Cambridge Centre for Risk Studies

The 10th Anniversary Risk Summit

CRS RISK OUTLOOK: NATURAL HAZARDS AND CLIMATE RISK

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UNIVERSITY OF CAMBRIDGE
Judge Business School

RISK 10

Outline

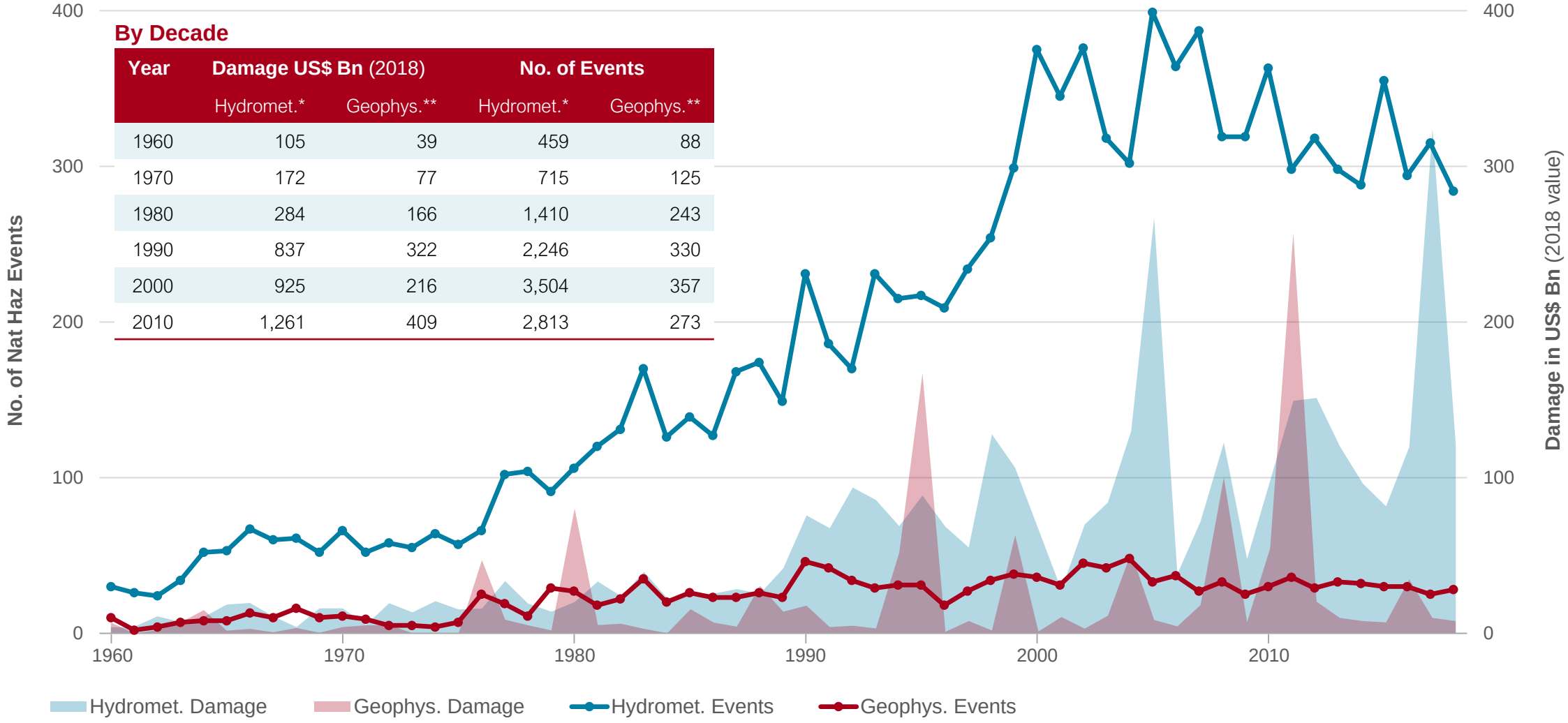
- Natural Hazards: A Growing Risk?
- Climate Change Risk
- Transition Risks
  - e.g. Market Risks
  - e.g. Liability Risks
  - e.g. Reputation & Consumer Change Risks
- Physical Risks
  - Modelling Extreme Weather Disruption
  - Quantifying Disaster Recovery

Natural Hazards: A Growing Risk

Annual Occurrence of Natural Hazard Events Globally and Total Losses; By Event Group

By Decade

Year	Damage US$ Bn (2018)		No. of Events	
	Hydromet.*	Geophys.**	Hydromet.*	Geophys.**
1960	105	39	459	88
1970	172	77	715	125
1980	284	166	1,410	243
1990	837	322	2,246	330
2000	925	216	3,504	357
2010	1,261	409	2,813	273



