
# Climate risk discussion

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Munich RE


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1. Climate risk assessment: natural catastrophe losses, climate science
2. Climate risk measurement: policy, financial disclosure, measurement tools
3. Transitional risk transfer: green tech investment, renewables risk, mining rehabilitation risk
4. Physical risk transfer: Nat Cat schemes, cyclone, drought, resilience bonds, pandemic emergency financing
5. Next step discussions

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# Natural catastrophes and climate change

## >40 years of expertise at Munich Re

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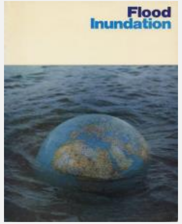
**1973**
MR's first global warming alert




**1974**
Foundation of Geo Risks Research department

**1978**
First edition of „World Map of Natural Hazards"


**1989**
First (physical) Globe of Natural Hazards

**1990**
Analyses of NatCat events in "Schadenspiegel"

**1994**
First edition of "Topics GEO"


**2000**
First CD-ROM „World map of Natural Hazards"

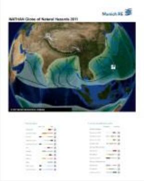
MCII

**2005**
Founding of „Munich Climate Insurance Initiative" (MCII)

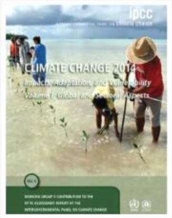
**2007**
Climate change defined as strategic topic
→ Founding Corporate Climate Centre

**2009**
Founding of „Desertec Industrial Initiative" (Dii)


**2011**
NATHAN Risk Suite



**2014**
Contribution to IPCC 5th Assessment Report




**2015**
G7 Climate Risk Insurance

**2017**
NatCatSERVICE online Analysis Tool


Source: Munich Re, Geo Risks Research / Corporate Climate Centre

# Munich Re's climate change strategy with focus on the following fields of activity

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## RISK ASSESSMENT & MEASUREMENT

Detecting and assessing climate change impacts on frequency and intensity of natural hazards

Understanding climate related financial disclosure requirements and providing tools to measure physical & transitional risk

## RISK TRANSFER SOLUTIONS

Providing risk transfer solutions for new technologies and PPP solutions for markets particularly affected by adverse effects of climate change

## ASSET MANAGEMENT

Supporting the expansion of renewable energies and infrastructure projects with our sustainable investment strategy

**Carbon neutrality of Munich Re**

*Munich: since 2009, reinsurance worldwide: since 2012, Munich Re (Group): since end 2015*

**New Coal Guidelines**

*Withdrawal from insurance of new coal power plants and coal mines; no investment in coal intensive shares and bonds*

**TCFD (Task Force on Climate-related Financial Disclosures)**

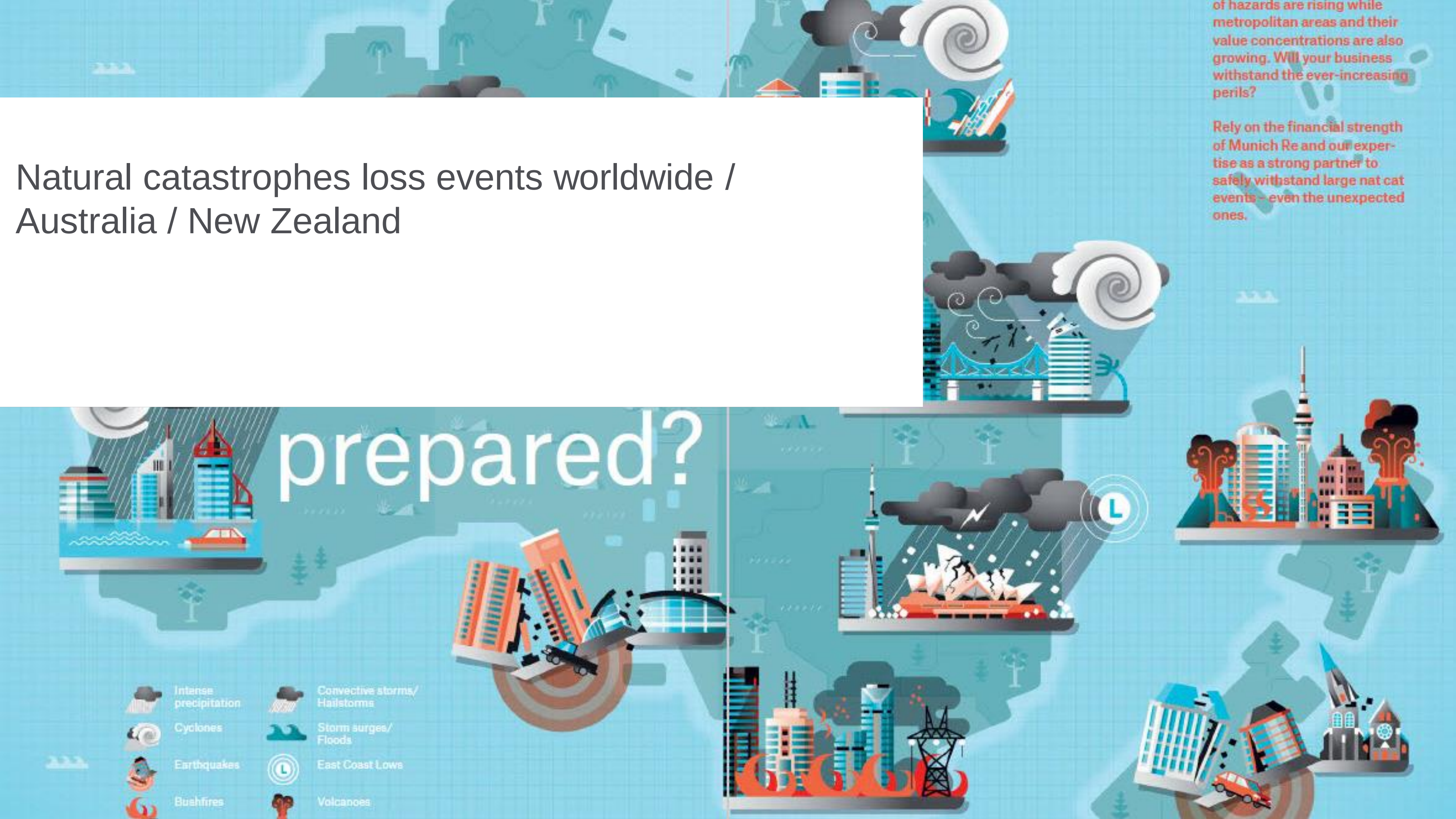
*Participation in UNEP PSI Working Group on TCFD elaborating industry standards for disclosures*

Source: Munich Re

# 1. Climate risk assessment:

natural catastrophe losses, climate science

# Natural catastrophes loss events worldwide / Australia / New Zealand



# NatCatSERVICE

## One of the world‘s largest databases on natural catastrophes

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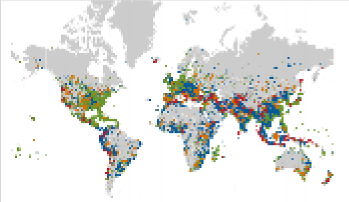
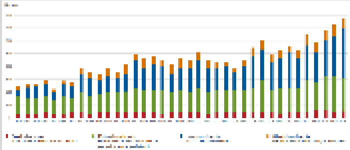
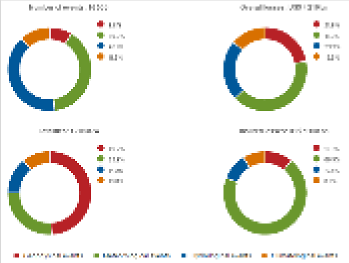
### The Database

- Loss events from 1980 until today; for USA and selected countries in Europe: loss events since 1970
- Retrospectively, all great disasters since 1950
- In addition, ~2,600 major historical events starting from 79 AD with the eruption of Mt. Vesuvius
- **Currently ca. 43,000 data sets**

### Online Analysis Tool



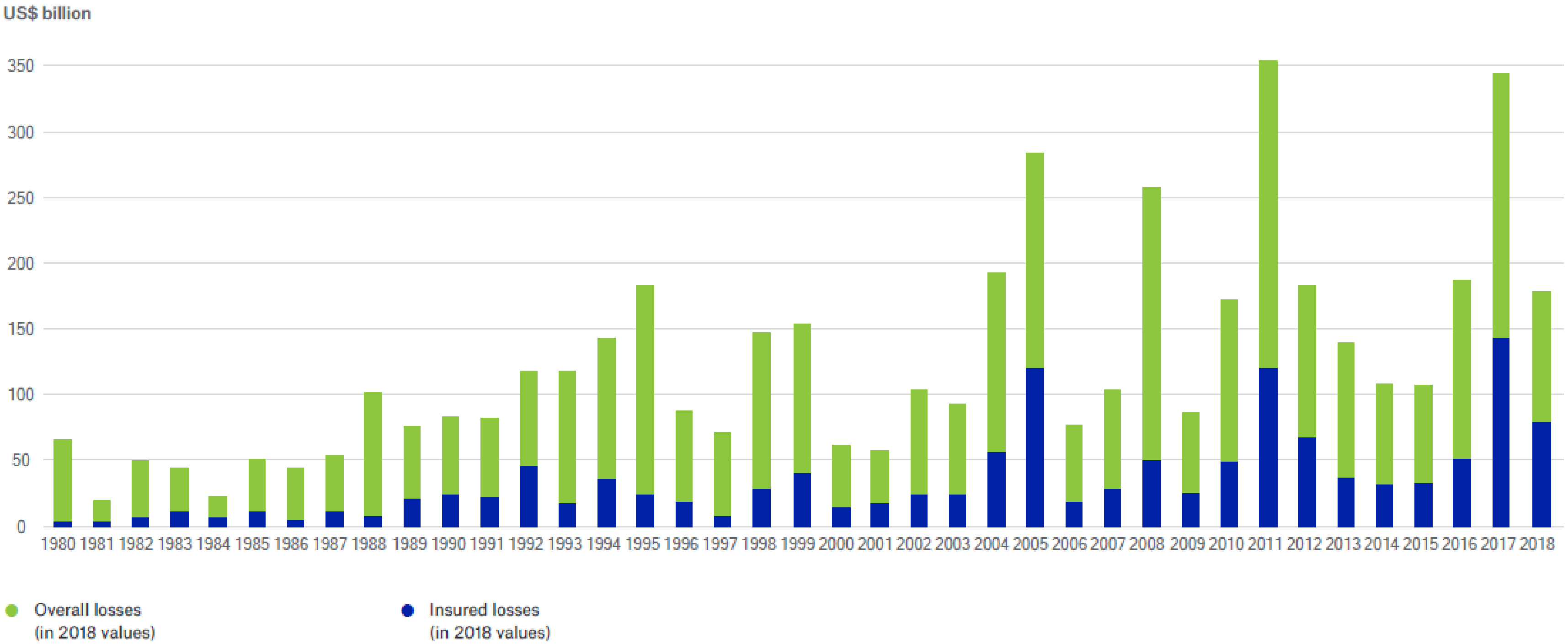




http://natcatservice.munichre.com

# Natural catastrophes loss events worldwide 1980-2018

## Development of overall and insured losses




Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

# Natural catastrophes loss events worldwide 1980-2018

## Costliest events ordered by inflation adjusted overall losses

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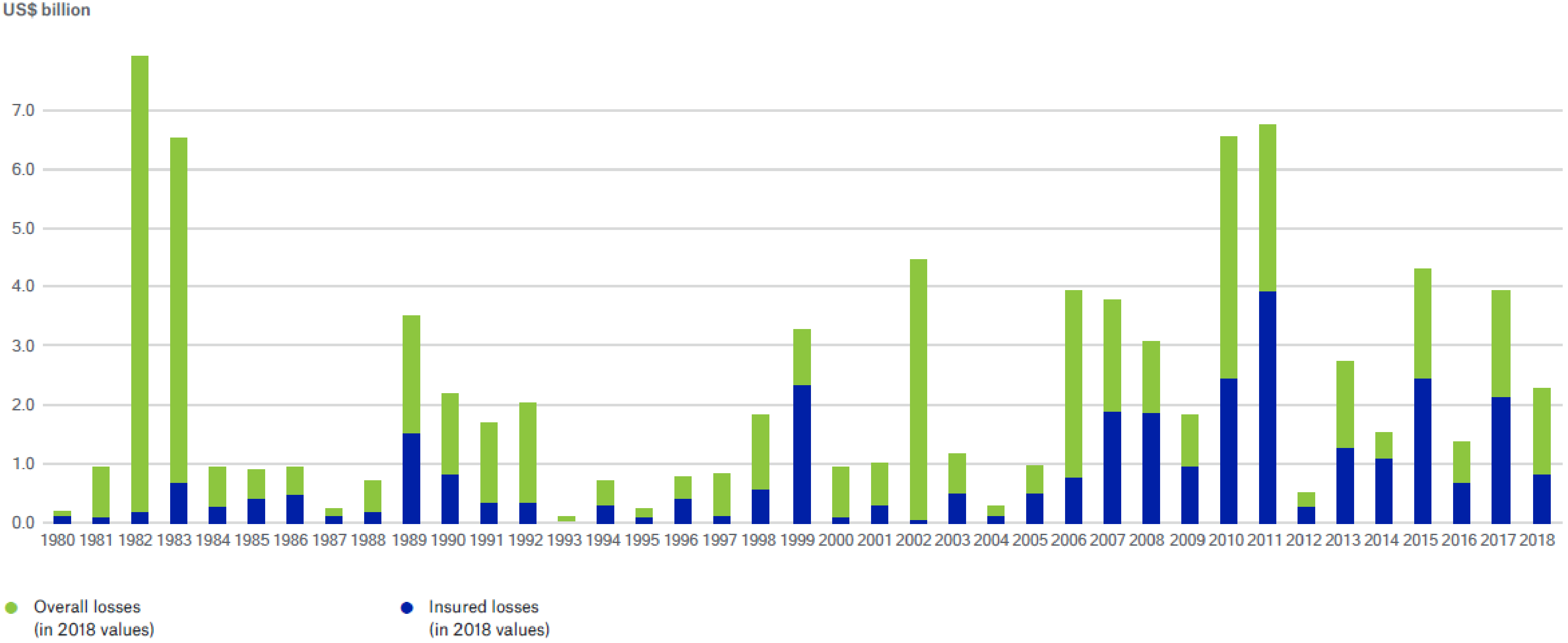
| Date | Event | Affected Area | Overall losses (US$m, in 2018 values) | Insured losses (US$m, in 2018 values) | Fatalities |
|---|---|---|---|---|---|
| 25 - 30 Aug 2005 | Hurricane Katrina, storm surge | United States: LA, New Orleans, Slidell, MS, Biloxi, Pascagoula, Waveland, Gulfport, Bay St. Louis, Hattiesburg, McComb, AL, FL | 157,000 | 75,900 | 1,720 |
| 11 Mar 2011 | Earthquake, tsunami | Japan: Honshu, Miyagi, Sendai, Aomori, Tohoku, Fukushima, Mito, Ibaraki, Tochigi, Utsunomiya, Iwate, Morioka, Yamagata, Chiba, Tokyo | 157,000 | 29,800 | 15,880 |
| 12 May 2008 | Earthquake | China: Sichuan, Mianyang, Beichuan, Wenchuan, Shifang, Chengdu, Guangyuan, Ngawa, Ya'an, Ziyang, Meishan, Suining, Garzê, Neijiang, Gansu, Shaanxi, Chongqing, Yunnan, Maoxian | 107,000 | 380 | 87,149 |
| 25 Aug - 1 Sep 2017 | Hurricane Harvey, storm surge, flood | United States: TX, Harris County, Houston, Rockport, Refugio, Corpus Christi, Galveston, Crosby, LA, Lake Charles, Evangeline, AL, LA, MS, NC, TN, Nashville, Davidson County | 95,000 | 30,000 | 88 |
| 17 Jan 1995 | Earthquake | Japan: Hyogo, Kobe, Osaka, Kyoto | 86,800 | 2,600 | 6,430 |
| 23 - 31 Oct 2012 | Hurricane Sandy, storm surge | United States, Cuba, Haiti, Bahamas, Canada, Jamaica, Dominican Republic, Puerto Rico | 73,100 | 31,100 | 207 |
| 17 Jan 1994 | Earthquake | United States: CA, Northridge, Los Angeles, San Fernando Valley, Ventura, Orange | 72,800 | 25,300 | 61 |
| 19 - 22 Sep 2017 | Hurricane Maria, flood | Puerto Rico, Virgin Islands, U.S., Dominica, Guadeloupe, Dominican Republic, Martinique, Haiti | 68,600 | 29,900 | 3,019 |
| 6 - 14 Sep 2017 | Hurricane Irma, storm surge, flood | United States, Virgin Islands, U.S., Virgin Islands, British, Cuba, Saint Martin, Sint Maarten, Saint Barthelemy, Anguilla, Puerto Rico, Turks and Caicos Islands, Antigua and Barbuda, Bahamas, Bonaire, Sint Eustatius, Saba, Dominican Republic, Haiti, Saint Kitts and Nevis | 60,600 | 33,400 | 128 |
| 23 - 27 Aug 1992 | Hurricane Andrew | United States, Bahamas | 46,700 | 29,700 | 66 |

# Natural catastrophes loss events in Australia 1980-2018

## Development of overall and insured losses




Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

# Natural catastrophes loss events in Australia 1980-2018

## Percentage distribution of overall and insured losses by event family

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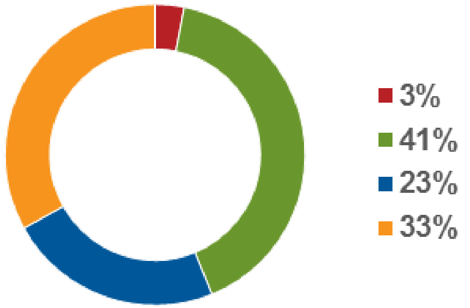
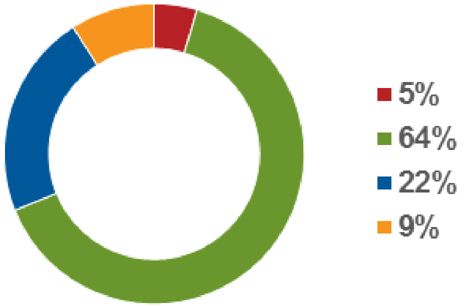
### Overall losses: US$ 88bn




### Insured losses: US$ 31bn




- Geophysical events (Earthquake, tsunami, volcanic activity)
- Meteorological events (Tropical cyclone, extratropical storm, convective storm, local storm)
- Hydrological events (Flood, mass movement)
- Climatological events (Extreme temperature, drought, forest fire)

Accounted events have caused at least one fatality and/or produced normalised losses ≥ US$ 100k, 300k, 1m, or 3m (depending on the assigned World Bank income group of the affected country).

Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

# Natural catastrophes loss events in Australia 1980-2018

## Costliest events ordered by inflation adjusted overall losses

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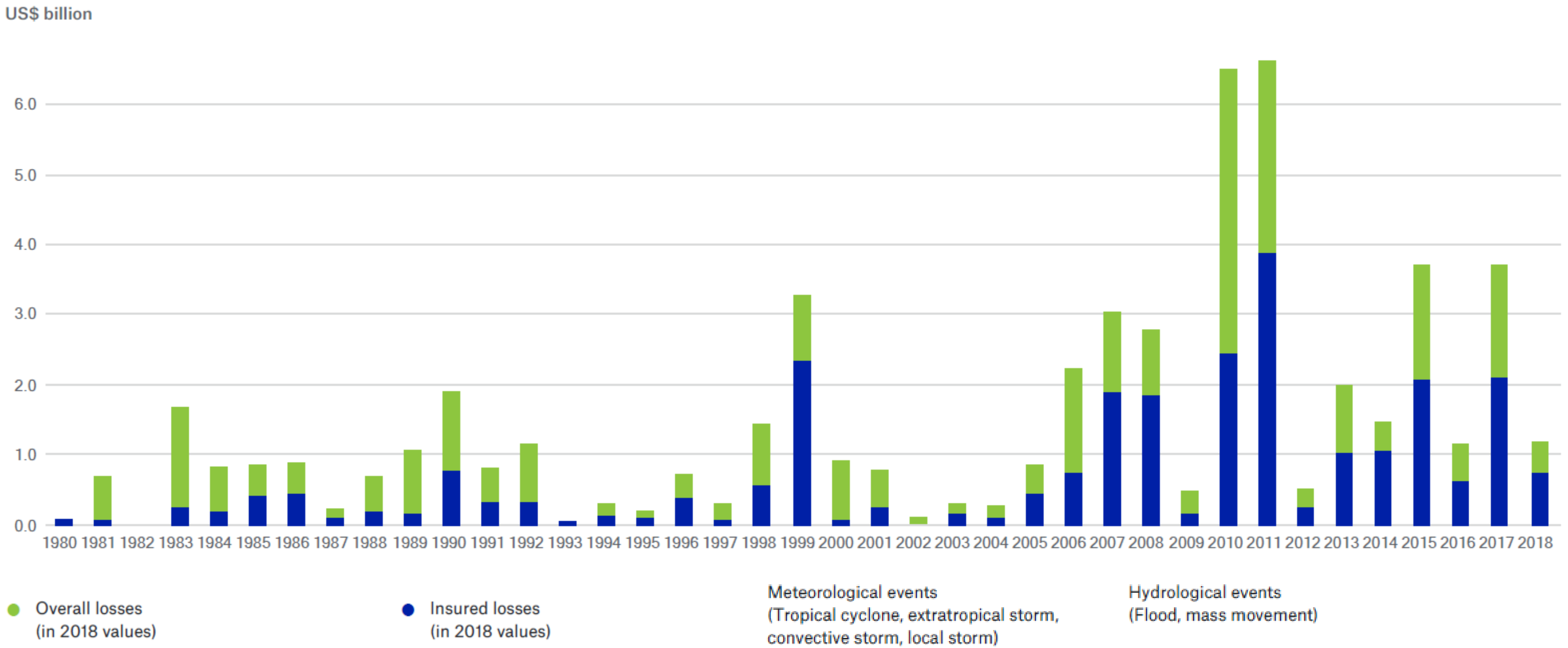
| Date | Event | Affected Area | Overall losses (US$m, in 2018 values) | Insured losses (US$m, in 2018 values) | Fatalities |
|---|---|---|---|---|---|
| Sep - Dec 1982 | Drought | Australia: Victoria, New South Wales, Broken Hill, Queensland, South Australia | 7,800 | 130 | |
| 1 Mar 2002 - 31 Jan 2003 | Drought | Australia: almost entire country | 4,300 | | |
| Jan - Jun 1983 | Drought | Australia: South Australia, Victoria, New South Wales, Broken Hill, Queensland, | 4,000 | | |
| 3 Dec 2010 - 20 Jan 2011 | Flood | Australia: Queensland, Rockhampton, Cairns, Innisfail, Theodore, Chinchilla, Dalby, Moura, Mundubbera, Jericho, Alpha, Emerald, Bundaberg, Burnett, Woorabinda, Warra, Wowan, Pittsworth, Condamine, Burketown, Bajool, Logan, Mackay, Baralaba, Dysart, Warrick, Gympie, Withcott, Heldion, Gatton, Murphys Creek, Stanthorpe, Ingham, Lowood, Withcott, Goondiwindi, New South Wales, Boggabilla, Toomelah, Grafton, Tenterfield | 3,600 | 510 | 13 |
| 14 Apr 1999 | Hailstorm | Australia: Wollongong, Bundeena, Sydney, Cronulla, Sutherland, Surry Hills, Double Bay, Albion Park, Randwick, Kensigton, Paddington | 2,900 | 2,100 | 1 |
| 27 Mar - 6 Apr 2017 | Cyclone Debbie, flood | Australia: Queensland, Proserpine, Bowen, Whitsunday Islands, Mackay, Airlie Beach, Sarina, New South Wales, Tweed, Lismore, Byron, Richmond Valley, Kyogle, Ballina, Murwillumbah | 2,700 | 1,400 | 12 |
| 10 - 14 Jan 2011 | Flood, flash flood | Australia: Queensland, Brisbane, Ipswich, Toowoomba, Grantham, Gladstone | 2,700 | 1,600 | 22 |
| 28 Dec 1989 | Earthquake | Australia: New South Wales, Newcastle, Sydney | 2,400 | 1,300 | 13 |
| 2 - 7 Feb 2011 | Cyclone Yasi | Australia: Queensland, Tully, Townsville, Mission Beach, Cardwell, Giru, Ingham, Innisfail, Cassowary Coast Shire, Cairns, Bedarra and Dunk islands | 2,300 | 1,200 | 1 |
| 21 - 31 Jan 2013 | Flood, flash flood (Ex-Tropical Storm Oswald) | Australia: Queensland, Kowanyama, Pormpuraaw, Bundaberg, Brisbane, Gympie, Northern New South Wales, Grafton | 2,000 | 1,000 | 6 |

# Meteorological* and hydrological** loss events in Australia 1980-2018

## Development of overall and insured losses




Meteorological events (Tropical cyclone, extratropical storm, convective storm, local storm)

Hydrological events (Flood, mass movement)

Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

# Meteorological and hydrological loss events in Australia 1980-2018

## Costliest events ordered by inflation adjusted overall losses

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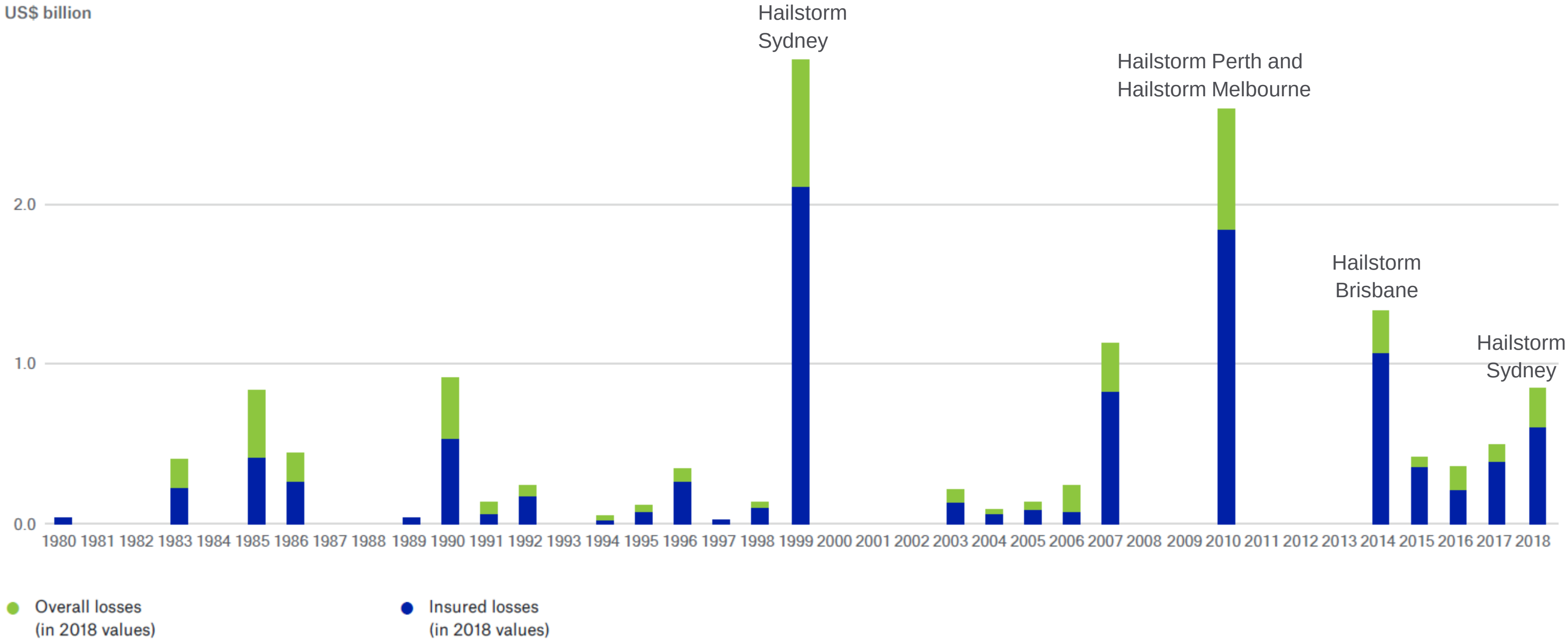
| Date | Event | Affected Area | Overall losses (US$m, in 2018 values) | Insured losses (US$m, in 2018 values) | Fatalities |
|---|---|---|---|---|---|
| 3 Dec 2010 - 20 Jan 2011 | Flood | Australia: Queensland, Rockhampton, Cairns, Innisfail, Theodore, Chinchilla, Dalby, Moura, Mundubbera, Jericho, Alpha, Emerald, Bundaberg, Burnett, Woorabinda, Warra, Wowan, Pittsworth, Condamine, Burketown, Bajool, Logan, Mackay, Baralaba, Dysart, Warrick, Gympie, Withcott, Heldion, Gatton, Murphys Creek, Stanthorpe, Ingham, Lowood, Withcott, Goondiwindi, New South Wales, Boggabilla, Toomelah, Grafton, Tenterfield | 3,600 | 510 | 13 |
| 14 Apr 1999 | Hailstorm | Australia: Wollongong, Bundeena, Sydney, Cronulla, Sutherland, Surry Hills, Double Bay, Albion Park, Randwick, Kensigton, Paddington | 2,900 | 2,100 | 1 |
| 27 Mar - 6 Apr 2017 | Cyclone Debbie, flood | Australia: Queensland, Proserpine, Bowen, Whitsunday Islands, Mackay, Airlie Beach, Sarina, New South Wales, Tweed, Lismore, Byron, Richmond Valley, Kyogle, Ballina, Murwillumbah | 2,700 | 1,400 | 12 |
| 10 - 14 Jan 2011 | Flood, flash flood | Australia: Queensland, Brisbane, Ipswich, Toowoomba, Grantham, Gladstone | 2,700 | 1,600 | 22 |
| 2 - 7 Feb 2011 | Cyclone Yasi | Australia: Queensland, Tully, Townsville, Mission Beach, Cardwell, Giru, Ingham, Innisfail, Cassowary Coast Shire, Cairns, Bedarra and Dunk islands | 2,300 | 1,200 | 1 |
| 21 - 31 Jan 2013 | Flood, flash flood (Ex-Tropical Storm Oswald) | Australia: Queensland, Kowanyama, Pormpuraaw, Bundaberg, Brisbane, Gympie, Northern New South Wales, Grafton | 2,000 | 1,000 | 6 |
| 20 Mar 2006 | Cyclone Larry | Australia: Queensland, Innisfail, Kurramine Beach, Mission Beach, Babinda, Cairns, Townsville, Mareeba, Atherton, Eacham, Cardwell, Silkwood, Mourilyan, Tully | 1,700 | 590 | |
| 8 - 10 Jun 2007 | Winter storm, flood | Australia: New South Wales, Newcastle, Hunter Valley, Maitland, Sydney | 1,500 | 900 | 9 |
| 11 - 18 Feb 2008 | Flood | Australia: Queensland, Mackay, Rockhampton, Mareeba, Townsville, Bowen, Burdekin, Burnett, Charters Towers, Dalrymple, Mirani, Miriam Vale, Nebo, Peak Downs, Thuringowa, Whitsunday Shire | 1,400 | 1,000 | 2 |
| 19 - 24 Apr 2015 | Winter storm, flash flood | Australia: New South Wales, Sydney, Dungog, Coalfields, Lake Macquarie, Port Stephens, Hunter Valley | 1,400 | 790 | 7 |

# Hailstorm loss events in Australia 1980-2018

## Development of overall and insured losses




Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

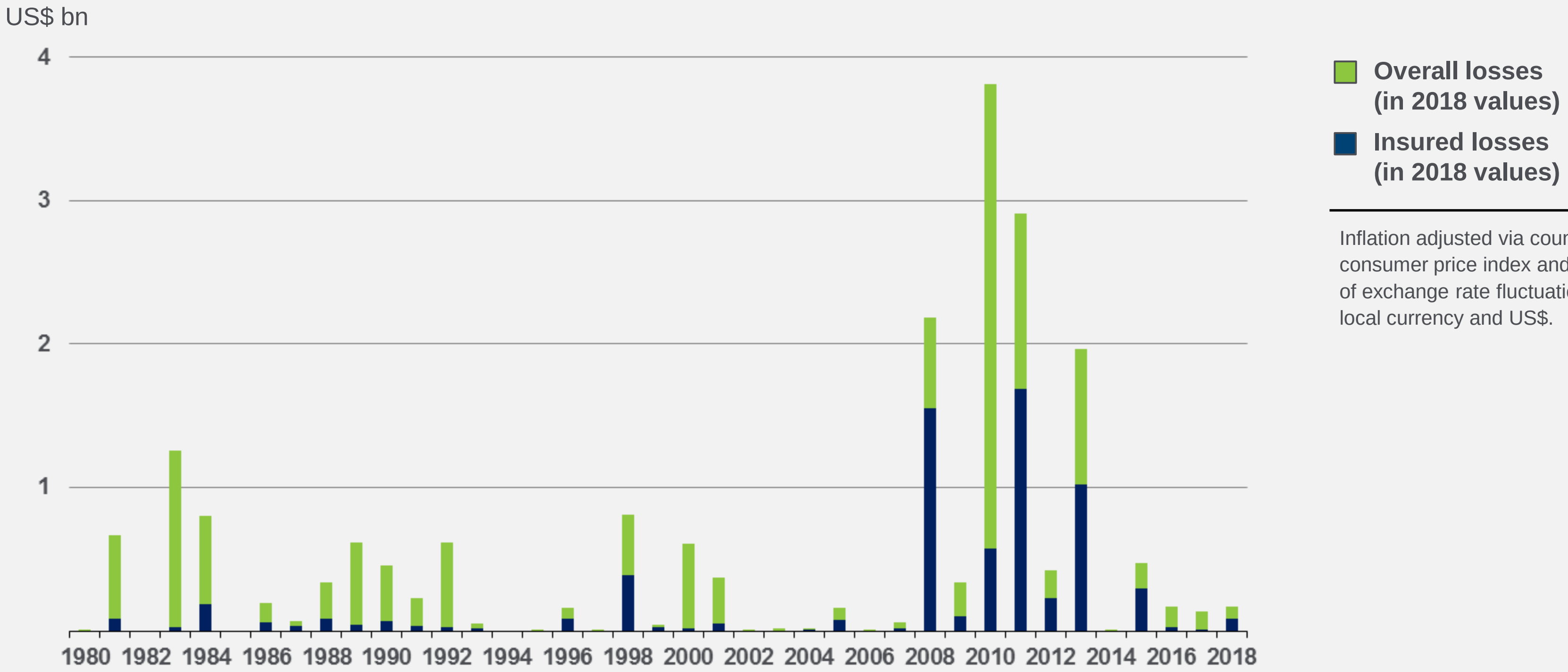
# Hailstorm loss events in Australia 1980-2018

## Costliest events ordered by inflation adjusted overall losses

| Date | Event | Affected Area | Overall losses (US$m, in 2018 values) | Insured losses (US$m, in 2018 values) | Fatalities |
|---|---|---|---|---|---|
| 14 Apr 1999 | Hailstorm | Australia: Wollongong, Bundeena, Sydney, Cronulla, Sutherland, Surry Hills, Double Bay, Albion Park, Randwick, Kensigton, Paddington | 2,900 | 2,100 | 1 |
| 22 Mar 2010 | Hailstorm, severe storm | Australia: Western Australia, Perth | 1,300 | 930 | |
| 27 Nov 2014 | Hailstorm | Australia: Queensland, Brisbane | 1,300 | 1,100 | |
| 6 - 7 Mar 2010 | Hailstorm, severe storm | Australia: Victoria, Melbourne, Mangalore, Shepparton, Menzies Creek, Ferntree Gully, Knox | 1,300 | 920 | |
| 9 Dec 2007 | Hailstorm | Australia: New South Wales, Sydney, Blacktown, Kemps Creek, Illawarra, Penrith, Baulkham Hills, Hornsby | 810 | 610 | |
| 20 Dec 2018 | Hailstorm, severe storm | Australia: New South Wales, Sydney | 800 | 610 | |
| 18 Jan 1985 | Hailstorm | Australia: Queensland, Brisbane | 780 | 400 | |
| 18 - 19 Mar 1990 | Hailstorm, severe storm | Australia: New South Wales, Sydney | 760 | 470 | |
| 17 - 19 Feb 2017 | Hailstorm | Australia: New South Wales, Sydney, Illawarra | 490 | 390 | |
| 25 Apr 2015 | Hailstorm | Australia: New South Wales, Blue Mountains, Sydney | 420 | 350 | |

# Flood events in Australia 1980 – 2018

## Overall and insured losses




Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

# Flood events in Australia 1980 – 2018

## Costliest events ordered by overall losses in 2018 values

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| Date | Event | Affected area | Overall losses in US$ m (in 2018 values) | Insured losses in US$ m (in 2018 values) | Fatalities |
|---|---|---|---|---|---|
| 3.12.2010-20.1.2011 | Flood | Queensland, Rockhampton, Cairns, Innisfail, Theodore, Chinchilla, Dalby, Moura, Mundubbera, Jericho, Alpha, Emerald, Bundaberg, Burnett, Woorabinda, Warra, Wowan, Pittsworth, Condamine, Burketown | **3,600** | 510 | 13 |
| 10-14.1.2011 | Flood, flash flood | Queensland, Brisbane, Ipswich, Toowoomba, Grantham, Gladstone | **2,700** | 1,600 | 22 |
| 21-31.1.2013 | Flood (Ex-Tropical Storm Oswald) | Queensland, Kowanyama, Pormpuraaw, Bundaberg, Brisbane, Gympie; Northern New South Wales, Grafton | **2,000** | 1,000 | 6 |
| 11-18.2.2008 | Flood | Queensland, Mackay, Rockhampton, Mareeba, Townsville, Bowen, Burdekin, Burnett, Charters Towers, Dalrymple, Mirani, Miriam Vale, Nebo, Peak Downs, Thuringowa, Whitsunday Shire | **1,400** | 1,000 | 2 |
| 21-29.5.1983 | Flood | New South Wales, Queensland | **1,000** | | 1 |

# Tropical cyclone events in Australia 1980 – 2018

## Overall and insured losses

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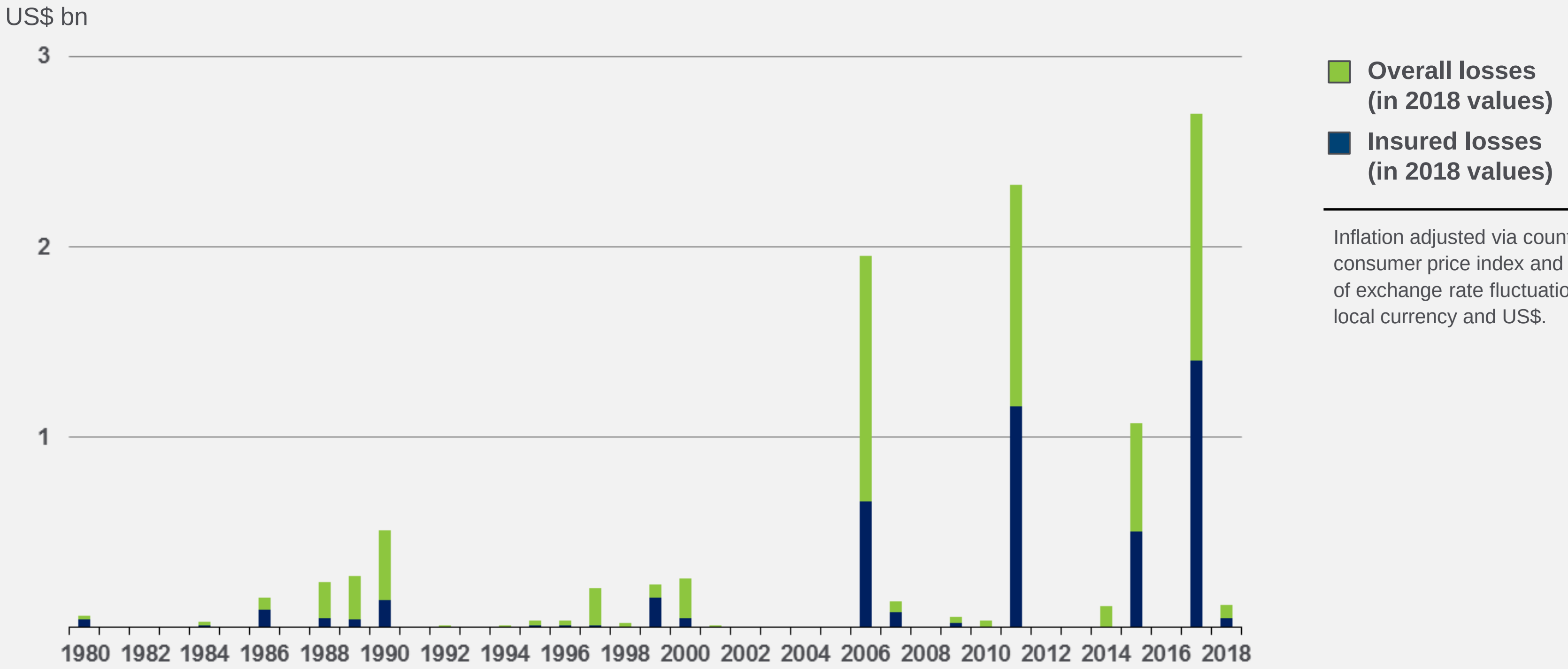


Inflation adjusted via country-specific consumer price index and consideration of exchange rate fluctuations between local currency and US$.

