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Exploring alternate realities: counterfactual approaches for extreme loss modelling

The case of the 2016 Alberta Wildfires

GIRO 2016 workshop D9

Junaid Seria

SCOR

The Art & Science of Risk

Key messages

1. **The Nat Cat Validation Working Party's first phase of work is complete**
    - a report detailing the validation framework proposed including case studies will be published in Spring 2017.

2. **Embedding Solvency II in Catastrophe Risk Management is challenging for various reasons**
    - process uncertainty, model complexity, SII requirements, organisational design and resource constraints – we need to get back to basics and make validation more relevant to business

3. ***Counterfactual analysis*, a scenario testing technique we explain and illustrate via a case study helps us do this:**
    - it's easy to implement, stimulates engagement because it is rooted in history and achieves the goal of increasing risk awareness amongst decision-makers
    - Actuaries with no inquisitiveness / curiosity need not apply

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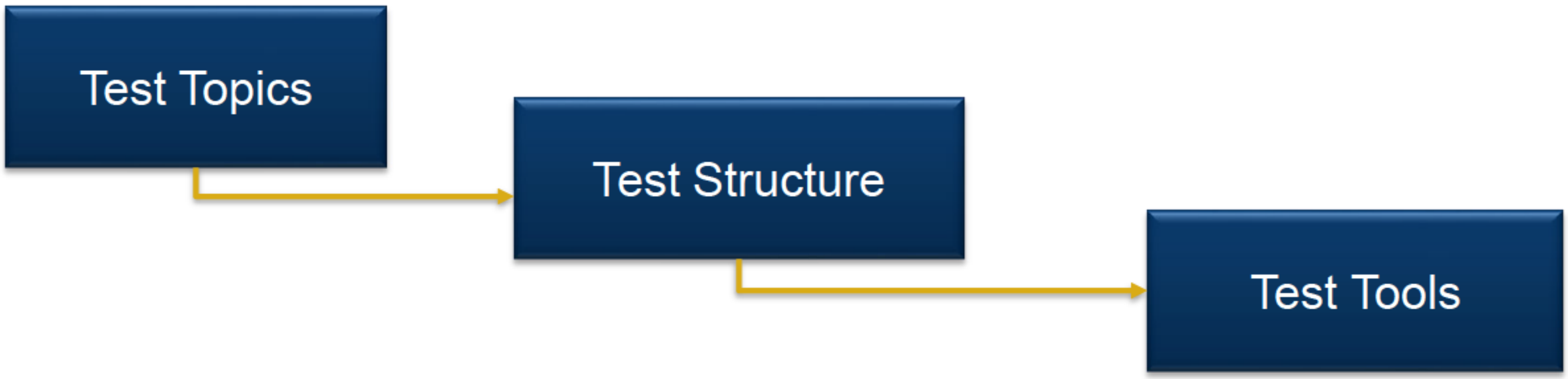
Nat Cat Validation Working Party

Update on Validation Framework Report



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Nat Cat Validation Working Party
Comprehensive Scope of Test Topics

Data
Design
Results
Key drivers
Governance

Hazard
Event Set
Vulnerability
Financial

Leverage **internal** and **external** resource

Key assumptions
Key switches / options
Key distribution choices and parameters
Expert judgements

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Nat Cat Validation Working Party

Consistent Unbiased Test Structure

Specification
Quantitative / Qualitative
Pass / Fail criteria
Test result and rationale
Conclusion / Recommendation

What's the context/issue?
Materiality
Scope
Objectives
Limitations

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Nat Cat Validation Working Party

Range of Test Tools and (target) Conclusions

- Analysis of change
- Back-testing / As-if testing
- Benchmark testing
- (Reverse) Stress testing
- Scenario testing
- Sensitivity testing
- Functional testing
- Risk attribution testing

Resilient to shocks, both historical and hypothetical

"Complete" (material risks)
Represents range of possible outcomes
Serves capital and pricing functions
Consistent model response

Stable results (consistent run times)
Validates well against observed history
Can replicate important vendor methods

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Case Studies

Demonstrate application of the framework

1. **Back-test:** validate third-party vendor UK windstorm cat model vulnerability curves against internal claims history
2. **Sensitivity test:** investigate sensitivity of assumptions made about earthquake seismic resistance of insured property in Taiwan in order to decide whether or not to load for corrupt building practice
3. **Stress test:** assess whether range of events in the stochastic catalogue includes plausible stress scenarios
4. **Reverse stress test:** Validate Cat Risk loss distribution against most probable stresses that would threaten viability of the risk carrier
5. **Benchmark test:** Compare internal calibration of clustering of European windstorm events against alternative vendor approaches

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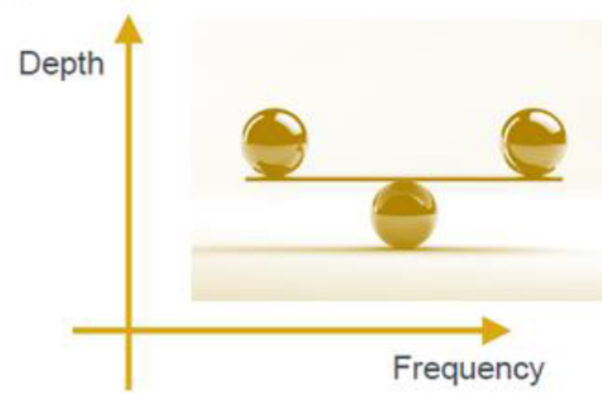
Challenges to embedding Solvency II

1. **Objective:** help senior management / Board gain comfort over the modelling methods and results used in catastrophe risk management in support of key decisions – *help them make sense of the numbers*
2. **Challenges:** complexity of processes modelled, modelling techniques, overly detailed validation, automated processes devoid of fundamental analysis
3. **Implications:** Risk insights either not revealed or where revealed do not always find their way to those at the front-line: e.g., underwriters and reinsurance departments

4. **Guidance:**
- less regulatory "tick-box" exercises
- more focus on application in decision-making – e.g., portfolio / capital management, pricing, exposure monitoring and business planning
- Dynamic validation cycles to keep pace with decision-making



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Counterfactual Analysis
Goals

1. Understand counterfactual analysis as a validation tool
2. Understand how to apply the approach as illustrated in the context of the 2016 Fort McMurray wildfires
3. Understand the benefits of this approach

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The GIRO effect

2015 Plenary: Modelling: The Next Generation (Dr Gordon Woo)

Remember this?