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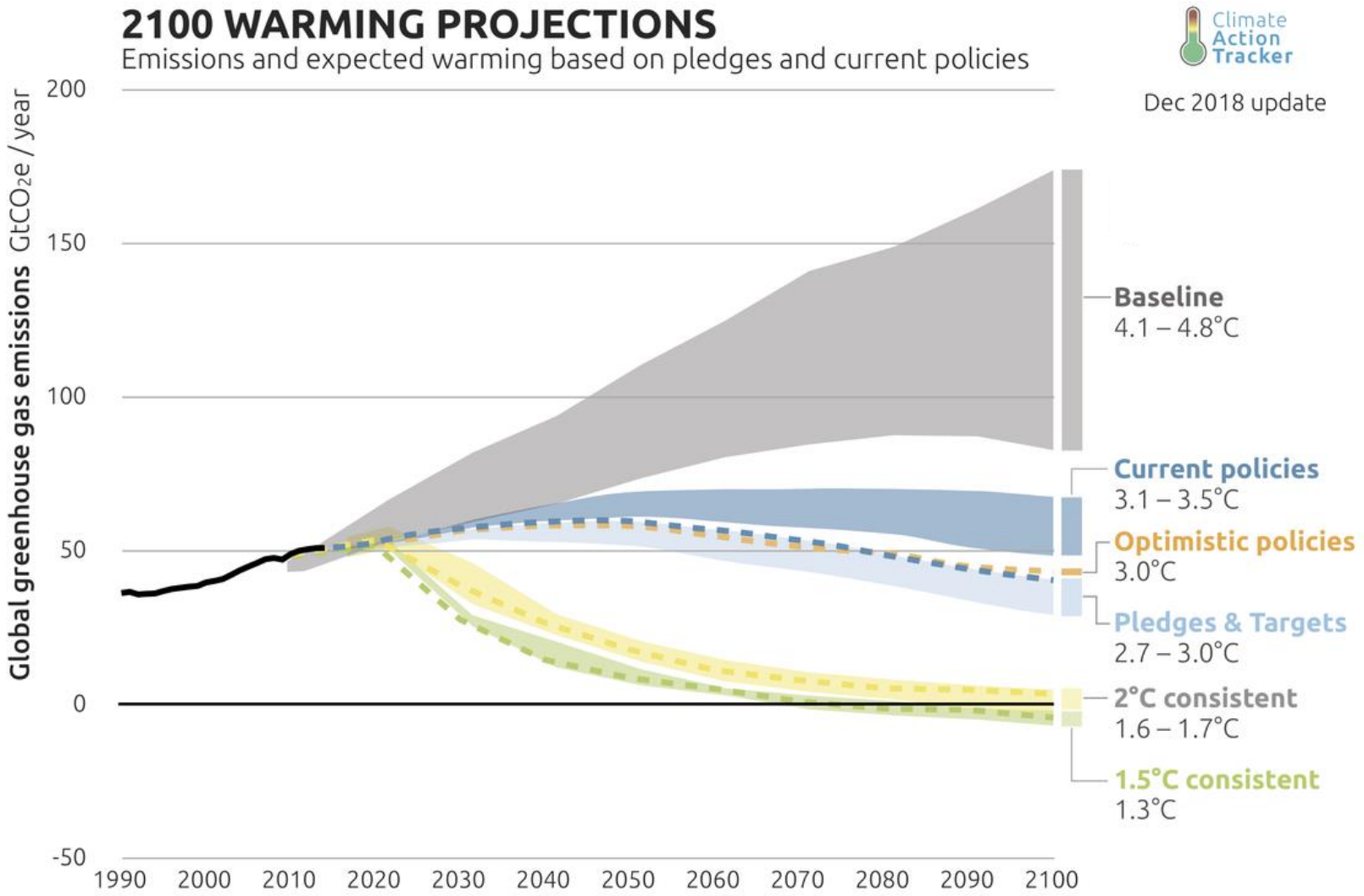
*__Hydrometeorological__: incl. storm, extreme temperature, flood, landslide, drought, wildfire
**__Geophysical__: incl. earthquake, tsunami, volcano

