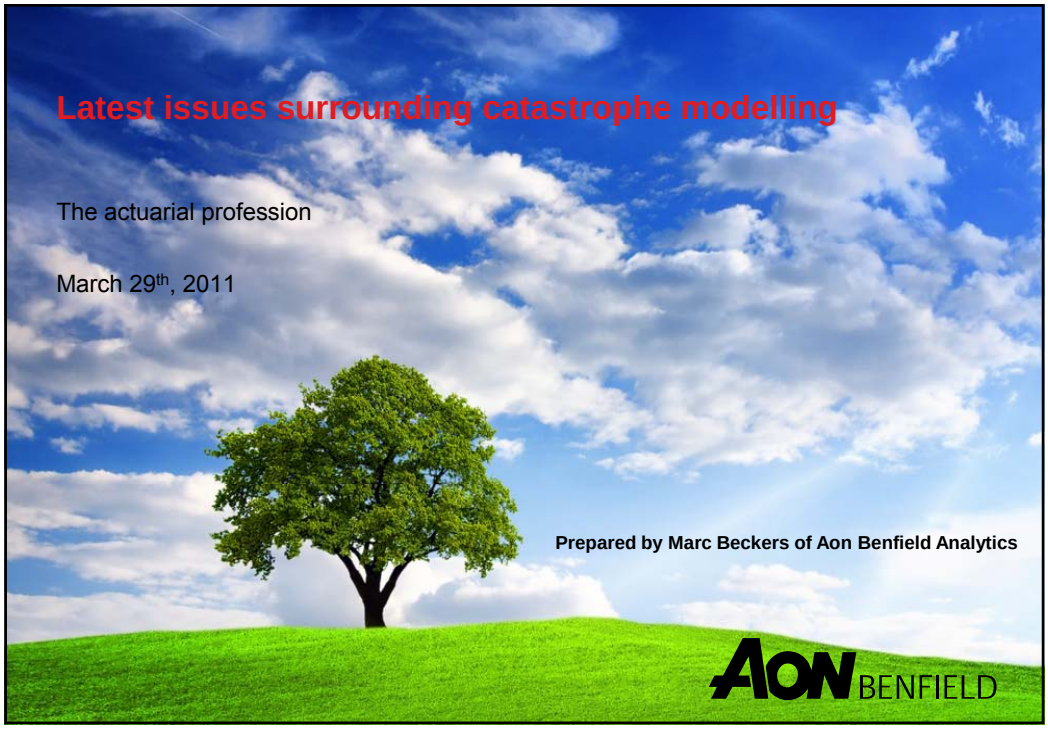

Topics for discussion

Section 1	The Science and Art of Cat Modelling
Section 2	Impact of Climate Change on Natural Catastrophes
Section 3	Death & Disability Catastrophe Risk
Section 4	Impact On Demand to Manage Catastrophe Risks
Section 5	Partial Internal Models for Catastrophe Risk

Section 1: The Science and Art of Cat Modelling

- Evolution of natural catastrophe losses
- The history of catastrophe models
- Lack of experience introduces significant volatility
- Historical results show rather large model misses
- Access to data is key !

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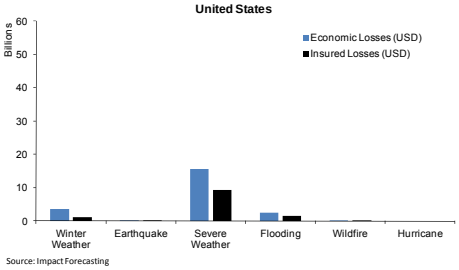
Global Catastrophe Activity indicates importance of the science

United States

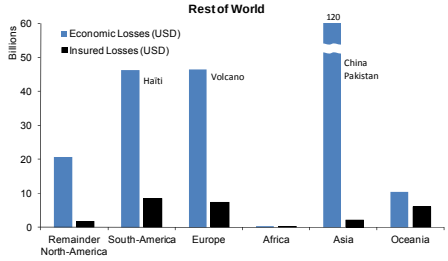
- Significantly higher severe weather and winter storm in the U.S. in 2010
  - At about 50% of average losses based on prior years
  - High hurricane activity, no hurricane losses



Source: Impact Forecasting

Rest of World

- Higher non-U.S. catastrophe activity in 2010
  - Economic losses were gargantuous in 2010 with insured losses at $26bn being more than twice as large as the U.S. 2010 insured loss

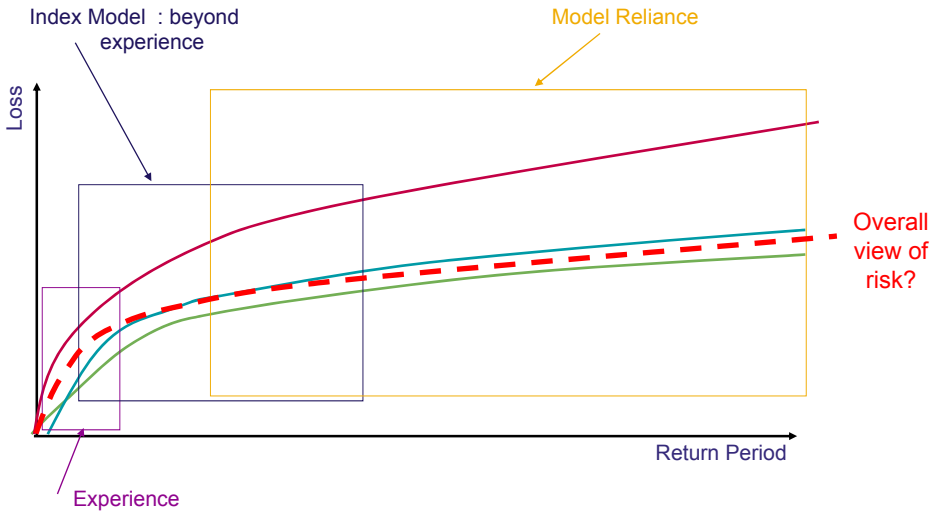


Source: Impact Forecasting

Catastrophe Modelling – A rather young science

- RMS (Risk Management Solutions)
  - Founded 1989
  - Owned by Daily Mail & General Trust
- AIR (Applied Insurance Research)
  - Founded 1987
  - Owned by Insurance Services Office
- EQECAT
  - Founded 1994
  - Owned by ABS Consulting
- Impact Forecasting
  - Founded in 1995
  - Aon Benfield subsidiary

Evaluate and Decide
Combining results, experience, knowledge

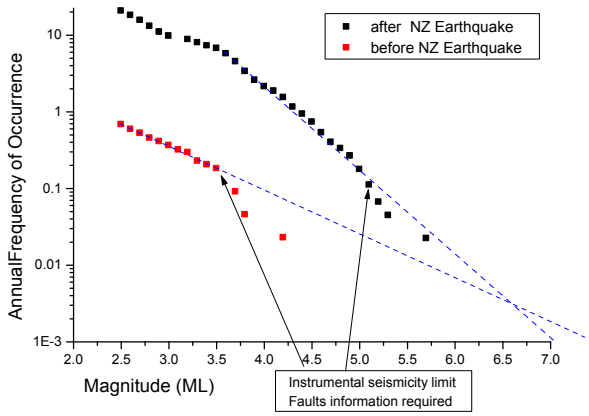


What is the value of frequency for catastrophe models?