"Why didn't this happen before?"

Landslide in Ronchi di Termeno, northern Italy, 21 January 2014

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The GIRO effect

2015 Plenary: *Modelling: The Next Generation*
Dr Gordon Woo

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Counterfactual Analysis
Available scenario tools

Catalogue of historical events

Lloyd's RDS

Hypothetical Extreme Disaster Scenarios

Regulatory scenarios

Selected scenarios from stochastic catalogue

Counterfactual scenarios

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Counterfactual Analysis

Introduction

- Recognises that what happened was not inevitable, but is only one realisation of numerous alternative possibilities
- Allows us to access more data points: **losses are rare, near misses are common**
- We consider the historical record and ask:
  - *what if things had gone wrong? (in the case of near-misses)*
  - *what if things had turned for the worse? (in the case of a loss event)*
- More relevant for region-perils not modelled by third-party vendor cat models

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Counterfactual Analysis
Method

System characteristics → Hazard behaviour → Exposure distribution

Scenario identification → Loss frequency and severity computation

Communication

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Counterfactual Analysis
Case Study: 2016 Fort McMurray wildfires

Canadian Press, 3 May 2016

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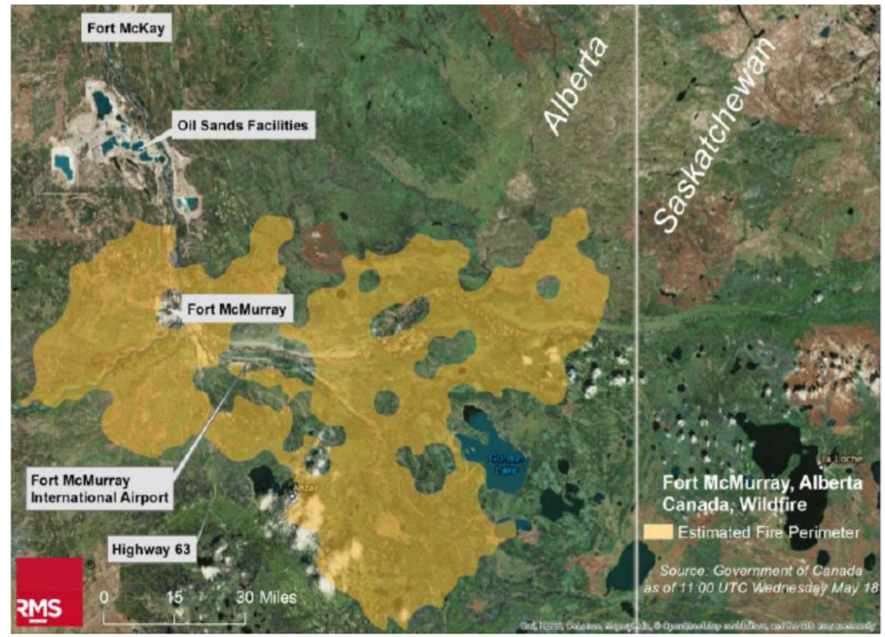
Counterfactual Analysis
Case Study: 2016 Fort McMurray wildfires

- **Case Study:** We consider the wildfires that affected Fort McMurray, in Alberta Canada in early May 2016
- **Facts:** most costly natural disaster in Canada to date, surpassing the 2013 Alberta floods, and indeed the costliest wildfire event in the world



According to data from Property Claim Services (PCS), Alberta wildfires are estimated to cost the insurance industry US$3.5bn, at the lower end of AIR Worldwide's loss forecast range of US$3.4bn – US$6.9bn and Morgan Stanley's estimated loss range of US$3bn - US$7bn. The Insurance Bureau of Canada reported a lower estimate of $2.73bn on 7 July 2016. These estimates exceed previous insured loss records of US$1.9bn for the 2013 Alberta floods and US$1.6bn for the 1998 Quebec ice storm (Sigma reports)

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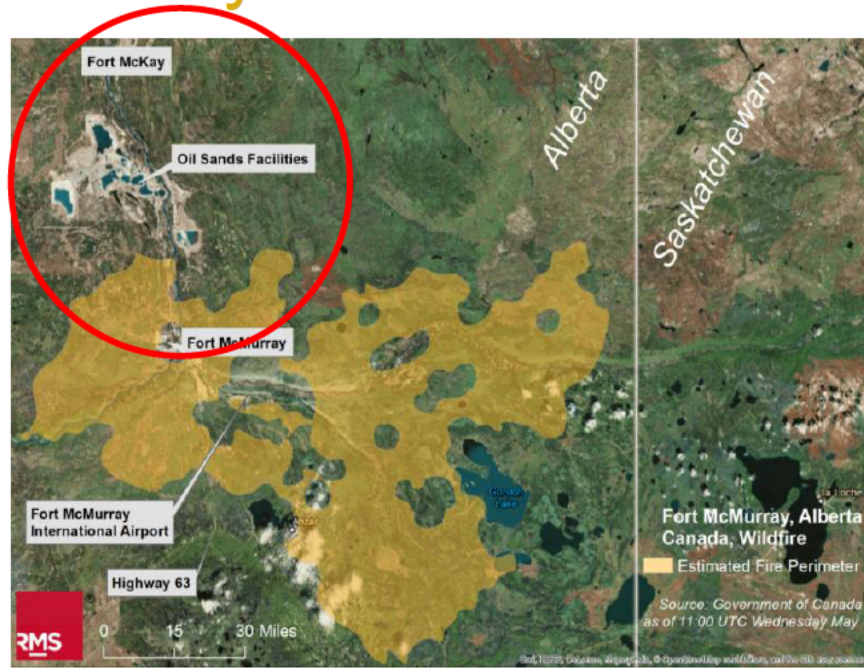
Counterfactual Analysis

Case Study: 2016 Fort McMurray wildfires



Curiosity: a possible near-miss?