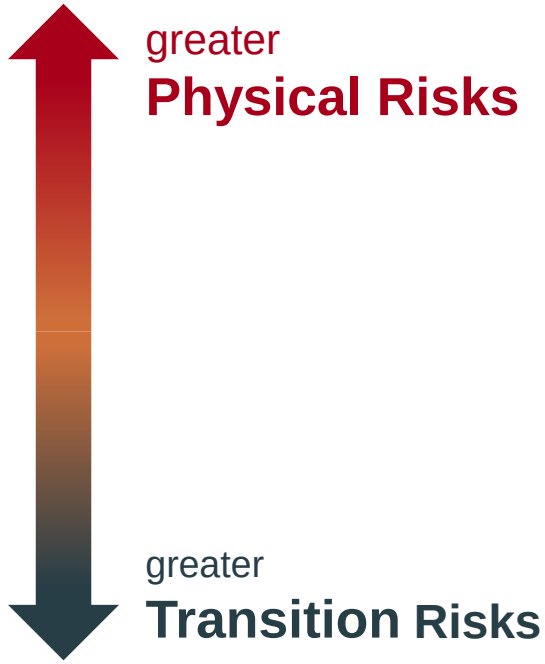
Data Source: EM-DAT 2019

The Decade in Natural Hazard Risk

2010	The Haitian earthquake is the deadliest natural catastrophe of the decade, with more than 222,000 fatalities
2011	The fourth most powerful earthquake ever recorded strikes Japan's Tōhoku region, triggering a major tsunami and the meltdown of Fukushima Nuclear Power Plant
2012	Hurricane Sandy devastates New York and New Jersey, a region rarely affected by windstorms
2013	Floods in Central Europe are the worst in recent European history and marked a step change in the understanding and management of flood risk
2013	Typhoon Haiyan is the deadliest storm to ever hit the Philippines and one of the most powerful storms ever recorded, prompting a global response to the disaster
2015	The Gorkha earthquake devastates Nepal, and gives new insights into Himalayan seismicity, suggesting the densely-populated region is at risk of more extreme mega-earthquakes
2015-16	Droughts in India affect 330 million people, making it the most widespread natural catastrophe of the decade
2016	The year is declared the warmest ever on record, with a global average of .94°C over the 20th Century norm
2017	Atlantic hurricanes Harvey, Irma and Maria contribute to the costliest hurricane season ever, with a $220bn loss overall
2018	California is affected by unprecedented wildfires, triggering an insurance response equivalent to those reserved for flood, hurricanes and earthquakes

Climate Change Risk





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Climate Change Risk

- **Physical Risks** are increasing in response to climate change
- Society's response towards a low-carbon economy provides opportunities;
- But also presents **Transition Risks** to businesses, assets, and economies

Climate Change Risks

Physical Risks	**Shocks** ▪ Exacerbated extreme weather events – Magnitude – Frequency – Geography
	Trends ▪ Changes to average climatic conditions ▪ Sea level rise ▪ Ocean acidification ▪ Cryosphere change/reduction ▪ Disruption of biogeochemical cycles ▪ Loss of biosphere integrity
Transition Risks	**Regulation & Liability** ▪ Carbon pricing & reporting obligations ▪ Asset stranding ▪ Regulation of existing products & services ▪ Exposure to litigation
	Market ▪ Market uncertainty or negative outlook ▪ Investor sentiment – carbon divestment ▪ Raw material costs
	Reputation & Consumer Power ▪ Consumer preference change ▪ Sector stigmatisation
	Disruptive Technology ▪ Disruptive, low-carbon products & services ▪ Innovation failure

Adapted from TCFD 2017

Market Risk Scenarios

Unhedgeable risk: How Climate Change Sentiment Impacts Investment

- Awareness of climate change transition risks shifts market sentiment
- Economic shock through rapid divestment of carbon intensive assets
- Represent financial tipping points: losses to portfolio value within investor-sensitive timescales
- Changing asset allocations can offset only half of the negative impacts on financial portfolios: climate change thus entails ‘unhedgeable risk’

Impacts of Severe National Catastrophes on Financial Markets

- Few nat cats have impacted global markets, but growing global exposure means more potential loss vectors
- ‘Trillion Dollar Nat-Cat’ scenarios – threshold of loss that would trigger market shocks and economic downturns
- Impacting insurance balance sheets: through losses from property casualty underwriting portfolio and the devaluations to assets in their investment portfolio

Liability Risks

Litigation risk arising from breaches of tort, consumer, corporate & financial risk management laws:

- Claims for failing to **mitigate** impacts of climate change
- Claims for failing to **adapt** to the impacts of climate change
- Claims for failure to **disclose** climate-related risks to shareholders

- Notable cases against energy companies include:
  - **Public nuisance claim** *City of Oakland v. BP p.l.c.*
  - **Attribution claim** *Lliuya v. RWE AG*
  - **Breach of human rights claim** *In re Greenpeace Southeast Asia and Others*
  - **Securities fraud class action** *Ramirez v. Exxon Mobil Corp.*

e.g. Liability Risks: Insurance Clash Scenarios

CRS Developing **insurance clash scenarios**

- Assess how an event triggers loss across all types of insurance and their coverages
- Large Nat Cats have potential to trigger losses in many property lines and casualty liability

Hurricane Kayla

- Counterfactual Hurricane Katrina: CAT 5 hits Gulf of Mexico
  - Storm surge: 2.4 m
  - Peak sustained wind speed: 305 km/h
- Significant liability & casualty claims due to perceived negligence & failure in duty of care
  - Impacts offshore energy assets, producing oil spill; environmental liability & clean-up costs
  - Medical malpractice lawsuits by injured patients
  - Workers compensation claimed by injured emergency personnel
  - Technical errors & omissions following failures in transmitting evacuation warnings

Insurance Loss Estimates

Class of Business		US$ Bn
Commercial Lines	Property	45
	Non-Property	
Personal Lines	Property	84
	Non-Property	3
Casualty and Liability		20
Energy		49
Marine		10
Aviation		9
Total		**224**

