the climate system in the equatorial Pacific region – the ocean and the atmosphere – and the complex interaction between them. The way in which these components influence one another and the extent of this influence cause climate conditions to oscillate between El Niño, La Niña and the neutral state that lies between the two in a pattern referred to as the ENSO cycle.

El Niño and La Niña

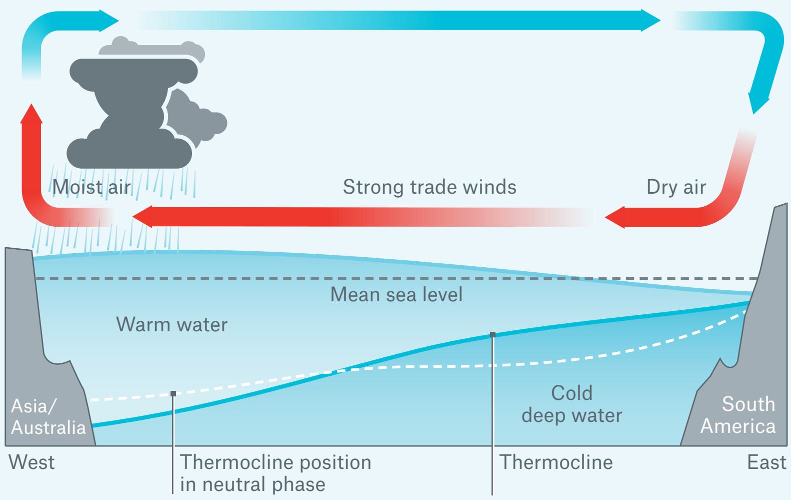
In the El Niño phase, the trade winds, which usually blow from a southeasterly direction, drop or even reverse direction and begin to blow from the west. This moves the pool of warm surface water located to the northeast of Australia eastwards in the direction of the central and eastern equatorial Pacific, thereby shifting the associated regions of convective precipitation. Dryness and warmth in the northeast and east of Australia and in eastern parts of the New Zealand islands are the result.

In a La Niña phase, the effect is reversed: the trade winds grow stronger than the long-term mean, shifting the warm surface water to just off the coast of Indonesia and northeastern Australia. Large quantities of the warm surface water evaporate here, greatly increasing precipitation in the northeast and east of Australia.

El Niño phase

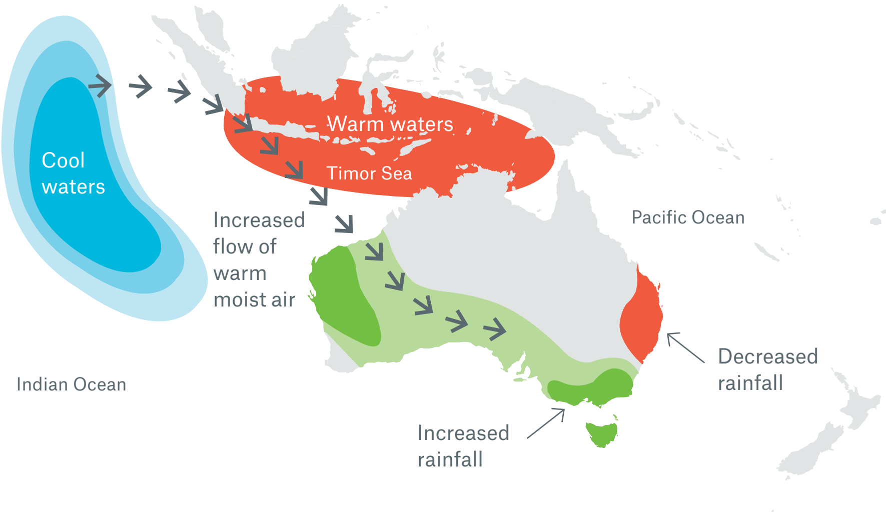


La Niña phase

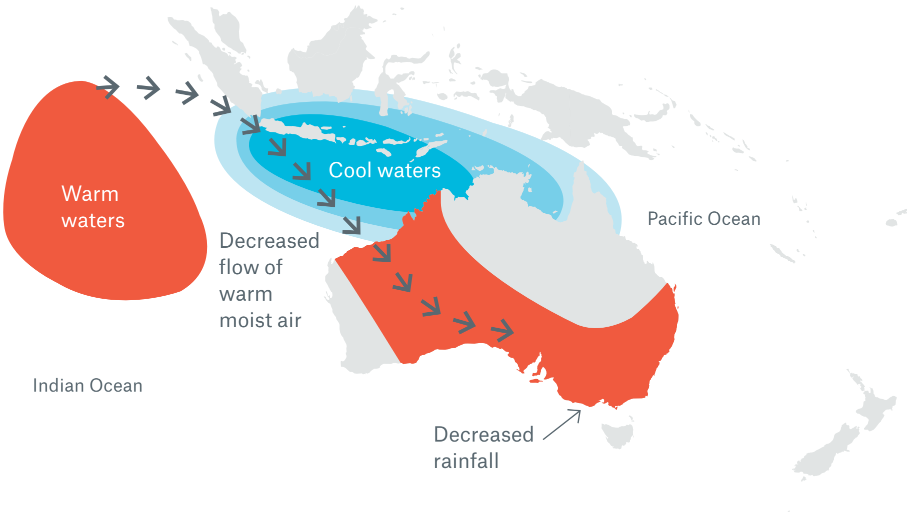


Indian Ocean Dipole

Negative phase of the Indian Ocean Dipole



Positive phase of the Indian Ocean Dipole



In the negative phase of the Indian Ocean Dipole (IOD) (upper panel), an increased atmospheric transport of warm moist air occurs from the Indian Ocean warm pool area into western and southern parts of Australia, reaching the south-east. As a consequence, rainfall is increased in these regions (green shadings). In contrast to this, the positive IOD phase (bottom panel) leaves Australia much drier (less rainfall over land indicated by red shading).

Source: Munich Re, in the style of Caroline Ummenhofer, http://ummenhofer.whoi.edu/southeast-australian-drought/

Shift in activity patterns

Thunderstorms

Severe thunderstorms can only occur under specific atmospheric conditions. Only in smaller subregions does the ENSO cycle cause a marked change in the frequency with which conditions conducive to severe thunderstorms develop in Australia – for instance, in a region of eastern Australia encompassing the southern half of Queensland, New South Wales and Victoria. During a strong El Niño event, conditions conducive to severe thunderstorms occur much less frequently here than under La Niña or neutral conditions.

However, the ENSO phases generally do have an effect on the geographical distribution of severe thunderstorms. This is because humidity decreases in southeastern Australia during El Niño episodes. As a result, severe thunderstorm activity decreases considerably in the coastal regions of New South Wales and along the Great Dividing Range, and increases in southeast Queensland. Activity also increases in extensive parts of Western Australia, including the region around Perth. During La Niña episodes, severe thunderstorm activity in eastern Australia shifts much further southwards and inland: this increases the frequency of severe thunderstorms in the south of New South Wales and the north of Victoria, including the area around Melbourne. Meanwhile, severe thunderstorm activity drops in the southeast of Queensland and the northeast of New South Wales.

Cyclones

During an El Niño event, cyclones tend to develop further to the east and closer to the equator. As a result, fewer storms hit the Australian coast than under La Niña conditions, when the storms develop much closer to the continent. By contrast, the cyclone hazard increases for the islands of Oceania to the far north-east of Australia during El Niño phases. More, and above all stronger, cyclones then develop in this region. Their high wind speeds and storm surges can wreak untold damage on the islands.

The second force – The Indian Ocean Dipole

Apart from ENSO, a further natural climate oscillation also has a strong influence on extratropical and tropical Australia: the Indian Ocean Dipole (IOD). Its impact can combine with ENSO effects, diminishing or increasing their intensity. The IOD is characterised by an oscillation of mean annual sea surface temperatures. These natural oscillations show a dipole pattern between the east of the Indian Ocean off the coast of Sumatra and the west of the ocean basin – particularly in the period from May to November. The positive IOD phase (pIOD) causes low temperatures in the east and high temperatures in the west of the Indian Ocean. In a negative IOD phase (nIOD), the pattern is reversed.