Could prevailing winds have allowed the wildfire to engulf high value oil sands facilities north of Fort McMurray?

Little or no business interruption (BI) losses from oil sands projects were included in the estimates (see previous slide). However, BI can be a significant loss driver as illustrated by Alberta Sands (2011) and Suncor (2005) losses where finalised BI claims totalled US$250m and $830m respectively (Canadian Underwriter)

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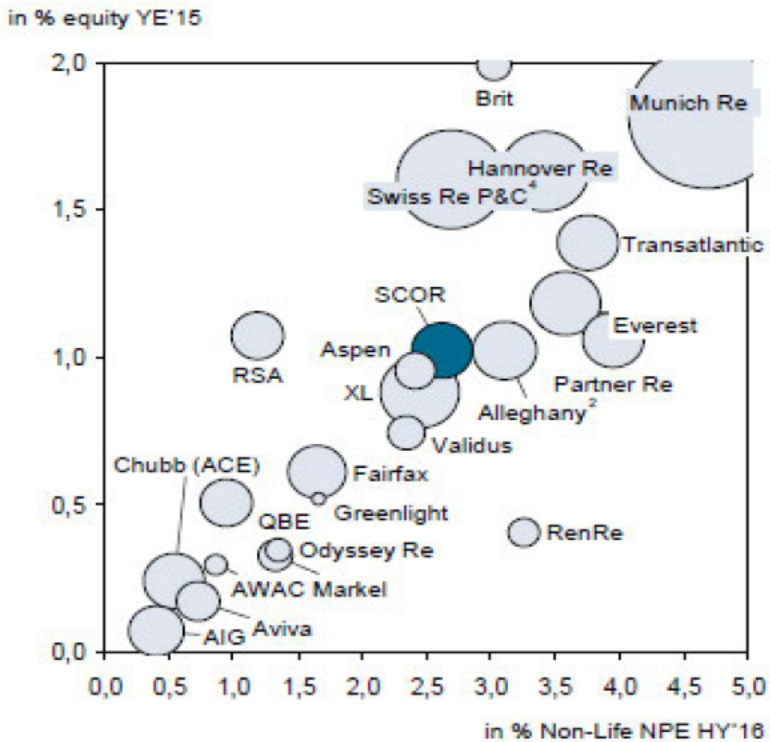
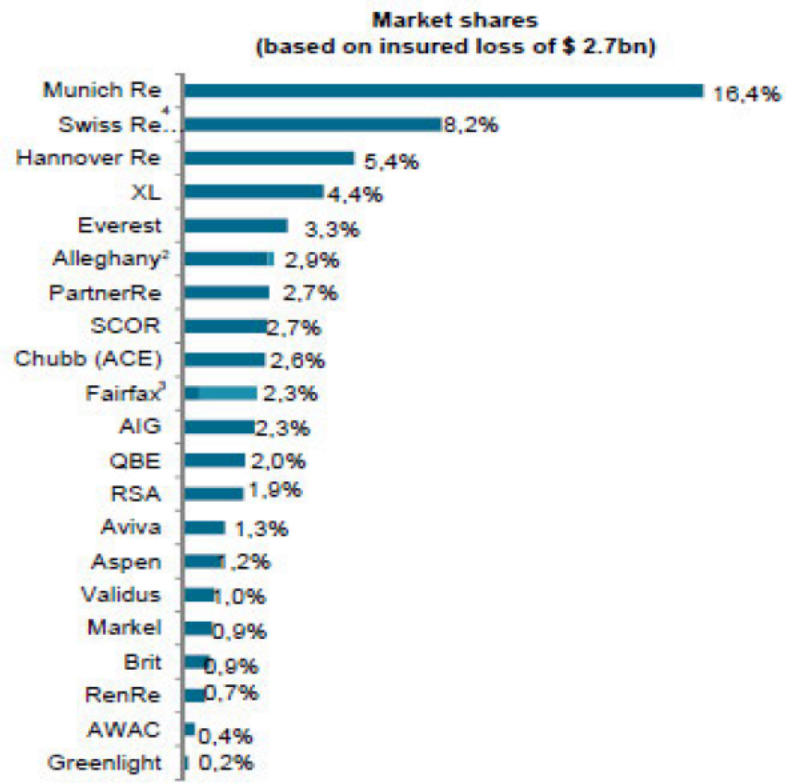
2016 Fort McMurray wildfires
Market benchmarks





Following companies did not provide the details of the individual events: Arch, Argo, Axis, Blue Capital, Endurance, Hiscox, Zurich
Aviva, Markel, Swiss Re and XL only provided the loss amount for the Canada wildfires.

