Catastronomics in World City Risk

Centre for
Risk Studies

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CAMBRIDGE
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Agenda

- ■ Introducing Catastronomics
- ■ Case Study Illustration:
    - – The Cambridge World City Risk Project
    - – Lloyd's City Risk Index 2015-2025
- ■ Future Research Directions

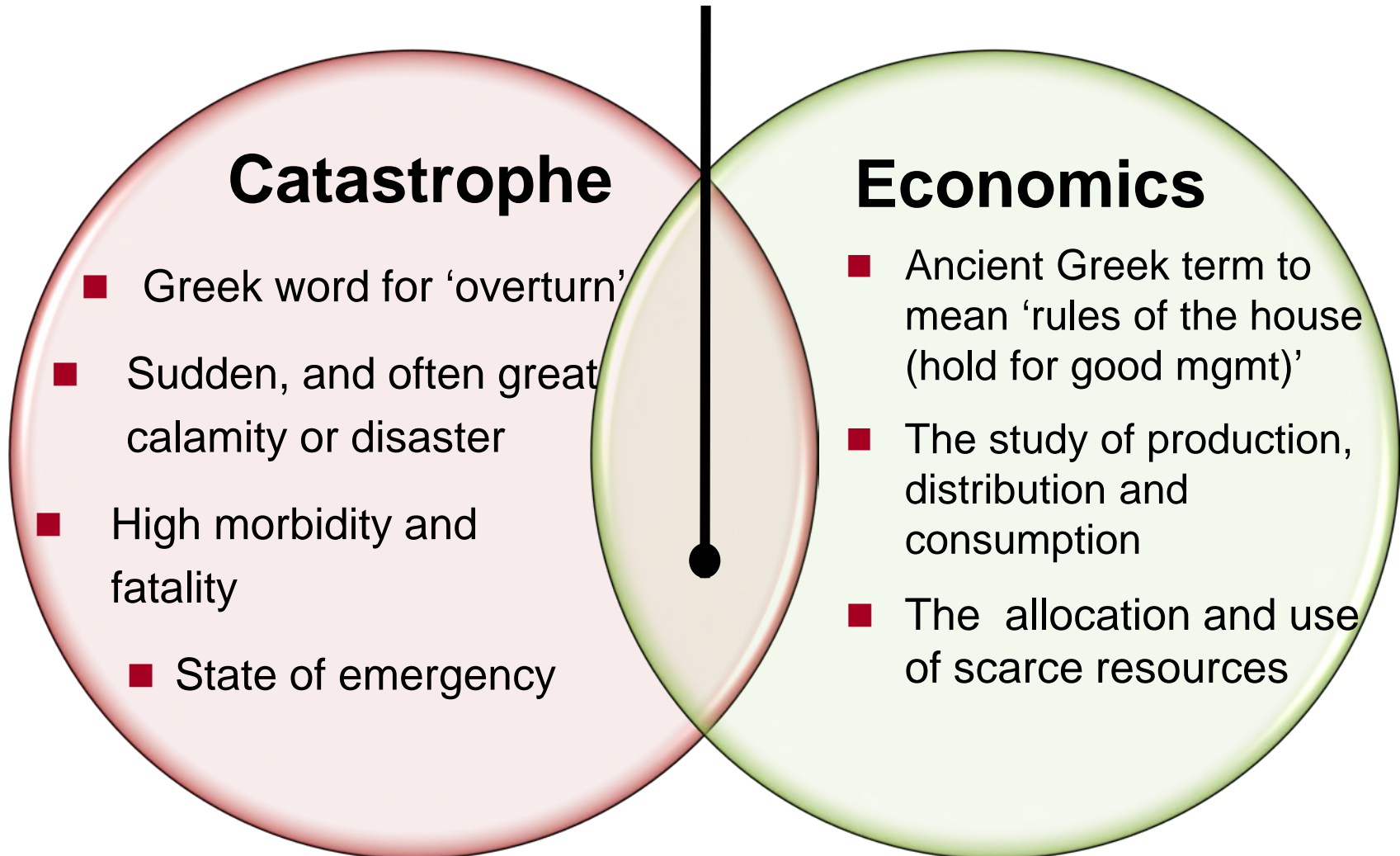# In this world nothing can be said to be certain,

except death, taxes,

- Benjamin Franklin (1789)

and Catastrophe.