# Tropical cyclone events in Australia 1980 – 2018

## Costliest events ordered by overall losses

Munich RE

| Date | Event | Affected area | Overall losses in US$ m (in 2018 values) | Insured losses in US$ m (in 2018 values) | Fatalities |
|---|---|---|---|---|---|
| 27.3-6.4.2017 | Cyclone Debbie, flood | Queensland, Proserpine, Bowen, Whitsunday Islands, Mackay, Airlie Beach, Sarina; New South Wales, Tweed, Lismore, Byron | **2,700** | 1,400 | 12 |
| 2-7.2.2011 | Cyclone Yasi | Queensland, Tully, Townsville, Mission Beach, Cardwell, Giru, Ingham, Innisfail, Cassowary Coast Shire, Cairns, Bedarra and Dunk islands | **2,300** | 1,200 | 1 |
| 20.3.2006 | Cyclone Larry | Queensland, Innisfail, Kurramine Beach, Mission Beach, Babinda, Cairns, Townsville, Mareeba, Atherton, Eacham, Cardwell | **1,700** | 590 | |
| 18-21.2.2015 | Cyclone Marcia | Queensland, Yeppoon, Rockhampton, Brisbane, Shoalwater Bay, Cairns | **890** | 450 | 1 |
| 23.12.1990 - 22.1.1991 | Cyclone Joy | Queensland, Cairns, Port Douglas, Innisfail, Mackay | **440** | 95 | 6 |

# Natural catastrophes insurance gap

# The NatCat Insurance Gap by income group:
## still a serious issue not only in low-income countries

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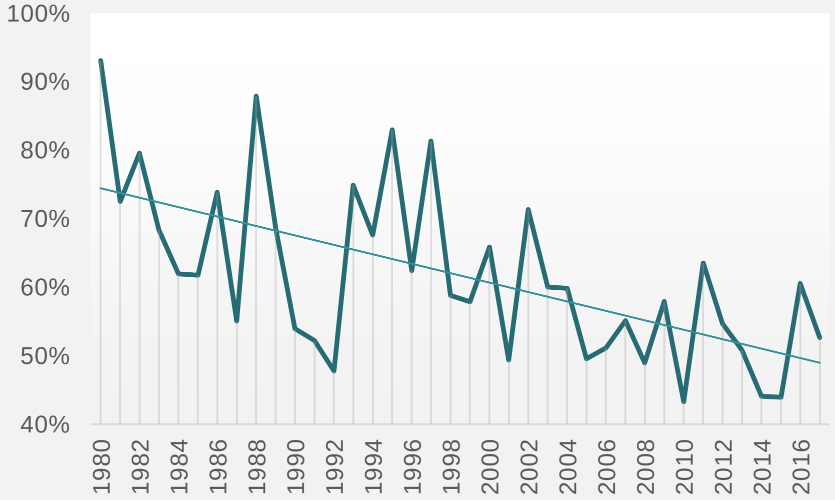
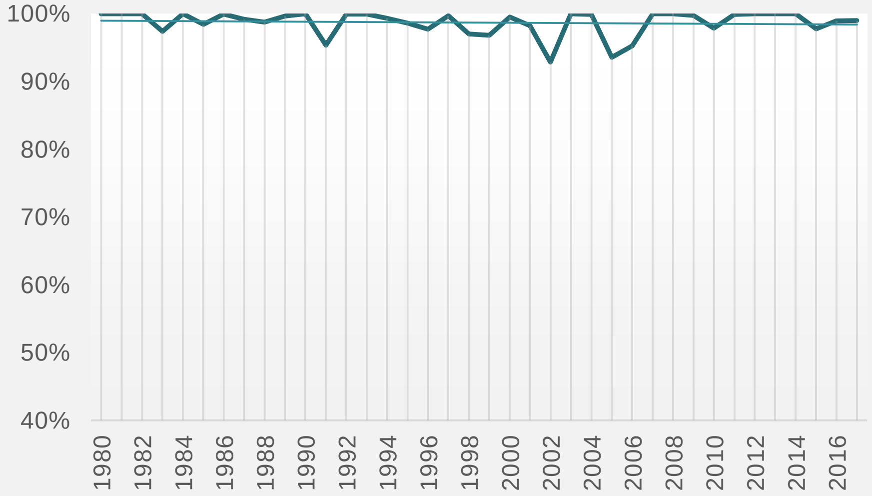
Insurance gap in high- (left) and low-income* (right) countries 1980-2017 based on MR NatCatSERVICE




Since 1980 the insurance gap (uninsured losses as a share of overall losses) has significantly decreased in high-income countries (below 60%), while in low-income countries it is still >95%.

Source: Munich Re (2018) *Income classification defined by World Bank: high-income countries GNI ≥ 12,736 US$; low-income countries GNI ≤ 1,045 US$

# The NatCat Insurance Gap for Australia:
## uninsured losses as a percentage of overall losses in Australia 1980 – 2017

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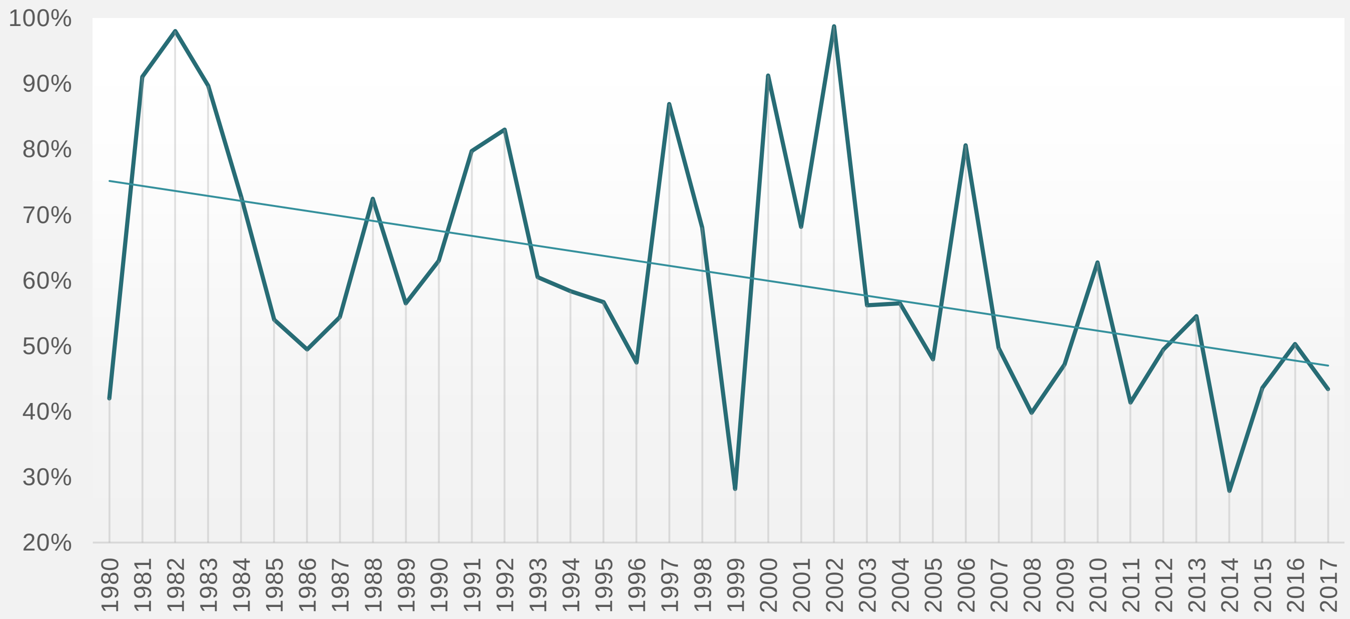
Insurance gap decreasing esp. since the beginning of the 21st century




Source: Munich Re NatCatSERVICE (2018)

# Climate science:
# How does climate change influence weather conditions in Australia?

# Drivers for globally increasing losses from natural hazards

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| Driver | Description | Assessment |
|---|---|---|
| **Global increase in population** | From 4 billion (1975) to 7.6 billion (2018) | **Not necessarily problematic** for insurers (premiums grow proportionally with risk) |
| **Improved standard of living** | Middle class is growing rapidly worldwide | |
| **Concentration of people / assets in urban areas** | Share of urban population is increasing continually: 37% (1975) - 50% (2010) - 57% (2025) | |
| **Settlement and industrialization of vulnerable areas** | Especially coastal areas, areas close to rivers | **Problematic** for insurers, if risk models are not adjusted accordingly |
| **Increase of complexity and interdependencies** | Increasing complexity of value chains (i.e. production cycles) in industrial facilities | |
| **Climate Change** | Intensification and accumulation of extreme weather events in certain areas | |

# Annual deviation of global mean temperature
## from 1880-1900 average (proxy for preindustrial era)

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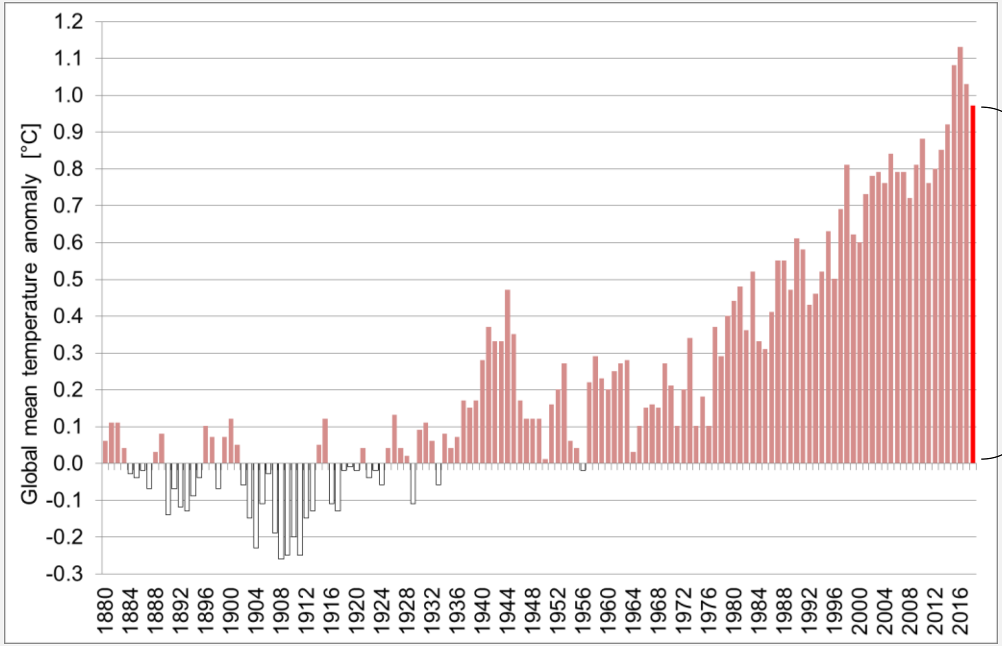


- 2018: Fourth warmest year since beginning of temperature measurement
- 9 of 10 warmest years cumulate in the phase since 2005

Source: Munich Re, based on National Centers for Environmental Information/NOAA.

# Increase of mean sea level rise is increasing globally and is expected to further increase over the next centuries

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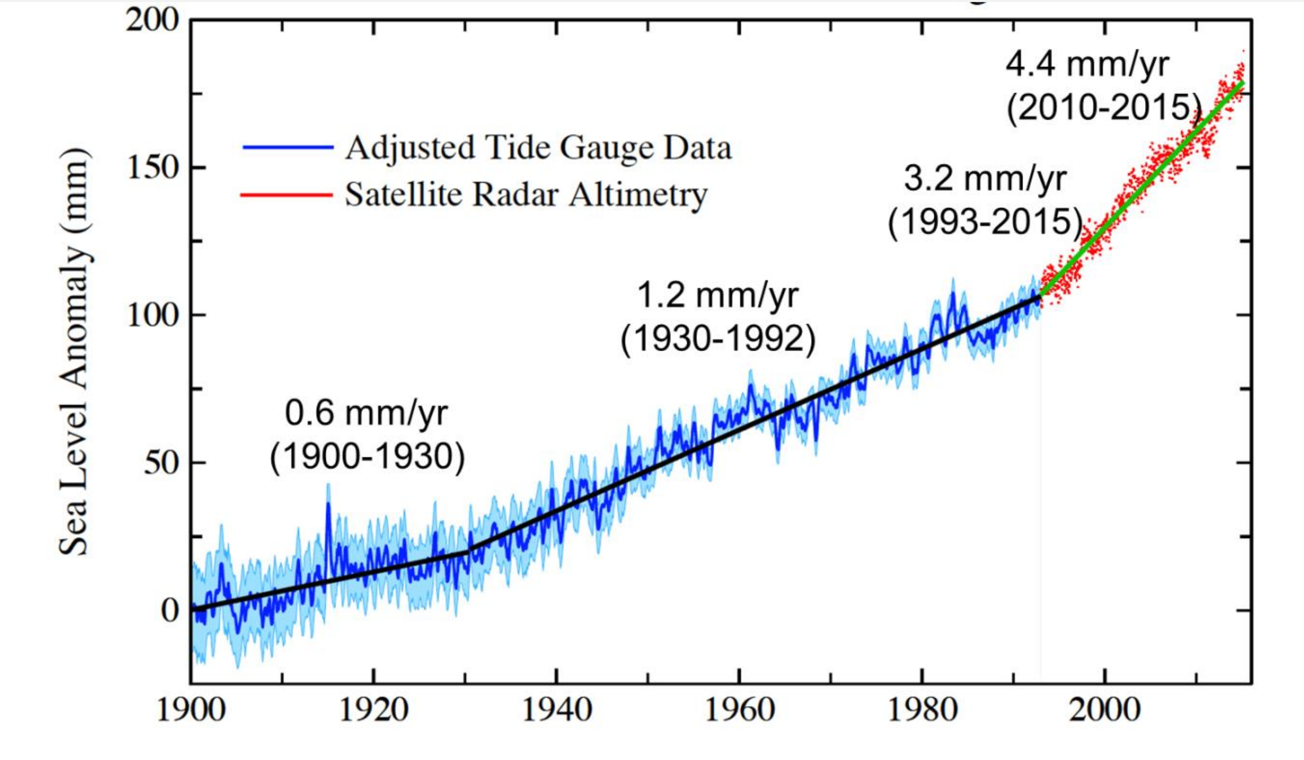
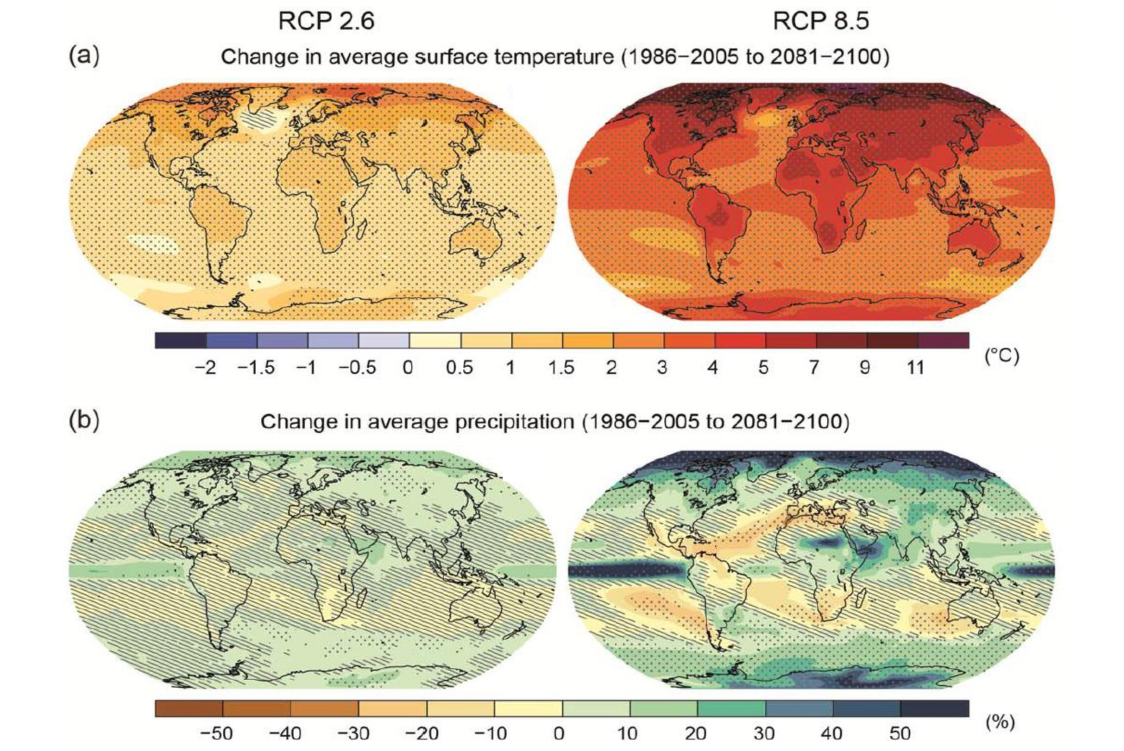



Source: Columbia University

# Changes in average surface temperature and precipitation 1986-2005 to 2081-2100




- Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850-1900 for all RCP scenarios except RCP2.6.
- The Arctic region will warm more rapidly than the global.
- The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase.
- Over most of the mid-latitude land masses and wet tropical regions extreme precipitation events will become more intense and more frequent; monsoon precipitation is likely to intensify.