The Big Dry and other droughts

Long periods of severe drought in Australia in particular are associated with IOD oscillations. The Federation Drought (1895–1902), the World War II Drought (1937–1945) and The Big Dry (1995–2010) are examples of such events. Recent research has revealed the causes of these prolonged droughts in southeastern Australia, which can extend over several years and affect other regions in the southwest and south of Australia: the drought episodes are primarily associated with positive or neutral IOD phases. Negative IOD phases transport large quantities of moisture from the tropical eastern Indian Ocean in a southeasterly direction towards western, southern and southeastern Australia.

However, the drop in overall precipitation in the cool season recorded over the course of the last 50 years is unlikely to be the result of natural climate oscillations alone. It is probable that climate change was already starting to take effect, reducing the frequency of the cut-off lows which bring rains to the southwest, south and southeast of Australia, and to Tasmania.

The interaction of ENSO and IOD

The natural climate oscillations can sometimes interact in complex ways, influencing one another. This makes for considerable variability from one year to the next: for instance, in southeastern Australia and in the Murray-Darling Basin, monthly rainfall can increase by up to 25 mm during a concurrent La Niña and negative IOD event.

When an El Niño phase coincides with a positive IOD phase, this same region is hit by severe drought. However, a precipitation deficit or surplus can also ensue in the eastern half of Australia when an El Niño or La Niña event occurs on its own during a neutral IOD phase.

Climate oscillations also affect the risk of bushfires: in southeastern Australia, particularly in Victoria, the risk is higher during positive IOD phases and during El Niño events. There is a steep rise in the risk of bushfires here when these two climate conditions occur simultaneously.

In the eastern parts of the New Zealand islands, drought episodes primarily occur during summer El Niño events. Winds from the west prevail during these periods, bringing precipitation to the western coasts and dry weather to eastern parts. There is a greater risk of forest fires during these phases.

El Niño and La Niña also have a dominant influence on the development of intense precipitation events. This emerged, for instance, during the recent intense precipitation events between 2010 and 2013. During La Niña phases and negative IOD phases and when the two phases coincide, there is a greater risk of heavy rainfall in the eastern half of Australia. However, 10–20% of the heavy rainfall events which hit the Brisbane area between 2010 and 2011 can most likely be attributed to higher sea surface temperatures in the north. Indeed, it is possible that we are already seeing the additional influence of climate change.

Predictability of natural climate oscillations

El Niño, La Niña and IOD phases can be forecast on a seasonal basis. Based on climate models, institutes provide forecasts with a moderate predictive skill for lead times of about four to six months. These forecasts are much better at predicting the sign of an imminent phase than at predicting the intensity. Australia's Bureau of Meteorology provides an overview of forecasts on its website.

Conclusion

Improved forecasting of natural climate oscillations means that insurers' risk management teams can prepare more efficiently for regional changes in weather-related loss probabilities. For one thing, it helps them to plan sufficient human resources for loss adjustment, and to ensure that appropriate emergency plans are in place. What is more, the knowledge about climate phases could also be used to inform and raise awareness among policyholders and the general public, providing knowledge-based incentives to take preventive measures: for example, in response to risks in potential floodplains or bushfire areas, where it is essential to ensure an adequate distance from vegetation.

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Sources: See page 52

Never underestimate troubled water

Wolfgang Kron
Munich Re expert on floods

Flood is probably the natural peril Australia is most aware of. Major floods frequently isolate towns, create major disruptions to road and rail links, and can cause many fatalities. Widespread damage to houses and business premises as well as losses in agriculture are common. Practically every year there are flood losses, sometimes with devastating consequences.

#Flood events in Australia can be mitigated but never prevented. Politics and insurance need to partner closely #climate change, #mitigation

Despite regular loss events, the consequences of flooding are still often underestimated – both in Australia and around the world. One reason for this is that almost no one expects the unexpected, even if it happens often, as is the case with this phenomenon. Floods, in particular the flash floods common in Australia, can happen anywhere – also in extremely dry regions. This element of surprise makes these events even more dangerous than they would otherwise already be.

Flood appears controllable

People tend to be less frightened of floods than of other natural hazards. Unlike earthquakes, for example, it is assumed that a flood can be controlled by appropriate measures. Most people think that when a flood happens, they will still be able to barricade themselves in or escape safely with their belongings. Precautionary measures taken by the authorities, such as storm and flood warnings or flood control structures, also give people a sense of security.

But experience shows: extreme events can neither be entirely prevented, nor can they be completely controlled. Their frequency is likely to increase as climate change progresses.

Varying risk

Even if nowhere is entirely safe from flooding, the risk varies greatly from region to region in Australia. Major loss occurrences are to be expected in Queensland and along the entire east of the country. The costliest flood of recent times hit Brisbane – although the city appeared to be very well protected by two large dams. It would be false to believe that the water level of 4.56 m in January 2011 was the worst case that can be expected. In the past, Brisbane has experienced much higher flood levels (e.g. 8.35 m in 1893 and 5.45 m in 1974). The Wivenhoe and Somerset dams cannot offer any guarantee that these levels will not be reached again.

While it is mainly tropical cyclones that bring huge volumes of rain to Queensland, in New South Wales it is the East Coast Lows that bring high wind speeds and copious rainfall. Australia has suffered a lot in this region, and has taken great steps to mitigate the consequences from future events, but they cannot be totally prevented.

Along the entire northern and western coasts of Australia, from Brisbane to Perth, tropical cyclones with their enormous amounts of precipitation can occur and cause flash flooding. Large-scale floods and losses in the billions are most likely in the densely populated area of Perth, should a cyclone hit at full force.

The biggest floods since 2005

Flood periods	Affected region(s)	Overall losses (A$)	Insured losses (A$)
January to February 2008	Northeastern Australia, especially Queensland	2.2bn	1.5bn
December 2010 to January 2011	Eastern and northeastern Australia: incl. the Brisbane flood and the Toowoomba/ Lockyer Valley flash floods;	6.8bn	2.4bn
January 2013	Northeastern Australia	2.2bn	1.1bn

All losses given in original values at the times of the events

Source: Munich Re NatCatSERVICE

There can even be flooding in the arid middle of Australia, although this is rare, invariably very localised and of little economic consequence given the low concentration of values involved. For example, in January 2015 more than 200 mm of rain fell in the space of just a few days in Alice Springs. Several buildings were flooded and one person drowned.

Short rivers

Apart from the Murray-Darling basin, there is no major river system in Australia. That is why river floods often behave in a similar way to flash floods, providing little or no advance warning. The flood wave in the Brisbane River in 2011 also rose very rapidly. Similar events are possible on nearly all Australian rivers, because they generally run a short route to the sea and have very few tributaries, allowing flood waves to approach quickly and suddenly. The usual feature of river flood remains: flooding caused by the overflowing of a river (in contrast to local rainfall flooding). Hazard zoning and flood protection are therefore highly relevant aspects.

Risk on the beach

Most coastal regions of Australia are exposed to the risk of storm surges. On the east coast they can arise in connection with East Coast Lows, and on the northeast, north and west coasts as a result of cyclones. The fact that Australian cities have largely escaped storm surge catastrophes to date does not mean that it will stay that way. It is precisely this lack of negative past experience that has led to highly exposed building developments near beaches. An unfavourable storm constellation could easily put large parts of cities like Brisbane, Cairns, Darwin or Perth under water, triggering unprecedented losses there. On Australia's northern coast, storm surges can be higher than almost anywhere else on the planet. In 1887, a storm surge swamped the city of Burketown, 30 km inland from the Gulf of Carpentaria. The water level was about 5.5 m higher than the highest-ever mark recorded during a spring tide. In 1923, a 6.5 m water level was even measured on Groote Eylandt in the Gulf itself. The highest combined storm surge and wave action ever to hit Australia was during Cyclone Mahina, which struck Bathurst Bay in March 1899 and claimed over 400 lives. The ultimate high-water line was estimated to be 14.6 m – still claimed by some to be the world record.