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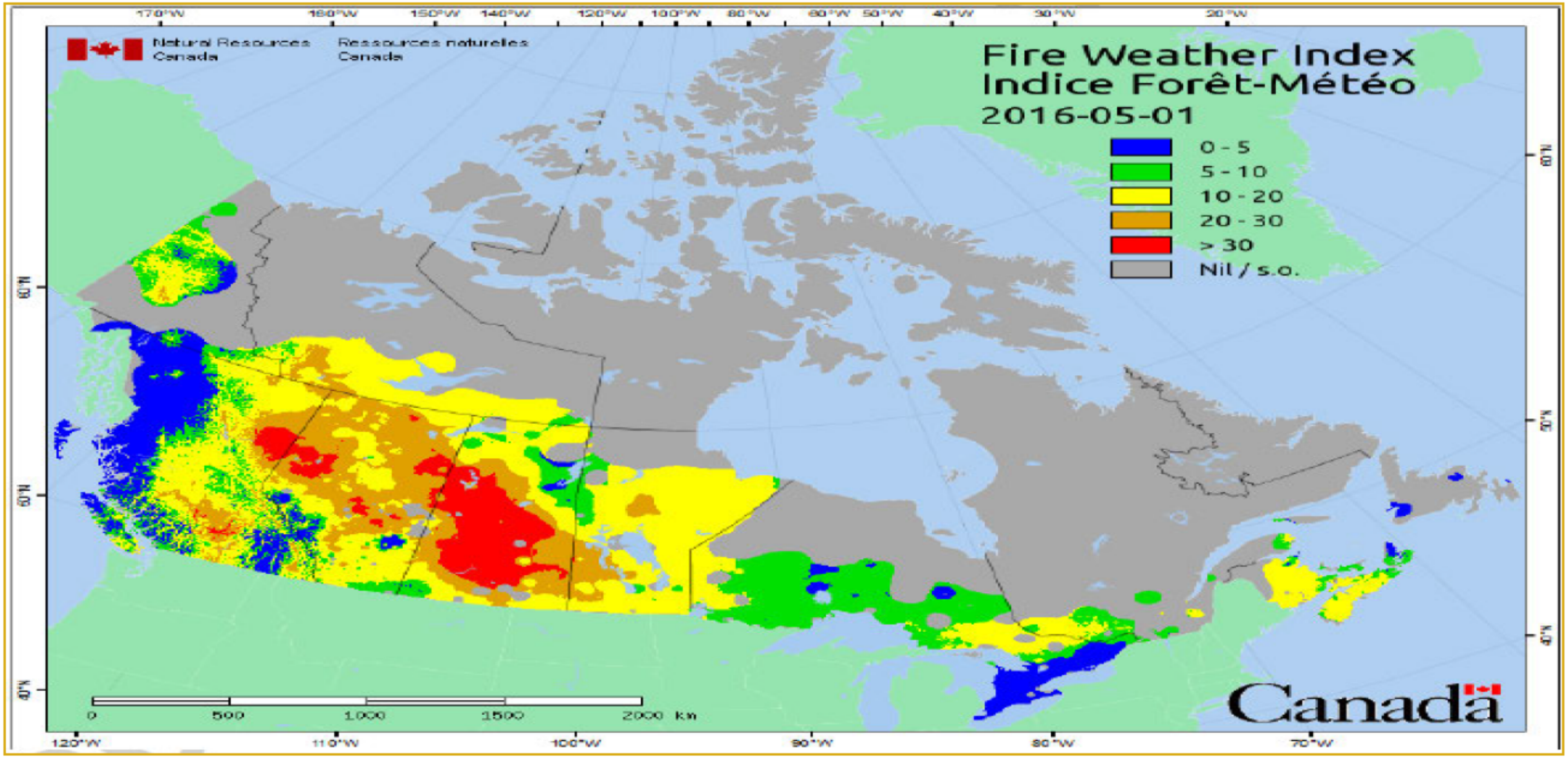
[2]Alleghany market share includes Transatlantic + RSUI market shares
[3]Fairfax market share includes OdysseyRe's market share
[4]Swiss Re P&C Reinsurance segment only, no loss estimate available for Corporate Solutions
Source: Company press releases

5

2016 Fort McMurray wildfires
Hazard maps

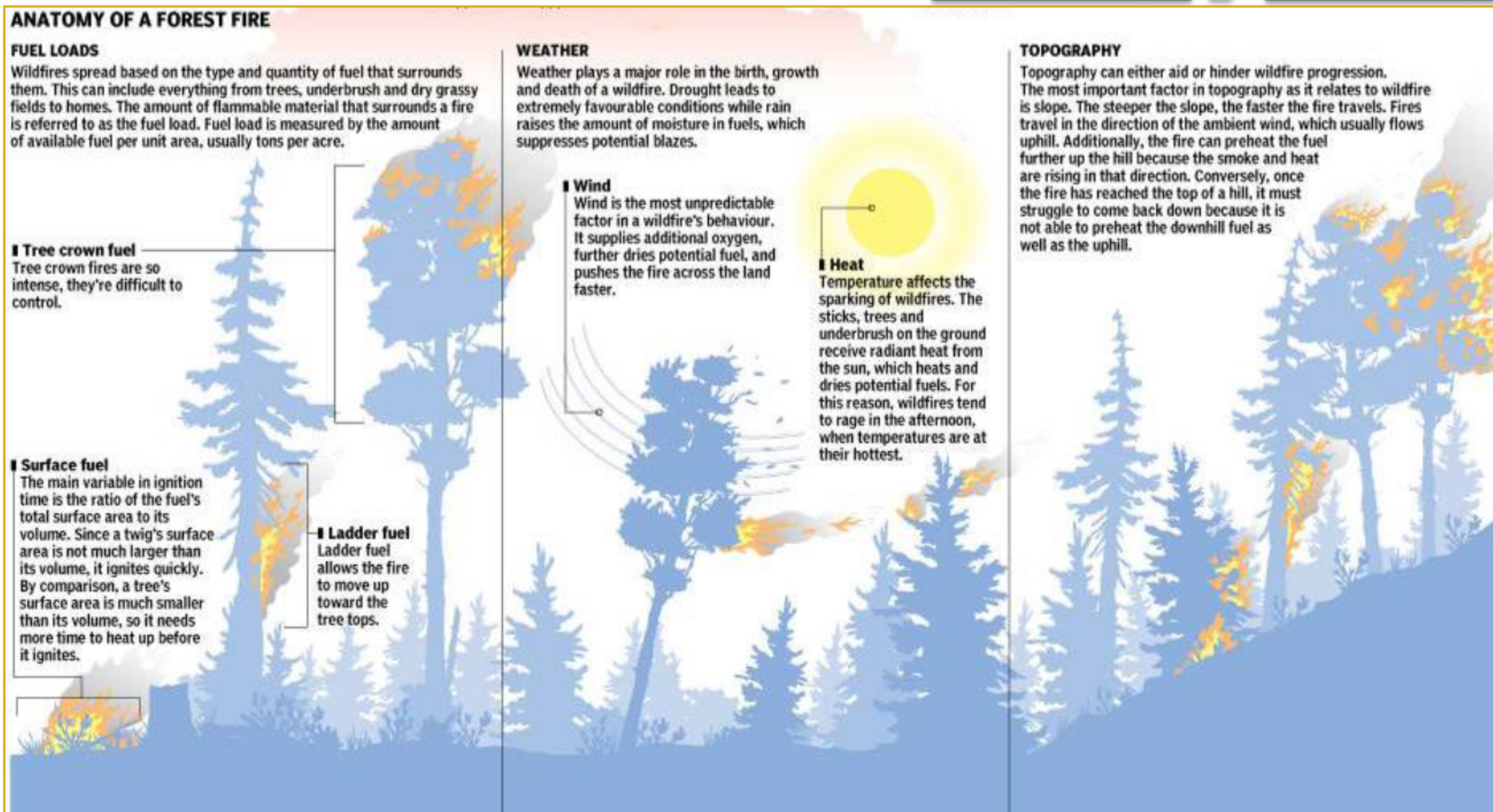
System characteristics → Hazard behaviour