- Scott Kelly (2015)

Catastronomics

"the economic analysis of catastrophes"

Catastrophe

- Greek word for 'overturn'

- Sudden, and often great calamity or disaster

- High morbidity and fatality

- State of emergency

Economics

- Ancient Greek term to mean 'rules of the house (hold for good mgmt)'

- The study of production, distribution and consumption

- The allocation and use of scarce resources

Catastronomics: The 5 Critical Questions

What
- Economic analysis of catastrophes
- Mega-disruptive economic phenomenon

Why
- Want to understand the complex concept before managing
- We are greedy; we want to hope for the best and plan for the worst

Who
- Insurance companies
- Corporate businesses
- Financial risk managers
- Policy-makers
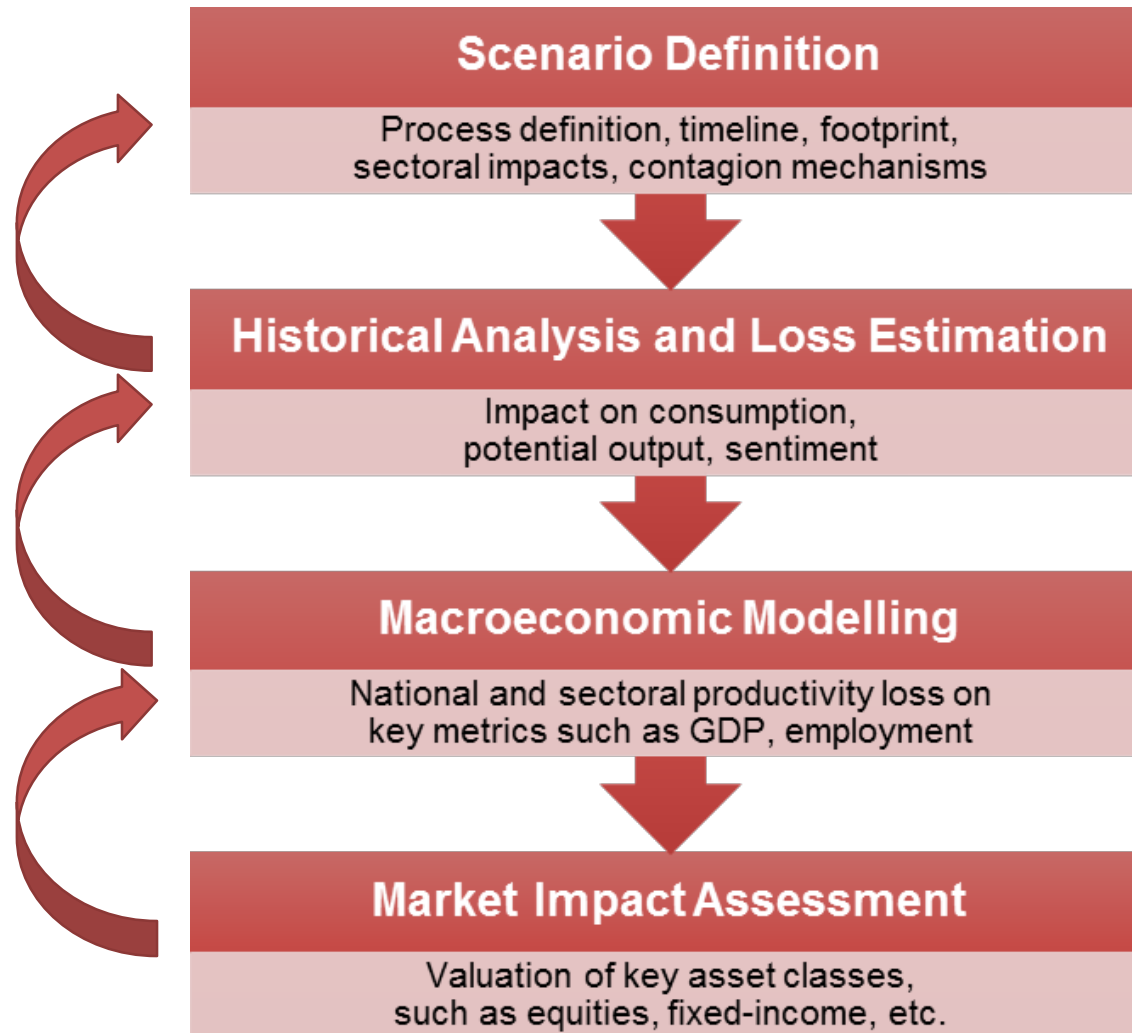- Cambridge Centre for Risk Studies