Building resilience

The enormous economic and financial losses caused by floods are a considerable burden for Australia. That is why it has put a lot of effort into containing the risk in recent years. Four components of prevention are of key significance:

1.
Flood prevention is designed to prevent dangerous floods from occurring, or at least to make it more difficult for them to occur (measures such as forestation or removing impermeable surfaces in the catchment area to increase local water storage).

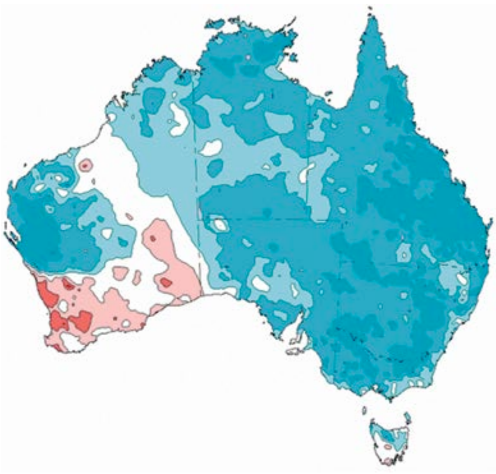
2.
Flood control is supposed to prevent high-value areas from being flooded (e.g. dykes, detention basins, dams).

3.
Loss mitigation limits the material losses if the flooding of a building cannot be prevented (e.g. floodproofing, evacuation).

4.
Financial protection – usually in the form of an insurance policy – protects against financial ruin, enables immediate reconstruction and is a key factor in managing risk and building high resilience.

The lack of warning and time to react and the very limited options available for structural flood prevention and control in the case of flash flood events make loss mitigation almost impossible and insurance particularly important. Flash floods generally impact the immediate area close to where they arise, which makes them difficult to fully prevent, control and mitigate against. However, flood-proofing of buildings can effectively reduce the consequences of moderate flash flood events.

Rainfall deciles for October to December 2010



Decile

	Highest value on record
10	Very much above average
8–9	Above average
4–7	Average
2–3	Below average
1	Very much below average
	Lowest value on record

Deciles represent a ranking. Oct.–Dec. 2010 rainfall in decile 10 means that it belongs to the top 10% of all historically recorded Oct.–Dec. rainfall depths. Decile 1 means it was within the lowest 10%.

Source: Bureau of Meteorology, Australia

A prudent, affordable and sustainable development of flood plains and coastal areas calls for risk-based flood control. To clarify: the protective measures taken are always based on what is called a "design flood". The protection is then designed to be effective up to that high-water level. Here, irrespective of what the region is used for, a standard protection objective is often pursued, for example a 100-year return period. But it does not make sense to subject all regions to the same flood probability. Risk-based flood protection minimises the overall risk much more efficiently. Many countries have already started rethinking their approach here. Munich Re supports this re-evaluation process and provides the required local risk knowledge about the development of natural hazards, for instance with NATHAN Risk Suite.

Government and insurers need to work together

There is a wide range of products providing flood cover available in Australia. The insurance ratio also seems reassuring at first glance: around 90% of insured homeowners (77% of all) have flood cover for building and/or contents. But upon closer consideration, it becomes apparent that most of the homeowners in high-risk areas do not have flood cover. In New South Wales, only 2% of these areas have full flood cover. In Queensland, the figure is 5%. The reasons are easy to understand: for an average house in these areas, the premium for flood insurance alone can be between A$ 10,000 and A$ 20,000. By comparison, in Queensland the average premium for all other perils together is in the order of A$ 1,000.

Australia is not the only country that struggles to make the flood risk in highly vulnerable areas insurable. The insurance industry cannot solve this problem on its own; it needs to be addressed by governments, insureds and other stakeholders. Once the concept of total risk is understood, then prevention and control measures can be used to mitigate the risk. Insurance can be further used to minimise the residual risk. In this regard, as insurers calculate premiums that are commensurate with the risk, mitigation would have a positive impact on pricing, and potentially on penetration of flood coverage. The frequently used option of "disaster relief", or swift financial aid after catastrophes, is no alternative. It rewards those who have not taken precautions, thus undermining all efforts to protect against risk and losses. Much more preferable would be financial incentives from the state and local governments to invest in mitigation and protection activities, so that everyone can afford cover, and so that the insurance industry can develop suitable products. Putting pressure on insurers to bear the risks on their own through discounted premiums that do not cover costs would distort the market and probably prompt some providers to withdraw entirely.

Conclusion

The natural peril "flood" and its potential consequences can be significantly reduced by taking the right measures, but there will never be complete protection against it. So it is all the more important not to underestimate the danger – especially of flash floods. Because at the end of the day, an insurance policy is the only reliable way of at least making a new beginning possible in the event of a loss or personal catastrophe. All homeowners, companies and communities should be aware of this. The insurance industry can do its bit by educating clients, giving them helpful tips on how to deal effectively with the risk, and providing comprehensive support.

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What is a return period?

A return period is the inverse value of the exceedance probability and indicates the *average* time between events of the same intensity. Hence, there is a 1% (1⁄100) chance of an event with a 100-year return period being equalled or exceeded in any given year. This does not permit any forecast to be made about the next event. If a flood protection structure is built on the basis of a 100-year design flood, it (theoretically) does not offer protection against a 150-year event.

Flood volumes are huge

In January 2011, the peak flow rate in the Brisbane River at the Brisbane Port Office was 12,400 m^3/s. If you were to take half of this flow and direct it onto a rugby field of about 10,000 m^2 (140 x 70 m), the field would be submerged under 37 metres of water in just one minute. The flow rate remaining in the river (6,200 m^3/s) would still represent a flood the likes of which only occurs every 20 years on average.

Check into NATHAN Risk Suite

Jürgen Schimetschek
Munich Re NATHAN expert

Munich Re's NATHAN Risk Suite optimises the assessment of natural hazard risks, from entire portfolios down to individual objects at address level – worldwide and now directly via smartphone and tablet. How does this work? Three questions for Dr. Jürgen Schimetschek, Geo Risks Manager, Munich Re.

What is the idea behind NATHAN Risk Suite?

NATHAN (Natural Hazard Assessment Network) Risk Suite supports users all around the world with customised, innovative services for risk assessment. Its added value lies in combining data on objects to be insured (locations) with the various natural hazards. Its goal is to achieve efficient pricing, identify accumulation risks, optimise claims adjustment and derive options for prevention.

What are the benefits of NATHAN Risk Suite for our clients?

Modern integrated risk management requires a detailed knowledge of geographical environment. Geointelligence creates many possibilities. The full potential of this knowledge can be realised if the applications are closely linked to the companies' existing work processes. Natural hazard zoning, population distribution maps, altitude information and loss data can be included in the clients' own applications quickly via online connection. Most of this knowledge is now accessible via smartphone and tablet with our NATHAN Mobile application.

Can you give us an example of how to work with NATHAN Risk Suite?

In order to evaluate, for instance, the exposure to bushfire within an insurance portfolio, the comprehensive cover policies can be joined with the NATHAN wildfire zones, providing bushfire probabilities and intensities estimated for postal codes or addresses. On this basis, individual loss forecasts can be determined, and precisely what percentage of the portfolio is affected by or exposed to bushfire can be calculated. With this transparent risk assessment, the best-possible reinsurance protection can be better defined. The information also helps the risk assessors on location to look more closely at the risk situation of an insured object.

