Flood Risk Assessment

Insuring An Emerging CAT

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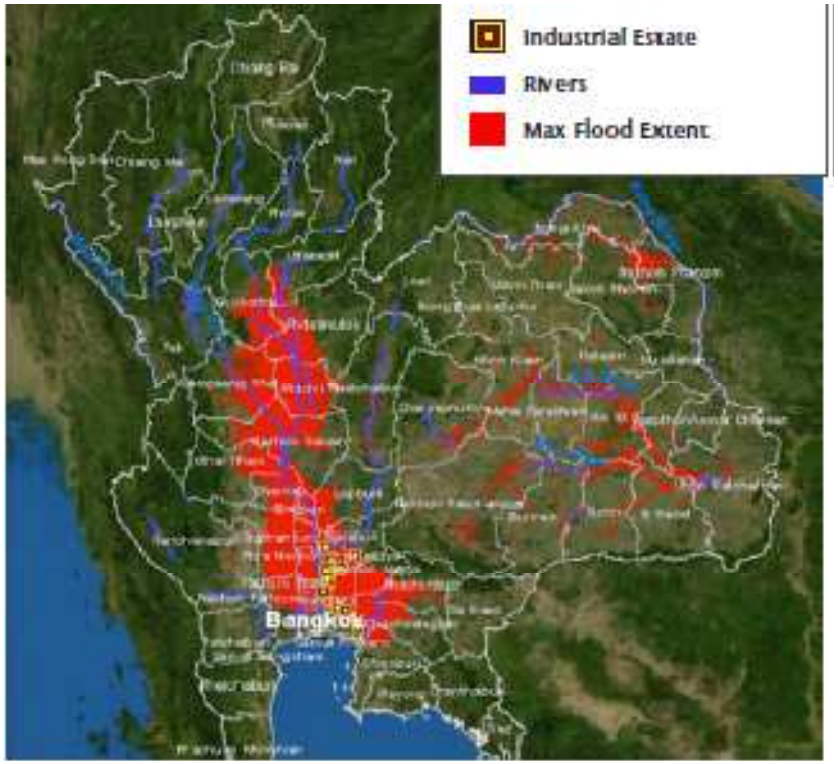
Overview

- Thailand 2011 Flood – a case study
- A Global Perspective
- Emerging Issues: Flood Hazard and Loss
- Flood Risk Management: Key challenges

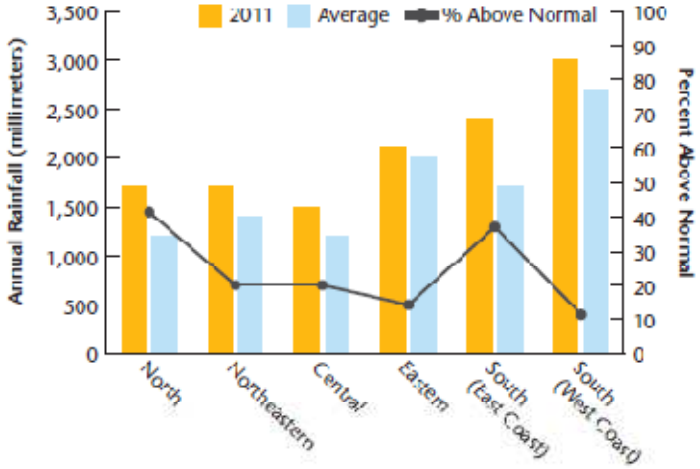
Thailand Flood of 2011

- Extensive flooding across the country from July-Dec 2011
  - 65 of 77 provinces affected
- Damages
  - 813 fatalities
  - Economic damages: $45.7B (80% of GDP in 4Q) – making it a top Nat CAT event
  - Insured damages: $10.8B – 4th largest insured loss event
- Widespread Economic Impact
  - Agriculture
  - Manufacturing
  - Tourism
  - Personal property
  - Infrastructure
  - Global Supply chains: Significant loss to entities not primarily based in Thailand



Thailand 2011 Flood: Key drivers

1. Excessive rainfall
   1. Heavy Monsoons
   2. Tropical Cyclones
2. Urbanization
3. High tides
4. Insufficient drainage and flood protection systems
5. Land subsidence
6. Water mgmt decisions
7. Climate Factors
   1. La Nina
8. Wet pre-season



