Institute and Faculty of Actuaries

FROM BACKGROUND TO FRONT

Catastrophe Modelling – a quick tour

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Peak Re

May, 2015

Outline

- Why do we need Catastrophe Model?
- Evolution of Catastrophe Models
- How to build a Catastrophe Model
- Risk Management

Why do we need Catastrophe Model?

https://www.opendemocracy.net/wataru-sawamura/japan-earthquake-and-media
http://www.theatlantic.com/infocus/2013/03/japan-earthquake-2-years-later-before-and-after/100469/
http://www.ibtimes.co.uk/japan-2011-earthquake-tsunami-30-powerful-images-1439673
http://www.coastal.jp/tsunami2011/index.php?Field%20survey%20results
http://yonasu.com/landslide-caused-by-earthquake-in-japan/
http://coastalcare.org/2011/04/japan-quake-caused-surprisingly-severe-soil-collapse/
http://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster

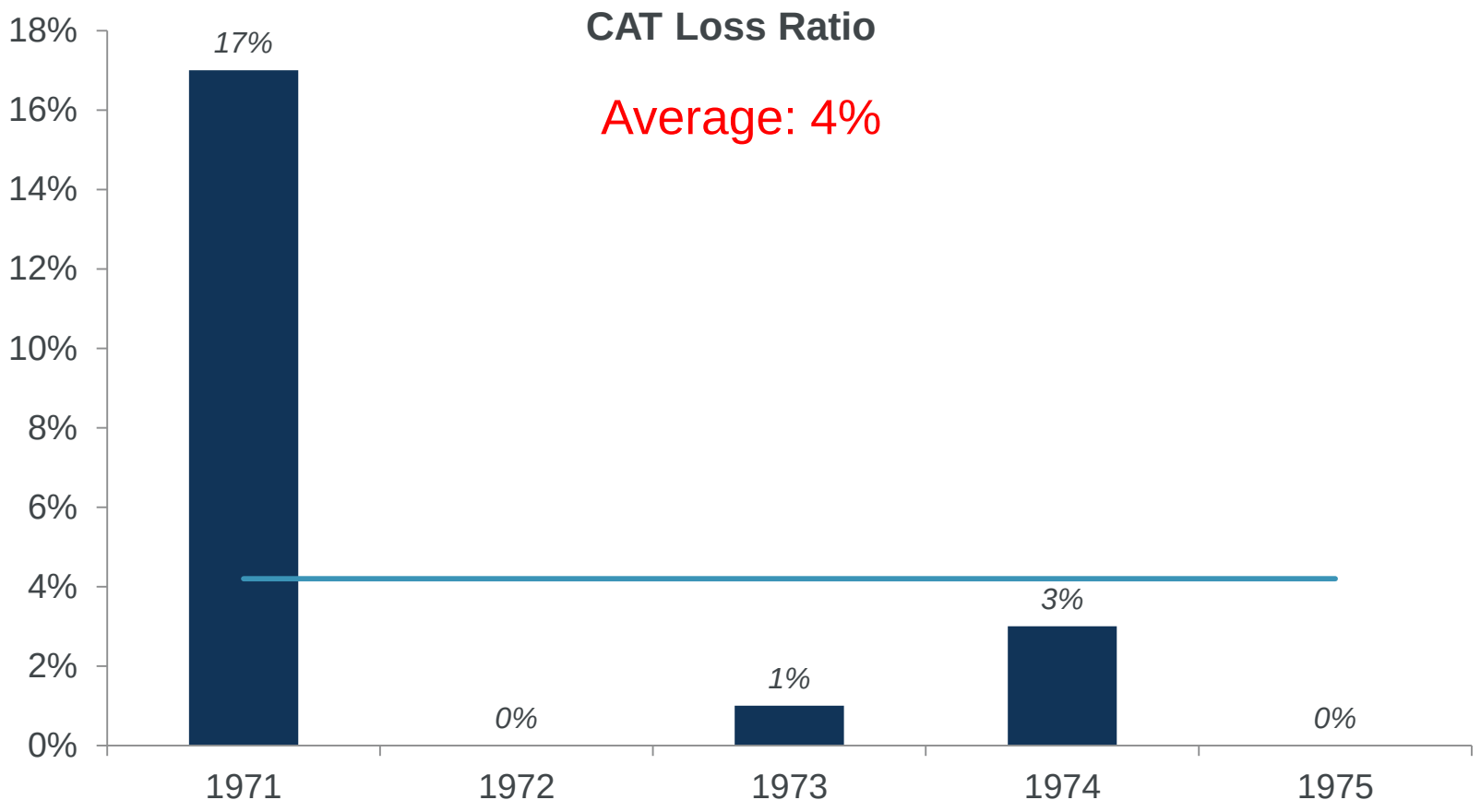
What are Catastrophes?

- Infrequent events that cause severe loss, injury or property damage to a large population of exposure.

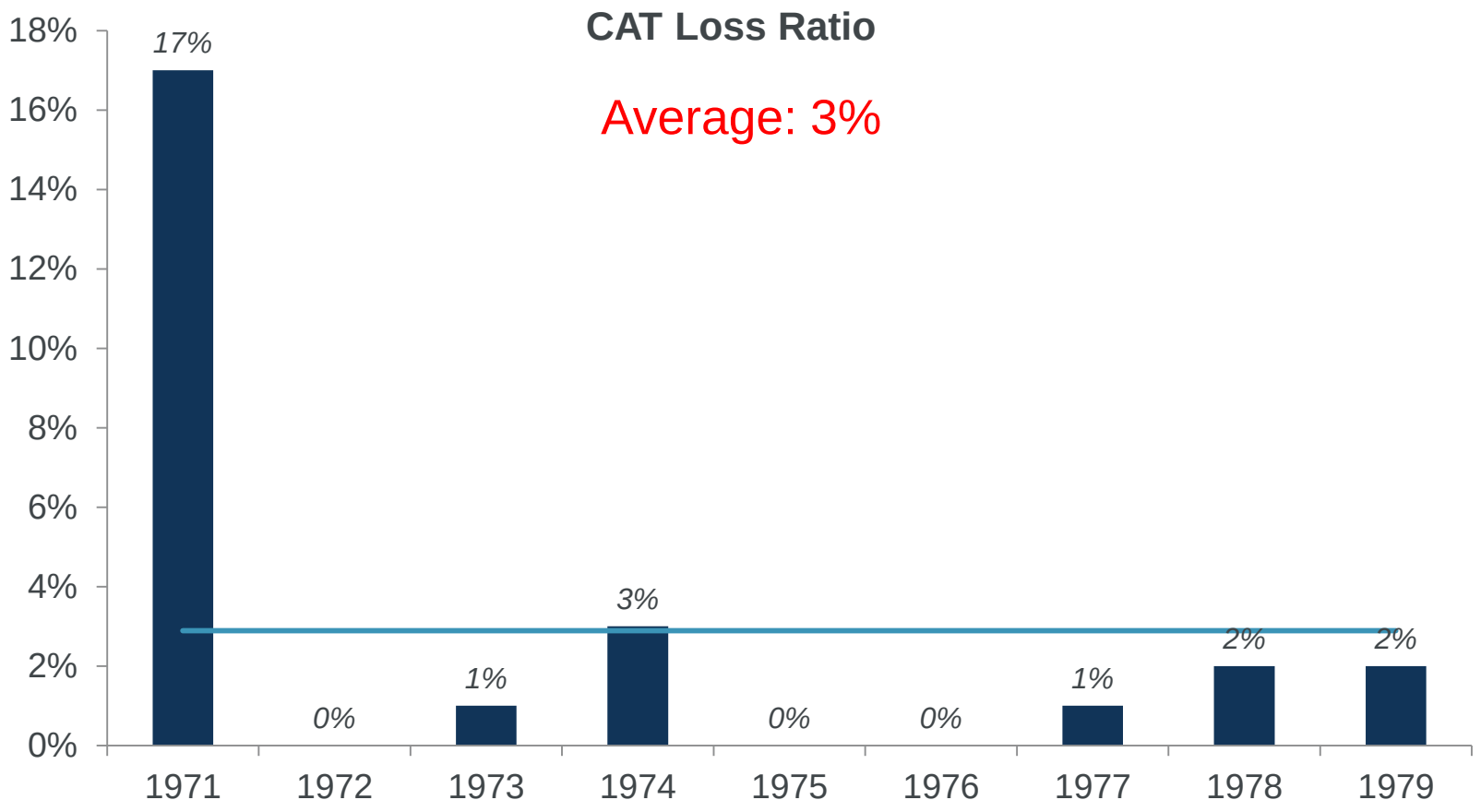
- The term is most often associated with natural events.
  - Examples: Earthquake, Flood or Typhoon

