INTEGRATING MARINE RISK INTO A VIEW OF CATASTROPHE EXPOSURE

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March 17, 2015

AGENDA

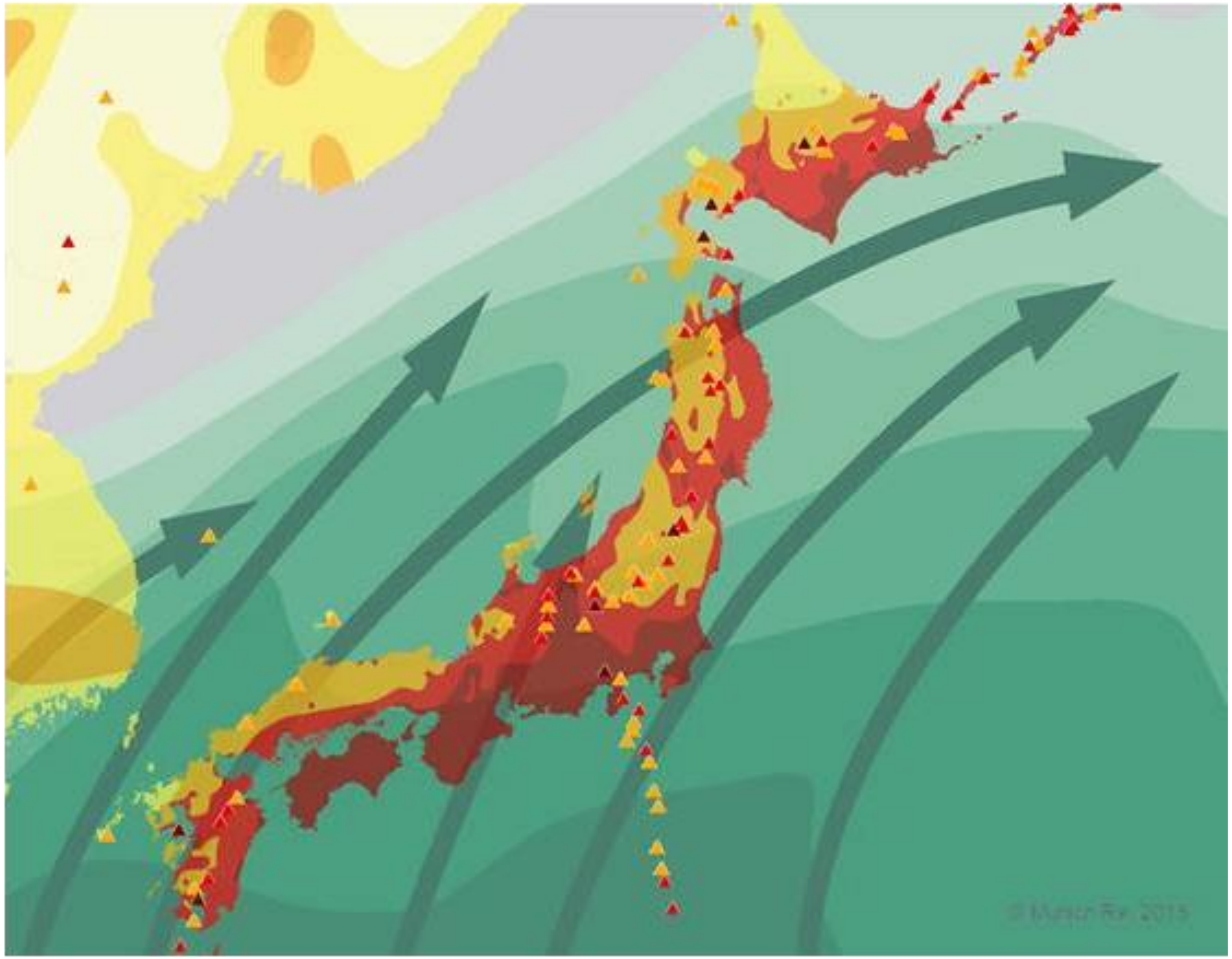
- Overview of RMS & catastrophe modeling
- Impact of Hurricane Sandy on the Marine Industry
- Potential resulting benefits to the Marine Insurance industry
  - Data standardization
  - Exposure accumulation capabilities
  - Loss modeling
  - Formulating a holistic view of Cat risk across Marine and other lines of business
- Potential applications to the Maritime industry
- Discussion

RMS BACKGROUND

RMS is the world's leading provider of products and services for the quantification and management of catastrophe risk

- Work with most major insurance and reinsurance companies in US & Europe
- $2 trillion worth of insurance and capital markets transactions based on RMS Risk Models
- Trusted by regulators and rating agencies for over 20 years
- RMS catastrophe risk models used for rated capital market transactions

CATASTROPHE RISK IN JAPAN



Legends

Earthquake	
Zone 0: MM V and below	
Zone 1: MM VI	
Zone 2: MM VII	
Zone 3: MM VIII	
Zone 4: MM IX and above	

Probable maximum intensity (MM: modified Mercalli scale) with an exceedance probability of 10% in 50 years (equivalent to a „return period" of 475 years) for medium subsoil conditions.

Volcanoes
No hazard*
Zone 1: Minor hazard
Zone 2: Moderate hazard
Zone 3: High hazard

*Secondary effects that can occur as a result of the large-scale distribution of volcanic particles (e.g. climate impacts, supraregional ash deposits) are not considered.

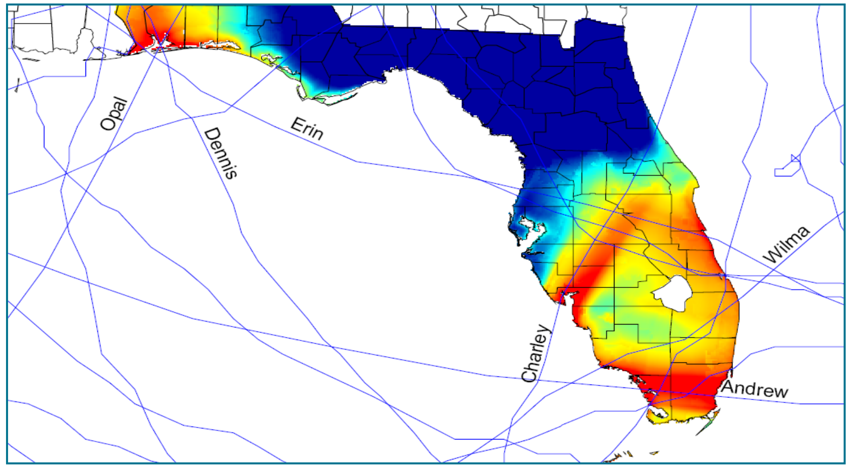
Tropical cyclone			
Peak wind speeds			
No hazard: < 76 km/h			
Zone 0:	76	–	141 km/h
Zone 1:	142	–	184 km/h
Zone 2:	185	–	212 km/h
Zone 3:	213	–	251 km/h
Zone 4:	252	–	299 km/h
Zone 5:		≥	300 km/h
Typical track directions			

Probable maximum intensity with an exeedance probability of 10% in ten years (equivalent to „return period" of 100 years).

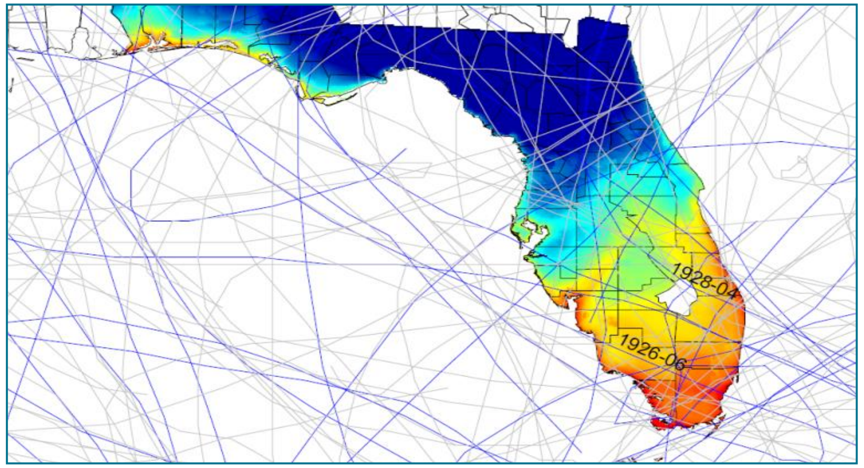
Source: *NATHAN - Worldmap of Natural Hazards, Munich Re*

WHY STOCHASTIC MODELING?

