GIRO Conference and Exhibition 2012
Juggling uncertainty the actuary’s part to play

20 September 2012
GIRO Conference and Exhibition 2012

Weather and climate related aspects of catastrophe risk

Dr Emily Shuckburgh, British Antarctic Survey
Agenda

Weather and Climate Risk

- A review of weather and climate events of 2011
- Attributing the risk of weather events
- Quantifying future climate risk
- The international political dimension
- Summary
A review of weather and climate events of 2011
La Niña influences weather worldwide

Source: NOAA, 2012
Global climate change

Source: Met Office, 2012
Drought in East Africa 2011

Rains failed in fall 2010 – only $\frac{1}{4}$ usual moisture delivered to the region – and in spring 2011.

Drought in East Africa, with social & political factors, led to **food insecurity** in parts of Ethiopia & Kenya and **famine** in Somalia.

**Worst drought in 60 years** (UN Food and Agriculture Organization)

Link to **La Niña** and warm sea surface temperatures in central and southeastern Indian Ocean.

Source: Funk, 2012, BAMS
Drought in southern United States 2011

In Texas, growing season (March-August) and summer (June-August) were hottest and driest on record (back to 1895).

Texas agriculture producers lost $7.62bn. Costliest drought in the state’s history.

The 100-yr return period March-August precipitation is now 25-yr return (taking into account La Niña conditions).

The 100-yr return period March-August heat event is now 5-yr return.

Source: Rupp et al., 2012, BAMS
Thai floods 2011

Storms and heavy rain from July-October contributed to worst flooding since 1942.

Cost global insurance business $12bn (highest insured loss ever for freshwater flooding). Total damage estimated $45bn (World Bank).

Monsoon season for Chao Phraya basin wettest on record. Estimated 140-yr return time.

Likely influence of La Niña, but no clear climate change trend. Models indicate future increase in mean & variability of precipitation (but much uncertainty).

Source: van Oldenborgh et al., 2012, BAMS
UK weather winter 2010/11 and spring 2011

Coldest December in UK in the last 100 years (but global average was warm). Estimated to have cost UK economy £1.2bn per day.

Followed by warmest spring in 100 years.

Possible link between cold winter in UK and Arctic sea ice decline?

Source: NASA-GISS

Source: NSIDC, 2012

50m estimated to live in its path. Disrupted power to more than 7m homes and businesses. Caused 45 deaths. Estimated $19bn property damage.

Future projections uncertain. It is more likely than not that frequency of most intense storms will increase in some ocean basins.

Source: Knutsen et al, Nat Geosci, 2010
Attributing the risk of weather events
Impact of climate change on extremes

Risk of extreme weather can be altered by:

- Shifted mean
- Increased variability
- Changed symmetry

Source: IPCC SREX report, 2012
Increasing vulnerability, exposure or severity/frequency of climate events increases disaster risk

Source: IPCC SREX report, 2012
European heatwave summer 2003

Death toll in Europe estimated at 30,000. **Deadliest natural disaster in Europe in 50 years** (UNEP).

Very likely **climate change doubled the odds** of heatwave.

Return period of heatwave **with** and **without** climate change

9 in 10 chance that more than **100% increase** in risk of heatwave

Source: Stott et al, 2004
UK floods autumn 2000

Autumn 2000 was wettest on record in England and Wales. Flooding estimated to have cost £3.5bn.

Likely climate change doubled the odds of the flooding.

Source: Pall et al, 2011
Quantifying future climate risk
Projected temperature change

Source: IPCC, AR4, 2007
Risk of coastal flooding over coming decades

Sea level: fear that rise by 2100 may be up to 1 m

People at risk: about 150 million people in Asia exposed to coastal flooding; could more than double with 30 cm rise

Cities and infrastructure at risk: London, Rotterdam, New York, Tokyo, Shanghai, Bangkok, Dhaka at risk of flooding

Sources: IPCC 2007; APN 2011; Foresight 2011

Projected sea level rise for 2040 (relative to 1980-99).