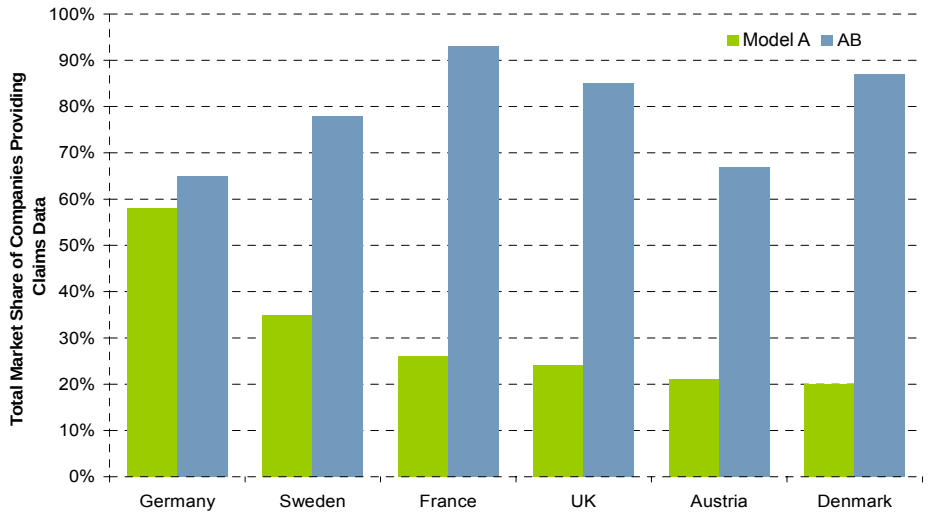
- Frequency of 1:200 does not mean much for EQ risks !
- New Zealand: a 1:1,000 event ?

  The second Christchurch earthquake occurred directly underneath the city on a fault that wasn't in any of the vendor models since it had not been previously identified !
- Japan ?

  Vendor models did not have relevant event in database. RMS took two events, averaged them and then added 30% to the result.



Eurowind Model 2010



Section 2: Climate Change and Natural Catastrophes

- Who believes that climate change will have a major effect on natural catastrophes?
- Increasing losses from natural catastrophes
- Normalising the results
- Stable number of cat events
- Loss of life due to tsunami risk can not be underestimated

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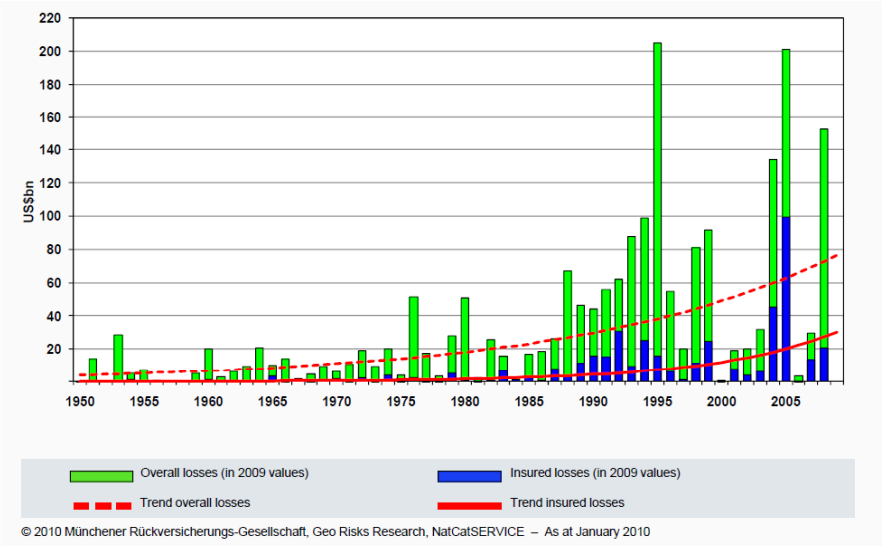
Munich Re data suggests an increase in the number of natural catastrophes…
…or is the data just much better today?



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1926 Great Miami hurricane would show $140-157bn losses today