- It can also be used when there is concentrated or widespread damage from man-made disasters
  - Examples: Fires, Explosion, or Terrorism.

Traditional Ways?



Traditional Ways?



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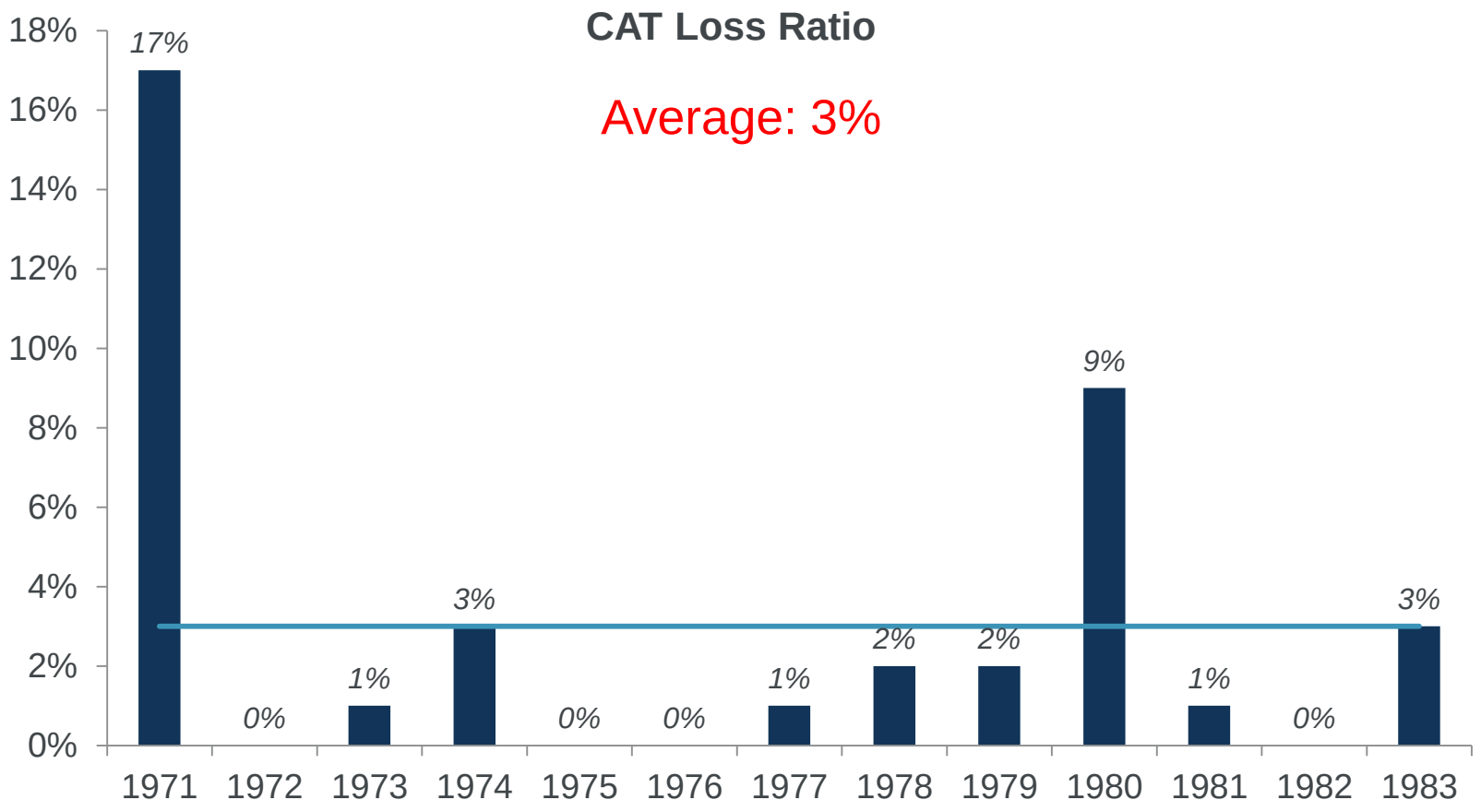