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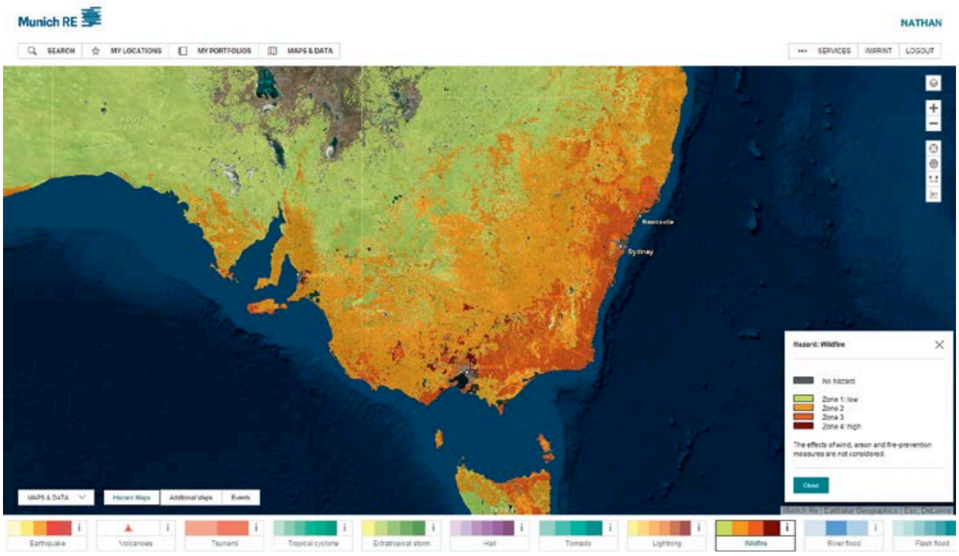
NATHAN Risk Suite



Bushfire (wildfire) hazard in southeastern Australia.

Source:
Munich Re NATHAN

Icy cricket balls from above

Jan Eichner
Munich Re expert on convective storms

Losses from severe convective storms, in particular from hail, represent the most frequent and (on an annual aggregate basis) the highest losses for the insurance industry in the entire Australian nat cat business. Apart from the Sydney hailstorm of 1999, the five most expensive insured convective storm losses in Australia have all occurred within the last five years.

Severe #convective storms are the most expensive hazards with high frequencies and great values at risk. #Mitigation is key #hailstorms, #flash floods

Over the last 35 years, the accumulated losses (all in Australian CPI-adjusted values for 2014) from severe convective storms total around A$ 14.8bn for insured losses and A$ 25bn for direct economic losses. Compared to other perils in Australia, only losses from flood events reach similar dimensions. In terms of frequency, losses from severe convective storms make up about 50% of all loss-producing natural hazard events that occur in Australia. Hence, severe convective storm is the number one peril in nat cat business in Australia.

The costliest loss event in Australia to date (after adjusting for inflation) was the Sydney hailstorm of 1999. In the early evening of 14 April – untypically late in the season – a supercell storm had developed south of Sydney in the area around Kiama. It moved northwards, parallel to the coastline, via Wollongong, Bundeena, straight to central Sydney and further north to Palm Beach, up as far as Gosford – a distance of more than 200 km. The storm produced hailstones the size of cricket balls (7 cm), reaching its maximum intensity around the eastern suburbs of Sydney. On its path, it caused damage to more than 45,000 houses, 63,000 cars, 23 planes and countless boats, resulting in more than 120,000 insurance claims. The total sum of insured losses reached A$ 1.7bn, and the estimated direct economic losses were over A$ 2.3bn. Adjusted for inflation, those values today would be equivalent to A$ 2.9bn and A$ 4bn respectively. And accounting for the increase in wealth and assets since 1999 (using GDP growth as a proxy), the values could reach as much as A$ 4.6bn and A$ 6.3bn.

Brisbane hailstorm of 2014 produced the largest hailstones

In November 2014, a rather short-lived and localised but intense hailstorm battered the Brisbane area. The supercell produced hailstones even larger than those in 1999, and hit central parts of Brisbane during rush hour, causing damage to some 60,000 cars. The roofs, windows and claddings of more than 22,000 homes and commercial buildings were damaged, and about 30 people were injured. The number of insurance claims exceeded 100,000, with a total insured loss of A$ 1.35bn, and a direct economic loss estimated at A$ 1.8bn.

The Brisbane area is hit by hailstorms quite frequently. The most severe event affecting Brisbane prior to 2014 occurred in 1985. It caused insured losses of A$ 180m and about A$ 360m in direct economic losses, which compares to A$ 540m and A$ 1.1bn in CPI-adjusted values.

Two other recent prominent convective storm events with large hailstones and significant flash floods occurred in March 2010, affecting Melbourne and Perth. Each event generated insured losses of about A$ 1bn, with the Perth event becoming the most expensive natural disaster in Western Australia.

Thunderstorm damage

Most of the losses from severe convective storms in Australia arise from hail and flash floods. Large hail causes damage to the roofing, windows and claddings of buildings, as well as hull damage to automobiles, trains, planes and boats. Once a roof is damaged, the accompanying rain can cause substantial damage to the interior and the content of the damaged property. Small hailstones can be harmful to certain crops, especially during the growing stage of the agricultural cycle. Flash floods inundate cars (which usually involves a total loss of the vehicle), as well as flooding basements and ground floors, damaging both the content and the structure of an affected building.

In Australia, tornadoes – though potentially the most devastating of the perils in a severe thunderstorm – do not occur as frequently and intensely as to rival the losses from hail and flash floods. Downbursts and strong wind gusts also cause damage (in particular from flying debris).

Distribution of thunderstorms

Thunderstorms can happen throughout the year, but the season when the storms are most frequent and severe is September to April. In addition to the annual season, other external factors such as the El Niño Southern

Oscillation (ENSO) in the equatorial Pacific have a measurable influence on thunderstorm activity in Australia (although the impact on the spatial distribution of thunderstorm occurrences is greater than on intensities).

The meteorological hazard probability, i.e. the areas where severe hail and strong thunderstorms are most frequent, is shown in Map 1, together with the locations of historic hailstorm loss events from the Munich Re NatCatSERVICE database.

The big red dots over the cities of Brisbane, Sydney, Melbourne and Perth mark the largest loss events. The map confirms that the highest meteorological probability of significant hail coincides with the historic large losses experienced in major metropolitan areas of Australia.

Map 2 displays the annual insured loss per capita caused by severe convective storms for each state. The values were calculated on the basis of empirical insured loss data from 1980 to 2014, normalised by increase in GDP. Such a denotation of the losses helps to identify high-risk regions. These regions do not necessarily coincide with the states that experienced the largest losses in absolute terms, or were prone to the most extreme convective storms from a meteorological perspective. However, a clear correlation between the hazard/event map (1) and the risk map (2) can be found for the east coast states, where the highest value of around A$ 40 per capita and year appears in New South Wales (with a good chunk of the A$ 40 stemming from the 1999 Sydney hailstorm). The small value assigned to the Australian Capital Territory (ACT) has to be seen as an artefact derived from a lack of statistics on loss events in this small area. The true risk for ACT would not be different from the risk for the surrounding state of New South Wales.

The correlation between the most highly exposed areas and greatest values at risk is unlikely to change, given that an increasing number of people want to live close to the coast and the majority of the population is concentrated in the eastern states. A reduction in the frequency of severe convective storm events cannot be expected, and owing to the ever-increasing exposure of values at risk, focusing on risk mitigation is paramount. Investing in new technologies and using materials that perform better in severe weather is therefore key. Individual risk rating has a major influence on risk behaviour, and it is essential to charge the appropriate price for exposure, since it will take time for improved materials to flow through the housing and motor stock.