Miami Beach 1926

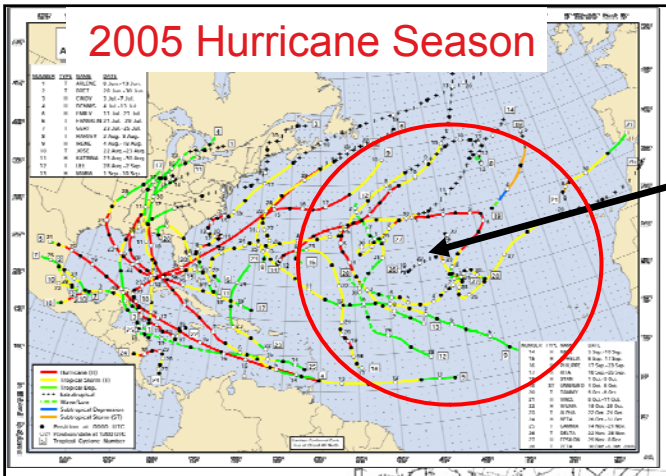
Wendler Collection

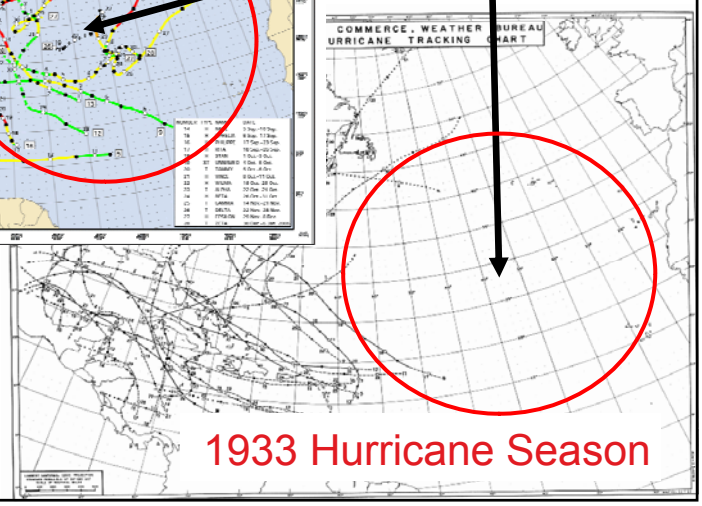
Miami Beach 2006

Joel Gratz © 2006

2005 Hurricane Season

Open Atlantic Ocean Differences

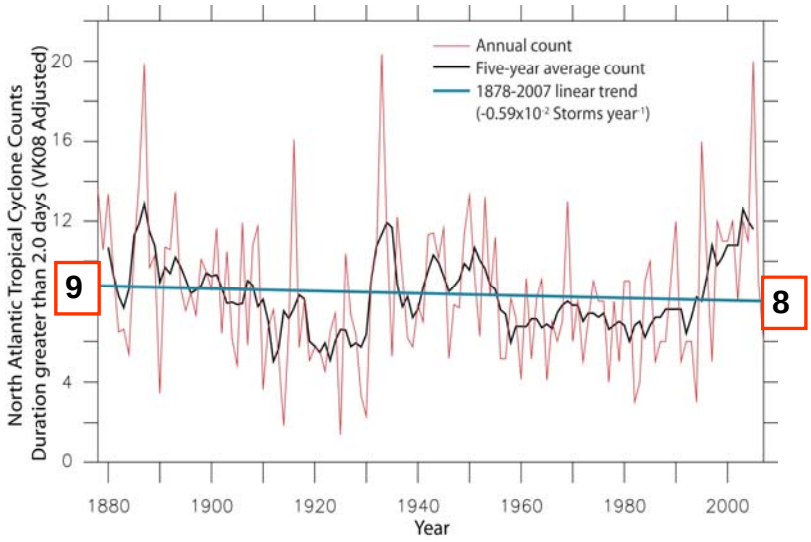




1933 Hurricane Season

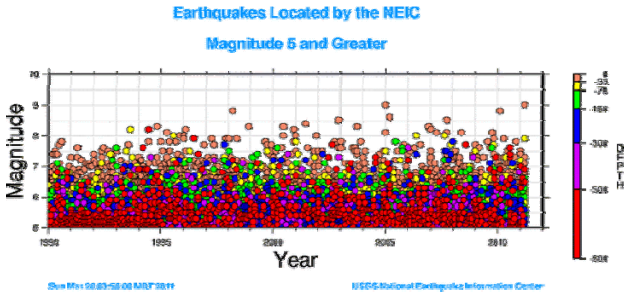
Tropical storm and hurricane events

Upward trend gone after adding in "Missed" and removing very short-lived cyclones



EQ activity worldwide fairly constant

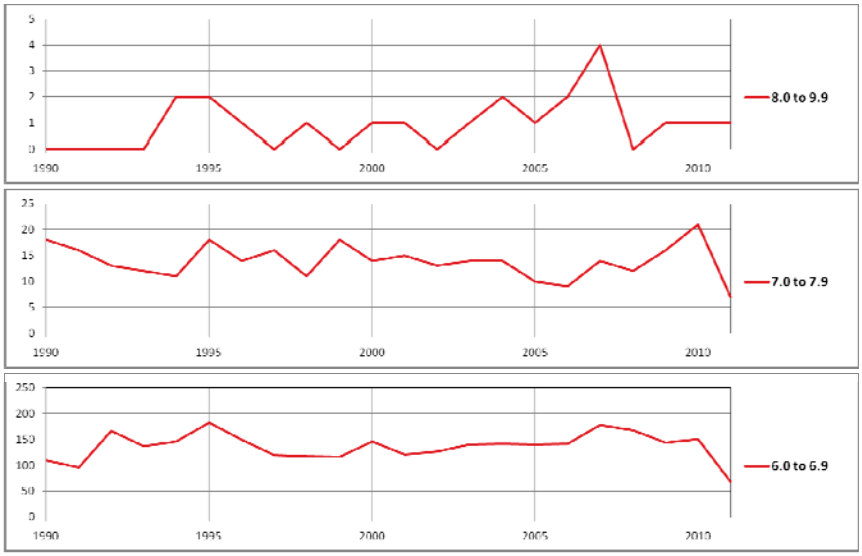
- There is no statistically significant increase in earthquake activity worldwide:



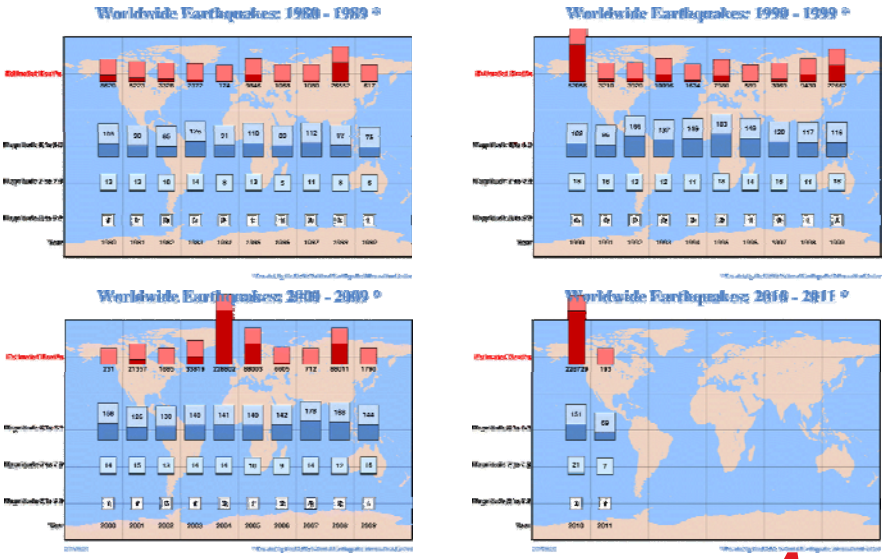
"According to long-term records (since about 1900), we expect about 17 major earthquakes (7.0 - 7.9) and one great earthquake (8.0 or above) in any given year. Although it may seem that we are having more earthquakes, earthquakes of magnitude 7.0 or greater have remained fairly constant. "

(Source: US Geological Survey, http://earthquake.usgs.gov/learn/topics/increase_in_earthquakes.php)

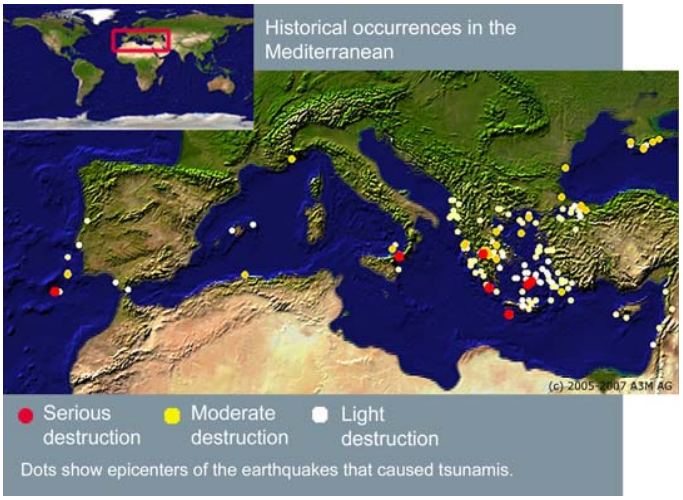
Stable pattern of EQ events occurring since 1990



Loss of life is a real risk although under-insured



Significant tsunamis have occurred in the Mediterranean Sea.



