An Actuarial Career in Catastrophe Modelling

Graham Hall

January 2016
A bit about me...
<table>
<thead>
<tr>
<th></th>
<th>Agenda</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Why is catastrophe modelling so important today?</td>
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<tr>
<td>02</td>
<td>How do catastrophe models work?</td>
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<td>03</td>
<td>How can insurance companies manage their catastrophe risk?</td>
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<td>04</td>
<td>What role can actuaries play?</td>
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</tbody>
</table>
Why is catastrophe modelling so important today?
Recent catastrophe events have caused significant damage in the UK

- 2009 storms caused economic losses of £276m
- 25,000 claims were made and insured claims of £174m were paid out.

Cockermouth 2009

- 3 storms – Desmond, Eva and Frank hit the UK in December 2015
- Latest estimates of economic losses are about £2billion
- Latest estimate of insured losses are about £1billion

Appleby 2015
Global warming is arguably increasing the level of catastrophe losses around the world.
Why are actuaries talking about catastrophe events?

Mohammad Khan (general insurance leader at PwC):
“If the storm continues, the damage – and therefore the costs – could be significantly worse. Any additional rainfall, even 1 to 2cm, could cause flash flooding in rain-affected areas as the ground is already saturated with water”

Domenico del Re (head of catastrophe management at PwC):
"Recent additional flooding once again highlights a need to recognise that the rebuilding of flood defences will not automatically solve the affordability of flood insurance, nor will it stop flooding when severe rain falls. Following the 2007 floods, a lot of work was undertaken on flood defences but clearly more can be done. Flood defences cannot stop everything, as they are based on historical information, but a lot more information exists today than there was even five years ago.”
How do catastrophe models work?
4 ages of catastrophe models

1980s 1990s 2000s 2010s

Age of Aggregates

Age of RDSs

Cat Models

9/11

Age of EP Curve

SII

Age of Recognised Uncertainty
Who builds catastrophe models?

- **Main model vendors:**
  - AIR Worldwide
  - CoreLogic
  - Risk Management Solutions

- **Secondary vendors:**
  - PERILS
  - JBA Consulting
  - ambiental

- **Brokers:**
  - GUY CARPENTER
  - Willis
  - AON BENFIELD

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Which perils do catastrophe models consider?

- River flooding
- Wind
- Earthquake
- Hail/Tornadoes
Catastrophe model modules

Define Event
Assess Risk
Apply Exposure
Calculate Damage
Quantify Financial Loss

Stochastic Event Module
Hazard Module
Geocoding/Exposure Module
Vulnerability Module
Financial Analysis Module
**Stochastic event / hazard module**

- A catalogue of potential catastrophe events in a territory.
- Each event is characterised by frequency and magnitude.
- For each event in the event catalogue define the key risk drivers:
  - Direction/course
  - Windspeed
  - Magnitude
- Based on historical events but given very limited record augmented through science current scientific understanding
Vulnerability module

- This module is all about the response of a particular portfolio.
- Each (re)insurer inputs information about the actual buildings on the ground (location as well as structural characteristics) together with the value of coverage.
- The vulnerability module assess the damage to the structure for different risks types, given their characteristics.
- The output of this model is the ground up loss – loss to the structure itself.
**Financial module**

- Applies location policy terms and reinsurance terms to determine the liability for damage between the insurer, insured, and the reinsurer.
- Generates total loss to the insurer per event across the portfolio.
**Inputs to catastrophe models include...**

<table>
<thead>
<tr>
<th>Location</th>
<th>Structural</th>
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<tbody>
<tr>
<td>Street Address</td>
<td>Sums Insured (BSI, CSI, BISI)</td>
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<tr>
<td>Postcode</td>
<td>Occupancy Type</td>
</tr>
<tr>
<td>City</td>
<td>Construction Type</td>
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<tr>
<td>County</td>
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<tr>
<td></td>
<td>Number of storeys</td>
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</table>