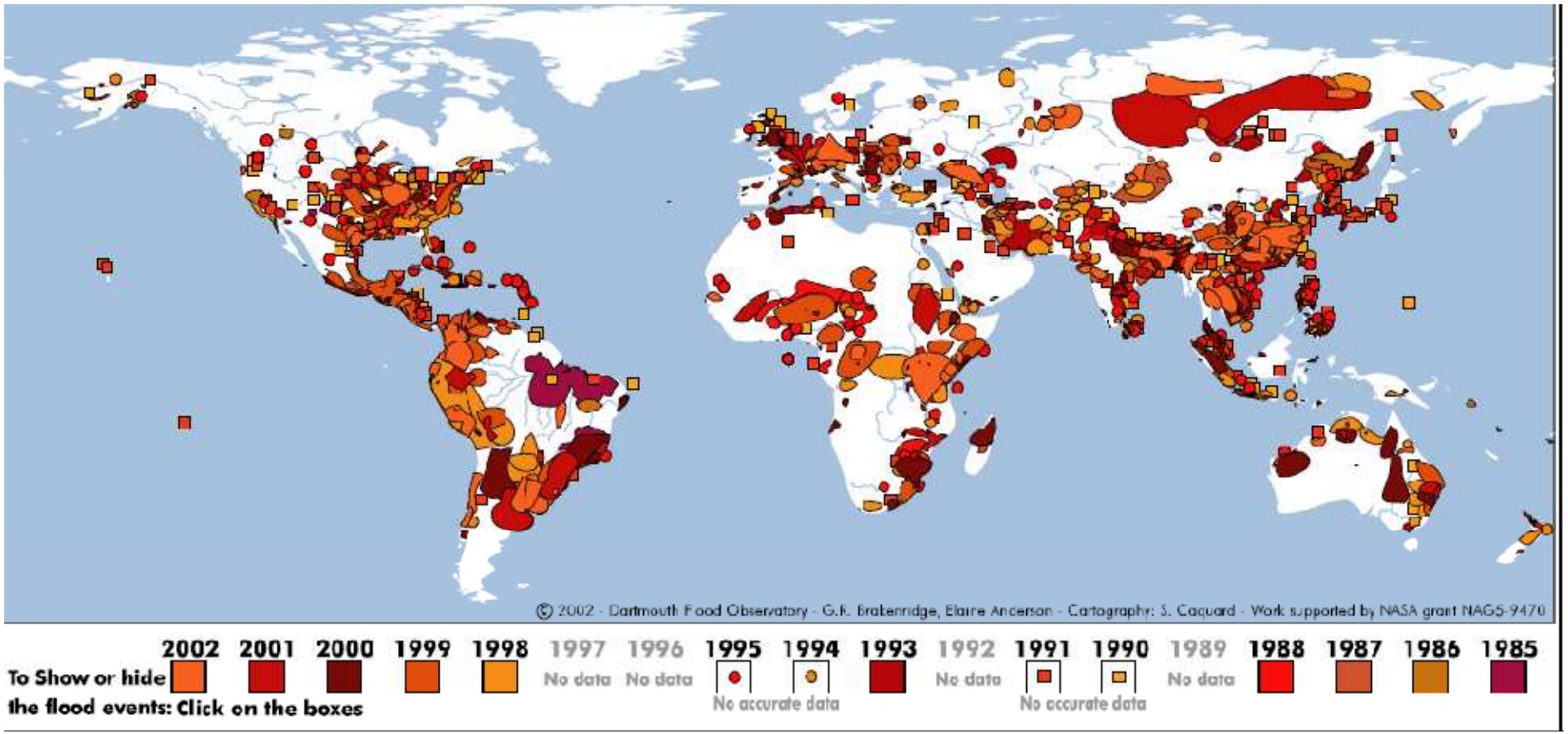
Source: Thai Meteorological Department

2011 Floods: A Wake up call

- The Thai floods were severe but by no means unusual
  - Floods are a common phenomena in Thailand
  - A combination of various natural and man-made factors led the 2011 flood to have a severe impact
- Australia, Mississippi & Pakistan floods were significant loss events in the same time period
- Industry reaction: Flood no longer a secondary peril
  - Rating agencies/Regulators
    - Increase capital requirements
  - Insurers
    - Increase rates 100%+
    - In the past, flood cover was almost given away for free
    - Terms and conditions have tightened
    - Recognition of supply chain risks and impact of flood on CBI
  - Reinsurers: Material rate increases
    - Recognition of non-US risk as significant driver of balance sheet/earnings risk

Year	Flood Description	Economic Cost (THB)	Economic Cost (USD)
1785	4.25-meter (13.94-foot) flood height	N/A	N/A
1819	3.20-meter (10.50-foot) flood height	N/A	N/A
1831	Floodwaters reached the top of protective walls	N/A	N/A
1917	All roads underwater for at least one month's time	N/A	N/A
1942	1.50-meter (4.92-foot) flood height, which persisted for two months' time	N/A	N/A
1975	Floods caused by tropical depression	1.1 billion	36.2 million
1980	Four days of excessive rainfall in city prompts widespread flooding	700 million	23.1 million
1982	Heavy rainfall prompts flooding	1.1 billion	36.0 million
1983	Remnants of multiple tropical cyclones prompts 3-5 months of flooding in the city	6.6 billion	217.5 million
1995	Chao Phraya River measured at 2.27 meters (7.45 feet) above sea level	3.0 billion	98.8 million
1996	Water levels measured at 2.14 meters (7.02 feet); flood dike overtopped	1.5 billion	49.4 million