Source: Tsunami Alarm System
(http://www.tsunami-alarm-system.com/en/phenomenon-tsunami/occurrences-mediterranean.html)

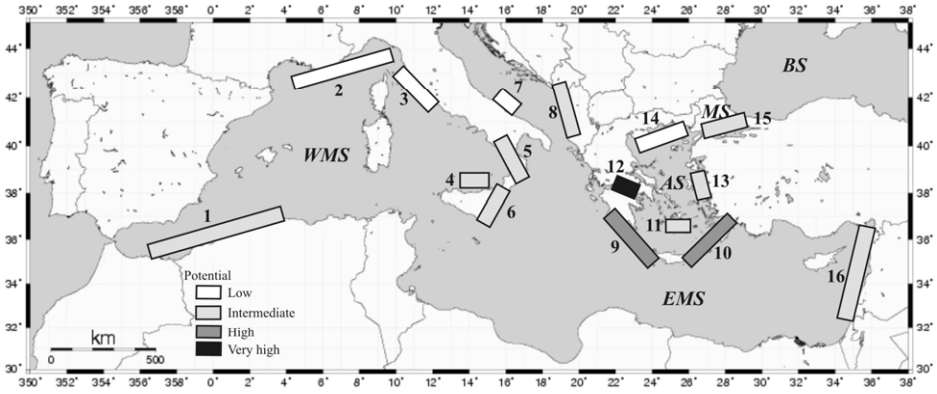
A long history of tsunamis in the Mediterranean Sea

29 events in the last 100 years with tsunamis ranging from 30cm to 15m

code	Zone	Number of events of different origin					Average period of repetition, years	Magnitude of earthquakes		Intensity of tsunami		Year of last tsunami	Probability of the next tsunami
		total	seismic	volcanic	landslide	unknown		M	average	average	imax		
SM	Sea of Marmara, Bosporus and Dardanelles	17	15	0	0	2	104	6.5 - 7.7	7.0	3.1	4	1999	M
NG	Aegean coast of northern Greece	5	5	0	0	0	22 (?)	6.2 - 7.0	6.6	2.4	3	1978	L
EG	Coast of eastern Greece	7	5	0	1	1	26 (?)	6.0 - 7.1	6.8	3.1	4	1956	H
AM	Mediterranean coast of Asia Minor	13	10	0	0	3	18 (?)	6.5 - 7.2	6.8	2.6	3	1961	H
AS	Aegean Sea	24	20	1	1	2	9	6.3 - 7.5	6.7	3.7	10	1991	H
HA	Hellenic Island Arc	19	18	0	0	1	21 (?)	6.5 - 8.3	7.2	3.5	6	1979	H
IC	Island of Cyprus	7	7	0	0	0	17(?)	6.5 - 7.3	6.9	3.5	5 (?)	1953	L
NE	Coast of Near East	23	22	0	0	1	106	6.2 - 7.8	7.0	3.2	5	1882	M
WG	Coast of western Greece	44	34	0	5	5	11	6.3 - 7.5	6.8	3.0	6	1990	-
				The Ionian Sea			14		6.8		6	1953	H
				The Gulf of Corinth			20		6.8		5	1996	L
AL	Coast of Albania	7	6	0	0	1	31	6.4 - 6.6	6.5	3.2	4	1920	H
DL	Coast of Montenegro and Croatia	12	11	0	0	1	20	7.0 - 7.0	7.0	3.3	5	1979	L
				AL+DL			12		6.5				
GV	Gulf of Venice	5	5	0	0	0	180 (??)			3.0	6	1511	-
EI	Eastern (Adriatic and Ionian) coast of Italy	9	9	0	0	0	52			3.2	5	1889	H
				GV+EI			85						
CA	Calabrian Island Arc (Calabria and Sicily)	36	29	5	1	1	12	6.0 - 7.0	6.5	3.8	6	1954	H
WI	Western coast of Italy	29	16	0	0	13	46			3.5	5	1895	H
LS	Ligurian Sea	36	17	0	0	19	17			3.8	4	1914	H
SP	Coast of Spain	2	2	0	0	0	100			3.0	3 - 4	1860	H
AF	Coast of northern Africa	8	5	0	0	3	36		6.7	4.2	6	1980	H
	Total	303	236	6	8	53							
			77.9%	2.0%	2.6%	17.5%							

Source: Soloviev et al., "Tsunamis in the Mediterranean Sea 2000 B.C. – 2000 A.D.", Kluwer Academic Publishers

Overview of main tsunamigenic coasts in the Mediterranean Sea

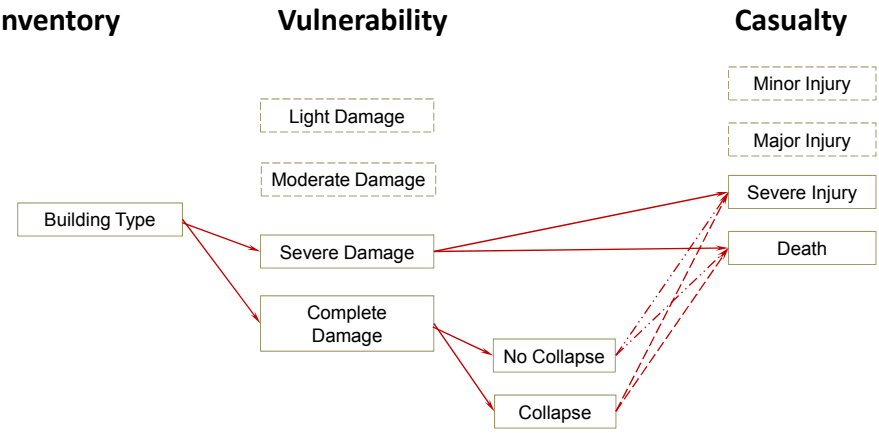


Source: Gerassimos A. Papadopoulos and Anna Fokaefs, ISET Journal of EQ Technology, Dec-2005

Section 3: Death & Disability Catastrophe Models

- Earthquake related loss of life can be modelled, but…
- … the quality of the output depends on the quality of the data

Casualty of Life Vulnerability Function



Casualty of Life Event Tree Model

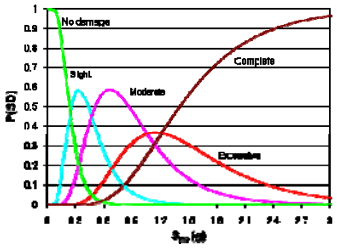
Casualty of Life Vulnerability Function

The casualty of life can be deduced from structural fragility curves times casualty rates for related structural damage.

