Climate Change – Global Warming
Munich Re’s Perspective

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Climate change today
increasing temperatures – higher weather hazards

approx. 1°C warming since 1900

Source: Munich Re, based on National Centers for Environmental Information/NOAA.
The physics of climate change
Radiative forcing in 2011 relative to 1750

The table shows the radiative forcing of various greenhouse gases and aerosols compared to 1750.

- **CO₂**: 1.08 (1.02 to 1.14) W m⁻²
- **CH₄**: 0.97 (0.78 to 1.19)
- **Halo-Compounds**: 0.51 (0.33 to 0.69)
- **N₂O**: 0.34 (0.21 to 0.47)
- **CO**: 0.18 (0.11 to 0.27)
- **NMHC**: 0.16 (0.09 to 0.23)
- **Amylaldehyde**: 0.00 (0.00 to 0.00)
- **Cloud Adjustments due to Aerosols**: -0.05 (-0.31 to -0.06)
- **Total Anthropogenic**: 2.29 (1.99 to 2.59) W m⁻²

Source: IPCC AR5, WG1 (2013)

Consequences of a warmer world
Sea level rise

The graph shows the sea level anomaly from 1900 to 2000 with the following rates:
- **0.6 mm/yr** (1900-1930)
- **1.2 mm/yr** (1930-1992)
- **3.2 mm/yr** (1993-2015)
- **4.4 mm/yr** (2010-2015)

Source: Columbia University
Example: sea level rise around New York
exceptional storm surge level Hurricane Sandy – 35cm between 1920-2012 @ 3.8 mm p.a.

Impacts on Australia: changing tracks of tropical cyclones
Location of maximum cyclone intensity is moving southward over time

Future areas affected by tropical cyclones in Australia
distance southward from equator

Source: Munich Re, based on Center for Operational Oceanographic Products and Services

Source: NATHAN Risk Suite (left), Jim Kossin, NASA (right)
Drivers for globally increasing losses from natural hazards

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global increase in population</td>
<td>From 4 billion (1975) to 7.6 billion (2018)</td>
</tr>
<tr>
<td>Improved standard of living</td>
<td>Middle class is growing rapidly worldwide</td>
</tr>
<tr>
<td>Concentration of people / assets</td>
<td>Share of urban population is increasing continually: 37% (1975) - 50% (2010) - 57% (2025)</td>
</tr>
<tr>
<td>in urban areas</td>
<td></td>
</tr>
<tr>
<td>Settlement and industrialization of</td>
<td>Especially coastal areas, areas close to rivers</td>
</tr>
<tr>
<td>vulnerable areas</td>
<td></td>
</tr>
<tr>
<td>Increase of complexity and</td>
<td>Increasing complexity of value chains (i.e. production cycles) in industrial</td>
</tr>
<tr>
<td>interdependencies</td>
<td>facilities</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Intensification and accumulation of extreme weather events in certain areas</td>
</tr>
</tbody>
</table>

Not necessarily problematic for insurers (premiums grow proportionally with risk)

Problematic for insurers, if risk models are not adjusted accordingly
The NatCat Insurance Gap by income group:
still a serious issue not only in low-income countries

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%.

*Income classification defined by World Bank: high-income countries GNI ≥ 12,055 US$; low-income countries GNI ≤ 995 US$, based on Munich Re NatCatSERVICE data

Convective storm events* in West Europe 1980 – 2017
uninsured and insured losses

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

*Convective storm events include: tempest / severe storm, tornado, lightning, hailstorm, flashflood

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Convective storm events* in West Europe 1980 – 2017
Overall losses: residual upward trend after normalization