When
- Research and more extensive research
- Emerging risks
- Evolving (traditional) risks

How
- Construct high impact hypothetical and coherent stress-test scenarios
- Internal structural modelling methodology

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CRS Structural Modelling Methodology

Scenario Definition
Process definition, timeline, footprint, sectoral impacts, contagion mechanisms

Historical Analysis and Loss Estimation
Impact on consumption, potential output, sentiment

Macroeconomic Modelling
National and sectoral productivity loss on key metrics such as GDP, employment

Market Impact Assessment
Valuation of key asset classes, such as equities, fixed-income, etc.

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An example: Cambridge World City Risk

- **World City Risk looks at**
  - ~20 threat types
  - ~300 of world's top cities by GDP
  - Up to 3 representative scenarios for each city
  - ~16,000 scenarios modelled
  - ➢ Simple = **Scalable** model of threat types and city characteristics

- **Lloyd's Cities Risk Index 2015-2025**
  - An original research project by the Centre for Risk Studies
  - Launched globally 3rd Sep 2015

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Lloyd's City Risk Index
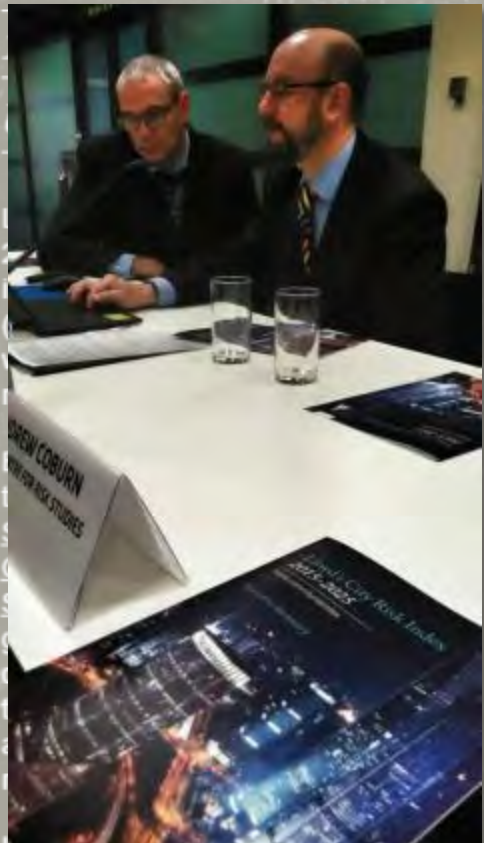## 2015–2025

301 cities

18 threats

US$4.56trn at risk

Lloyd's City Risk Index 2015-2025 analyses the potential impact on the economic output (GDP@Risk) of 301 of the world's major cities from 18 manmade and natural threats.

Based on original research by the Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School, the Index shows that governments, businesses and communities are highly exposed to systemic, catastrophic shocks and must do more to mitigate risk and improve resilience.

Identifying the risks, modelling and measuring their impacts.

Lloyd's City Risk Index 2015-2025

And the global distribution of wealth is changing rapidly

0:28 / 1:58

Explore

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World City Risk

- GDP@Risk 2015-2025 is $4.56Tn
  - 1.2% of total GDP forecast ($373Tn)
- Value of Improving Resilience

  - Reduces GDP@Risk by 10 – 25%
- Improve Resilience & Strengthen Vulnerability
  - Reduces GDP@Risk by up to 50%