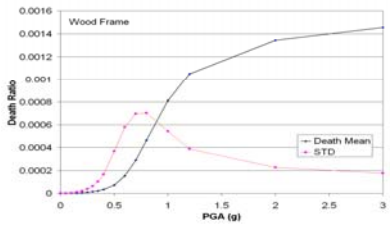
$$R_{casualty,i} = \sum_{SD=3}^{4} P_i[SD]R_i[SD]$$

where

P_i[SD] = the probability of structural damage
States: 3 – severe damage,
4 – complete damage.
R_i[SD] = casualty rates for related structural damage.

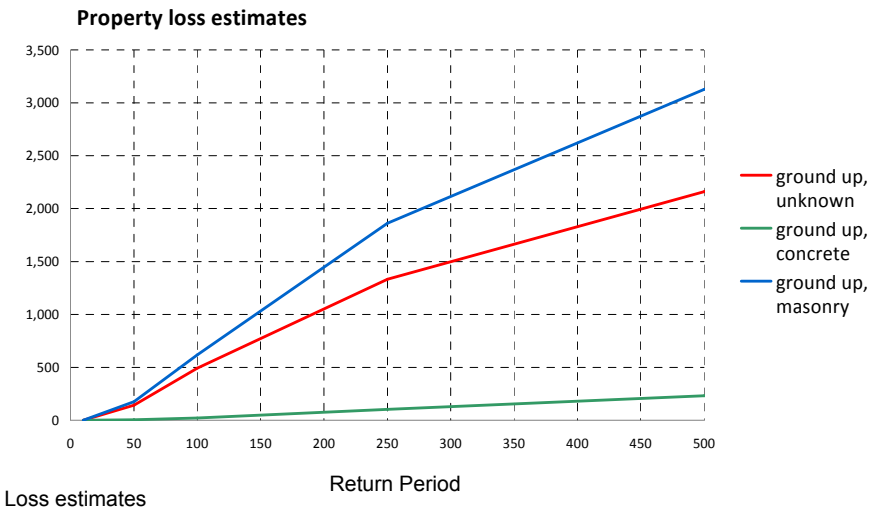


Structural fragility curves

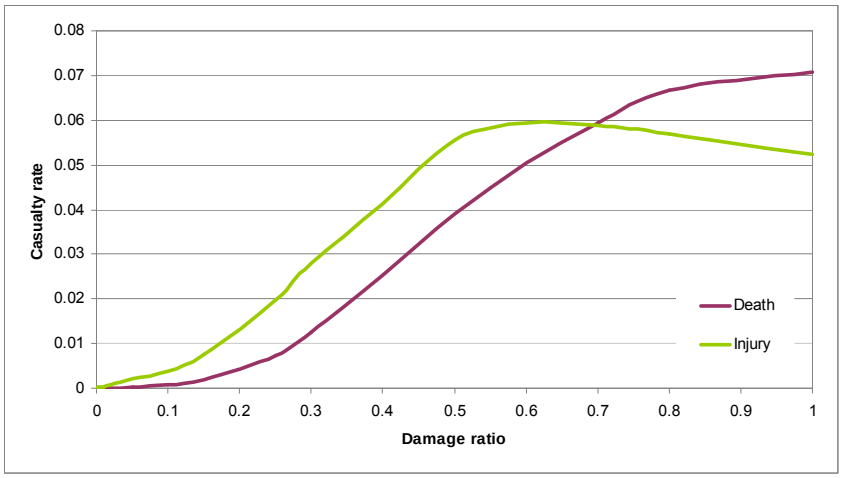


Typical casualty of life vulnerability function

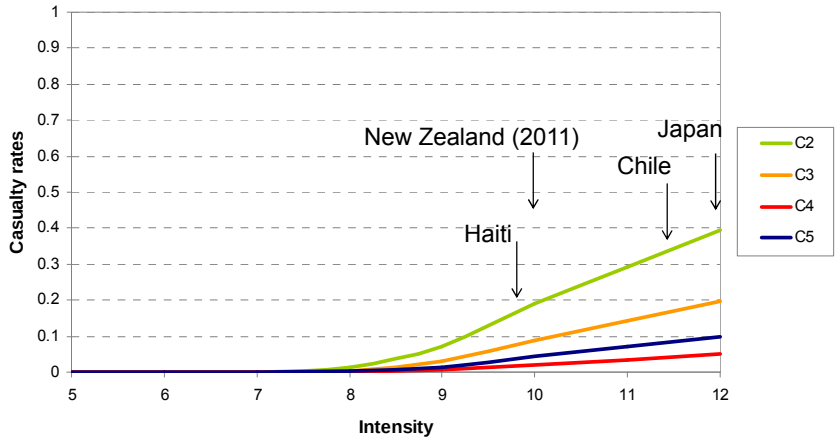
Better data quality will ensure much more certainty on results



Casualty Estimation Model

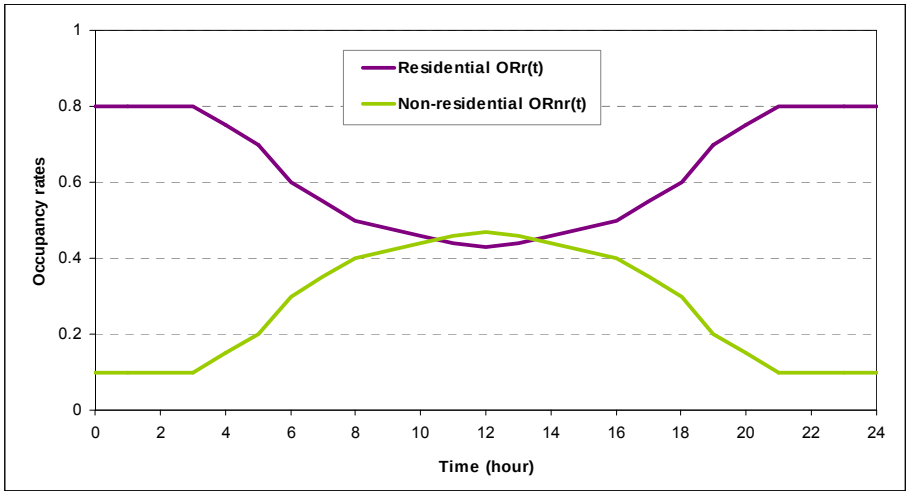


Intensity, construction type and time of the EQ are very important



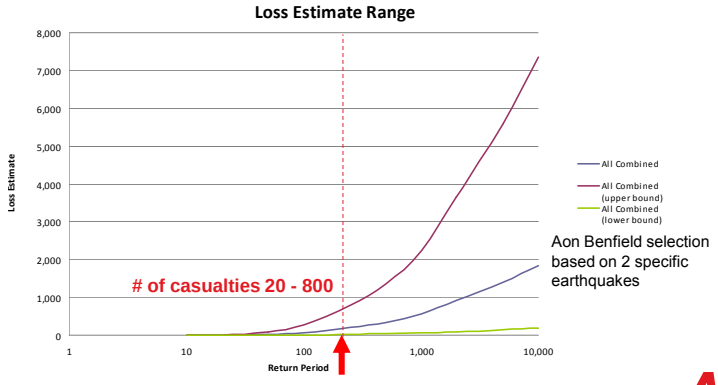
Earthquake Human Loss curves for four casualty states
(C2-slightly injured; C3-moderately injured, C4-heavily injured, C5-dying or dead)