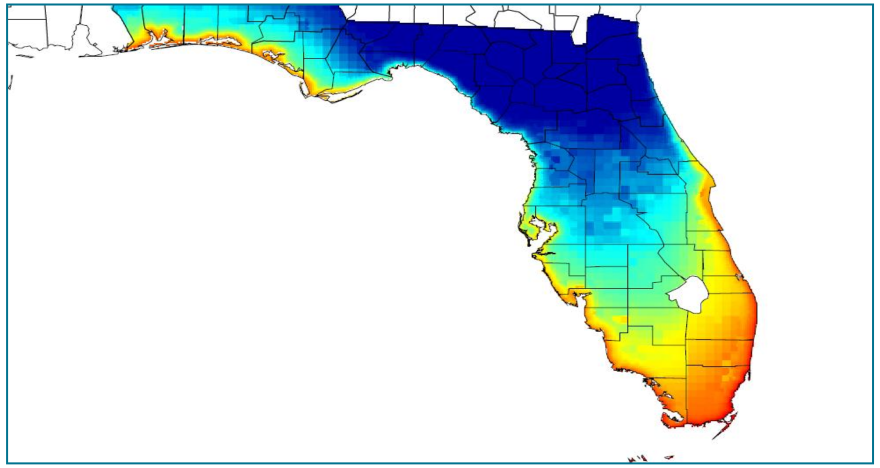
15 yrs of historical data



100 yrs of historical data



100,000 yrs of stochastic model



Common mistake: assume the worst observed historical event is the "worst case" and make mitigation plans accordingly

EXAMPLE: HURRICANE MODEL FRAMEWORK

Define Hurricane

Stochastic Event Module

Assess Wind & Wave Hazard

Hazard Module

Apply Exposure

Geocoding/ Exposure Module

Calculate Damage

Vulnerability Module

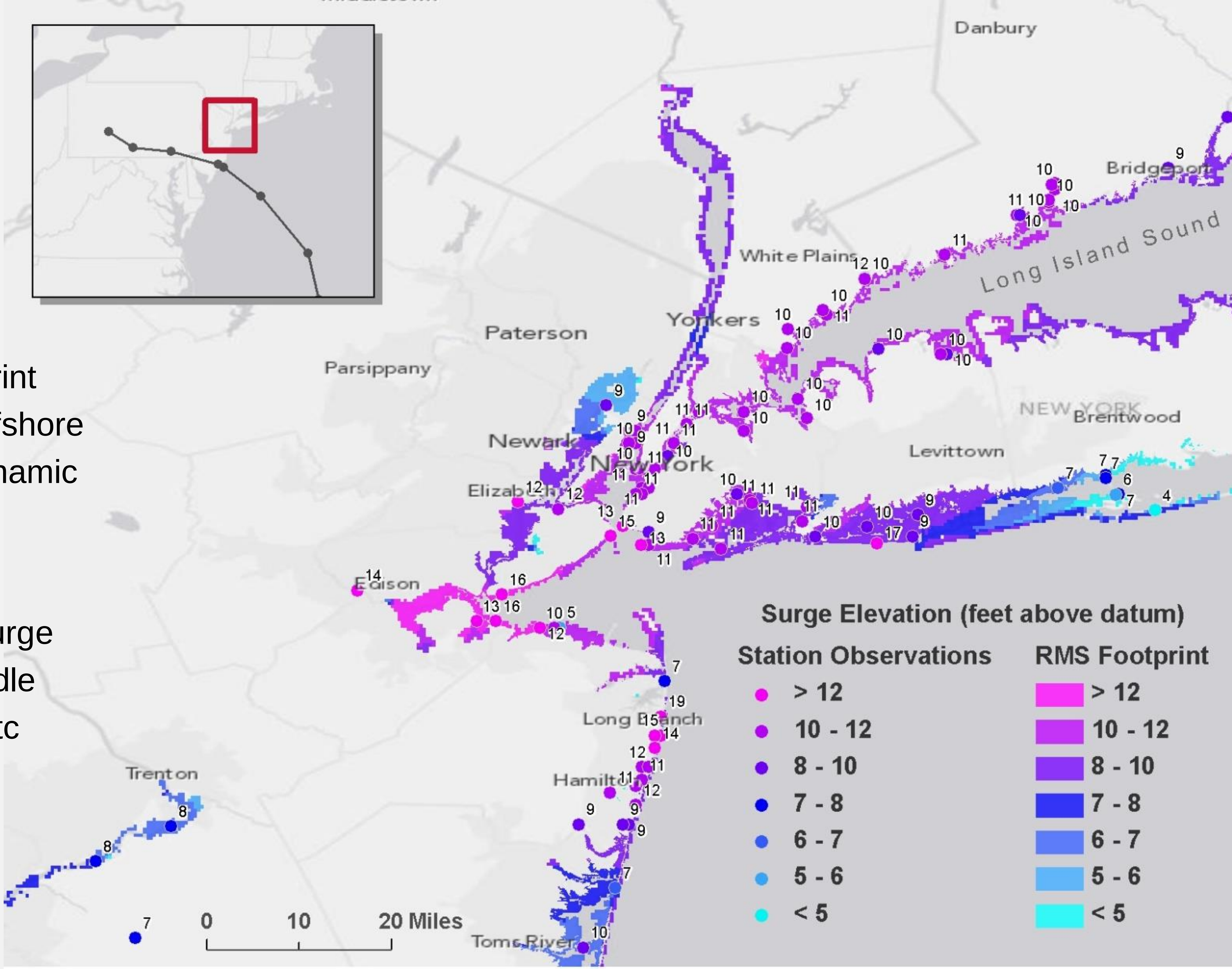
Quantify Financial Loss

Financial Analysis Module

RMS STORM SURGE FOOTPRINT FOR SANDY

Coastal surge height footprint based on time stepping offshore windfield and the hydro-dynamic model MIKE21

Traditional Cat modeling surge methodologies cannot handle complex inlets, estuaries etc around NYC



RISK MANAGEMENT DECISIONS

CAT MODEL OUTPUT SUPPORTS DECISIONS SUCH AS:

MARINE INSURANCE

- Quantification of Marine exposure aggregation
- Loss modeling for key perils under the spectrum of potential events
- Probabilistic loss modeling supporting
  - Capital requirements & reporting
  - Risk transfer
- Clash with non-Marine lines of business

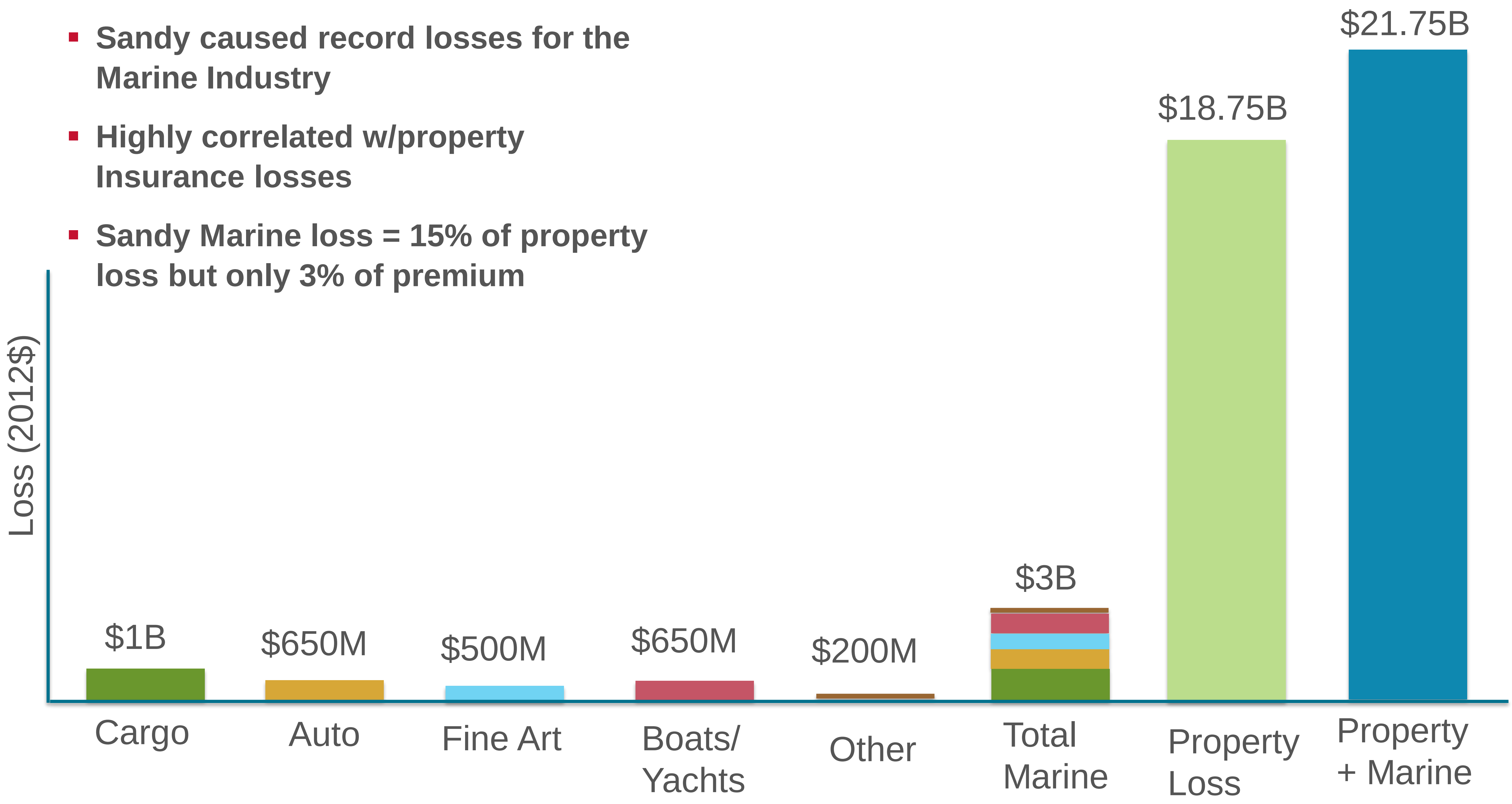
MARITIME OPERATIONAL RISK

- Analysis of port facilities
  - Risk of individual structures
  - Cargo risk
  - Risk of port downtime (frequency & severity)
- Correlation across ports in a given event
- Emergency planning (network risk)

IMPACT OF HURRICANE SANDY ON THE MARINE INDUSTRY

A TIPPING POINT FOR MARINE INSURANCE

- **Sandy caused record losses for the Marine Industry**
- **Highly correlated w/property Insurance losses**
- **Sandy Marine loss = 15% of property loss but only 3% of premium**



MARINE CAT RISK MANAGEMENT POST SANDY

WHAT HAS SANDY TAUGHT THE INDUSTRY?