Global Scope: Extreme Flood Events 1985-2002



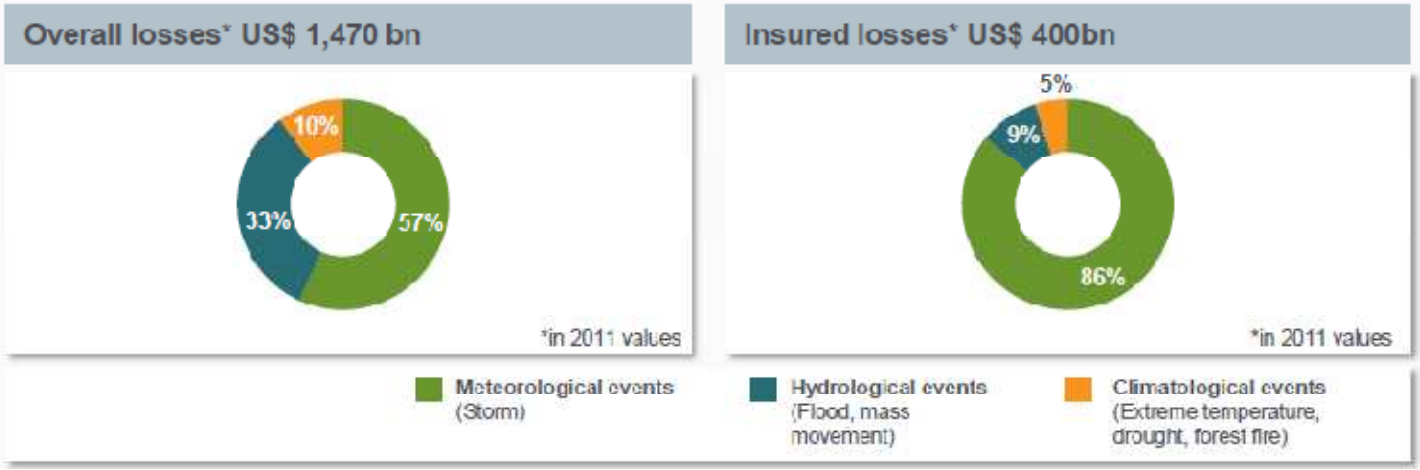
- Extreme floods are more widespread than other CAT perils
- Latin America, Southeast Asia & Europe – Floods are the leading cause of disasters

Munich RE

Significant natural catastrophes 1980 - 2011

10 costliest floods worldwide ordered by overall losses

Period	Event	Affected Area	Overall losses	Insured losses	Fatalities
			US$ m, original values		
1.8-15.11.2011	Floods	Thailand: Phichit, Nakhon Sawan, Phra Nakhon Si Ayuttaya, Pathumthani, Nonthaburi, Bangkok	40 000	10 000	813
May-Sept 1998	Floods	China: Yangtze, Songhua Jiang	30 700	1 000	4,159
27.6-13.8.1996	Floods	China: Guizhou, Guiyang, Zhejiang; Sichuan; Hunan; Anhui; Jiangxi; Hubei, Guangxi; Jiangsu; Fuijian	24 000	445	3,048
27.6-15.8.1993	Floods	USA: MS, MO, IA, IL, ND, IN, MN, WI, KS, NE, SD	21 000	1 270	48
12-20.8.2002	Floods	Germany, Austria, Czech Republic, Hungary, Moldova, Switzerland, Slovakia	16 500	3 400	39
24.7-18.8.1995	Floods	North Korea	15 000		68
May-Sept 1991	Floods	China: Huai, Anhui, Jiangsu, Hubei	13 600	410	2,628
21.6-20.9.1993	Floods	China: 10 provinces affected	11 000		3,300
June 2008	Floods	USA: IA, IL, IN, KS, MI, MN, MO, WI	10 000	500	24
21.7-14.9.2010	Floods	Pakistan: entire country	9 500	100	1,760



As at March 2012

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10 Largest Insured Flood Losses