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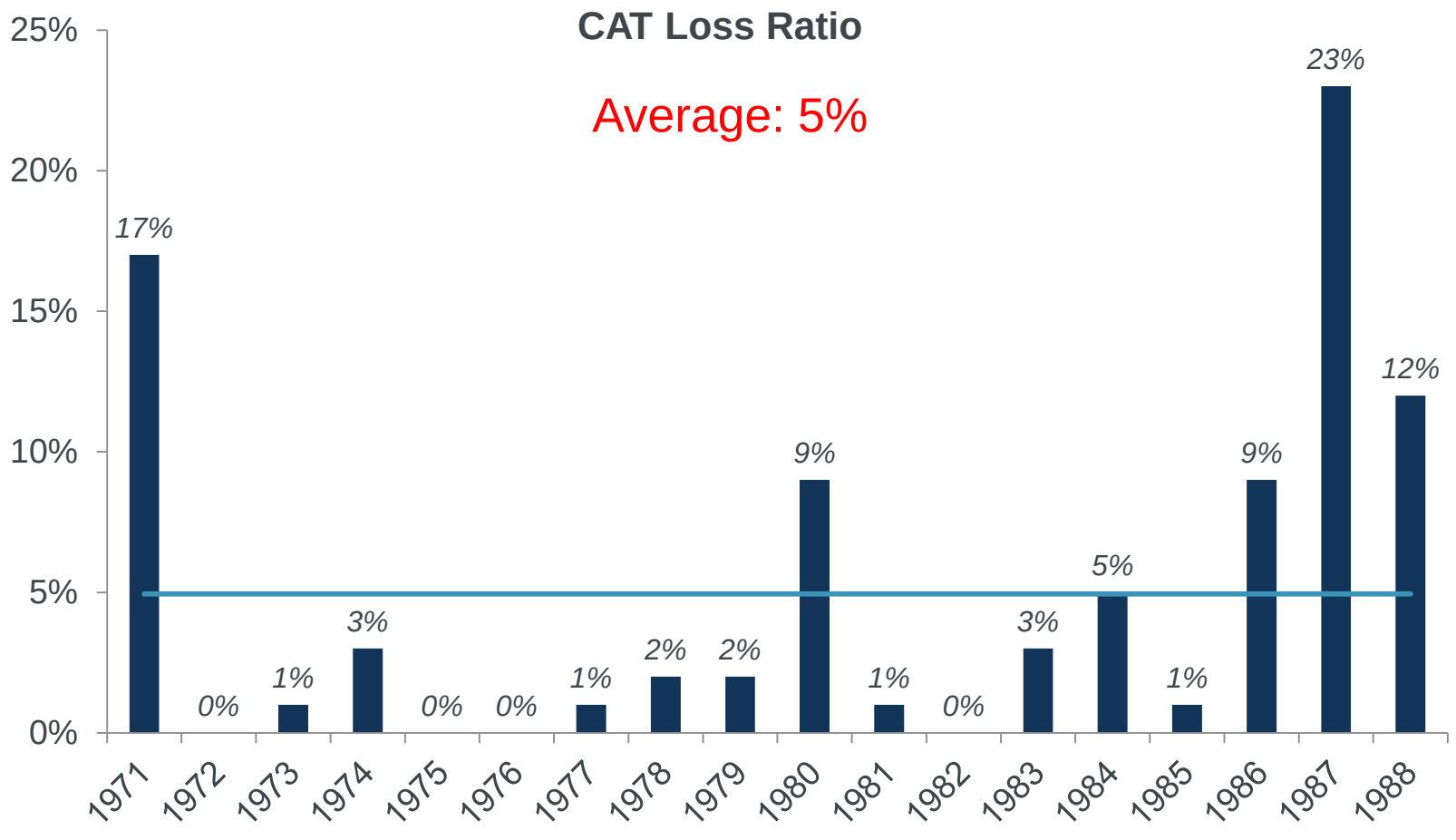
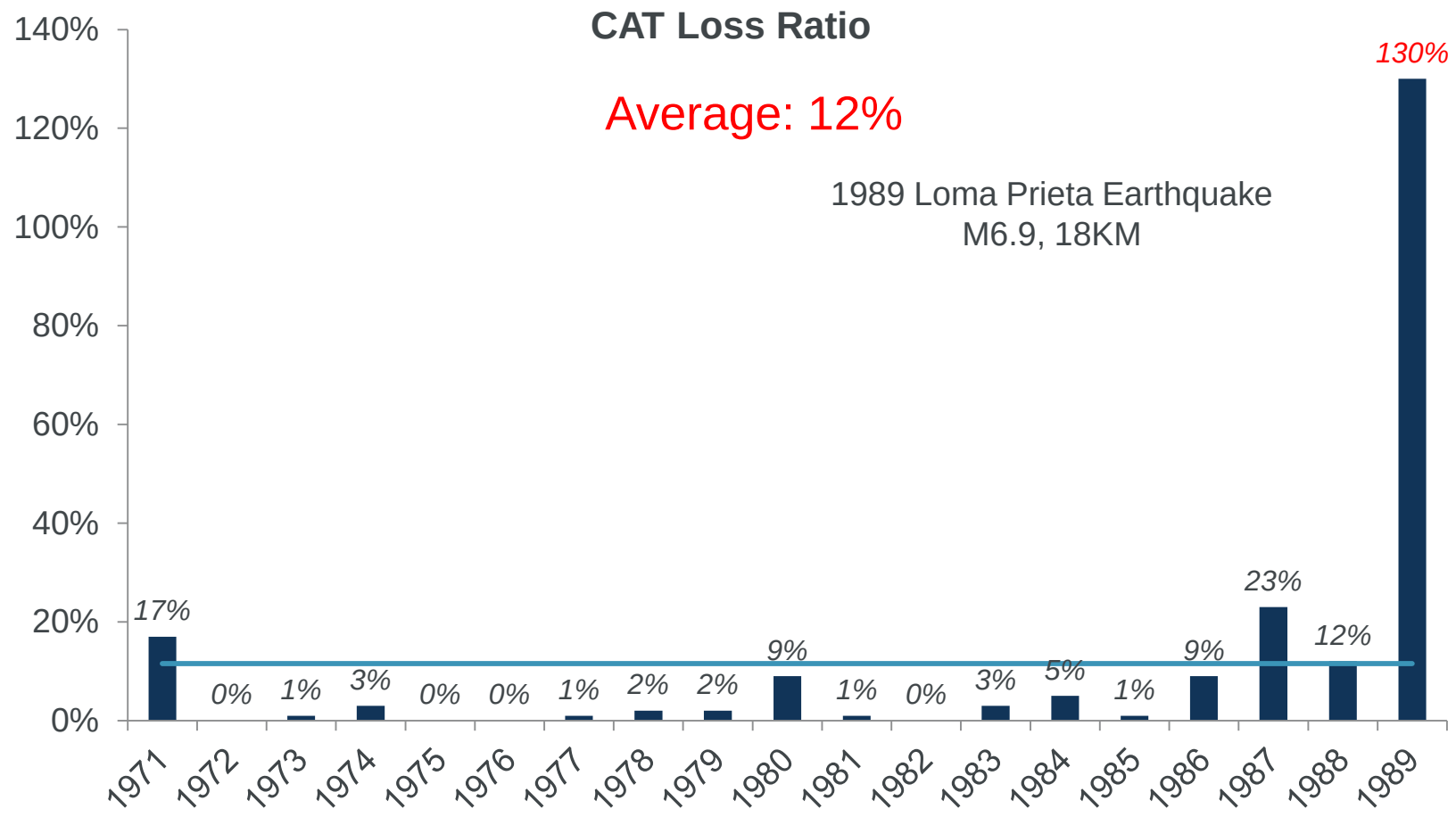
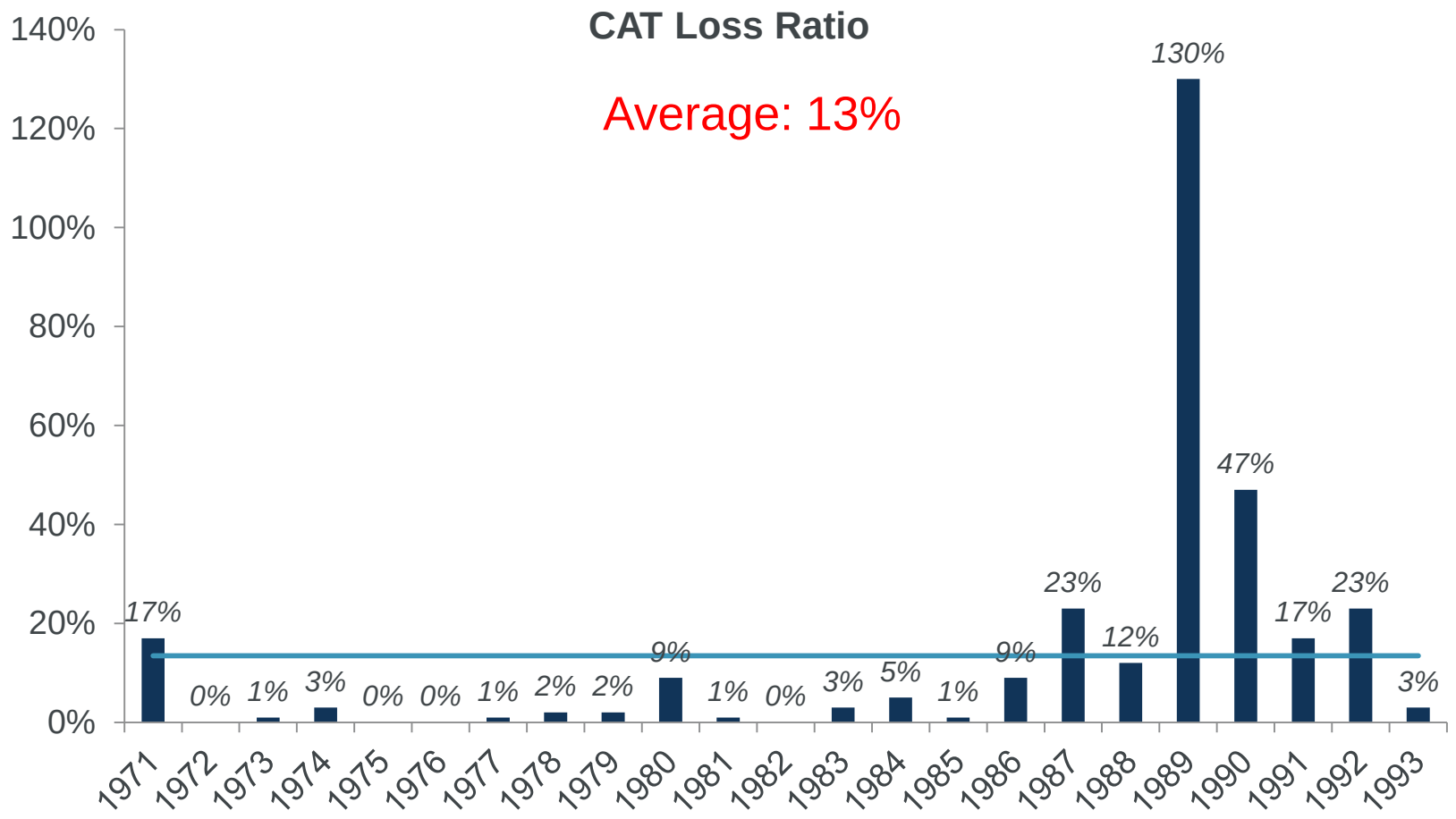


