Cambridge Global Risk Index 2017
5 December 2016

Cambridge Global Risk Vision

Prof Danny Ralph
Academic Director
Cambridge Centre for Risk Studies

- Banking
- Corporate
- Insurance
- Investment
- Government / Policy

Trillion Dollar Event Set

Cambridge Global Risk Index

Pandora: Cambridge Risk Framework
Cambridge Centre for Risk Studies Research Team 2016

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1. Catastronomics: The Economics of Catastrophe

2. Cities: A Foundation for Cambridge Global Risk Analytics

3. Project Pandora: The Management of Tail Risk
Catastrophic Failures of Complex Systems

- Motivated to understand
  - Catastrophe modeling and extreme risk analytics
  - Failure of complex systems and networks
  - Science of resilience to catastrophic failures

- To answer questions such as:

  How would [War in China] affect [Trade Networks] and impact [Global Economy]?
Beyond NatCat: Cambridge Taxonomy of Threats

- Earthquake
- Windstorm
- Volcanic Eruption
- Flood
- Tsunami
Beyond NatCat: Cambridge Taxonomy of Threats

**Financial Shock**
- Market Crash
- Sovereign Default
- Bank Run
- Asset Bubble
- Financial Irregularity

**Trade Dispute**
- Cartel Pressure
- Nationalization
- Tariff War
- Labour Dispute
- Trade Sanctions

**Geopolitical Conflict**
- Conventional War
- Asymmetric War
- External Force
- Civil War
- Nuclear War

**Political Violence**
- Organized Crime
- Assassination
- Social Unrest
- Terrorism
- Separatism

**Natural Catastrophe**
- Volcanic Eruption
- Flood
- Tsunami
- Earthquake
- Windstorm

**Climatic Catastrophe**
- Tornado & Hail
- Electric Storm
- Heatwave
- Freeze
- Drought

**Environmental Catastrophe**
- Wildfire
- Pollution Event
- Ocean System Change
- Sea Level Rise
- Atmospheric System Change

**Technological Catastrophe**
- Nuclear Meltdown
- Industrial Accident
- Infrastructure Failure
- Cyber Catastrophe
- Technological Accident

**Humanitarian Crisis**
- Famine
- Water Supply Failure
- Child Poverty
- Welfare System Failure
- Refugee Crisis

**Externality**
- Meteors
- Solar Storm
- Space Threat
- Ozone Layer Collapse
- Satellite System Failure

**Disease Outbreak**
- Human Epidemic
- Animal Epidemic
- Waterborne Epidemic
- Zoonosis
- Plant Epidemic

**HealthCat**
- Sovereign Default
- Bank Run
- Asset Bubble
- Financial Irregularity

**TradeCat**
- Cartel Pressure
- Nationalization
- Tariff War
- Labour Dispute
- Trade Sanctions

**WarCat**
- Conventional War
- Asymmetric War
- External Force
- Civil War
- Nuclear War

**EcoCat**
- Nuclear Meltdown
- Industrial Accident
- Infrastructure Failure
- Cyber Catastrophe
- Technological Accident

**TechCat**
- Nuclear Meltdown
- Industrial Accident
- Infrastructure Failure
- Cyber Catastrophe
- Technological Accident

**Other**
- Meteors
- Solar Storm
- Space Threat
- Ozone Layer Collapse
- Satellite System Failure
CCRS Research Outputs: Explorations of individual threats

- **Taxonomy of Threats**
- **Geopolitical Conflict** - Emerging Risk Scenario
- **Pandemic** - Emerging Risk Scenario
- **Cyber Catastrophe** - Emerging Risk Scenario
- **Social Unrest** - Emerging Risk Scenario
- **Ebola** - Emerging Risk Scenario

- **Financial Catastrophes**
- **Global Property Crash** - Financial Risk Scenario
- **Eurozone Meltdown** - Financial Risk Scenario
- **High Inflation** - Financial Risk Scenario
- **Dollar Dethroned** - Financial Risk Scenario
- **Historical Crises** - Financial Risk