Significant natural catastrophes 1980 - 2011

10 costliest floods worldwide ordered by insured losses

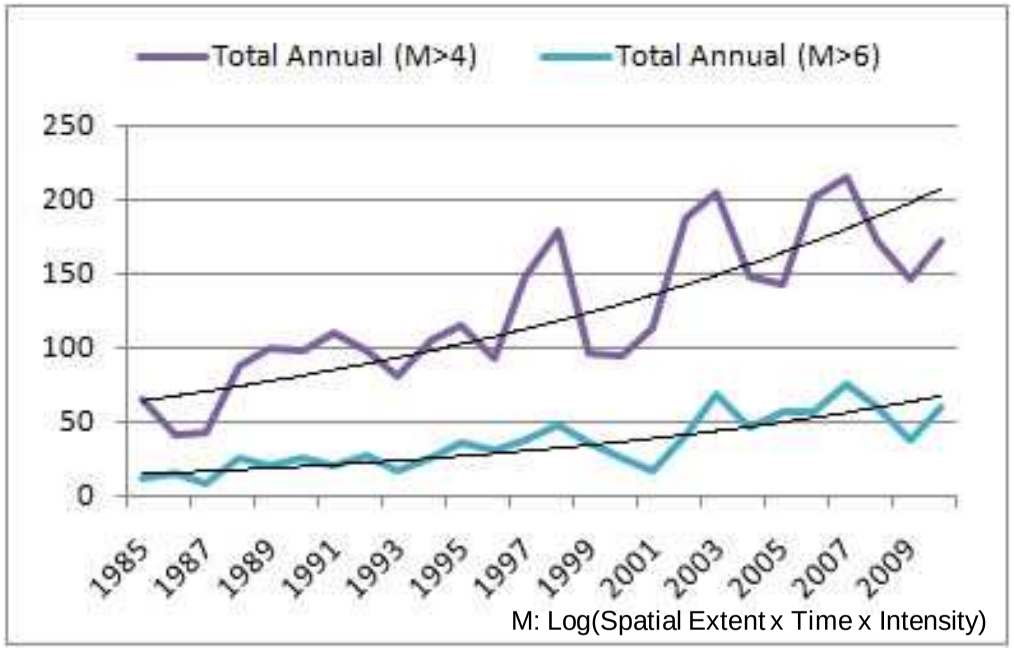
Period	Event	Affected Area	Overall losses	Insured losses	Fatalities
			US$ m, original values		
1.8-15.11.2011	Floods	Thailand: Phichit, Nakhon Sawan, Phra Nakhon Si Ayuttaya, Pathumthani, Nonthaburi, Bangkok	40,000	10,000	813
12-20.8.2002	Floods	Germany, Austria, Czech Republic, Hungary, Moldova, Switzerland, Slovakia	16,500	3,400	39
25-30.6.2007	Floods	United Kingdom: England, Yorkshire, Hull, Humberside; Sheffield; Worcestershire	4,000	3,000	4
20-23.7.2007	Floods	United Kingdom: England, Worcestershire, Oxfordshire, Gloucestershire; Wales	4,000	3,000	1
10-14.1.2011	Floods	Australia: Queensland	2,800	1,875	22
20-28.8.2005	Floods	Austria, France, Germany, Hungary, Slovenia, Switzerland	3,300	1,760	11
27.6-15.8.1993	Floods	USA: MS, MO, IA, IL, ND, IN, MN, WI, KS, NE, SD	21,000	1,270	48
Oct-Nov 2000	Floods	United Kingdom: England, Kent, Tonbridge, Yalding, London; Wales, Ireland	1,700	1,100	10
4-9.11.2011	Flash floods	France, Italy, Spain	2,100	1,100	14
15.6.2010	Flash floods	France: Provence-Alpes-Cote d'Azur, Draguignan, Luc, Muy, Les Arcs, Toulon	1,500	1,070	27

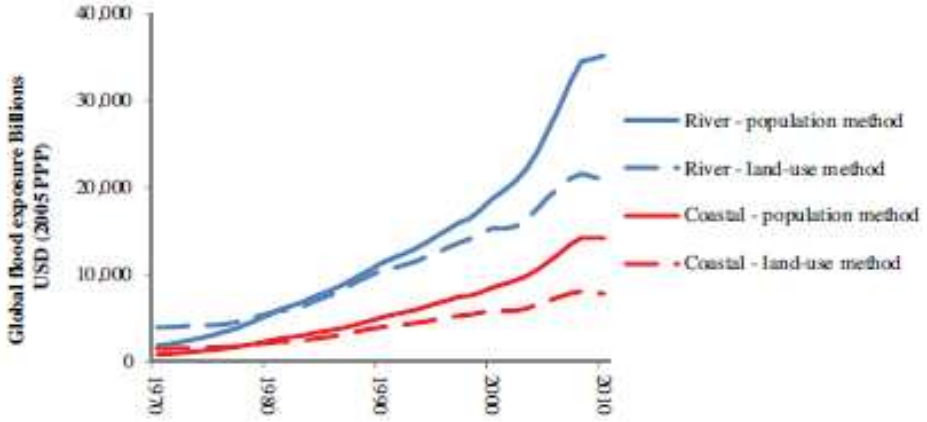
As at: March 2012

Emerging Flood Issues

Increase trend in both hazard & exposures

- **Urbanization**
  - Landscape changes & deforestation imply that riverine floods carry more punch
  - Urban floods are more likely in densely populated non-riverine areas
  - 33% of UK floods are attributed to urbanization
    - UK Floods of 2007 – (Industry: $6B loss)
- **Climate Change**
  - Extreme Precipitation increases
  - Sea Level Rise
  - Tropical cyclone rain potential
- **Globalization**
  - Growth in Emerging economies
    - Greater insurance exposure
    - Greater penetration
  - Supply chain complexity – CBI exposure
- **Increasing coastal & riverine exposure**