Timing and portfolio do play a role as well



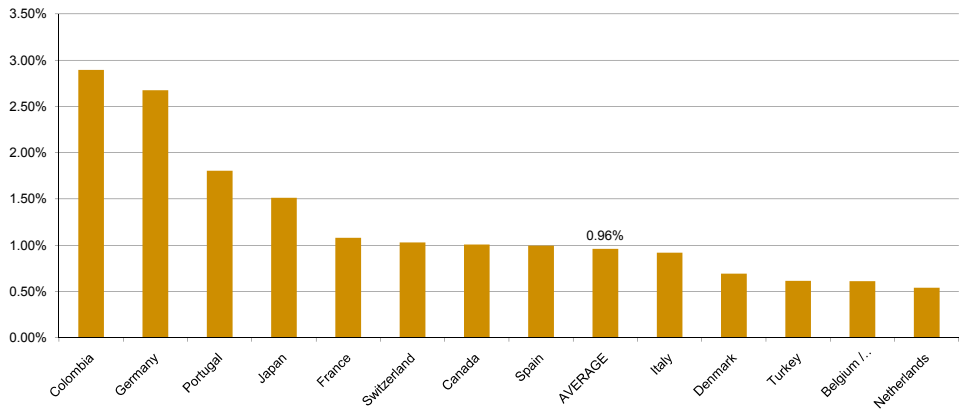
Case study: Calibration of estimated losses

- Aon Benfield selected two specific earthquakes for whom sufficient data was available to calibrate the death and injury losses:
  - Izmit EQ in Turkey, occurred on Aug 17, 1999, 3 AM, magnitude 7.6, number of death: about 17,000 and number of injuries about 43,000. It lasted about 37 seconds.
  - Athens EQ, 1999, moment magnitude, lasted about 15 second. It struck between Achames and mount Parnitha National park at 2:56 AM. Number of death was about 143 and number of injuries about 1,500.



Aon Benfield selection based on 2 specific earthquakes

The average RoL for death & disability cat cover is below 1%



Section 4: Impact On Demand to Manage Catastrophe Risk

- Innovative geographical tool to manage catastrophe risk exposures
- Data quality is critical

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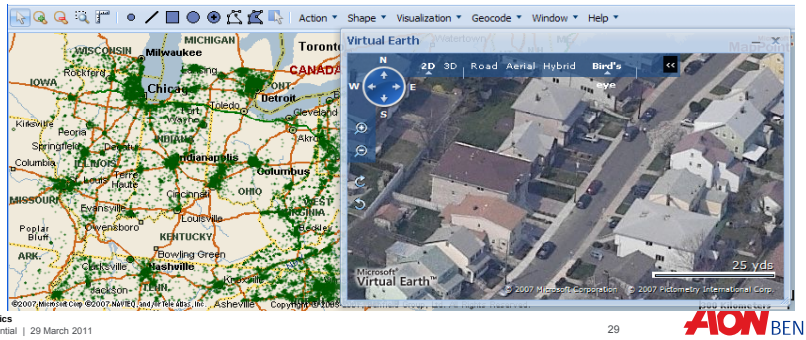
Highlights

- No Limit to Number of Locations
  - 40 million + records
- Optimized for Speed
  - e.g. display 500,000 locations in 5 seconds
- New User Interface
  - Desktop look and feel
  - Large mapping area
- Personalized Settings
- Satellite and Aerial Imagery
- Overlay Multiple Datasets
- Multiple Map Types
  - Heat maps
  - Thematic points
- Global Solutions
  - Street-level detail maps ready for 35 countries
  - Available in 67 countries



Used for Many Lines of Business

Personal Property

Commercial Property

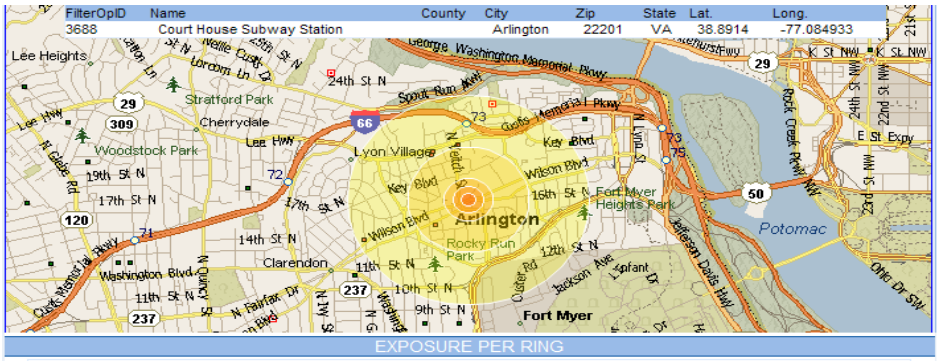
Personal & Commercial Auto

Workers' Compensation

Offshore Platforms

Any Address with Latitude/Longitude

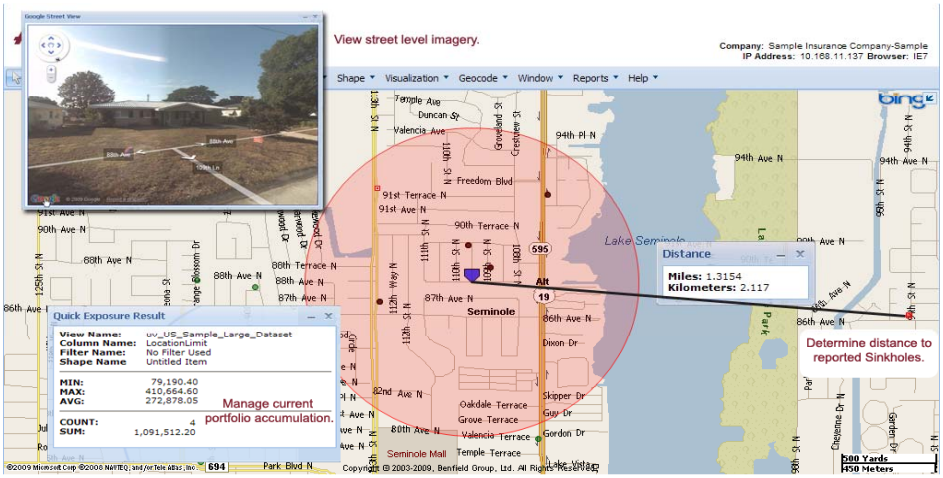
Single Point Terror Ring Analysis



EXPOSURE PER RING

RING	COUNT	EXPOSURE	DAMAGE FACTOR	LOSS
180 FEET	0	$ 0.00	100%	$ 0.00
380 FEET	0	$ 0.00	75%	$ 0.00
600 FEET	0	$ 0.00	50%	$ 0.00
1500 FEET	1	$ 80,682.00	10%	$ 8,068.20
3000 FEET	4	$ 1,455,123.60	1%	$ 14,551.24
	5	$ 1,535,805.60		$ 22,619.44