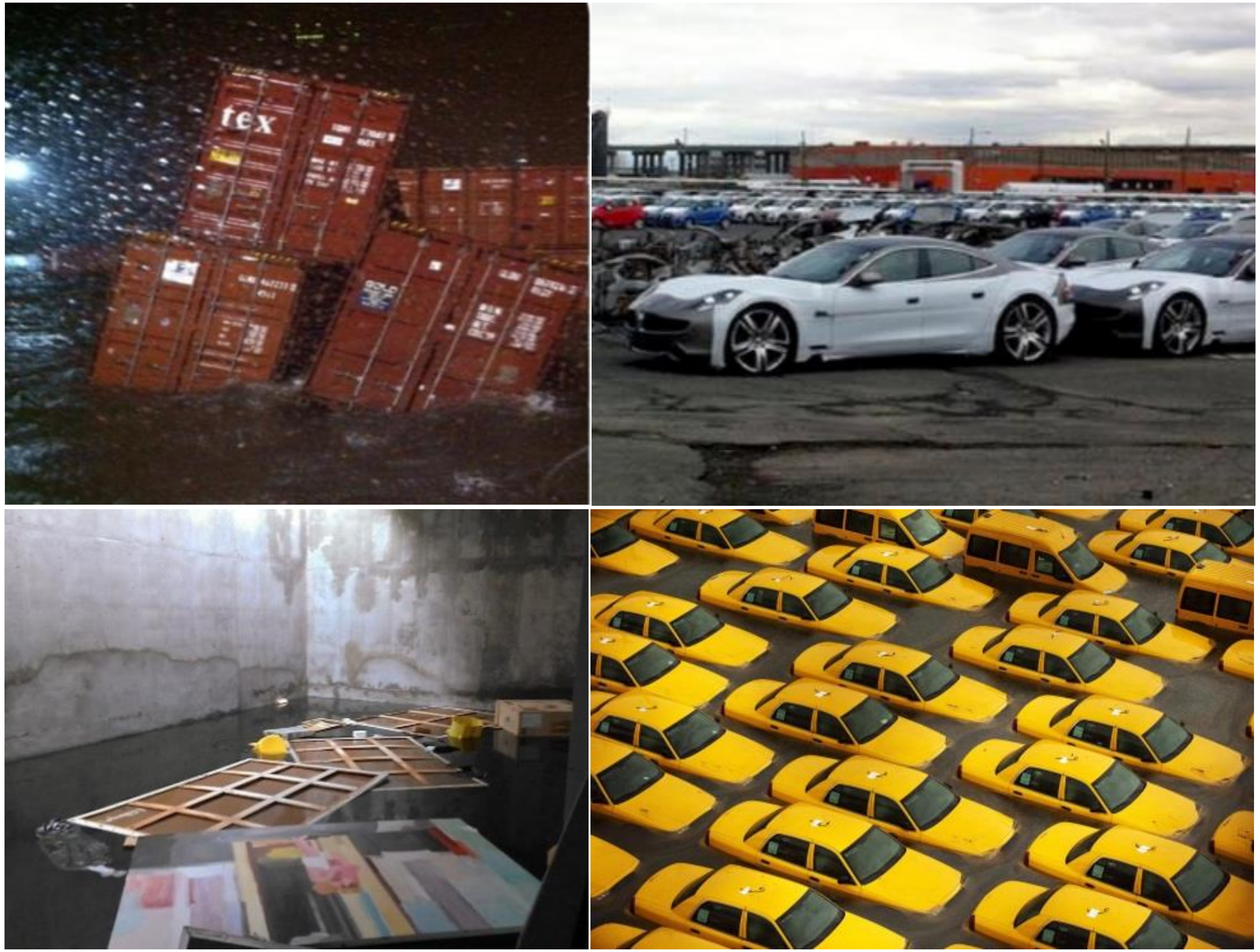
Marine business faces broad range of CAT Perils including:

- Wind
- Surge/flood
- Earthquake
- Tsunami
- Terrorism
- Hail

Effective Marine risk management entails analysis of multi-perils across multiple lines of business

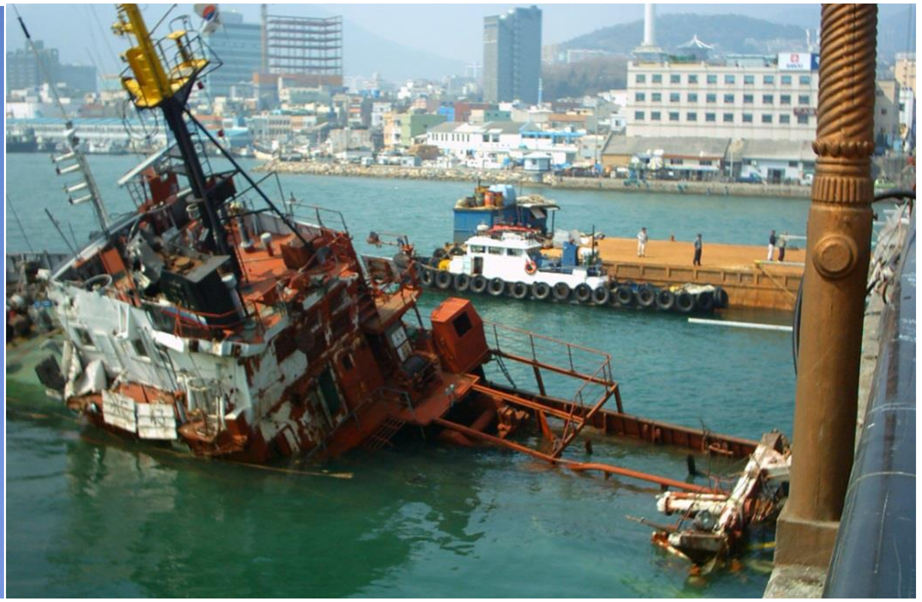
HURRICANE SANDY: 2012

- Hurricane Sandy caused a record $3B+ marine loss
  - Cargo loss $1B+. 15,000 TEU of loaded containers sustained damage
  - 3,000 truck chassis total loss
  - Over 100 miles of rail cars and chassis damaged
  - Cargo automobile: $650M (16,000 cars)
  - 65,000 boats/yachts damaged: $350M
  - Saltwater damage to port facilities
- Real-time mitigation efforts were focused on hurricane **winds** rather than **surge**
- Precautionary measures in art galleries and cargo container yards may have actually served to **increase** losses



TYPHOON MAEMI: 2003

- The most powerful storm on South Korea record
- Wrecked 11 cranes weighing 900 tons each
- Cargo capacity of the Busan port cut by 20%
- Capsized ships and ran others aground
- Wind turbines damaged extensively



KOBE EQ 1995

- First major quake in Kobe in 900 years destroyed Japan's top port
- Severe shaking and liquefaction in landfilled areas lead to collapse of piers & cranes, destruction of cargo warehouses and flooding of ground around stacked containers
- Multiple Japanese ports out of service for months
- Some port facilities operable, but connecting roads and rail were destroyed rendering port useless
- Severe congestion at alternative ports
- Over $3B/day in lost seaborne trade

TSUNAMI: TOHOKU EQ 2011

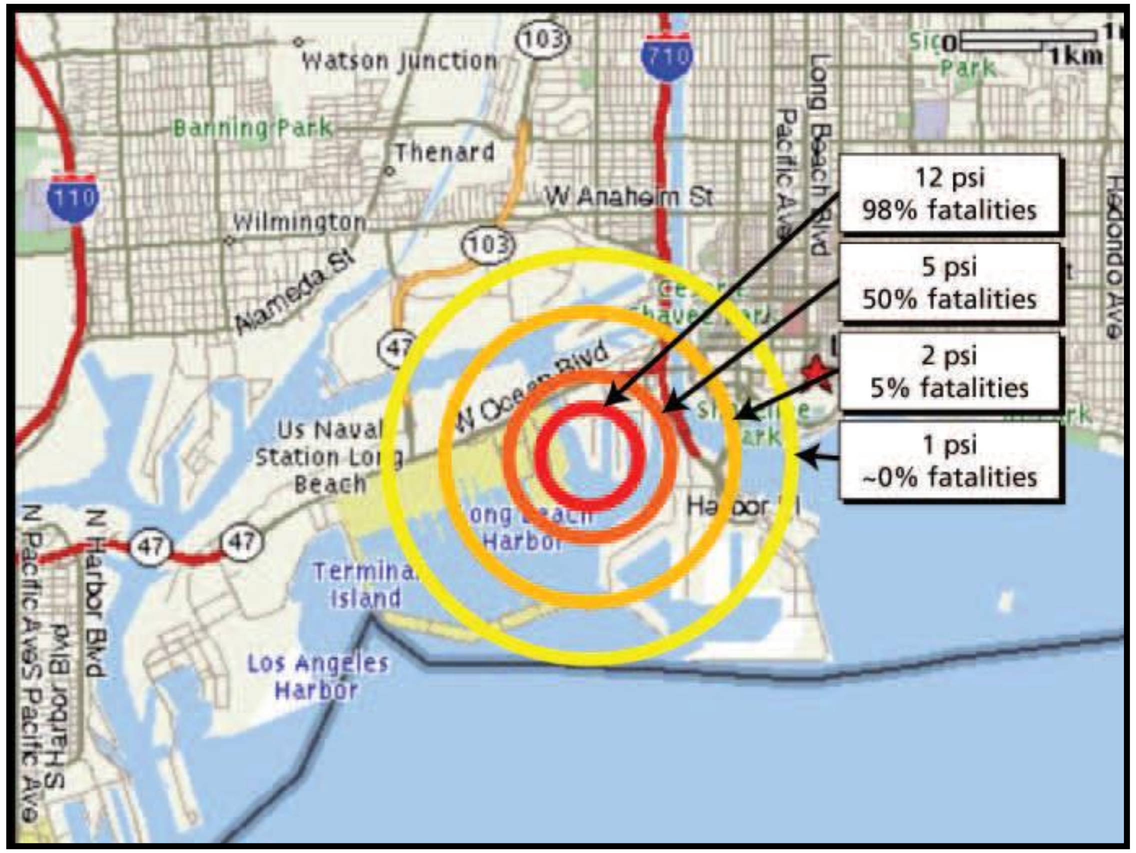
- At magnitude 9.0, the largest ever recorded in Japan and the fourth largest EQ in the World since 1900
- Resulting tsunami reached a max height of 15 metres and washed as far as 10km inland
- Port damage:
  - All Japan ports closed initially
  - 15 ports in damage area – reopened partially after 18 days
  - Tsunami height 5-15 meters in 7 ports
- “Most” boats in the impacted area were destroyed
- Damage to yachts & marinas in California over 500 miles away