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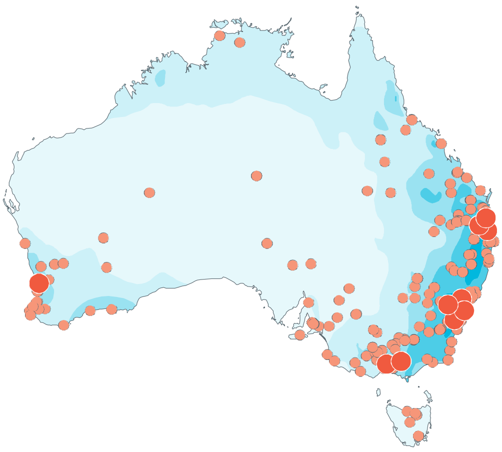
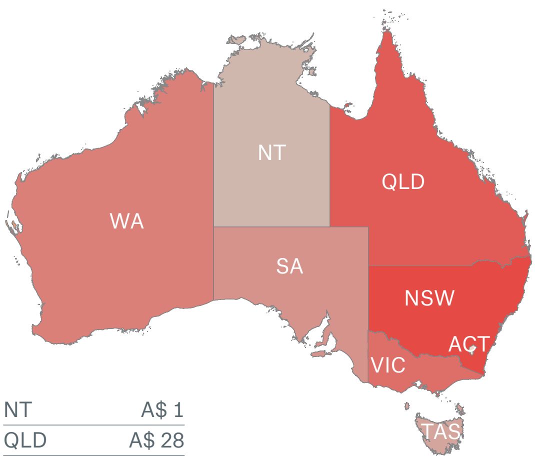
Hailstorm loss events in Australia



Map 1: NATHAN hail hazard layer and the locations of hail losses registered in the Munich Re NatCatSERVICE database (shown as dots). The large red dots indicate the locations of ten major hailstorms since 1980.

Source: Munich Re NatCatSERVICE.

Insured per-capita losses from convective storms



NT	A$ 1
QLD	A$ 28
WA	A$ 14
SA	A$ 5
NSW	A$ 40
ACT	A$ 1
VIC	A$ 17
TAS	A$ 2

Map 2: Annual average insured loss per capita from severe convective storms, broken down by state/territory. The values are colour-coded and range from <A$ 1 (Northern Territory) to about A$ 40 per year per person (New South Wales). The statistics are based on GDP-normalised insured losses per state (over the period 1980–2014).

Sources: ICA, Munich Re NatCatSERVICE

Table 1: Most expensive (CPI-adjusted) convective storm losses in Australia since 1980, ranked by insured losses in A$ m of 2014

Date	Affected area	Losses (CPI-adjusted in A$ m) Overall losses	Insured losses
14.4.1999	Wollongong, Sydney, Central Coast	3,800	2,800
27.11.2014	Brisbane	1,750	1,300
22.3.2010	Perth	1,800	1,200
6–7.3.2010	Melbourne, Mangalore, Shepparton	1,700	1,150
25.12.2011	Melbourne, Yarra Valley	1,100	810
9.12.2007	Illawarra, Sydney, Penrith	1,050	790
18–19.3.1990	Sydney	990	620
4–6.2.2011	Melbourne, Gippsland	730	540
18.1.1985	Brisbane	1,010	510
1–3.2.2005	Melbourne, Sydney, Newcastle, Brisbane	520	300

After accounting for loss normalisation, the 1999 Sydney hailstorm could generate an estimated insured loss of about A$ 4.6bn and reach an overall loss dimension of up to A$ 6.3bn.

Source: Munich Re NatCatSERVICE

Fig. 1: Number of convective storm events, split by perils as the dominant loss cause of each event

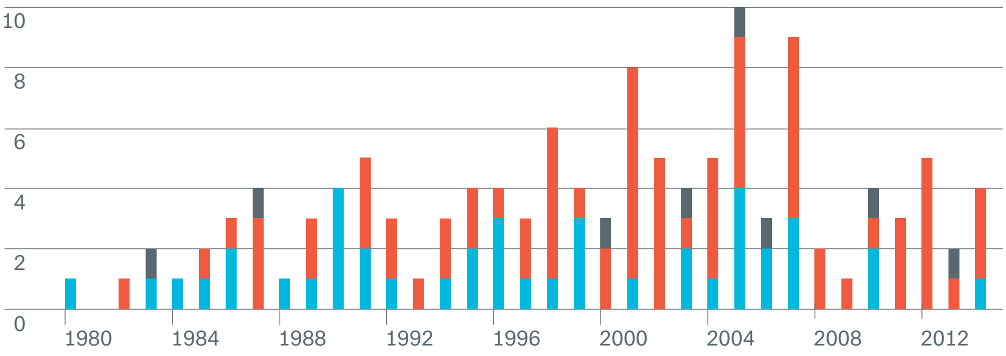


Fig. 1: Number of loss events from convective storms in Australia exceeding A$ 5m in normalised economic loss values. Part of the increase since the 1980s is driven by improved reporting of loss events (particularly smaller loss events).

Source: Munich Re NatCatSERVICE

Fig. 2: Annually aggregated insured losses from convective storms in Australia (in A$ m)

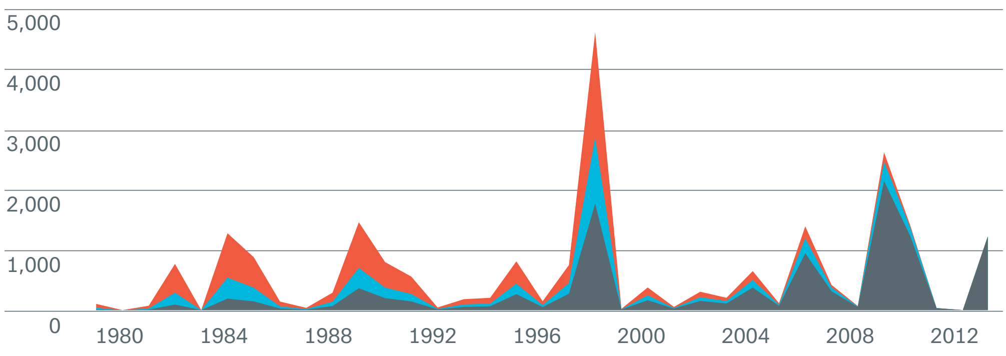


Fig. 2: The grey curve displays the nominal losses as occurred in the year of each event. The blue curve shows the same chart, adjusted for inflation (Australian consumer price index or CPI). The red curve shows the same losses normalised to today's distribution of wealth and assets, using Australian GDP growth as a proxy for the development of wealth. The normalised losses reflect the loss potential if past events occurred today.

Source: Munich Re NatCatSERVICE

Despite improvements in the scientific understanding of natural perils and our ability to capture and analyse ever-increasing amounts of data, uncertainty remains a fundamental notion in catastrophe modelling – with a strong impact on risk and capital decisions.

Dreaming of the perfect model

Cameron Hick
Client Manager

The role of stochastic catastrophe models in the (re)insurance industry has evolved since the release of the first commercially available models in the late 1980s. In fact, recent events and new scientific advances have shown us that the degree of uncertainty in the results produced by catastrophe models is even bigger than originally thought. This has led to a growing focus amongst regulators and rating agencies on how companies address the issue of model uncertainty when making capital and catastrophe risk decisions.

Uncertainty arises from all components of a catastrophe model. The hazard calculation, the vulnerability assignment and the representation of the exposed values contribute to the overall model uncertainty. Even where a long historical record exists, its accuracy is often questionable. In addition, the time span of such data is far too short to cover the full range of realistic scenarios. The Tohoku earthquake, for example, came as a complete surprise to the modelling companies, despite the very long historical record in Japan.

Beware of wrong accuracy

In many countries, vulnerability functions are mainly based on engineering calculations and are not constrained by loss data. The tendency to use ever-more detailed vulnerability functions for specific building characteristics is aggravating this issue and creates a sense of wrong accuracy. The assumption in the exposure data input to comply with all these parameters has a major impact on the modelling results. After catastrophes, it often becomes clear that wordings or valuation aspects were not adequately addressed.

Good corporate governance demands that companies explicitly consider this uncertainty in model outputs, with risk and capital decisions reflecting this understanding. Greater focus is being given to data quality, reasonableness checks against recent events, and the setting of catastrophe reinsurance limits that make allowance for the uncertainty in the modelled outputs on which they are based.

Munich Re's modelling approach

Prudent exposure management and understanding of risk is essential. This is particularly the case for one of the largest exposures an insurance company faces: natural catastrophe risks. At Munich Re, we have developed our own proprietary internal natural catastrophe models that provide us with an alternative view of risk.

In addition to modelling capabilities, Munich Re provides expertise, global experience and a multitude of tailored reinsurance solutions for frequency and severity exposures. Reinsurance can play a vital role in an insurer's capital management plan through capital enhancement, substitution or efficiency.