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WCR: GDP@Risk Estimation Process
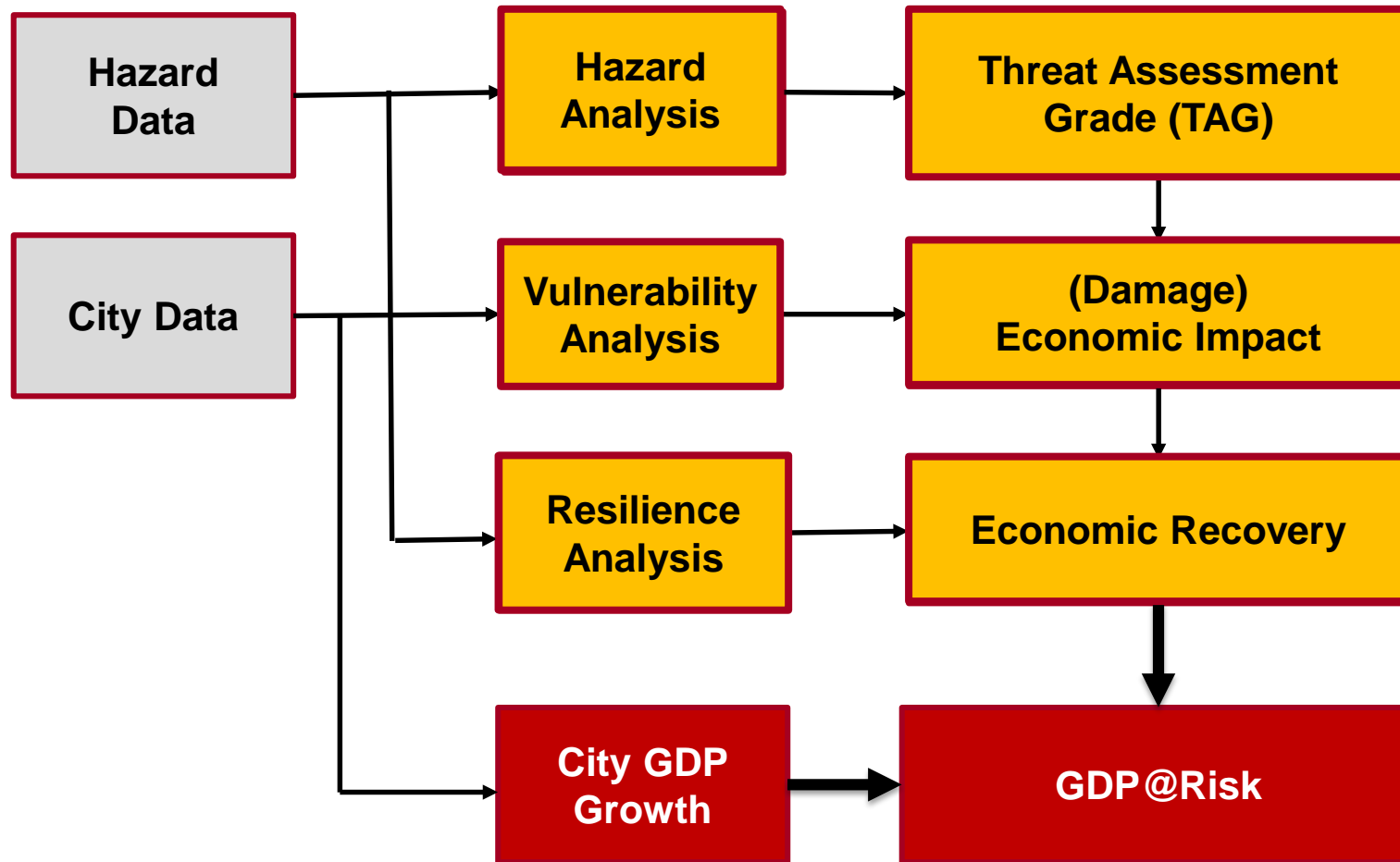
Hazard Analysis – Tagging the TAGs

| Data and Science | Geographical Mapping | Frequency Severity | Define Three Scenarios | TAG Cities |

City Name	EQ-TAG	Scenario Probability (T=1)		
		Small	Medium	Large
Beijing	C	0.21%	0.12%	0.02%
Los Angeles	A	1.24%	0.75%	0.31%
New York	D	0.01%	0.00%	0.00%
St. Petersburg	F	0.00%	0.00%	0.00%
Tokyo	B	0.66%	0.42%	0.18%
Toronto	E	0.00%	0.00%	0.00%