TERRORISM ATTACK (HYPOTHETICAL)

- Port of Long Beach and Port of Los Angeles are totally destroyed by the blast and fire
- All ships, cargo and facilities destroyed
- Area uninhabitable for a period of years
- They account for approx. 30% of US shipping imports
- Following the attack the US likely to close ALL ports for a period of time to mitigate risk of follow-on attacks
- Financial & real estate interests will require terrorism insurance
- CBRN Terrorism coverage for ports will be unavailable
- Workers hesitant to go to work due to fear of attack

10 KT NUCLEAR BLAST AT PORT OF LONG BEACH*



Source: RAND "Considering the Effects of a Catastrophic Terrorist Attack"

RAISING THE BAR ON MARINE CAT RISK MANAGEMENT
THE RMS MARINE DEVELOPMENT AGENDA

MARINE CAT RISK MANAGEMENT CHALLENGES

MARINE CAT RISK MANAGEMENT IS FULL OF UNIQUE CHALLENGES:

- Marine covers a vast range of exposures
- Marine exposure is global in nature
- Marine business is susceptible to a wide range of Cat events
- Many marine exposures move around
- Some exposures fluctuate over time
- Data capture practices are typically inadequate to support risk analyses

DEVELOPMENT OF A COMPREHENSIVE MARINE DATA SCHEMA

STANDARDIZING MARINE RISK DATA CAPTURE

- Working with a steering group of industry leaders to define a standard Marine insurance data schema
  - Define all "realistically obtainable" data fields for category, value and location
- Capture all coverages and exposure categories
  - Both property and liability
- Standardizing the industry data capture practices will enable:
  - Use of new RMS Marine risk management technology
    - ✓ Exposure accumulation
    - ✓ Loss modeling
  - Enhanced Marine risk management practices
  - Enhanced information sharing between risk transfer parties
  - Consistent communication with regulators

Use of standardized data schema will facilitate risk transfer and enable more sophisticated risk management exercises

Build Industry Exposure Databases for Key Accumulation Locations

BY LINE, BY CATEGORY, BY PERIL

- Identify the top global locations of potential Marine exposures
  - Ports
  - Warehouses
  - Marinas
  - Museums
- Compile relevant information on location
  - Address
  - Elevation
  - Construction & protection characteristics
- Estimate value at risk in the location
  - Average value on site
  - Seasonal fluctuation
  - Cargo/Marine category (vulnerability type)

Identify & quantify potential sources of concentration risk and correlate with property exposures

Develop Specialized Vulnerability Curves

- Review event loss data to determine the different applicable vulnerability classes of cargo and the elevation at which different cargo categories were stored
- Use claims data and engineering to refine vulnerability curves
  - Cargo: eg: auto, electronics, perishables, other
  - Fine art
  - Specie
  - Port facilities
- Differentiate vulnerability curves by peril
  - Wind
  - Tornado/Hail
  - Surge/flood/tsunami
  - Earthquake
  - Terrorism

Model losses at key locations and analyze correlation with property losses

POTENTIAL REGIONS FOR FUTURE DEVELOPMENT

Expand Coverage of RMS Offshore Energy Models

- Evaluate all worldwide offshore platform exposure concentrations
- Identify the relevant perils for each region
- Explore the engineering resilience standards of the facilities in that region
- Potential to use hazard scenarios
- Identify what would be needed to generate the appropriate probabilistic hazard fields for that region
- Capture all the relevant OP coverages that could be affected by a loss event
- Show how these coverages would be modeled alongside one another – ie how damage to the platform links with removal of wreckage, redrilling of wells, BI etc.
- Plan for how this new functionality will be made available in RMS(one).

Perform comprehensive risk assessment of Offshore Energy book

INDUSTRY STUDY: MARINE CAT RISK

Raise Awareness of Marine Cat Risk

- For select key ports worldwide
- Identify principal hazards at key return periods
- Identify critical elevations of port facilities and cargo storage
- Identify typical exposures in that port
- And the potential for loss accumulations affecting multiple ports
- Explore the potential overlaps between property Cat and marine risks
- And supply chain risks linked to the disruption from that port.
- Explore in detail five significant marine loss Cat scenarios

Raise Industry awareness of the magnitude of Marine Cat risk and the best practices to manage the risk

Improving Cat Risk Management:

A Recap

KEY STEPS FOR IMPROVED RISK MANAGEMENT

- Expanded breadth and accuracy of Marine data capture
- Estimate potential aggregations of mobile exposures at ports, warehouses, marinas, museums, other.
- Loss modeling of Marine portfolio (deterministic/probabilistic)
- Look at possible correlation across multiple key locations (eg 2 ports that could be damaged by the same event)
- Develop a holistic view of Cat risk
  - Clash within Marine sub-lines
  - Clash of Marine with Property and possibly other lines of business

MARITIME APPLICATION OF MARITIME TECHNOLOGY

Applications to Maritime Risk

MARITIME RISK MANAGEMENT

Cat models can help improve current Maritime risk management in a variety of areas

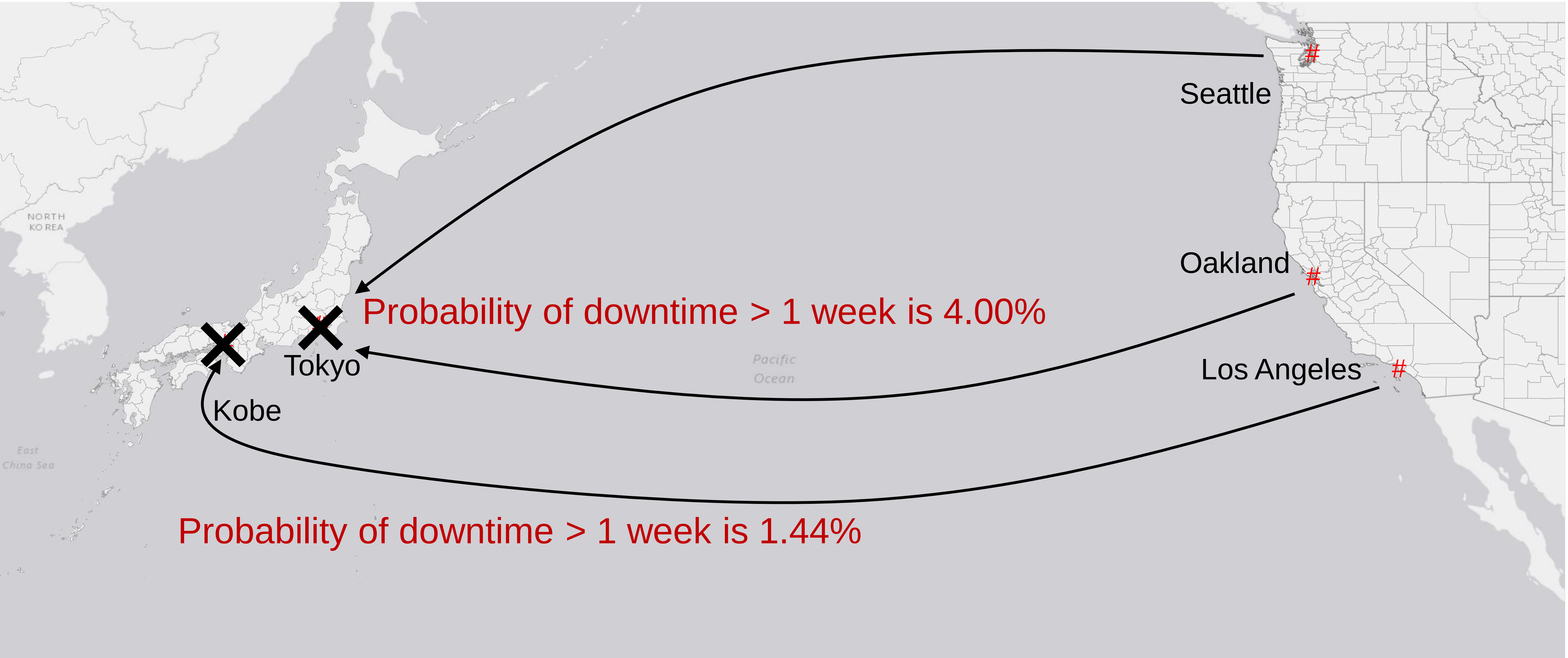
- Understand the types of perils each port is susceptible to and make mitigation plans accordingly
- Quantify the likelihood and possible length of a port closure due to natural catastrophe
- Identify the cargo storage facilities at high risk of damage from Cat event
- Quantify the correlation of risk across ports in a single Cat event
- Assist in formulating contingency plans