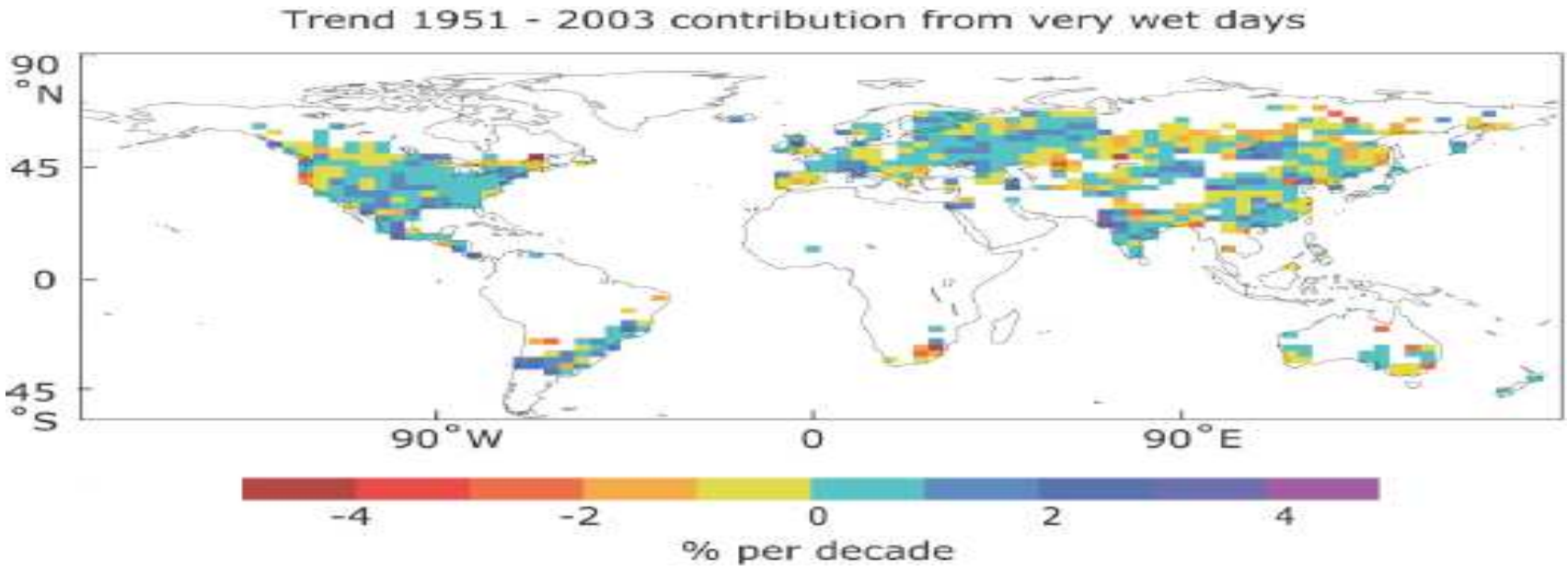




Climate Change

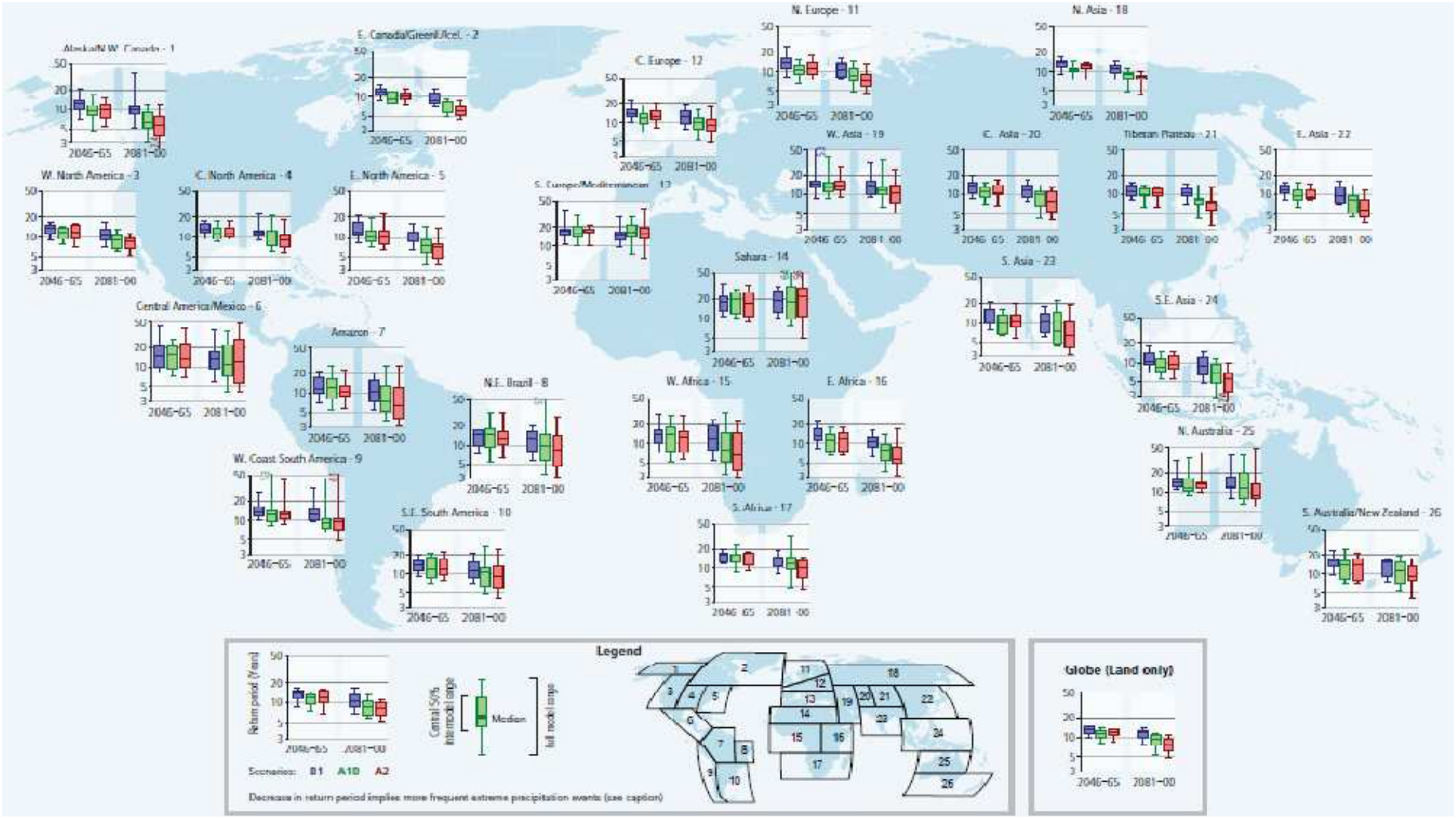
Precipitation extremes on the rise

- A Series of long term rainfall records are being broken leading to devastating floods
  - Germany (2002), England & Wales (2000, 2007, 2009), Pakistan (2010), Australia (2010), Japan (Typhoon Talas – 2011)
  - Climate Change has already contributed to the observed intensification of heavy precipitation events found over approximately two-thirds of data-covered parts of Northern Hemisphere land areas