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"APRA wants each insurer to challenge itself about its governance and management of catastrophe reinsurance arrangements, and to adopt very good practice. We particularly want the insurer to understand the strengths and weaknesses of any models it uses, and the degree of uncertainty in the results produced. And we want model outputs to be complemented by significant further analysis. Lastly, we want the insurer to satisfy itself that the residual risk is truly within its appetite."

Ian Laughlin – Former Deputy Chairman,
Australian Prudential Regulation Authority

Australia on fire

Markus Steuer
Munich Re expert on bushfires

In the southern half of Australia, bushfire is one of the biggest causes of loss due to natural hazards. The risk can only be reduced through close collaboration between the authorities, home and business owners, industrial enterprises and the insurance industry.

#Bushfire risks are on the rise, #class actions, #mitigation, #climate change.

Bushfire hazard results from the complex interaction of highly disparate anthropogenic and natural factors. It is the only natural hazard in which humans have a direct influence on the hazard situation. The majority of fires near populated areas are caused by human activity, the smaller portion starts naturally by lightning. Besides accidental causes, a significant number of fires are ignited deliberately.

In Australia, most of the overall and insured losses are caused by bushfires in the southeastern part of the country, where high hazard meets high exposure. The Black Saturday Victorian Fires in 2009 – the most recent major loss event for property and casualty insurers – burnt some 4,500 km^2 of land, killed 173 people, injured hundreds more and destroyed about 2,000 homes. Domestic property and contents insurance accounted for around three quarters of the A$ 1.2bn insured property loss (indexed using CPI); commercial, industrial and farming policies accounted for one quarter. Estimates indicate that 80% of the insured people affected by the fires were underinsured.

Compared with other natural hazards, the share of total losses (destroyed houses) is higher on average in the case of bushfires; therefore underinsurance effects can be greater. Most houses are either destroyed completely or left virtually undamaged – there are only few structures with partial damage. Aside from underinsurance, 13% of the destroyed residential properties in the Black Saturday Fires were not insured at all.

The most significant bushfires in history

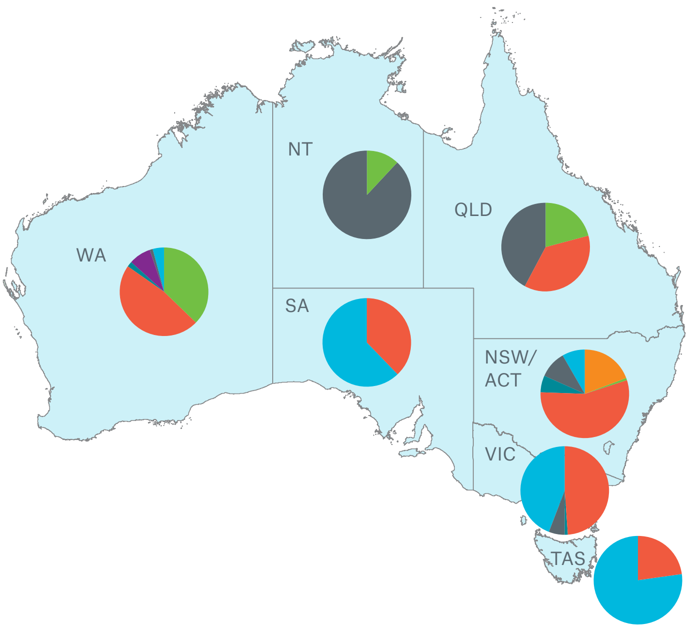
The Black Saturday Fire (VIC) in 2009, which burnt 4,500 km^2 of land, killed 173 people and destroyed some 2,000 homes. Overall losses A$ 1.7bn, insured losses A$ 1.07bn (in original values).

The Ash Wednesday Fire (VIC/SA) in 1983, which burnt 5,200 km^2, destroyed some 2,400 homes and killed 75 people. Overall losses A$ 335m, insured losses A$ 176m (in original values).

The Tasmanian Black Tuesday Fires (TAS) in 1967, which burnt more than 2,600 km^2, destroyed some 1,400 homes and killed 62 people. Overall losses A$ 35m, insured losses A$ 14m (in original values).

The Black Friday Fire (VIC) in 1939, which burnt almost 20,000 km^2, destroyed more than 700 homes and resulted in 71 fatalities.

Normalised insured property losses 1980–2014: Percentage distribution per peril in each state

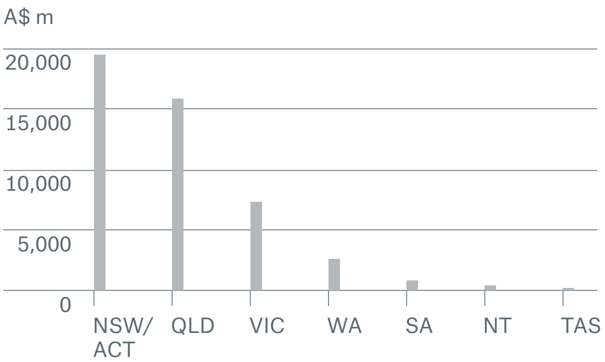


A significant share of the normalised insured property losses in Victoria (VIC), South Australia (SA), and Tasmania (TAS) were caused by bushfires.

Normalisation removes the effect that increased wealth, i.e. the number of houses and their price over time, has on losses. This makes it possible to compare losses that occurred at different points in time.

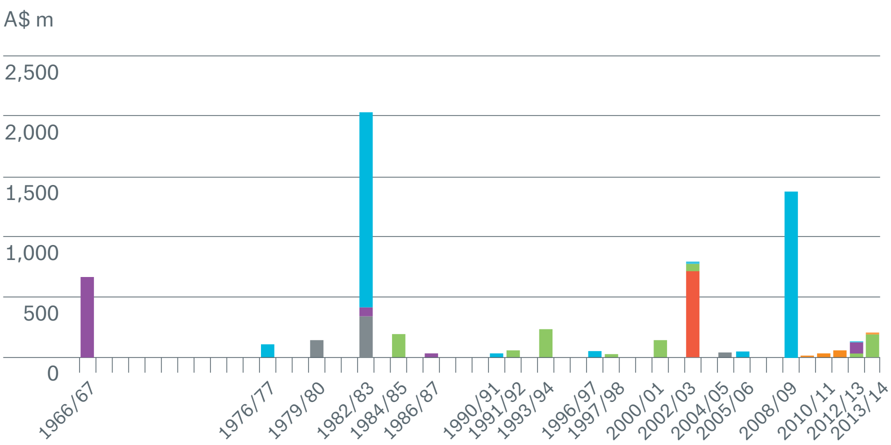
Sources: ICA, Munich Re NatCatSERVICE

- Earthquakes
- Tropical cyclones
- Convective storms (incl. hail)
- Winter storms
- Sandstorms
- Floods
- Bushfires



- Normalised insured property losses caused by all natural disasters

Normalised insured property losses 1967–2014 caused by bushfires



Since the devastating 1967 Tasmanian fires, about half of the normalised insured property losses were caused in Victoria (VIC) and one quarter in New South Wales and the Australian Capital Territory.

Sources: ICA, Munich Re NatCatSERVICE

- WA
- VIC
- TAS
- NSW
- ACT
- SA

Accidentally caused fires

In a human-caused bushfire, the party responsible for the fire may face civil and/or criminal charges, based on negligence or strict liability. Liability insurance comes into play if a party caused the fire with a legal liability, but no wilful intent was involved. Since a large proportion of damaging fires in Australia are directly or indirectly attributable to human activity, and given the substantial monetary losses, fire-fighting costs and harm to people they cause, the risk of bushfire also needs to be considered in connection with casualty contracts.