- US Geological Service (USGS)
- Global Seismic Hazard Assessment Program (GSHAP)
- Rank cities according to the Worldwide Seismic Design Parameter, $Ss(g)$

EQ TAG (USGS Ss(g) range)	Annual Probability of City Experiencing Event of Scale:		
	S	M	L
A (2.0-4.0)	1.24%	0.75%	0.31%
B (1.0-2.0)	0.66%	0.42%	0.18%
C (0.5-1.0)	0.21%	0.12%	0.02%
D (0.3-0.5)	0.01%	0%	0%
E (0.1-0.3)	0%	0%	0%
F (<0.1)	0%	0%	0%

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City Vulnerability & Resilience Analysis

City Physical Vulnerability^	Magnitude Shock Parameters		
	Small	Medium	Large
1 Very Strong	96.9%	94.9%	79.4%
2 Strong	94.9%	84.6%	69.1%
3 Moderate	89.7%	74.3%	58.8%
4 Vulnerable	79.4%	67.0%	48.5%
5 Very Vulnerable	74.3%	48.5%	38.2%

^Includes assessment of the quality of buildings and compliance to construction codes
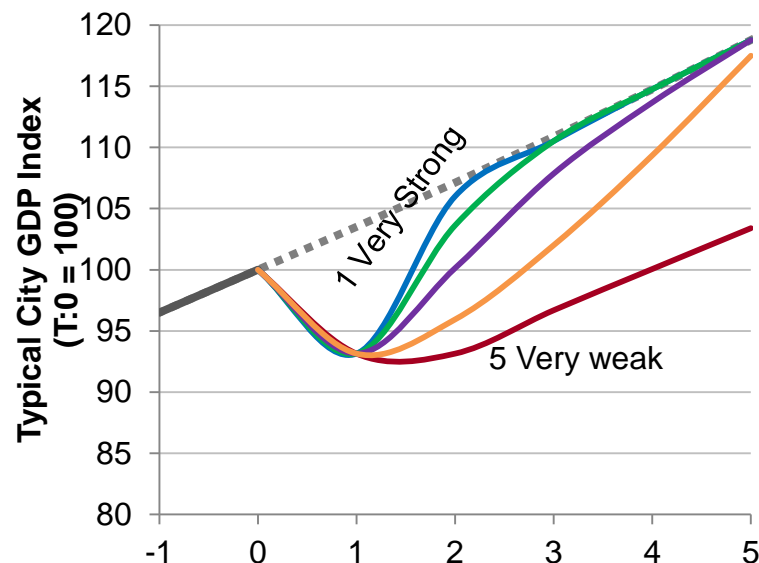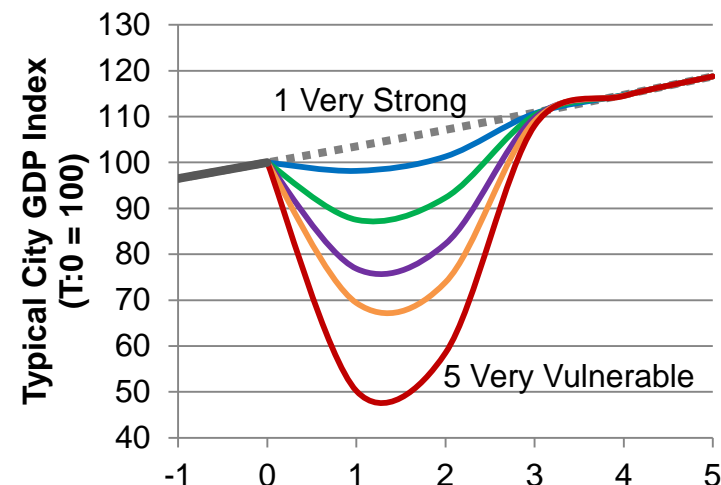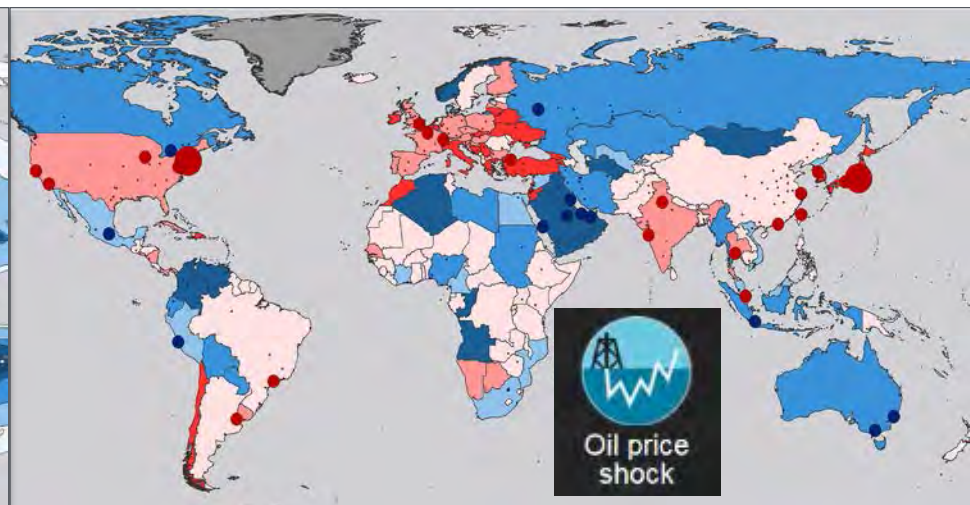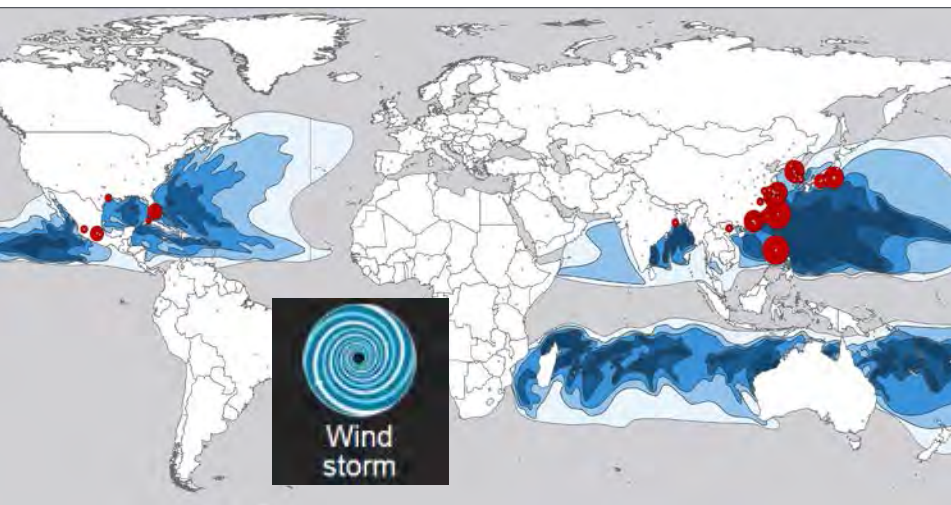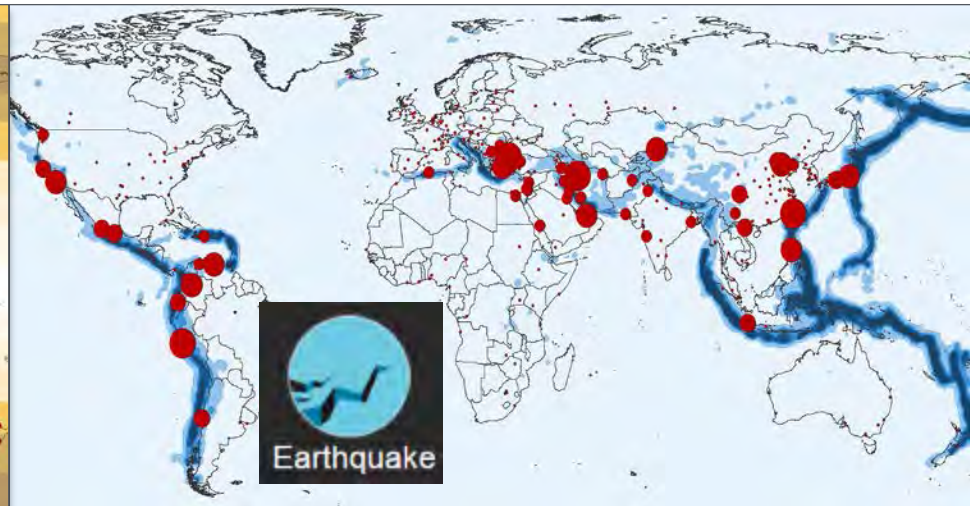