Traditional Ways?



http://en.wikipedia.org/wiki/1989_Loma_Prieta_earthquake

Traditional Ways?



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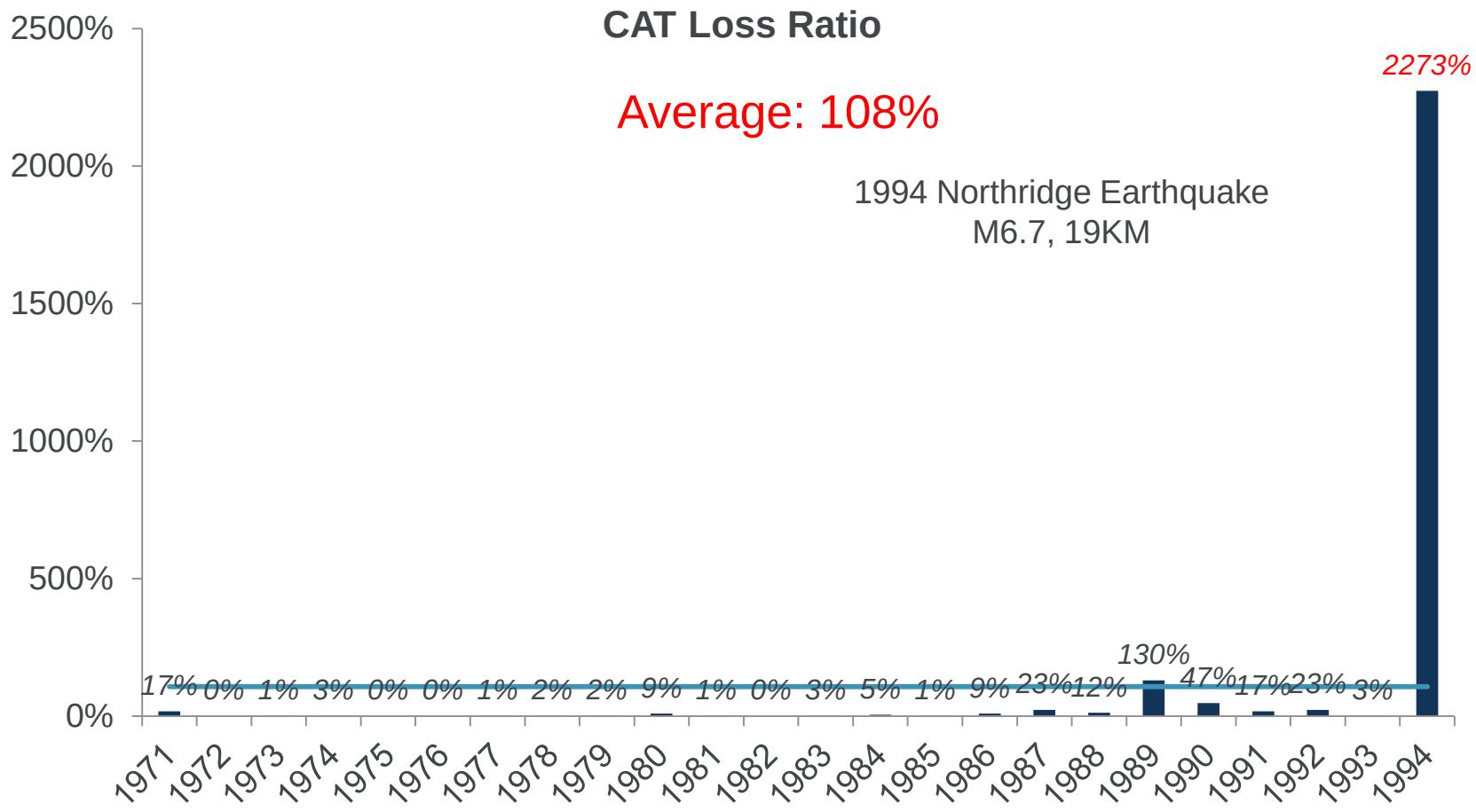


http://en.wikipedia.org/wiki/1994_Northridge_earthquake

Why do we need Catastrophe models?

- High severity of events: Importance of accurately estimating losses

- Company experience inadequate due to long return periods and historical change of portfolio's geographic characteristics

- Provide for a better understanding of risk and the vulnerability of a company's assets to this risk