  - The frequency of 1 in 1000 yr daily rain events has increased in mid-latitudes, particularly n the US by 33%. Europe winter precipitation beyond 98th percentile has increased eightfold (8x)
- England & Wales 2000 Flood ($1-2B Industry event)- Wettest Autumn on record since 1766 – 90% confidence that its risk was influenced by global warming.
- Tropical cyclone rainfall projected to increase by 20%



Extreme Precipitation Projections

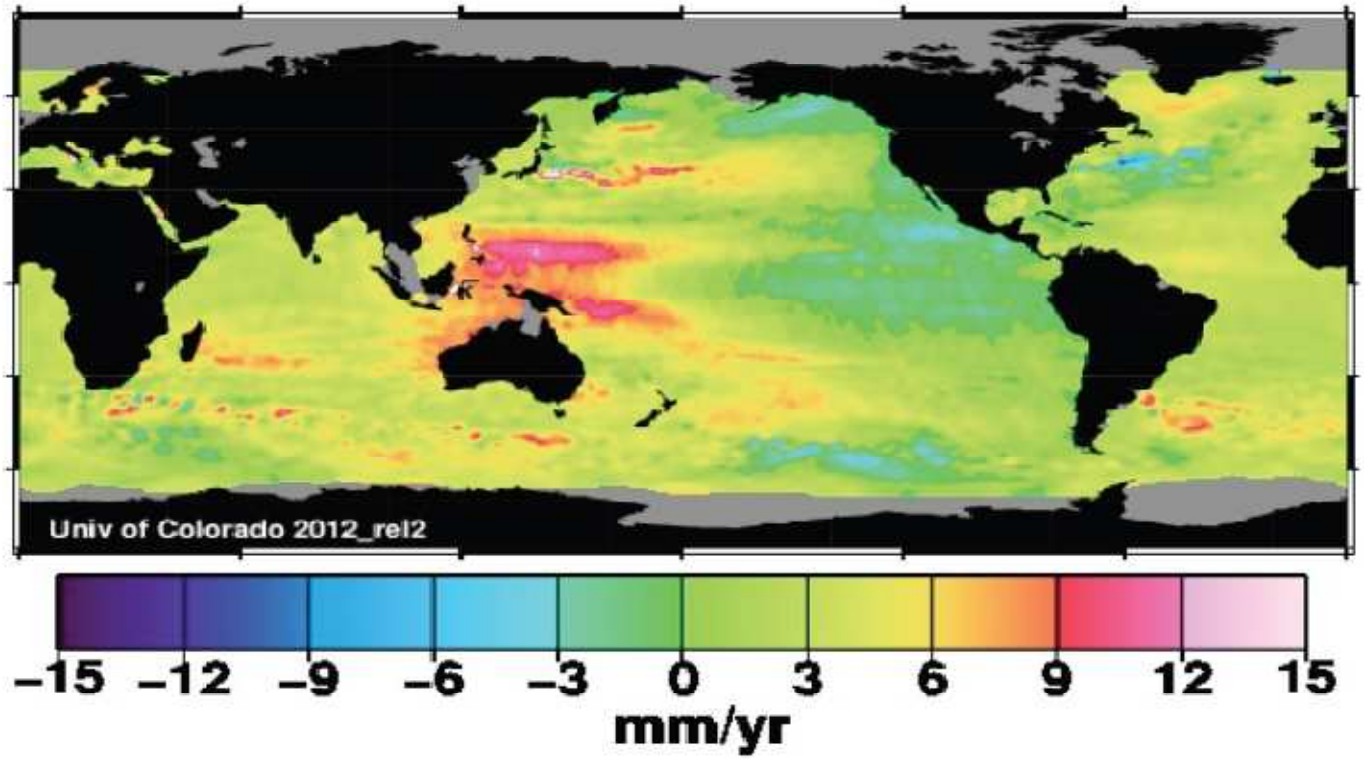
Increased likelihood of excess rain events