OPERATIONAL RISK PLANNING

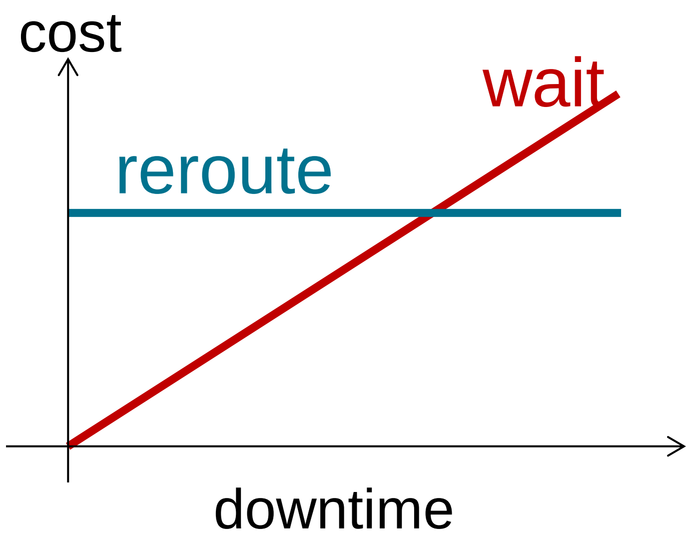
TYPHOON	Probability (Downtime ≥ X)			Average Downtime (days)
	1 day	1 weeks	1 month	
Tokyo	0.84%	0.24%	0.04%	0.02
Yokohama	0.82%	0.23%	0.04%	0.02
Kobe	0.87%	0.28%	0.06%	0.03
Beijing	0.01%	0.00%	0.00%	7E-7
Shanghai	0.15%	0.05%	0.02%	0.0002
Hong Kong	0.28%	0.07%	0.02%	0.0002

EARTHQUAKE	Probability (Downtime ≥ X)			Average Downtime (days)
	1 day	1 weeks	1 month	
Tokyo	7.54%	4.00%	1.88%	1.06
Yokohama	7.74%	4.06%	1.88%	1.11
Kobe	2.66%	1.44%	0.64%	0.36
Beijing	1.08%	0.67%	0.36%	0.31
Shanghai	0.18%	0.10%	0.05%	0.04
Hong Kong	0.34%	0.22%	0.14%	0.08

OPERATIONAL RISK PLANNING



FAILURE OF DESTINATION PORT

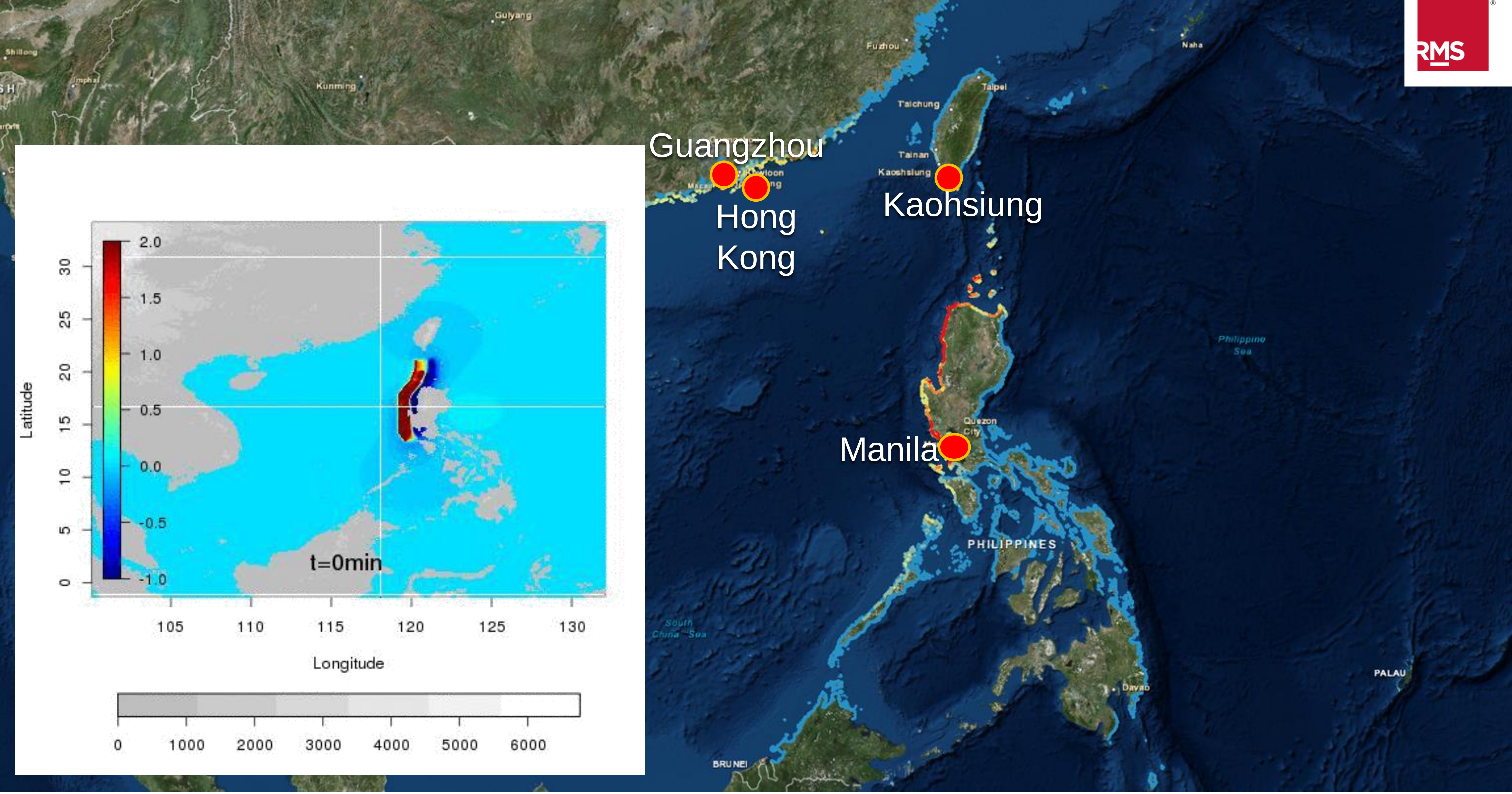


Additional Considerations

A comprehensive network analysis would also consider a range of factors including:

- Potential for multiple ports impacted
- Potential spoilage of cargo (do customers care)
- Capacity of alternative port(s)
- Potential damage to land route
- Uncertainty of port & infrastructure restoration times
- Other……


Guangzhou
Hong
Kaohsiung
Inundation depth (m)
0.1-1.5
1.5-3.0
3.0-4.5
4.5-6.0
6.0-9.0
> 9.0
MYANMAR (BURMA)
THAILAND
Kunming
Nanning
Hanoi
Taipei
Taichung
Tainan
Kaohsiung
Fuzhou
Bangkok
Rangoon
Mandalay
BRUNEI
PALAU
Philippine Sea
Davao


Guangzhou
Hong Kong
Kaohsiung
Manila
Taipei
Taichung
Tainan
Kaohsiung
Fuzhou
Kunming
Guiyang
Naha
Quezon City
PHILIPPINES
Philippine Sea
South China Sea
PALAU
Davao
BRUNEI
t=0min
Latitude
Longitude
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
105
110
115
120
125
130
0
1000
2000
3000
4000
5000
6000


Guangzhou
Hong Kong
Kaohsiung
Manila
MYANMAR (BURMA)
LAOS
VIETNAM
THAILAND
CAMBODIA
PHILIPPINES
HAINAN
BRUNEI
PALAU
South China Sea
Philippine Sea
Inundation depth (m)
0.1-1.5
1.5-3.0
3.0-4.5
4.5-6.0
6.0-9.0
> 9.0

THANK YOU!

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CATASTROPHE RISK MANAGEMENT FOR MARINE RISKS

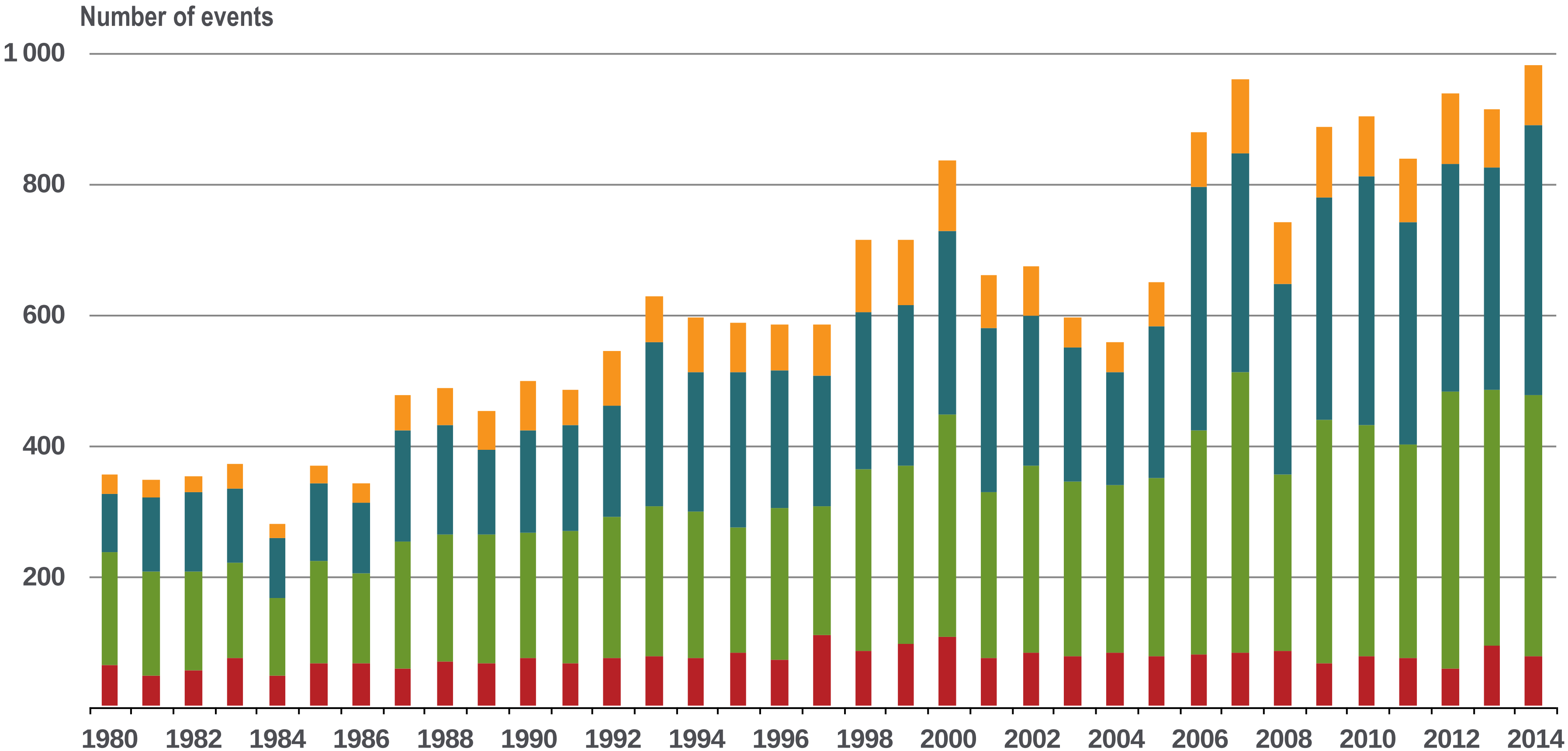
RICHARD SANDERS - Willis Re (Singapore)