The exposure of public utility companies is particularly high, as overhead power lines are a potential ignition source and run throughout the country over long distances. Under "normal conditions" a low single-digit percentage figure of bushfires start in the context of power lines. But during days of extreme fire danger, the percentage of fires caused by electrical distribution installations rises strongly above the long-term average. This becomes evident when regarding the three costliest bushfire disasters since 1980. A significant portion of the individual fires were electricity-caused – half of the fires during the Ash Wednesday disaster in 1983 and one third of the fires during the Black Saturday events in 2009. Only the Canberra fires in January 2003 were all started by lightning. Wind is a key variable. Adverse wind conditions, i.e. high wind speeds and change in wind direction, can turn a normal fire into an uncontrollable inferno. High wind speeds also increase the probability of an inferno being triggered by electrical assets.

Recent settlements set new records

The 2009 Black Saturday Fires also showed the great loss potential for the casualty line of business. Class action lawsuits were filed against an electricity distribution company and other parties. The Kilmore East Fire, which destroyed 1,242 homes and killed 119 people, was claimed to be caused by faults in the company's power transmission system. The parties agreed to settle the action and Victoria's Supreme Court approved an almost A$ 500m payout to a total of 5,000 plaintiffs – the largest settlement in Australian legal history.

The electricity distribution company, which had liability insurance that especially provided cover for bushfire liability, agreed to pay A$ 378.6m. Victorian State Parties – another defendant – agreed to pay A$ 103.6m and a maintenance contractor settled for A$ 12.5m. The settlement was without admission of liability by the parties. The two companies and state parties also settled with plaintiffs for A$ 300 million in a class action over the Murrindindi-Marysville Fire, the electricity distribution company paying a share of A$ 260.9 million.

Disaster mitigation measures reduce economic costs

In 2014, the Australian Business Roundtable commissioned a case study that focused on a worst-case bushfire scenario in the Greater Melbourne metropolitan area. The study illustrated the economic benefit of mitigation. Expressed in monetary terms, the ratio of the benefits of undergrounding electricity wires relative to its costs projected up until 2050 was estimated to be as high as 3.1. The benefit-cost ratio of building more resilient houses and proper vegetation management near houses were estimated to be 1.4 and 1.3 respectively.

There is a need for coordination to ensure that the most effective activities are targeted. Measures suggested by the Australian Business Roundtable include more detailed mapping of bush and fire loads that allows the determination of the risk level for each house, as well as the ascertainment of the most effective ways of mitigating the bushfire risk. The incentives for mitigation can be either market-based (insurance discount) or mandated (legal requirement).

In order to reduce the risk of electrically caused bushfires, the Victorian Government announced a A$ 750m programme of works to take place over a ten-year period in 2011. The programme is focused on activities that will reduce the risk and not cause significant impact on electricity supply reliability. Part of the programme is replacing bare wire power lines with underground cables in the highest bushfire risk areas.

Munich Re strongly supports the concept of targeted pre-loss mitigation work for bushfire and other critical natural hazards as a means of increasing resilience in communities and saving life and property. This was and remains one of the motivating factors behind our support for the Australian Business Roundtable.

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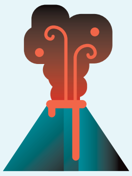
Sleeping giants underneath

Alexander Allmann
Munich Re expert on volcanoes

With the exception of extremely rare major meteorite impacts, no other natural events can devastate such large areas with the intensity and suddenness of volcanic eruptions. Their direct effects: lava, mudflows and pyroclastic flows, ash clouds and ash deposits. The indirect effect: climate impact. The losses: besides the direct losses, disruption of air traffic and shipping, and crop losses.

Twenty-eight Holocene volcanoes are located in New Zealand. They are called "Holocene" because they were active in the Holocene epoch, starting some 11,700 years ago. A total of 326 Holocene eruptions have been documented in New Zealand, 228 of them occurring after 1500 AD. The largest Holocene eruption in New Zealand happened some 1,800 years ago – with dramatic impact: the Taupo eruption generated a pyroclastic flow that devastated an area of about 20,000 km^2 and produced pumice and ash falls over a wide expanse of the central North Island. It was the most violent volcanic eruption the world has seen in the last 5,000 years.

Taupo also produced the world's most recent VEI 8 (Volcanic Explosivity Index) eruption, about 26,500 years ago. VEI 8 is defined by an eruption volume of more than 1,000 km^3. This eruption created a caldera that is partly filled by lake Taupo today. The thickness of thepra (volcanic material) reached up to 200 m in the central North Island. Heavy ash falls went far beyond New Zealand's coasts: on the Chatman Islands, some 1,000 km away, 18 cm of ash was deposited.



#Volcanoes close to people and infrastructure, limited historical data, risks nobody dares to think of. #New Zealand, #Auckland, #Volcanic fields.

Much of the North Island of New Zealand lies within 100 km of one or more Holocene volcanoes, this includes seven airports and eight ports. Also, some 5,600 km of roads and 770 km of railroads are located within 100 km of a volcano. While the proximal population of most of New Zealand's volcanoes is relatively small, a particular exception to this is the Auckland Volcanic Field beneath the city of Auckland, the economic hub of the country. This volcanic field extends over 360 km^2 and comprises 50 separate volcanic vents which are located beneath and next to a heavily populated area. Even a small eruption could have a huge impact.

In the course of 250,000 years, the Auckland volcanoes have transformed the local landscape. The field includes small cones as well as explosive craters. The volcanoes are fed by a single hotspot at a depth of 100 km. Each eruption occurred in a new location, and it is rather unlikely that a forthcoming event will reactivate one of the existing vents. The last eruption took place 600 years ago and created Rangitoto Island.

The global perspective

Worldwide, around 550 volcanoes are classed as being active. Each year, between 50 and 65 of them erupt. The 1980 eruption of Mount St. Helens in the US state of Washington demonstrated quite dramatically the disaster potential of volcanoes. Since then, the eruptions of Mount Pinatubo (Philippines, 1991), La Soufrière (Montserrat, 1995–97) and Mount Tavurvur (Papua New Guinea, 2006) also caused substantial losses. During the eruption of Mount Eyjafjallajökull on Iceland in 2010, an ash cloud rose several kilometres high into the atmosphere and was carried towards northern and central Europe by the prevailing winds. European airspace was closed to air traffic for safety reasons, and more than 100,000 flights were cancelled, with consequent knock-on effects for airline profits. A local eruption might thus have tremendous global impacts.

Eruptions can also lead to devastating agricultural losses. Some crops do not survive a layer of ash just 1 cm deep. In addition, major volcanic eruptions can have an impact on the global climate. During a major event, ash clouds and volcanic gases are often ejected into the higher atmosphere, where they are distributed around the globe over time. Blocking portions of the sunlight, they can cause global temperatures to drop for a couple of years. Such a temperature drop would trigger weather extremes and cause crop losses over vast regions.

Frequency of volcanic eruptions

The effects of large volcanic eruptions are so severe that the occurrence probability needs to be considered not only on a local basis but also globally. Unfortunately, major eruptions have not been fully documented – either in historical or in geological terms. In order to be able to arrive at more precise values of the occurrence probability in future, Munich Re is currently supporting a research project under the overall control of the Department of Earth Sciences at the University of Bristol (UK). The aim is to extend the database for major eruptions from the current 2,000 years to 10,000 years. This work increasingly allows us to get a more dependable idea of the overall occurrence rate of major volcanic eruptions.

Despite the availability of better data on overall volcano statistics and our ability to warn people more reliably of imminent eruptions, we still have no means of predicting when or where the next VEI 8 eruption will strike.

Volcanic eruption – An insurable risk?

In principle, volcanic eruption is an insurable risk. Apart from a few exceptions, however, the infrequency of loss occurrences means that the technical rate is low. Any action taken in response to an advance warning – in other words, an evacuation – would constitute an immense logistical challenge. In the case of the Auckland Volcanic Field, more than 1.3 million people would be affected.

However, volcanic eruptions can also become global catastrophes. An event on the scale of the Yellowstone volcano eruption 630,000 years ago would exceed the limits of insurability. At that time, huge areas of North America were covered in ash. The scale of the damage is unimaginable.

So far, the insurance industry has not dealt systematically with such extreme events, including those involving other natural hazards. Munich Re will therefore continue to support projects like the Global Volcano Model that will make it possible to assess such risks more effectively in the future.

