Cambridge Judge Business School

Centre for Risk Studies 7th Risk Summit Research Showcase

Putting It All Together: Cambridge Risk Framework

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Centre for **Risk Studies**



Engagement, Outreach and Collaboration

Engagement (UK, EU, US)

- Government (Cab Office, DECC, GCHQ, CPNI...)
- Regulators (PRA, Lloyd's, OfGen, NERC...)
- Industry (Insurance, Power...)
- Outreach
 - Risk Briefings
 - Conferences & Meetings
 - Data standards

Collaboration

- Subject Matter Experts
- Academia
- Consultants



CCRS Outputs Since Last Risk Summit



Business Blackout Lloyd's Launch 8 July 2015



Unhedgeable Risk December 2015



Cyber Data Schema RMS Launch 2 Feb 2016



Historical Crises 12 August 2015



Global Property Crash 15 December 2015



Cyber Accumulation RMS Launch 2 Feb 2016



World City Risk 2025 3 September 2015



Eurozone Meltdown 15 December 2015



Solar Storm AIG March 2016







High Inflation 15 December 2015



Integrated Infrastructure Lockheed Launch 12 April 2016



Lloyds City Risk Index Launch 3 September 2015



Dollar Deposed 15 December 2015



Cyber Terrorism Pool Re May 2016



Overview of Project Pandora

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Project Pandora

- Project Pandora is the culmination of the Centre for Risk Studies 7 year programme to understand systemic risk in business, the economy and society
- Consortium Funded on a three year basis
- We propose to model all the meaningful events from 22 threat categories to the economy and translate this into insurance loss and corporate revenue disruption
- Sponsor organisations get interactive access to online data and models



Cambridge Taxonomy of Threats

Labour Dispute

Trade Sanctions







Financial Irregularity



Run

Windstorm

Tsunami

Human Epidemio

Market









Ζ



Crash



Flood

Volcanic



Eruption



Waterborne

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Cartel

Catastrophe

Climatic

Humanitarian Crisis

Hail

Child

Poverty

Pressure









Freeze Tornado &





Famine

Water Supply Failure



Welfare System Refugee Crisis

Failure





Force

Environmental Catastrophe

Civil

War







Pollution Event





Conventional War

Asymmetric War

Nuclear

Sea Level Rise

Ocean System Change

Atmospheric System

War







Failure



Crime

Technological Catastrophe

Cyber

Catastrophe





Hate

Terrorism

Senaratisr

Unrest









Failure





Accident







6



































Ozone Laver Collapse





















Threat

Externality

Multi-Threat Analysis A Standardized Approach to Threat Maps and Scenario Models

Finance and Trade Geopolitics and Society Market Sovereign Oil price Interstate Separatism Terrorism Social crash default shock Conflict Conflict Unrest **Natural Catastrophe and Climate** T in Earthquake Tropical Temperate Tsunami Flood Volcanic Drought Freeze Heatwave Windstorm Windstorm eruption **Technology and Space** Health and Humanity Plant Human Nuclear Cyber Power Solar pandemic epidemic accident attack storm outage



Lloyd's Cities Risk Index 2015 - 2025



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Al	l threats	
1	Taipei	\$181.20bn
2	Токуо	\$153.28bn
3	Seoul	\$103.50bn
4	Manila	\$101.09bn
5	New York	\$90.36bn
6	Los Angeles	\$90.32bn
7	Istanbul	\$82.50bn
8	Osaka	\$79.32bn
9	Shanghai	\$78.21bn
10	Hong Kong	\$74.51bn
11	Lima	\$69.36bn
12	Tehran	\$64.14bn
13	Sao Paulo	\$62.95bn
14	Mexico City	\$60.74bn
15	Moscow	\$55.77bn
16	Paris	\$54.94bn
17	London	\$53.43bn
18	Singapore	\$51.11bn
19	Buenos Aires	\$50.31bn
20	Jakarta	\$48.23bn

- How much of the world's economy might be eaten up by catastrophes
- This is also known as the 'technical premium' – if you could insure the economy of a city, here's how much it would cost to insure against catastrophe loss
- A big city with a large economy will pay more than a city with a small economy for the same risk