17th Mar 2015

Introduction

- Natural Catastrophe events and losses
- Natural Catastrophe in SE Asia
- Natural Catastrophe risk to marine – in particular to Marine Cargo
- Recent significant events
- Key Marine Cargo modelling issues
  - Containers
  - Non container cargo
  - Vehicles
- Tsunami Risk

Loss Events Worldwide 1980 – 2014



Source: Geo Risks Research, NatCatSERVICE – As at January 2015

Geophysical events (Earthquake, tsunami, volcanic activity)

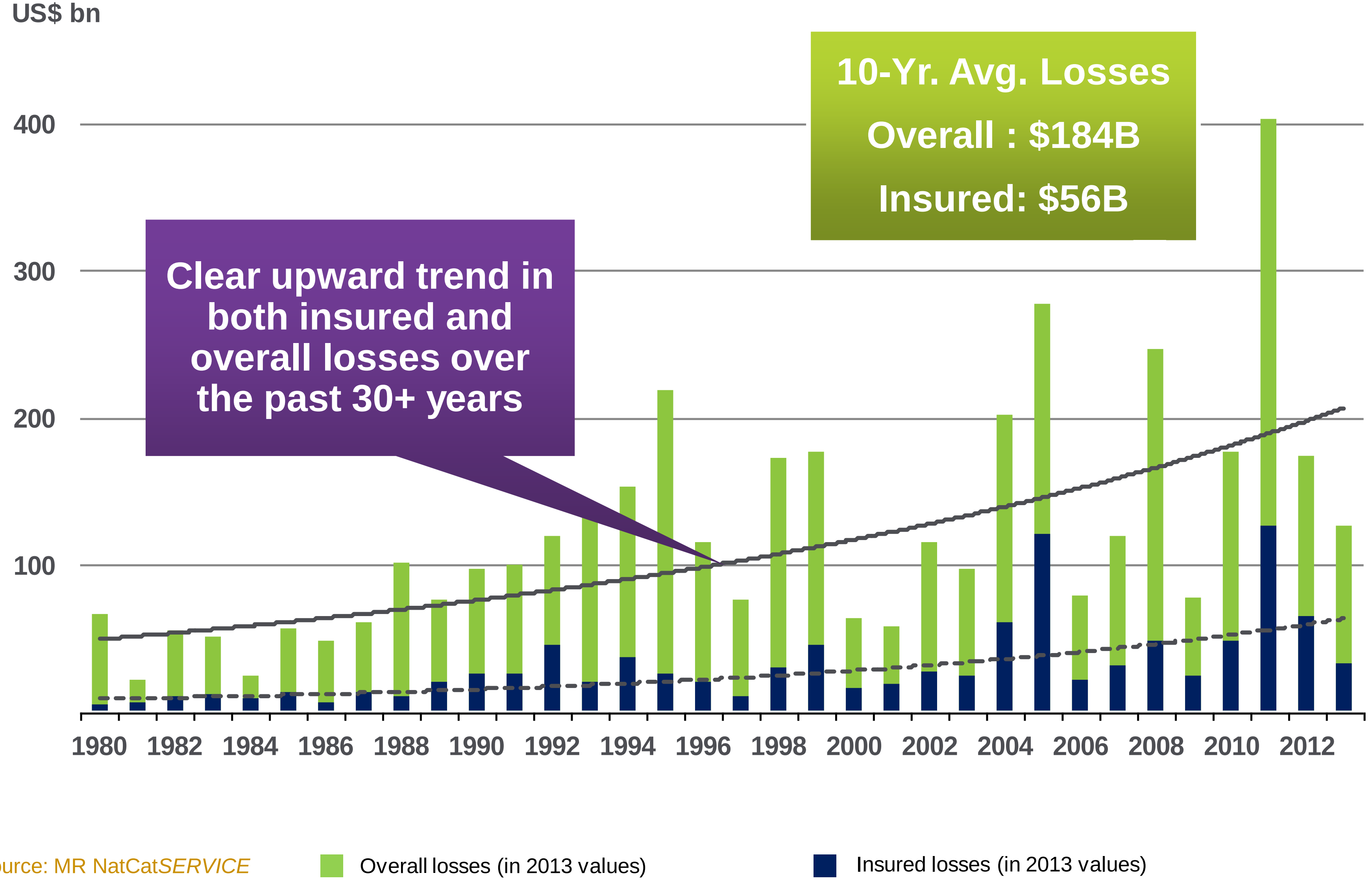
Meteorological events (Storm – tropical, convective, local etc.

Hydrological events (Flood, mass movement)

Climatological events (Extreme temperature, drought, forest fire)

Global Losses Due to Natural Disasters, 1980–2013

MANAGING EXTREMES Willis Re



Source: MR NatCat*SERVICE*

Natural Catastrophe Risk in Asia/Pacific

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- “countries in Asia and the Pacific are more prone to natural disasters than those in other parts of the world”
- “people in the region are four times more likely to be affected by natural catastrophe than those in Africa and 25 times more vulnerable than Europeans or North Americans”
- “generated one quarter of the world’s gross domestic product (GDP)”;
  - “accounted for 85 per cent of deaths due to natural disasters globally”
  - “accounted for 42 per cent of global economic losses due to natural disasters”

Asia-Pacific Disaster Report 2010 – United Nations Economic and Social Commission for Asia and the Pacific and the United Nations International Strategy for Disaster Reduction

Natural hazards in Asia

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Conventional view of risk from natural catastrophe in Asia

Territory	Earthquake	Windstorm	River flood	Flash flood overland flow	Coastal flood	Tsunami	Volcano	Other
China	Extreme	Extreme	Extreme	Extreme	Extreme	High	Low	Sandstorm, freeze
Hong Kong	Low	Extreme	Low	High	High	Medium	Low	
Indonesia	Extreme	Low	Extreme	Extreme	High	Extreme	Extreme	
Korea S.	Low	Extreme	Medium	Medium	High	Medium	Low	Freeze/Snowstorm
Malaysia	Low	Low	Low	High	Low	High	Low	
Philippines	Extreme	Extreme	Extreme	Extreme	Extreme	High	Extreme	
Singapore	Low	Low	Medium	Medium	Low	Medium	Low	
Taiwan	Extreme	Extreme	High	Extreme	High	Medium	Medium	Landslide
Thailand	Low	Low	Extreme	Extreme	Low	Extreme	Low	
Turkey	Extreme	Low	High	High	Low	High	Medium	
Vietnam	Low	Extreme	High	Extreme	High	Medium	Low	

Natural hazards - marine

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Conventional view of risk from natural catastrophe in Asia

Primary Peril	Secondary Peril	Falling from stack	Disruption of port	Fire damage	Water damage
Earthquake	Shaking	High	High	Zero	Low
Earthquake	Fire following	Low	High	High	Medium
Earthquake	Tsunami	High	High	Low	High
Earthquake	Liquifaction	Medium	High	Low	Low
Flood	Storm surge	Medium	High	Low	High
Flood	River	Medium	Medium	Low	High
Flood	Flash	Medium	Medium	Low	High
Windstorm		High	Medium	Low	Medium
Freeze		Zero	Medium	Zero	Low

Major Flood Events; Thailand 2011

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Malaysian Flood Dec 2014

Tohoku earthquake and tsunami

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- Global businesses have suffered as a result of massive supply chain disruptions.
- The disasters caused an estimated $35 to $40 billion in insured losses
- Call on insurers to deliver broader and deeper business interruption coverage, covering both property damage and non-property damage related perils.

PHOTO CREDIT: REUTERS/KYODO Kyodo

Super Storm Sandy

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- Sandy is a unique storm but not the worst case scenario for the Northeast or New York.
- Sandy is one of very few storms that made landfall perpendicular to the Northeast's coast. In general, storms in the Northeast have tracks going from southwest to northeast.
- Intense wind speeds exist on the right-hand side of the storm track in the hurricane wind field. Therefore, for a majority of historical storms the high winds are on the ocean side where there is no insured property exposure.
- A storm with the 1938 New England hurricane strength on a path like Sandy could be a major windstorm event for the insurance industry in the Northeast. Property loss from the wind component of this hurricane scenario would be significant and could impact high value commercial buildings in the New York and New Jersey metro areas.

- It would be useful for effective catastrophe risk management to look at alternative scenarios that include: 1) Superstorm Sandy taking the 1938 storm path and 2) The 1938 New England hurricane taking the Sandy path (i.e. landfall perpendicular to the coast).