Source: IPCC AR5, WG1 (2013)

# Climate projections and associated risks

… the reason for the 2°C target

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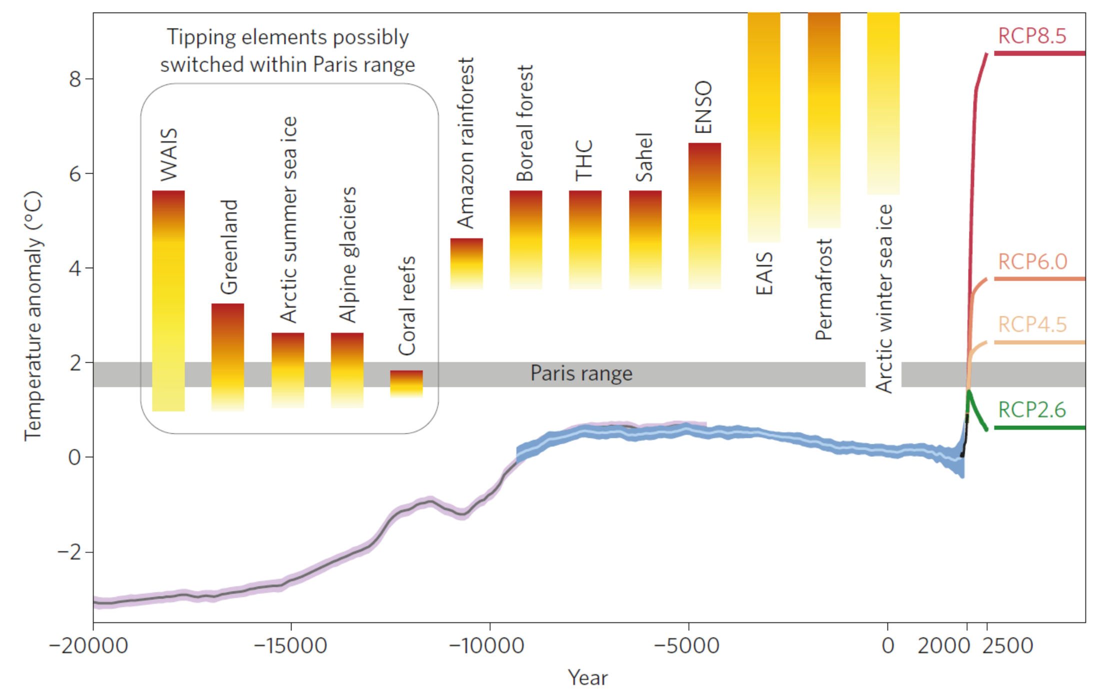
## Tipping elements in dependence on levels of increases of global mean temperature




Historic* and projected** global mean temperature (lines)

*and*

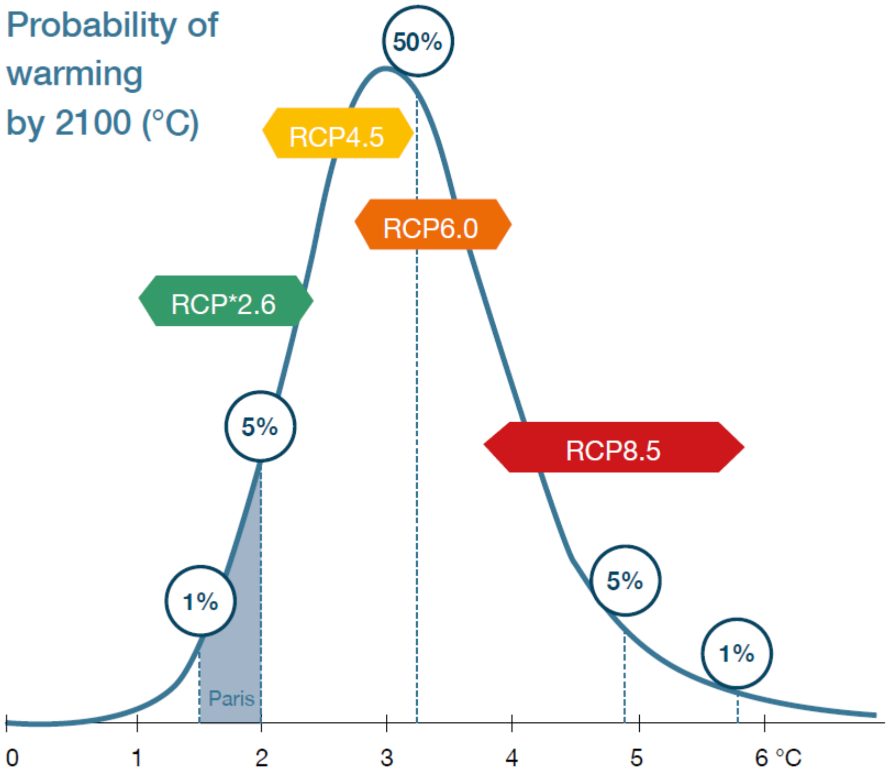
threshold ranges for crossing tipping points where major subsystems of the climate system are destabilized (columns)

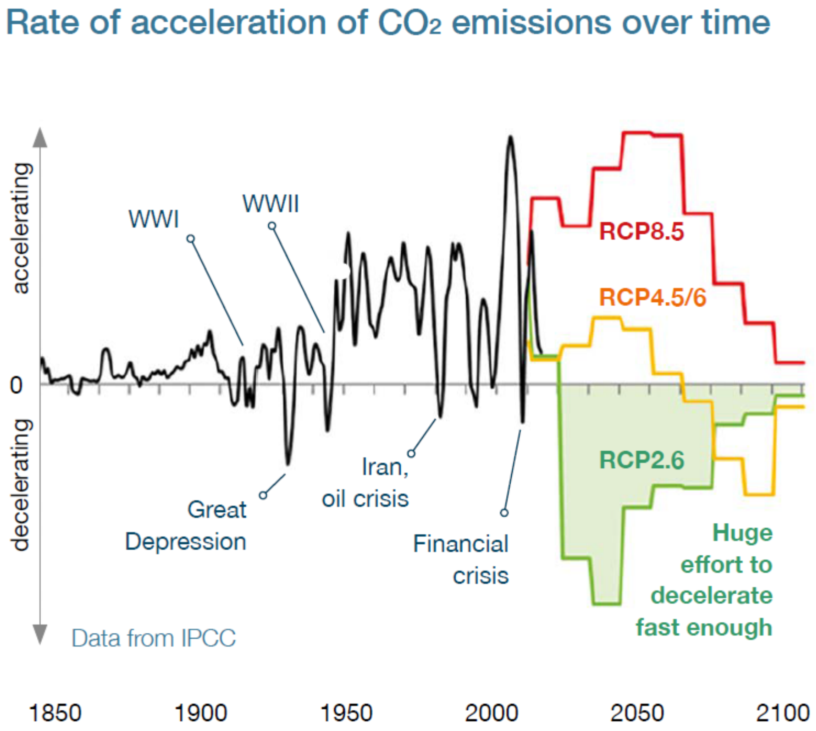
* shading shows one standard deviation
**different global warming scenarios according to IPCC 2014

Source: Schellnhuber, J. et al. (2016): Why the right climate target was agreed in Paris? Nature Climate Change.

# Meeting the Paris 1.5°-2° target is vital for our climate

sustained and extended large new emissions cuts every year necessary




Source: CRO-Forum "The Heat is on" (2019)

# Meeting the Paris 1.5°-2° target is vital for our climate

## Physical impacts of global warming until the end of this century

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| Warming by 2100 | | <2 °C | | 3 °C | 5 °C |
|---|---|---|---|---|---|
| **Physical impacts** | | 1.5 °C | 2 °C | | |
| Sea-Level Rise (cm) | | 0.3-0.6 m | 0.4-0.8 m | 0.4-0.9 m | 0.5-1.7 m |
| Coastal assets to defend ($tn) | | $10.2tn | $11.7tn | $14.6tn | $27.5tn |
| Chance of ice-free Arctic summer | | 1 in 30 | 1 in 6 | 4 in 6 (63%) | 6 in 6 (100%) |
| Tropical cyclones: | Fewer (#cat 1-5) | -1% | -6% | -16% | Unknown |
| | Stronger (# cat 4-5) | +24%* | +16% | +28% | +55% |
| | Wetter (total rain) | +6% | +12% | +18% | +35% |
| Frequency of extreme rainfall | | +17% | +36% | +70% | +150% |
| Increase in wildfire extent | | x1.4 | x1.6 | x2.0 | x2.6 |
| People facing extreme heatwaves | | x22 | x27 | x80 | x300 |
| Land area hospitable to malaria | | +12% | +18% | +29% | +46% |

Source: CRO-Forum "The Heat is on" (2019)

# Meeting the Paris 1.5°-2° target is vital for our climate

## Economic impacts of global warming until the end of this century

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| Economic impacts | <2 °C | | 3 °C | 5 °C |
|---|---|---|---|---|
| | 1.5 °C | 2 °C | | |
| Global GDP impact (2018: $80tn) | -10% | -13% | -23% | -45% |
| Stranded assets | Transition: fossil fuel assets (supply, power, transport, industry) | | Mixed: some fossil fuel assets mothballed, some physical stranding | Physical: uninhabitable zones, agriculture, water-intense industry, lost tourism etc |
| Food supply | Changing diets, some yield loss in tropics | | 24% yield loss | 60% yield loss, 60% demand increase |
| Insurance opportunities | New low-carbon assets and infrastructure investment (e.g. CCS) | | Increasing demand to manage growing risks | Minimal: recession, tensions, high and unpredictable risks |

Source: CRO-Forum “The Heat is on” (2019)

# Trends in hot weather in Australia

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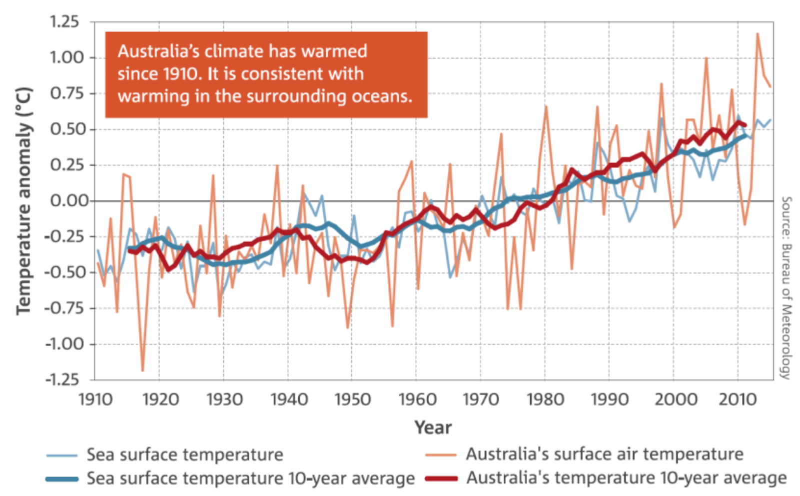
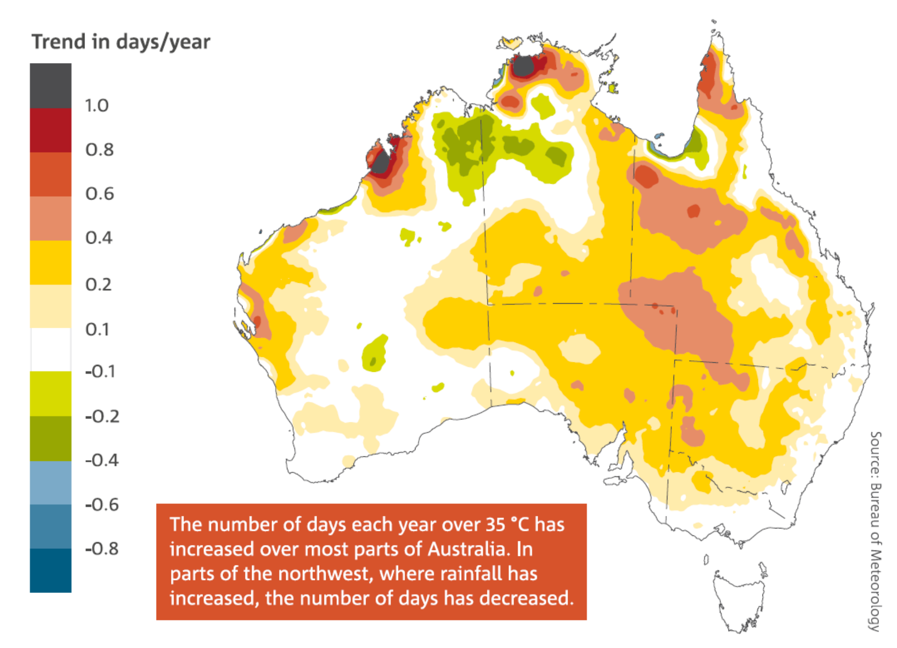
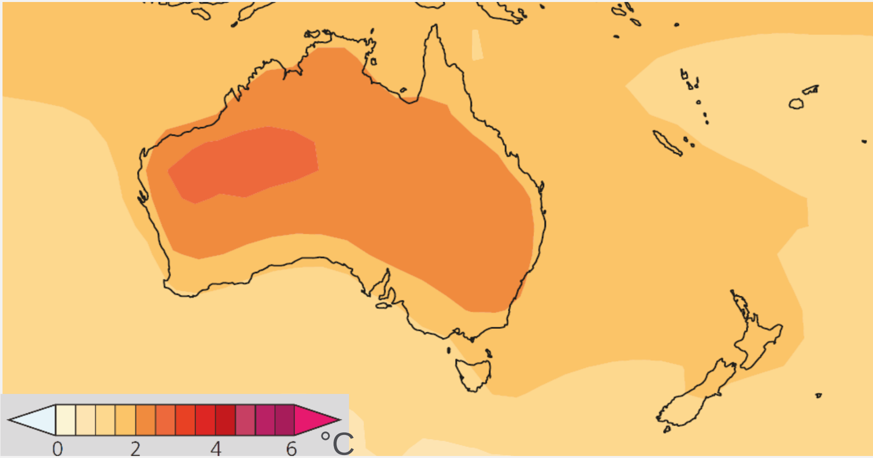


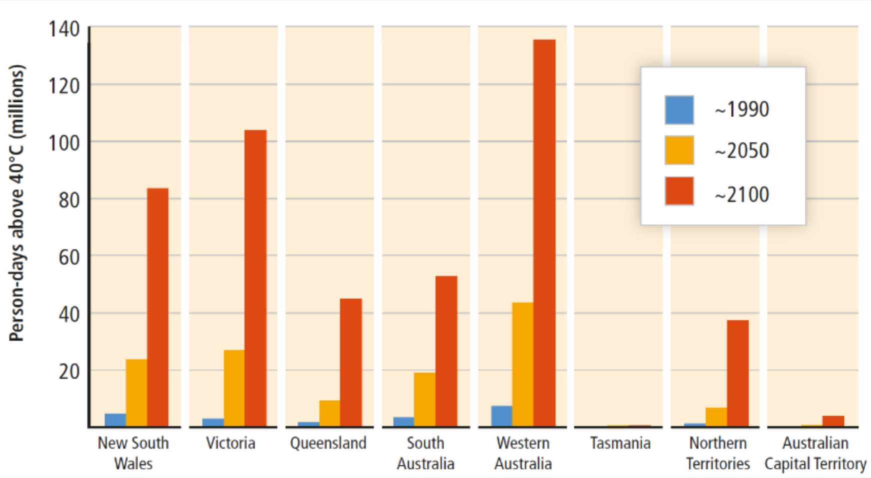

The trend in annual number of days >35°C. An increase of 0.2 days/year since 1957 means, on average, that there are almost 12 more days per year over 35°C.

Source: CSIRO amd BoM: State of the Climate 2016

# A hot future ahead …



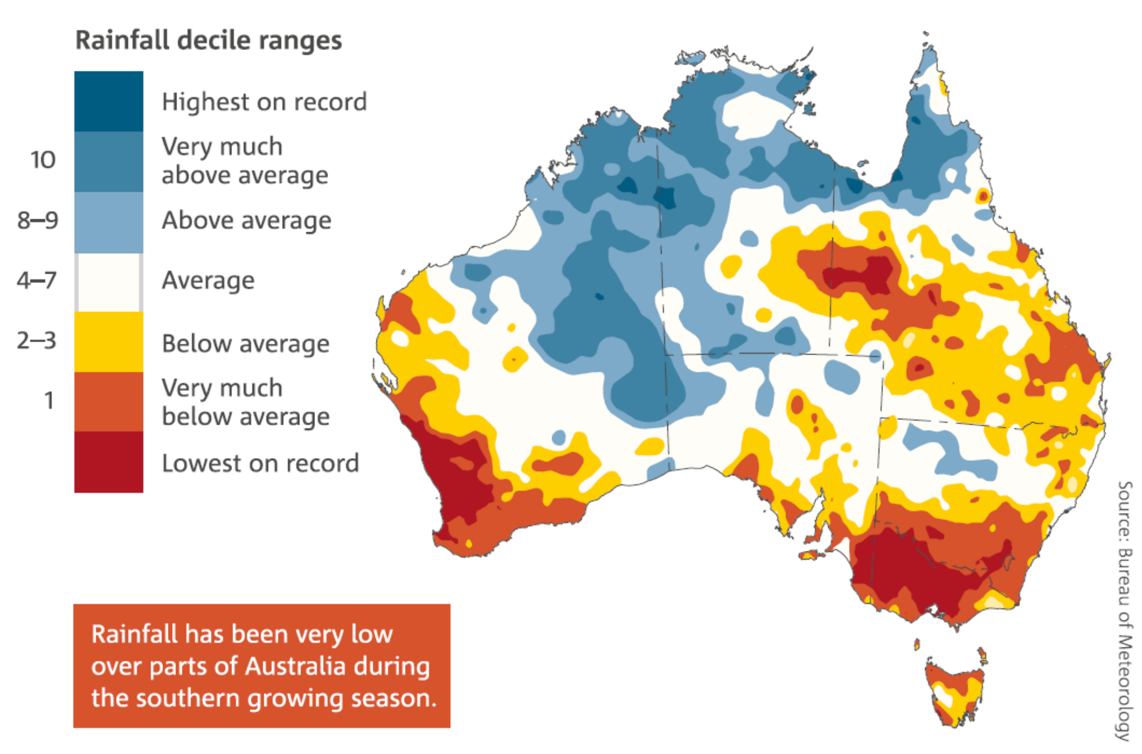

Projected temperature change by 2050
relative to 1986–2005 (RCP8.5)




Projected change in person-days above 40°C
relative to 1986–2005 (SRES A1FI),
including projected population growth.

Source: IPCC, Fifth Assessment Report, WG II, Ch.25: Australasia

# Rainfall deciles for the growing season (Apr-Oct) in Australia (1996-2015)




Growing season (April–October) rainfall deciles for the last 20 years (1996–2015). A decile map shows where rainfall is above average, average or below average for the recent period, in comparison with the entire rainfall record from 1900.

Source: CSIRO amd BoM: State of the Climate 2016

# Trends in fire weather (FFDI) in Australia

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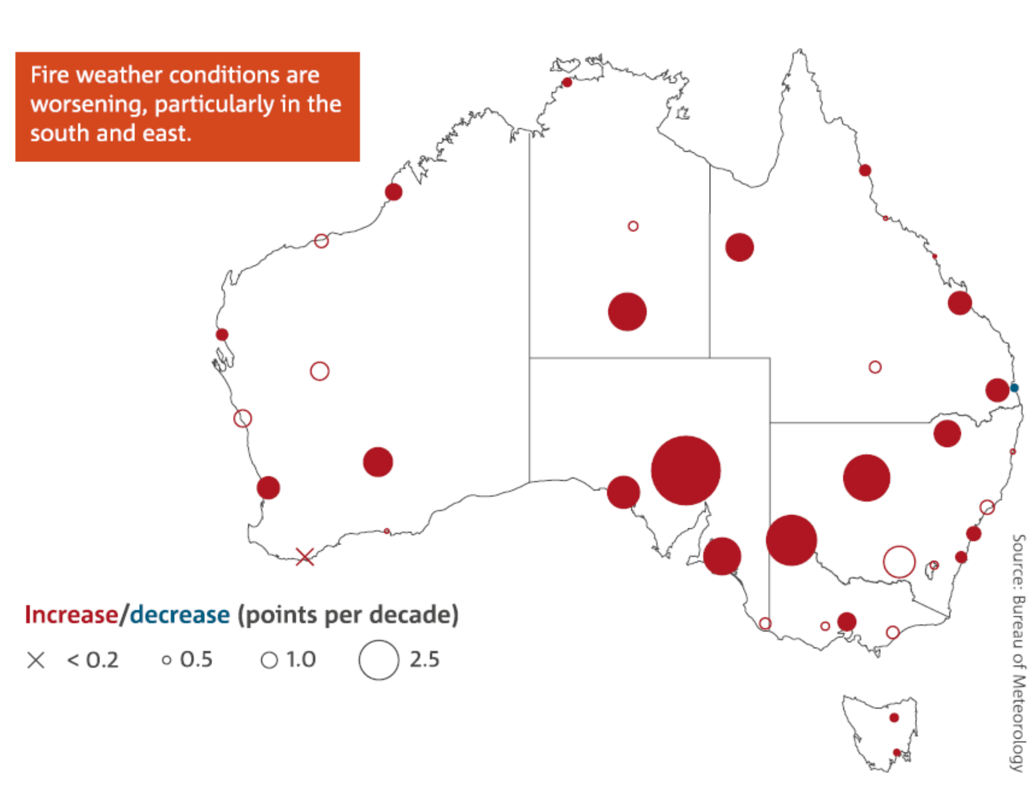


Trends from 1974 to 2015 in annual 90th percentile of daily FFDI at 38 climate reference locations. Trends are in FFDI points per decade and larger circles represent larger trends. Filled circles represent statistically significant trends. Trends are upward (in red), except for Brisbane airport (in blue). Figure is updated to 2015 from Clarke et al. (2013).