Source: IPCC Special Report on Extremes (2011)

Climate Change: Sea Level Rise

- Sea Level rise
  - Raises the launching pad for storm surge
  - Increases the odds for coastal flooding, especially when combined with coastal subsidence



Geographic distribution of linear trends in mean sea level (mm per year) from 1993-2012

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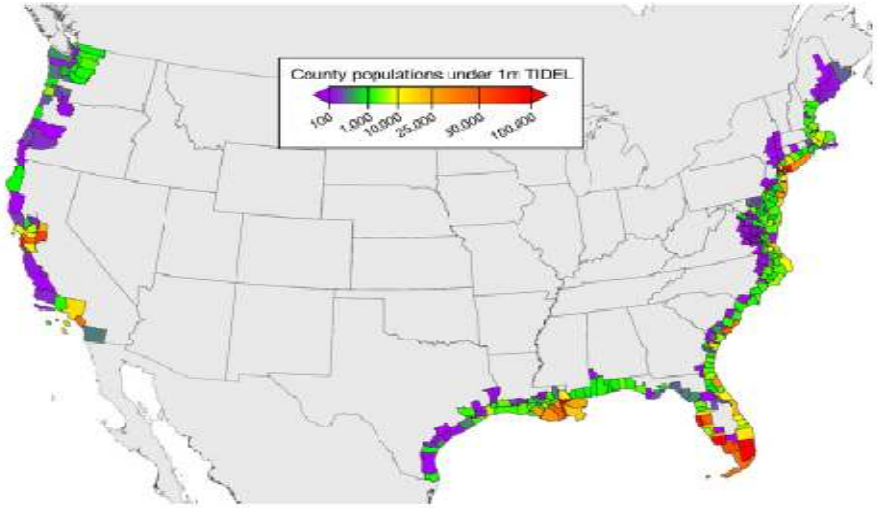
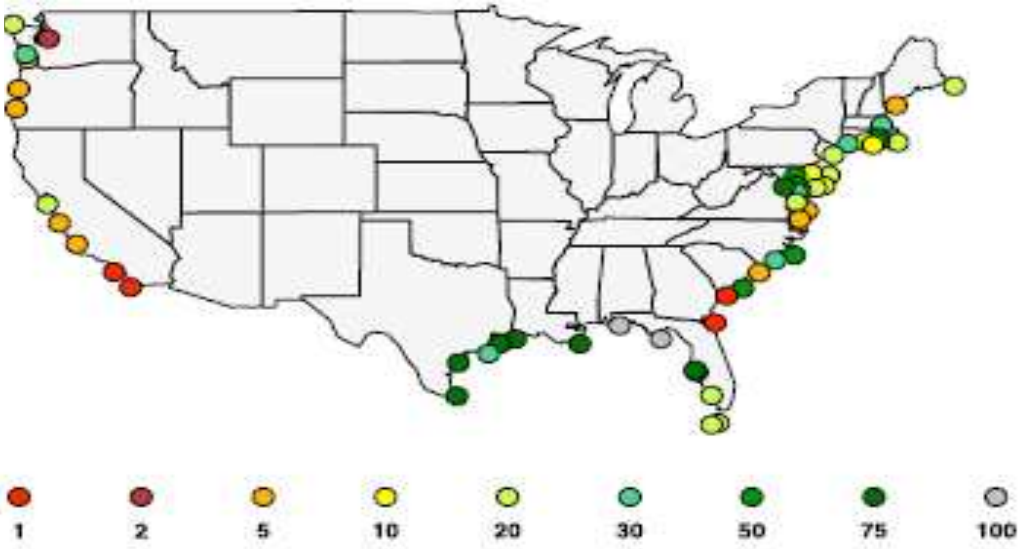
Coastal Flood Risk

Relative Sea Level Rise: Coastal Flood potential



County Population below 1m of maximum Tidal elevation



Ensemble average estimate of relative SLR at each gauge, projected return periods, by 2050, for floods currently qualifying as 100 yr events.