2016 Fort McMurray wildfires

Factors of influence

System characteristics → Hazard behaviour



Source: National Post, May 2016

2016 Fort McMurray wildfires

Factors of influence

System characteristics → Hazard behaviour

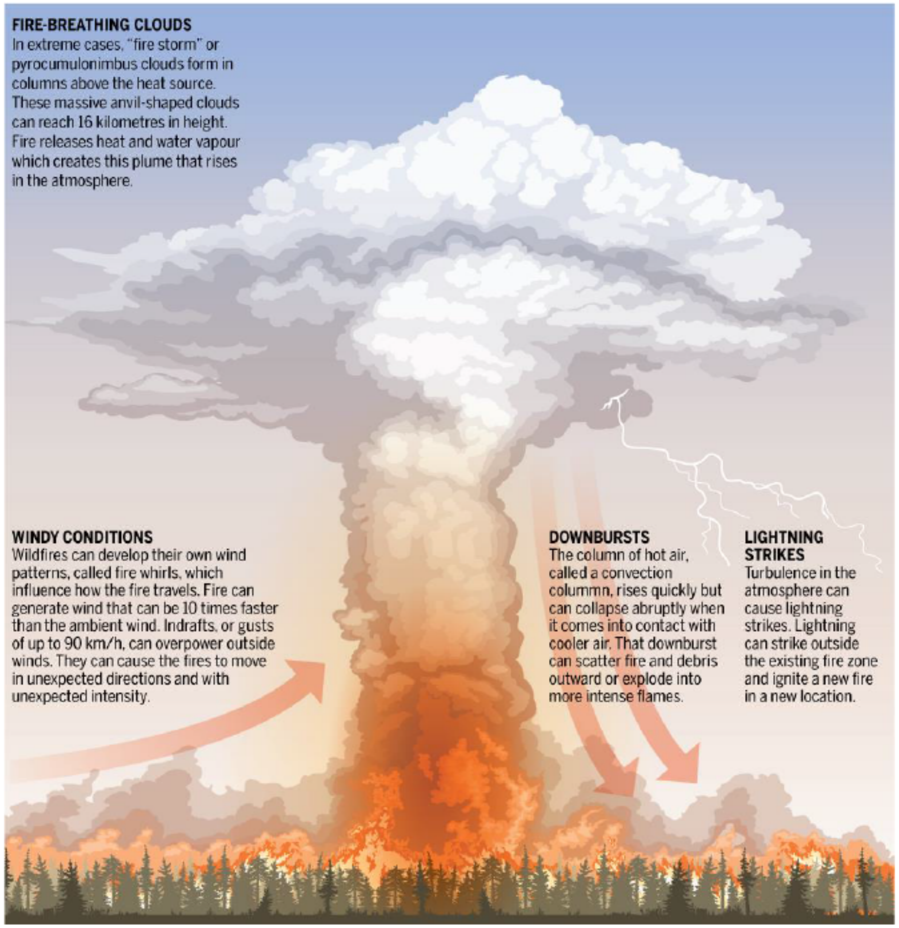
1. Frequency (ignition):
   - an ignition source (human / natural)
   - High temperatures,
   - Low humidity / no precipitation

2. Severity:
   - availability of dry vegetation,
   - supportive local topography and
   - gusty wind conditions

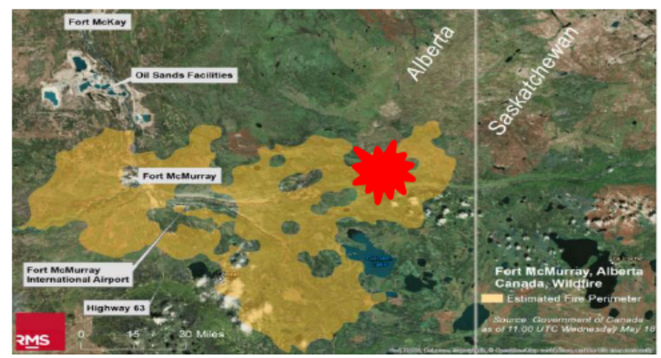
2016 Fort McMurray wildfires

Pyrocumulonimbus

System characteristics → Hazard behaviour



"Weather plays a major role in the birth, growth and death of wildfires – but intense fires can create their own circumscribed conditions – as in Fort McMurray" [National Post]