Super Storm Sandy

MANAGING EXTREMES Willis Re

- At the Port Newark-Elizabeth Marine Terminal, more than 16,000 vehicles were damaged by Sandy's tidal surge
  - Nissan scrapped 6,000 new cars and trucks, the most of any automaker,
  - Toyota is next with at least 4,825 vehicles damaged, most of which were scrapped

PORT AUTHORITY OF NEW YORK AND NEW JERSEY

Increasing catastrophe losses

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- Catastrophe losses continue to increase due to;
  - Increased property values
  - Increased insurance penetration
  - Accumulation of risks

  - Increased exposure/population/development in areas at risk
  - Increased vulnerability of structures?

  - Changes in hazard?
  - Climate change, sea level rise

Key issues for Marine Cargo risk analysis

- Key issues for Marine Cargo risk analysis
- Location
  - General location – where is the port
  - Specific location – where within the port
- Time at location
  - “Season” at location
- Description
- Value
- Vulnerability

Discussion on modelling containers

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- Value is entirely related to contents, and is difficult to estimate for aggregate information.
- Value may vary dependent on direction of journey, i.e SE Asia to US/Europe - high value manufactured goods, US/Europe to SE Asia – material for recycling.
- Contents may consist of perishables which will increase vulnerability and may suffer loss due to delays in transit
- In the event of a catastrophic hazard, contents may suffer from vibration, inversion, immersion, damp, pollution, temperature, pests/infestation
- Particular high value items (possibly fine arts and specie) will not be considered in any aggregate modelling

10 largest container ports 2013

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Rank	Port, Country	Volume 2013 (Million TEUs)	Volume 2012 (Million TEUs)	Volume 2011 (Million TEUS)
1	Shanghai, China	33.62	32.53	31.74
2	SIngapore,Singapore	32.6	31.65	29.94
3	Shenzhen, China	23.28	22.94	22.57
4	Hong Kong, China	22.35	23.12	24.38
5	Busan, South Korea	17.69	17.04	16.18
6	Ningbo-Zhoushan, China	17.33	16.83	14.72
7	Qingdao, China	15.52	14.5	13.02
8	Guangzhou Harbor, China	15.31	14.74	14.42
9	Jebel Ali, Dubai, United Arab Emirates	13.64	13.3	13
10	Tianjin, China	13.01	12.3	11.59

Singapore Container Accumulation

World Port Risk Analysis

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COUNTRY	PORT	PML				
		EQ	WF	River flood	Storm surge	Hail
Argentina	Buenos Aires	X%	X%	Med	Med	Med
Argentina	Buenos Aires	X%	X%	Med	Med	Med
Argentina	Buenos Aires	X%	X%	Med	Med	Med
Australia	Port Hedland	X%	X%	Med	Med	Med
Australia	Dampier	X%	X%	Med	Med	Med
Australia	Newcastle	X%	X%	Med	Med	Med
Australia	Hay Point	X%	X%	Med	Med	Med
Australia	Gladstone	X%	X%	Med	Med	Med
Australia	Brisbane	X%	X%	Med	Med	Med
Australia	Brisbane	X%	X%	Med	Med	Med
Australia	Melbourne	X%	X%	Med	Med	Med
Australia	Melbourne	X%	X%	Med	Med	Med
Australia	Sydney	X%	X%	Med	Med	Med
Australia	Sydney	X%	X%	Med	Med	Med
Australia	Sydney	X%	X%	Med	Med	Med
Austria	Vienna	X%	X%	Med	Med	Med
Bangladesh	Chittagong	X%	X%	Med	Med	Med
Belgium	Antwerp	X%	X%	Med	Med	Med
Belgium	Antwerp	X%	X%	Med	Med	Med
Belgium	Zeebrugge	X%	X%	Med	Med	Med
Belgium	Zeebrugge	X%	X%	Med	Med	Med
Belgium	Zeebrugge	X%	X%	Med	Med	Med
Belgium	Brussels	X%	X%	Med	Med	Med

(cyan)	Airport
(green)	Container Cargo
(yellow)	Non-Container Cargo
(orange)	Vehicle cargo

Risk Accumulation Process

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- Simple first-pass analysis
- Using averages for many parameters
- Using port specific data where published
- Using local/industry expertise
- Based on primary hazards only
  - Using "market" PML's

Port		Hong Kong
Annual Container Throughput		22,350,000
Average value of a container		75,000
Average number of days container held in port		3.5
Value of cargo in port at any one time		16,073,630,137
% insured in Asian market		100%
BOV uplift in cargo policies		10%
Insured value of Cargo any one time		17,680,993,151
Client Asian Market Share %		3.00%
Total Client Exposure		530,429,795
Plus uplift to cater for fluctuation		20%
Total Potential Client exposure		636,515,753
Hazard		**Typhoon**
100 yr loss as % TSI		3.50%
100 year Potential loss		22,278,051
Hazard		**Earthquake**
100 yr loss as % TSI		0.20%
100 year Potential loss		1,273,032

Location;
Enhancing Geocoding

MANAGING EXTREMES Willis Re

- Resolution of exposure data is a key factor in risk management
  - Exposure and risk accumulation
  - Modelling
- Ports are usually easy to locate, but warehouses etc. are very dificult
- Geocoding resolution has started to improve – particularly since Thailand 2011
- CRESTA zones have been updated – better match to Province etc.
- Some companies have started to collect Longitude/Latitude for key locations
- Postcodes are often an optimal first improvement
  - Still require disaggregation, and are often provided as centroids
  - Philippines postcodes not often/always used
  - Malaysia two digit postcode often provided as 5 digit e.g. 50000 used instead of 50100 etc.
  - P.O. Boxes and other non-spatial locations
- Also issues with risks geocoded to H.O. address and multi location policies

Average value of a container

MANAGING EXTREMES Willis Re

- Average value of a container has been obtained from various sources, including market knowledge, published information and client specific details
- This figure may differ depending on source/destination, business type, season, etc.
- High values would be expected for high-tech industry cargo, lower values for primary/extractive industry.
- Most important source is client
- More information on this will always be available.

Average number of days container held in port

MANAGING EXTREMES Willis Re

- This is related to annual throughput
- This may be affected by the type of port, i.e. this will differ between;
  - source
  - hub
  - destination
- This may also vary depending on local practices, e.g.
  - weekend working,
  - holidays
- It will also critically be affected by seasonality, related to:
  - Production
  - Markets
  - Climate

Other parameters

- The Asian (or other) market share will vary between ports and will require client input to validate the estimates.
- BOV uplift in cargo policies and uplift to cater for fluctuation are contingency factors.
- The clients market share is essential information, and may vary by region, port/location and cargo type. It may also vary by season etc.

- Where these values are not available from clients, Willis has considerable market experience, and also has access to all authoritative data sources worldwide.

Non container cargo

- The above methodology only considers cargo carried in containers and located at sea ports. It does not implicitly consider:
  - Airports (usually modelled with same methods, but with very different values for each parameter – usually, more volatile, higher values, more vulnerable particularly to wind)
  - Bulk materials (usually modelled with same methods, but with very different values for each parameter – usually, less volatile, lower values, less vulnerable)
  - Liquid cargo such as oil
  - Vehicles (see next pages)
  - Cargo on ships at sea/river or other transport while moving (use actuarial approach)

Motor vehicles – hazard and vulnerability

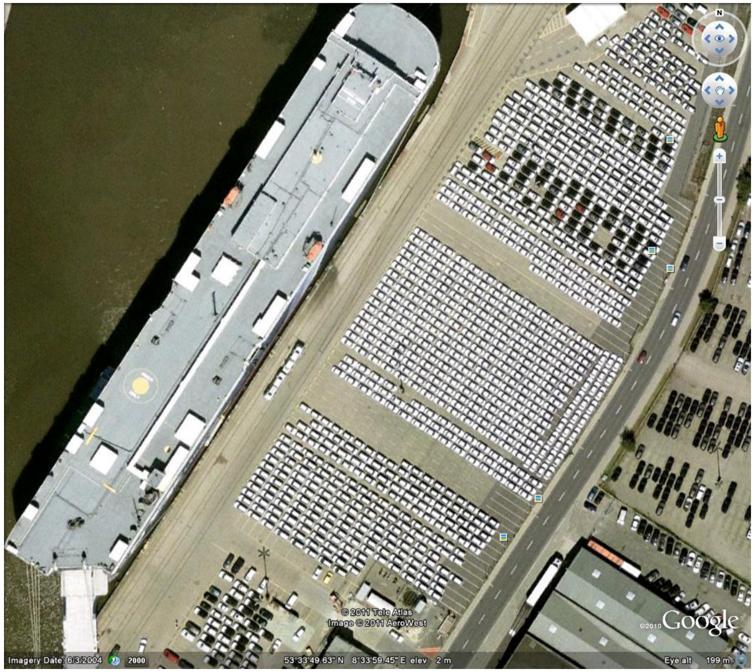
MANAGING EXTREMES Willis Re

- Motor vehicles at ports can be considered in a similar way to containers
  - Hazards are primarily Hail and Flood (coastal and river)
  - Vulnerability is very different to containers – vehicles have much higher vulnerability to hail and flood but less to wind and earthquake
  - Commercial model vulnerability curves are mostly not relevant as they do not apply to vehicles
  - Loss information is therefore critical
  - Coastal flood (salt water) is an issue in all sea ports but greater where there is associated wind hazard, i.e. European windstorms or hurricane
  - Tsunami needs to be considered
  - River flood is a hazard to many inland ports and some coastal ports.