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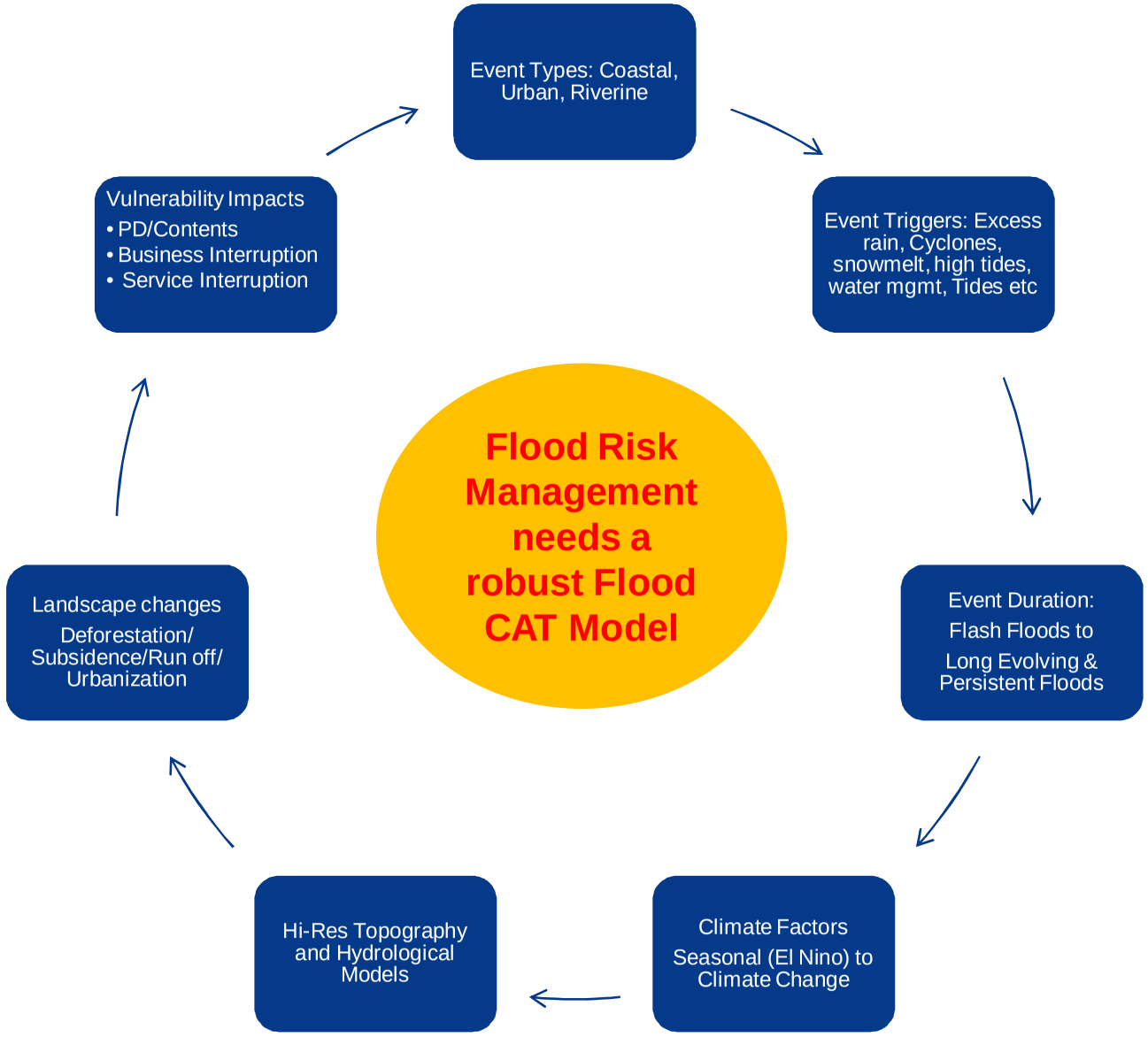
Flood Risk: Unique Characteristics

Characteristic	WS	EQ	Flood
Event Duration	Hours	Instantaneous	hours-months
Event Triggers	Landfall	Shake	Multiple (natural + human decisions)
Event Footprint	State/County	State/local	Depends on elevation, slope, protection
Statistics	semi-stationary	Stationary	Non-stationary
Climate Change Impact	Not certain	N/A	Increasing risk
Exposure Changes	Increasing	Stable	Rapidly Increasing
Human influence on hazard	Limited	Limited	Significant (Urbanization etc)

Flood Underwriting/Risk Management

- Traditional Approach: Primarily driven by Limit management in critical Flood zones
  - US:
    - FEMA Flood zone maps and derived products
  - International regions:
    - Locally developed flood maps
    - Vendor flood models in certain European countries
  - Pricing of risk relatively unsophisticated for a CAT risk
    - Typically based on the Flood zone, subject to minimum ROLs.
    - Engineering provides input for Loss Estimates for select locations
    - U/W guided by an exhaustive list of considerations/recommendations
  - Portfolio management done mainly through accumulation monitoring in certain hydro-geographic areas
- Key Areas for consideration
  - Are the Flood zones reliable/stable? Is Zone B the new Zone A? For instance Mobile, AL was not an SFHA pre-H. Katrina
  - How is urban flooding and non -SFHA flood handled? – majority of losses occur outside designated flood zones?
  - Are the SFHA rates adequate?
  - Portfolio Risk Accumulation and the marginal impact of a risk is not adequately handled
  - Flood damage/loss characteristics are not explicitly quantified
    - Impact on contents
    - Impact on BI or CBI due to long duration floods

An Ideal Flood Model



Summary

- Recent large flood losses have led to the recognition of flood as a key CAT peril
  - No longer a secondary or attritional peril that can be covered for almost free
- An increasing trend is observed in Riverine, Coastal and Urban Flood risk, driven mainly by
  - Exposure increases
    - Assets, Business complexity, Insurance penetration
  - Urbanization/Landscape changes
  - Climate Change
- Flood risk management needs better CAT models, that can handle
  - The complex interplay between hydrography, landscape changes, human influence and meterological/climatological factors.
  - The uniqueness of flood induced vulnerability