Evolution of Catastrophe Models

http://www.techgeeze.com/2014/01/evolution-mobile-phone.html

Some History

1987 AIR

1988 RMS and Hurricane Gilbert

1989 Hurraine Hugo/Loma and Prieta Earthquake

1991 Typhoon Mireille

1992 Hurriane Andrew

1994 EQECAT and Northridge Earthquake

1995 Kobe Earthquake

1999 Europe Winter Storm

2001 911 Attack

2003 RMS Model for Terrorism

2004 Indian Ocean Earthquake and Tsunami

2005 Hurricane Katrina

2008 Wenchuan Earthquake

2011 Japan Earthquake and Thai-Flood

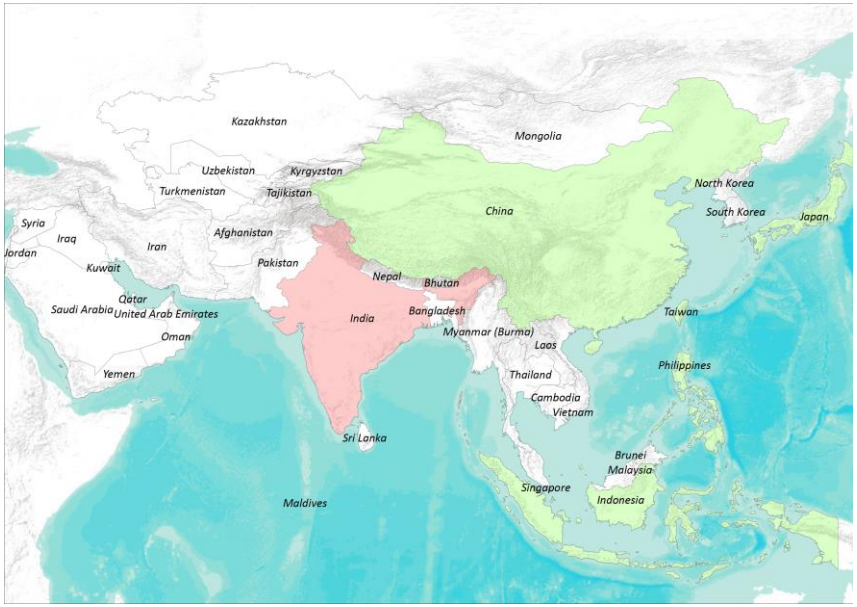
2013 Typhoon Fitow, Haiyan

2014 JP Snow Storm, AU Hail, CN EQ

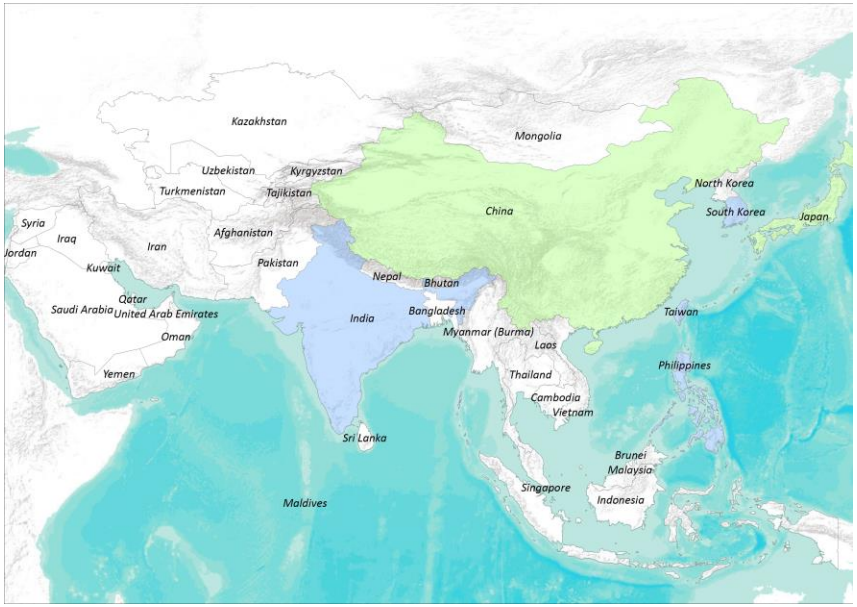
2015 ……

Models in Asia

EQ Model Coverage



TY Model Coverage



RMS and AIR

RMS Only

AIR Only

None

Model Outside Asia

AIR PERIL MODELS

TROPICAL CYCLONES (HURRICANES, TYPHOONS)

North America	Central America**	Caribbean**	Asia-Pacific
Hawaii Gulf of Mexico (Offshore Assets) Mexico** United States* *(29 hurricane states and the District of Columbia)*	Belize Costa Rica El Salvador Guatemala Honduras Nicaragua Panama	Anguilla Antigua & Barbuda Aruba Bahamas Barbados Bermuda British Virgin Islands Cayman Islands Cuba Dominica Dominican Republic Grenada Guadeloupe Haiti Jamaica Martinique Montserrat Netherlands Antilles Puerto Rico Saint Barts, Saint Kitts & Nevis St. Lucia St. Maarten St. Martin St. Vincent & the Grenadines Trinidad & Tobago Turks & Caicos Island U.S. Virgin Islands	Australia*, ** China** Hong Kong** India** Japan** Philippines** Taiwan** South Korea**

** includes coastal storm surge*
*** includes precipitation-induced flooding*

EARTHQUAKE

North America	Caribbean	Central America	South America	Pan-European		Asia-Pacific
Alaska Canada Hawaii Mexico United States *(contiguous)*	Bahamas Barbados Cayman Islands Dominican Republic Jamaica Puerto Rico St. Maarten St. Martin Trinidad and Tobago U.S. Virgin Islands	Belize Costa Rica El Salvador Guatemala Honduras Nicaragua Panama	Chile Colombia Peru Venezuela	Austria Belgium Bulgaria Cyprus Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Israel Italy	Latvia Lithuania Luxembourg Monaco Netherlands Norway Poland Portugal Romania Slovakia Slovenia Sweden Switzerland Turkey United Kingdom	Australia China Japan Indonesia New Zealand Philippines Taiwan

AIR

Peril Models, Industry Exposure Databases, and Industry Loss Curves List
RMS® RiskLink® RiskBrowser® Version 13.1

March 7, 2014

Risk Management Solutions, Inc.

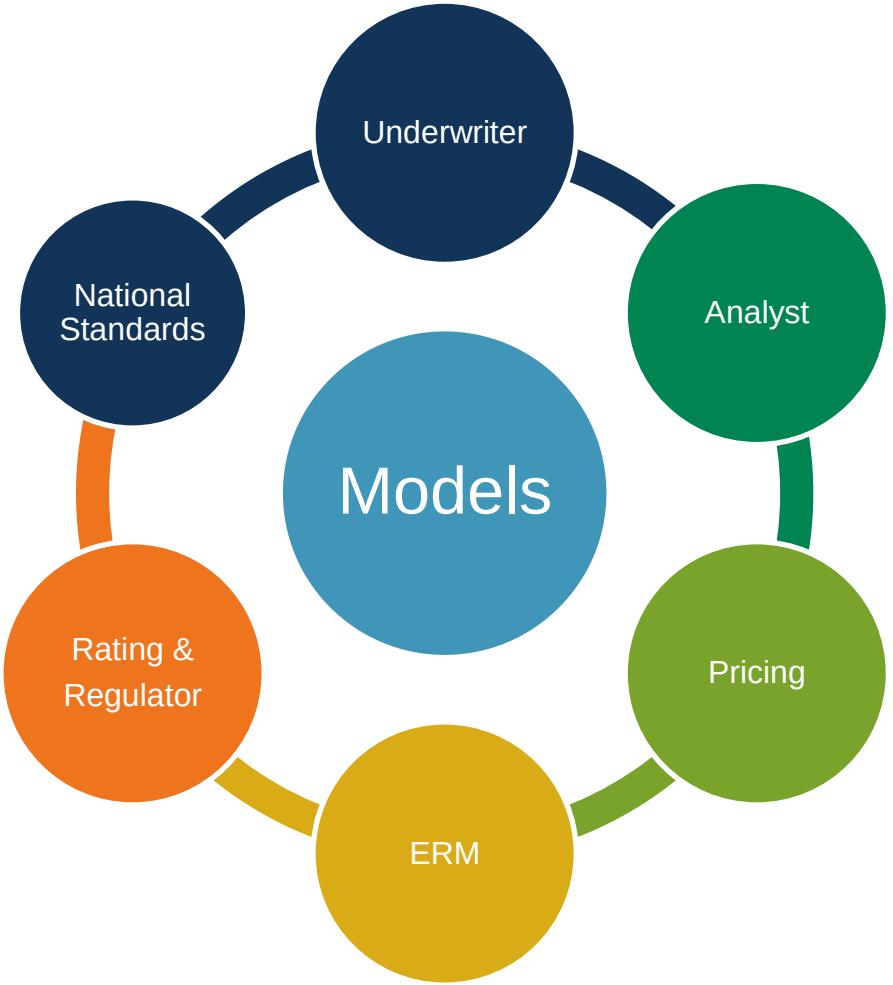
7575 Gateway Boulevard, Newark, CA 94560 USA
http://support.rms.com/