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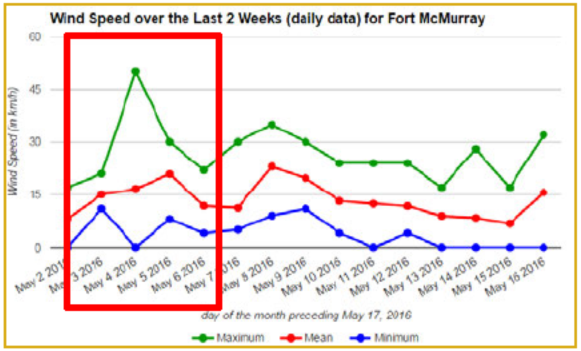
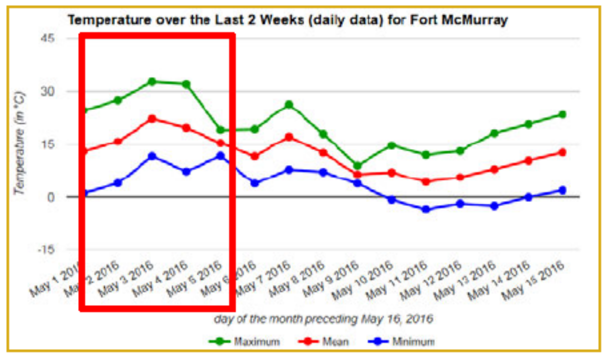
2016 Fort McMurray wildfires

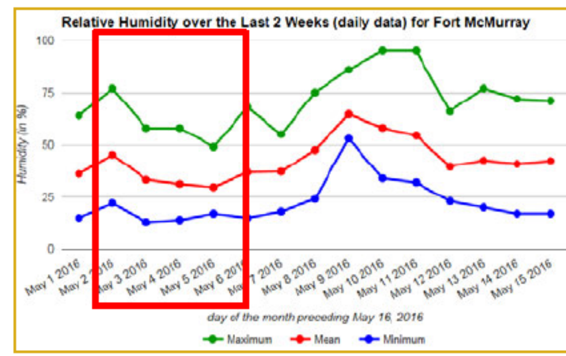
30-30-30 rule

System characteristics → Hazard behaviour

Frequency Computation







http://fortmcmurray.weatherstats.ca/charts/wind_direction-5years.html

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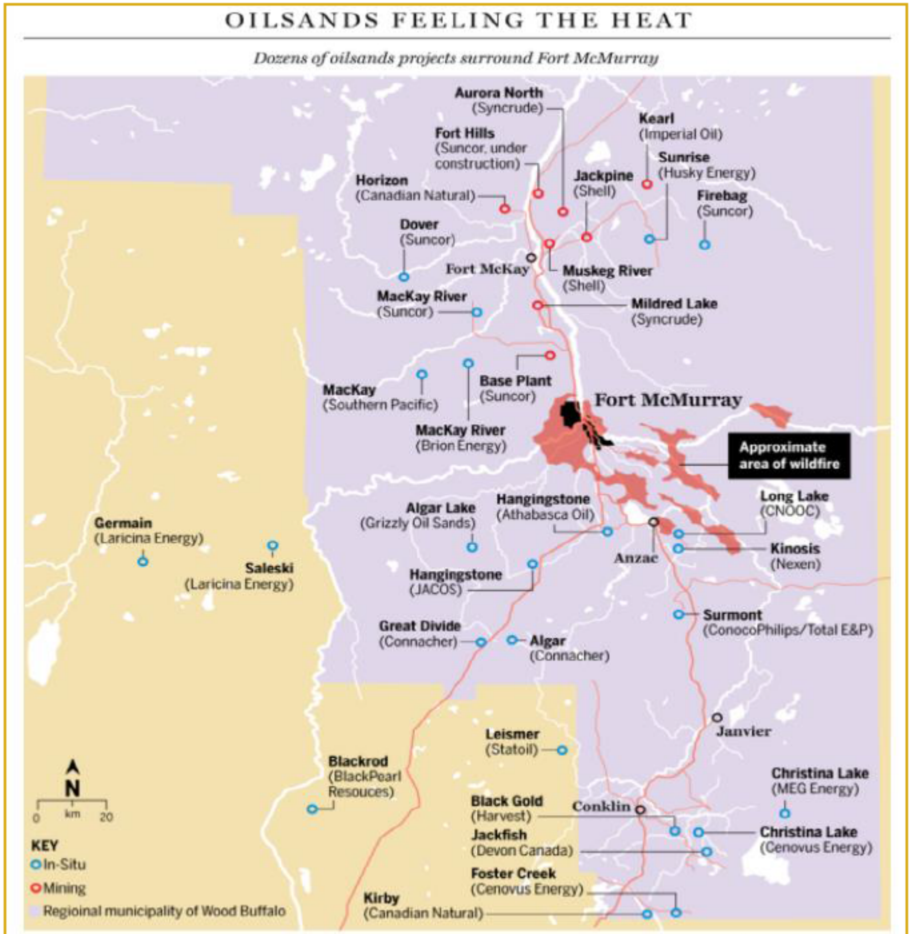
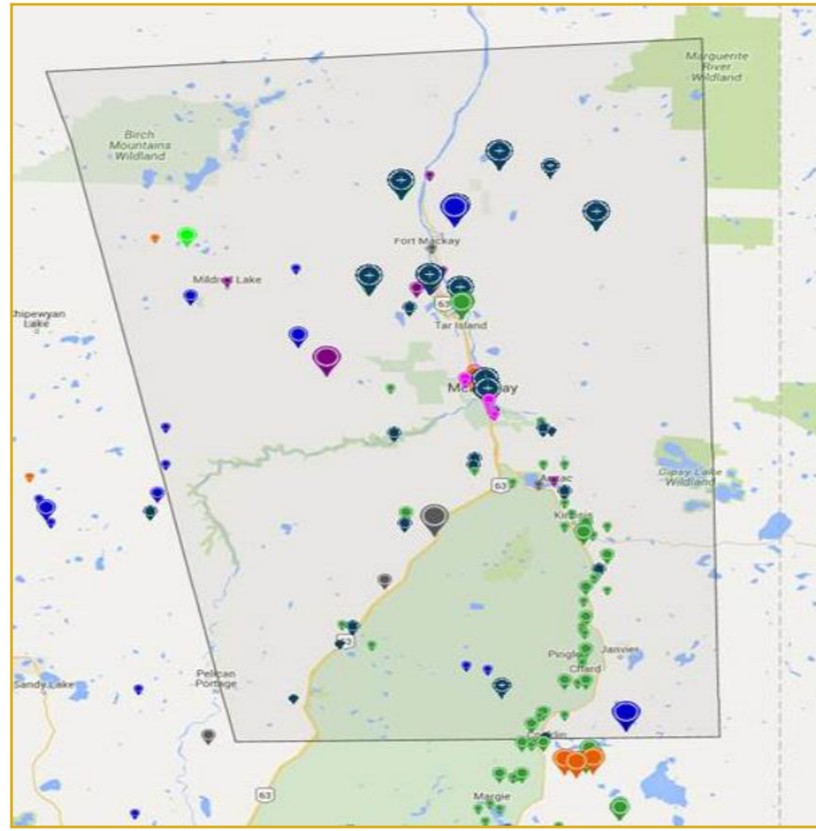
2016 Fort McMurray wildfires
Market and portfolio perspectives