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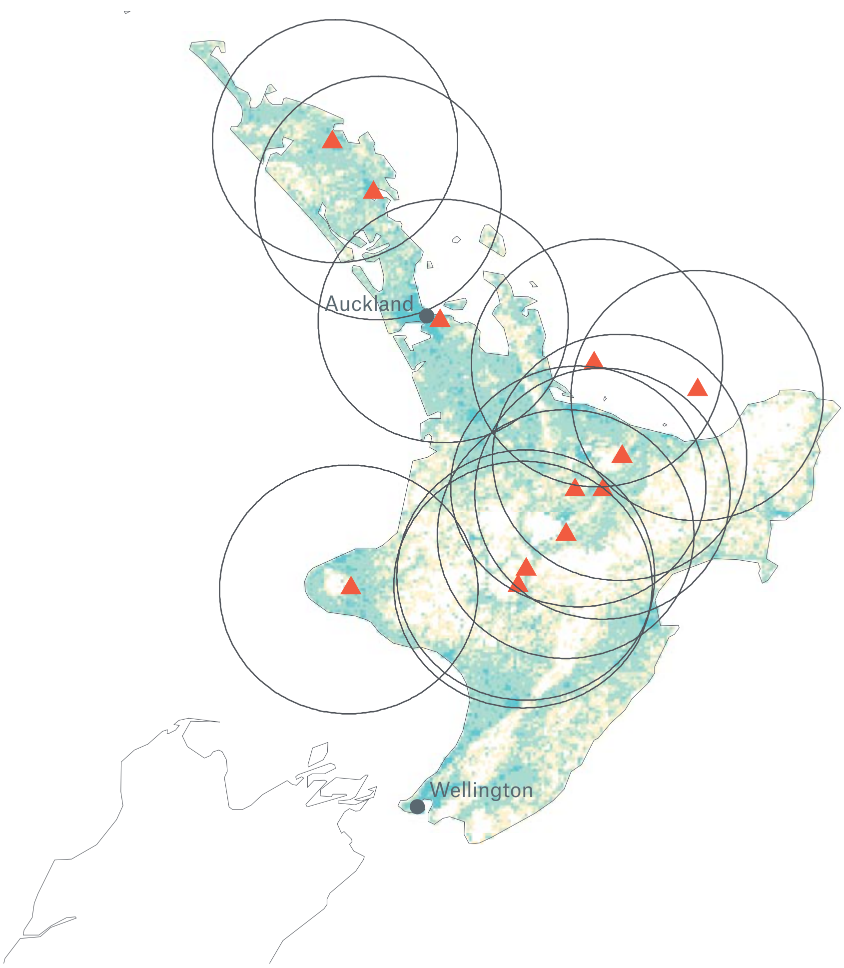
Volcanoes in New Zealand



Much of the North Island of New Zealand lies within 100 km of one or more Holocene volcanoes, this includes seven airports and eight ports.

Source: Munich Re

How much can Australia’s economy withstand?

Michael Menhart
Munich Re’s Chief Economist

Major natural catastrophes are a burden even to successful national economies like Australia's. The Australian government spends over half a billion Australian dollars annually on post-disaster relief and recovery, but only A$ 50m on pre-disaster prevention and mitigation. Is Australia adequately prepared for potential risks of change?

The development of the Australian economy is a remarkable success story. It has seen inflation-adjusted, average growth of over 3% every year for the last 20 years. Though it did not emerge totally unscathed, Australia even weathered the global financial crisis without slipping into recession.

The country benefits from its wealth of natural assets and resources, particularly in the sectors of mining, tourism and farming. Iron ore and coal make up over one third of its total export volume. In fact, Australia is one of the world's largest coal producers and exporters. However, these economic strengths are also what make the country so vulnerable when natural catastrophes occur. The situation is further compounded by a rising concentration of values in Queensland and Western Australia, and growing urbanisation in the coastal regions.

Australia hit hard by 2010/2011 floods

In late 2010 and early 2011, the Queensland floods, one of the costliest natural catastrophes ever to hit Australia, led to direct losses of A$ 6.8bn. While this is equivalent to just 1% of Australia's economic output, the overall economic effect of a natural catastrophe is not just the sum of direct damage to buildings, roads and mines. Indirect, secondary effects must also be taken into account, such as production losses in flooded mines or a reduction in coal exports. Roughly 25% of mines had to temporarily suspend operations altogether, another 60% suffered severe restrictions. The mining sector was hit hardest, with immediate production losses of A$ 6bn. Australian farming sustained crop losses of A$ 2bn while revenue losses in tourism came to A$ 400m.

Major natural catastrophes take a lasting economic toll

The immediate effects of natural catastrophes on a country's economic activities can easily be observed and measured, but what lasting impacts do natural catastrophes have? It is often assumed that natural catastrophes (notwithstanding the tragic human consequences) can have a positive effect on an economy because reconstruction acts as an economic stimulus.

Empirical studies show, however, that the indirect, positive effects on overall prosperity do not make up for the indirect losses natural disasters cause. For example, "severe, devastating, major" natural catastrophes with over 100 fatalities and over US$ 250m (A$ 300m) in direct, inflation-adjusted losses were found to lead to a statistically significant reduction in real GDP of nearly 4% after five years, compared to real GDP growth without the catastrophe.

The financial burden of natural catastrophes is not immediately evident in economic growth rates, for instance because the costs of recovery work in the wake of a disaster are subsequently posted as income. Nevertheless, the long-term repercussions should not be underestimated. This applies in particular to government finances. As data from the International Monetary Fund indicate, Australia's general government debt, at 34% of GDP, is still relatively low by international

> "Climate change is a risk to the success story of the Australian economy"
>
> Michael Menhart,
> Munich Re's Chief Economist

standards, but has risen sharply since the global financial crisis. The debt level in 2007 was still below 10% of GDP. The objective of balancing the budget has not been achieved to this day, due not least to support payments made to private households and businesses, as well as government expenditure on replacement investment following the natural disasters of recent years.

The comparatively low public debt is a critical advantage in global competition, but it is not enough to rely solely on prudent fiscal policy. In the case of a natural catastrophe, the state usually has little alternative but to provide generous support to the affected regions. A future increase in the loss potential from natural hazard events – resulting from a continued rise in the concentration of values and the effects of climate change – would place a huge strain on the national budget and jeopardise this important competitive advantage.

Australia's economy is far from immune

Australia has a stable, dynamic economy, a tried-and-tested natural disaster management system and a well-funded insurance industry. The country is therefore better equipped to cope with natural disasters than less developed nations. Nevertheless, events like the Queensland floods show that Australia is far from immune. This is true now more than ever, for although the growth outlook for the Australian economy is still positive, things are not looking quite as rosy as in past years, when the Australian economy was boosted considerably by the mining boom and the tremendous dynamism of the Chinese economy.

Accordingly, it will become more difficult for the Australian government and for private households to cushion the consequences of natural disasters. The coffers will not be quite so full.

Hardly a year goes by in which Australia is not hit by a relatively severe natural catastrophe, not to mention frequent minor to moderate events.

The Australian government currently spends an estimated A$ 560m annually on post-disaster relief and recovery, but only A$ 50m on pre-disaster prevention and mitigation. Public investments in cost-efficient resilience and disaster reduction measures could reduce natural catastrophe costs by more than 50% by 2050, as estimated by the Australian Business Roundtable for Disaster Resilience & Safer Communities in June 2013.

Australia must arm itself against changing parameters

Should climate change greatly increase the frequency and/or intensity of events, the prevention and recovery costs will pose an immense economic challenge. In Australia and New Zealand, the increase in greenhouse gas concentrations over the last 50 years has already led to a significant rise in average temperatures. They are expected to rise further in this century. The consequences could be more frequent hot extremes and extreme rainfall, associated with the flood risk in many locations.

Precisely because of the country's impressive economic success story, Australia must arm itself against the changing parameters. Research shows that countries with higher insurance penetration suffer less from the economic impact of natural catastrophes. Insurance has an essential role to play in mitigating these adverse effects.

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