RMS

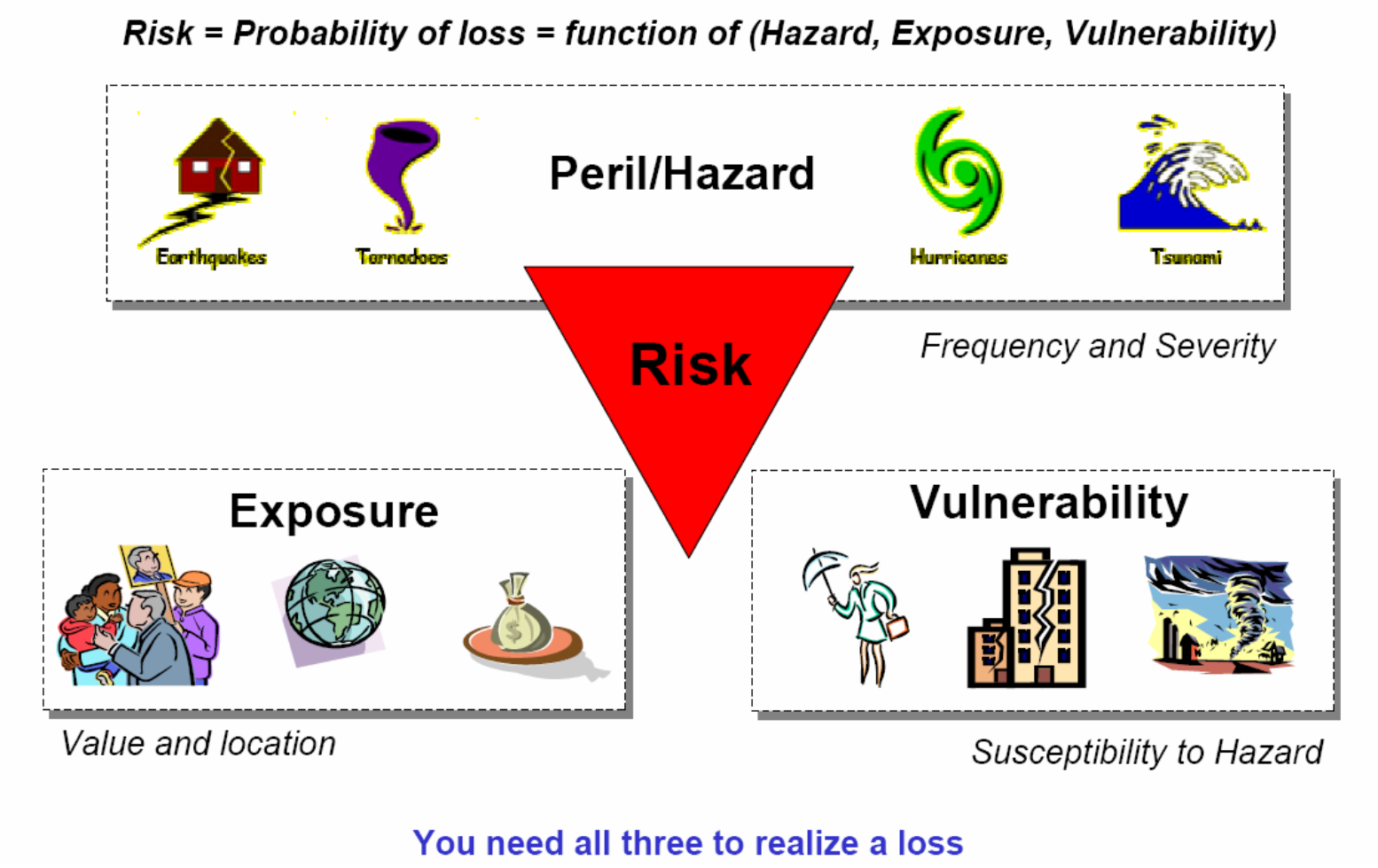
Builder and USER

- Building the model is interpreting the complexity of how the various natural perils work in the sophisticate earth system into formulas and computer languages for best estimating the event impact to human society

- Earth Science
  - Geologist
  - Meteorologist
  - Hydrologist
  - GIS/RS Expert
- Engineering Science
  - Civil Engineer
- Computer Science
  - Programmer
- Mathematics
  - Mathematician
  - Statistician
  - Actuary



The Notion of Risk



Modules of Model

- Define Event
- Define Location

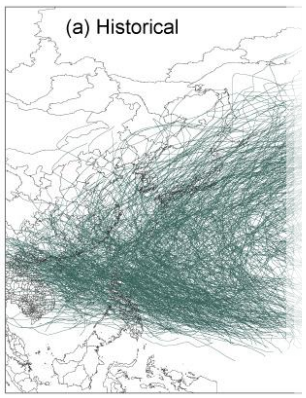
- Define Risk Attribute
- Determine Damage

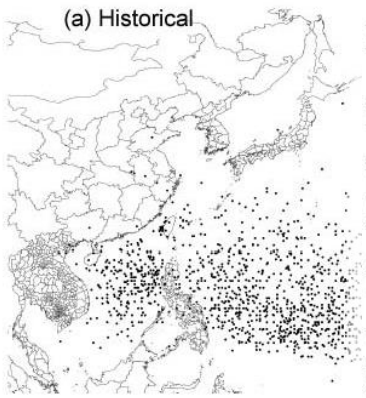
- Generate Loss
- Apply Policy Terms

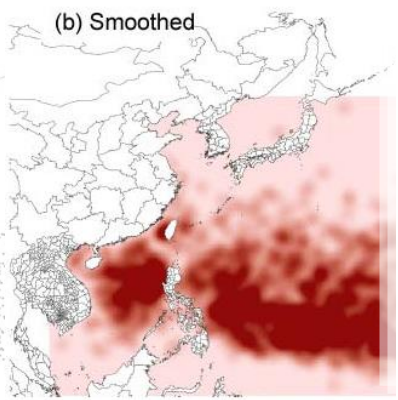
- Model Input – Risk Data
  - Risk Location
  - Risk Properties
    - Occupancy
    - Construction
    - Height
    - Replacement value of risk
    - Quality
    - … …
- Model Output
  - Estimated Losses
    - Ground Up Loss
    - Gross Loss
    - Treaty Loss
    - Retained Loss
    - PML
    - Event Loss Table
    - … …