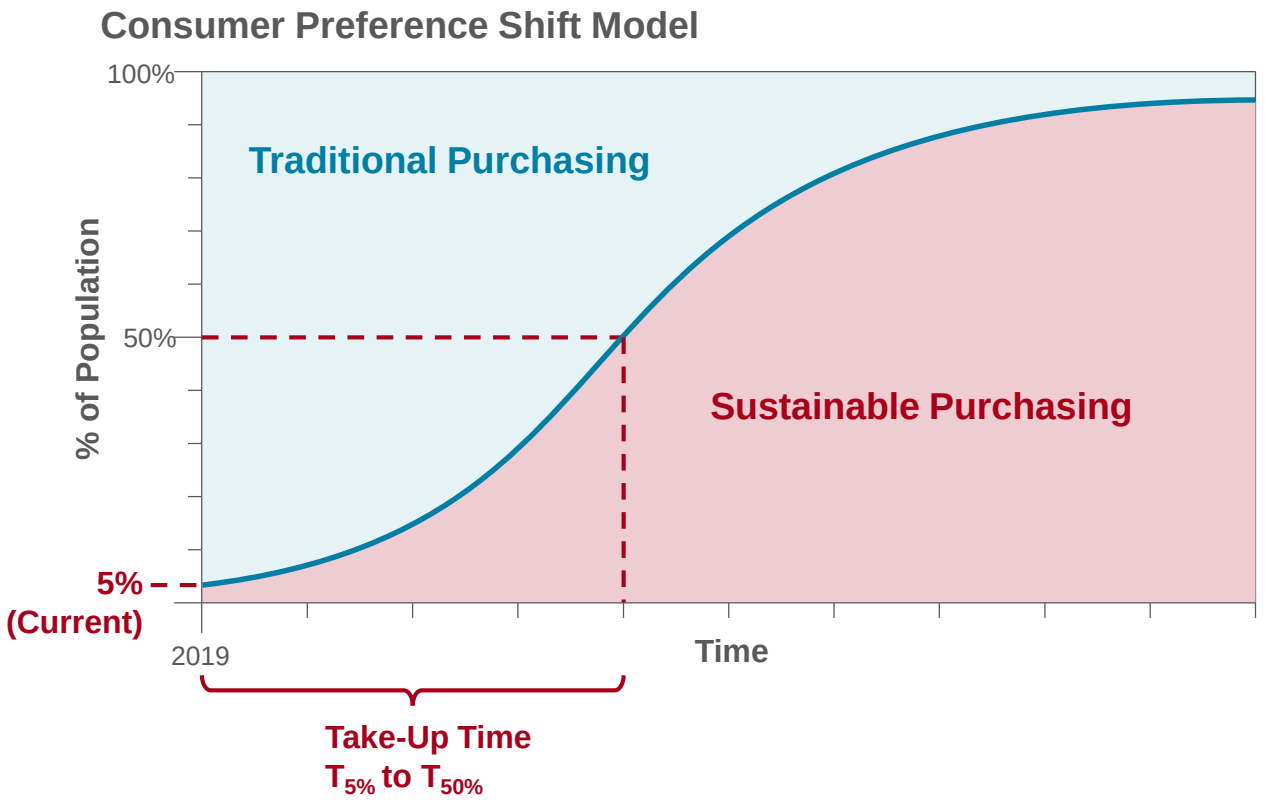
Ranked Liability Loss

	Liability Coverage	
1	Pollution Liability	
2	Professional Liability	
3	Directors and Officers	
4	Employers Liability	
5	Aggregate Policy	
6	Commercial General Liability	
7	Workers' Compensation	
8	Product Liability	
Total		**15.4**

Reputation & Consumer Power Risks

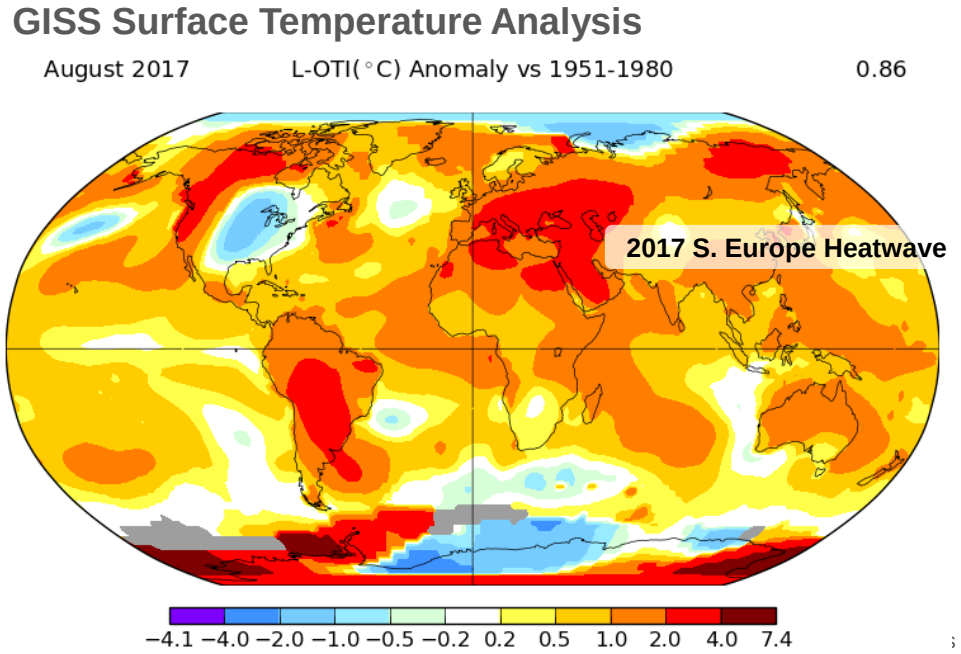
61% of consumer say they're likely to switch to a brand that is more environmentally friendly than their current brand