<table>
<thead>
<tr>
<th>Reinsurance</th>
<th>Policy</th>
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<tbody>
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<td>Type (Facultative, Quota Share, Excess of Loss etc.)</td>
<td>Coverage Deductibles</td>
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<tr>
<td>Limits</td>
<td>Coverage Limits</td>
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<td>Retention</td>
<td>Co-insurance</td>
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</table>
Catastrophe model outputs - statistical

- Exceedance probability:
  - OEP
  - AEP
Catastrophe model outputs - financial

- Ground up loss
- Gross Loss
- Net loss Pre Cat
- Event loss table – feeds into capital model

<table>
<thead>
<tr>
<th>Event number</th>
<th>Event frequency</th>
<th>Event mean severity</th>
<th>Standard deviation</th>
<th>Exposure value</th>
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</table>

All data in €.
How can insurance companies manage their catastrophe risk?
Cat models are used throughout insurance businesses

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Coverage of cat models varies around the world
Example: 2 years of significant non-modelled cat events

- Top 5 cat events in 2011 by insured losses (US$m)
  1) Japan (Earthquake, tsunami) – 35,000-40,000 Partially modelled
  2) New Zealand (Earthquake) – 13,000 Mostly modelled
  3) Thailand (Floods, landslides) – 10,000 Not modelled
  4) USA (Severe storms, tornadoes) – 7,300 and 6,900 Modelled
  5) Caribbean and North America (Hurricane Irene, storm surge, floods) – 5,600 Modelled

- Top 5 cat events in 2010 by insured losses (US$m)
  1) Chile (Earthquake, tsunami) – 8,000 Mostly modelled
  2) New Zealand (Earthquake) – 5,000 Mostly modelled
  3) Australia (Floods) – up to 5,000 Not modelled
  4) Southwestern and western Europe (Winter storm Xynthia) – 3,100 Modelled
  5) USA (Severe storms, floods) – 1,220 Modelled
Sources of non-modelled loss come from different areas

- **Classes of exposure** and coverage not suitable for models such as cargo, special risks

- **Non-modelled perils/regions** floods, wildfire, tsunami

- **Secondary-perils** such as liquefaction, demand surge, volcano and landslides following quake, fire following earthquake, government intervention, sprinkler leakage

- **Modelled perils**
Man made catastrophes are another source of non-modelled loss
Cyber risk is a current hot topic in catastrophe risk modelling
Flood Re is also a hot topic in catastrophe risk modelling

What is it?
• The Flood Re scheme will be a not-for-profit flood reinsurance fund to replace the statement of principles

How does it work?
• The flood element of a home insurance policy will be placed in Flood Re, based on Council Tax band. Insurers will use this facility for the 1-2% highest risk homes – an estimated 350,000 homes

Who is paying for it?
• Two sources of income - first is the flood element of the policies which are passed into it, second is an additional levy on the industry, equivalent to the existing cross-subsidy that exists in the market.
What role can actuaries play?
Actuaries are increasing becoming involved in cat modelling projects

• Traditionally actuaries and cat modellers had very separate roles

• Line is becoming blurred with many actuaries now being employed in catastrophe modelling roles, driven by the competitive market place and regulatory drivers (e.g. Solvency II)

• Variety of possible opportunities for actuaries in cat modelling roles including:
  o Cat modelling department of an (re)insurance company
  o (Re)insurance brokers
  o Consultancies
  o Corporate risk management – E.g. Oil / Gas
  o Multinational institutions – UN / World Bank
  o Where next?
### PwC’s catastrophe risk offering

<table>
<thead>
<tr>
<th>Solvency II Independent Model Validation</th>
<th>Global City Risk</th>
<th>Internal Audit</th>
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</thead>
<tbody>
<tr>
<td>IT Platform support (e.g. RMS (one))</td>
<td>ILS / Investment Funds</td>
<td>Start-up company modelling</td>
</tr>
<tr>
<td>Standard Formula Appropriateness</td>
<td>Cyber Risk</td>
<td>Exposure Management</td>
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</table>
Questions?
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