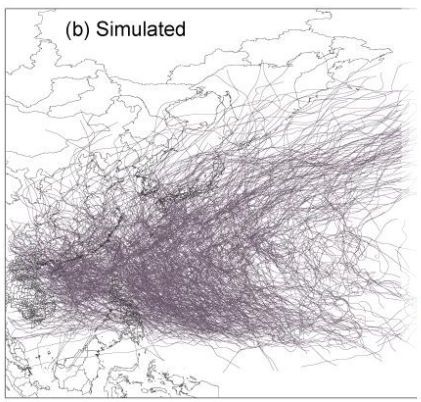
Stochastic Event Set

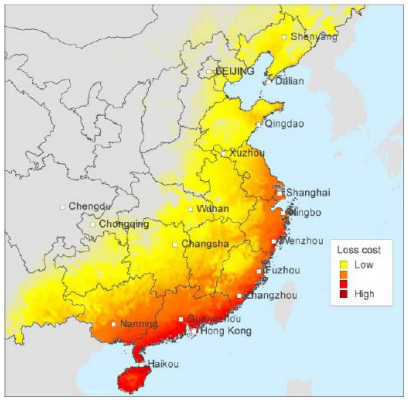
- Start from researching natural of the event based on Historical events
  - Event forming, Event Tracking, Event parameters
- Build up the probabilities of the occurrence database
- Simulate event occurrence parameters and filter un-possible events to build the stochastic event set
- Validate the stochastic event set to the realities







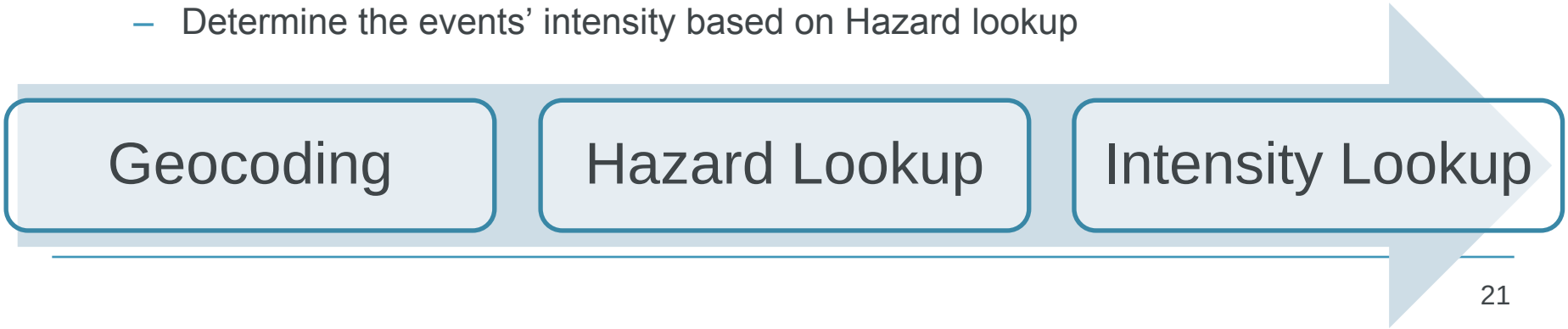




Source: AIR Worldwide

Hazard Module

- Geocoding
  - Convert the location of the Risk from model input to the model codes
- Hazard Lookup
  - Determine landcover, background soil type, elevation, liquefaction, etc, based on location
- Intensity Lookup
  - Determine the events' intensity based on Hazard lookup



Vulnerability Module

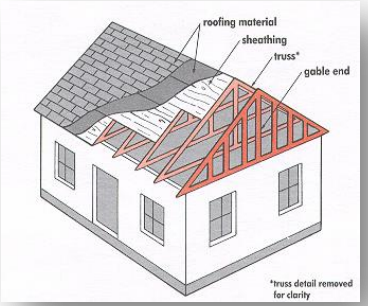
- Determine the damage caused by the event to the risk compare to risk's fully replacement value
  - Damage Function
  - Damage Curve/Ratio

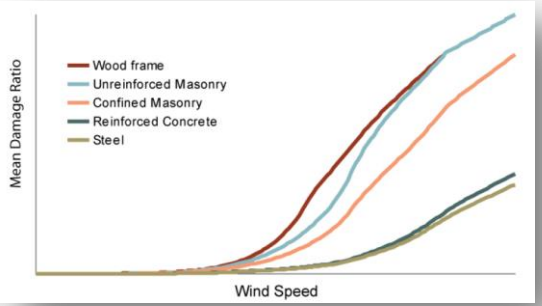
- Sensitive to
  - Location
  - Year of build
  - Structure type
  - Construction material
  - Usage of the property
  - … …

- Follow Hazards module
  - Determine the damage ratio of the risk
  - Calculate the ground-up loss of the impact