- **Cyber Accumulation** - Insurance Risk Report
- **NatCat FinCats** - Clash Report
- **Business Blackout** - Lloyds Emerging Risk Report
- **Climate Change** - Investor Sentiment Shock
- **World City Risk 2025** - Lloyds Co-Branded Report
- **Solar Storm** - Emerging Risk Scenario
Recent Publication: Solar Storm Scenario

- National power grids suffer damage from electromagnetic flux
- Damage to 6% of EHV transformers in US
- Catastrophic US power outage
  - 2-9 Billion person-days of lost power
  - 5% of the population is out for 5 months
- Cost to US economy
  - $200 Bn – $1.2 Tn (1.4% - 8%)
- Cost to global economy
  - $500 Bn – $2.7 Tn (0.7% - 4%)
- US insurance payouts
  - $60–300+ Bn
Why are These the Threats to Worry About?

- Extensive review of potential causes of macroeconomic shocks
  - Used 1000 years of historical records

The review included

A. Chronological Histories
B. Disaster Catalogues
C. Counter-factual evidence
D. Scientific conjecture
E. Peer review
F. Other Approaches

- 11 broad families of threat with around 50 threat types. Focus:
  - 20+ threats from taxonomy
  - Most important risks from known threat universe

The Cambridge Centre for Risk Studies publication that describes the development of the Cambridge Threat Taxonomy

Available for Download from Website: CambridgeRiskFramework.com
Catastronomics

GDP@Risk as a metric for comparing impacts
## Single Threat Scenario GDP@Risk

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Lloyd’s Cities Risk Index 2015-2025

- Launch at Lloyd’s, 3 September 2015
- Cities Risk Index assesses the GDP@Risk for 300 cities and 18 threats
We picked the ‘A List’ of the world’s cities for this analysis, which:

- Are responsible for half of the World’s GDP today
- Will be responsible for two-thirds of the World’s GDP in 2025
- Are the largest cities in the 50 largest economies in the world
  - Top 25 cities in US (#1 economy) and top 32 cities in China (#2 economy)
  - Between 5 and 12 top cities for each of the rest of the top 17 economies
- Include all cities over 3m population in the world
- Consist of half of the world’s capital cities
A History of Urban Economic Shocks

The 300 cities have experienced many catastrophes over the past 50 years.

- Lost more than a million of their citizens to earthquakes
- Half of them have suffered a serious flood
- Suffered more than 1,000 terrorist car bombs in city centres
- Seen a third or more of their economic capital wiped out by stock market crashes 5 times
- A quarter of them have been flooded more than 5 times
- Financial crisis of their governments defaulting on sovereign debts on 50 occasions
- Experienced thousands of cyber attacks
- Had to cope with a volcanic eruption less than 100 km away
- 32 cities have had to cope with a volcanic eruption less than 100 km away
- Had to combat the outbreak of a previously unknown disease five times
Catastronomics for Cities

Impact of 1995 Earthquake on Kobe, Japan

- Great Hanshin earthquake January 17, 1995, Magnitude 7.3
- Death toll 6,400; Direct damage costs $100 billion
- The port of Kobe, one of the world's busiest, was destroyed
- Kobe Steel Ltd, major steel maker, heavily damaged
- 80% of shoe factories damaged
- 50% of the region's sake breweries put out of action
- Kobe’s economic output halved in 1995, reducing Japan’s total industrial output by 2.6 percent
A Standardized Economic Profile of Each City

- City economy is categorized by type

- G: Agriculture with Industry & Service
  - Agriculture: 39%
  - Industrial: 37%
  - Service: 24%

- E: Industrially-Oriented
  - Agriculture: 33%
  - Industrial: 63%
  - Service: 4%

- A: Service-Dominated
  - Agricultural: 22%
  - Industrial: 77%

- City resilience assessment

  Resilience index (1-5) for cities based on four factors (cf, ND-GAIN)
  - Governance
  - Social coherence
  - Economic strength
  - Infrastructure

  1 - Strongly Resilient
  5 - Weakly Resilient
Standardized Approach to All Threats