Global Web Index 2019



Modelling Extreme Weather Occurrence

- Climate change models forecast that changes will occur in long-term average climatic conditions
  - Course-resolution models are still poor at predicting volatility
- However, it is **short-term extreme weather events** that will be disruptive to businesses & economies **in the next decade**
  - Already departed historic baseline: exacerbating event impacts
- Growth of attribution science linking climate change to individual events:



European Heatwaves

"Across the Euro-Mediterranean the likelihood of a heat wave at least as hot as summer 2017 is now on the order of 10%. Anthropogenic climate change has increased the odds at least threefold since 1950."

Kew et al. 2018

North Atlantic Hurricanes

"Relative to pre-industrial conditions, climate change so far has enhanced the average and extreme rainfall of hurricanes Katrina, Irma and Maria, but did not change tropical cyclone wind-speed intensity."

Patricola & Wehner 2018

Bangladesh Floods

"Anthropogenic climate change doubled the likelihood of the 2017 pre-monsoon extreme 6-day rainfall event at northeast Bangladesh."

Rimi et al. 2018

Australia Wildfire

"Extreme vapor pressure deficits (VPD) have been associated with enhanced wildfire risk. Using one model, we found for 2015/16 that human influences quintupled the risk of extreme VPD for western North America and increased the risk for extratropical Australia."