Exposure distribution





Source: National Post (left) and SCOR Business Solutions geocoded locations (right)

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2016 Fort McMurray wildfires
Range of (adverse) scenarios considered

Scenario identification

1. Higher loss to Fort McMurray town
   - 90% of FMM remained intact
   - In contrast, third of 2011 Slave Lake destroyed

2. Increase wildfire duration
   - Slave lake wildfire out of control for 2 days
   - Fort McMurray = +38 days
   - Accelerated loss beyond 30 – 60 day deductibles for industrial risks

3. Damage to Oil Sands facilities
   - High concentration of assets
   - Spared by change in winds from prevailing southerly to westerly
   - What if strong southerly winds persisted?

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2016 Fort McMurray wildfires
Financial Liability Considerations

Severity Computation

Damage rates needs to consider:

- Contract attachment and exhaustion points and overall TIV
- Underlying deductibles on industrial risks: 30-120 day time-based deductibles
- Occupancy type and its relationship to assumed production downtime
- Range of reasonable damage rates rather than a single point estimate

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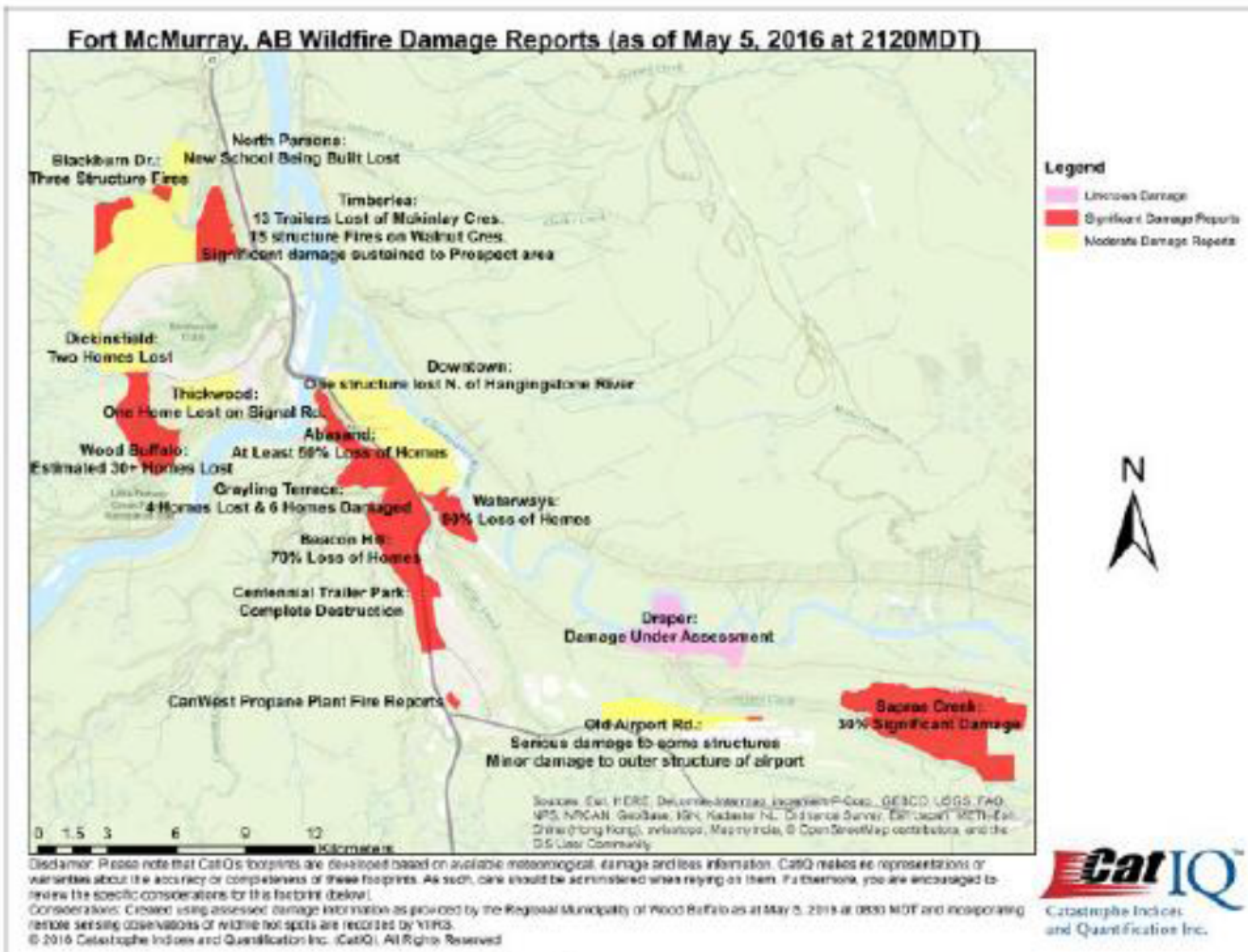
2016 Fort McMurray wildfires
1. Damage to FMM Town