Underwriting Capabilities



ExposureCube

- Drag and Drop Functionality
- Drill down to location detail
- Export to Excel
- Unlimited Sorting, Grouping, and Filtering Capabilities
- Charting and Graphing Capabilities
- Conditional Formatting

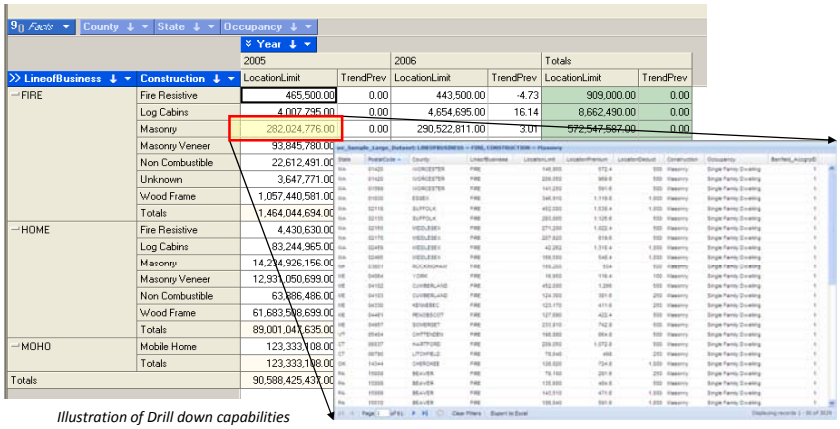
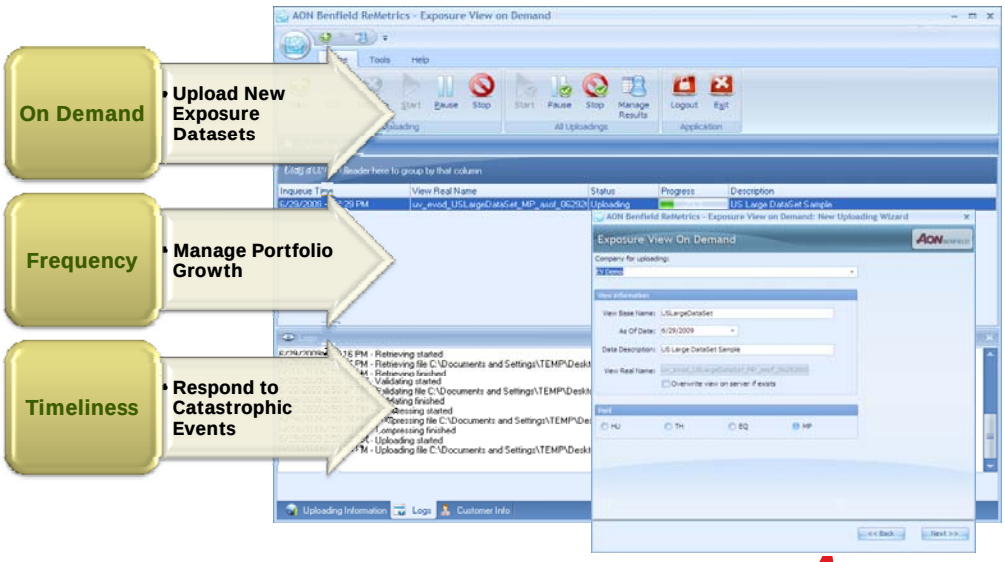


Illustration of Drill down capabilities

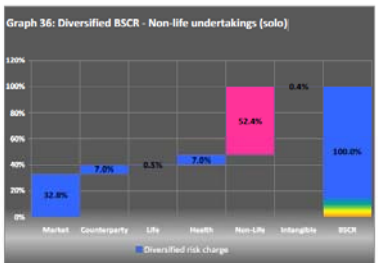
Load Data On Demand

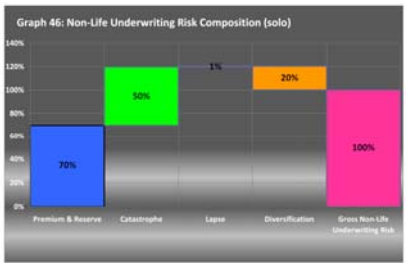


Section 5: Partial Internal Models for Catastrophe Risk

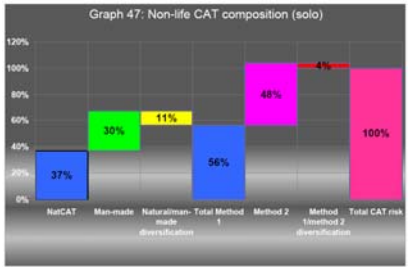
- Who is planning an internal model for catastrophe risk?
- The Standard Formula ignores data quality
- Is an Internal Model worth it?
- Do not underestimate the complexity !
- Internal models could be the answer, but will they be?

QIS 5 results show the importance of EQ risk (net of reinsurance)





- Overall reinsurance is a key aid to reduce the exposure to NatCat risks
- Overall (net) EQ exposure within a local Cypriot non-life insurer would be about 25% of the total capital requirement
- **"The CTF recommends a more accurate and appropriate estimation of the undertaking's catastrophe risk through the use of a partial internal model"**



NatCat: Earthquake

Calculate the gross 1/200 OEP per country

Provided by company

$$CAT^{Country}_{Eartquake} = Q^{Country}_{Earthquake} \sqrt{\sum AGG \times (F_{Zone} \times TIV_{Zone}) \times (F_{Zone} \times TIV_{Zone})}$$