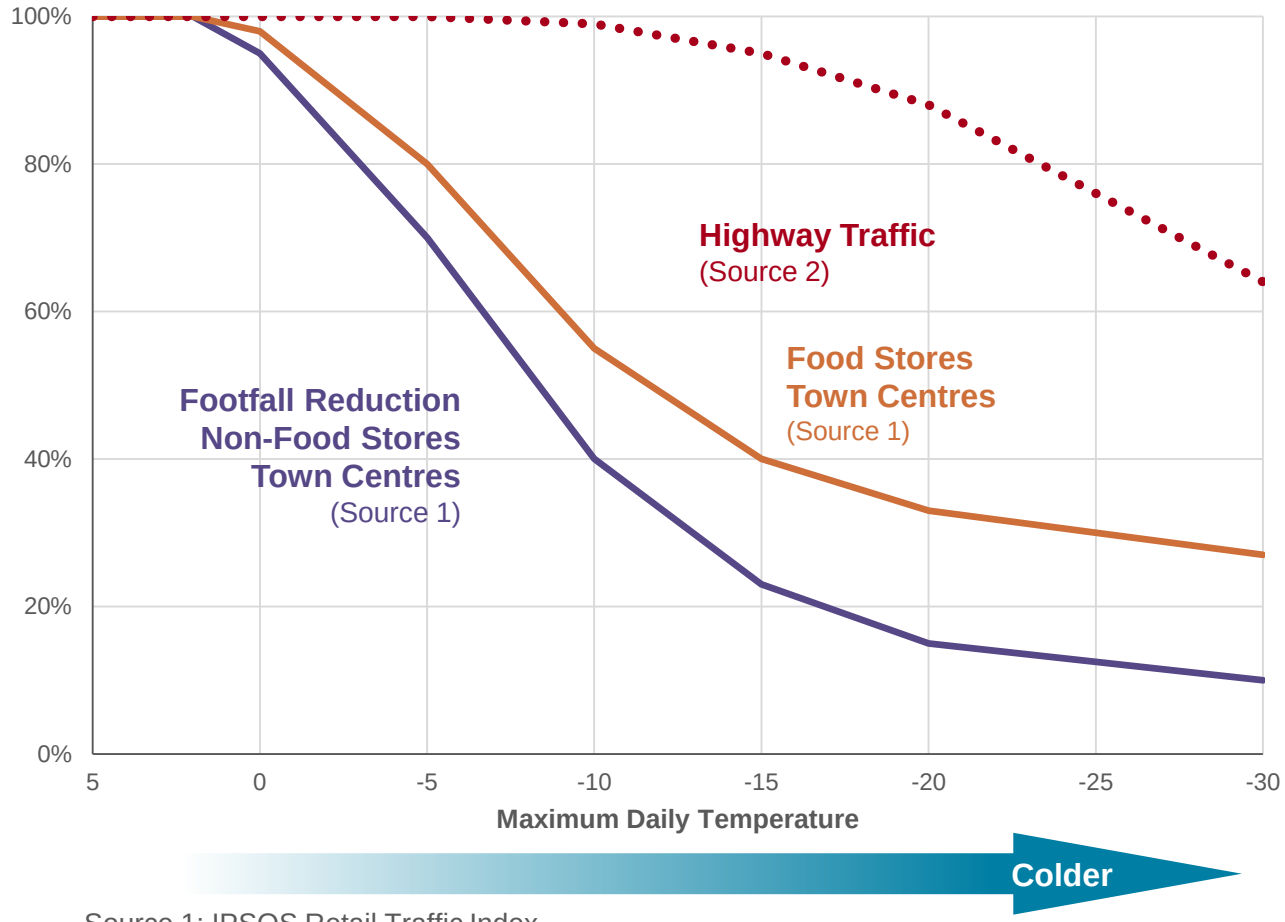
Tett et al. 2018

Modelling Extreme Weather Disruption

- CRS approach to compile a short-term outlook of stress test for potential disruption
- Focus on **vulnerability** of **economic productivity** to extreme events
- Vulnerable economic sectors include:
  - Agriculture
  - Construction
  - Energy & Utilities
  - Finance
  - Healthcare
  - Leisure & Retail
  - Online Continuity
  - Tourism
  - Transportation
- We analyse the number of **weather disruption days per year**, i.e.:
  - When transport networks are unable to function
  - When retail footfall drops as customers deterred or restricted
  - When the productivity of business operations is reduced

Business Productivity Reduction

Store Footfall with Cold Weather



Source 1: IPSOS Retail Traffic Index
Source 2: Roh 2016

Freezing weather costs UK economy £1bn a day

Financial impact of the 'beast from the east' and storm Emma worst since Christmas 2010

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Extreme Weather Operational Thresholds

Event	Operational Thresholds		Impact
 **Tropical Cyclone or Temperate Windstorm**	Wind speed on land; lighting & hail	>72 km/h	Key ports affected; unsafe to operate cranes
		>75 km/h	Road & rail traffic disrupted; infrastructure damage & debris, incl. power outages
		>83 km/h	Key airports closed; aircraft cannot taxi
	Wind speed at sea	>62 km/h; gale force 8	Cargo ships halted; shipping traffic disrupted
 **Flash Flood**	Precipitation >10 cm in 3 hours		Loss of economic activity; infrastructural damage
 **Coastal Flood**	Storm surge 1 m height (high tides coincident with low pressure storm systems >990 mb central pressure & high wind-driven waves >75 km/h)		Loss of economic activity; infrastructural damage
 **River Flood**	Precipitation >20 cm/d in catchment; or, rapid snow melt in catchment (winter temperature rise >5°C/d)		Loss of economic activity; infrastructural damage
 **Freeze**	Temperature <-10°C; Snowfall >5 cm		Reduced air, rail & road traffic
 **Heat Wave**	Prolonged temperature deviation (e.g. >1SD from 1-month mean); includes drought		Consumer demand drop & unpredicted purchasing patterns
 **Drought**	Extreme soil moisture deficit (prolonged reduced rainfall & high temperatures (e.g. below 1SD from 1-month mean))		Agricultural productivity loss in key growing areas (*to Tesco*); Loss of economic activity; particularly in water-intensive industries
 **Wildfire**	Extreme fuel moisture deficit (prolonged reduced rainfall & high temperatures); Wind speed		Agricultural productivity loss; infrastructural damage