$$\text{Ground Up Loss} = \sum_{1}^{n} (Replacement\ Value\ * Damag\ Ratio)$$

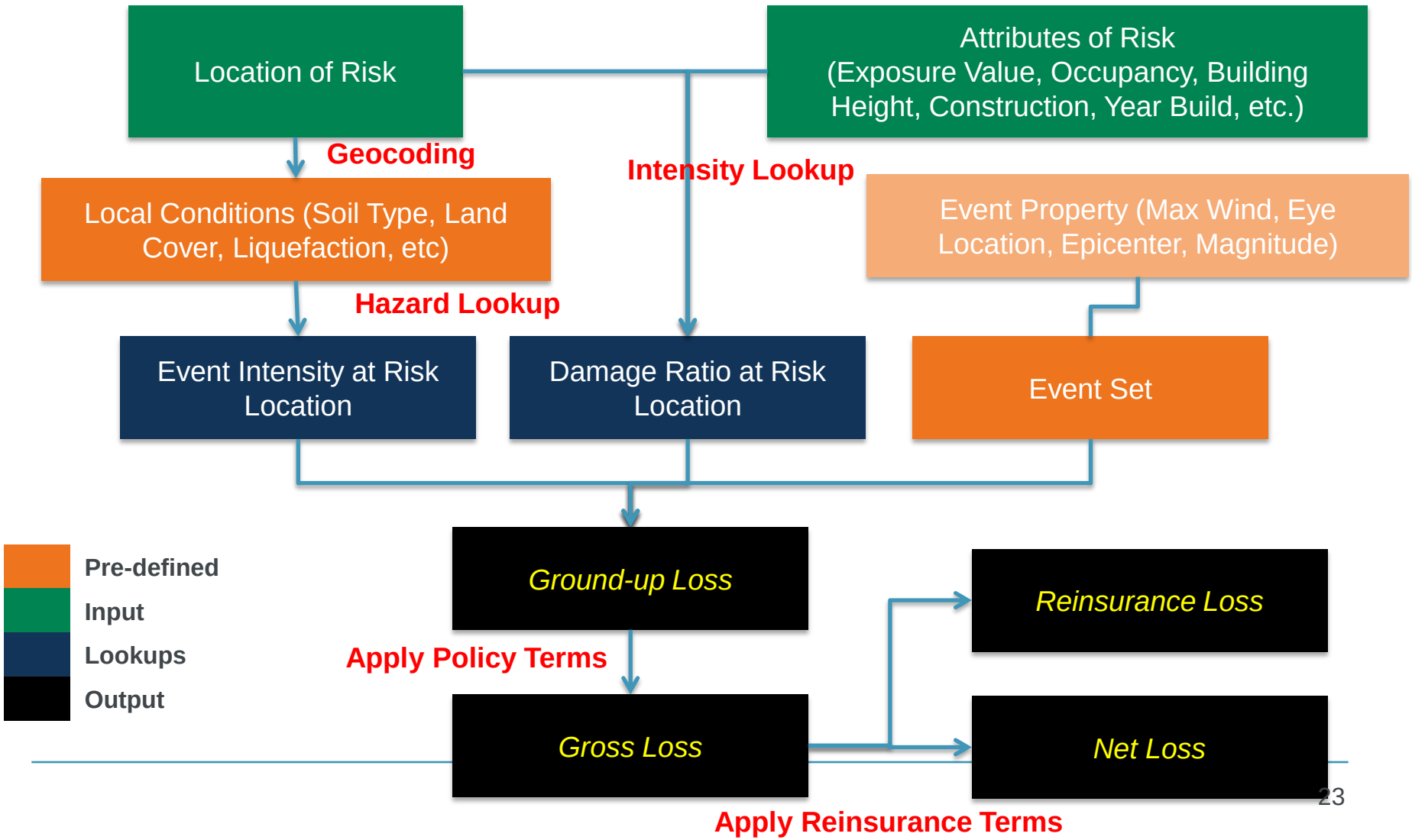
n is Number of Risks





Source: AIR Worldwide

Work flow in side



How a model is built

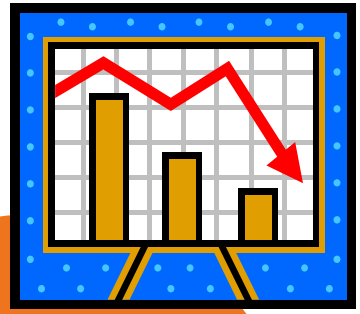
- Model the HAZARD
  - Historical data
  - Scientific understanding
- Model the VULNERABILITY
  - Industry inventory data
  - Develop Damage functions
- Model the LOSSES
  - Loss amplification factors
  - Validate with claims/loss data
- Model the UNCERTAINTY
  - Secondary uncertainty

Uncertainties

- Un-modelled perils
  - Primary
    - Tsunami, Hail
  - Secondary perils
    - Tsunami followed by seaquake or earthquake
    - Landslides followed by earthquake
- Empirical factor in certain territory for certain peril
  - Localized experience and local damage factors
  - Localized building standards
- Different damaging function perspective
  - Damage curve varies by different model
- Input data integrity, completeness
  - Accuracy and Availability
  - Location and Coverage

Accumulation to CAT LOSS

Different kinds of risk accumulate



Catastrophe Loss

STILL Challenging

http://wuwei1101.popo.blog.163.com/blog/static/4867086720137511505828/

Importance of robust data record

Source: Aon Benfield

Catastrophe management

- Managing Catastrophe Risk is key and vital to insurance industry

- One event may cause significant impact
  - 1992 Hurricane Andrew
  - 2005 Hurricane KRW
  - 2010/2011 Canterbury Earthquake
  - 2011 Tokohu Earthquake
  - 2011 Thai Flood
  - 2013 Typhoon Fitow

- “3M” rule to manage catastrophe risks
  - Monitoring
  - Measurement
  - Mitigation

Risk monitoring

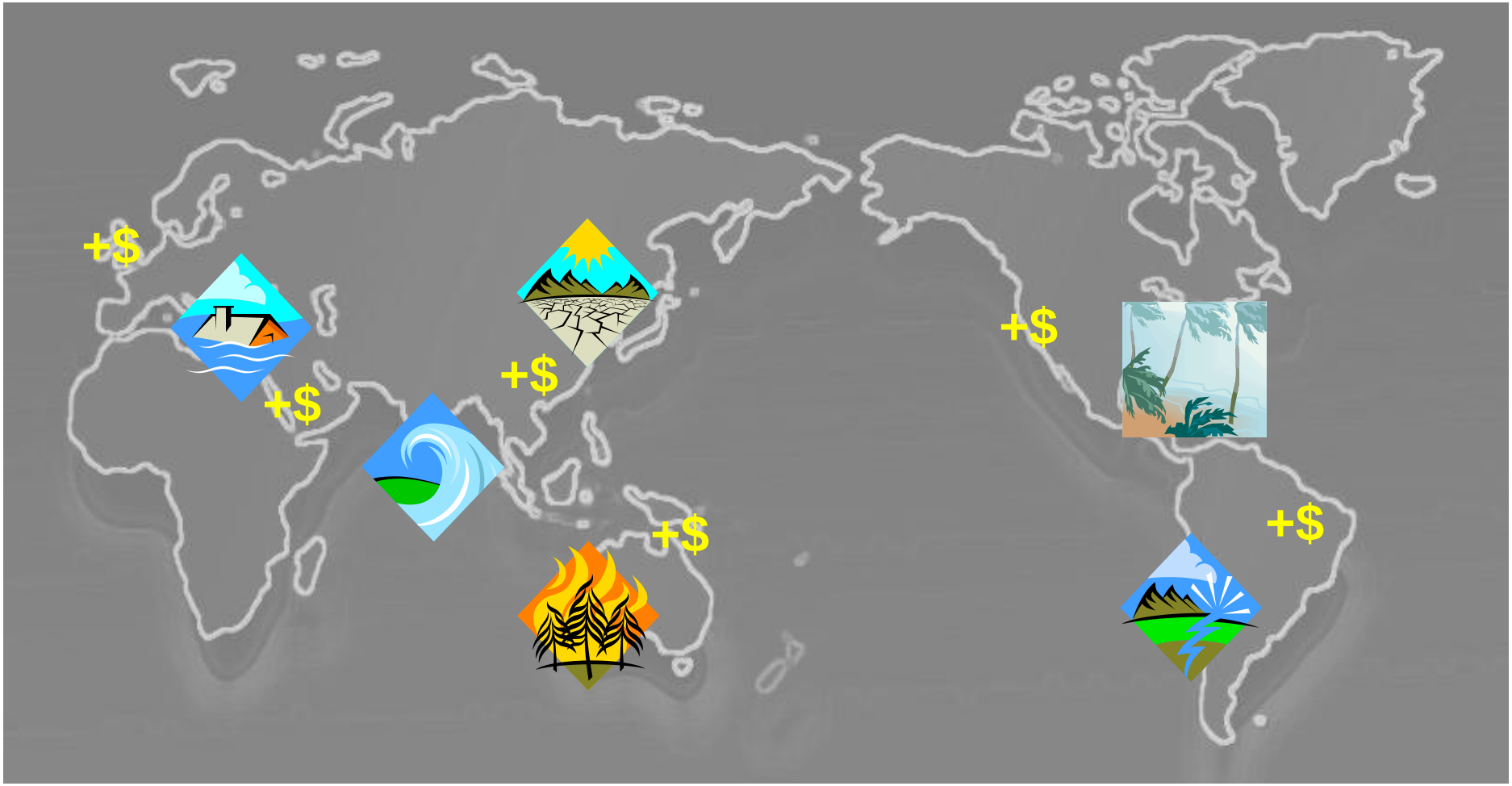
- Monitoring
  - Where is the risk
  - What is this risk
  - Is there any over concentration
- Traditional method – local surveying
  - Details of risk attributes
- Assisting by 3S (GIS, GPS, RS) technologies
  - Visualizing the risk remotely
  - Loss surveying and adjustment
- Involve in research – more understanding of hazards
  - In-depth understanding of the nature of hazards

Risk mitigation

- Transferring risk is one way but not the only way

- Bottom-up approach
  - Sophisticated risk registration
  - Strict underwriting guideline
  - Risk selection and diversification
  - Self-disciplined operation
  - Robust data management system

Risk Diversify – By LOB, by Territory



Conclusions – Catastrophe models

- Modelling of risk leads to a greater understanding of risk
- Hazard, Vulnerability and Exposure
- Data quality is a important driver of model uncertainty
- Catastrophe model is not a black-box and actuaries should not use it like a black-box