Source: CSIRO amd BoM: State of the Climate 2016

# El Niño/La Niña - Precipitation impacts on Australia

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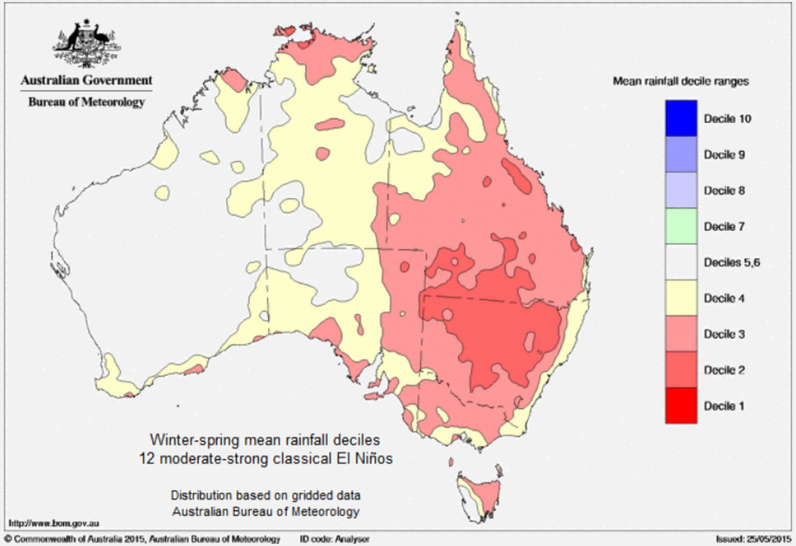
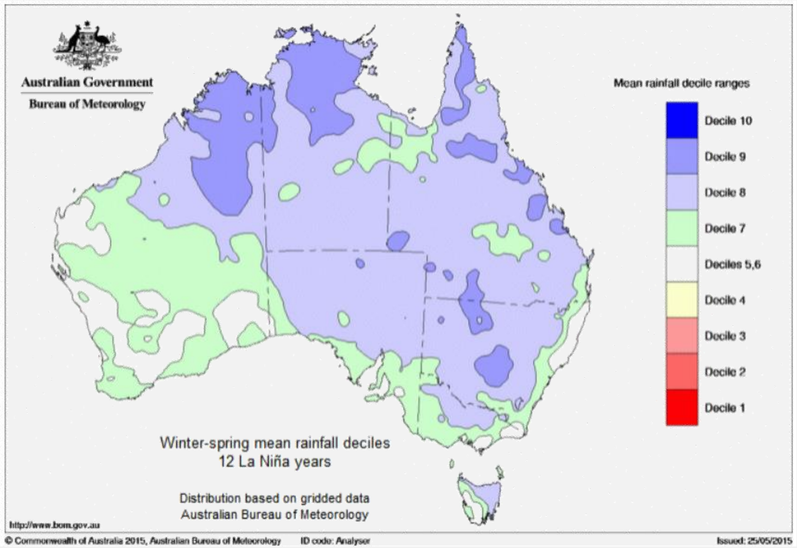
## El Niño precipitation impacts




Dryness and increased warmth in E Australia

## La Niña precipitation impacts




Wet and reduced warmth in N and E Australia

Source: http://www.bom.gov.au

# Tropical Cyclones over Australia: Location of maximum Cyclone intensity is moving southward over time

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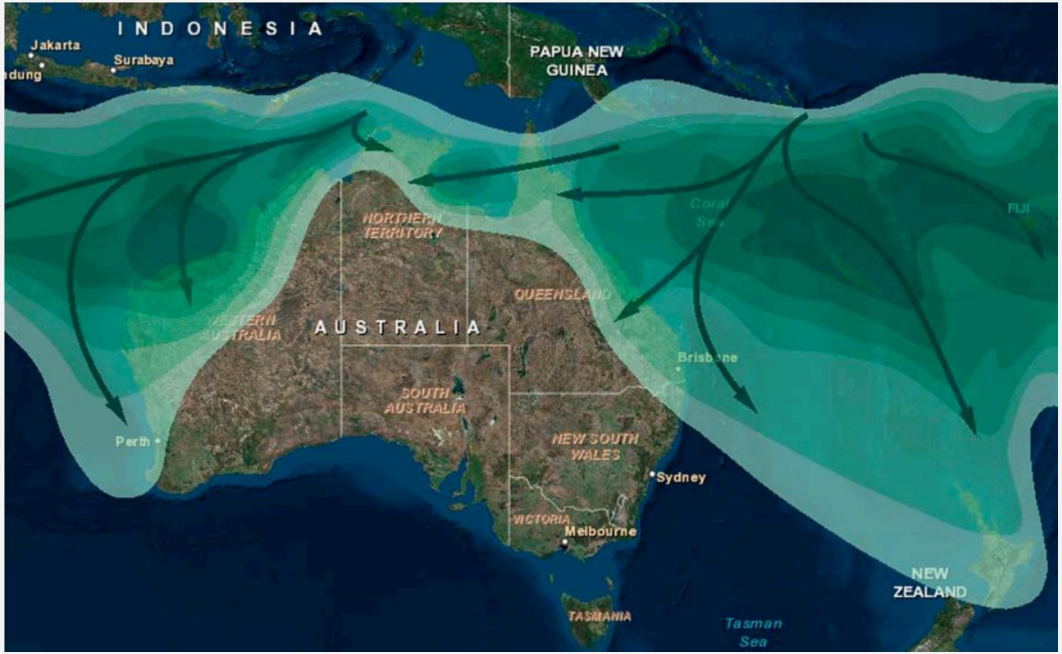
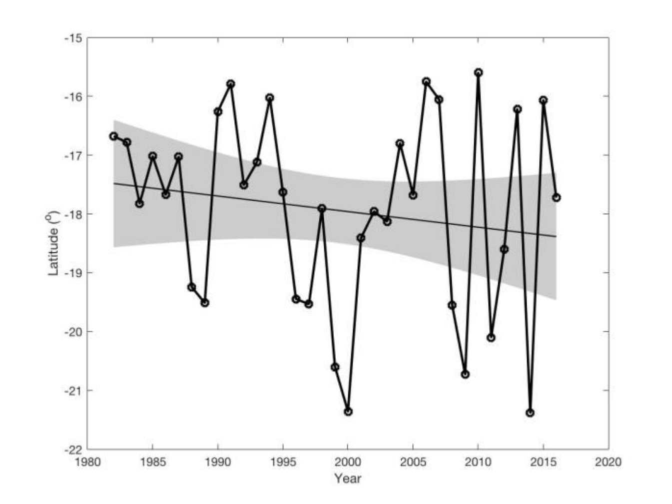
## Future areas affected by tropical cyclones in Australia



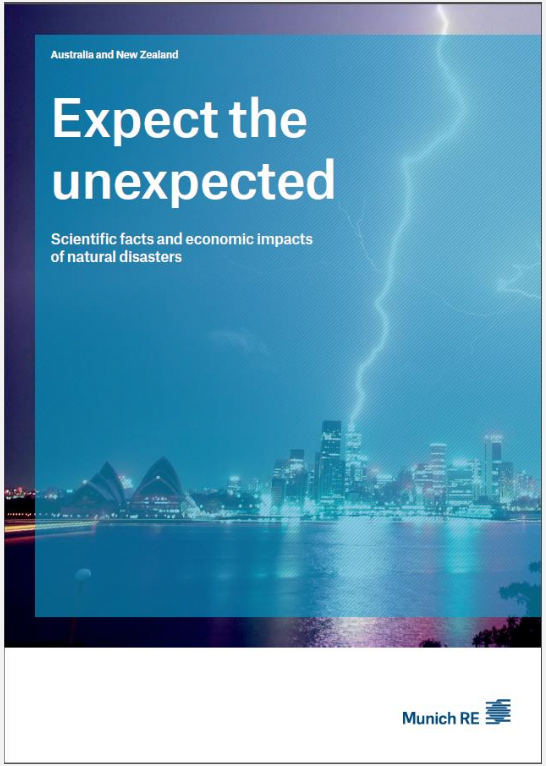

## Distance Southward from Equator




Source: NATHAN Risk Suite (left), Jim Kossin, NASA (right)

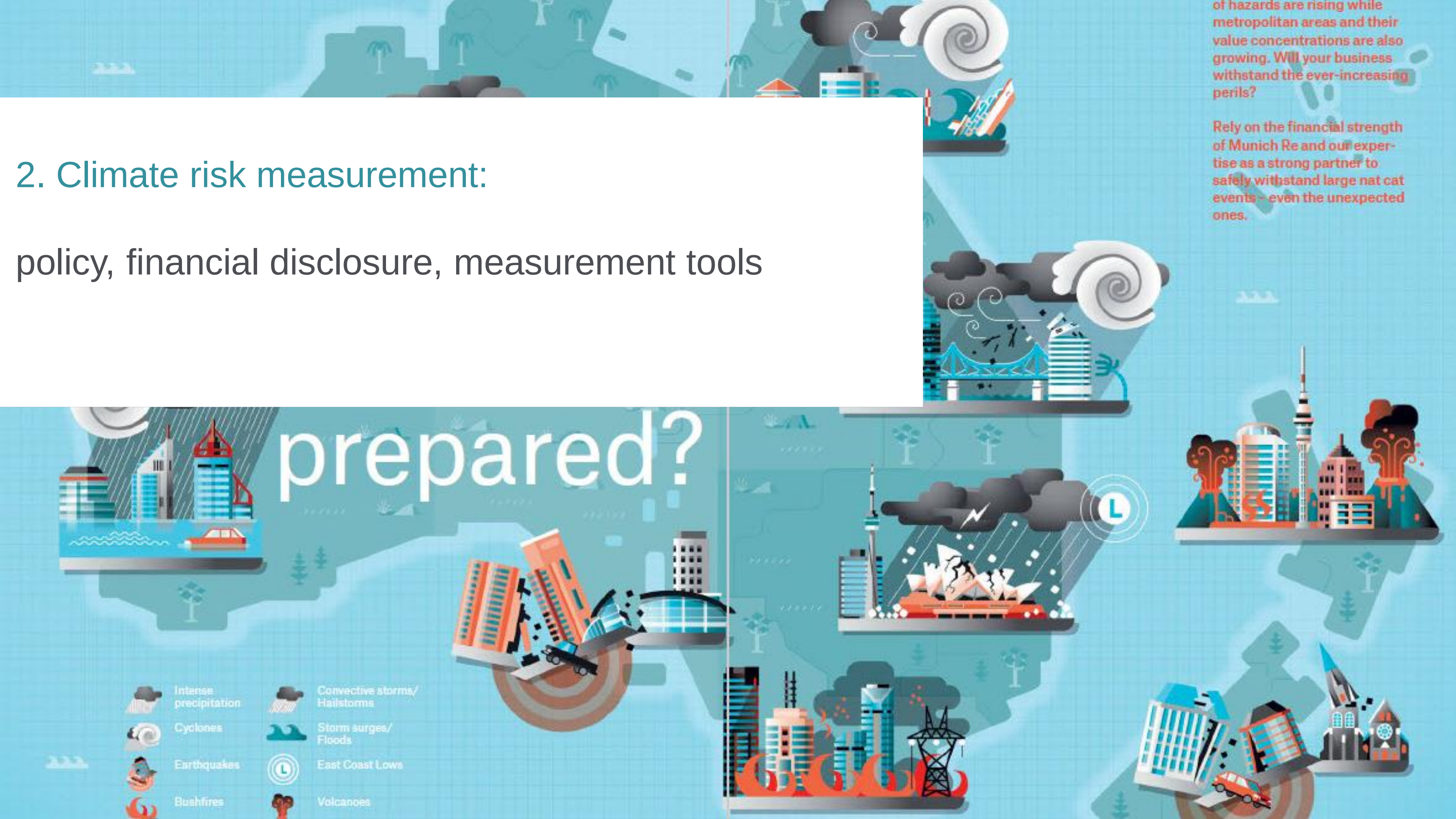
# Munich Re's Australia & New Zealand Publication and Web Portal

http://www.munichre.com/australia/homepage/index.html




## 2. Climate risk measurement:

policy, financial disclosure, measurement tools



# Climate and renewable energy policy

# UN Climate Change Conference COP21 Paris (12/2015)
## Outcome and assessment

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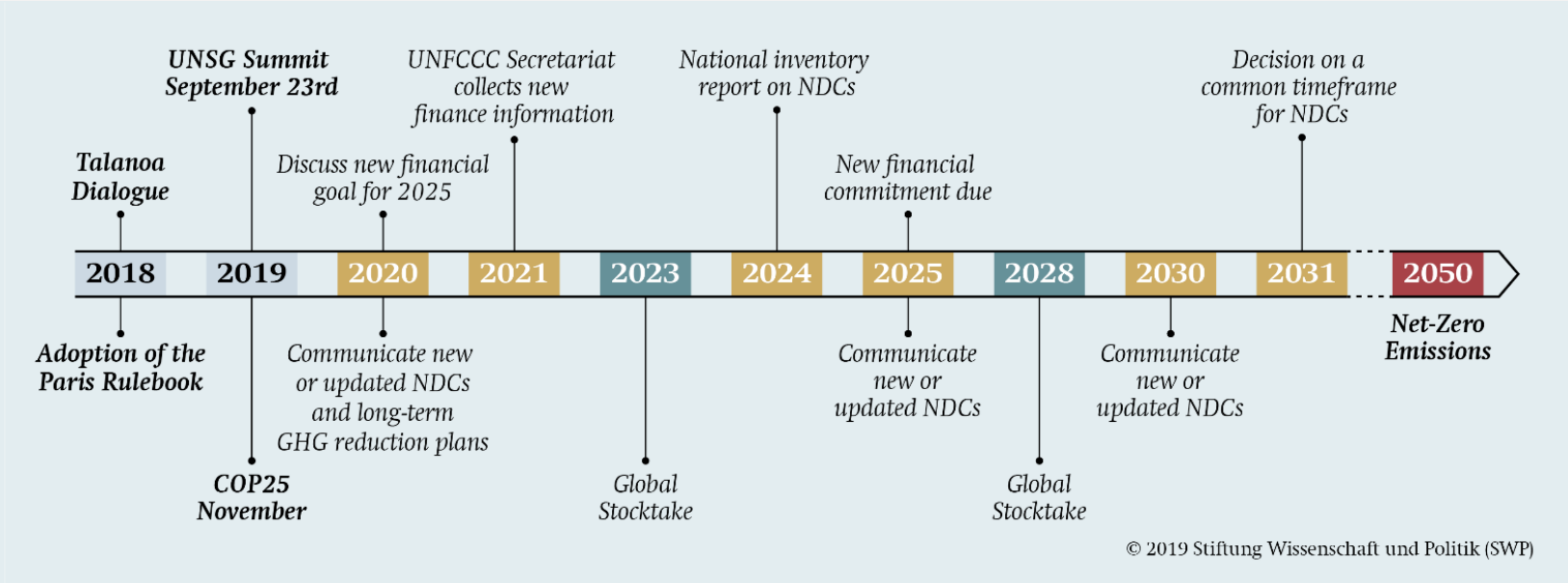
- 195 UN nations agreed on **“Decisions”** (non-binding) and on the **“Agreement”** (binding)
- **The Agreement entered into force on 4 November 2016** when at least 55 Parties to the Convention accounting in total for at least an estimated 55% of the total global greenhouse gas emissions have deposited their instruments of ratification, acceptance, approval or accession.

**Decisions of the Paris Agreement:**

- **2°C target:** Recognition of all parties to limit the increase in global mean temperature to well below 2°C, targeting even a temperature limit of 1.5°C (but weak formulations in crucial articles to achieve target)
- **National climate goals**: All parties are obliged to undertake and maintain plans for their reduction targets (without sanctioning)
- **Climate finance**: industrial countries to deliver USD100bn a year starting 2020, plus voluntary amendments of developing countries
- **Climate risk insurance**: climate-related losses and damages are acknowledged as a third climate strategy pillar next to adaptation and mitigation. A clearinghouse for risk transfer will be established serving as a repository.

# UN climate agenda – timeline and deliverables to reach net-zero emissions by 2050



# Australia’s climate and renewable energy targets

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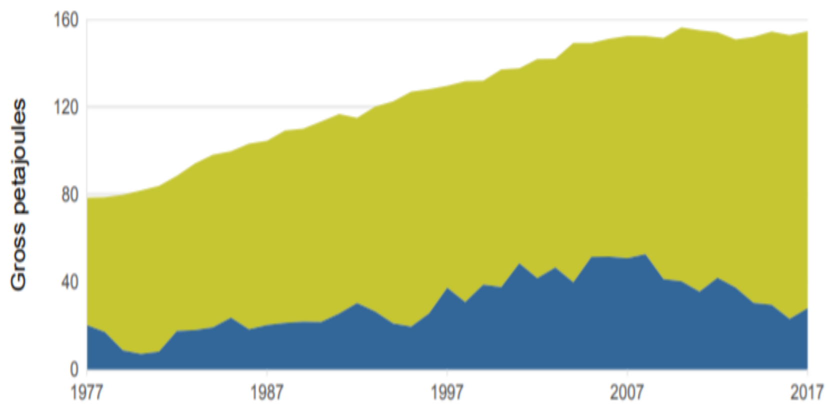
| Measure | Target (relative to 2005 level) | Time horizon |
|---|---|---|
| Greenhouse gas emission reduction | -26 to -28 % | By 2030 |
| Renewable energy generation share | + 23 % | By 2020 |
| Improve energy productivity (GDP / PetaJ) | + 40 % | By 2030 |
| Australia´s renewable energy capacity | Doubling | By 2020 |

- **23 governmental programs** supporting action on climate change (including “emissions reduction fund”, “renewable energy target
- **7** governmental policies and **7** governmental tools issued

Source: https://www.environment.gov.au/climate-change; “2017 Review of Climate Change Policies” (issued 12/2017)

# New Zealand's climate and renewable energy targets

| Measure | Target (relative to 2005 level) | Time horizon |
| --- | --- | --- |
| Greenhouse gas emission reduction | - 30 % | By 2030 |
| Renewable electricity generation target | 100% (today 82 %) | By 2035 |




- **82 %** renewable electricity generation in New Zealand (3rd highest of all OECD countries)
- biggest contribution from **hydro (59%)**
- **39.6 %** of primary energy supply from renewable sources in New Zealand

Renewable

Non-renewable

Source: "*Energy in New Zealand 2018 – 2017 Calendar Year Edition*"