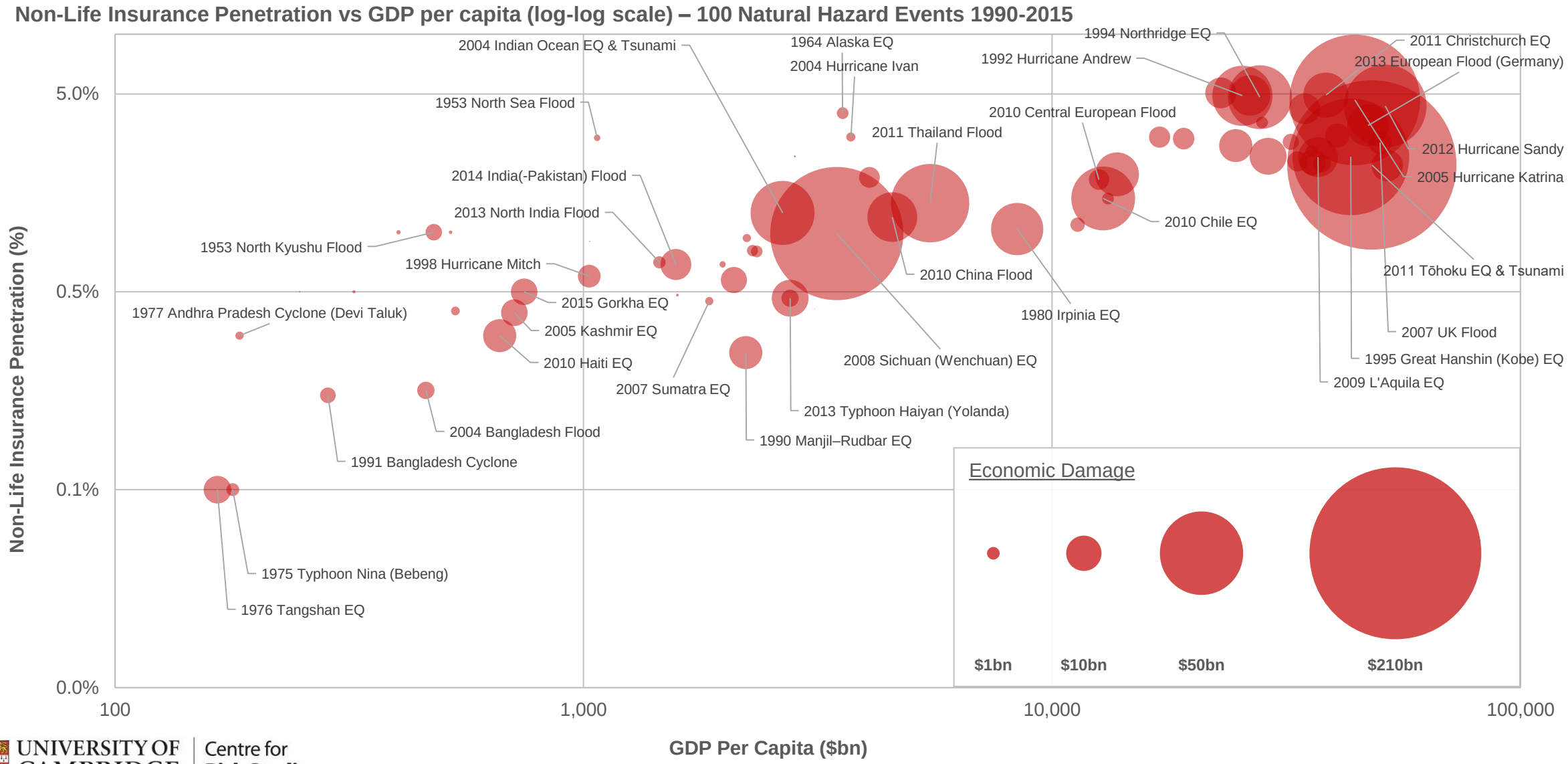
Quantifying Natural Disaster Recovery

If physical climate change risks are increasing, what can we do about it?

CRS research addresses:

- What are the key controls on socioeconomic recovery from disasters?
- What can be learnt about recovery dynamics from previous disasters?
- How can insurance improve recovery speed and quality and enhance resilience?

Disaster Recovery: The Relationship between GDP and Economic Loss



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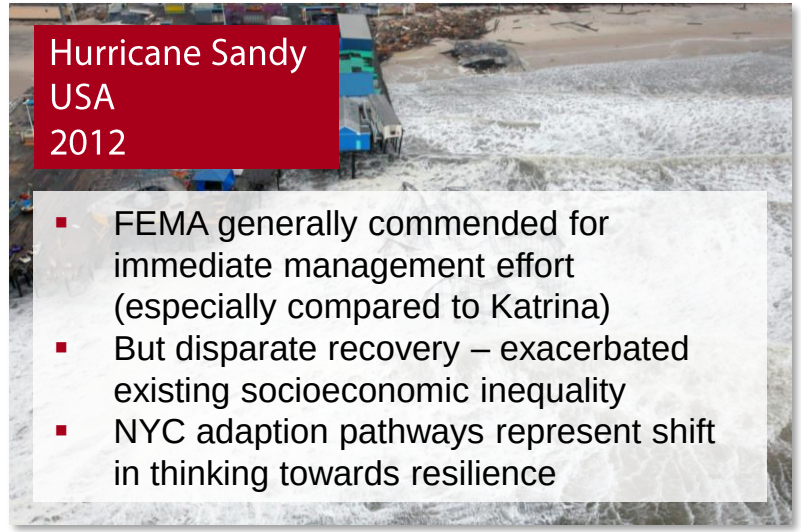
Disaster Recovery: Case Study Narratives

Germany Floods 2013

- Adequately financed & effectively managed
- Coordinated FRM strategies at catchment level, but questionable across state/national borders
- Reliance on flood protection & significant residual risk ('levee effect')

UK Floods 2007

- Marked a step change in UK FRM (motivated by Pitt review)
- Developed (subsidised) flood insurance market (90% penetration)
- But improved resilience has had limited impact on recovery speed/quality

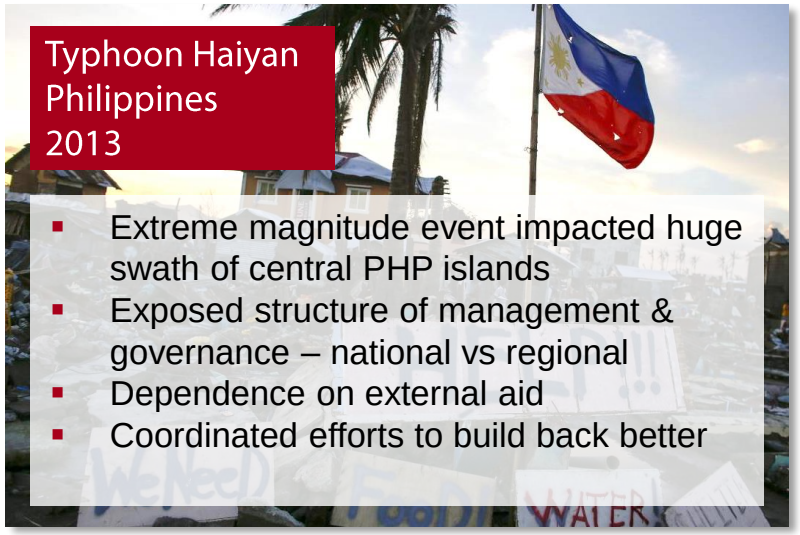


Hurricane Sandy USA 2012

- FEMA generally commended for immediate management effort (especially compared to Katrina)
- But disparate recovery – exacerbated existing socioeconomic inequality
- NYC adaption pathways represent shift in thinking towards resilience