City Resilience *	Duration to Full Recovery		
	Small	Medium	Large
1 Very Strong	3	3	3
2 Strong	3	3	3
3 Moderate	3	4	6
4 Weak	4	4	7
5 Very Weak	4	5	8

*Influenced by:

- Governance
- Social coherence
- Economic strength
- Infrastructure systems

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WCR: Threat-City Mapping

Solar storm

Earthquake

Wind storm

Oil price shock
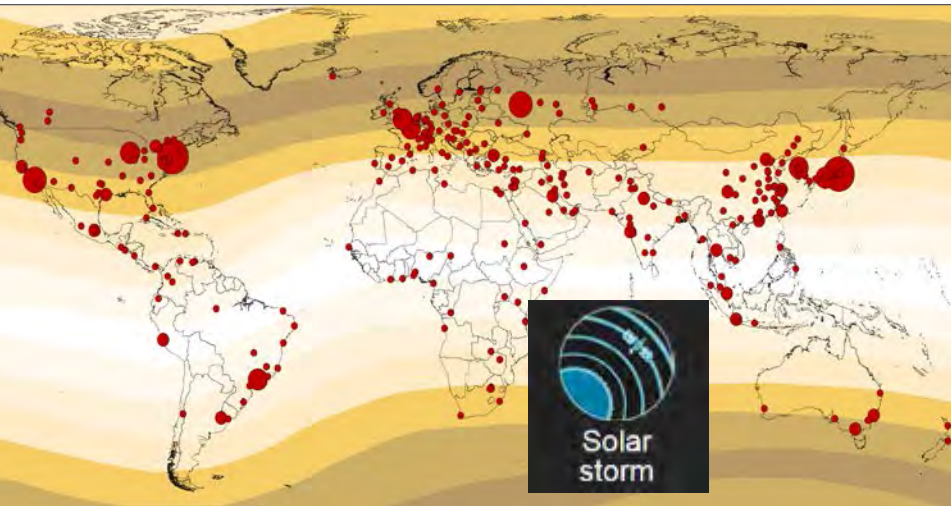
GDP@Risk from ~20 Threats to the Global Economy

Horizontal bar chart. X-axis: US$ Bn, scale 0 to 1,000 in increments of 100. Threats listed top to bottom with approximate values:

- Financial Crisis Market Crash — ~1,000
- Interstate War — ~740
- Human Pandemics — ~590
- Wind Storm — ~570
- Earthquake — ~460
- Flood — ~430
- Cyber — ~290
- Separatism — ~250
- Oil Price Shock — ~240
- Sovereign Default — ~180
- Terrorism — ~100
- Drought — ~90
- Electrical Power Outage — ~80
- Volcano — ~75
- Plant Epidemic — ~70
- Solar Storm — ~55
- Social Unrest — ~35
- Temperate Wind Storm — ~30
- Freeze — ~25
- Heatwave — ~15
- Nuclear Power Plant Accident — ~10
- Tsunami — ~8

GDP@Risk from 2015 to 2025

Future Research Directions

- **World City Risk Model**
  - Threats and cities are treated as independent
  - ⇨ **Introduce interdependence**

- **What is the arithmetic of catastrophe?**
  - Does a combined 1-in-50 year Hurricane and 1-in-50 year Sovereign Default cause more havoc than a 1-in-100 year event?
  - ⇨ **Combined effects nonlinearity**

  - Can a War cause a Pandemic resulting in far greater mortality than either event on their own?
  - ⇨ **Cascading risks**

- **Applicability and Value Proposition (2016)**
  - Use cases and scenario-threat specificities
  - ⇨ **Project Pandora**

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