# Climate and renewable energy targets in Germany and the European Union

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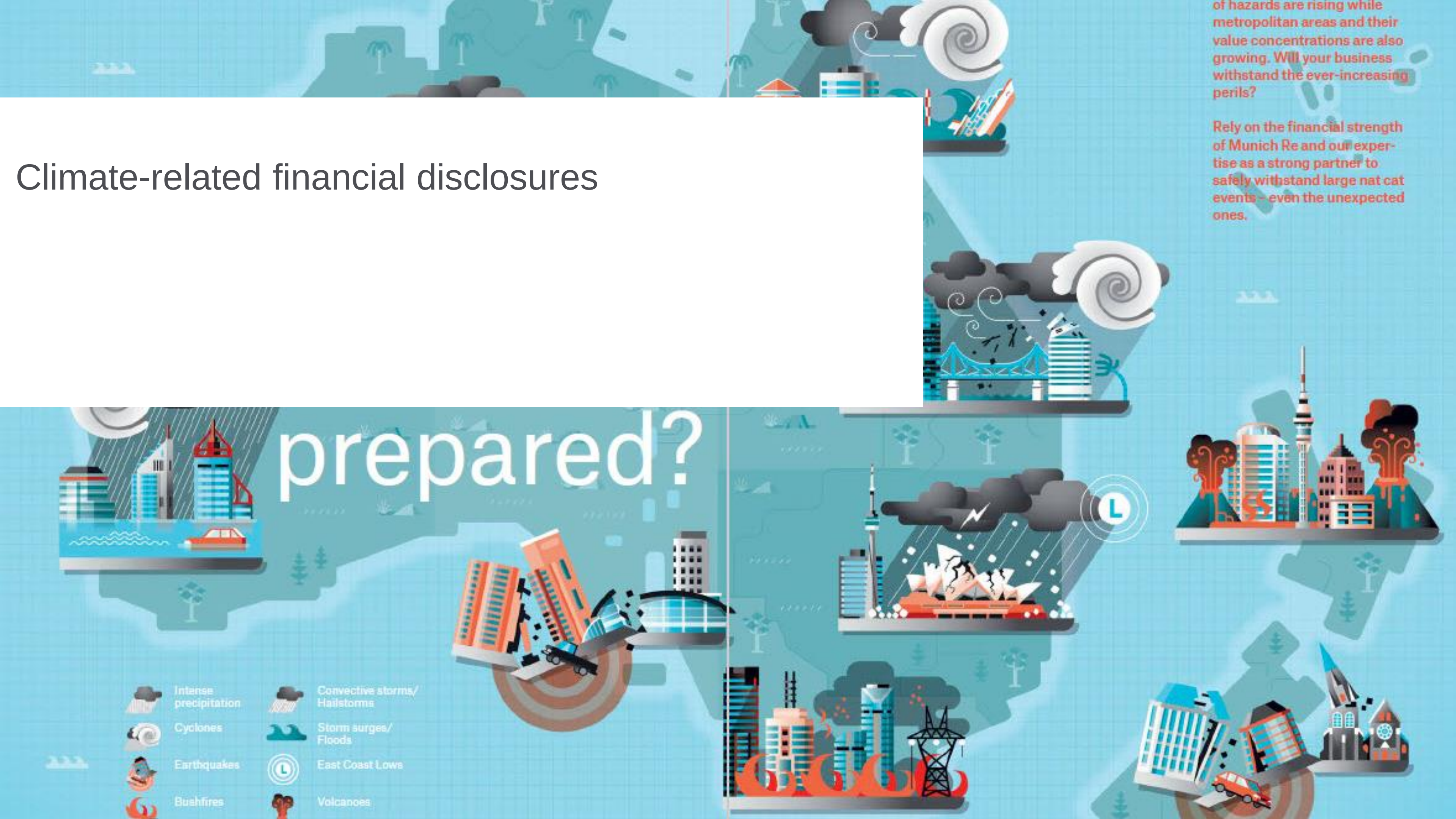
| | Germany | | | | European Union | | | |
|---|---|---|---|---|---|---|---|---|
| **Target** | **2020** | **2030** | **2050** | *As at 2017* | **2020** | **2030** | **2050** | *As at 2017* |
| **Greenhouse gas emission reduction** | | | | | | | | |
| GHG emission compared to 1990 | At least -40% | At least -55% | At least -80 till -95% | *-27,70%* | -20% | -40% | -80 till -95% | *-24%* |
| **Renewable energy share in final energy consumption** | | | | | | | | |
| Renewable energy share of gross final energy consumption | 18% | 30% | 60% | *15,60%* | 20% | 27% | | *17%* |

Source: Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit; BMWi, UBA

# Climate-related financial disclosures



# Financial stability risks from climate change

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Mark Carney, Governor of the Bank of England and Chairman of the G20's Financial Stability Board, highlights in his 2015 speech three channels through which climate change can affect financial stability:

1. **Physical risks**: the impacts today on insurance liabilities and the value of financial assets that arise from climate- and weather-related events, such as floods and storms that damage property or disrupt trade;

2. **Liability risks**: the impacts that could arise tomorrow if parties who have suffered loss or damage from the effects of climate change seek compensation from those they hold responsible. Such claims could come decades in the future, but have the potential to hit carbon extractors and emitters – and, if they have liability cover, their insurers – the hardest;

3. **Transition risks**: the financial risks which could result from the process of adjustment towards a lower-carbon economy. Changes in policy, technology and physical risks could prompt a reassessment of the value of a large range of assets as costs and opportunities become apparent.

Source/Link to Mark Carney‘s speech: http://www.bankofengland.co.uk/publications/Pages/speeches/2015/844.aspx

# Financial Stability Board (FSB) and the Task Force on Climate-related Financial Disclosures (TCFD)

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- The TCFD was commissioned by the Financial Stability Board in December 2015. The objective is to address the impact climate change is having on companies and the global financial system.
- TCFD aimed to develop recommendations for voluntary climate-related financial disclosures that are consistent, comparable, reliable, clear and efficient which provide decision-useful information to lenders, insurers and investors.
- In June 2017 the Task Force released its final recommendations report
- The voluntary recommendations are designed to help companies identify and disclose the potential financial impacts of climate-related risks and opportunities on their businesses.
- TCFD's 32 members were chosen by the FSB to include both users and preparers of disclosures from across the G20's constituency covering a broad range of economic sectors and financial markets.
- 2018 Status Report: 500+ supporters with a combined market capitalization of US$ 7,900 bn including financial firms responsible for almost US$ 100,000bn of assets

# Task Force on Climate-related Financial Disclosures (TCFD)

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2015 | 2016 | 2017 | Now

**December 2015**

Establishment of TCFD

**January 2016**

Financial Stability Board (FSB) announced membership of TCFD

**December 2016**

TCFD release recommendations and 60-day public consultation period begins

**June 2017**

Final recommendations published

**July 2017**

Issuance of final report to FSB and presentation to G20

**2018**

Gradual implementation in more and more countries and more and more companies

Source: https://www.fsb-tcfd.org/

# Task Force on climate-related financial disclosure (TCFD)

## Consequence from Paris Agreement to ensure a Level-Playing Field

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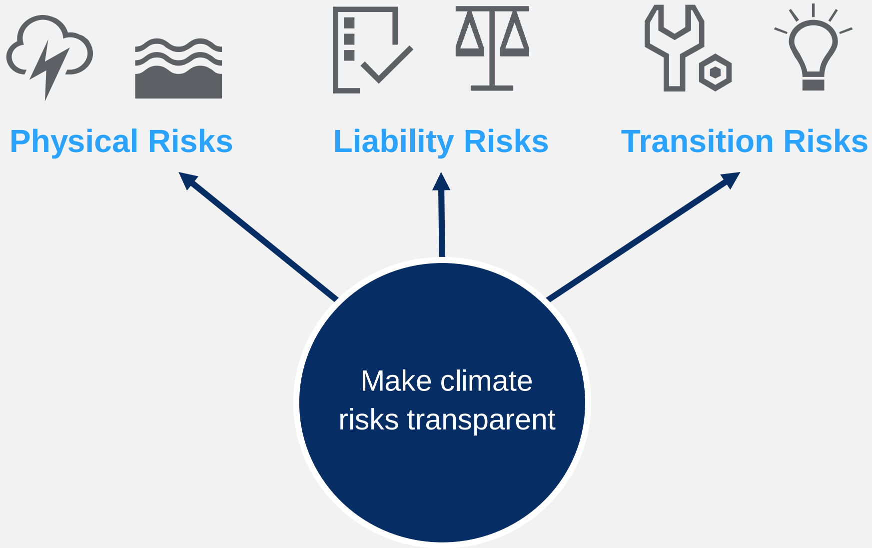
### Risk landscape in focus of TCFD




### Core elements of recommended climate-related financial disclosures


**Governance**
The organization's governance around climate-related risks and opportunities

**Strategy**
The actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, financial planning

**Risk Management**
The process used by the organization to identify, assess, manage climate-related risks

**Metrics and Targets**
The metrics and targets used to assess and manage relevant climate-related risks and opportunities

Source: FSB Task Force, Final Report, www.fsb-tcfd.org

# Munich Re’s activities with the UNEP FI TCFD Working group

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- Rapid-onset physical risks:
  It is asked whether the insurance industry needs guidance in modelling, in a standardized, portfolio-specific way future business impacts based on historical data, third-party climate scenarios
- Slow-onset physical risks:
  do those risks need to be included in scope of the project?
- Transition risks:
  insurance companies should focus on “*transition risks resulting from a reduction in insurable interest due to a decline in value, changing energy costs, or implementation of carbon regulation.”* (also: reputational risks, stranded assets, … ; but have differing nature to physical risks)
- Liability risks:
  liability insurance = long-tail business and scarce (historical) data base makes situation very challenging; claims could take years

# Climate Intelligence:
# Munich Re’s measurement tools

# Munich Re's risk evaluation services based on digital intelligence

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## Risk Suite

| Location Intelligence | Business Intelligence | Climate Intelligence |
|---|---|---|
| NATHAN | M.I.N.D. | Climate Risk Score |
| Global Hazard and Risk Maps | Manager for interactive disaster assessment | Climate change related risks as future potential |

# Physical Risk Assessment

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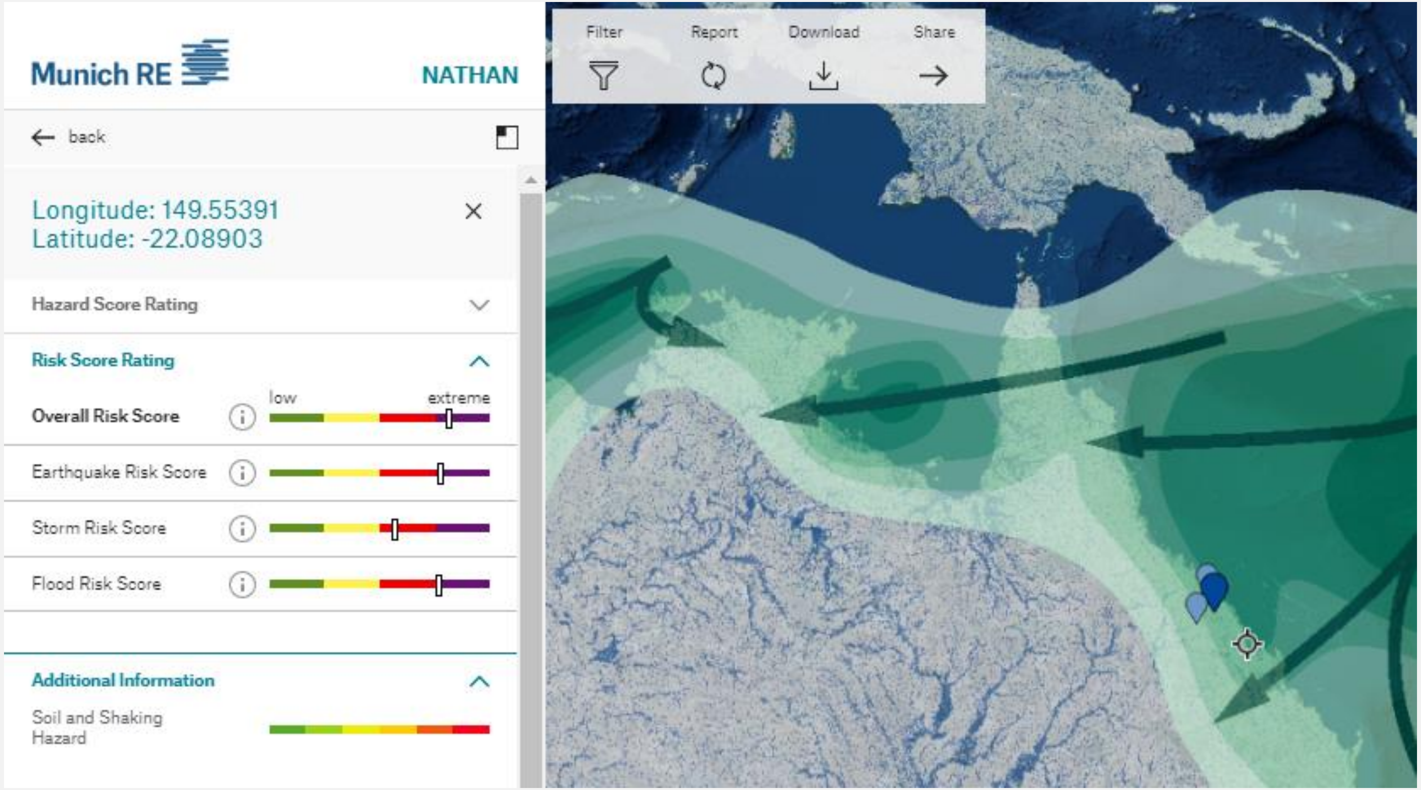


## Risk Score Rating

- Earthquake Risk Score: Includes the Earthquake, Volcano and Tsunami Risk
- Storm Risk Score: Includes the Tropical cyclone, Extratropical storm, Hail, Tornado and Lightning Risk
- Flood Risk Score: Includes River flood, Flash Flood and Storm Surge Risk

# Munich Re's digital location intelligence: NATHAN

## assessment of NatCat risks in the underwriting process

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Location Information

Hazard Score Rating

Risk Score Rating

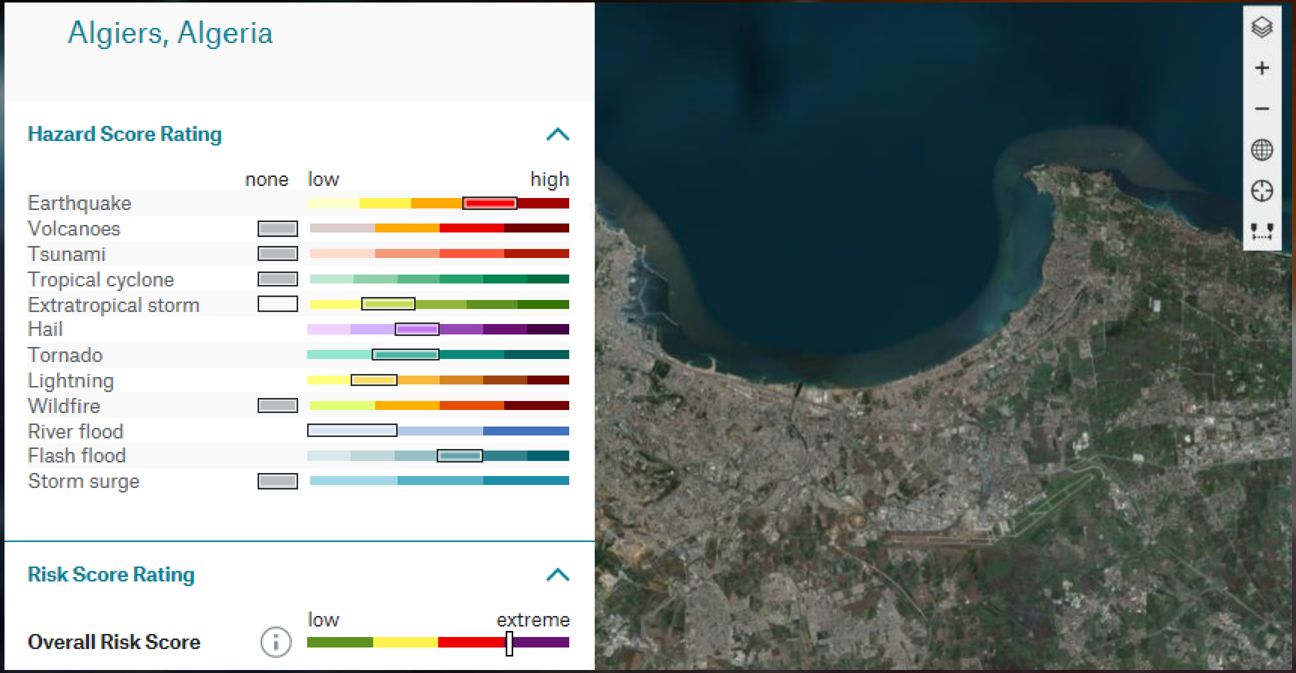




Image: used under license from shutterstock.com

# Munich Re's digital location intelligence: NATHAN

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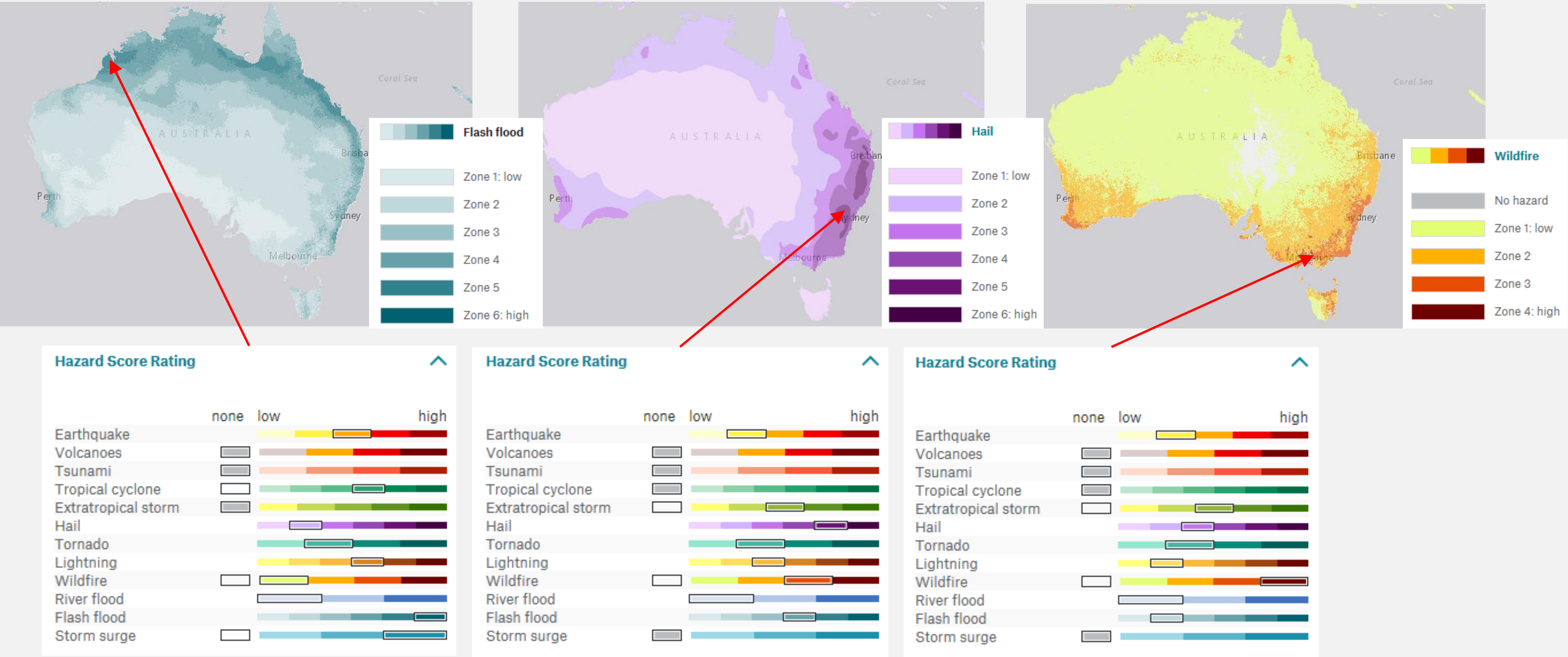

# 3. Transitional risk transfer solutions:

green tech investment, renewables risk transfer, mining rehabilitation risk transfer