Source: Foresight report on Migration, 2012
Climate risk: droughts and floods

More intense and longer droughts

Greater risk of flooding

Source: IPCC SREX report, 2012
Interconnected risks

Risk of flash floods in Kenya
Interconnected: health & sanitation, infrastructure

Risk of drought in West Africa
Interconnected: food & water security, health

Climate-risk to infrastructure
Interconnected: energy and water supply

Urban flood risk
Interconnected: health, infrastructure, economy

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Interconnected risks

The great acceleration

Source: New Scientist 2008 from Steffen et al 2004
Accounting for uncertainty

Knowledge about outcomes (impacts)

<table>
<thead>
<tr>
<th>Knowledge about probabilities</th>
<th>Knowledge about outcomes (impacts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>Ambiguity</td>
</tr>
<tr>
<td>e.g. probabilities of global average temperature to 2100</td>
<td>e.g. future emissions; who, where, what</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Ignorance</td>
</tr>
<tr>
<td>e.g. “tipping points”</td>
<td>Based on: Stirling 2007</td>
</tr>
</tbody>
</table>

Based on: Stirling 2007
Risk of irreversible change

Source: Lenton, 2011
In the past, changes of 10°C have occurred in Greenland over a decade or so.

In 2002 an ice sheet the size of Rhode Island state collapsed in a few weeks.

Larsen B ice shelf

31 Jan 2002
23 Feb 2002
5 Mar 2002

Source: Arctic Council, 2004
Source: NASA, 2002
Risk of dangerous climate change

Source: AVOID project, 2010

No mitigation, medium emissions
Peak 2016 then 5% p.a. reduction
Chances of staying below thresholds

Probability of staying **below** thresholds

<table>
<thead>
<tr>
<th>Temperature</th>
<th>2°C</th>
<th>3°C</th>
<th>5°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>0%</td>
<td>7%</td>
<td>80%</td>
</tr>
</tbody>
</table>
Chances of staying below thresholds

**Probability of staying below thresholds**

- **2°C**
  - No mitigation: 50%
  - Strong mitigation: 90%

- **3°C**
  - No mitigation: 7%
  - Strong mitigation: 100%

- **5°C**
  - No mitigation: 0%

**Dangerous climate change**

Source: AVOID project, 2010
Impacts in 2080

Food

50%

decrease in crop suitability as % of cropland

No mitigation

Water

850

 Millions of people with increase in water stress

Flood

50%

% of flood-prone population with increased hazard

Source: AVOID project, 2010

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Impacts in 2080

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<th>Food</th>
<th>Water</th>
<th>Flood</th>
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<tr>
<td>decrease in crop suitability as % of cropland</td>
<td>Millions of people with increase in water stress</td>
<td>% of flood-prone population with increased hazard</td>
</tr>
<tr>
<td>50%</td>
<td>850</td>
<td>50%</td>
</tr>
<tr>
<td>30%</td>
<td>450</td>
<td>25%</td>
</tr>
</tbody>
</table>

Source: AVOID project, 2010

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The international political dimension
Possible mitigation strategies

![Graph showing possible mitigation strategies](source: AVOID project, 2010)

- e.g. peak 2015-2020 then decrease at 5% per year gives 50-50 chance
Possible mitigation strategies

<table>
<thead>
<tr>
<th>Year of peak emissions</th>
<th>Decrease after peak for 50-50 chance of avoiding dangerous climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>4% p.a. or more</td>
</tr>
<tr>
<td>2020</td>
<td>5% p.a. or more</td>
</tr>
<tr>
<td>2025</td>
<td>n/a</td>
</tr>
<tr>
<td>2030</td>
<td>n/a</td>
</tr>
</tbody>
</table>

But, IEA World Energy Outlook 2011: risk of “lock-in” – after 2017 may have to prematurely scrap assets to avoid exceeding 2°C

Source: AVOID project, 2010 and IEA, 2011
Current carbon trajectory

Source: Global Carbon Project, 2011
Summary

- Climate change is altering return periods of some weather events
- Future risk of more intense and longer droughts and more flooding (coastal and river) in many areas
- Increasing vulnerability, exposure or severity/frequency of climate events increases disaster risk
- Climate risk assessment needs to include uncertainty, ambiguity & ignorance (recent past not a good guide to future)
- Risk are highly interconnected (and in ways that are not always appreciated)
- Can avoid dangerous climate change, but only if rapid and strong mitigation undertaken
- High risk some impacts cannot be avoided: adaptation will be required

All this offers threats and opportunities for the risk profession
Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.
The views expressed in this presentation are those of the presenter.