Risk Profile of a City - Seoul

Seoul GDP@Risk: All threats \$103.50bn Wind storm \$44.68bn 1 2 Oil price shock \$12.72bn 3 Market crash \$12.63bn Flood \$9.83bn 4 5 Human pandemic \$7.61bn 6 Drought \$6.08bn 7 Cyber attack \$2.71bn STOLENIS ASSAULT AND ADDRESS OF THE OWNER. Sovereign default \$2.02bn 8 9 Freeze \$1,42bn TRACK AND ADDRESS WORKS HIM 10 Solar storm \$1,08bn Power outage \$1.01bn 11 12 Volcano \$0.85bn 13 Plant epidemic \$0.66bn 14 Terrorism \$0.19bn 15 Earthquake \$0.00bn States States Heatwave \$0.00bn APRIL OF THE OWNER OF Nuclear accident \$0.00bn Tsunami \$0.00bn \$11,50bn \$23.00bn \$34.50bn \$46.00bn

Risk from 22 Threats to the Global Economy



Application Areas ('Use Cases')

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Use Cases

- Insurance portfolio management
 - Create a data standard for capturing multi-line exposure
 - Portfolio-specific loss
 - o Identification of scenarios of most concern to a particular insurer
 - o 'Trillion Dollar events'
 - Risk Capital Allocation
 - Cross-Balance Sheet Tail Risk (both underwriting and investment)
- Corporate risk profiling
 - Location risk assessment
 - Supply chain risk assessment
 - Balance Sheet EP curve ('1-in-100 year loss estimation')
- Investment portfolio risk management
 - Which investment assets are impacted by scenarios
 - Portfolio stress tests and tail risk frequency & severity of loss
 - Investor risk assessment for public company default/insolvency
 - Sectoral assessment
- Policy Decision Making Tools
 - Break even analysis for Critical National Infrastructure investment

How Can Companies Become More Resilient to Shocks?

Companies face threats to their:

- Operations and activities
- Personnel and workforce
- Supply chains and counterparties

- Critical assets and facilities
- Markets & customer demand
- Financial assets, investments and balance sheets
- Develop a checklist of the threats to each
 - What is the minimum data needed to assess these?
- Strategies for resilience include:
 - Operational risk minimization (e.g. supplier options)
 - Risk culture and risk awareness decision-making
 - Risk transfer and financial risk capital management
 - Strategic planning, incorporating stress test scenarios



Manila's Risk Profile

Manila GDP@Risk: All threats \$101.09bn



In the analysis the 'resilience' of **Manila, Philippines**

is categorized as '4: Weak Resilience'

Recovery of the economy after a disaster depends on

- Access to recovery finance
- Economic spare capacity
- Capital infrastructure
- Social cohesion
- Governance capability

Philippines is recognized as being Under-Insured



Lloyd's Global Underinsurance Report October 2012

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If Manila improved its 'resilience'

	Total \$GDP@Risk (Bn)	World Ranking by \$GDP@Risk	as % of total GDP 2015- 2025	World Ranking by % of GDP
Resilience 'Weak'	\$101.09	4	5.03%	1
Resilience Improved from 'Weak' to 'Moderate'	\$88.53	6	4.40%	2
Resilience Improved from 'Weak' to 'Very Strong'	\$70.41	10	3.50%	5

Improving the resilience of Manila by one grade of resilience would save **\$12 Bn** of expected economic loss over the next decade

Examples of 'Moderate resilience' countries include Thailand, Malaysia, and Colombia

Countries with Lloyd's Underinsurance ratings of less than half those of the Philippines



Project Pandora Methodology

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'Project Pandora' – A Toolkit for Risk Science

Threat Maps



Scenarios



Exposure Data



Network Models



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Risk Models & Output Data



Software Platform (Cambridge Risk Framework)



Use Cases – Business Applications



Private Portals, APIs and modeling interfaces



Geographical Mapping of All the Threats



Event-Based Analytics

Volcanic Eruption

- **VE1** Ashcloud shuts city for extended period, and covers it with several centimeters of ash, preventing air travel, road traffic, port functions, and normal business activity.
- VE2 Ashcloud covers city to 1m depth, entailing lengthy recovery process
- VE3 Parts of city impacted by direct effects of volcanic eruption (pyroclastic gases, lahar flows etc.). City evacuated and population not allowed to return for some time.