# Green tech investment

# How could a complete decarbonisation be achieved?

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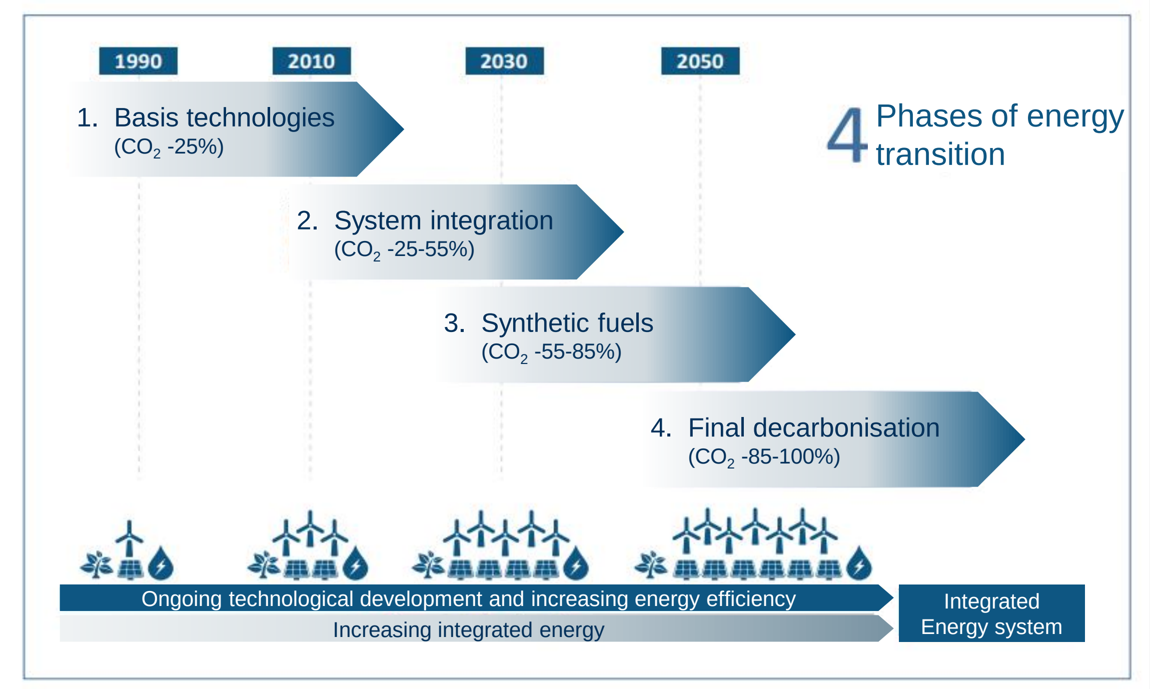


## Four phases of energy transition

1. Basis technologies
   → Deployment of renewables
   → Energy efficiency
2. System integration
   → Flexibilisation, digitalization
   → Direct use of electricity, storage
   → New electricity markets
   → Incorporating also traffic, industry and heat
3. Synthetic fuels
   → upscaled electrolysis
   → hydrogen as potential accelerator for this phase
4. Final decarbonisation
   → displacement of all fossil fuels
   → Renewables imports

► Synthetic fuels on the basis of renewables are the next big challenge for the energy transformation

Source: Munich Re

# Energy generation by source in Australia

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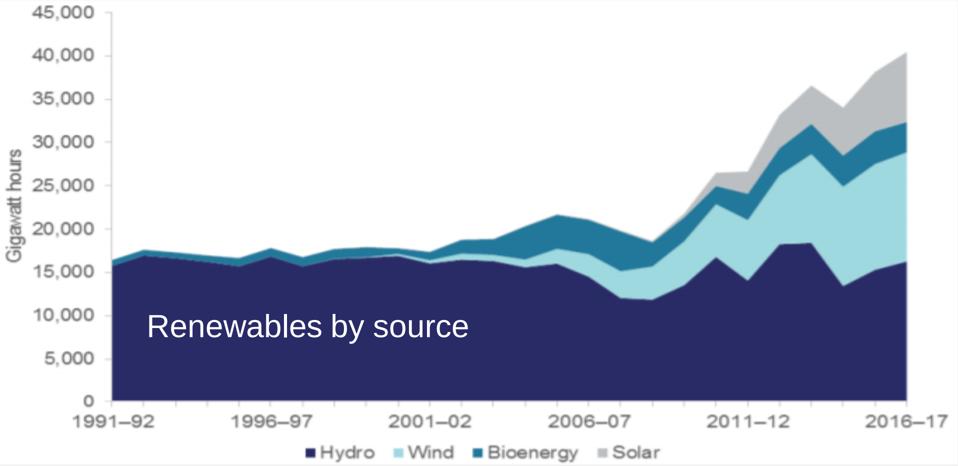
| | 2016–17 | | Average annual growth | |
|---|---|---|---|---|
| | GWh | share (per cent) | 2016–17 (per cent) | 10 years (per cent) |
| **Fossil fuels** | **217,562** | **84.3** | **-0.8** | **-0.3** |
| Black coal | 118,272 | 45.8 | 3.5 | -1.0 |
| Brown coal | 43,558 | 16.9 | -10.7 | -2.5 |
| Gas | 50,460 | 19.6 | -0.2 | 4.2 |
| Oil | 5,273 | 2.0 | -6.8 | 3.0 |
| **Renewables** | **40,455** | **15.7** | **6.1** | **8.2** |
| Hydro | 16,285 | 6.3 | 6.3 | 3.4 |
| Wind | 12,597 | 4.9 | 3.3 | 16.9 |
| Bioenergy | 3,501 | 1.4 | -7.6 | -3.0 |
| - bagasse | 1,435 | 0.6 | -20.7 | na |
| - wood, woodwaste | 355 | 0.1 | 42.7 | na |
| - municipal, industrial waste | 76 | 0.0 | 76.9 | na |
| - sulphite lyes, biofuels | 442 | 0.2 | 6.2 | na |
| - landfill biogas | 970 | 0.4 | -8.6 | na |
| - sludge biogas | 223 | 0.1 | 5.6 | na |
| Solar PV | 8,072 | 3.1 | 18.0 | 59.2 |
| - small scale | 7,399 | 2.9 | 16.0 | 57.7 |
| - large scale | 672 | 0.3 | 47.1 | na |
| Geothermal | 1 | 0.0 | 133.3 | na |
| **Total** | **258,017** | **100** | **0.2** | **0.7** |

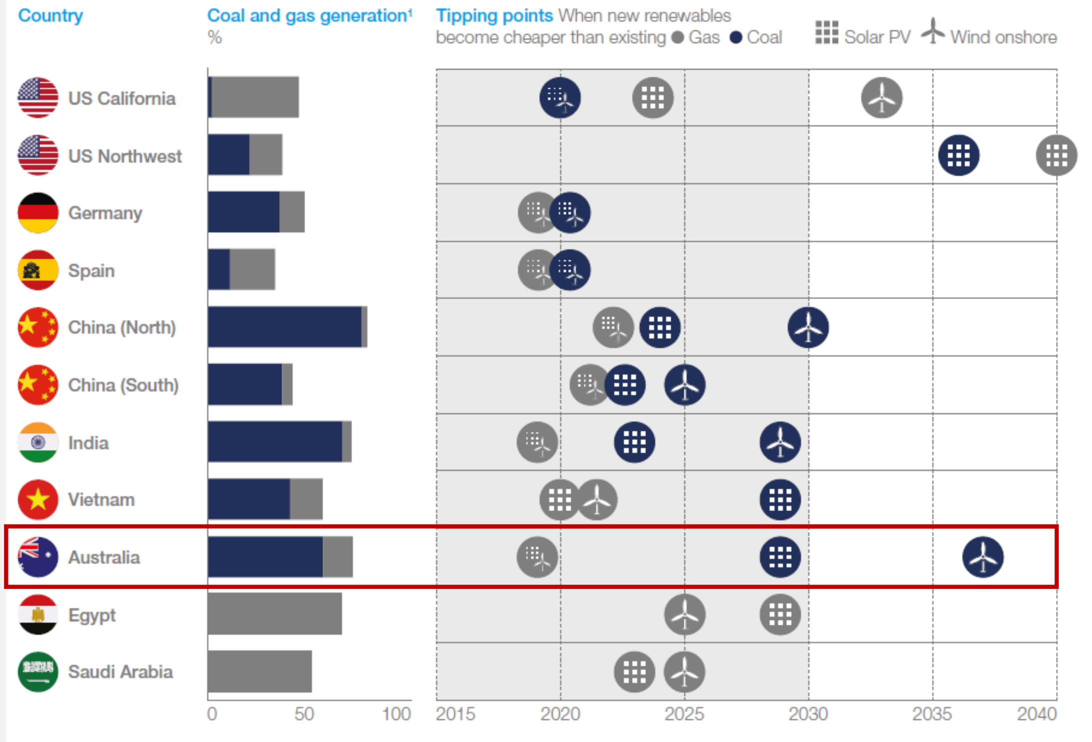
Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*

- **15.2 %** renewable energy generation in Australia
- Share of renewables increased by **8.2 %** in the past 10 years
- highest growth rates in **solar PV**
- biggest contribution from **hydro**



# Cost-Tipping points for renewable energy power generation

renewables will become cheaper than existing coal in most regions before 2030




1 Power generation from existing coal and gas power plants in 2018, as share of total

- By 2030, new-build renewables will outcompete existing fossil fuel generation on energy cost in most countries
- The majority of countries will reach this tipping point in the next ~5 years
- Australian tipping point: today

A tipping point represents a year when new renewables (solar PV, onshore wind, or both) become cheaper than existing fossil fuel plants

Source: McKinsey Energy Insights – Global Energy Perspective (2019)

# Investment in renewable energies in Australia

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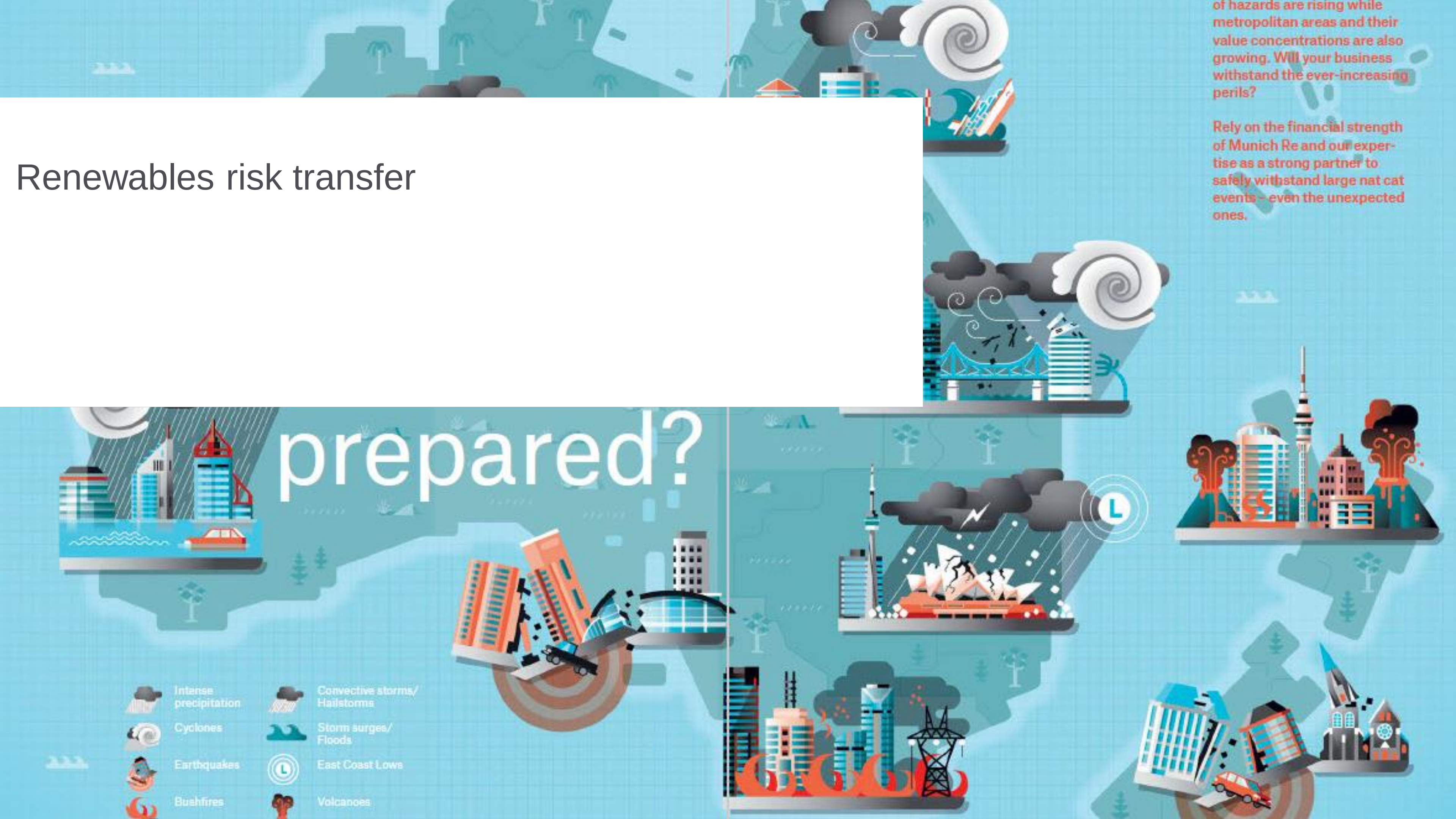
- There were sharp increases in renewable investment in Australia, 147% up compared to 2016 to $8.5 bn in 2017.
- Solar advanced 189% to $4.9 billion, and wind 109% to $3.6 billion.
- The largest projects include the Goldwind wind project (530 MW) with ~$822 mio and an PV portfolio (270 MW) with ~500 mio.
- Australia accounted for the 4th country of Small Distributed Capacity investment (<1MW) of $1.5 bn, a 18% increase compared to 2016.
- 2016: 17% of electricity was supplied by renewable generation (10% non-hydro)
- South Australia aims for 50% renewables in 2025
- 4/7 Australian states committed to reach net-zero carbon emissions by 2050

Source: BNEF / UNEP „Global Trends in Renewable Energy Investments 2018“

# Renewables risk transfer



# Munich Re's Green Tech Solutions

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## Established Renewables

- Solar Energy
- Wind Energy
- Hydro
- Inverter

## Smart Energy

- Electrical Energy Storage
- E-Mobility
- Energy Efficiency
- LED Asset/Installation Perfor-mance
- Air Condi-tioning/ Heating
- Sustain-ability Improvements

## Disruptive Technologies

- Bio Energy/ Waste to Energy
- Fuel Cells
- Decont-amination
- Water Treatment
- Efficient Resource Extraction

Source: Munich Re / Green Tech Solutions

# Business enabling examples
# Wind Energy Yield Cover

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## Project Description

Wind speeds can fall far short in time and area in comparison to the most conscientious forecasts

Resulting turnover losses could severely affect the owner's balance sheet and financing obligations

## Achievements

The Lack-of-Wind cover is a solution that protects the revenue stream against poor wind years

If power generation of the windfarm falls under a predefined threshold,  the cover cushions the loss impact


## Value Proposition

Strong business enabling partner for owners and investors

Revenue protection against low wind speed years

Source: Munich Re / Green Tech Solutions

# Business enabling examples
# Energy Storage System (ESS) Performance Warranty Cover

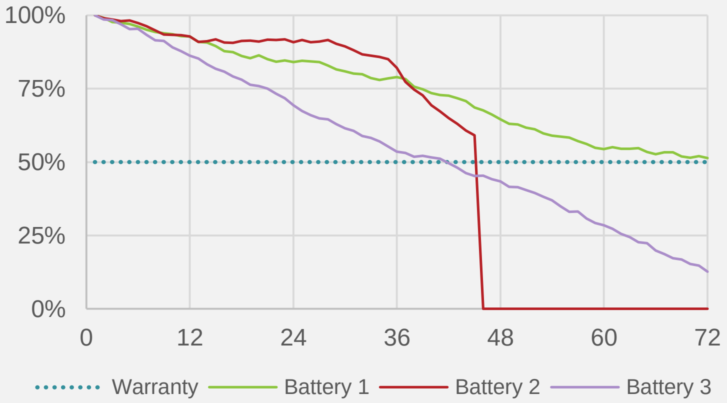
## Project Description

Long-term performance cover for
Battery Cells & Packs / Stationary ESS /
E-Mobility Applications

## Achievements

- Indemnification of excessive claims
- One time premium based on insured year's revenue
- Non-cancellable for insurer
- Increased predictability for financial reserving
- Boost of growth-relevant cash reserves for R&D / marketing
- Balance Sheet protection

Capacity over time (72 months)



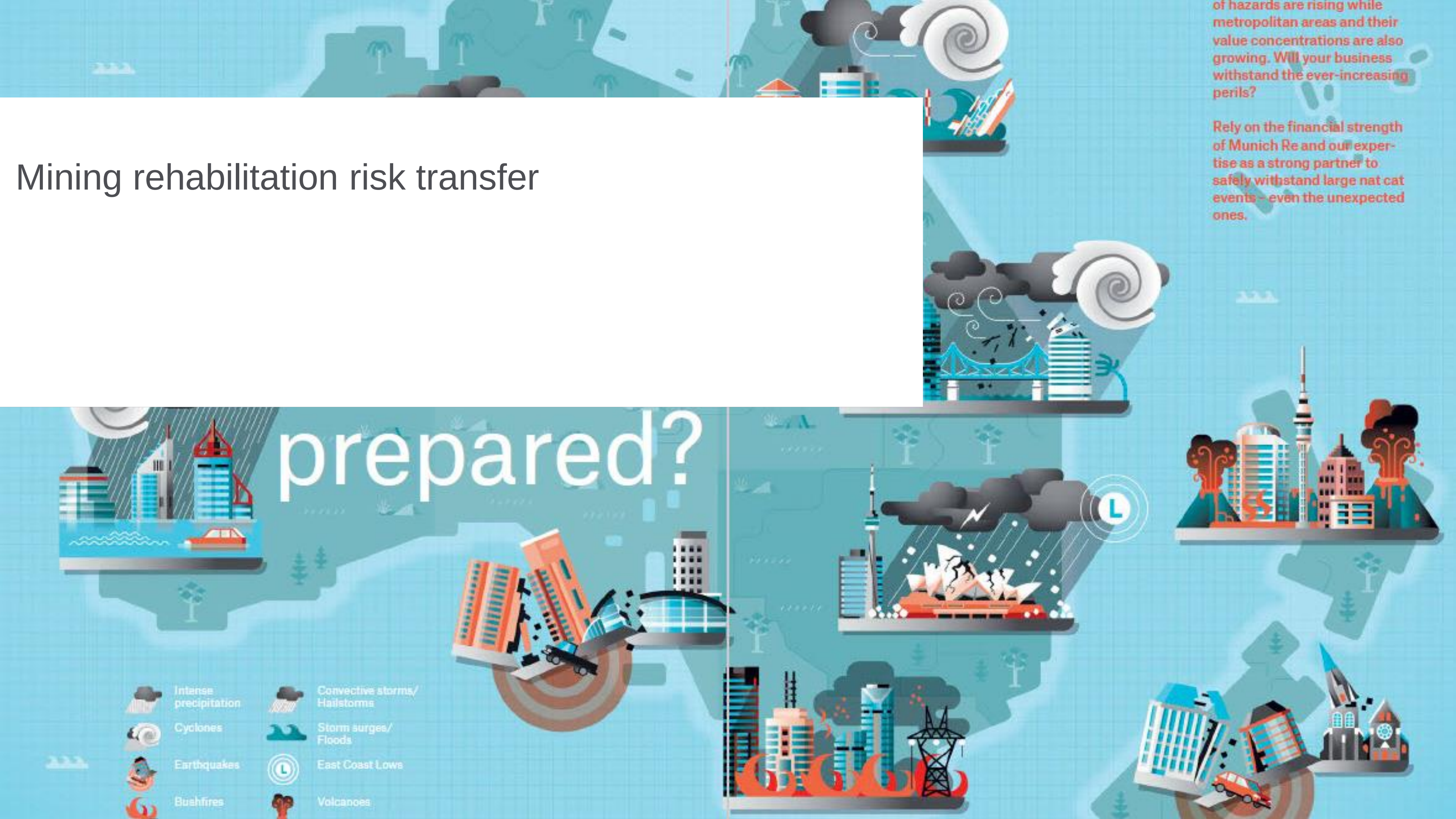

## Value Proposition

Cover for revenues of production

Long-term security for manufacturer during multi-year liability period

Source: Munich Re / Green Tech Solutions

# Mining rehabilitation risk transfer



# Mining Rehabilitation Cost Cap

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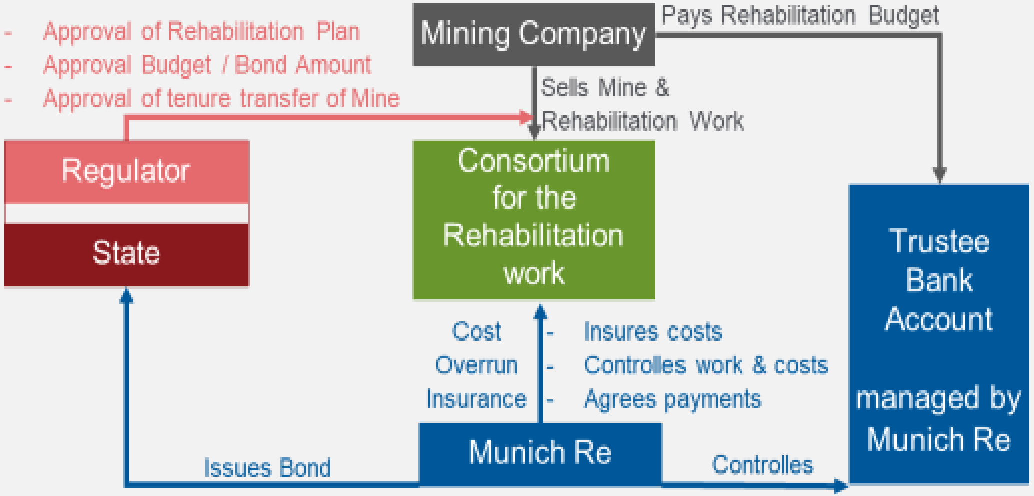
Consortium Management:

- Specialists in building and managing consortium to acquire and rehabilitate end-of-life mine sites.
- Ensures that the community is not left with the burden of funding mine rehabilitation.
- Mine will be converted into safe green spaces or land for new industry.