**Finance, Economics and Trade**
- Market Crash
- Sovereign Crisis
- Commodity Prices

**Geopolitics and Security**
- Interstate Conflict
- Terrorism
- Separatism Conflict
- Social Unrest

**Natural Catastrophe and Climate**
- Earthquake
- Tropical Windstorm
- Temperate Windstorm
- Tsunami
- Flood
- Volcanic Eruption
- Drought
- Freeze
- Heatwave

**Technology and Space**
- Nuclear Accident
- Power Outage
- Cyber Attack
- Solar Storm

**Health and Humanity**
- Human Pandemic
- Plant Epidemic
Delhi Example: Threat Event Analysis of Expected Loss

Power Outage

Localized Impact Severity

PO1  One City-Day of Power Loss (100% of city loses power for 1 day or 50% of city loses power for 2 days, etc.)

PO2  A 5-City-Day event (100% of city loses power for 5 days, 50% of city loses power for 10 days, etc.)

PO3  A 10 City-Day event (100% of city loses power for 10 days)

The Impact of a Power Outage Event PO3 on Delhi occurring in 2017

Diagamatic illustration

Delhi total lost GDP from PO3 = $8.5 Bn

GDP@Risk

Diagrammatic illustration

Po1. Power outage $1.79bn

Power Outage Threat

- A - Very High Threat of Outages ( occurrence a year)
- B - High Threat of Outages (10-50 a year)
- C - Moderate Threat of Outages (1-10 a year)
- D - Low Threat of Outages (<1 a year)

Delhi GDP@Risk: All threats

- Market price shock $5.63bn
- Human pandemic $10.70bn
- Cyber attack $2.85bn
- Power outage $1.79bn
- Sovereign default $1.53bn
- Flood $11.28bn
- Terrorism $2.23bn
- Solar storm $0.64bn
- Wind storm $0.47bn

GDP ($Bn)
Geographical Mapping of All the Threats

Earthquake
Volcano
Windstorm
Flood
Tsunami
Drought
Freeze
Heatwave
Market Crash
Sovereign Default
Oil Price Shock
Interstate War
Separatism
Terrorism
Social Unrest
Power Outage
Cyber Attack
Solar Storm
Nuclear Meltdown
Human Epidemic
Plant Epidemic
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Tail Risks and Top Risks

Cost of Recovery

Buffers & Operational Flexibility
Insurance
Divestment
Cut Dividends
Capital Markets
Distress
Bankruptcy

Large contained events
Enterprise-wide Shocks
Systemic Shocks or Existential Events

Size of Disruption
Tail Risks and Top Risks

Cost of Recovery

Buffers & Operational Flexibility
Insurance
Divestment
Cut Dividends
Capital Markets
Distress
Bankruptcy

Operational / Cash Flow
Large contained events
Enterprise-wide Shocks
Systemic Shocks or Existential Events

Likely
Extremely Unlikely
Probability

Size of Disruption
Take 22 categories of threats [and the rest!]

For your organisation, looking beyond

- ordinary or acceptable cash flow shocks,
- large but insured disasters – painful but manageable:

How often do you experience

- a dividend threatening event?
- a downgrade to your credit rating?
- … or worse?

“A trillion dollar global economic shock every 8 years!!”
A major innovation of Centre for Risk Studies has been to standardise shock assessment
- Express costs & benefits of resilience via financial metrics for risk, like GDP@Risk

“Corporate Risk Profiling” for quantifying balance sheet risk
- “Assets@Risk” for manufacturing and finance
- “Revenue@Risk” for disruption of markets

Insurance & Finance
- “Insurance@Risk” for probable maximal loss
- “Underwriting@Risk” for (new) insurance products
- “Investments@Risk” for financial portfolios

Government policy
- “Infrastructure@Risk”

International capital markets
- Accounting standards for expected losses from shocks
A Toolkit for Risk Science: Quantifying Resilience

Threat Maps

Scenarios

Exposure Data

Network Models

Risk Models & Output Data

Software Platform (Cambridge Risk Framework)

Use Cases – Business Applications

Private Portals, APIs and modeling interfaces