Severity Computation



Perturbations:

- 10% base
- 25%
- 50%
- 75%

2016 Fort McMurray wildfires
2. Wildfire Duration

Frequency and Severity Computation

- **Frequency:** Estimate persistence of the “30-30-30” rule
- **Hazard extent:** hourly wind direction data from local weather stations to estimate as-if fire footprint
- **Severity:**
  - Ensure availability of dry vegetation for wildfire spread
  - Consider large firebreaks, though not unreasonable to assume limited effectiveness of fire suppression efforts while extreme hazardous conditions persist

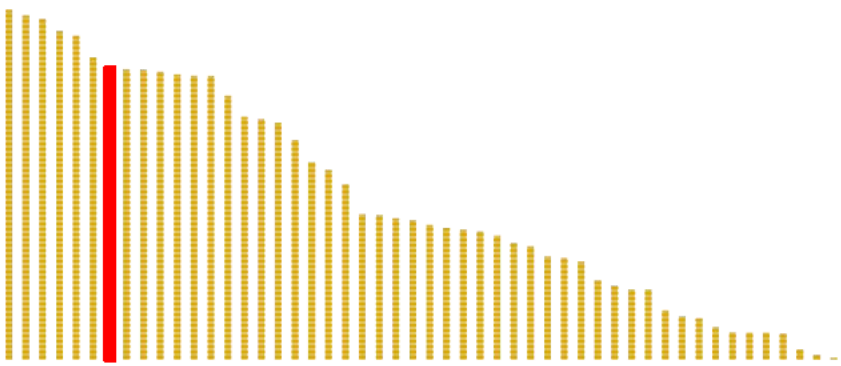
2016 Fort McMurray wildfires
3. Damage to oil sands facilities

Frequency and Severity Computation

- **Frequency:**
  - hourly wind direction data from local weather stations to estimate likelihood of wildfire spread to oil sands facilities around Fort McKay
  - As at May 6^{th} one in eight chance of fires spreading north
- **Hazard extent:**
  - hourly wind direction data from local weather stations to estimate as-if fire footprint
  - Average speed of fire spread = 40m / min (CatIQ) => southerly prevailing winds could have fanned wildfires toward oil sand facilities within one or two days
  - Possible accelerated spread due to pyrocumulonimbus clouds ignitions
- **Severity:**
  - Ensure availability of dry vegetation for wildfire spread
  - Consider large firebreaks, though not unreasonable to assume limited effectiveness of fire suppression efforts while extreme hazardous conditions persist

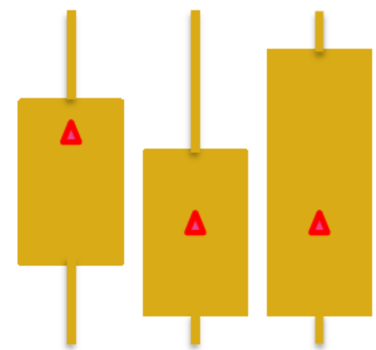
2016 Fort McMurray wildfires
Proximity to Extreme Loss

Communication



Actual loss ranked against range of scenarios computed

Percentiles or more qualitative: conservative, best estimate, optimistic



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Benefits and limitations

Applications in decision-making

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Counterfactual Analysis
Benefits and Limitations

- Compels us to explore the characteristics of a system and the mechanism for producing loss, thus revealing (potentially hidden) lessons from the past:
- Can help make sense of modelled numbers, but also reveal proximity to extreme loss for poorly modelled region-perils
- Catastrophe Risk: Tsunami, liquefaction, earthquake aftershocks and contingent business interruption
- Man-Made catastrophes: Cyber, Terrorism
- Mitigates the prospect of an unpleasant surprise as it reduces outcome bias*
- Complementary rather than stand-alone as this is not a *push of the button* type scenario, but certainly <u>not</u> labour intensive

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* Management's assessment of the quality of the decision-making process is heavily influenced by the outcome of the decision: i.e., no/small losses => good UW decisions rather than good luck

Counterfactual Analysis
Application in decision-making

- Improve risk selection in underwriting / pricing
- Refine the reinsurance / retrocession purchase decision
- Improve transparency in exposure management (setting and monitoring capacity)
- Develop Board understanding of proximity to extreme loss

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Resources

SCOR Technical Newsletter – coming soon!

http://www.rms.com/blog/2015/11/03/learning-more-about-catastrophe-risk-from-history/

https://www.actuaries.org.uk/documents/plenary-5-modelling-next-generation-gordon-woo

Fort McMurray weather station statistics

Wildfire spread animation:
http://news.nationalpost.com/news/canada/watch-the-fort-mcmurray-fire-spread-over-18-days-in-may-beastly-blaze-just-wont-die-growing-to-423000-hectares

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Questions

Comments

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