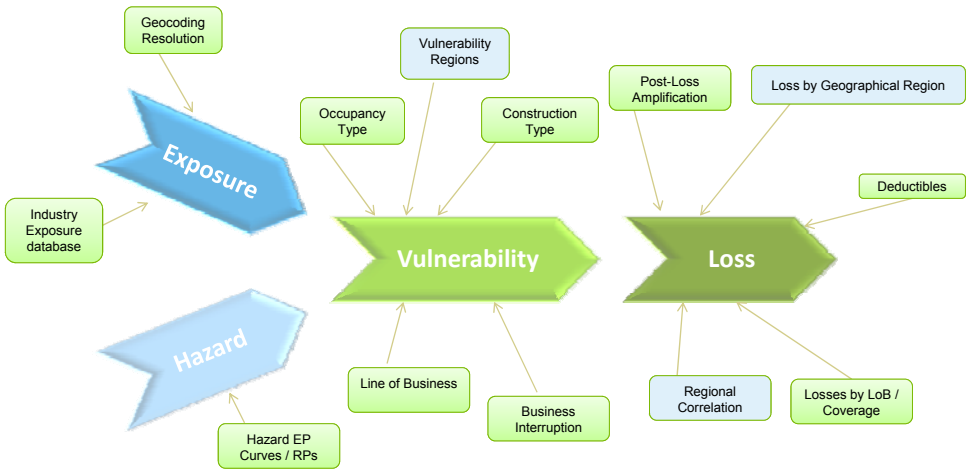
- TIV_{Zone}: Total Insured Value per Cresta
- F_{Zone}: Vulnerability factor (quake)
- AGG: "Aggregation" Matrix (quake)
- $Q^{Country}_{Earthquake}$: 1 in 200 OEP factor

Parameters-non-life-catastrophe-risk_en.xls
EQ_CRESTA_CY

	A	B	C	D	E	F	G	H	I	J
1										
2			Market Factor							
4			2.35%							
6		Cresta Zone	Cresta Relativity		Aggregation Matrix					
7						1	2	3	4	5
8		Nicosia	0,470		1	1,00	0,50	0,50	0,50	0,50
9		Limassol	1,827		2	0,50	1,00	0,25	0,75	0,25
10		Larnaca -	1,228		3	0,50	0,25	1,00	0,00	0,75
11		Paphos	1,871		4	0,50	0,75	0,00	1,00	0,00
12		Famagust	0,303		5	0,50	0,25	0,75	0,00	1,00

Evaluating catastrophe models – components

- Several steps along the catastrophe modelling chain where we can evaluate and compare models



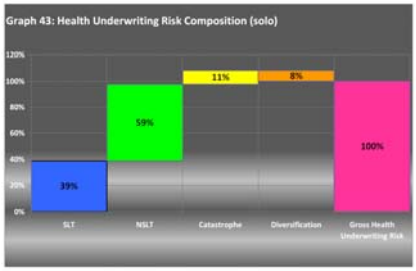
QIS 5: Life and Health Cat Risk 11% of U/W risk pre-diversification

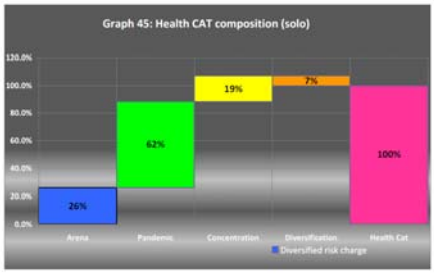
LIFE CAT RISK 1.5 per mille on capital at risk

HEALTH CAT RISK

- Arena risk (50% of stadium) +
- Concentration risk (100% + 300m around) +
- Pandemic risk (0.075 per mille)

Accidental Death	10%
Permanent total disability	1.5%
Long term disability	5%
Short term disability	13.5%
Medical / Injuries	30%



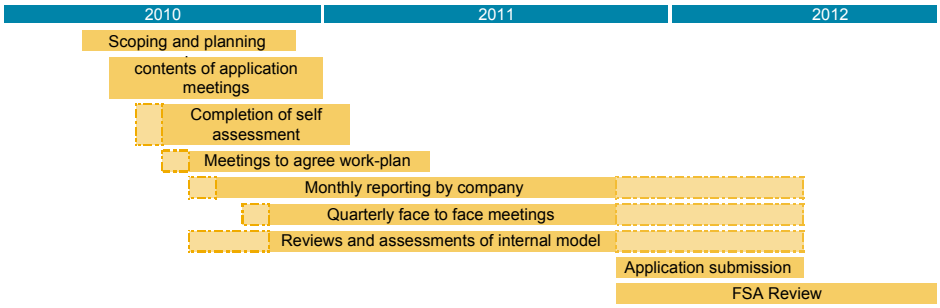


Internal Models – too complex or worth the effort ?

- For a model to be approved the following need to be satisfied:
  - Use test: have to show that the model is used as a decision tool in daily risk management work
  - Statistical quality standards
  - Calibration standards
  - Profit and Loss attribution
  - Validation standards
  - Documentation standards
  - Internal Model governance
  - Integration of external models needs to be understood
- In general: what regulators want to see is a controlled process around the internal model, acknowledged and used by management
- **Most popular use test example: reinsurance !**

Do regulators have the capabilities or will they rely on outside consultants (like they are doing in Switzerland for the SST)

An example of a pre-application timetable (FSA)



- Experience shows that it takes at least 2 years from kickoff to approval (expect over 50 on-site visits from regulator)
- Hundreds of documents
- Thousands of pages
- About 200 meetings
- About 100 employees involved (60% quantitative people)
- About 15 departments involved

Catastrophe Partial Internal Models

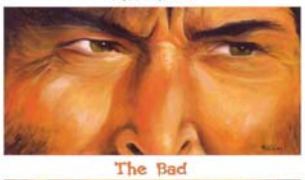
Area	Considerations
Model Approval Process	▪ Internal model approval process is **currently very onerous** required detailed documentation and validation of the science behind the catastrophe model ▪ If the client cannot answer questions about the internal model (including the underlying external models), the model **will not be approved** ▪ Potential issue for most commercial models, which are largely **black boxes** ▪ One regulator indicated preference for Impact Forecasting due to **transparency**

Model Change	▪ Clients **fix the "model boundaries" at the outset**
	  ▪ If model changes fall within the boundaries, no need for renewed model approval
	▪ One regulator indicated that they prefer a **multi-model approach**
	  ▪ Advantage: a change in one of the models would only partially impact the results
	  ▪ No need for equal weighting of different models: **is this ensuring best practice?**

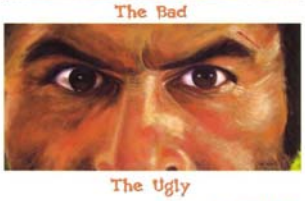
Simplified Approval Process	▪ Some regulators indicated a **pragmatic approach** to facilitate the use of external commercial cat models and have the clients benefit from their data quality ▪ Possible solution: **simplified internal model approval process** for cat (proposal submitted in February 2011 to EIOPA by Aon Benfield) ▪ A simplified Internal Model approval process would be beneficial to insurers and to regulators and **lower significantly the barrier for internal models** as well as **reduce the workload (and cost) for regulators** ▪ Focus for a simplified approval process should be on **input data requirements** and the **process to correctly apply the catastrophe models**

Catastrophe Models: The good, the bad and the ugly

- Better risk management and transparency
- Push for higher quality and more granular data
- Accepted method for measuring catastrophe risk



- Model miss is still significant
- Not accepted for Solvency II Standard Formula
- Limited knowledge outside of reinsurance market



- Black box, lack of transparency?
- Will regulators understand the models?
- Correct interpretation of the results is key

Time for questions?

Thank you for your attention