Market Crash

- MC1 Stockmarket Index drops 10% peak to trough in single year (e.g. Asian Crisis 1997)
- MC2 Stockmarket Index drops 50% peak to trough in single year (e.g. SubPrime 2008)
- MC3 Stockmarket Index drops 85% in a single quarter (e.g. Wall Street Crash 1929)



Human Epidemic

- HE1 Localized epidemic of new emergent disease with case fatality rate (CFR) of 10% causes public health emergency and fear in population, leads to loss of tourism trade
- HE2 Pandemic influenza virus infects 43% of the population, with CFR of 0.3%
- **HE3** Pandemic of high fatality disease (3% case fatality rate)



Terrorism

- Terror campaign with small arms and limited resources e.g. shootings, bombings, TR1 food chain sabotage etc., with repeated attacks over a period of many months that causes fear and distrust in urban population.
- Well resourced and organized terrorist attacks on high profile targets e.g. major TR2 truck bombings, airplanes into buildings or other surprise destructive events, causes horrific loss of life and major destruction to property in and around city centre
- WMD Terrorist Attack City is attacked by sophisticated terrorist operation using TR3 weapons of mass destruction; (e.g. anthrax, air-dispersed bio-weapons, chemical or radioactive contaminant, or small yield nuclear detonation) kills large numbers of people and contaminates many buildings in Central Business District

Power Outage

- One City-Day of Power Loss (100% of city loses power for 1 day or PO1 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)



Nuclear Power Accident

- NP1 City receives radioactive fallout of >0.01Bg/km3 (0.3 Curies of C137), similar to within 200km of Chernobyl 1986 or 120km of Fukushima 2011
- NP2 City receives radioactive fallout of >0.1Bg/km2 (3 Curies of C137) similar to within 70 km of Chernobyl 1986 or 50km of Fukushima 2011
- NP3 City receives radioactive fallout of >1Bg/km2 (30 Curies of C137) similar to within 30km of Chernobyl INES 7 event in 1986

'Catastronomics': Recovery and Resilience

- How do economies react to shocks?
- Which 'resilience' factors speed up recovery?
- How can urban economies be made more resilient?
- Research track on case studies to develop improved models of Catastronomics



Impact of 1995 earthquake on the economy of Kobe, Japan



Economy Mix: Classification of Cities



Average mix within cities classified in that category



Pandora Development Agenda

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CCRS – Future Research

- CCRS is pioneering a holistic approach to understanding the full taxonomy of threats
- This continues our work on catastrophic failures of complex systems
- Our primary focus is helping mitigate the risk of business disruption and economic output loss
- We are now working with our supporters to apply these analytics to business problems



Pandora Development Agenda

- Benchmark Economics
 - Update city GDP projections for 2017-2027
- Add 'hub' locations
 - World ports
 - World airports
- Update the threat models for 2017 (& 2018)
 - New Threat model for selected threats
- Make it a Scenario Based Model
 - Create footprints of likely scenarios
- Improve Catastronomics Methodology
 - Case studies of economic impact of past catastrophes and recovery
 - Sectoral differentiation for catastronomics
 - City economy interdependencies which cities have 'first order' dependencies on another?
- Use Case: Insurance@Risk
 - Data schema for multi-lines of insurance exposure
 - Loss analysis methodology
- Use Case: Corporate Risk Profiling
 - How to overlay a corporate global footprint on CRS mapping
 - How to estimate the impact of the events on the corporate revenues
 - Supply chain disruption
- Software and delivery platform



Centre for Risk Studies is Hiring

- I. Research Assistant/Associate in Cyber Risk <u>http://www.jobs.cam.ac.uk/job/10494/</u>
- 2. Research Assistant/Associate in Insurance Modelling <u>http://www.jobs.cam.ac.uk/job/10493/</u>
- 3. Research Assistant/Associate in Risk Modelling <u>http://www.jobs.cam.ac.uk/job/10545/</u>
- 4. Research Assistant/Associate in Data Science <u>http://www.jobs.cam.ac.uk/job/10546/</u>



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