Munich Re:

- Issues a bond to the regulator
- Takes the risk of mine rehabilitation cost overrun.

## 4. Physical risk transfer:

Nat Cat schemes, cyclone, drought, resilience bonds, pandemic emergency financing

# Natural catastrophe insurances

## examples of sovereign and public-private Nat Cat risk transfer schemes

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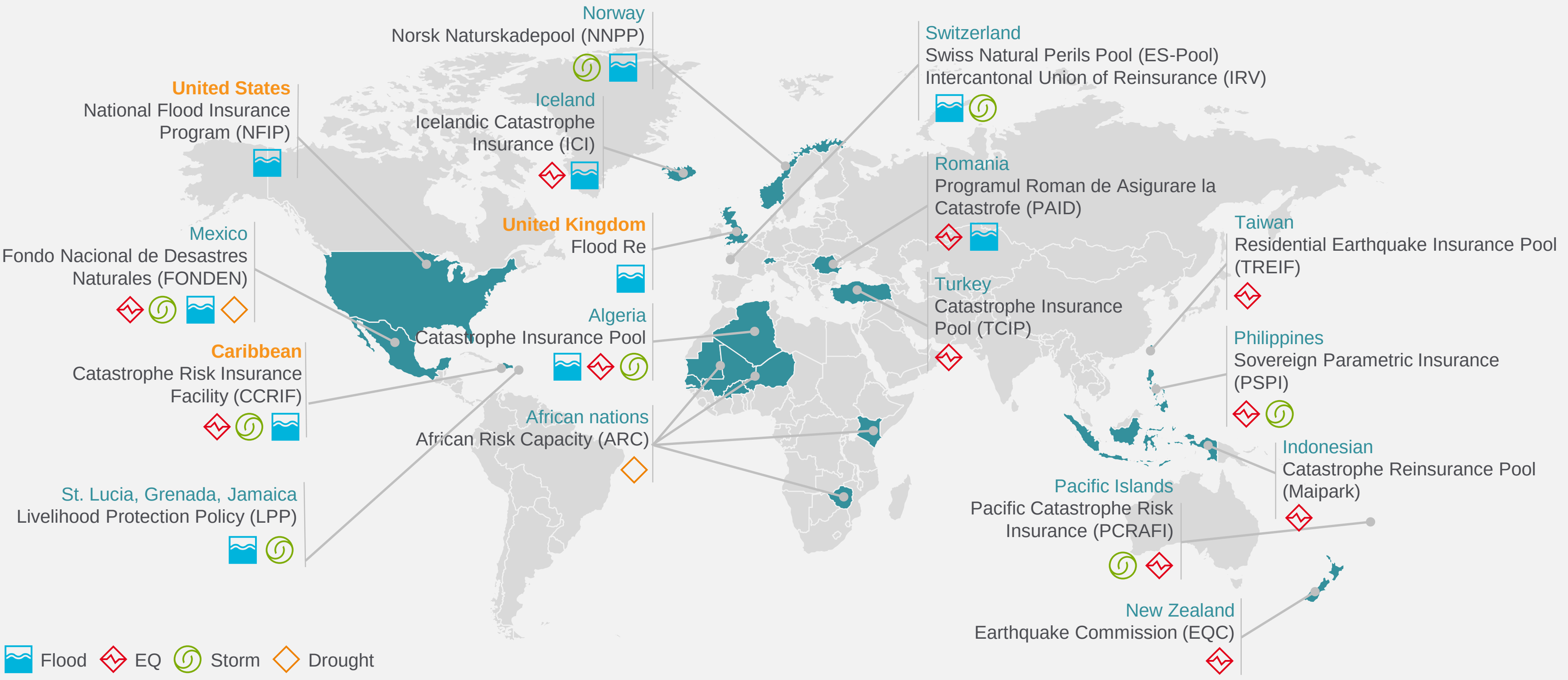

# Natural catastrophe insurances

## best practices for ex ante disaster risk insurance schemes

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| | Turkish Catastrophe Insurance Pool (TCIP) | National Flood Insurance Program (NFIP), United States | Fondo Nacional de Desastres Naturales (FONDEN), Mexico |
|---|---|---|---|
| **Challenge** | Provide homeowners with reconstruction financing after EQs. | Affordable flood insurance for home and business owners. | Provide immediate liquidity to public entities after a major NatCat event.<br>Shift from ex-post disaster relief to ex-ante disaster financing and prevention scheme. |
| **Solution** | World Bank funded TCIP until 2006, since then it is reinsured by Munich Re. Insurance companies act as agents and sell the earthquake cover to private homeowners and cede risk to gov. pool. | Encouraging communities to adopt and enforce floodplain management regulations. | Munich Re reinsures FONDEN (sum insured U.S.$245 bn.). After a NatCat event, funds are transferred to a trust fund and distributed to national and state governments. |
| **Stakeholder Benefit** | Reduction of contingent liability for Turkish government. | Reinsurance treaty contributes to NFIP with risk expertise and more insurance coverage options, thus promotes flood protection, and reinforces basis for improved risk management. | Broad coverage of public assets and good governance in the management of post-disaster claims. |

# Tropical Cyclone Oma: February 2019

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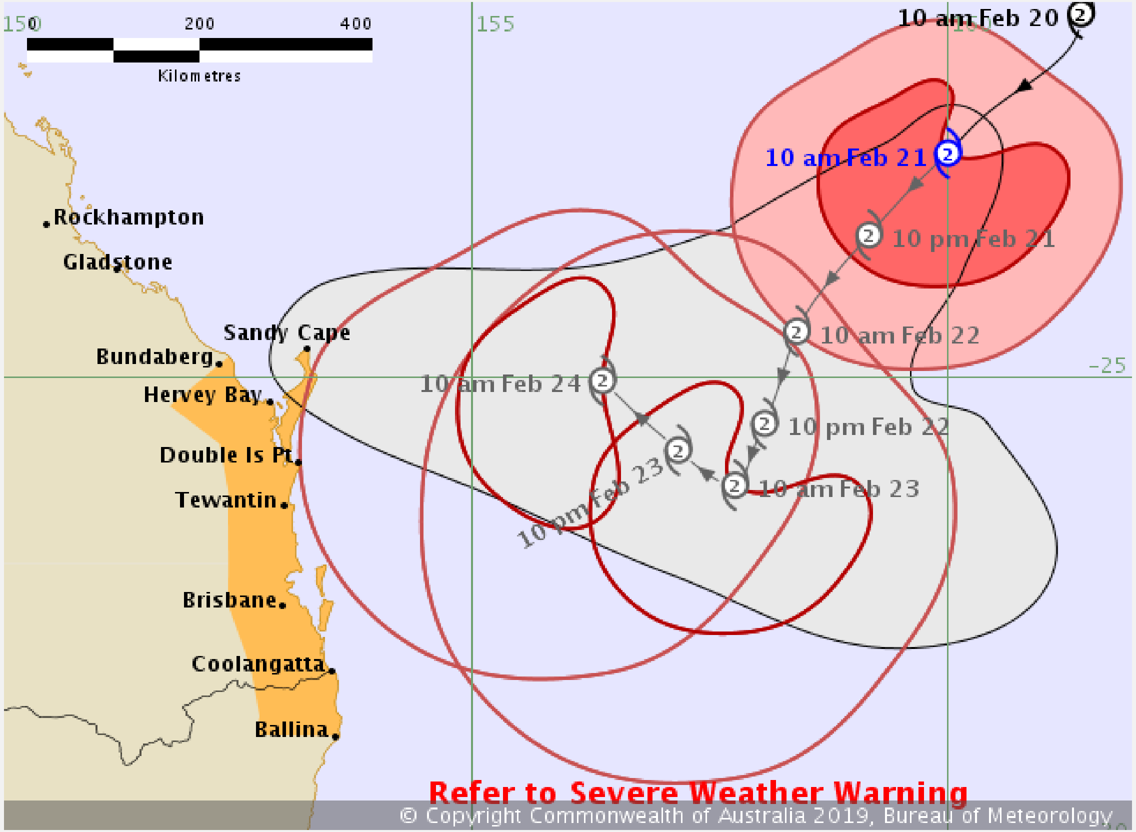

# Parametric cyclone cover: Brisbane trigger

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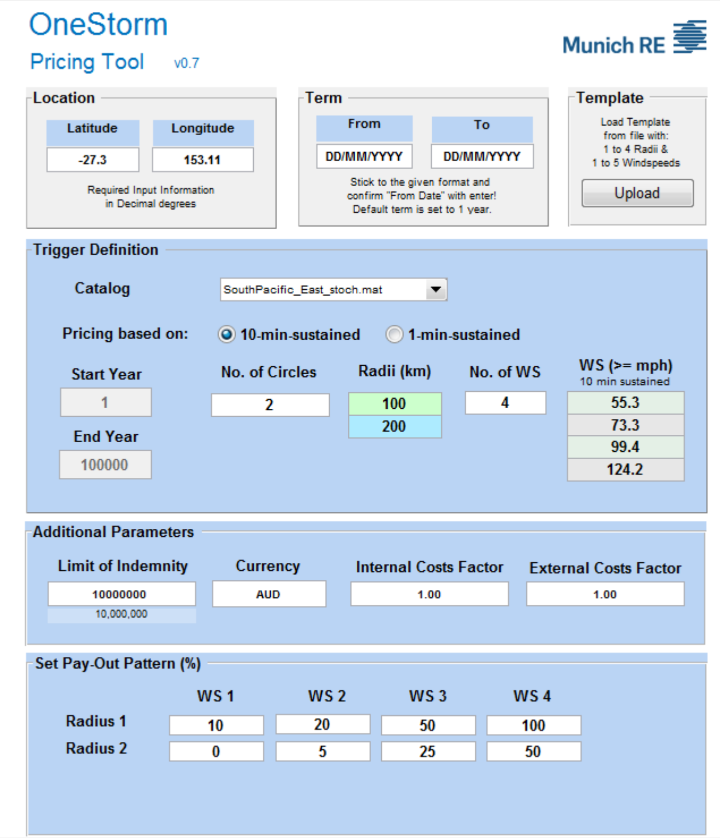


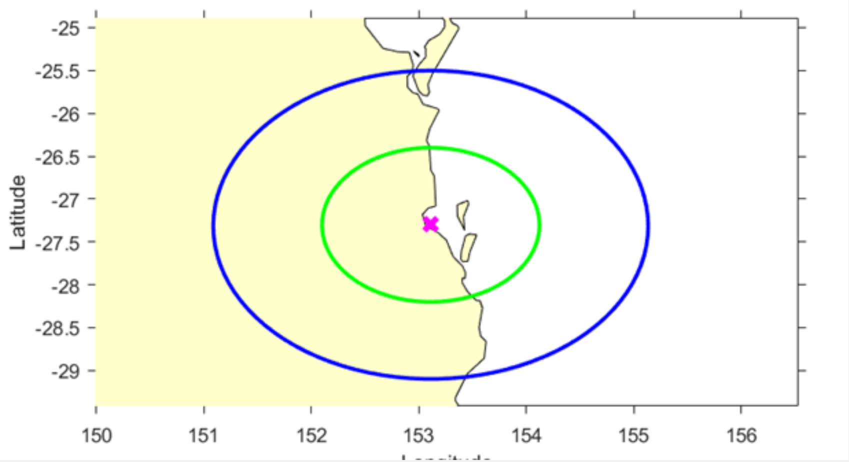


- 2 Circles (100, 200 km)
- Centred at Brisbane CBD
- 4 Wind Speeds (Cat2, Cat3, Cat4 and Cat5)
- Indicative premium of ~X.XX%

# Transferring exposure to extreme weather (drought) + QTC funding

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Parametric cover– a quick intro if you don’t know it already…

- Parametric cover refers to a parameter (or index) used to define a particular ‘trigger’ event at a particular location (for example a 1 in 20 year drought experience in Queensland)
- Parametric cover can be provided in a form of a derivative, insurance or a bond. The bond form of a parametric cover is known as Index Linked Securities (ILS).
- Index Linked Securities refer to an index (or parameter) to define a ‘trigger’ event at a particular location
- An ‘insurable interest’ or proof of loss is <u>not required</u> for parametric cover - it could be consider as a ‘bet’ on the trigger event occurring
- Once triggered, a parametric cover payout is made within days/weeks of the event
- Basis risk between the parametric cover and the underlying risk being hedged needs to be considered
- A clearly defined (and well researched) trigger description will decrease the basis risk
- The public ILS market is large (USD30bn+ outstanding) with additional private deals as well
- ILS investors are interested in Australian risks to diversify their global portfolios

# Transferring exposure to extreme weather (drought) + QTC funding

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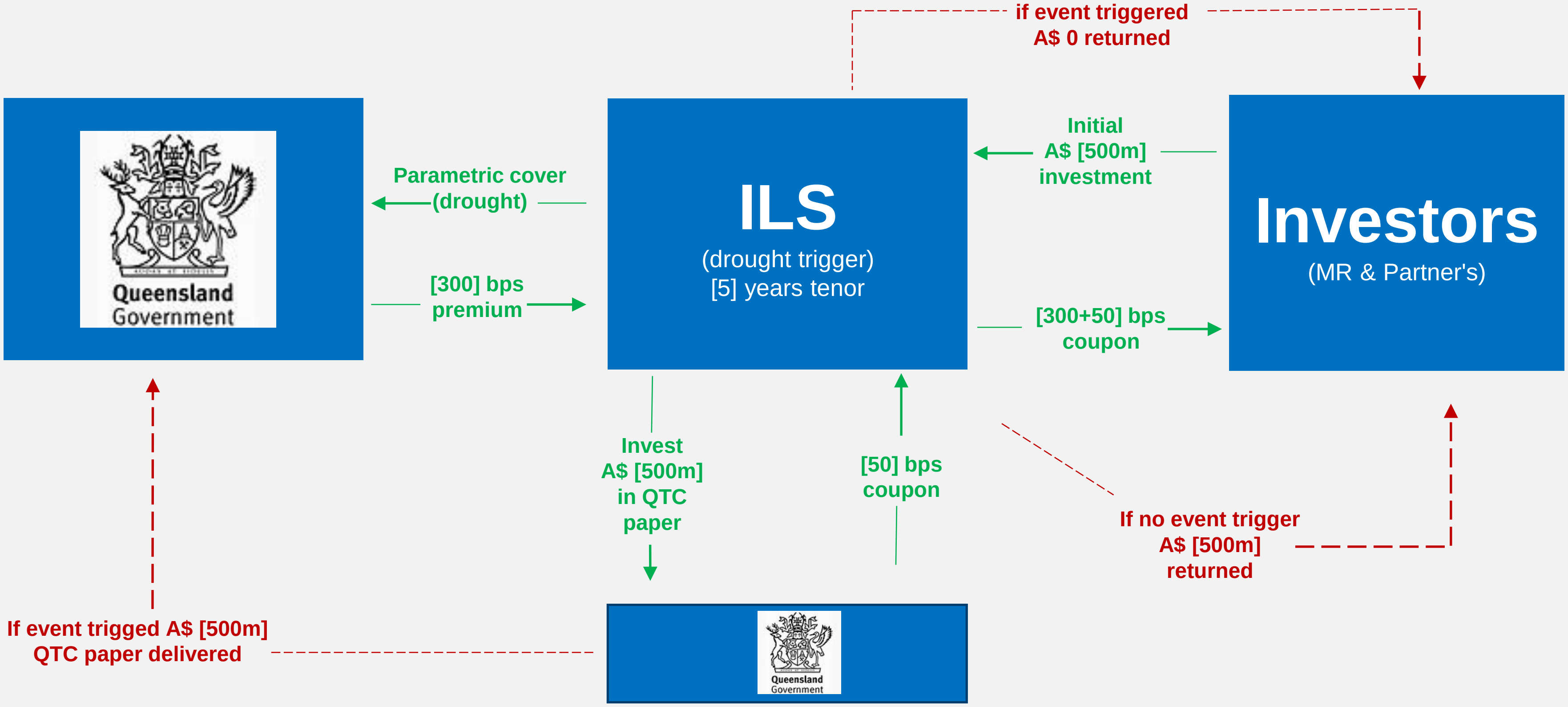


# Combined Resilience and Risk Transfer Solution

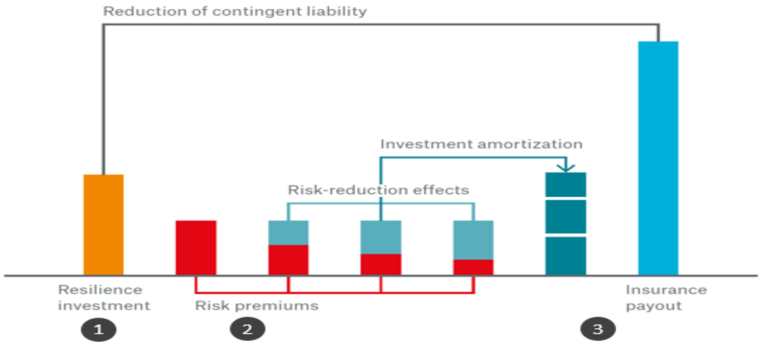
## Combining traditional disaster risk insurance with proactive resilience-building measures

### Client motivation

- Strengthening resilience in coastal areas towards tropical induced storm surge
- The solution helps the client to overcome the tradeoff between investing into resilience measures and purchasing a risk transfer solution
- Making double use of available funds deemed to increase resilience in coastal areas

### Solution proposal

1. A resilient investment for habitat restoration (e.g. coral reefs) at the beginning of the insurance treaty term reduces the underlying risk (as reefs act as highly effective natural wave breakers)
2. The risk-mitigating impact is quantified and confirmed, leading to monetization via reduced premiums per a pre-identified formula
3. An incentive is created for risk-reducing infrastructure as well as for risk transfer, resulting in increased community resilience



# Pandemic Emergency Financing Facility (PEF)

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## Client motivation

The World Bank (IBRD) has issued pandemic bonds and entered into derivative transactions for a total volume of $425m to support the funding of the PEF via its CAR Note program. PEF is a Financial Intermediary Fund (FIF) of the WB providing surge funding for containment of certain pandemic disease outbreaks in developing countries.

## Solution

| | |
|---|---|
| **Issuer** | International Bank for Reconstruction and Development |
| **Volume Bond**<br>**Volume Swap** | Class A: USD 225 million, Class B: USD 95 million<br>Class A: USD 50 million, Class B: USD 55 million |
| **Peril** | Class A: Influenza, Coronavirus<br>Class B: Coronavirus, Filovirus, Lassa Fever, Rift Valley Fever, Crimean Congo Hemorrhagic Fever |
| **Covered Territory** | Influenza: 196 countries (worldwide); Other: 144 countries |
| **Term** | 3 years (possibility of 1 year extension) |
| **Trigger Type** | Parametric, per occurrence |
| **Modeling Agency** | AIR |
| **Reporting Agency** | World Health Organization |

# 5. Next step discussions

# Next step discussions…

Intentionally left blank!

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# Thank You!

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