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Affected Area</th>
<th>Overall losses (US$m, in 2018 values)</th>
<th>Insured losses (US$m, in 2018 values)</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 - 10 Jun 2014</td>
<td>Severe storm, hailstorm</td>
<td>Germany, France, Belgium</td>
<td>3,200</td>
<td>2,600</td>
<td>6</td>
</tr>
<tr>
<td>12 Jul 1984</td>
<td>Hallotorm</td>
<td>Germany, Bavaria, esp. Munich, Potsdam, Landsberg, Attersee, Freising, Aschach, Bad Tölz, Miesbach, Rosenheim, Baden-Württemberg, Ravensburg</td>
<td>2,900</td>
<td>1,400</td>
<td></td>
</tr>
<tr>
<td>31 May - 7 Jun 2016</td>
<td>Flash flood, severe storm</td>
<td>Germany, Belgium, Switzerland</td>
<td>2,200</td>
<td>970</td>
<td>9</td>
</tr>
<tr>
<td>22 - 24 Jun 2016</td>
<td>Hallotorm, severe storm, flash flood</td>
<td>Netherlands, Germany</td>
<td>2,200</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td>23 - 24 Jul 2009</td>
<td>Severe storm, hailstorm</td>
<td>Switzerland, Austria, Germany</td>
<td>1,800</td>
<td>1,000</td>
<td>1</td>
</tr>
<tr>
<td>28 May - 2 Jun 2008</td>
<td>Severe Storm, Hallotorm, flash flood</td>
<td>Germany, North Rhine-Westphalia, Krefeld, Münster, Neuss, Euskirchen, Münchshagen, Düren, Jülich, Düsseldorf, Düsseldorf, Baden-Württemberg, Hechingen, Zollernalbkreis, Neuried, Offenburg, Weinstadt, Remstal, Heusen, Rhineland-Palatinate, Ulm, Osnabrück, Saxony, Schwarzwald</td>
<td>1,400</td>
<td>1,000</td>
<td>3</td>
</tr>
<tr>
<td>27 - 30 May 2016</td>
<td>Flash flood, severe storm</td>
<td>Germany, France, Netherlands, Austria, Belgium, Switzerland</td>
<td>1,300</td>
<td>770</td>
<td>6</td>
</tr>
</tbody>
</table>

*Convective storm events include: tempest / severe storm, tornado, lightning, hailstorm, flashflood.

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Insurance risk of change: wildfire losses in N.A. since 1980
“hockey stick” wildfire loss development in the North America

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

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Insurance risk of change: tropical cyclone losses Australia since 1980
new dimension of cyclone losses in Australia

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

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Physical and economic impacts of global warming until the end of this century

Physical impacts

- **Sea Level Rise (m)**
  - 0.5-1.7m

- **Coastal assets to defend ($tn)**
  - $27.5tn
  - +150%

- **Frequency of extreme rainfall**
  - x2.6

- **Increase in wildfire extent**

Economic impacts

- **Uninhabitable zones, agriculture, water intense industry, lost tourism**
- **Some fossil fuel, physical**
- **-24% yield**
- **+60% demand**
- **-60% yield**
- **+150%**
- **x2.6**
- **Rcession, tensions, high / unpredict. risks**

**Global Warming by 2100**

- **0.4-0.9m
- 0.5-1.7m**

**Insurance demand**

- **Uninhabitable zones, agriculture, water intense industry, lost tourism**
- **Some fossil fuel, physical**
- **-24% yield**
- **+60% demand**
- **-60% yield**
- **+150%**
- **x2.6**
- **Rcession, tensions, high / unpredict. risks**

**Coastal assets to defend ($tn)**

Source: Munich Re, based on CRO-Forum “The Heat is on” (2019)

Munich Re’s Climate Change Strategy

Holistic: risk and opportunity - liability and asset management – corporate responsibility

**UNDERSTAND, MEASURE & MANAGE**

- **Detecting, assessing and modeling** climate change impacts (frequency and intensity of natural hazards)
- **Understanding** climate-related financial disclosure requirements
- **Developing** tools to measure physical & transitional risk

**NEW RISK TRANSFER SOLUTIONS**

- **Enabling** technology shift e.g. “green tech”
- **Derisking** investments and balance sheets e.g. “parametric triggers”

**ASSET MANAGEMENT**

- **Investment and divestment** strategy to tackle new opportunities and transition risk

**Carbon neutrality of Munich Re**

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

Source: Munich Re
Measuring Climate Risks: Munich Re’s “RISK SUITE”
Quantifying location-based current natural catastrophe and future climate risks

RISK SUITE

- Geo Intelligence
  - Global Hazard and Risk Evaluation (NATHAN)

- Business Intelligence
  - Geo Analytics

- Climate Intelligence
  - Climate Risk Score

Enabling New Technologies by Managing New Risks
e.g. long-term performance warranties for solar and battery storage by Munich Re

Source: Munich Re / Green Tech Solutions
Picture source: Gordon Gross - Pixelio
Technology drivers of climate change
achieving a complete decarbonisation by 2050: 4 phases

1. Basis technologies
   - deployment of renewables, energy efficiency
   - CO₂ reduction by 25%

2. System integration
   - digitalisation, new electric markets, industry, transportation, heat
   - CO₂ reduction by 85%

3. Synthetic fuels
   - electrolysis, hydrogen, methanol
   - CO₂ reduction by 85%

4. Final decarbonisation
   - displacement of all fossil fuels by renewables and net zero carbon technologies
   - CO₂ reduction by 100%

Source: Munich Re, based on acatech data

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Ernst Rauch

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