Motor vehicles – exposure to flood

MANAGING EXTREMES Willis Re

- Motor vehicles are often stored on low value land
  - often not developed due to high historic flood risk
- Vehicles are often stored very close to one another – high velocity water (waves) can push vehicles together causing damage.
- Salt water inundation is very likely to cause 100% loss
- Dirty water inundation (sewerage, oil etc) is very likely to cause 100% loss
- Clean and fresh water damage may be dried out, but often duration of flood is critical
- Experience shows that affected vehicles may be destroyed by manufacturer to maintain reputation



Motor vehicles – exposure to hail

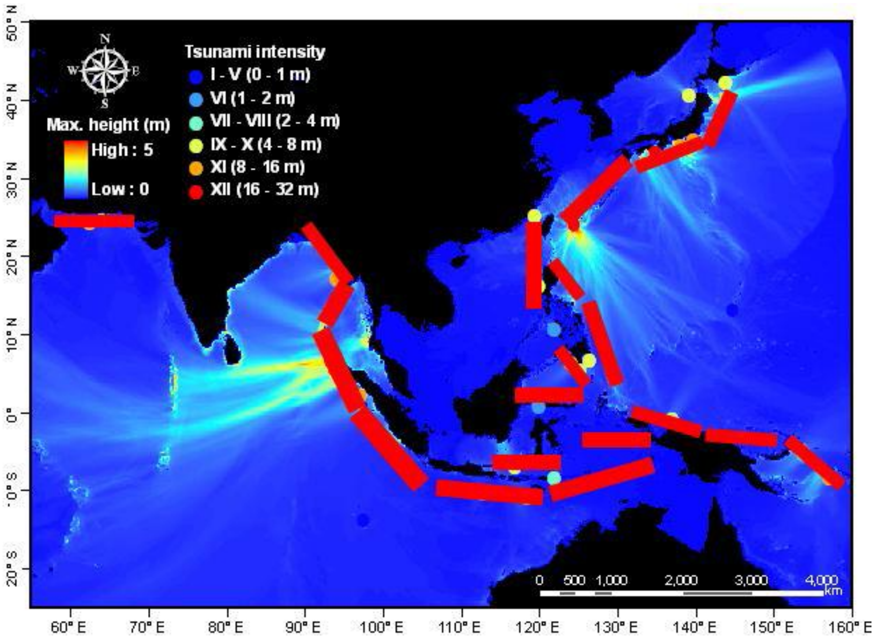
MANAGING EXTREMES Willis Re

- Hail damage can potentially damage all vehicles at a single site,
- May affect adjacent sites
- Hail damage can be repaired depending on intensity (usually hailstone size) but loss to multiple vehicles may lead to considerable loss amplification due to lack of repairers and shortage of spares
- Hail is seasonal and maybe considered location specific. Significant events are rare, i.e. Munich 1984 and Sydney 1999

WRN Tsunami research

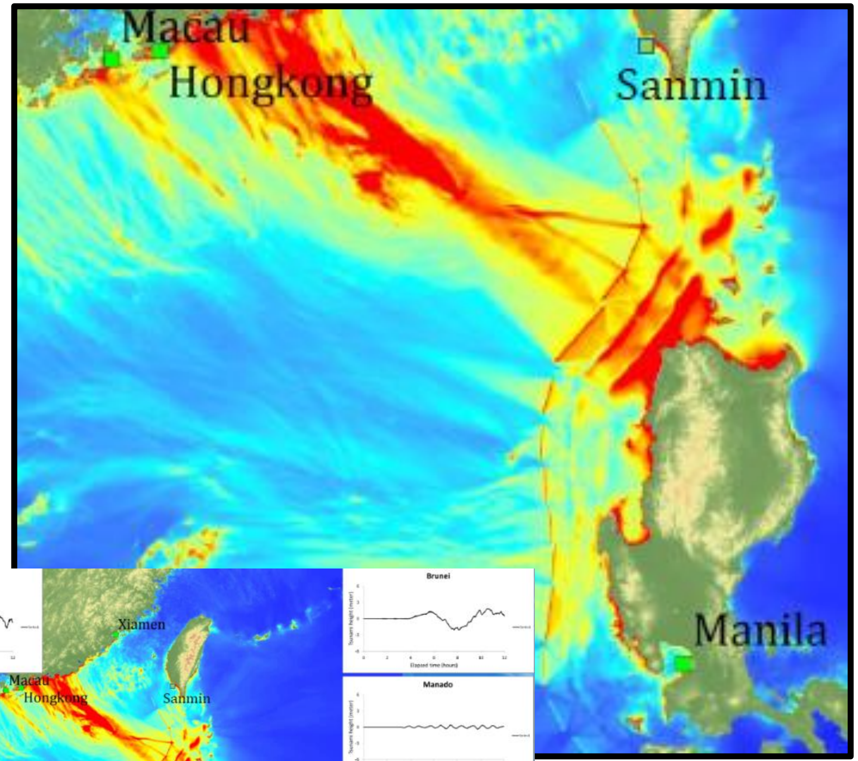
MANAGING EXTREMES

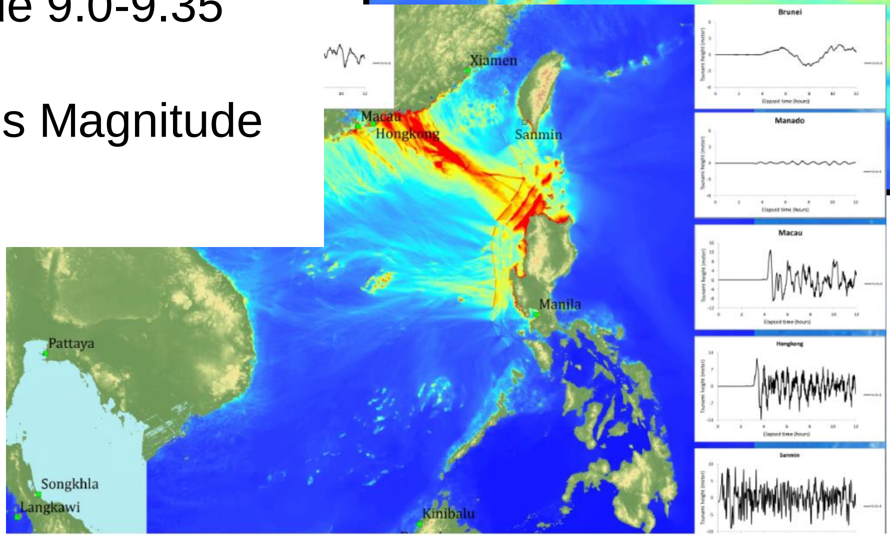
- WRN Senior Academic Prof Fumihaku Imamura, Disaster Control Research Center, Tohoku University, Japan
- Study started by analyzing tsunami generation rate from earthquake events
  - proposed index to determine the tsunami generation.
- Large scale tsunami hazard map based on historical events established
  - understand the background of tsunami impact in the past.
- Probabilistic Tsunami Hazard Analysis (PTHA) applied together with a scaling law to different tsunami sources from earthquake M7.6-9.0.
- Tsunami hazard maps from different events combined for the maximum and overlaid with global population.
- Tsunami risk level to coastal population in a tsunami inundation zone can be evaluated using a risk score.



Manila Trench

- One realistic event is modeled in this area,
- The fault consists of 33 segments covering the entire Manila Trench
- This segment is predicted from GPS data (Yu et al. 1999) and transferred into the slip estimation by Megawati et al. (2009)
- This segment can potentially generate a Magnitude 9.0-9.35 earthquake
- The modeled event is Magnitude 9.0



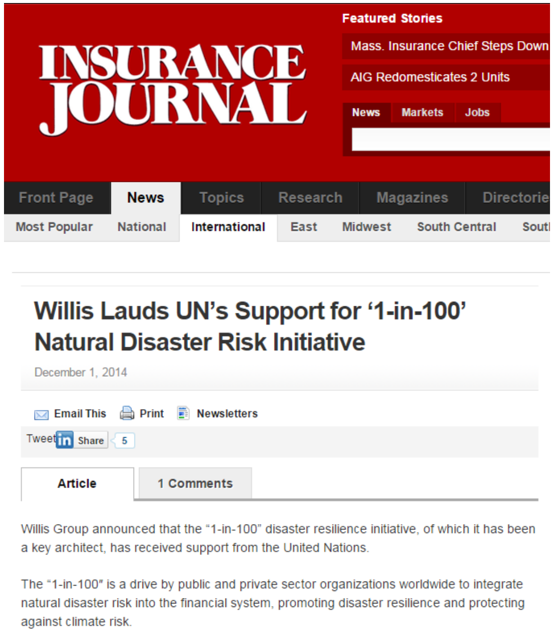


Appendix

The Future: 1-In-100 Initiative

MANAGING EXTREMES Willis Re

- **Context:** UN Climate Summit took place in New York in September
- **Objective:** Raise political momentum to reduce greenhouse gas and build resilience
- **Outcome:** 1-in-100 Initiative
  - Drive to integrate natural disaster and climate risk into financial regulation
  - 1 in 100 year solvency “stress test” evaluates the maximum probable annual financial loss that an organization, city, or region, could expect once in 100 years
  - Would enable management of risk in a more informed and effective way



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Willis Lauds UN’s Support for ‘1-in-100’ Natural Disaster Risk Initiative

December 1, 2014

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Willis Group announced that the “1-in-100” disaster resilience initiative, of which it has been a key architect, has received support from the United Nations.

The “1-in-100” is a drive by public and private sector organizations worldwide to integrate natural disaster risk into the financial system, promoting disaster resilience and protecting against climate risk.

- **Suggestion:** Companies listed on stock exchanges should publish their maximum probable annual losses to natural disasters against current assets and operations at:
  - *1 in 100 year return period*
  - *1 in 20 year return period*
  - *Annual Average Loss*
- Key ratios can then be developed to understand the relationship between these annualised risk corporates assets, annual earnings and other indicators
- Insurance industry will save millions of lives and livelihoods and billions of dollars in the decades ahead by integrating climate and disaster risk into the very heart of economic and financial decision making

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