Typhoon Damrey Vietnam 2017

- Communal self help & finance
- Little international attention & involvement
- Rapid development of economy provides opportunity but challenges existing resilience mechanisms



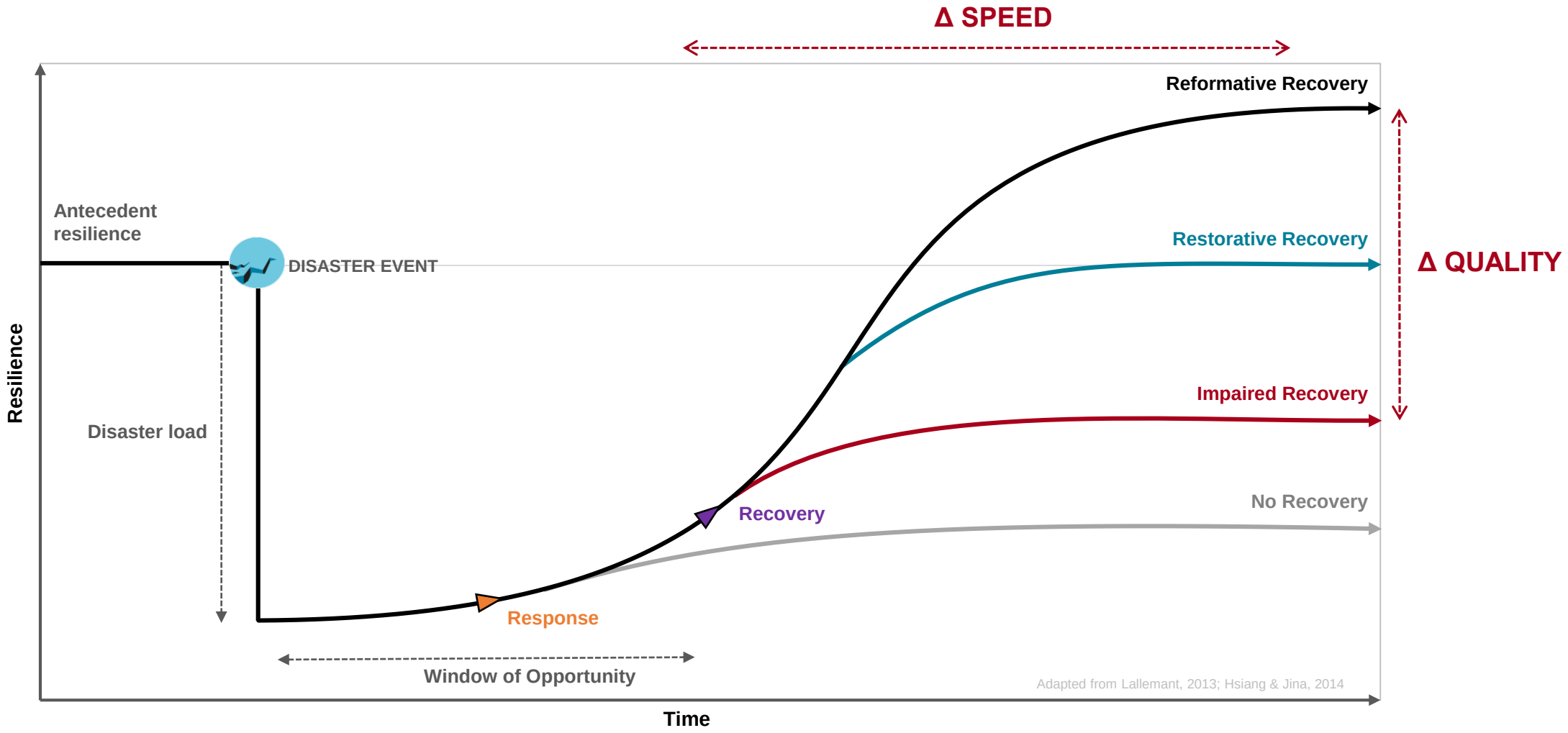
Typhoon Haiyan Philippines 2013

- Extreme magnitude event impacted huge swath of central PHP islands
- Exposed structure of management & governance – national vs regional
- Dependence on external aid
- Coordinated efforts to build back better

India-Pak. Floods 2014

- Poor regional risk management, no early warning systems
- Cross-border tension & Kashmiris reject Indian rule – media further eroded gov. trust
- Reliance on external aid, but failure of state to provide timely relief

Building Resilience Through Disaster Recovery



Conclusions

- Next decade will see climate change risks increasing
  - As society transitions towards a low-carbon economy
  - As extreme weather is exacerbated
- Balance of these risks dependent on global response
  - Transition risks greater in the near-term
  - Short-term extreme weather events will disrupt businesses & economies
- Low probability, high-impact scenarios offer stress tests to assess vulnerability & management/mitigation options

Climate Change Risks

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